Appendix I

I. Appendix I: Mitigation Option Details

This section outlines indicative costs for the investigated Culcairn Options and provides drawings to assist in detail design and investigation works.

These Options include:

- Option A3 – Lowering the Stock Route near the Balfour Street Intersection (see Section 5.3.4.3);
- Combined Option S2 / A7 / A8 - Stopping Billabong Creek Flood Affectation (see Section 5.3.8.1);
- Combined Option L3 / A5 / B4 – Southern Flow Path Flood Mitigation (see Section 5.3.8.2);
- Combined Option L1 / S5 / A1 / B1 / B3 – Central Flow Path Mitigation (see Section 5.3.8.3); and
- Combined Option L2 / S1 – Re-directing the Northern Flow Path near Baird Street (see Section 5.3.8.4).

Note all costs are indicative and are not guaranteed. Cost will vary with contractor prices, market forces and other factors. Detailed design will enable more accurate costs to be prepared.

All of the above listed Options with the exception of Option L2 / S1 are recommended for implementation at Culcairn as they provide significant reductions in flood affectation and risk and have good B/C ratio. Option L2 / S1 is not recommended for implementation at Culcairn.

Freeboard Assumptions

Freeboard is incorporated into the final design height of an embankment (either for a levee or dam wall) and is expressed as the incremental difference in height between the level of the flood the embankment is designed to protect against, and the design crest level of the embankment. Freeboard varies dependant on uncertainties in flood level estimates, wind and wave actions, storm surge, settlement, climate change etc. and therefore requirements can change significantly from embankment to embankment. Applying a standard freeboard allowance for an embankment is considered simplistic, and in many instances, overly conservative (Reference 20).

Typical levee freeboards range from 0.5 m to 1 m in the region. For example the Main City Levee upgrade at Wagga Wagga will use a freeboard of 0.9 m (Reference 20). However, the due to the flat nature of the terrain at Culcairn, and the use of embankments for overland flow flood events only, the expected freeboard will be significantly less than this. A full freeboard assessment is beyond the scope of the current study and will be undertaken as part of the detailed design. An estimated average freeboard allowance of 0.3 m has been assumed for all embankments and dam walls in Culcairn. It should be noted that this freeboard is applied only to overland flow mitigation structures and that scaling (increases in peak flood level) of these types of events is minor and the consequence of failure in terms of risk to life are negligible.

For modelling of design events greater than the design height of an embankment, the freeboard has been incorporated into the modelling with the assumption that the embankment will not fail

until it is overtopped.

Option A3

Preliminary concept design information for Option A3 is presented in Figure I 1. This Option involves lowering the stock route by 0.3 m for approximately 20 m length.

Easement Requirements

Nil. All works are undertaken on the road easement.

Third Party Compensation

Nil. No properties affected by increased flood levels.

Option L1 Estimated Costing

A summary of the estimated costings for Option A3 is contained in Table I 1. All costs are not guaranteed. Costs will vary with contractor's prices, market forces and competitive bids from tenderers. It has been assumed that existing culverts will not be replaced, coffer dams and dewatering will not be required and that works will be undertaken during a dry period.

Table I 1: Option A3 – Estimated Costing

Option A3

Road Design

Foundation Preparation	UNIT	QUANTITY	2014 RATE RURAL NSW	COST (with factors)
Road Demolition	m^2	450	20	$ 9,000
Removal of Soil/Road	m^3	90	10	$ 900
compact foundation	m^2	450	3	$ 1,350
Road Resurfacing	m^3	450	55	$24,750

Olympic Hwy Traffic Control				
Traffic Control	weeks	0.5	1,450	$ 725

Construction Cost	$ 36,725

TOTAL PROJECT ESTIMATE	$ 58,200	
TOTAL PROJECT ESTIMATE	$ 58,172	a+b+c+d+d
Construction Cost (a)	$ 36,725	
Contingency (b)	$ 7,345	20% of a
Design (c)	$ 4,407	10% of a+b
Construction Management (d)	$ 5,288	12% of a+b
Project Management (e)	$ 4,407	10% of a+b

**All costs are not guaranteed. Costs will vary with contractor's prices, market forces and competitive bids from tenderers.*

Combined Options S2 / A7 / A8

Preliminary concept design information for the combined Option S2 / A7 / A8 are presented in Figure I 2. Features of this option include:

- Filling of the east anabranch breakout with approximately 1,700 m³ of earth (max depth 1.4, width of anabranch breakout is 40 m, length of fill is assumed 30 m (see anabranch profile D-E, Figure I 2);
- Filling of the east anabranch breakout with approximately 4,200 m³ of earth (max depth 0.4, width of anabranch breakout is 380 m, length of fill is assumed 30 m (see anabranch profile D-E, Figure I 2);
- No freeboard applied to anabranch fill, instead the anabranch is filled to the surrounding ground level;
- Non-return valve fitted to 0.6 m diameter Gordon Street Drain outlet;
- Non-return valve fitted to 0.6 m diameter Gamble Street Drain culvert under Gamble Street; and
- Design for the 1% AEP flood level.

Freeboard

The anabranch has been filled to the level of the surrounding ground level which is 0.3 m higher than the 1% AEP flood level. Addition of a freeboard above the height of the surrounding ground level is not possible without construction of a levee which would need to be extended to higher ground. This would lead to the levee being several kilometres long and financially unviable.

Easement Requirements

The filling of the anabranch is required on private land and acquisition of easements is necessary. The total area of land that will require acquisition for each works location is presented below:

- East anabranch breakout – 1,200 m²
- West anabranch breakout – 11,400 m²

The area requirement for both easements was determined as the area of fill placement for the anabranch breakouts. The estimated price of land in the region is $15 per/m² (source: realestate.com).

Third Party Compensation

Nil. No properties affected by increased flood levels.

Option S2 / A7 / A8 Estimated Costing

A summary of the estimated costings for the combined Option S2 / A7 / A8 are contained in Table I 2. All costs are not guaranteed. Costs will vary with contractor's prices, market forces and competitive bids from tenderers. It has been assumed that existing culverts will not be replaced, coffer dams and dewatering will not be required and that works will be undertaken during a dry period.

Table I 2: Option S2 / A7 / A8 – Estimated Costing

Combined Option S2 / A7 / A8

Fill Anabranches

Foundation Preparation	UNIT	QUANTITY	2014 RATE RURAL NSW	COST (with factors)
Remove top soil and vegetation	m^3	780	2	$ 1,560
Place Fill	m^2	5,900	13	$ 76,700
Compact Fill	m^3	7800	3	$ 23,400

Finishes				
top soil placement	m^2	7,800	8	$ 62,400
seeding	m^2	7,800	7	$ 54,600

Non return valves

Non return valves				
Cost of non-return valve	per/valve	2	20000	$ 40,000
Attach non-return valve	hours	20	200	$ 4,000

Construction Cost	**$ 262,660**

Option S2 - Easement Costs (f)				
Easement Requirements	m^2	12,600	15	$ 54,000

TOTAL PROJECT ESTIMATE	**$ 470,100**	
TOTAL PROJECT ESTIMATE	$ 470,053	*a+b+c+d+e+f*
Construction Cost (a)	$ 262,660	
Contingency (b)	$ 52,532	*20% of a*
Design (c)	$ 31,519	*10% of a+b*
Construction Management (d)	$ 37,823	*12% of a+b*
Project Management (e)	$ 31,519	*10% of a+b*

Combined Options L3 / A5 / B4

Preliminary concept design information for the combined Option L3 / A5 / B4 is presented in Figure I 3. Features of this option include:

Option L3

- Option L3 has an 80 m embankment length;
- Typical Option L3 embankment height of 0.6 m (including 0.3 m freeboard) from dry side;
- Balfour Road incorporated into Option L3 embankment;
- Option L3 embankment top width of 3 m;
- Option L3 embankment slopes at 1:4 ratio for both wet and dry sides;

Option B4

- Option B4 basin has an 250 m dam wall embankment;
- Option B4 basin has an average height of 0.5 m including 0.3 m freeboard;
- Option B1 embankment top width of 3 m;
- Option B1 embankment slopes at 1:4 ratio for both wet and dry sides;

Option A5

- Option A5 lowers the Olympic Highway for approximately 120 m length;
- Option A5 lowers the Olympic Highway by an average of 0.4 m;

Note that all Options have been design for the 1% AEP event.

Freeboard

A freeboard of 0.3 m has been applied to both Options L3 and B4.

Easement Requirements

Nil. All works are proposed for construction on Crown land

Third Party Compensation

Nil. No residential properties are affected by increased flood levels. Increased peak flood levels occur on Crown owned land on the playing fields and around two open walled tin sheds (see Image I 1). Damages associated with filling of the Option B4 basin are negligible.

Image I 1: Tin sheds susceptible to increased peak flood levels on Crown land

Option L3 / A5 / B4 Estimated Costing

A summary of the estimated costings for the combined Option L3 / A5 / B4 are contained in Table I 3. All costs are not guaranteed. Costs will vary with contractor's prices, market forces and competitive bids from tenderers. It has been assumed that existing culverts will not be replaced, coffer dams and dewatering will not be required and that works will be undertaken during a dry period.

Table I 3: Option L3 / A5 / B4 – Estimated Costing

Combined Option L3 / A5 / B4

Option L3 - Embankment Design and Road Raising

Foundation Preparation	UNIT	QUANTITY	2014 RATE RURAL NSW	COST (with factors)
remove top soil and vegetation	m³	43	5	$ 215
compact foundation	m²	429	3	$ 1,287
excavate foundation channel (core - assumed 10% of total)	m³	23	8	$ 184
lime stabilisation (core - assumed 10% of total)	m³	23	15	$ 345
Embankment Construction				
Material	m³	228	8	$ 1,824
shaping of batter slopes	m²	429	2.5	$ 1,073
Compaction	m²	429	2.5	$ 1,073
Allowance to dispose of unsuitable material (10%)	m³	23	8	$ 184
Finishes				
top soil placement	m²	429	8	$ 3,432
seeding	m²	429	7	$ 3,003
Pavement/Rail Reinstatement				
Road resurfacing	m²	500	$ 55	$ 27,500
Balfour Street Traffic Control				
Traffic Control	weeks	1	$ 1,450	$ 1,450

Option B4 - Basin Design

Foundation Preparation	UNIT	QUANTITY	2014 RATE RURAL NSW	COST (with factors)
remove top soil and vegetation	m³	203	5	$ 1,015
compact foundation	m²	2,028	3	$ 6,084
excavate foundation channel (core - assumed 10% of total)	m³	84	8	$ 672
lime stabilisation (core - assumed 10% of total)	m³	84	15	$ 1,260

Embankment Construction				
Material	m^3	842	8	$ 6,736
shaping of batter slopes	m^2	2,066	2.5	$ 5,165
Compaction	m^2	2,066	2.5	$ 5,165
Allowance to dispose of unsuitable material (10%)	m^3	48	8	$ 384

Finishes				
top soil placement	m^2	2,066	8	$ 16,528
seeding	m^2	2,066	7	$ 14,462

Option A5 - Road Realignment

Foundation Preparation	UNIT	QUANTITY	2014 RATE RURAL NSW	COST (with factors)
Road Demolition	m^2	720	20	$ 14,400
Removal of Soil/Road	m^3	432	10	$ 4,320
compact foundation	m^2	720	3	$ 2,160
Road Resurfacing	m^3	720	55	$ 39,600

Olympic Hwy Traffic Control				
Traffic Control	weeks	1	1,450	$ 1,450

Construction Cost	$ 160,970

TOTAL PROJECT ESTIMATE	$ 255,000	
TOTAL PROJECT ESTIMATE	$ 254,976	*a+b+c+d+e*
Construction Cost (a)	$ 160,970	
Contingency (b)	$ 32,194	*20% of a*
Design (c)	$ 19,316	*10% of a+b*
Construction Management (d)	$ 23,179	*12% of a+b*
Project Management (e)	$ 19,316	*10% of a+b*