3 Further investigations

3.1 Introduction

The outcomes of additional investigations undertaken or completed since the release of the Environmental Report are described below.

3.2 Additional entry/exit ramps

3.2.1 Background

The proposed route of the Northern Expressway as described in the Environmental Report has interchanges or intersections at:

- Gawler Bypass interchange where movements are allowed to/from Northern Expressway from/to Gawler Bypass north
- Curtis Road interchange with ramps/movements to and from the south only
- Heaslip and Womma roads interchange where all movements are allowed
- Port Wakefield Road, T-junction traffic signals where all turns are allowed except right turns from Northern Expressway to Port Wakefield Road north.

The *Northern Expressway Traffic and Transportation Technical Paper* also discussed the need and possible provision of additional interchanges/ramps at:

- Two Wells Road, ramps/movements to and from the south only
- Angle Vale Road, allowing partial movements or full movements
- Curtis Road interchange, additional ramps/movements to and from the north.

Questions raised together with submissions received during the community engagement process, following the project's announcement in November 2006 and the release of the Environmental Report in March 2007, clearly indicated that the community and stakeholders (including the Corporation of the Town of Gawler, the Light Regional Council and the City of Playford) sought additional connections to the Northern Expressway from the arterial and local road network to be provided early in the project. This was seen as being necessary to provide improved accessibility to local businesses and communities, particularly for trips to and from the north, greater opportunities for economic development and greater relief to existing roads particularly in Gawler and Munno Para.

During the course of the stakeholder presentations and Environmental Report Open Days, DTEI responded to the need for additional interchanges and ramps by advising that they would be designed and their implementation staging and timing would be determined based on need, community accessibility, traffic demand and cost. However, the land for these additional interchange facilities would be acquired at the same time as the rest of the land for the Northern Expressway.

Following consultation on the proposed route, a funding submission is currently being considered by DoTARS and the Australian Government to provide the following interchanges and ramps:

- Two Wells Road: ramps/movements to and from the south only

- Angle Vale Road: ramps/movements to and from the south and, if demand shows a need and funding is available, ramps/movements to and from the north in the future
- Curtis Road: ramps/movements to and from the north (in addition to the initial ramps/movements to and from the south).

3.2.2 Traffic modelling

Further traffic modelling at 2031 has been undertaken using the DTEI Metropolitan Adelaide Strategic Transport Evaluation Model (MASTEM) (refer to the *Northern Expressway Traffic and Transport Technical Paper*, 28 February 2007) to estimate the potential traffic demand that would be attracted to the Northern Expressway by these additional interchanges and ramps. These more recent forecasts take into account proposed and possible developments in the study area, including those at Evanston Gardens, Munno Para North, RAAF Base Edinburgh and Edinburgh Parks.

If all the additional interchanges and ramps as described above were provided on the Northern Expressway, it has been estimated that the following significant traffic demand would be attracted to the new ramps in 2031:

- Two Wells Road interchange ramps: 4700 vehicles per day (vpd) for movements to and from the south
- Angle Vale Road interchange ramps: 8100 vpd for all movements to and from the north and south
- Curtis Road interchange ramps: 7900 vpd for movements to and from the north.

The provision of these ramps would also change to some extent the distribution of traffic on the Northern Expressway and the adjoining network compared to the project case described in the Environmental Report as traffic finds new optimum travel routes.

A comparison between the 2031 daily traffic forecasts as described in the Environmental Report without these additional interchanges and ramps, and the 2031 forecasts with these additional ramps on selected roads is shown in Table 3.1.

Table 3.1
Comparison of estimated 2031 daily traffic forecasts*

Road link	Without additional interchanges and ramps	With additional interchanges and ramps**
Redbanks Road, south of Gawler Bypass	17,000	13,900
Two Wells Road, west of Gawler Bypass	3,700	7,500
Angle Vale Road, east of Angle Vale	3,300	6,300
Curtis Road, east of Northern Expressway	15,500	19,500
Heaslip Road, south of Womma Road	6,500	6,500
Womma Road, east of Heaslip Road	12,600	8,000
Northern Expressway, south of Gawler Bypass	28,000	28,000
Northern Expressway, south of Curtis Road	33,000	37,800
Northern Expressway, south of Womma Road	39,000	42,300
Main North Road, south of Gawler Bypass	25,400	24,000
Main North Road, at Munno Para, north of Womma Road	32,000	20,500

* *Based on DTEI's MASTEM model, March 2007. MASTEM is updated and refined from time to time to reflect the latest status of demographic and employment data, and planned road improvements and therefore may vary in the future.*

** *Includes full interchange on Angle Vale Road.*

Effects

The changes in traffic forecasts due to the provision of the additional ramps, compared to the project described in the Environmental Report, would result in:

- decreased traffic on Redbanks Road, but increased traffic on Two Wells Road (and Ryde Street)
- reduced traffic on Main North Road in Evanston, south Gawler, increased traffic on the Northern Expressway and reduced traffic on Main North Road south of Gawler
- increased traffic on Angle Vale Road and Curtis Road but decreased traffic on Womma Road. This would increase pressure for improvements to Curtis Road, east of the Northern Expressway, which would be required due to the significant increase in residential development planned in the areas in and around Munno Para. The City of Playford is currently undertaking this work in a staged process.

In general, roundabouts are preferred for the ramp connections to the local roads as they will provide a more efficient traffic management solution and will slow vehicles.

The greater use of the Northern Expressway and reduced use of the congested Main North Road would reflect a greater benefit to the local communities, the horticultural industry and other businesses as a result of the improved accessibility particularly for trips to and from the north, reduced travel delays and improved road safety. It would be expected that the economic benefits (net present value and benefit cost ratio) derived by the Northern Expressway Project would be greater than the initial project case described in the Environmental Report and would particularly benefit the Town of Gawler, Light Regional Council and City of Playford council areas.

3.2.3 Conclusion

A funding submission is currently being considered by DoTARS and the Australian Government to provide the following additional interchanges and ramps as part of the initial implementation of the Northern Expressway, to provide a high level of accessibility to the Northern Expressway from the surrounding community and commercial areas, as well as improving overall travel benefits and safety:

- Two Wells Road, ramps/movements to and from the south only
- Angle Vale Road, ramps/movements to and from the south only
- Curtis Road interchange, additional ramps/movements to and from the north which, together with the previously proposed ramps for movements to and from the south, will provide full movements.

3.3 Secondary economic effects

The Northern Expressway is a major infrastructure project that will generate substantial employment and supporting activities over the course of its construction. While the economic effects from the construction phase will be substantial, its main impact will be felt once it is completed leading to significant ‘flow-on’ social and economic benefits. The potential for large-scale benefits derives from the fact that the project will directly link one of South Australia’s largest economic regions with the Port of Adelaide and other key industrial areas; with residential and industrial growth areas such as Greater Edinburgh Parks; with employment hubs; and with key intrastate and interstate destinations.

The secondary benefits assessed are not solely as a result of the investment into the Northern Expressway. A number of pre-existing drivers and opportunities will create the necessary pre-conditions for this investment to be fully realised in social and economic terms.

The direct benefits include:

- road user's benefits: travel time savings, accident cost and vehicle operating cost reductions
- off-road benefits: through improving links between industrial zones and growth areas.

The road will also become a catalyst for delivery of potential secondary benefits and flow-on effects such as:

- improved access for expanding industries in the region and to the national transport network and rail, airport and port facilities. This includes easier access to employment hubs
- better services to businesses due to quicker, more frequent and more reliable deliveries lowering freight costs by between 15–25% based on vehicle hours saved
- the use of larger vehicles (B-doubles, etc.) due to the improved standard of access/roads connecting to the Northern Expressway. This will lower relevant freight costs by up to 30%
- provision of an efficient transport network to a substantial inland freight port opportunity. This will lead to improved delivery times and increased cost efficiency which will in turn provide industries with a competitive edge. The Northern Expressway and its interchange on Heaslip and Womma roads are well placed to facilitate efficient freight distribution to and from this future intermodal facility
- using benefit multipliers for the non-residential construction sector, suggests there could be direct employment of around 2650 jobs over the life of the project. There could be incomes created which are estimated in the order of $240 million (contribution to Gross State Product)
- identification from the benefit cost analysis of travel time benefits of around $1000 million (present value) or approximately $60 million per year. If it could be assumed (conservatively) that 50% of this was a benefit to business in terms of freight savings, etc., and that the export elasticity of demand was (also conservatively) a multiplier of approximately 5 (from input–output analysis), then the effect on annual exports (interstate and overseas) would be a stimulus of around $150 million per year, which would create approximately 1600 new jobs per year. It is expected that approximately half of these may accrue to industry in the Mid North through to the Riverland, related to improved access to the Port of Adelaide, Adelaide Airport and the industry base of northern Adelaide. The other half would be associated with industry in Adelaide getting better and easier access through freight to New South Wales and other eastern state markets. This estimated benefit is expected to be conservative as it does not allow for benefits from the development of the potential inland freight port opportunity planned in association with the project and further savings could double the benefit
- enhancement of nearby industrial and residential property values by up to 15% based on similar overseas examples and the distance from the Northern Expressway. An overseas study (Palmquist 1980), showed that: '*when highways significantly increased the accessibility of the residences, property values increased by 12 to 15 percent... commercial industrial areas by 16.7 percent*'
- possible creation of significant industrial land development opportunities building on the Greater Edinburgh Parks project and making better use of existing infrastructure. The short supply of industrial land in South Australia has been recently addressed through an industrial land development program. The proposed Expressway could create as much as 10–20 years of additional supply of industrial land

servicing this State's economic growth well into the future, placing this land adjacent to existing industry clusters, sunk infrastructure investment and a state-of-the-art intermodal facility

- possible creation of further significant residential land development opportunities building on the City of Playford's development program and population targets
- preservation of the long-term potential of the Virginia Triangle horticultural region while improving its accessibility to local and interstate warehousing, transport and distribution facilities
- improved access to job markets for people who must commute to and from the region
- creation of employment opportunities for the region's unemployed including 'up-skilling' programs. In 2001, only 27% of the City of Playford population earned $500 or more a week. The unemployment rate for the City of Playford's area was about twice that of the general metropolitan area with a youth unemployment rate of 27.5%. Employment and industry skills formation programs targeted at youth unemployment could be directly addressed by the construction and urban development program of the Northern Expressway over several years. Employment will bring with it increased average incomes for households in the region and in turn increased economic prosperity. This will inevitably lead to greater investment in the region and the attraction of national and interstate migrants (skilled and unskilled) contributing to the State's population and employment targets
- a boosted retail/commercial sector within the region through demand generated by growth.

3.4 Alternative routes considered

3.4.1 Route selection process

Questions and responses received during the community engagement program, following the project's announcement in November 2006 and the release of the Environmental Report in March 2007, clearly indicated that the community and stakeholders wanted more detailed information on the route selection process and outcomes. In response to these questions, during the course of the stakeholder presentations and Environmental Report Open Days, further detailed information was given on the process and findings of the route selection process. This section outlines that additional information.

Section 5 of the Environmental Report sets out the 'Alternative routes considered and the selected route', describes the 'Overview of the route selection process' (Section 5.1.3) and the evaluation of the four alternative routes (White, Green, Blue and Purple) undertaken against six non-monetised route selection criteria. In addition, monetised criteria of net present value and benefit cost ratio were also determined and assessed; refer to Environmental Report Section 5.1.5, 'Initial route assessment and selection using monetised criteria'.

Initial assessment criteria

A workshop was held to facilitate route selection by means of non-monetised route selection critera.

Based on the adopted approach, the following non-monetised criteria were selected to best evaluate the various route options in terms of land use, social, environmental and development factors. The criteria selected were community accessibility, horticultural effect, business development, visual impact, noise and property (Table 3.2).

Table 3.2
Route selection criteria

Selection criterion – Community accessibility	
Definition	Maintaining access to local shops, schools, places of employment and community services
Indicator	The number of discrete residential communities whose accessibility to major communal, public and/or commercial activities is significantly impeded
Selection criterion – Horticultural effect	
Definition	The viability of existing horticultural/agricultural industry is maintained or improved
Indicator	Annual $ value of production plus the dollar value of agricultural capital (e.g. irrigation systems, greenhouses, fences, sheds) located within the 100 m corridor and potentially lost to the State
Selection criterion – Business development	
Definition	Improve overall access for business and economic development nodes and do not constrain future development opportunities
Indicator	Supports local economic development initiatives and transport-related activities, including the development of an intermodal, Edinburgh Parks, RAAF Base Edinburgh and agricultural processing
Selection criterion – Visual impact	
Definition	Integrate road into the surrounding landscape by minimising dramatic alterations to the natural landform
Indicator	Impacts on the view of individuals and communities based on proximity impact, view corridor impact, place impact Identification of opportunities at gateways, places and along the corridor
Selection criterion – Noise	
Definition	Minimise effect of noise on the community
Indicator	Number of houses that cannot achieve the noise criteria – between the road reserve and the 63 dB(A) contour. Number of houses that can achieve the noise criteria with acoustic treatments – between the 63 dB(A) contour and 50 dB(A) contour
Selection criterion – Property	
Definition	Minimise effect of acquisition on property owners (titles) and houses
Indicator	Total number of properties (titles), number of whole properties affected, number of properties partially affected, and number of houses under threat

Paired analysis of non-monetised selection criteria assessment

The selection criteria were paired and workshop attendees (the team) asked to make a judgement about the relative importance of one selection criterion against the other. The final decision (Table 3.3) was based on the majority view of attendees about the relativity of the criteria.

The paired analysis resulted in the following weighted scores being established for each selection criterion:

- community accessibility 4 points
- horticultural effect 5 points
- business development 5 points
- visual impact 1 point
- noise 10 points
- property acquisition 2 points.

Table 3.3
Paired analysis

Selection criteria	B		C		D		E		F	
A Community accessibility	B	1	A	1	A	2	E	3	A	1
B Horticultural effects			C	1	B	2	E	1	B	2
C Business development					C	2	E	2	C	2
D Visual impact							E	3	F	2
E Noise									E	2
F Property										

Importance: 1= Minor preference; 2 = Medium preference; 3 = Major preference

Noise was weighted highly and clearly considered by the group as a major selection criterion whereas at the other end of the scale, visual impact was not. The actual score for visual impact was nil, but this was allocated a score of one so that this assessment criterion was not ignored in the final evaluation.

The paired analysis of the six selection criteria resulted in a weighted assessment of each selection criterion being established followed by re-weighting so that the highest score was 10. The re-weighting of the scores so that the highest score was 10 only affected noise by changing its score from 11 to 10.

After a briefing on the various routes, and the selection criteria assessment of the various routes, the attendees were divided into groups to assess the four established routes in detail against one of the selection criteria.

Following the group assessment, each of the groups was asked to table their results and summarise their thought process and the reasoning used to arrive at their decision. Each result was then included in a scoring matrix that multiplied the weighted assessment score with the selection assessment score that was allocated as follows:

- large negative 1 point
- moderate negative 2 points
- slight negative 3 points
- neutral 4 points
- slight positive 5 points
- moderate positive 6 points
- large positive 7 points.

This method of scoring or rating non-monetised effects is consistent with the project appraisal framework developed by DTEI to enable triple bottom line (TBL) reporting.

The route alternatives were then ranked based on these scores (refer Table 3.4).

The scoring matrix scores the White route with the highest final score and therefore it is the preferred route based on the route selection criteria. The second highest score was for the Purple route.

Table 3.4
Weighted evaluation

Routes	Community accessibility	Horticulture	Business development	Visual impact	Noise	Property	Final score	Ranking
Selection assessment score	4	5	5	0	11	2		
Weighted score	4	5	5	1	10	2		
Green	3	2	5	3	2	1	72	3
	12	10	25	3	20	2		
Blue	4	3	4	4	1	2	69	4
	16	15	20	4	10	4		
Purple	3	1	7	2	2	1	76	2
	12	5	35	2	20	2		
White	3	2	5	6	3	1	85	1
	12	10	25	6	30	2		

The route alternatives were then ranked based on these scores (Table 3.5).

Table 3.5
Unweighted evaluation

Routes	Community accessibility	Horticulture	Business development	Visual impact	Noise	Property	Final score	Ranking
Selection assessment score	4	5	5	0	11	2		
Weighted score	1	1	1	1	1	1		
Green	3	2	5	3	1.5	1	15.5	3
Blue	4	3	4	4	1	2	18	2
Purple	3	1	7	2	1.5	1	15.5	3
White	3	2	5	6	3	1	20	1

The scoring matrix again scored the White route with the highest final score of the four original routes. The re-weighting resulted in the previously fourth ranked Blue route being ranked second. The economic benefit cost analysis showed that the White route had the highest net present value and equal highest benefit cost ratio, and was therefore considered overall to be the best route. This White route was subsequently developed into the proposed route; refer to Yellow route in Figure 5.1 of the Environmental Report Section 5.1.6. The Blue route had negative net present value and a benefit cost ratio less than 1, which would mean it would have been eliminated on economic grounds.

The City of Playford subsequently commissioned an independent review of the Environmental Report with this review endorsing the process carried out by DTEI.

3.4.2 Red route

The Red route was eliminated early in the route investigations (refer to Environmental Report Section 5.1.3) because it was found to have a number of significant disadvantages compared to the other Expressway routes investigated (including the proposed route).

Direct impacts

Direct effects of the proposed Yellow and Red routes have been estimated by PIRSA (2007) using a technique that measures crop areas on affected properties along each route and calculates the total value of production on the affected land (Table 3.6). On this basis, the Red route has a slightly higher estimated impact than the proposed alignment although that estimate is conservative as it excludes the area of road interchanges and bridges.

Table 3.6
Direct and long-term impacts of alternative routes on horticultural production

Routes	Direct impacts	Long-term impacts*
Proposed Northern Expressway alignment	• 1178 hectares • $9,103,544 estimated annual production value • 7% of total Northern Adelaide Plains farm gate value	• 3128 hectares • $23,544,326 estimated annual production value • 19% of total Northern Adelaide Plains farm gate value
Red route	• 1257 hectares • $9,253,754 estimated annual production value • 8% of total Northern Adelaide Plains farm gate value	• 4868 hectares • $34,912,724 estimated annual production value • 29% of total Northern Adelaide Plains farm gate value

** Direct impact area plus all zoned land south/east of route.*

Effect on resource base

Besides issues of actual horticultural activity and production, a more westerly alignment would also affect the resource base used for production. The Red route has a relatively greater long-term effect in terms of soil suitability, groundwater resources and infrastructure. Over the long term, the Red route would alienate:

- a significantly greater area of soils with good suitability for irrigated horticulture than would the proposed Northern Expressway route
- a significantly larger area of land with good groundwater resources – high flow rates, low salinity
- a significantly larger portion of the Virginia recycled water pipeline.

In summary, the proposed Northern Expressway alignment is preferable to the Red route. Its long-term consequences will have a lower adverse effect on horticultural activity and production, alienate less good horticultural land and less high quality groundwater, and minimise losses on investment in recycled water pipeline infrastructure.

Economic analysis

The economic analysis of the Red route gave the following key indicators:

- total cost: $569 million (2006 values)
- net present value: –$104 million
- benefit cost ratio: 0.8.

This analysis shows that the net present value of the Red route is negative and the benefit cost ratio is less than one, therefore the Red route did not meet some of the fundamental project objectives and was eliminated from further investigations.

A separate assessment of secondary economic effects undertaken showed the following relative benefits of the proposed route against the alternative routes. This is shown in Table 3.7.

Table 3.7
Assessment of secondary economic benefits – relative assessment[1]

Routes[2]	Business/ industry benefits[3]	Community access employment induced[4]	Horticultural impact[5]	Long-term land development opportunity[6]	Property value increase[7]
Proposed route	High because close to industrial areas of Elizabeth West, Greater Edinburgh Parks	High because close to major traffic generators including employment	Initially low direct regional effects (7% of farm gate value) and effect (19%)	Very high where very close to Urban Boundary	Moderate where close to Urban Boundary correlated to accessibility levels
Intermediate routes – Green etc.	Medium to high, depending on route and interchanges	Medium to high, depending on route and interchanges	Medium to high, depending on route and interchanges	Very low because development in vicinity of Northern Expressway not likely in order to preserve horticultural use	Low because further distance from dense urban areas (except Blue route)
Red route/or routes west of Angle Vale	Medium because local intra-regional freight/commercial traffic less likely to use Expressway north of Edinburgh Parks	Low because furthest distance from traffic generators including employment	Initially low direct regional effects (8% of farm gate value) and relatively high long-term effect (29%)	Very low because development in vicinity of Northern Expressway not likely in order to preserve horticultural use	Low because furthest distance from dense urban areas

1. Whilst separate quantitative analysis has measured the impact of the proposed route (and to some extent the Red route) against the above criteria, the above can only be used as a relative qualitative assessment only.

2. Routes shown on Figure 5.1 of Environmental Report.

3. Direct effect of investment into the Northern Expressway (on the State economy) is consistent across all options; however, ongoing economic activity is dependent on the level of access to the facility.

4. Direct employment effect of investment into the Northern Expressway is consistent across all options. The employment induced is directly correlated to level of industrial/economic activity and the use of the facility by employment to the east of the Northern Expressway. Community access is based on intra-regional movement.

5. Horticultural effects expressed as a percentage of the 'Total Northern Adelaide Plains farm gate value'. The long-term effect is considered more critical on the effect of the continual viability of the region.

6. A direct measurement of the long-term land development opportunity east of the Northern Expressway if horticultural land uses change to industrial/residential. The potential land development benefits and employment effects are not expressed here. See also Note 5 for long-term horticultural impact in relation to land development east of the Northern Expressway.

7. Based on overseas experience in relation to highway projects and assuming that no long-term development is able to occur east of the Northern Expressway for the intermediate and Red route options.

3.5 Noise modelling

3.5.1 Introduction

This section outlines the updated noise assessment based on the refined route. For information on the existing environment, legislative requirements, assessment methodology, noise catchment areas and

noise treatment options, refer to the Noise and Vibration sections of the Environmental Report and the *Northern Expressway Noise and Vibration Technical Paper*.

3.5.2 Noise effects of the project

Revised modelling

The Northern Expressway refined route (explained in Section 2 of the Supplement Report) has been modelled for noise effects.

Tables 3.8 and 3.9 provide an overview of the noise effect by indicating the percentage of sensitive receptors/ receivers per catchment area, which fall within a specific noise level range. Figure 3.1 shows the locations of each catchment area.

Table 3.8
Predicted daytime noise levels (L_{eq},15h)

Catchment area (no. of receptors)	Model scenario	>70 dB(A) (%)	65–70 dB(A) (%)	60–65 dB(A) (%)	55–60 dB(A) (%)	< 55 dB(A) (%)
A (221)	Existing 2011	0	6	28	36	30
	NExy 2011	0	3	21	33	43
	NExy 2026	0	13	23	38	25
B (37)	Existing 2011	0	0	0	5	95
	NExy 2011	0	0	3	5	92
	NExy 2026	0	0	5	11	84
C (14)	Existing 2011	0	0	0	0	100
	NExy 2011	0	0	0	21	79
	NExy 2026	0	0	0	36	64
D (13)	Existing 2011	0	0	0	23	77
	NExy 2011	15	8	0	31	46
	NExy 2026	15	8	0	46	31
E (60)	Existing 2011	0	0	0	0	100
	NExy 2011	0	0	3	2	95
	NExy 2026	0	3	0	7	90
F (10)	Existing 2011	0	0	0	10	90
	NExy 2011	0	0	0	0	100
	NExy 2026	0	0	0	0	100
G (33)	Existing 2011	0	0	0	0	100
	NExy 2011	0	0	0	12	88
	NExy 2026	0	0	9	18	73
All (388)	Existing 2011	0	3	16	22	59
	NExy 2011	1	2	13	22	63
	NExy 2026	1	8	14	28	48

Notes:

- *Existing 2011 represents the predicted 2011 traffic noise effect with the existing road network, i.e. without Northern Expressway (NExy).*
- *NExy 2011 represents the predicted traffic noise effect of the NExy route at road opening in 2011.*
- *NExy 2026 represents the predicted traffic noise effect of the NExy route 15 years after opening (2026).*
- *Figures may not sum precisely due to rounding.*

Table 3.9

Predicted night-time noise levels (L_{eq},9h)

Catchment area (no. of receptors)	Model scenario	> 65 dB(A) (%)	60–65 dB(A) (%)	55–60 dB(A) (%)	50–55 dB(A) (%)	< 55 dB(A) (%)
A (221)	Existing 2011	0	8	29	41	21
	NExy 2011	0	3	27	35	35
	NExy 2026	1	18	25	38	18
B (37)	Existing 2011	0	0	0	8	92
	NExy 2011	0	0	5	5	89
	NExy 2026	0	0	5	11	84
C (14)	Existing 2011	0	0	0	0	100
	NExy 2011	0	0	0	21	79
	NExy 2026	0	0	0	43	57
D (13)	Existing 2011	0	0	23	15	62
	NExy 2011	15	8	0	46	31
	NExy 2026	15	8	8	54	15
E (60)	Existing 2011	0	0	0	0	100
	NExy 2011	0	2	2	2	95
	NExy 2026	0	3	0	13	83
F (10)	Existing 2011	0	0	0	20	80
	NExy 2011	0	0	0	0	100
	NExy 2026	0	0	0	10	90
G (33)	Existing 2011	0	0	0	0	100
	NExy 2011	0	0	0	9	91
	NExy 2026	0	0	9	21	70
All (388)	Existing 2011	0	5	18	25	53
	Nexy 2011	1	2	16	24	57
	Nexy 2026	1	11	16	30	42

Notes:

- *Existing 2011 represents the predicted 2011 traffic noise effect with the existing road network, i.e. without Northern Expressway (NExy).*
- *NExy 2011 represents the predicted traffic noise effect of the NExy route at road opening in 2011.*
- *NExy 2026 represents the predicted traffic noise effect of the NExy route 15 years after opening (2026).*
- *Figures may not sum precisely due to rounding.*

Noise logging site

Noise catchments boundary

Figure 3.1 Noise catchment areas and monitoring sites

Refer Figure 14.2 Environmental Report

3.5.3 Receptor noise effects above criteria

Tables 3.10 and 3.11 summarise the difference between the predicted 2026 noise levels and the noise criteria adopted for individual noise-sensitive receptors in each noise catchment area.

Table 3.10
Percentage of sensitive receptors predicted to be above the daytime noise criteria (L_{eq},15h) in 2026

Catchment area	>8 dB(A) (%)	5–8 dB(A) (%)	3–5 dB(A) (%)	1–2 dB(A) (%)	Below criteria (%)
A (221)	0	0	3	13	84
B (37)	3	3	3	8	84
C (14)	0	0	21	14	64
D (13)	23	0	23	0	54
E (60)	3	0	2	5	90
F (10)	0	0	0	0	100
G (33)	3	6	3	15	73
All (388)	2	1	4	11	83

Table 3.11
Percentage of sensitive receptors predicted to be above the night-time criteria (L_{eq},9h) in 2026

Catchment area	>8 dB(A) (%)	5-8 dB(A) (%)	3–5 dB(A) (%)	1–2 dB(A) (%)	Below criteria (%)
A (221)	0	1	2	15	81
B (37)	5	0	8	3	84
C (14)	0	0	21	21	57
D (13)	23	0	23	0	54
E (60)	3	0	2	12	83
F (10)	0	0	0	0	100
G (33)	3	6	9	12	70
All (388)	2	1	5	13	79

A number of noise-sensitive receptors are above the adopted noise criteria by varying amounts.

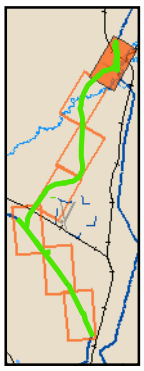
In the majority of catchments, the percentage of sensitive receptors exceeding daytime criteria has decreased and the percentage exceeding night-time criteria has increased. This is due to the increase in the predicted night-time traffic flow as compared with the previous modelling.

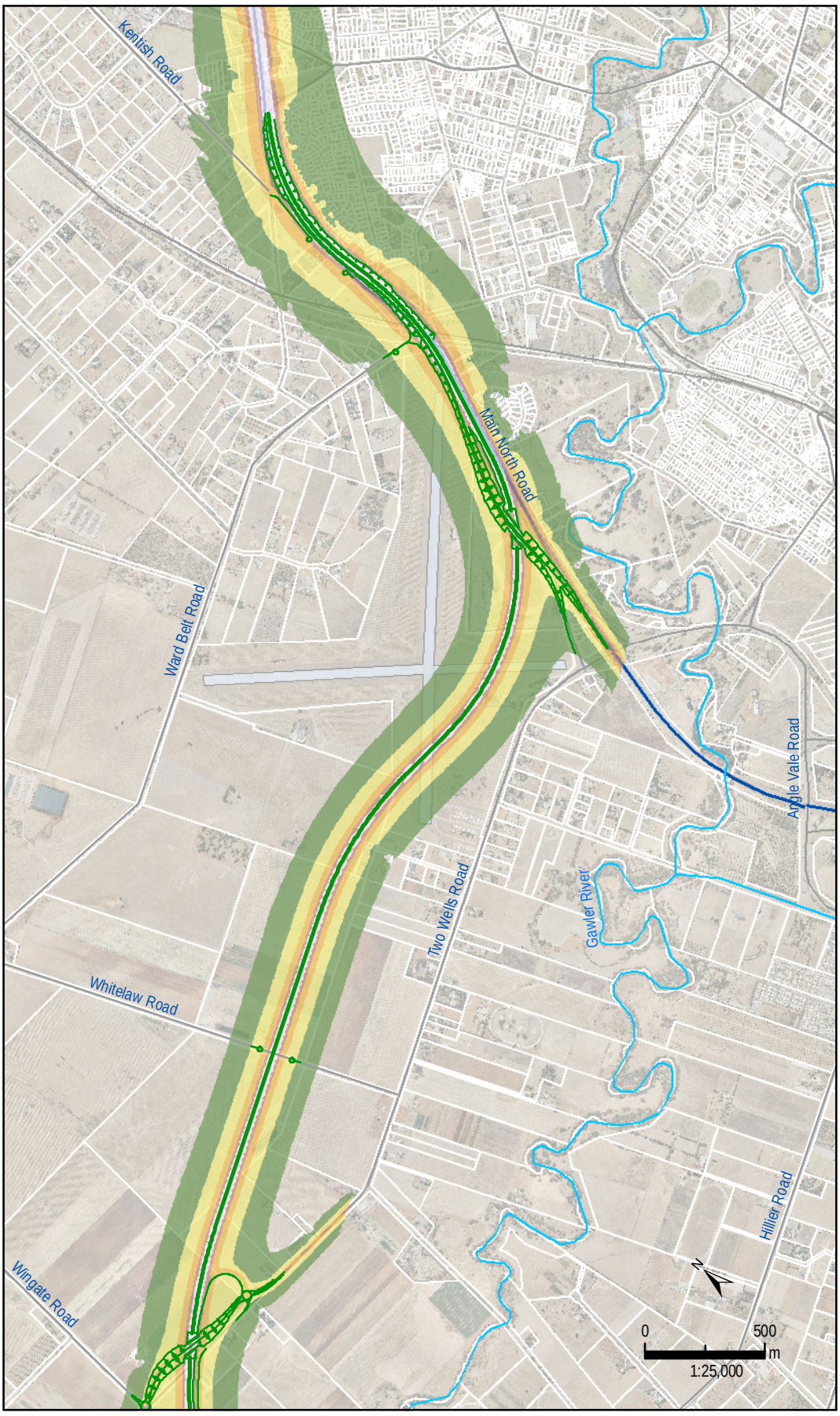
Unlike the noise levels predicted in the Environmental Report, compliance with the daytime criteria does not automatically achieve compliance with the night-time criteria.

3.5.4 Noise contours in 2026 without mitigation measures

Figures 3.2 to 3.5 indicate the predicted daytime 2026 noise contours in 5 dB(A) intervals.

Noise level contours provide a visual noise 'footprint' indicating predicted noise levels at different distances from the Northern Expressway. They should be used as an indicative guide only.

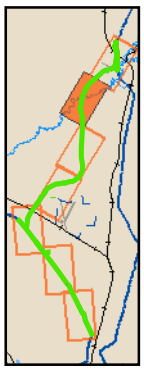




55 - 60 dB(A) band
60 - 65 dB(A) band
65 - 70 dB(A) band
70 - 75 dB(A) band
> 75 dB(A)

Figure 3.2 2026 daytime noise projections plan 1 of 4

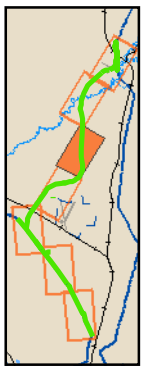
Refer Figure 14.3 Environmental Report



55 - 60 dB(A) band
60 - 65 dB(A) band
65 - 70 dB(A) band
70 - 75 dB(A) band
> 75 dB(A)

Figure 3.3 2026 daytime noise projections plan 2 of 4

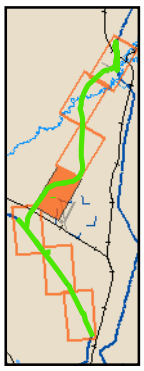
Refer Figure 14.4 Environmental Report



55 - 60 dB(A) band
60 - 65 dB(A) band
65 - 70 dB(A) band
70 - 75 dB(A) band
> 75 dB(A)

Figure 3.4 2026 daytime noise projections plan 3 of 4

Refer Figure 14.5 Environmental Report



55 - 60 dB(A) band
60 - 65 dB(A) band
65 - 70 dB(A) band
70 - 75 dB(A) band
> 75 dB(A)

Figure 3.5 2026 daytime noise projections plan 4 of 4

Refer Figure 14.6 Environmental Report

3.5.5 Conclusions

Noise modelling of the modified Northern Expressway route with updated traffic volumes has predicted an increase in night-time L_{eq},9h levels, and a decrease in daytime L_{eq},15h levels at the majority of noise-sensitive receptors located near the route, due to an increase in the predicted night-time traffic levels.

3.6 Aboriginal heritage

3.6.1 Field survey

An initial Aboriginal cultural heritage field survey was undertaken in November 2006. This survey concentrated on areas of high archaeological sensitivity and was undertaken in conjunction with Kaurna community representatives and a qualified archaeologist to determine the presence of artefacts or sites of Aboriginal cultural heritage significance. A summary of the initial survey can be found in Section 16 and Section 31 of the Environmental Report. In February 2007, a further field survey was carried out. The summary results were not produced in time for inclusion in the Environmental Report. Figure 3.6 shows the areas surveyed during the additional investigations. No Aboriginal cultural heritage sites or isolated artefacts were identified during the additional investigations.

An Aboriginal cultural heritage survey has now been completed for approximately four-fifths of the project area (including Port Wakefield Road). All areas having high potential for containing Aboriginal sites have been surveyed. The Northern Expressway Project will avoid all currently known and recorded Aboriginal sites. Aboriginal cultural heritage issues (including management of sites found during construction) will be managed in accordance with the environmental management measures outlined in Part D, Section 16 of the Environmental Report and will continue to be managed in consultation with the Kaurna community in a way that recognises the significance of the heritage issues and ensures the appropriate level of conservation.

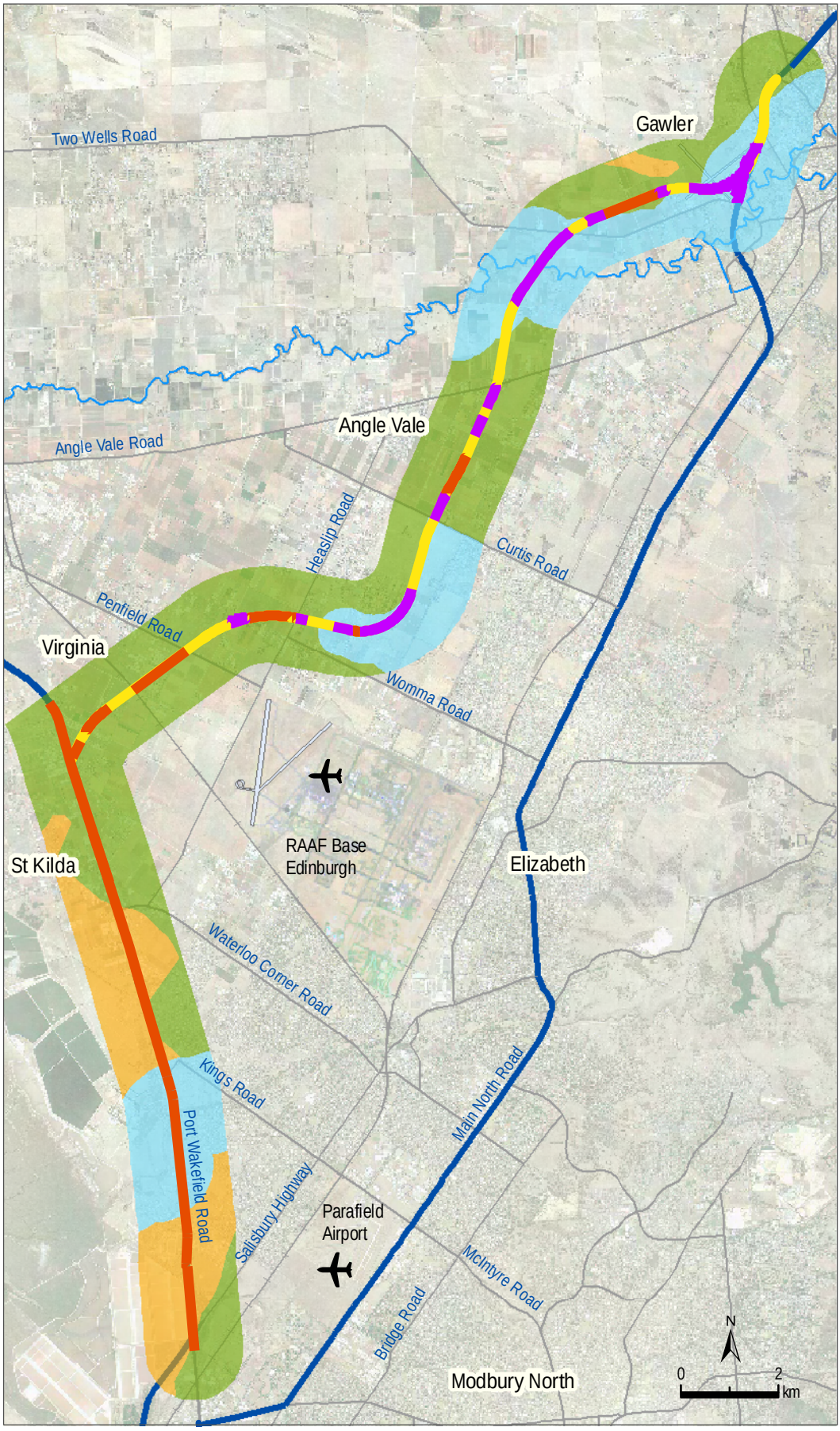
3.6.2 Native title

Part E, Section 31 of the Environmental Report stated that 'Legal advice will be sought from the Crown Solicitor's Office as to whether Native title has been extinguished on properties to be acquired for the Port Wakefield Road Upgrade'. Legal advice has now been received from the Crown Solicitor's Office that Native title has been extinguished on all parcels of land to be acquired for the Port Wakefield Road Upgrade.

3.7 Non-Aboriginal heritage

The Heritage Branch of the Department of Environment and Heritage (DEH) has been consulted a number of times regarding the Northern Expressway and its effect on State heritage items.

They indicated that it is preferable that the route does not pass between Buildings No. 29 and 33 in the former Smithfield Magazine Area, due to the significance of their separation distance. Due to the realignment of the corridor in the Macdonald Park area to the north-west, it no longer passes between the magazine buildings, further minimising the effects on these items.



Aboriginal Heritage investigations phase 1
Aboriginal Heritage investigations phase 2
Yet to be surveyed
Archaeologically sensitive areas
Low
Medium
High

Figure 3.6 Archaeologically sensitive areas within 1km of project

Refer Figure 16.1 Environmental Report

The proposed realignment of the Northern Expressway will however be closer to the State heritage-listed pisé cottage and brick well on Petherton Road. The property containing the pisé cottage is owned by the State Government and is now directly affected by the refined route. The building is in poor condition and likely to be at greater risk from effects such as vibration. The site is currently being assessed by the Heritage Branch of DEH.

The amended alignment will bring the pavement within 14 metres of the building and the standard batter slope (1:6) for drainage will effectively abut the building. This is likely to cause damage to the building during the construction period and further deterioration may occur over time.

A detailed building assessment will be undertaken during detailed design to determine alternative design parameters for the drainage works in the vicinity of the building. The assessment will also include detailed recommendations for management and protection during and post-construction.

The pisé cottage is currently listed on the South Australian Heritage Register. Development approval under the *Development Act 1993* will be required if the property is affected.

3.8 Surface water and groundwater

3.8.1 The Gawler River crossing

Hydrology of the Gawler River – background

The Environmental Report reported on existing flooding conditions within the Gawler River catchment and its associated flood plain. This was based on information available at the time of preparation and drew on the results of the Gawler River Flood Management Plan produced in 1994 following the significant flooding of 1992.

During the preparation of the 1994 Gawler River Flood Management Plan, hydrological models were produced to enable generation of estimates of the flows within the North Para, South Para and Gawler rivers. Further hydrology reviews were undertaken in 1999 and 2003 with findings varying little from the original study. The study undertaken in 2003 provided detailed hydrological information on which the detailed design was based for the North Para flood control dam (at Turretfield), which forms part of the current Gawler River Flood Mitigation Scheme (GRFMS) (refer to Section 20.4.1 Environmental Report).

In 2007, a further hydrological review was undertaken during planning works on the proposed modifications to the South Para Dam spillway (also part of the Gawler River Flood Mitigation Scheme). This study utilised recent advances in hydrological modelling techniques to better reflect the actual response to rainfall within the catchment.

The new model was used to assess the effect of the North Para flood control dam and to review the South Para spillway works. It was found that the North Para Dam was less effective at mitigating flood flows than was determined by the 2003 hydrology review.

The estimated flood frequency curves for the Gawler River downstream of the Gawler Junction, as predicted by the 2007 review, are summarised in Table 3.12, pre and post-mitigation.

The post-mitigation 1:100 year ARI event flow at the Gawler Junction, based on the 2007 estimate, is 662 m^3/s, compared with the estimated flow of 154 m^3/s in the 2003 study.

Table 3.12
Revised flood frequency curve for Gawler River

ARI (years)	Pre-mitigation flow, 2003 estimate (m^3/s)*	Post-mitigation flow, 2003 estimate (m^3/s)**	Pre-mitigation flow, 2007 estimate (m^3/s)**	Post-mitigation flow, 2007 estimate (m^3/s)**
10	189	N/A	179	102
20	N/A	N/A	270	137
50	342	N/A	463	432
100	422	154	671	662

* *Tonkin Consulting (2003).*

** *Based on 'varying loss model' (loss model 2) in 2007 hydrology review (Kemp 2007).*

N/A Indicates data not available.

Implications for the Northern Expressway

At the time of preparation of the Environmental Report, the combined effect of the proposed flood mitigation works was thought to reduce 1:100 year ARI interval flows to a level that could be accommodated by the main Gawler River channel between Gawler and the rail line near the township of Virginia. The new hydrology estimates indicate that this is probably not the case, and that the level of protection afforded will be somewhere between a 1:20 year and 1:50 year ARI event. It is assumed that the main river channel has (on average) a capacity in the order of 150–200 m^3/s.

Release of the new flow estimates for the Gawler River has necessitated further, more detailed investigations into the crossing of the Gawler River flood plain. It is recognised that during the estimated 1:100 year ARI event, a flood plain of considerable width will exist in the vicinity of the Northern Expressway. Through careful design measures, the construction of the Northern Expressway embankment (perpendicular to the Gawler River flow path) can avoid the potential for increased flood levels upstream (east) of the embankment.

Previous mapping prepared for the Gawler River flood plain was based on old hydraulic modelling techniques and flow estimates pre-dating the 1994 study. This model was calibrated to the 1917 flood which was estimated as approximately a 1:100 year ARI flood with an estimated flow of 400 m^3/s. The 2007 estimate indicated that the 1:100 year ARI flood downstream of Gawler is more than 50% greater than previous estimates, and therefore a detailed analysis of the extent of the flood plain was considered necessary to establish the existing flood plain and ensure that the crossing does not exacerbate flooding upstream (east) of the Northern Expressway embankment.

Modelling

A two-dimensional hydraulic model has been prepared for the portion of the Gawler River flood plain between Higgins Road and Riverbanks Road to establish the current extent of the 1:100 year ARI event flood plain, to determine the effects of the Northern Expressway and to assist in the design of the Gawler River crossing to minimise effects on surrounding property.

Work on this modelling is continuing, including the procurement of detailed survey to improve the accuracy of estimates. Consultation is also occurring with the Gawler River Floodplain Management Authority (GRFMA) to ensure planned flood mitigation works associated with the Gawler River crossing are consistent with the objectives of the GRFMS.

The Gawler River crossing

A number of options for the Gawler River crossing will continue to be investigated during the conceptual design process. These are likely to involve a combination of bridgeworks, culverts and earthworks.

The final design of the crossing will ensure that, during the peak 1:100 year ARI event, no additional area is inundated when compared to the predicted existing flood plain, and effects in other areas are minimised. The works will be designed for the predicted 1:100 year ARI design flow (2007 estimate), following completion of the upstream flood mitigation works.

Afflux caused by any culvert structures will be managed through the use of energy dissipaters and erosion protection to prevent scour around the structures and downstream.

3.8.2 Port Wakefield Road

The Environmental Report presented conceptual details, in descriptive format, of the proposed stormwater drainage strategy for the Port Wakefield Road Upgrade.

The recommendation of a preliminary drainage strategy was heavily dependent on establishing a clear understanding of the existing drainage situation, and whilst the Environmental Report presented a reasonably detailed description, this was based on very limited information primarily gained through site inspections and discussion with local councils.

The preliminary stormwater concept for Port Wakefield Road focused on maintaining the current drainage standard. There are a number of locations where drainage upgrades are under consideration; however, the need for these is considered to be independent of the Northern Expressway and Port Wakefield Road Upgrade and they are therefore not considered in the context of this study.

Known areas of likely future stormwater upgrade along Port Wakefield Road include:

- Whites Road catchment: intersection with Port Wakefield Road
- Angle Vale Crescent: connection of Waterloo Corner Road and Greyhound Road to Angle Vale Crescent drainage (Lazurko Drain outfall)
- Ryans Road (east): connection to Martins Road drain.

It is anticipated that the need for these will be considered separately and will involve further consultation with the City of Salisbury.

Detailed hydrologic calculations and the preparation of hydraulic design models will be undertaken during the design phase. During this phase, an assessment of the existing system will be undertaken to determine the need for upgrading of minor infrastructure as a result of the proposed works. Due to the minor nature of the works proposed, it is not anticipated that upgrades will be substantial. During the detailed design process, extensive consultation will also be undertaken with the City of Playford and the City of Salisbury to ensure any proposed works are consistent with local stormwater management plans.

Intersection of the Northern Expressway and Port Wakefield Road

Since the preparation of the *Northern Expressway Surface Water and Groundwater Technical Paper,* further preliminary design work has been undertaken near the Northern Expressway/Port Wakefield Road intersection. The proposed drainage strategy for the Northern Expressway west of Huxtable Road to the Port Wakefield Road intersection is described below.

As identified in Section 20 of the Environmental Report, between Pellew Road and Huxtable Road, stormwater flows south-west to Huxtable Road are diverted from both sides of the road (culvert under the Expressway) into a detention basin/water quality basin adjacent to the Smith Creek outfall drain.

From Huxtable Road, drainage will continue south towards Port Wakefield Road. A detention basin located adjacent to the intersection will limit flows under Port Wakefield Road to pre-construction flow levels. A new culvert will be constructed under the road, discharging to a new swale drain on the western side of Port Wakefield Road. This drain will be graded north towards the existing drain running west along Brown Road.

The capacity of the Brown Road drain and the need for upgrading will be assessed during the detailed design phase.

3.9 Greenhouse gas assessment

3.9.1 Introduction

This section provides a quantitative assessment of the net effect of the Northern Expressway Project on greenhouse gas emissions. This assessment had not been finalised at the time the Environmental Report was produced and released in March 2007. The assessment quantifies greenhouse gases released to the atmosphere as a result of construction activities, the emissions and sequestration of carbon dioxide from related landscape changes resulting from the project, and the emissions resulting from the operation of the Northern Expressway in two time horizons, at the opening of the Northern Expressway in 2011 and at 2021.

For an explanation of the greenhouse effect and information about legislative requirements and management measures, refer to Part D, Section 22 in the Environmental Report.

Assessment limitations

Estimates of carbon sequestration for the landscape vegetation are indicative only, but suitable for determining the order of magnitude of the potential net benefit. Consideration of the greenhouse emissions associated with materials is not based on comprehensive life-cycle assessments, but general industry emission factors. Again, these are useful in ascertaining the order of magnitude of these emissions relative to other sources and sinks. Estimates of greenhouse gas emissions with and without the Northern Expressway have been obtained from the MASTEM traffic model.

3.9.2 Construction – greenhouse gas emissions

Method

The total quantities of materials required for the construction of the Northern Expressway have been calculated to arrive at an equivalent carbon dioxide (e-CO_2) emission based on coefficients derived from a variety of sources. The estimates have been calculated through a combination of quantity surveying of preliminary designs, estimates based upon previous experience on similar projects, machinery utilisation times and fuel consumption averages.

Table 3.13 is the product of quantity calculations of specific aspects of the construction process, combined with a carbon dioxide coefficient to produce an estimate of carbon dioxide emissions per activity. Note that Table 3.13 presents the greenhouse gas emissions as total figures for the activity of constructing the Northern Expressway.

Table 3.13
Greenhouse gas emissions from construction activities

Activity	Quantity	Unit	e-CO_2 co-eff.	e-CO_2 (t)	Source
Diesel fuel – site related	7,545	kL	3 (Diesel)	22,635	AGO *Factors and Methods Workbook* (Dec 2005b, p. 10)
Petrol fuel – site related	866	kL	2.6 (Petrol)	2,252	AGO *Factors and Methods Workbook* (Dec 2005b, p. 10)
Concrete supply	10,000	m^3	0.389	3,890	Flower, Sanjayan and Baweja (2005 p. 6)
Asphalt supply*	590,000	tonnes	0.0178	10,502	Canadian Ortech (2002) Environmental Inc, JEGEL
Electricity – site related	100	MWh	1.042	104	AGO *Factors and Methods Workbook* (Dec 2005b, p. 13)
Steelwork supply	3,000	tonnes	0.55	1,650	Kim, Y (2002) International comparison of CO_2 emission trends in the iron and steel industry
Estimated total				41,000	

* *This figure includes asphalt for Port Wakefield Road Upgrade. Other components may not include the Port Wakefield Road construction.*

The modelling has assumed the same rates of growth in the study area with and without the Northern Expressway.

Each activity relating to the construction phase of the Northern Expressway is defined as follows:

- Fuel (site related): This figure includes fuel consumed by vehicles transporting workers and machinery within the worksite as well as the plant operation on site. It is assumed that approximately 90% of the fuel consumed will be diesel and will be consumed by plant operation on site. The remaining 10% is assumed to be ULP petrol related to light vehicles.
- Concrete supply: The majority (95.5%) of the emissions is related to the production of concrete. Consumption of diesel fuel (4%) and LPG (0.5%) account for the remainder of the emissions. The conversion factor used in the table assumes a 50 mega Pascals strength for the concrete.
- Asphalt supply: This activity accounts for the second largest quantity of emissions, behind fuel consumption. Energy used in the manufacture of the asphalt and the binder is the most significant contributor to emissions relating to this activity.
- Steelwork supply: This relates to the casting and supply of steelwork for bridge supports, barriers and signage. Electricity consumption is the main contributor to the emissions for this activity.
- Electricity (site related): The site electricity used is a benchmark set from a previous project where the total site electricity cost was $20,000. Due to the similarities between the Northern Expressway Project and this previous project, electricity consumption is estimated at 100,000 kWh and is without any implementation of energy efficiency measures. Heating, cooling, lighting and electrical appliances would be the main sources of electricity consumption.

Management measures

There are specific management measures that can be employed to reduce the greenhouse gas emissions of the construction phase of the Northern Expressway. Construction is a phase where a certain amount of

control over greenhouse gas emissions exists, and employing management measures geared towards reducing greenhouse gas emissions can be of significant benefit. In addition to the management measures outlined in Part D, Section 22 of the Environmental Report, the following measures could be used:

- greenhouse gas-friendly design and use of purchasing power to reduce effect of supply materials
- shifting cultural practices and behaviour change
- GreenPower (electricity from renewable energy sources) to be purchased for on-site electricity used in demolition and construction
- tree planting
- establishing Green Office programs to promote sustainable work practices within the project offices
- rationalising the use of vehicles by site workers and undertaking workplace travel planning to reduce private motor vehicle travel for home to work journeys
- discouraging idling by construction vehicles and plant
- using biodiesel or biodiesel blends for construction vehicles and plant (e.g. 20% biodiesel – B20)
- maximising the use of recycled steel (e.g. for concrete reinforcing), as well as collecting waste steel for recycling
- considering the whole-of-life for material use (e.g. understanding the need for periodic resurfacing and the relative durability of materials' choices).

Summary

The most significant greenhouse gas effect from construction is anticipated to be as a result of site-related fuel consumption (55%) and concrete supply (26%) representing 81% of the total emissions. The total emissions from the construction component of the project are estimated to be 41,000 t of e-CO_2.

Some offsetting of the carbon dioxide emissions from the construction of the Northern Expressway may be achieved through carbon sequestration by vegetation used in the landscaping of the project.

3.9.3 Landscaping – emissions and sequestration

Method

The rate at which vegetation sequesters carbon is influenced by site productivity characteristics such as climate, topography and soils, as well as tree characteristics and management actions. The Northern Expressway Project is located in an area determined to have 'medium high' potential for carbon sequestration (AGO 2006).

Carbon sequestration rates of vegetation change over time. Generally, the trend of sequestration rate accelerates initially and slows down over time. When plotted, the rates form a generally logarithmic curve, as seen in the diagram below adapted from the Australian Greenhouse Office *Planning for Forest Sinks Guide* (2007).

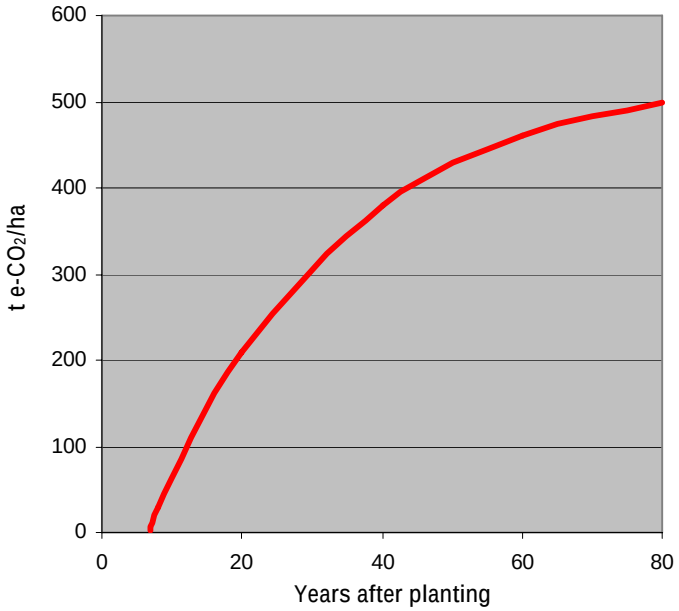


Figure 3.7
Carbon sequestration rate for mixed species plantings for a 'medium high' potential

The assessment of carbon sequestration by vegetation plantings associated with the Northern Expressway will be the result of an averaging of sequestration rates over time for landscaping vegetation. There are two broad vegetation categories within the proposed landscaping design of the project, woody vegetation plantings and grass plantings.

3.9.4 Potential sequestration

Woody plantings

The indicative landscape treatment for the Northern Expressway is illustrated on Figures 2.8 to 2.16. Landscape areas will be planted at a density of three plants per square metre. Within each landscaped area, groupings of vegetation type are as follows:

- tree layer – 20% of the species
- tall shrubs – 20% of the species
- low shrubs – 20% of the species
- native grasses, sedges and groundcovers – 40% of the species.

AGO's sequestration rates for forests located in 'medium high' sequestration potential areas are for a mixed distribution of tree species. In order to determine a more accurate reflection of sequestration rates for the Northern Expressway, the relative distribution of plant types must be accounted for to derive a correspondent value that reflects the landscaping vegetation distribution. AGO's sequestration rates apply to forests; therefore, the values correspond to a density per hectare and a grouping of vegetation type which correlates accordingly. Because the landscaping for the Northern Expressway will not reflect this density and distribution, the sequestration rates must be suitably modified.

According to the groupings of vegetation type for woody plantings, 20% consist of tree layer vegetation, whilst a remaining 40% consist of tall and low shrubs. Accordingly, an assumption is made that the relative biomass of both the tall and low shrub layer vegetation combined would be approximately 50% of that of an equivalent area of tree layer plantings.

Therefore, the combined values of the tree layer and adjusted shrub layers result in a 40% distribution of tree layer equivalent vegetation.

The AGO's sequestration rate for a 'medium high' mixed species forest at 80 years of age is 500 t e-CO_2/ha/y. Averaging this value over a time span of 80 years yields a yearly sequestration rate of 6.3 t e-CO_2/ha. This value represents the average for a mixed species forest at 100% tree layer distribution. The Northern Expressway has an equivalent 40% tree layer distribution; therefore 40% the value of 6.3 t e-CO_2/ha/y represents the appropriate sequestration rate. As a result, the average annual carbon sequestration rate for woody plantings of the Northern Expressway is 2.5 t e-CO_2/ha.

A total of 45.57 hectares is allocated for woody plantings as per the preliminary landscape design; therefore, the total carbon dioxide sequestration realised from landscape plantings for the Northern Expressway will amount to 45.57 ha x 2.5 e-CO_2/y = 114 t e-CO_2/ha/y, over an 80-year time horizon.

Grass plantings

The remaining areas to be landscaped will contain grasses exclusively. For the purposes of this assessment, carbon sequestration by grasses is assumed to be negligible due to their relatively low biomass and rapid carbon cycling rendering the net effect over time to be insignificant.

3.9.5 Management measures

As the area of the Northern Expressway route is already largely denuded of its original vegetation, the expected loss of vegetation as a result of construction relative to carbon sequestration potential is expected to be insignificant. The planning of the Northern Expressway has identified areas of dense vegetation, avoiding them where possible. Minimising clearance of vegetation will aid in obtaining a net carbon balance for the Northern Expressway.

A number of areas are proposed to be landscaped with woody vegetation. There is a direct relationship between plant biomass and carbon sequestration rates; denser plantings of woody vegetation will sequester higher amounts of carbon dioxide in a given area. During the detailed design phase, increasing the proportion of woody plantings of tree layer and tall shrub varieties to say 80%, will increase landscaping sequestration potential by 100% to approximately 228 t e-CO_2/y.

3.9.6 Operation – greenhouse gas emissions

Method

Emissions of greenhouse gases have been modelled for the study area using MASTEM to include the effects of changed traffic flows that are expected to occur on sections of the road network outside the immediate project area. The Northern Expressway is expected to result in some increases in total traffic and hence total emissions as a result of attracting traffic from other areas or making trips easier. Reducing the emission rates of vehicles through reduced congestion may partly offset this, due to improved average speeds, less time spent idling at intersections, and less start–stop driving. These small changes in emissions are probably not significant when viewed against the likely accuracy of the combined traffic and emission estimation models that have been used to estimate total emissions and the

total emissions in the area. Based on the travel demand and MASTEM modelling, the project is considered to generate an insignificant cumulative effect on greenhouse gas emissions.

The method for calculating the greenhouse gas emissions from the operation of the Northern Expressway is derived from the *Australian Methodology for the Estimation of Greenhouse Gas Emissions and Sinks* (2005), and includes two main scenarios: emissions resulting from the operation of the Northern Expressway, and emissions resulting from not constructing the Northern Expressway. These two options are analysed at two points in time, 2011, the year in which the Northern Expressway is expected to be completed and opened to the public, and 2021.

Potential effects on greenhouse gas production

Table 3.14 shows the results of MASTEM modelling of two scenarios, 'with the Northern Expressway (NExy)' and 'without NExy' for traffic within the study area. The overall result for the road network is that although the Northern Expressway results in a greater distance of vehicle kilometres travelled per annum increasing over time, the increase in average vehicle speed provides a positive influence over vehicle efficiency; therefore, less fuel is used per kilometre. Even though total vehicle kilometres travelled (vkt) on the road network is greater with the Northern Expressway, efficiency increases are enough to realise an overall reduction in carbon dioxide emissions from vehicles within the study area as a result.

Table 3.14
Results of MASTEM modelling for t e-CO_2, distance and fuel consumption of traffic in the study area under two scenarios

	2006	2011		2021	
	Base	Without NExy	With NExy	Without NExy	With NExy
Network vkt per day	27,300,000	30,300,000	30,400,000	35,300,000	35,600,000
Average speed (km/h)	43.7	43.1	43.2	41.5	43.2
Average fuel consumption (L/km/veh)	0.1627	0.1640	0.1627	0.1675	0.1638
Annual fuel consumption* (ML)	1,501	1,682	1,675	1,997	1,970
GHG emissions (kt e-CO_2)	3,692	4,137	4,120	4,913	4,845
Emissions > 2006 base (kt)	N/a	445	428	1,221	1,153

* *Using the equivalent of 338 days per year to account for travel changes on weekends and public holidays.*

It should be noted that this analysis is dependent on the extent to which the travel models have successfully predicted future travel behaviour including any potential induced travel demand. Induced travel demand is the phenomenon where new transport facilities encourage additional total vehicle movements due to the attractiveness of the facility to travellers (e.g. travel which may have otherwise been discouraged due to congestion or inconvenience may emerge).

At 2011, the overall reduction in greenhouse gas emissions against the baseline ('no build' scenario) is 17 kt/y, growing to 68 kt/y in 2021.

3.9.7 Management measures

Traffic modelling and carbon dioxide emissions analysis indicate that the construction of the Northern Expressway will realise a slight reduction in emissions for the study area. The downward trend of average traffic speed is inversely proportional to carbon dioxide emissions in this instance, therefore relieving

congestion relates to lower carbon dioxide emissions. These results should be treated with caution due to the potential for induced travel demand to exceed benefits from congestion reduction.

The emissions factors employed in this modelling did not account for changes in vehicle fleet composition. Although changes in the vehicle fleet would be experienced across the entire network, there is a possibility that some vehicle technology will minimise the fuel inefficiency effect that is currently experienced in congested situations (e.g. hybrid electric cars that can shut off their petrol engines when not moving).

DTEI will investigate additional efficiencies in the construction of the Northern Expressway including using highly efficient lighting and possibly incorporating solar electric panels where feasible.

3.9.8 Conclusions

This report has assessed the implications of the Northern Expressway on greenhouse gas emissions. The project affects greenhouse emissions through its construction, landscape, operation and maintenance. This assessment has been undertaken because of the significant State and Australian Government commitments to reducing greenhouse gas emissions.

Table 3.15 presents an overall summary of greenhouse gas emissions associated with the project. For the purposes of comparison, all figures have been spread over an 80-year time frame. Thus, the 41,000 t e-CO_2 generated from construction is spread to 513 t/y. Similarly, the sequestration benefit of the landscape becomes 114 t e-CO_2/y for 80 years. The operations figures are already annual and it is clear that emissions associated with operations are dominant.

Table 3.15
Summary of greenhouse gas emissions' impact of Northern Expressway

Component	Annual emissions e-CO_2 (t/y attributed over 80 years)*
Construction	513
Landscape	-114
Operation (net against 'no build' in 2021)	-68,000 (rounded)
Net	-67,600 (rounded)

* *Negative sign indicates reduction in greenhouse gas emissions.*

For comparison purposes, an average household accounts for approximately 15 t of e-CO_2/y: thus, the net saving implied in Table 3.15 for the Northern Expressway is equivalent to the annual emissions of 4,500 households. Although the modelling suggests that the Northern Expressway will achieve a reduction in greenhouse emissions as against the 'no build' trend, it will see emissions grow 708 kt/y above 2006 levels.

Some may view the net greenhouse positive effect of the Northern Expressway development as counter-intuitive. Indeed, in the context of the gross emissions associated with vehicle travel on the facility and using the network, the change in greenhouse gas emissions with or without the project is small. The result is most appropriately interpreted as indicating that there is a degree of balance between the transport efficiencies introduced by the project and the attractiveness of a new road.

Throughout the construction process, there are opportunities to reduce greenhouse gas emissions, including through the landscaping. Although the benefit of these measures may seem small when divided by an 80-year time frame, they are nonetheless attractive opportunities for greenhouse abatement.

3.10 Fill materials

The Northern Expressway will require large quantities (approx 1.5 million m^3) of high quality fill material with specific engineering properties for use in overpass structures and fill platform below the road pavement. It is proposed to source this fill locally to reduce transport costs, including using recycled materials, that is, Bakewell Bridge surplus material.

Suitable material has been identified within the flood attenuation basins on the northern side of the Gawler River (between the river and Two Wells Road) adjacent to Wingate Road. Geotechnical testing shows approximately 1.5 million m^3 of high quality river sand/clay material would be available – typically of fill Type A and B quality. These flood attenuation basins are indicated on Figure 2.10 and comprise:

- a large basin west of the proposed Northern Expressway alignment which has an overall area of approximately 10 ha with a potential depth of 8–9 m
- two basins east of the proposed Northern Expressway; one east of Wingate Road (approximately 7 ha) and one west of Wingate Road (approximately 2 ha in area).

Various land use options are being considered for the basins and surrounding areas post-construction.

Detailed investigations are required to reconcile the amount of material available with the quantities required for road and bridge construction. Should the overall quantity of material required need to be reduced, then the depth or footprint of the basins will be minimised.

Environmental Management Plans will be developed for the extraction of material during construction.

An Aboriginal cultural heritage survey has been undertaken on the proposed site. No known sites will be disturbed by extraction activities. Aboriginal heritage issues will continue to be managed in consultation with the Kaurna community. Legal advice has been received from the Crown Solicitor's Office that Native title has been extinguished on the parcels of land relating to the excavation sites/attenuation basins.

The site will be managed in accordance with conditions required by the Environmental Protection Authority or other relevant bodies. A Noise and Vibration Management Plan and a Dust Management Plan will be prepared and implemented to minimise the effects of the operation of the excavation sites/ attenuation basins on the local community.

3.11 Visual analysis

Based on the refinements to the proposed Northern Expressway (as identified in Section 2), an assessment of landscape character areas, a summary of the effects the project will create and measures to minimise effects within each area (where change occurs) are outlined in Table 3.16.

A location plan, photographs and detailed descriptions of each landscape character area are provided in the *Urban Design, Landscape and Visual Assessment Technical Paper*.

Table 3.16

Landscape character areas, effects and mitigation measures along the proposed Northern Expressway

Landscape character area	Landscape character	Scenic quality and visual sensitivity	Proposed changes, effects and measures to minimise effects
9. Two Wells Road	Land is gently undulating and has an open pastoral feel. Sand hills in the distance to the north. Mount Lofty Ranges form a dominant backdrop. Land use includes cropping and irrigated market gardens. Residential properties exist along Two Wells Road.	Scenic quality: moderate In general, people living along Two Wells Road will be moderately sensitive to views of the Expressway. Residents in close proximity to the overpass will be highly sensitive to visual change due to the loss of existing views and new views of the road.	An interchange will be provided at Two Wells Road. Aesthetic considerations will be integral to the design of the bridge over the Northern Expressway at Two Wells Road. Overpass embankments will be highly visible from the surrounding area and a dominant visual feature of the landscape. The roundabouts and areas of land within the interchange ramps will be landscaped, as will the strip of land between the Northern Expressway and the realignment of Wingate Road. Landscape planting will help to soften and screen the interchange reducing its visual effect for local residents.
7. Angle Vale Road	Land gently undulates on approach to the Gawler River. Land use includes orchards, market gardens, cropping and grazing with residential properties along Angle Vale Road. Mature gum trees on Angle Vale Road are a dominant landscape feature. Views of the Gawler River vegetation to the north. Roadside vegetation screens views to the south.	Scenic quality: moderate In general, residents of the area will be highly sensitive to visual change. Residents of Bain Road and those in the immediate vicinity of the Angle Vale Road over-pass will be extremely sensitive to the visual changes that will arise from the Expressway due to its close proximity.	Angle Vale Road overpass will be constructed over the proposed Northern Expressway. Removal of large trees will be necessary. Overpass embankments and the proposed Northern Expressway will be a dominant foreground feature for residents of Bain Road. They will experience loss of views to the Mount Lofty Ranges and river. Planting on overpass embankments, along western side of Northern Expressway corridor and along service road will provide visual screening for residents of Bain Road and will reduce the visual effect. Ramps at the proposed Angle Vale Road interchange will be located on the northern side of Angle Vale Road. Land within the ramps will be revegetated, creating visual interest and reducing the impact of the overpass structure for the local community and road users travelling south on the Northern Expressway.

Landscape character area	Landscape character	Scenic quality and visual sensitivity	Proposed changes, effects and measures to minimise effects
6. Curtis Road and Smithfield Magazine Area	Terrain is flat, but large earth walls of a dam dominate the landscape. Red brick magazine buildings provide visual interest.	Scenic quality: moderate–high Residents on western edge of Andrews Farm will be moderately sensitive to visual change.	Curtis Road interchange will be a dominant landscape feature, visible from the surrounding road network. The interchange will not be visible to the majority of Andrews Farm residents due to existing fences and mounds. Land around the interchange will be revegetated creating visual interest and reducing impact of the overpass structure. The proposed northbound ramps at Curtis Road will be located on land within the southbound ramps. Therefore the visual effect and landscape design will not change significantly from the original proposal.
5. Macdonald Park area	Near Argent Road, the Smith Creek drain broadens from a deep, weed-infested channel to a shallow grassed swale. Surrounding land is flat. Land use includes rural residential area of Macdonald Park, almond and olive orchards, vineyards, horticulture, cropping and sheep grazing. Road verges are well vegetated with planted trees and shrubs. Several of the old Smithfield Magazine buildings have been converted into houses and other heritage sites also exist, adding an interesting visual and cultural element to the area. Distant views to the Mount Lofty Ranges are only available on roads running in an east–west direction.	Scenic quality: moderate Macdonald Park will be highly sensitive to the visual changes that will arise from the proposed Northern Expressway.	The revised route of the Northern Expressway brings the road in closer proximity to the southern area of Macdonald Park. Existing vegetation on Petherton Road provides a strong visual buffer between the proposed Northern Expressway and the existing residential area. There is opportunity for the proposed Northern Expressway to interact with the heritage buildings and local road network in a positive way. The existing vineyards and orchards will provide visual interest along the edge of the Northern Expressway corridor, and views to these will be retained.
2. Huxtable Road and the Taylors Road rail crossing	Terrain is flat with rail line elevated above surrounding land. Area of intense horticultural production dominated by greenhouses and irrigated market gardens. Shelterbelt planting and railway corridor planting is of poor visual quality. Road verges degraded and heavily weed infested. Distant flanking views of the Mount Lofty Ranges available where not obstructed by vegetation screening.	Scenic quality: low–moderate. Low sensitivity to visual change. Very few residential properties and these have existing boundary planting which will screen views of the proposed development.	Bridge over the Adelaide–Alice Springs/ Darwin rail line will be the largest and most visually dominant of all the proposed Northern Expressway overpasses. It will provide access to views that will not otherwise be available to travellers through the area. Removal of shelterbelt trees will be necessary on corner of Pellew Road and Taylors Road. Bridge embankments will be highly visible to local traffic but will be vegetated to provide stabilisation and to integrate the structure into the landscape. Aesthetic considerations will be integral to bridge design. As planting matures, the visual effect will be reduced.

Landscape character area	Landscape character	Scenic quality and visual sensitivity	Proposed changes, effects and measures to minimise effects
1. Port Wakefield Road	Topography is flat and open with land used for market gardens, green-houses and cropping. Residential properties are located along Taylors Road and Port Wakefield Road. Views to Mount Lofty Ranges limited by vegetation around property boundaries. Dense screen of vegetation and power lines within the Port Wakefield Road median dominate the existing landscape.	Scenic quality: low Residential properties near Port Wakefield Road will be moderately sensitive to visual change.	Installation of traffic lights and lighting is proposed at junction of the proposed Northern Expressway and Port Wakefield Road. Visual effect will be minimal, considering the low scenic quality of the existing environment. Excellent opportunity to make significant improvements to the visual quality of this area. Landscape works at junction will enhance visual amenity and unite the proposed Northern Expressway with existing vegetation on Port Wakefield Road.

3.12 Gawler Airfield

The effects of the Northern Expressway on the continued operation of the Gawler Airfield have been assessed in relation to:

- operational issues (including runways' characteristics and aircraft types)
- location of facilities and road access to the airfield
- current and long-term requirements of the facility owner and users.

3.12.1 Operational issues

Runways

The key issues regarding the current runway configurations are:

- frequency of use and wind direction
- take-off run available
- landing distance available
- accelerated stop distance available
- obstacle-clear gradients and runway ends.

DTEI has engaged the services of a consultant expert in the field of airfield design and safety, and has also consulted with the current users of the airfield including the Adelaide Soaring Club and the emergency services, in particular the Country Fire Service Aviation Services. DTEI's objective is to ensure the continuing operation of the airfield commensurate with Light Regional Council's objectives.

It is considered that, with some additional work including surface sealing, marking and minor extensions to the modified runways as proposed by the concept design, the airfield will be able to remain in operation by the current users and meet the necessary criteria for safe operation. The design of the interface with the Northern Expressway including fencing, location and height of light poles, and the placement of road advisory signs will be undertaken in a manner that will ensure appropriate standards are met.

Discussions with current users will continue, to reach a common understanding of the situation and how this will be managed particularly through the detailed design phase.

Facilities and access

The existing entrance and facilities will no longer remain available once the Expressway construction commences.

Alternative access via Ward Belt Road to a proposed location on the existing Gawler Harness Racing Club land will be provided as part of the alteration works. Details of these works will be developed in consultation with all relevant stakeholders as the project proceeds.