AADs can be used to calculate the economic benefit of carrying out flood mitigation works, by taking the reduction in AAD brought about by the work and converting this, using an appropriate discount rate, to a net present value. The ratio of the net present value of saved damages to the cost of the works provides a benefit-cost ratio.

Appendix E – Cost estimates

CONSTRUCTION COST ESTIMATE

Project: **West Lakes SMP**
Job No: 20190818
Date: 28/07/2021
Revision: A
Summary of works: Gleneagles Reserve underground tank
Estimated: BT
Review: BJT

Item No	Description	Comment	Unit	Qty	Rate	Cost
1.0	**Preliminaries**					
1.1	Preliminaries	Assumed to be 5% of estimate				$ 481,604.81
	Sub-Total					**$ 481,604.81**
2.0	**Construction costs**					
2.1	Excavation and disposal of spoil		m^3	30,000	$ 38.00	$ 1,140,000.00
2.2	Topsoil stripping and stockpiling		m^2	15,000	$ 3.50	$ 52,500.00
2.3	Topsoil respreading		m^2	15,000	$ 5.00	$ 75,000.00
2.4	Tree removal		item	15	$ 250.00	$ 3,750.00
2.5	Undergound storage tank	Supply and installation of proprietary tank	m^3	30,000	$ 270.00	$ 8,100,000.00
2.6	Pipe capping	Concrete capping of bypassed pipe	item	2	$ 500.00	$ 1,000.00
2.7	375 mm diameter RCP	Outlet pipe	m	35	$ 280.00	$ 9,800.00
2.8	675mm diameter RCP	Inlet diversion pipe	m	105	$ 530.00	$ 55,650.00
2.9	1200 x 600 RCBC	Inlet diversion culvert	m	30	$ 1,735.00	$ 52,050.00
	Sub-Total					**$ 9,489,750.00**
3.0	**Other costs**					
3.1	Design cost	Assumed to be 1.5% of construction cost	item			$ 142,346.25
	Sub-Total					**$ 142,346.25**
4.0	**Annual maintenance costs**					
4.1	Inspection and maintenance		item	1	$ 2,000.00	$ 2,000.00
	Sub-Total					**$ 2,000.00**

Sub-total		**$ 10,115,701.06**
Contingency	20%	$ 2,023,140.21
Grand Total		**$ 12,138,841.28**

Note: **Cost estimates provided by Tonkin Consulting are based upon historic cost information and experience, and do not allow for:**

- Latent conditions
- Changes in scope
- Market conditions (i.e. competition, escalation)
- No allowance for approvals for these works
- No allowance for site contamination and remediation or disposal of contaminated material
- No allowance for land acquisition
- No allowance has been made for the staging of these works
- No allowance has been made for landscaping works
- No allowance has been made for service depthing, liaison with service authorities, design of service relocations
- No allowance has been made for project delivery costs including project management
- Calculations assume clay soil and no rock will be encountered

These estimates are to be considered as indicative only, and are not purported to represent anything more than an indication of the cost of the scope of the work.
Tonkin Consulting recommend that an appropriately qualified quantity surveyor be consulted to provide detailed market cost inputs.

CONSTRUCTION COST ESTIMATE

Project: **West Lakes SMP**
Job No: 20190818
Date: 28/07/2021
Revision: A
Summary of works: Crittenden Road to Grange Lakes pipe upgrades
Estimated: BT
Review: BJT

Item No	Description	Comment	Unit	Qty	Rate	Cost
1.0	**Preliminaries**					
1.1	Preliminaries	Assumed to be 10% of estimate				$ 1,799,826.91
	Sub-Total					**$ 1,799,826.91**
2.0	**Construction costs**					
2.1	300 mm diameter RCP		m	865	$ 217.00	$ 187,705.00
2.2	375 mm diameter RCP		m	244	$ 280.00	$ 68,320.00
2.3	450 mm diameter RCP		m	638	$ 398.00	$ 253,924.00
2.4	900 mm diameter RCP		m	3,478	$ 904.00	$ 3,144,112.00
2.5	1050 mm diameter RCP		m	3,150	$ 1,302.00	$ 4,101,300.00
2.6	1200 x 900 RCBC		m	336	$ 2,299.00	$ 772,464.00
2.7	1800 x 900 RCBC		m	1,257	$ 4,500.00	$ 5,656,500.00
2.8	1350 x 675 RCBC		m	954	$ 1,930.00	$ 1,841,220.00
2.9	Side entry pit	Assumed to be double SEPs	item	138	$ 3,727.84	$ 514,441.92
2.10	Junction box	Assumed every 100 m	each	110	$ 9,130.00	$ 1,004,300.00
2.11	Outlet headwall upgrades		item	1	$ 15,000.00	$ 15,000.00
	Sub-Total					**$ 17,559,286.92**
3.0	**Other costs**					
3.1	Design cost	Assumed to be 2.5% of construction cost	item			$ 438,982.17
	Sub-Total					**$ 438,982.17**

Sub-total		**$ 19,798,096.00**
Contingency	20%	$ 3,959,619.20
Grand Total		**$ 23,757,715.20**

Note: **Cost estimates provided by Tonkin Consulting are based upon historic cost information and experience, and do not allow for:**

- Latent conditions
- Changes in scope
- Market conditions (i.e. competition, escalation)
- No allowance for approvals for these works
- No allowance for site contamination and remediation or disposal of contaminated material
- No allowance for land acquisition
- No allowance has been made for the staging of these works
- No allowance has been made for landscaping works
- No allowance has been made for service depthing, liaison with service authorities, design of service relocations
- No allowance has been made for project delivery costs including project management
- Calculations assume clay soil and no rock will be encountered
- No allowance has been made for the relocation of services. This is likely to be an issue where there is duplication of large pipes within the road corridor.
- No allowance has been made for reinstatement of road pavement/footpaths

These estimates are to be considered as indicative only, and are not purported to represent anything more than an indication of the cost of the scope of the work.

Tonkin Consulting recommend that an appropriately qualified quantity surveyor be consulted to provide detailed market cost inputs.

CONSTRUCTION COST ESTIMATE

Project: **West Lakes SMP**
Job No: 20190818
Date: 28/07/2021
Revision: A
Summary of works: Beatrice Avenue and Trimmer Parade pipe upgrades
Estimated: BT
Review: BJT

Item No	Description	Comment	Unit	Qty	Rate	Cost
1.0	**Preliminaries**					
1.1	Preliminaries	Assumed to be 10% of estimate				$ 688,185.27
	Sub-Total					**$ 688,185.27**
2.0	**Construction costs**					
2.1	300 mm diameter RCP		m	19	$ 217.00	$ 4,123.00
2.2	375 mm diameter RCP		m	1,517	$ 280.00	$ 424,760.00
2.3	450 mm diameter RCP		m	397	$ 398.00	$ 158,006.00
2.4	525 mm diameter RCP		m	352	$ 433.00	$ 152,416.00
2.5	1200 x 750 RCBC		m	730	$ 1,916.00	$ 1,398,680.00
2.6	1650 x 750 RCBC		m	460	$ 2,310.00	$ 1,062,600.00
2.7	1750 x 750 RCBC		m	199	$ 2,520.00	$ 501,480.00
2.8	1800 x 900 RCBC		m	539	$ 4,500.00	$ 2,425,500.00
2.9	Side entry pit	Assumed to be Double SEPs	item	52	$ 3,727.84	$ 193,847.68
2.10	Junction box	Assumed every 100 m	each	43	$ 9,130.00	$ 392,590.00
	Sub-Total					**$ 6,714,002.68**
3.0	**Other costs**					
3.1	Design cost	Assumed to be 2.5% of construction cost	item			$ 167,850.07
	Sub-Total					**$ 167,850.07**

Sub-total		**$ 7,570,038.02**
Contingency	20%	$ 1,514,007.60
Grand Total		**$ 9,084,045.63**

Note: **Cost estimates provided by Tonkin Consulting are based upon historic cost information and experience, and do not allow for:**

- Latent conditions
- Changes in scope
- Market conditions (i.e. competition, escalation)
- No allowance for approvals for these works
- No allowance for site contamination and remediation or disposal of contaminated material
- No allowance for land acquisition
- No allowance has been made for the staging of these works
- No allowance has been made for landscaping works
- No allowance has been made for service depthing, liaison with service authorities, design of service relocations
- No allowance has been made for project delivery costs including project management
- Calculations assume clay soil and no rock will be encountered
- No allowance has been made for the relocation of services. This is likely to be an issue where there is duplication of large pipes within the road corridor.
- No allowance has been made for reinstatement of road pavement/footpaths

These estimates are to be considered as indicative only, and are not purported to represent anything more than an indication of the cost of the scope of the work.
Tonkin Consulting recommend that an appropriately qualified quantity surveyor be consulted to provide detailed market cost inputs.

CONSTRUCTION COST ESTIMATE

Project: **West Lakes SMP**
Job No: 20190818
Date: 28/07/2021
Revision: A
Summary of works: Matheson Reserve underground tank
Estimated: BT
Review: BJT

Item No	Description	Comment	Unit	Qty	Rate	Cost
1.0	**Preliminaries**					
1.1	Preliminaries	Assumed to be 10% of estimate				$ 750,624.47
	Sub-Total					**$ 750,624.47**
2.0	**Construction costs**					
2.1	Excavation and disposal of spoil		m^3	45,000	$ 38.00	$ 1,710,000.00
2.2	Topsoil stripping and stockpiling		m^2	15,000	$ 3.50	$ 52,500.00
2.3	Topsoil respreading		m^2	15,000	$ 5.00	$ 75,000.00
2.4	Tree removal		item	5	$ 250.00	$ 1,250.00
2.5	Undergound storage tank	Supply and installation of proprietary tank	m^3	20,000	$ 270.00	$ 5,400,000.00
2.7	Drainage easement		m^2	1,420	$ 30.00	$ 42,600.00
2.8	300 mm diameter RCP	Inlet and outlet pipe	m	85	$ 217.00	$ 18,445.00
2.9	450 mm diameter RCP	Inlet pipe	m	240	$ 398.00	$ 95,520.00
	Sub-Total					**$ 7,395,315.00**
3.0	**Other costs**					
3.1	Design cost	Assumed to be 1.5% of construction cost	item			$ 110,929.73
	Sub-Total					**$ 110,929.73**
4.0	**Annual maintenance costs**					
4.1	Inspection and maintenance		item	1	$ 2,000.00	$ 2,000.00
	Sub-Total					**$ 2,000.00**

Sub-total		**$ 8,258,869.20**
Contingency	20%	$ 1,651,773.84
Grand Total		**$ 9,910,643.04**

Note: **Cost estimates provided by Tonkin Consulting are based upon historic cost information and experience, and do not allow for:**

- Latent conditions
- Changes in scope
- Market conditions (i.e. competition, escalation)
- No allowance for approvals for these works
- No allowance for site contamination and remediation or disposal of contaminated material
- No allowance for land acquisition
- No allowance has been made for the staging of these works
- No allowance has been made for landscaping works
- No allowance has been made for service depthing, liaison with service authorities, design of service relocations
- No allowance has been made for project delivery costs including project management
- Calculations assume clay soil and no rock will be encountered

These estimates are to be considered as indicative only, and are not purported to represent anything more than an indication of the cost of the scope of the work.

Tonkin Consulting recommend that an appropriately qualified quantity surveyor be consulted to provide detailed market cost inputs.

CONSTRUCTION COST ESTIMATE

Project: **West Lakes SMP**
Job No: 20190818
Date: 28/07/2021
Revision: A
Summary of works: Frank Mitchell Reserve underground tank
Estimated: BT
Review: BJT

Item No	Description	Comment	Unit	Qty	Rate	Cost
1.0	**Preliminaries**					
1.1	Preliminaries	Assumed to be 10% of estimate				$ 1,140,043.13
	Sub-Total					**$ 1,140,043.13**
2.0	**Construction costs**					
2.1	Excavation and disposal of spoil		m^3	36,000	$ 38.00	$ 1,368,000.00
2.2	Topsoil stripping and stockpiling		m^2	12,000	$ 3.50	$ 42,000.00
2.3	Topsoil respreading		m^2	12,000	$ 5.00	$ 60,000.00
2.4	Undergound storage tank	Supply and installation of proprietary tank	m^3	36,000	$ 270.00	$ 9,720,000.00
2.6	Pipe capping	Concrete capping of bypassed pipe	item	2	$ 500.00	$ 1,000.00
2.7	300 mm diameter RCP	Outlet pipe	m	20	$ 217.00	$ 4,340.00
2.8	1350 mm diameter RCP	Inlet diversion pipe	m	18	$ 2,034.00	$ 36,612.00
	Sub-Total					**$ 11,231,952.00**
3.0	**Other costs**					
3.1	Design cost	Assumed to be 1.5% of construction cost	item			$ 168,479.28
	Sub-Total					**$ 168,479.28**
4.0	**Annual maintenance costs**					
4.1	Inspection and maintenance		item	1	$ 2,000.00	$ 2,000.00
	Sub-Total					**$ 2,000.00**

Sub-total		**$ 12,540,474.41**
Contingency	20%	$ 2,508,094.88
Grand Total		**$ 15,048,569.29**

Note: **Cost estimates provided by Tonkin Consulting are based upon historic cost information and experience, and do not allow for:**

- Latent conditions
- Changes in scope
- Market conditions (i.e. competition, escalation)
- No allowance for approvals for these works
- No allowance for site contamination and remediation or disposal of contaminated material
- No allowance for land acquisition
- No allowance has been made for the staging of these works
- No allowance has been made for landscaping works
- No allowance has been made for service depthing, liaison with service authorities, design of service relocations
- No allowance has been made for project delivery costs including project management
- Calculations assume clay soil and no rock will be encountered

These estimates are to be considered as indicative only, and are not purported to represent anything more than an indication of the cost of the scope of the work.

Tonkin Consulting recommend that an appropriately qualified quantity surveyor be consulted to provide detailed market cost inputs.

CONSTRUCTION COST ESTIMATE

Project: **West Lakes SMP**
Job No: 20190818
Date: 28/07/2021
Revision: A
Summary of works: Nedford Reserve detention basin
Estimated: BT
Review: BJT

Item No	Description	Comment	Unit	Qty	Rate	Cost
1.0	**Preliminaries**					
1.1	Preliminaries	Assumed to be 10% of estimate				$ 18,211.69
	Sub-Total					**$ 18,211.69**
2.0	**Construction costs**					
2.1	Excavation and disposal of spoil		m^3	1,560	$ 38.00	$ 59,280.00
2.2	Tree removal		item	4	$ 250.00	$ 1,000.00
2.4	300 mm diameter RCP	Inlet diversion and outlet pipe	m	27	$ 217.00	$ 5,859.00
2.5	Pipe capping	Concrete capping for bypassed pipe	item	2	$ 500.00	$ 1,000.00
2.6	Headwall and connection to existing	375 mm RCP outlet headwall	item	1	$ 800.00	$ 800.00
2.7	Headwall and connection to existing	600 x 300 RCBC inlet headwall	item	1	$ 1,125.00	$ 1,125.00
2.8	Topsoil respreading		m^2	1,300	$ 5.00	$ 6,500.00
2.9	Topsoil strip and stockpiling		m^2	1,300	$ 3.50	$ 4,550.00
	Sub-Total					**$ 80,114.00**
3.0	**Other costs**					
3.1	Design cost	Assumed to be 2.5% of construction cost	item			$ 2,002.85
3.2	Landscaping					$ 100,000.00
	Sub-Total					**$ 102,002.85**
4.0	**Annual maintenance costs**					
4.1	Basin maintenance	Mow and slash grass	m^2	1,300	$ 1.50	$ 1,950.00
	Sub-Total					**$ 1,950.00**

Sub-total		**$ 200,328.54**
Contingency	20%	$ 40,065.71
Grand Total		**$ 240,394.24**

Note:

Cost estimates provided by Tonkin Consulting are based upon historic cost information and experience, and do not allow for:

- Latent conditions
- Changes in scope
- Market conditions (i.e. competition, escalation)
- No allowance for approvals for these works
- No allowance for site contamination and remediation or disposal of contaminated material
- No allowance for land acquisition
- No allowance has been made for the staging of these works
- No allowance has been made for landscaping works
- No allowance has been made for service depthing, liaison with service authorities, design of service relocations
- No allowance has been made for project delivery costs including project management
- Calculations assume clay soil and no rock will be encountered

These estimates are to be considered as indicative only, and are not purported to represent anything more than an indication of the cost of the scope of the work.

Tonkin Consulting recommend that an appropriately qualified quantity surveyor be consulted to provide detailed market cost inputs.

CONSTRUCTION COST ESTIMATE

Project: **West Lakes SMP**
Job No: 20190818
Date: 28/07/2021
Revision: A
Summary of works: Golfers Avenue pipe and pump upgrades
Estimated: BT
Review: BJT

Item No	Description	Comment	Unit	Qty	Rate	Cost
1.0	**Preliminaries**					
1.1	Preliminaries	Assumed to be 10% of estimate				$ 252,661.81
	Sub-Total					**$ 252,661.81**
2.0	**Construction costs**					
2.1	300 mm diameter RCP		m	377	$ 217.00	$ 81,809.00
2.2	375 mm diameter RCP		m	73	$ 280.00	$ 20,440.00
2.3	450 mm diameter RCP		m	742	$ 398.00	$ 295,316.00
2.4	525 mm diameter RCP		m	136	$ 433.00	$ 58,888.00
2.5	750 mm diameter RCP		m	175	$ 694.00	$ 121,450.00
2.6	900 mm diameter RCP		m	314	$ 904.00	$ 283,856.00
2.6	1050 mm diameter RCP		m	8	$ 1,302.00	$ 10,416.00
2.7	300 x 150 RCBC		m	2	$ 362.46	$ 724.92
2.8	450 x 225 RCBC		m	184	$ 552.66	$ 101,689.44
2.9	Pump station upgrades	Additional pumps to meet 750 L/s	item	1	$ 1,000,000.00	$ 1,000,000.00
2.10	Rising main infrastructure	Upsize the rising main to cater for increased flow	item	1	$100,000	$ 100,000.00
2.11	Side entry pit	Assumed to be double SEPs	item	40	$ 3,727.84	$ 149,113.60
2.12	Junction box	Assumed every 100 m	each	20	$ 9,130.00	$ 182,600.00
	Sub-Total					**$ 2,406,302.96**
3.0	**Other costs**					
3.1	Design cost	Assumed to be 5% of construction cost	item			$ 120,315.15
	Sub-Total					**$ 120,315.15**

Sub-total		**$ 2,779,279.92**
Contingency	20%	$ 555,855.98
Grand Total		**$ 3,335,135.90**

Note:

Cost estimates provided by Tonkin Consulting are based upon historic cost information and experience, and do not allow for:

- Latent conditions
- Changes in scope
- Market conditions (i.e. competition, escalation)
- No allowance for approvals for these works
- No allowance for site contamination and remediation or disposal of contaminated material
- No allowance for land acquisition
- No allowance has been made for the staging of these works
- No allowance has been made for landscaping works
- No allowance has been made for service depthing, liaison with service authorities, design of service relocations
- No allowance has been made for project delivery costs including project management
- Calculations assume clay soil and no rock will be encountered

These estimates are to be considered as indicative only, and are not purported to represent anything more than an indication of the cost of the scope of the work.

Tonkin Consulting recommend that an appropriately qualified quantity surveyor be consulted to provide detailed market cost inputs.

CONSTRUCTION COST ESTIMATE

Project: **West Lakes SMP**
Job No: 20190818
Date: 28/07/2021
Revision: A
Summary of works: Sansom Road pipe upgrades
Estimated: BT
Review: BJT

Item No	Description	Comment	Unit	Qty	Rate	Cost
1.0	**Preliminaries**					
1.1	Preliminaries	Assumed to be 10% of estimate				$ 502,994.96
	Sub-Total					**$ 502,994.96**
2.0	**Construction costs**					
2.1	300 mm diameter RCP		m	576	$ 217.00	$ 124,992.00
2.2	375 mm diameter RCP		m	494	$ 280.00	$ 138,320.00
2.3	450 mm diameter RCP		m	162	$ 415.00	$ 67,230.00
2.4	525 mm diameter RCP		m	531	$ 484.00	$ 257,004.00
2.5	600 mm diameter RCP		m	434	$ 544.00	$ 236,096.00
2.6	675 mm diameter RCP		m	39	$ 598.00	$ 23,322.00
2.6	750 mm diameter RCP		m	389	$ 694.00	$ 269,966.00
2.7	900 mm diameter RCP		m	421	$ 989.00	$ 416,369.00
2.8	1200 mm diameter RCP		m	1,116	$ 1,700.00	$ 1,897,200.00
2.9	1350 mm diameter RCP		m	440	$ 2,034.00	$ 894,960.00
2.10	300 x 225 RCBC		m	197	$ 380.32	$ 74,923.04
2.11	375 x 225 RCBC		m	203	$ 475.40	$ 96,506.20
2.12	600 x 225 RCBC		m	66	$ 552.65	$ 36,474.90
2.13	600 x 375 RCBC		m	12	$ 714.70	$ 8,576.40
2.14	Side entry pit	Assumed to be double SEPs	item	98	$ 3,727.84	$ 365,328.32
2.15	Junction box	Assumed every 100 m	each	51	$ 9,130.00	$ 465,630.00
	Sub-Total					**$ 4,907,267.86**
3.0	**Other costs**					
3.1	Design cost	Assumed to be 2.5% of construction cost	item			$ 122,681.70
	Sub-Total					**$ 122,681.70**

Sub-total		**$ 5,532,944.51**
Contingency	20%	$ 1,106,588.90
Grand Total		**$ 6,639,533.41**

Note: **Cost estimates provided by Tonkin Consulting are based upon historic cost information and experience, and do not allow for:**

- Latent conditions
- Changes in scope
- Market conditions (i.e. competition, escalation)
- No allowance for approvals for these works
- No allowance for site contamination and remediation or disposal of contaminated material
- No allowance for land acquisition
- No allowance has been made for the staging of these works
- No allowance has been made for landscaping works
- No allowance has been made for service depthing, liaison with service authorities, design of service relocations
- No allowance has been made for project delivery costs including project management
- Calculations assume clay soil and no rock will be encountered

These estimates are to be considered as indicative only, and are not purported to represent anything more than an indication of the cost of the scope of the work.

Tonkin Consulting recommend that an appropriately qualified quantity surveyor be consulted to provide detailed market cost inputs.

CONSTRUCTION COST ESTIMATE

Project: **West Lakes SMP**
Job No: 20190818
Date: 28/07/2021
Revision: A
Summary of works: Recreation Parade detention basin
Estimated: BT
Review: BJT

Item No	Description	Comment	Unit	Qty	Rate	Cost
1.0	**Preliminaries**					
1.1	Preliminaries	Assumed to be 10% of civil works estimate				$ 12,502.92
	Sub-Total					**$ 12,502.92**
2.0	**Construction costs**					
2.1	Property acquisition		each	4	$ 750,000.00	$ 3,000,000.00
2.2	Demolition of properties		m^2	930	$ 43.70	$ 40,641.00
2.3	Excavation and disposal of soil		m^3	1,560	$ 38.00	$ 59,280.00
2.4	375 mm diameter RCP	Outlet pipe	m	12	$ 280.00	$ 3,360.00
2.5	600 mm diameter RCP	Inlet diversion pipe	m	10	$ 544.00	$ 5,440.00
	Sub-Total					**$ 3,108,721.00**
3.0	**Other costs**					
3.1	Design cost	Assumed to be 15% of construction cost	item			$ 16,308.15
	Sub-Total					**$ 16,308.15**
4.0	**Annual maintenance costs**					
4.1	Basin maintenance	Mow and slash grass	m^2	1,460	$ 1.50	$ 2,190.00
	Sub-Total					**$ 2,190.00**

Sub-total		**$ 3,137,532.07**
Contingency	20%	$ 627,506.41
Grand Total		**$ 3,765,038.48**

Note: **Cost estimates provided by Tonkin Consulting are based upon historic cost information and experience, and do not allow for:**

- Latent conditions
- Changes in scope
- Market conditions (i.e. competition, escalation)
- No allowance for approvals for these works
- No allowance for site contamination and remediation or disposal of contaminated material
- No allowance for land acquisition
- No allowance has been made for the staging of these works
- No allowance has been made for landscaping works
- No allowance has been made for service depthing, liaison with service authorities, design of service relocations
- No allowance has been made for project delivery costs including project management
- Calculations assume clay soil and no rock will be encountered

These estimates are to be considered as indicative only, and are not purported to represent anything more than an indication of the cost of the scope of the work.

Tonkin Consulting recommend that an appropriately qualified quantity surveyor be consulted to provide detailed market cost inputs.

CONSTRUCTION COST ESTIMATE

Project: **West Lakes SMP**
Job No: 20190818
Date: 28/07/2021
Revision: A
Summary of works: Market Corner pipe upgrades
Estimated: BT
Review: BJT

Item No	Description	Comment	Unit	Qty	Rate	Cost
1.0	**Preliminaries**					
1.1	Preliminaries	Assumed to be 10% of estimate				$ 29,691.61
	Sub-Total					**$ 29,691.61**
2.0	**Construction costs**					
2.1	300 mm diameter RCP		m	180	$ 217.00	$ 39,060.00
2.2	375 mm diameter RCP		m	73	$ 280.00	$ 20,440.00
2.3	450 mm diameter RCP		m	262	$ 415.00	$ 108,730.00
2.4	600 mm diameter RCP		m	91	$ 544.00	$ 49,504.00
2.5	Side entry pit	Assumed to be double SEPs	item	14	$ 3,727.84	$ 52,189.76
2.6	Junction box	Assumed every 100 m	each	7	$ 6,570.00	$ 45,990.00
	Sub-Total					**$ 269,923.76**
3.0	**Other costs**					
3.1	Design cost	Assumed to be 10% of construction cost	item			$ 26,992.38
	Sub-Total					**$ 26,992.38**

Sub-total		**$ 326,607.75**
Contingency	20%	$ 65,321.55
Grand Total		**$ 391,929.30**

Note: **Cost estimates provided by Tonkin Consulting are based upon historic cost information and experience, and do not allow for:**

- Latent conditions
- Changes in scope
- Market conditions (i.e. competition, escalation)
- No allowance for approvals for these works
- No allowance for site contamination and remediation or disposal of contaminated material
- No allowance for land acquisition
- No allowance has been made for the staging of these works
- No allowance has been made for landscaping works
- No allowance has been made for service depthing, liaison with service authorities, design of service relocations
- No allowance has been made for project delivery costs including project management
- Calculations assume clay soil and no rock will be encountered

These estimates are to be considered as indicative only, and are not purported to represent anything more than an indication of the cost of the scope of the work.

Tonkin Consulting recommend that an appropriately qualified quantity surveyor be consulted to provide detailed market cost inputs.

Appendix F – Decision-making framework

West Lakes Catchment Stormwater Management Plan

Stage 3 Report – Decision Making Framework

City of Charles Sturt

CCS045206
4 December 2020
Ref: 20190818R003RevC

tonkin

Building exceptional outcomes together

Document History and Status

Rev	Description	Author	Reviewed	Approved	Date
A	For Council input of MCA framework	MM	OO	OO	30/10/20
B	For Council input of MCA framework (re-issue)	MM	OO	OO	04/11/20
C	For stakeholder comment	MM	OO	OO	04/12/20

Contents

Project: West Lakes Catchment Stormwater Management Plan | Stage 3 Report – Decision Making Framework
Client: City of Charles Sturt
Ref: 20190818R003RevC

Tables

Figures

Appendices

1 Introduction

Tonkin has been engaged by the City of Charles Sturt (Council) to prepare a stormwater management plan (SMP) for the West Lakes catchment. Once developed, the SMP will provide the framework for a coordinated, multi-objective approach for the management of stormwater within the catchment area.

The Stage 1 report provided details of the investigations that have been undertaken to date, including a summary of relevant studies and a review of available data. It also provided a summary of existing and future catchment conditions, with a recommendation for the catchment and climatic factors to be used in the hydrologic and hydraulic modelling.

The Stage 2 report built upon the work undertaken in Stage 1, identifying stormwater management problems and opportunities for achieving outcomes for public and environmental benefit in the catchment.

This report (Stage 3) describes the development of a framework to provide decision-makers with a tool to assess and compare the net benefits of proposed strategies for the management of stormwater within the West Lakes catchment. The decision-making tool described in this report will be used to compare and select stormwater management strategies that address the stated objectives for stormwater management within the catchment. The multi-criteria analysis criteria and weightings contained in this report are suggestions only and are subject to confirmation by Council.

2 Optimised Decision-Making Methodology

2.1 Background

Our approach is generally consistent with the 'Optimised Decision Making Guidelines' (ODMG) (NZNAMSG, 2004). The guidelines were developed to *"allow the application of the very best management techniques and practices to ensure that the decisions made on maintaining, renewing and investing in new assets are both optimal and sustainable"*.

The development of the West Lakes Stormwater Management Plan (SMP) will require the selection of solutions to identified problems from a range of available measures. The ODMG process will be applied as a tool to support the decision-making process, considering a range of objectives, in the preparation of the SMP.

2.2 Process overview

The process to implement the ODMG is flexible, and in preparing the SMP will be implemented according to a four-step process, as described below.

Step 1 – define the problem or opportunity

The definitions of problems or opportunities will relate to a particular problem (such as flooding) or desire to achieve a particular objective (such as a catchment water harvesting target). These problems and opportunities have been identified during the Stage 2 investigations.

Step 2 – identify potential options to manage the problem or opportunity

This step requires the broad identification of all possible solutions. Alongside these, a list of non-negotiable criteria ('deal breakers' such as performance standards and use of valuable open space) would apply, some of which may emerge in response to the nature of the solutions put forward. The options list is then subsequently reduced to a shortlist of potential options according to these criteria.

Step 3 – multi-criteria analysis of the potential options

The options are evaluated against a range of criteria that include economic, environmental and social considerations. All options are scored against each of the criteria which are given a weighting based on their (pre-agreed) relative importance.

Step 4 – identify the optimal solution

This step generally involves selecting a solution that obtains the highest score in the evaluation process.

2.3 Stormwater management goals

The key issues to be addressed in the development of any plan for the management of stormwater runoff from an urban catchment include:

- flooding
- water quality
- water use
- environmental protection and enhancement
- asset management.

Catchment specific objectives are set based upon the problems and opportunities identified within the study area. The Stormwater Management Planning Guidelines (SMA 2007) state that, as a minimum, objectives are to set measurable goals for:

- An acceptable level of protection of the community and both private and public assets from flooding.

- Management of the quality of runoff and effect on the receiving waters, both terrestrial and marine where relevant.
- Extent of beneficial use of stormwater.
- Desirable end-state values for watercourses and riparian ecosystems.
- Desirable planning outcomes associated with new development, open space, recreation and amenity.
- Sustainable management of stormwater infrastructure, including maintenance.

These broad goals have been used as the basis for defining the components that feed into the multi-criteria analysis described below.

2.4 Multi-criteria analysis

Options for the management of stormwater within the study area will be developed as part of the SMP. As part of optimising the selection of strategies for implementation, a multi-criteria analysis will be undertaken. It is proposed to use six main evaluation criteria which broadly align with the goals defined for stormwater management. A number of sub-criteria will also be used. Each of the proposed criteria is described in more detail below.

2.4.1 Flood protection

Flooding has been identified as a key concern within the study area and as part of the Stage 2 work a number of areas throughout the study area have been identified as being flood prone.

The weighting assigned to this criterion is related to the likely improvement in flooding (and associated risk).

2.4.2 Runoff quality and impact on receiving environment

Runoff from urban areas should be at least of a quality that does not cause degradation of the receiving waters (in this case West Lakes), and ultimately does not further contribute to the degradation of Adelaide's coastal marine environment through inputs of nutrient rich, turbid and coloured water cause further the coastal marine environment. Microplastics have also been identified as a key water quality concern within the study area.

The water quality targets shown in Table 2.1 are consistent with the latest state-wide WSUD performance targets (DEWNR, 2013) and are expected to be consistent with the requirements of the new Planning and Design Code (Phase 3) when it is released..

Table 2.1 Water quality targets

Pollutant	Reduction target
Total suspended solids (TSS)	80% reduction of the untreated urban annual load
Total phosphorus (TP)	60% reduction of the untreated urban annual load
Total nitrogen (TN)	45% reduction of the untreated urban annual load
Gross pollutants (GP)	90% reduction of the untreated urban annual load

It is proposed to divide this criterion into four sub-criteria:

- Removal of gross pollutants (which can be modelled within the Model for Urban Stormwater Improvement Conceptualisation (MUSIC)).
- Removal of suspended solids (can be modelled using MUSIC).
- Removal of nutrients (can be modelled using MUSIC).
- Reduction in micro-plastics.

2.4.3 Beneficial use of stormwater

The reuse of stormwater provides a number of benefits – it reduces the flows (and hence pollutants) into the receiving environment, it can promote vegetation growth thereby reducing the urban heat island effect and improving amenity value and it can also reduce the reliance on mains water consumption resulting in economic and environmental benefits. Council places a high value on increasing tree canopy cover and biodiversity within the catchment.

The criterion associated with the beneficial use of stormwater will be split into two sub-criteria.

PASSIVE REUSE FOR URBAN GREENING

The passive infiltration of surface water into the underlying shallow aquifer and the irrigation of vegetated areas such that downstream flows mimic the predevelopment flow regime. Examples include infiltration areas, biofiltration zones and swales.

STORAGE AND REUSE

Stormwater harvesting for water reuse. A target for reuse would be to provide a noticeable reduction in mains water usage. Storage and reuse can occur on a range of scales from individual rainwater tanks through to new or supplemented managed aquifer recharge (MAR) schemes.

2.4.4 Social values

Given the heavily urbanised nature of a large portion of the study area, the social values associated with the management of stormwater are considered to be important. The social values will be considered using the following four sub-criteria:

IMPROVED VISUAL AMENITY

Beautify developed areas by landscaping drainage elements such as wetlands and other WSUD features. WSUD features also have the potential to improve visual amenity if they result in improved vegetative health through increased infiltration.

IMPROVED SAFETY

Reduce high flood hazard (i.e. deep and fast flowing water) for the public.

ADDITIONAL USEFUL OPEN SPACE

Improve the functionality and the services available within an area of open space that is currently unavailable for public use e.g. wetlands or green space/green trails within drainage corridors.

DISRUPTION DURING CONSTRUCTION

The construction of some items of new infrastructure may result in disruption to the public. This could include physical displacement and traffic disruptions during construction. Given the relatively short-term impacts of construction, this will be given a lower weighting.

2.4.5 Environmental protection and enhancement

The management of stormwater offers opportunities for environmental protection and enhancement through habitat creation and increased biodiversity. The greatest benefits are likely to be in the construction of regional scale measures (such as wetlands and basins).

2.4.6 Economics

The capital and maintenance costs feed into Council's financial planning and asset management strategies. The cost criterion will be broken into the following three sub-criteria:

CAPITAL COST

The capital cost criteria relates to the upfront capital cost of the proposed works. This would be compared against what could reasonably be afforded by Council and the sources of financial support that may be available for each strategy.

ECONOMIC VIABILITY

The economic viability compares the capital cost of the works to the benefits derived from less flood damages to enable the derivation of a benefit to cost ratio. Due to the inability to quantify the benefits, the economic viability of non-structural works will be assessed qualitatively.

RECURRING/MAINTENANCE COST

Once established most new infrastructure will require some form of maintenance, therefore representing ongoing costs for Council. Consideration of ongoing costs is important when considering the affordability of the works.

Reflecting the importance of cost for the implementation of the works, the cost criterion has been assigned a relatively high weighting.

2.5 Criteria weightings

The weightings assigned to each of the criteria are subject to confirmation by Council. Table 2.2 and Table 2.3 show the suggested weightings for each of the criteria and sub-criteria. The weightings are not fixed and can be adjusted depending on the type of problem that is being assessed. For example, if the problem were focussed primarily on runoff quality, the flood protection weighting could be reduced to allow a higher importance to be placed on runoff quality.

It should be noted that the criteria/sub-criteria are not mutually exclusive; stormwater management options which result in the beneficial use of stormwater will most likely also result in improvements to runoff quality.

Table 2.2 Weighting of main criteria

Criteria	Weighting
Flood protection	30
Runoff quality and impact on receiving environment	25
Beneficial use of stormwater	10
Social values	5
Environmental benefit	5
Capital cost, maintenance cost and economic viability	25
TOTAL	**100**

Table 2.3 Weighting of sub-criteria

Criteria	Sub-Weighting
Flood protection of development	
Improved flood protection	100

Criteria	Sub-Weighting
Runoff quality and impact on receiving environment	
Reduction in gross pollutants	15
Reduction in suspended solids	40
Reduction in nutrients	30
Reduction in micro-plastics	15
Beneficial use of stormwater	
Storage and reuse	70
Passive reuse for urban greening	30
Social values	
Improved visual amenity	25
Improved public safety	40
Additional useful open space	25
Disruption during construction	10
Environmental benefit	
Habitat creation	50
Increased biodiversity	50
Capital and maintenance cost	
Capital cost	45
Economic viability	45
Maintenance cost	10

Each of the identified stormwater management options will be given a rating against each criterion. The ratings used for each criterion range from 0 through to 4. A description of the rating criteria is provided in Table 2.4.

Table 2.4 Criterion weighting guide

Rating	Flood protection of development
0	No improvement to existing flood risk.
1	Low level of improvement to flood risk.
2	Moderate improvement to flood risk.
3	Large improvement to flood risk. Flood protection during 10%–2% AEP event.
4	Large improvement to flood risk. Flood protection during 1% AEP event, the maximum level that can reasonably be expected.

Rating	Runoff quality and impact on receiving environment
0	No improvement in water quality.
1	Low level of improvement in downstream water quality.
2	Moderate improvement in downstream water quality.
3	Large improvement in downstream water quality.
4	Significant improvement in downstream water quality. Maximum level of improvement that could reasonably be achieved.

Rating	Beneficial use of stormwater
0	No beneficial use of stormwater.
1	Low level of beneficial use of stormwater.
2	Moderate beneficial use of stormwater.
3	Large beneficial use of stormwater.
4	Significant beneficial use of stormwater. Maximum level of improvement that could reasonably be achieved.

Table 2.4 Criterion weighting guide (continued)

Rating	Social values
0	No improvement in social values.
1	Low level of improvement in social values.
2	Moderate improvement in social values.
3	Large improvement in social values.
4	Significant improvement in social values. Maximum level of improvement that could reasonably be achieved.

Rating	Environmental benefit
0	No environmental benefit.
1	Low level of environmental benefit.
2	Moderate environmental benefit.
3	Large environmental benefit.
4	Significant environmental benefit. Maximum level of improvement that could reasonably be achieved.

Rating	Capital, economic viability and maintenance cost
0	Significant costs incurred. Major Council expenditure. Would require significant forward financial planning. Benefit/cost ratio significantly lower than other options and below 1.0.
1	Large costs incurred. Large Council expenditure. Likely to require changes to Council financial planning. Benefit/cost ratio moderately lower than other options.
2	Moderate cost option. Likely to be accommodated based on existing Council budgets. Benefit/cost ratio similar to other options.
3	Low cost option. Benefit/cost ratio moderately higher than other options.
4	Insignificant cost option. Benefit/cost ratio significantly higher than other options and above 1.0.

3 Worked examples

The following examples illustrate how the proposed process would be applied in deciding how to manage stormwater within the catchment. The matrices provided in Appendix A show how the examples would be evaluated.

3.1 Example 1 – flood risk

3.1.1 Step 1: Define the problem

The problem to be addressed is defined as follows: "Reduce the flood risk in the vicinity of Meakin Terrace."

Flooding within the area surrounding Meakin Terrace for the 20% AEP event is shown in Figure 3.1. The legend showing the depth of inundation is provided in Figure 3.2.

Figure 3.1 Flooding surrounding Meakin Terrace (20% AEP event)

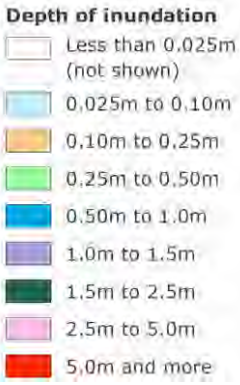

Figure 3.2 Flood inundation map legend

3.1.2 Step 2: Identify potential solutions

The following options to reduce flood risk have been identified:

1. Upgrade the trunk drain discharging to Grange Lakes so that there is no flooding or nearly no flooding in the identified area during a 20% AEP event.
2. Use the available open space within Wilford Reserve to construct a detention basin to detain runoff during rainfall events.
3. Educate the public – let people know that they are in a flood prone area.
4. Develop a flood warning system to provide residents with sufficient time to evacuate.

3.1.3 Step 3: Identify and evaluate the benefits and costs

This process would involve estimating the capital and ongoing costs associated with the mitigation measures. Flood damages would also be calculated, allowing the benefit to cost ratio of the works to be determined.

3.1.4 Step 4: Select the optimal solution

A comparison of the total scores of each option allows the optimal solution, based on the weighted criteria, to be identified.

In this instance, the Wilford Reserve detention basin obtained the highest score and would be the recommended measure to address the flood risk. Note that when working through the solutions in more detail, a combination of measures (such as pipe upgrades and the detention basin may be considered).

3.2 Example 2 – Water quality

This example is intended to show how the MCA works for non-flood related problems.

3.2.1 Step 1: Define the problem

The problem to be addressed is defined as follows: "Improve the water quality of runoff discharging to the Grange Lakes."

3.2.2 Step 2: Identify potential solutions

The following options for improving water quality have been identified:

1. Install gross pollutant traps at all outlets to the Grange Lakes.
2. Undertake precinct-scale works within the catchment, such as the construction of raingardens.
3. Channel works (such as deepening and widening) and planting of vegetation (aquatic and riparian).
4. Channel works and plantings with creation of a wetland.

3.2.3 Step 3: Identify and evaluate the benefits and costs

This process would involve estimating the capital and ongoing costs associated with the mitigation measures. The benefits could be determined either qualitatively or quantitatively with a MUSIC model.

3.2.4 Step 4: Select the optimal solution

A comparison of the total scores of each option allows the optimal solution, based on the weighted criteria, to be identified.

In this instance, the channel works, plantings and wetland obtained the highest score and would be the recommended measure to improve water quality.

As with the flood mitigation worked above, it is likely that the preferred solution would be a combination of multiple options.

4 References

Department of Environment, Water and Natural Resources (2013), *Water sensitive urban design – Creating more liveable and water sensitive cities in South Australia*, Government of South Australia.

New Zealand National Asset Management Steering Group (2004), *Optimised decision making guidelines: A sustainable approach to managing infrastructure*, 1st Edition, Thames, New Zealand.

Appendix A – Worked example results

Option	Criteria	Flood Protection of Development		Runoff Quality and Effect on Receiving Waters					Beneficial Use of Stormwater			Social Values					Environmental Benefit			Economics				Total Criteria Weighting
	Sub-Criteria	Improved flood protection	Criteria weighting	Reduction in gross pollutants	Reduction in suspended solids	Reduction in nutrients	Reduction in micro plastics	Criteria weighting	Storage and reuse	Passive reuse	Criteria weighting	Improved visual amenity	Improved public safety	Additional useful open space	Disruption during implementation	Criteria weighting	Habitat creation	Increased biodiversity	Criteria weighting	Capital Cost	Economic viability	Recurring / Maintenance Cost	Criteria weighting	Total Weighted Score
	Sub-criteria Weighting	100	**30**	15	40	30	15	**25**	70	30	**10**	35	20	35	10	**5**	50	50	**5**	45	45	10	**25**	**100**
Upgrade trunk drain	Score (max=4)	4	**30**	0	0	0	0	**0**	0	0	**0**	0	2	0	0	**0.5**	0	0	**0**	0	2	3	**7.5**	**38.0**
	Weighted Score	30		0	0	0	0		0	0		0	0.5	0	0		0	0		0	5.6	1.88		
Wilford Reserve detention basin	Score (max=4)	3	**22.5**	1	2	1	0	**7.8**	1	1	**2.5**	2	1	0	2	**1.4**	1	1	**1.3**	1	2	1	**9.1**	**44.5**
	Weighted Score	22.5		0.94	5.00	1.875	0		2	1		0.88	0.25	0.00	0.25		0.63	0.63		2.81	5.63	0.63		
Education and awareness	Score (max=4)	1	**7.5**	0	0	0	0	**0.0**	1	0	**0.0**	0	1	0	4	**0.8**	0	0	**0.0**	3	3	2	**18.1**	**26.4**
	Weighted Score	7.5		0.00	0.00	0.00	0.00		0	0		0.00	0.25	0	0.50		0	0		8.4	8.4375	1.25		
Flood warning system	Score (max=4)	1	**7.5**	0	0	0	0	**0**	0	0	**0**	0	2	0	4	**1.0**	0	0	**0**	2	3	1	**14.7**	**23.2**
	Weighted Score	7.5		0	0	0	0		0	0		0	0.5	0	0.50		0	0		5.6	8.4	0.63		

Option	Criteria	Flood Protection of Development		Runoff Quality and Effect on Receiving Waters					Beneficial Use of Stormwater			Social Values					Environmental Benefit			Economics				Total Criteria Weighting
	Sub-Criteria	Improved flood protection	Criteria weighting	Reduction in gross pollutants	Reduction in suspended solids	Reduction in nutrients	Reduction in micro plastics	Criteria weighting	Storage and reuse	Passive reuse	Criteria weighting	Improved visual amenity	Improved public safety	Additional useful open space	Disruption during implementation	Criteria weighting	Habitat creation	Increased biodiversity	Criteria weighting	Capital Cost	Economic viability	Recurring / Maintenance Cost	Criteria weighting	Total Weighted Score
	Sub-criteria Weighting	100	**30**	15	40	30	15	**25**	70	30	**10**	35	20	35	10	**5**	50	50	**5**	45	45	10	**25**	**100**
Install gross pollutant traps	Score (max=4)	0	**0**	4	1	1	1	**9.0625**	0	0	**0**	2	0	0	3	**1.3**	0	0	**0**	3	3	3	**18.8**	**29.1**
	Weighted Score	0		3.75	2.5	1.875	0.9375		0	0		0.875	0	0	0.38		0	0		8.4375	8.4	1.88		
Precinct scale works (e.g. raingardens)	Score (max=4)	1	**7.5**	2	3	3	2	**16.9**	0	3	**2.3**	3	0	1	2	**2.0**	2	2	**2.5**	2	3	2	**15.3**	**46.4**
	Weighted Score	7.5		1.88	7.50	5.625	1.875		0	2		1.31	0	0.44	0.25		1.25	1.25		5.63	8.44	1.25		
Channel works and plantings (aquatic and riparian)	Score (max=4)	2	**15**	0	2	2	1	**9.7**	0	2	**1.5**	3	0	0	3	**1.7**	3	3	**3.8**	2	3	3	**15.9**	**47.6**
	Weighted Score	15		0.00	5.00	3.75	0.94		0	1.5		1.31	0	0	0.38		1.875	1.875		5.6	8.4375	1.88		
Channel works and plantings with creation of a wetland	Score (max=4)	3	**22.5**	2	4	4	3	**22.1875**	1	3	**4**	4	0	3	2	**3.3**	4	4	**5**	1	2	1	**9.1**	**66.1**
	Weighted Score	22.5		1.875	10	7.5	2.8125		1.75	2.25		1.75	0	1.3125	0.25		2.5	2.5		2.8	5.6	0.63		