11. Pavements

11.1 Pavement design

Preliminary pavement designs have been developed for the highway travel lanes (through carriageways), the inner and outer shoulders, on and off ramps and service roads.

All flexible and rigid pavement designs have been carried out in accordance with the Austroads Pavement Design – A Guide to the Structural Design of Road Pavements 2004 (referred to as the Austroads 2004 Guide) and the RTA Supplement to the Austroads Guide to the Structural Design of Road Pavement Draft Version 16 August 2006 (referred to as the RTA Draft Supplement Version 16).

Flexible pavements have been analysed for design purposes using the program CIRCLY Version 5.0i. Rigid (concrete) pavements have been analysed using an in-house spreadsheet developed in accordance with the Austroads 2004 Guide, in particular Section 9 and Appendix 9.1.

11.2 Traffic volumes

Traffic volumes adopted for pavement designs are based on the parameters contained in Section 7 of this report.

11.3 Pavement design assumptions

The designs of the various pavements have been based on the following general and pavement specific assumptions:

11.3.1 General assumptions for pavements

- Open graded asphalt wearing course (if required) is not treated as a structural layer in the design in accordance with the RTA Draft Supplement Version 16.
- Design modulus of dense graded asphalt – Asphaltic Concrete (AC)14 - 2800 Mega Pascals (Mpa).
- AC20 - 2850 Mpa.
- Design modulus of lean mix concrete – 10,000 MPa (no post cracking fatigue life allowed for in the design - RTA Draft Supplement Version 16).
- Tyre pressure – 750 kPa.
- The mechanistic design relationships for the fatigue of asphalt and cemented materials and the subgrade were determined in accordance with Austroads 2004 Guide and the RTA Draft Supplement Version 16. A Reliability Factor or 1 was used to determine the allowable number of load repetitions for a project reliability level of 95 per cent unless noted otherwise below.

Table 11.1 provides a summary of traffic assumptions for the pavements. Further details are provided for each pavement, including the design traffic in Section 11.4.

Table 11-1 Traffic summary

Section	Design Life	2016 AADV *	Percentage Heavy Vehicles
Through carriageways (north bound and south bound)	40 yrs	5207 (1 way)	25%
North bound off-ramp at Range Road and South bound on ramp at New Link Road	40 yrs	185 (1 way)	10%
Northbound on-ramp at Range Road and southbound off-ramp at New Link Road	40 yrs	1133 (1 way)	10%
New Link Road	40 yrs	1315 (2 way)	10%
Service road near Eggins Close	40 yrs	3010 (2 way)	10%
Lemon Tree Road from highway to access road north	40 yrs	244 (2 way)	10%

* AADV Annual Average Daily Vehicles

11.4 Preliminary pavement design

Preliminary pavement designs have been prepared for each pavement as follows. These pavements have been designed for the purpose of the concept design and different pavements may be constructed following detailed geotechnical investigation and detailed design of the highway.

Full design information is provided in the preliminary pavement design report — working paper, however the key outcomes of the pavement design are summarised in the following sections.

11.4.1 Pacific highway through carriageways

Three options were considered for the pavement structure, namely a bound flexible pavement, a PCP and a CRCP rigid pavement. These are discussed here in some detail as this provides the most significant constructed pavement area for the project. It is likely that the plain concrete pavement will be adopted for the construction of the through carriageways.

Option 1 – Bound flexible pavement

The bound flexible pavement (deep strength asphalt over lean mix concrete) has the following structure:

- 50 mm AC 14 (Class 320 bitumen, Heavy Duty Application (HDA)).
- 125 mm AC 20 (Class 320 bitumen, HDA) placed in two layers.
- Bitumen emulsion curing coat.
- 225 mm lean mix concrete (critical layer, the nominal thickness shown is 10 mm greater than the design thickness).
- 7 mm bituminous sprayed seal.
- 300 mm minimum selected material zone in two layers (refer Section 11.2).

- Subgrade CBR 3 per cent.

Option 2 – Plain concrete pavement (PCP)

The PCP rigid pavement has the following structure:

- 260 mm plain concrete base, undowelled with structural concrete shoulders (critical layer, the nominal thickness shown is 10 mm greater than design thickness).
- Two coats was emulsion curing compound.
- 150 mm lean mix concrete subbase.
- 7 mm bituminous sprayed seal.
- 300 mm selected material zone in 2 layers (refer Section 11.2).
- Subgrade CBR 3 per cent.

Option 3 – Continuously reinforced concrete pavement (CRCP)

The CRCP rigid pavement has the following structure:

- 240 mm continuously reinforced concrete base, with tied structural concrete shoulders (critical layer, the nominal thickness shown is 10 mm greater than design thickness).
- Two coats was emulsion curing compound.
- 150 mm lean mix concrete subbase.
- 7 mm bituminous sprayed seal.
- 300 mm selected material zone in 2 layers (refer Section 11.2).
- Subgrade CBR 3 per cent.

11.4.2 On and Off-ramps at Range Road and the new link road

The on and off ramps for Range Road and the new link road would utilise the same pavement structure as the through carriageways. This would apply to the end of the gore area, with the remainder of the ramp being asphalt in accordance with the local service road design.

11.4.3 New link road

The bound flexible pavement (deep strength asphalt over heavily bound subbase) to be constructed for the new link road has the following structure:

- 50 mm AC 14 (Class 320 bitumen, HDA).
- 150 mm AC 20 (Class 320 bitumen, HDA) placed in two layers.
- Bitumen emulsion curing coat.
- 200 mm heavily bound sub-base (critical layer, the nominal thickness shown is 10 mm greater than the design thickness).
- 7 mm bituminous sprayed seal.
- 300 mm min selected material zone in 2 layers (refer Section 11.2).
- Subgrade CBR 3 per cent.

The realignment of the existing highway between the new link road and Range Road would also utilise the bound flexible pavement structure.

11.4.4 Service Road near Eggins Close

The bound flexible pavement (deep strength asphalt over heavily bound subbase) to be constructed at Eggins Close has the following structure:

- 50 mm AC 14 (Class 320 bitumen, HDA).
- 150 mm AC 20 (Class 320 bitumen, HDA) placed in two layers.
- Bitumen emulsion curing coat.
- 200 mm heavily bound sub-base (critical layer, the nominal thickness shown is 10 mm greater than the design thickness).
- 7 mm bituminous sprayed seal.
- 300 mm min selected material zone in 2 layers (refer Section 11.2).
- Subgrade CBR 3 per cent.

The realignment of the existing highway between the new link road and Range Road would also utilise the bound flexible pavement structure.

11.4.5 Other service and access roads

All other service and access roads throughout the project would consist of a flexible granular pavement approximately 400 mm in depth with a two-coat spray seal or a 50 mm thick layer of AC 14. These areas will require additional geotechnical investigation prior to finalisation of pavement design.

11.5 Whole of life pavement analysis

A whole of life costing comparison was undertaken for the three alternative pavement types considered for the main carriageways of the Pacific Highway, ie bound flexible pavement, PCP and CRCP (rigid pavements). For each of these pavement types, a whole of life costing was undertaken without a non-structural, open graded (OG), asphalt wearing course.

The Net Present Value method has been used for economic comparison of the alternative pavement types and includes initial construction cost, routine and periodic maintenance costs, and salvage value.

11.5.1 Initial construction, maintenance costs and salvage value

Initial construction, maintenance costs and salvage values used in the whole of life analysis have been derived directly from the respective unit rates data supplied by MacDonald International (cost estimates consultant). The rates for new construction were based on year 2007 prices. The rates for maintenance and salvage were based on rates provided in the RTA Economic Analysis Manual (May 2006 update) for bound flexible pavement and PCP. The rates for maintenance and salvage for CRCP were based on those for the M7 Westlink project. Where appropriate the rates for maintenance and salvage were adjusted using the Road Cost Index in Appendix C of the RTA Economic Analysis Manual.

11.5.2 Road user delay costs

Road user delay costs were not used in the whole of life analysis.

11.5.3 Analysis period

An analysis period of 40 years was used consistent with the pavement design life.

11.5.4 Maintenance diary

Maintenance diary (frequency) has been generated from the RTA Economic Analysis Manual Table 6.4 for the flexible pavement and PCP. For CRCP, the maintenance diary was taken from the Western Sydney Orbital (M7 Westlink) project.

11.5.5 Whole of life cost comparison summary

Discount rates of 4, 7 and 10 per cent were used in the analysis. Table 11-2 summarises the present value for each pavement type and discount rate analysed.

Table 11-2 Results of whole of life pavement type comparison

Pavement Type	Initial Construction Cost *	Net Present Value at 4%	Net Present Value at 7%	Net Present Value at 10%
1. Flexible pavement Option	$122 / sq m	$145.70	$137.60	$132.60
2. Rigid pavement (PCP) Option	$105 / sq m	$122.60	$117.00	$113.80
3 Rigid Pavement (CRCP) Option	$120 / sq m	$116.60	$120.20	$121.10

* Excluding common items such as SMZ and subgrade treatment which are common to all pavement types.

11.6 Conclusion

The through carriageway pavement is most likely to be a concrete pavement, based on current economic considerations, and of the two concrete pavement options considered, plain concrete pavement has the most favourable whole of life pavement cost/benefit results.

Further assessment should be undertaken closer to the project construction to confirm that the above selection is still appropriate.