This business case was used to inform decision-making on sustainable diversion limit adjustment mechanism projects.

Detailed costings and personal information has been redacted from the original business case to protect privacy and future tenders that will be undertaken to deliver this project.

Murray Futures: Coorong, Lower Lakes & Murray Mouth Recovery Project

South East Flows Restoration Project

Sustainable Diversion Limit Adjustment Supply Measure Phase 2 Submission

Government of South Australia
Department of Environment, Water and Natural Resources

1. Document purpose

The purpose of this document is to formally submit the South East Flows Restoration Project to the Sustainable Diversion Limit Adjustment Assessment Committee for Phase 2 Assessment.

This document provides a high level summary of the South East Flows Restoration Project, addresses the Phase 2 assessment eligibility criteria where possible (see Section 3) and refers to relevant existing documentation and the subsequent relevant sections, which satisfy the Phase 2 assessment criteria (see Section 4). Phase 2 information requirements that are not satisfied within existing documentation, specifically the hydrology of the area and the operating regime, are provided in Sections 5 and 6 of this document, respectively.

2. Summary of Proposal

The South East Flows Restoration Project (SEFRP) is a sub-project of the South Australian Government's priority project *Murray Futures: Coorong, Lower Lakes and Murray Mouth (CLLMM) Recovery Project* that aims to enhance flows to wetlands in the Upper South East and to provide flows to the South Lagoon of the Ramsar listed Coorong[1], to help manage its salinity levels and enhance ecosystem resilience.

The $60 million SEFRP is fully costed and funded through the *Coorong, Lower Lakes and Murray Mouth Recovery Project Schedule SA-07 to the South Australian and Commonwealth Water Management Partnership Agreement*, with project delivery underway. No additional Commonwealth funding is required through the sustainable diversion limit (SDL) adjustment mechanism for project delivery.

The ecological health of the Coorong South Lagoon is primarily dependent upon water levels and water quality, principally salinity. Flows delivered over the barrages from the River Murray affect Coorong water levels and salinity by the way they interact with local meteorology, sea levels, and the Murray Mouth. Flows from the South East region of South Australia, primarily influence the salinity of the Coorong South Lagoon with little to no effect on water levels (Lester et al 2009).

The drought of 2006 to 2010 demonstrated the impact of extreme salinities on the Coorong and the consequences of insufficient fresh water reaching the Coorong (see for example Brookes et al (2009)). If salinity extremes in the Coorong could be reduced, these ecological impacts could be substantially ameliorated and result in improved resilience of the site.

The SEFRP project will construct the SEFRP channel which will use a combination of widening existing drains (totalling approximately 81 kilometres) and newly constructed drains (totalling approximately 12 kilometres) to divert additional water from the Upper South East into the Coorong South Lagoon. This will provide fresh water to reach the Coorong from the South East drains via Salt Creek. This freshwater will be in addition to the estimated median flow of 29.7 gigalitres per year (GL/yr) (AWE 2012) from existing projects.

[1] The Coorong and Lake Alexandrina and Albert Wetland was listed as a Wetland of International Importance under the Ramsar Convention on Wetlands in 1985.

The SEFRP comprises a package of infrastructure works and an accompanying environmental management program. Channel capacity will range between 1,300 megalitres per day (ML/day) and 800 ML/day, and has the potential to deliver an additional 5 - 45.3 GL of environmental water per year directly into the Coorong South Lagoon, with a median volume of up to 26.5 GL per year.

Additional fresh water to the Coorong through the SEFRP will result in positive ecological benefits, by contributing to reducing salinity levels in the Coorong, especially the South Lagoon. Reducing the salinity levels in the Coorong will improve the resilience of the Coorong before, during and after drought periods in the Murray-Darling Basin.

The SEFRP will also provide the opportunity to enhance flows to wetlands in the Upper South East, providing significant environmental outcomes to en route wetlands through the meeting of their water requirements.

3. Eligibility criteria

Eligibility criteria applicable to the South East Flows Restoration Project as an SDL adjustment supply measure proposal are outlined below:

- *Reflects the definition of "Supply measure" under Basin Plan (cl.7.03 and cl.7.15)*

The SEFRP meets the criteria of a supply measure that operates to increase the quantity of water available to be taken compared with that under the benchmark conditions as specified in Schedule 6 of the Basin Plan. Furthermore, advice provided by the Murray-Darling Basin Authority during Phase 1 Assessment of the SEFRP indicates that the default method to determine the SDL adjustment can be used to assess the SDL adjustment potential of the SEFRP.

In particular, the SEFRP will influence the Coorong South Lagoon average daily salinity remaining less than 100 grams per litre (g/L) for 96% of days. The SEFRP project will deliver increased fresh flows directly into the Coorong South Lagoon, and potentially reduce the frequency of periods where the salinity exceeds 100 g/L. This has the potential to reduce requirements for barrage flows.

To demonstrate this potential, two scenarios for barrage flow inflows have been considered:

- SDL Adjustment Benchmark run, representing a water recovery volume of 2750 GL; and
- BP2400 model run, representing a water recovery of 2400 GL and a possible reduced water recovery volume resulting from the SDL Adjustment Mechanism.

The years where diversions from SEFRP to the Coorong South Lagoon occurred (see Operating Plan section 6) were back calculated based on the modelled Coorong South Lagoon salinity for each barrage flow scenario. The results from these two barrage flow scenarios and with and without SEFRP are presented in Table 1. It can be seen that as the barrage flows reduce from benchmark to BP2400 salinities exceeding 100 g/L start to occur, and the inclusion of SEFRP starts to mitigate these occurrences. As more and more days exceeding 100 g/L start to occur through the application of the SDL Adjustment Mechanism, the benefits of SEFRP are expected to become clearer. Table 1 also demonstrates the maximum difference in salinity with and without the SEFRP. It can be seen from Table 1 that the SEFRP is expected to have minimal influence on the limit of change metrics related to the

Murray Mouth. This potential will need to be modelled and confirmed by the Murray-Darling Basin Authority.

Table 1: Coorong results from the two barrage flow scenarios and with and without the SEFRP.

Barrage Flow Scenario	**BP2400**	**BP2400**	**Benchmark**	**Benchmark**
Drain Flow Scenario	**Existing**	**SEFRP**	**Existing**	**SEFRP**
% of time when Salinity in south Coorong < 100 g/L	99.4%	99.5%	100.0%	100.0%
Largest salinity reduction in South Lagoon due to SEFRP (g/L)		18.2		14.4
% of years when average annual depth at Murray Mouth > 1 m	93.9%	93.9%	93.0%	93.0%
% of years when average annual depth at Murray Mouth > 0.7 m	97.4%	97.4%	97.4%	97.4%

The affected resource unit from the South East Flows Restoration Project is the SS11 South Australian Murray within the SA River Murray Water Resource Plan area.

- *Measures not included in the benchmark conditions of development (cl.7.02 of the Basin Plan)*

The measure is not included in the benchmark conditions of development. The drain alignment proposed as part of SEFRP is yet to be constructed, and as such, not included in the inflows to the Coorong South Lagoon used in the benchmark model.

The benchmark modelling included a mandated change to better represent the inflows to the Coorong South Lagoon based on the drainage network as of 30 June 2009 over the whole modelled period.

- *Operational by 30 June 2024 (cl.7.12 of the Basin Plan)*

The SEFRP proposal is a 2.5 year project with key elements as outlined in Table 2. A 75 week period has been estimated for construction of the Salt Creek to Blackford Drain channel, including upgrading the existing drainage system, and construction of approximately 12 km of new drain. Construction is likely to commence in spring 2015, and is expected to be completed by December 2016.

Table 2: South East Flows Restoration Project delivery activities and timeframes

Activity	**Year 1**	**Year 2**	**Year 3**
Funding approval	**X**		
Engage Staff and contractors	**X**		
Detailed design	**X**		
Land acquisition	**X**	**X**	
Approvals	**X**	**X**	
Construction		**X**	**X**
Testing and Operating			**X**
Project closure			**X**

4. Addressing the Phase 2 SDL adjustment evaluation criteria

The key business case and other relevant documentation (Table 3) to support the SEFRP as an SDL adjustment measure are outlined below. The relevant sections within each document which satisfy the Phase 2 assessment criteria are documented in Table 4.

Table 3: List of key documents in relation to the South East Flows Restoration Project.

Document	Purpose	Appendix
South East Flows Restoration Project Phase 2 Business Case **DEWNR 2013.** *Murray Futures: Coorong, Lower Lakes & Murray Mouth Recovery Project South East Flows Restoration Project Phase 2 Business Case*	This document is the final business case submitted to the Commonwealth Government to undertaken its due diligence assessment.	Appendix 1
Funding Schedule *Third Deed of Variation to the Project Schedule for the South Australian Priority Project SA – 07: Coorong, Lower Lakes and Murray Mouth Recovery Project*	This document provides details of the funding arrangements for the project, including operations and maintenance. As well as project deliverables and timeframes.	Appendix 2
Environmental water requirements for the CLLMM **Lester et al. 2011**, *Murray Futures: Lower Lakes, and Coorong Recovery. Specifying an environmental water requirement for the Coorong and Lakes Alexandrina and Albert: A first iteration. Summary of methods and findings to date. Department of Environment, Water and Natural Resources.*	Details the environmental water requirements of the CLLMM region.	Appendix 3
Initial Hydrological Modelling **Montazeri et al. (2011).** *COORONG SOUTH LAGOON FLOW RESTORATION PROJECT– Hydrological modelling and transmission loss analysis*	This document provides details of the rainfall-runoff and water balance modelling undertaken to estimate the flow that can be delivered to the Coorong South Lagoon from the Blackford Drain	Appendix 4
Hydrological Modelling Update **AWE (2011).** *CSLFRP Extension of Existing Modelling. Final Report. Department for Water, Adelaide, South Australia*	This document is an update to the modelling outlined in Appendix 4, revising a number of assumptions resulting in the volumes presented in the Business Case in Appendix 1.	Appendix 5
South East Flows Restoration Project EPBC Referral	This document is currently in draft form and will be provided when publicly available.	Not provided

Table 4: Relevant documents and document sections that address the evaluation criteria.

Note that as an existing project not seeking Commonwealth funds through the SDL adjustment process, there are a number of evaluation criteria not addressed in this proposal as specified by the Phase 2 Assessment Guidelines.

Key evaluation criteria	Guidelines Reference	Relevant Document and section of Document
Eligibility	Section 3	Refer to Section 3 of this document
Project details	Section 4.1	• Site description and location maps *Section 2 and 5, Murray Futures: Coorong, Lower Lakes & Murray Mouth Recovery Project South East Flows Restoration Project Phase 2 Business Case (DEWNR 2013).* • Proponent name and proposed implementing entity *Section 6.1, Murray Futures: Coorong, Lower Lakes & Murray Mouth Recovery Project South East Flows Restoration Project Phase 2 Business Case (DEWNR 2013).* • Governance information *Section 13, Murray Futures: Coorong, Lower Lakes & Murray Mouth Recovery Project South East Flows Restoration Project Phase 2 Business Case (DEWNR 2013).* • Summary of estimated costs and proposed schedule *Third Deed of Variation to the Project Schedule for the South Australian Priority Project SA – 07: Coorong, Lower Lakes and Murray Mouth Recovery Project; and* *Refer to Appendix 6 of this document and Section 7, Murray Futures: Coorong, Lower Lakes & Murray Mouth Recovery Project South East Flows Restoration Project Phase 2 Business Case (DEWNR 2013).* Please note that the Business Case (DEWNR 2013) provides initial budget details, noting that the budget was subsequently revised as part of the due diligence assessment process with the Commonwealth. As a result, the revised budget is provided at Appendix 6 of this document. • Definition of Measure *Outlined above in eligibility criteria*

Key evaluation criteria	Guidelines Reference	Relevant Document and section of Document
Ecological values of the site	Section 4.2	• Descriptions of the ecological values and features of the site *Section 2, Murray Futures: Coorong, Lower Lakes & Murray Mouth Recovery Project South East Flows Restoration Project Phase 2 Business Case (DEWNR 2013).*
Ecological objectives and targets	Section 4.3	• Ecological objectives and targets *Section 3, Murray Futures: Coorong, Lower Lakes & Murray Mouth Recovery Project South East Flows Restoration Project Phase 2 Business Case (DEWNR 2013).* This section of the Business Case provides description of ecological drivers of the Coorong, salinity target values and threshold values to support Coorong biota and potential for salinity reduction. More detail in *Murray Future: Lower Lakes, and Coorong Recovery. Specifying an environmental water requirement for the Coorong and Lakes Alexandrina and Albert: A first iteration. Summary of methods and findings to date. Department of Environment, Water and Natural Resource (Lester et al. 2011).*
Anticipated ecological benefits	Section 4.4.1	• Anticipated ecological benefits Environmental benefits of the SEFRP *are described in Section 3, Murray Futures: Coorong, Lower Lakes & Murray Mouth Recovery Project South East Flows Restoration Project Phase 2 Business Case (DEWNR 2013; and* *Section 5.4, Murray Futures: Coorong, Lower Lakes & Murray Mouth Recovery Project South East Flows Restoration Project Phase 2 Business Case (DEWNR 2013).* Details of the environmental management to be undertaken for the SEFRP are described in *Section 6.7, Murray Futures: Coorong, Lower Lakes & Murray Mouth Recovery Project South East Flows Restoration Project Phase 2 Business Case (DEWNR 2013).*
Potential adverse ecological impacts	Section 4.4.2	• Potential adverse ecological impacts *Section 6.6 and 6.7, Murray Futures: Coorong, Lower Lakes & Murray Mouth Recovery Project South East Flows Restoration Project Phase 2 Business Case (DEWNR 2013); and* *Section 3, South East Flows Restoration Project EPBC Referral* – noting that this document will be provided when publicly available.

Key evaluation criteria	Guidelines Reference	Relevant Document and section of Document
		• Monitoring and evaluation *Section 6.7, Murray Futures: Coorong, Lower Lakes & Murray Mouth Recovery Project South East Flows Restoration Project Phase 2 Business Case (DEWNR 2013).*
Current hydrology and proposed changes to the hydrology	Section 4.5.1	Refer to Section 5 of this document and reference as cited in this section.
Environmental water requirements	Section 4.5.2	• Environmental Water Requirements Summarised in Section 3, *Murray Futures: Coorong, Lower Lakes & Murray Mouth Recovery Project South East Flows Restoration Project Phase 2 Business Case (DEWNR 2013).* More detail in *Murray Future: Lower Lakes, and Coorong Recovery. Specifying an environmental water requirement for the Coorong and Lakes Alexandrina and Albert: A first iteration. Summary of methods and findings to date. Department of Environment, Water and Natural Resource (Lester et al. 2011).*
Operating regime	Section 4.6	Refer to Section 5 of this document
Assessment of risks and impacts of the operation of the measure	Section 4.7	• Assessment of risks and impacts of the operation of the measure, including mitigation options, monitoring needs and management responses *Refer to Appendix 7 of this document and Section 12 and Appendix C, Murray Futures: Coorong, Lower Lakes & Murray Mouth Recovery Project South East Flows Restoration Project Phase 2 Business Case (DEWNR 2013).* Please note that Appendix 7 to this document provides additions to the SEFRP Risk Register provided in the Business Case (DEWNR 2013) as a result of the due diligence process undertaken with the Commonwealth.
Technical feasibility and fitness for purpose	Section 4.8	• Design of project *Section 5.2, Murray Futures: Coorong, Lower Lakes & Murray Mouth Recovery Project South East Flows Restoration Project Phase 2 Business Case (DEWNR 2013).* • Location of activities

Key evaluation criteria	Guidelines Reference	Relevant Document and section of Document
		Section 5.1, Murray Futures: Coorong, Lower Lakes & Murray Mouth Recovery Project South East Flows Restoration Project Phase 2 Business Case (DEWNR 2013) • Estimate of costs and benefits Details of Costs are provided on *Page 75, Third Deed of Variation to the Project Schedule for the South Australian Priority Project SA – 07: Coorong, Lower Lakes and Murray Mouth Recovery Project; and* *Refer to Appendix 6 of this document and Section 7, Murray Futures: Coorong, Lower Lakes & Murray Mouth Recovery Project South East Flows Restoration Project Phase 2 Business Case (DEWNR 2013).* Cost-Benefit Analysis provided in *Section 9, Murray Futures: Coorong, Lower Lakes & Murray Mouth Recovery Project South East Flows Restoration Project Phase 2 Business Case (DEWNR 2013)* • Ongoing operational monitoring and record keeping arrangements *Section 6.7, Murray Futures: Coorong, Lower Lakes & Murray Mouth Recovery Project South East Flows Restoration Project Phase 2 Business Case (DEWNR 2013).* • Reliance on other measures or other actions *N/A* • Governance information *Section 13, Murray Futures: Coorong, Lower Lakes & Murray Mouth Recovery Project South East Flows Restoration Project Phase 2 Business Case (DEWNR 2013).* • Funding arrangement for Ongoing Operations and Maintenance *Page 73, Third Deed of Variation to the Project Schedule for the South Australian Priority Project SA – 07: Coorong, Lower Lakes and Murray Mouth Recovery Project; and* *Section 11, Murray Futures: Coorong, Lower Lakes & Murray Mouth Recovery Project South East Flows Restoration Project Phase 2 Business Case (DEWNR 2013).*
Complementary actions and interdependencies	Section 4.9	• SDL resource unit *Section 3 of this document.*

Key evaluation criteria	Guidelines Reference	Relevant Document and section of Document
		• Complementary actions and interdependencies *Not applicable*
Costs, Benefits and Funding Arrangements for Projects not seeking Commonwealth Supply or Constraint Measure Funding	Section 4.10.2	• Reference to costing documentation • Details of funding arrangements *Pages 6, 72-75, Third Deed of Variation to the Project Schedule for the South Australian Priority Project SA – 07: Coorong, Lower Lakes and Murray Mouth Recovery Project; and* *Section 7.1, Murray Futures: Coorong, Lower Lakes & Murray Mouth Recovery Project South East Flows Restoration Project Phase 2 Business Case (DEWNR 2013).* • Details of ongoing operation and maintenance costs *Section 11, Murray Futures: Coorong, Lower Lakes & Murray Mouth Recovery Project South East Flows Restoration Project Phase 2 Business Case (DEWNR 2013).*

5. Hydrology of the area

Current hydrology and proposed changes to the hydrology

This section should be read in conjunction with the broader context of the South East and the current and proposed hydrology of the region provided in *DEWNR 2013, Murray Futures: Coorong, Lower Lakes & Murray Mouth Recovery Project South East Flows Restoration Project Phase 2 Business Case* at Appendix 1.

The MDBA's benchmark model includes inflows to the Coorong South Lagoon that represent the drainage network as of 30 June 2009 over the whole modelled period.

Daily time step rainfall – runoff and water balance models have been developed previously to represent the USE drainage system, outlined in Wood and Way (2011), Montazeri et al. (2011) and AWE (2011, 2012). The most recent versions of the models were extended to simulate the period of the MDBA's benchmark modelling. The period from 1891 – 2009 is used, as the Coorong model includes a five year warmup period prior to 1895. The salinity of the inflows was calculated based on a regression relationship developed between flow and salinity recorded at the station flowing into the Coorong South Lagoon (the Salt Creek gauge, A2390568). The relationship is based on data recorded prior to 2009, as outlined in Table 2 of MDBA (2013).

As a validation of the models used, the volumes simulated have been compared to the gauged flows entering the Coorong South Lagoon. Figure 1 presents the annual volume delivered to the Coorong South Lagoon, both recorded and simulated. The text on Figure 1 below outlines when drains were constructed upstream of this gauge in the USE network.

While the model overestimates the flow in these few years where the actual drain construction aligns with that represented in the model, given that the model produces the expected behaviour in the periods before and after this, it is proposed that the time series developed provides a reasonable representation of the flow volumes that could be expected from the USE drainage network based on 2009 conditions (Figure 1).

It can be seen from Figure 1 that:

- the modelled annual volumes are greater than the observed volumes (A2390568) in the period up to 2007/8. This is the expected result, as the model includes all drains constructed by 2009, and as such includes drains and the subsequent contributing flows that were not constructed in the earlier part of the data record; and
- the model simulates a lower annual volume compared to that observed in 2011/12. This is also the expected result, as a further drain is contributing flow to the Coorong South Lagoon (Bald Hills drain) in the observed data but is not represented in the model, as the drain was constructed after 2009.

It would be expected that the modelled annual volume should be representative of the observed annual volume in the water years 2009/10 and 2010/11. It can be seen that the model overestimates the annual flow volume in 2009/10, likely due a limitation in the rainfall – runoff model representing the initial catchment conditions after three very dry years. The model provides a closer approximation, but still slightly overestimates, the observed volume delivered to the CSL in the 2010/11 water year.

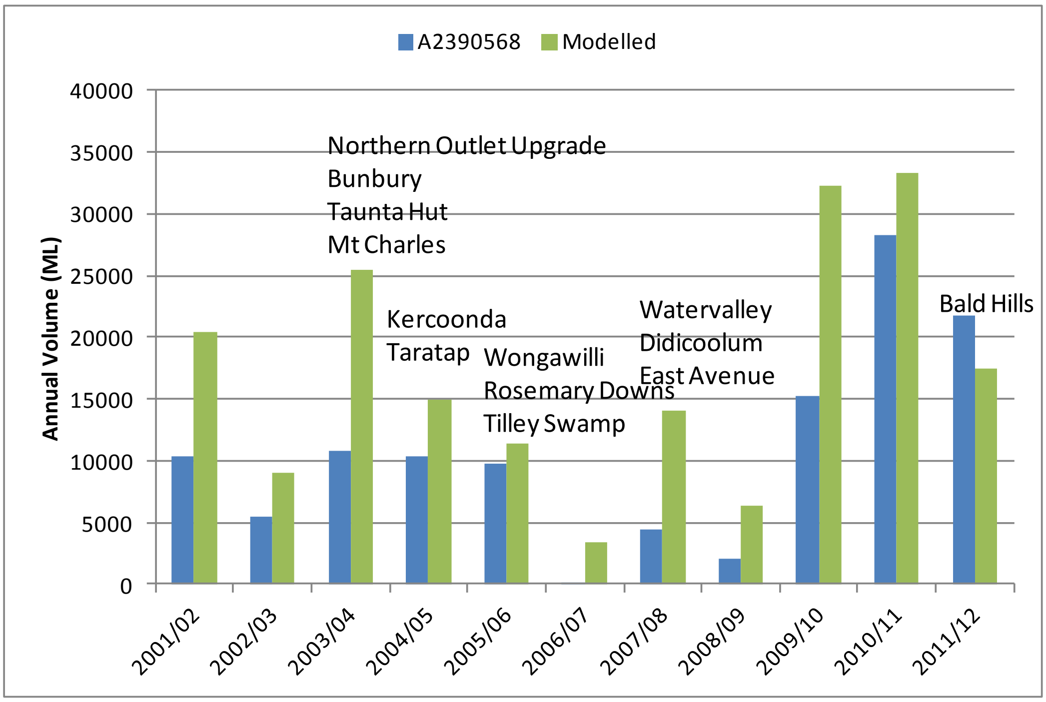

Figure 1: Comparison of simulated volumes, and years that drains were constructed

The SEFRP will construct the SEFRP channel which will use a combination of widened existing drains (totalling approximately 81 kilometres) and newly constructed drains (totalling approximately 12 kilometres) to divert additional water from the USE into the Coorong South Lagoon. The same rainfall-runoff and water balance models (AWE, 2012) were used to simulate the increased flow that can be delivered to the Coorong South Lagoon as a result of the SEFRP. For the SEFRP proposal the corresponding salinity was calculated from the modelled daily flow based on the post 2009 regression relationship, outlined in Table 3 of MDBA (2013). Further details of the preliminary design of the SEFRP can be found in Section 5 of the Business Case provided at Appendix 1.

The maximum volume that could be delivered to the Coorong South Lagoon through implementing the project, on top of that provided by the existing drainage network, can be seen in Figure 2. As outlined in the Operating Regime section, it has been assumed that 4 GL of suitable quality flows available each season will be delivered to support the ecological outcomes of en route wetlands. The average volume delivered to the Coorong South Lagoon from the existing network presented in Figure 2 is 26.8 GL/yr, increasing to a maximum combined total if diversions were undertaken in every year of 42.7 GL/yr with the inclusion of the SEFRP. These volumes do not include the 4 GL delivered to en route wetlands. The values are slightly different to those presented in the Business Case provided at Appendix 1, due to the different time periods considered (e.g. 1891 – 2009 compared to 1971 – 2000) and different operation of Morella Basin (outlined in the Operating Regime section).

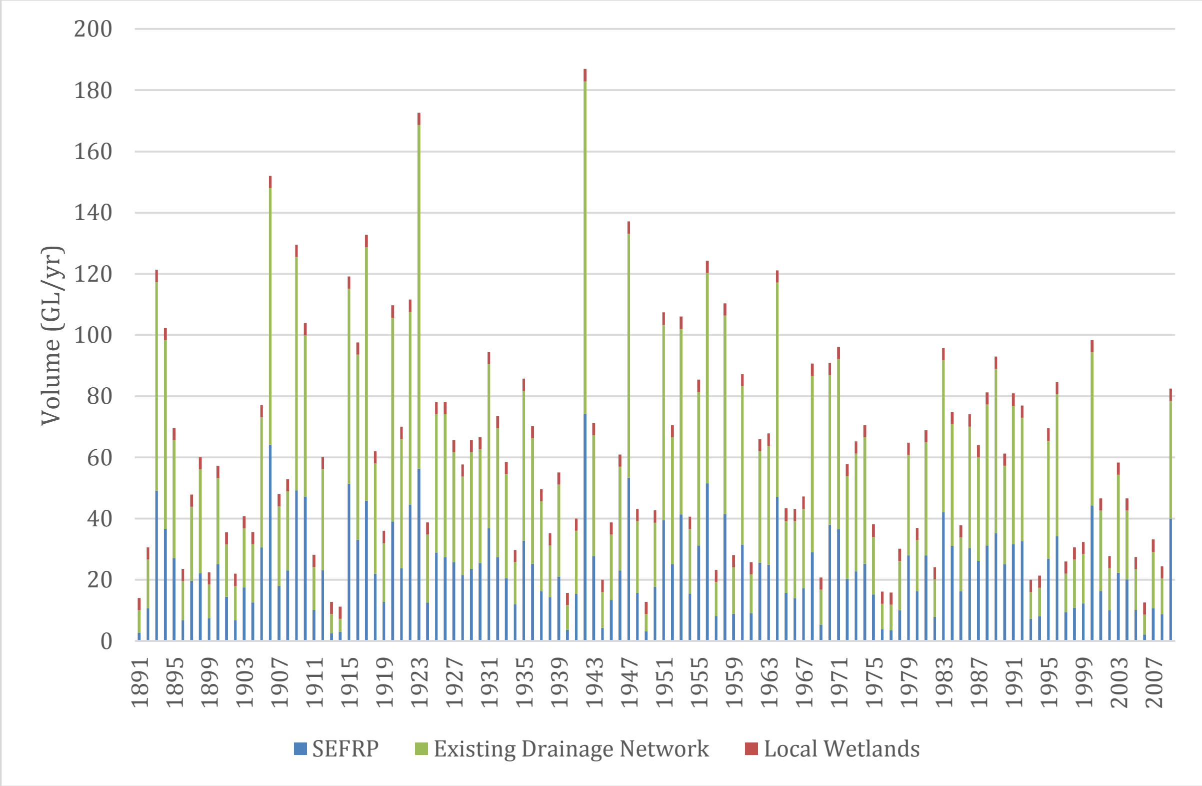

Figure 2: Maximum annual volumes divertible to the CSL from the SEFRP alone (blue), total inflow to the CSL (sum of blue and grey), and volume diverted to en route wetlands (orange).

6. Operating regime

The Salt Creek to Blackford watercourse operating strategy will be determined in consultation with the local community and take into account any information generated through additional ecological investigations funded under the SERFP to support the development of Operating Management Principles. For the purposes of the SDL adjustment mechanism and enabling the Murray-Darling Basin Authority to represent the SEFRP in the SDL adjustment benchmark model run, a number of operating assumptions have been developed based on the current understanding/assumptions of how the SEFRP may be operated. These are provided below, noting that these assumptions may not be included in the final operating regime of the SEFRP to be developed as part of project implementation.

There are a number of proposed structures as part of SEFRP that will be operated depending on the water requirements of the Coorong South Lagoon. These are:

1. ancillary structures to deliver flow from the proposed channel to local en route wetlands (Taratap wetlands and Tilley Swamp Conservation Park)
2. the weir on the Blackford Drain to divert flow into the proposed drain
3. releases made from Morella Basin to the Coorong South Lagoon at the end of the system.

Taratap Wetlands and Tilley Swamp Conservation Park Structures

Based on the mapped extent of wetlands in the Taratap and Tilley Swamp complexes, along with 2m DEM of the region, the estimated storage volume of each complex is 2 GL, or a total of 4 GL. In order to account for the water requirements of these wetlands, the first 4 GL diverted out of the Blackford Drain each year has been removed from the time series of flow into the Coorong South Lagoon. It is assumed that the volume is diverted every year and is lost from the drainage network. This is likely to be a conservative assumption as diversions may not be required in all years, and does not account for return flows from the wetland complexes.

Blackford Drain Weir

While a detailed Operating Procedure will be developed as part of the implementation of the SEFRP, assumptions regarding diversion rules are required for the purposes of modelling and assessing the proposal. As such, it has been assumed that flow from the Blackford drain will be diverted, when needed to improve environmental benefits and when water is available, up to the capacity of the proposed drain of 800 ML/d. These includes the 4 GL assumed for local wetland benefits, and diversion for the Coorong when the salinity of the Coorong South Lagoon is high (greater than 60 g/L).

It has been assumed that if the salinity of the Coorong South Lagoon exceeded 60 g/L on any day in the previous water year (July – June) all volume available through the SEFRP alignment would be diverted to the Coorong South Lagoon (subject to the local wetland needs). It is proposed to code this rule into the 1D hydrodynamic model of the Coorong, to allow diversions to occur as needed in response to changes in barrage flow that occur through application of the SDL Adjustment Mechanism.

Morella Basin

For the existing drainage network scenario, the operating rules used were to maintain a water level in Morella Basin of 4.2 m AHD, and draw the water level down to 2.7 m over the period from October 15 to December 31 each year. This was based on observed water level in Morella Basin prior to 2009.

Based on the most current operating procedure for Morella Basin, the target water level for Morella Basin presented in Figure 3 has been adopted for the SEFRP scenario. This target level has been developed to meet a number of objectives:

- Eliminate backwater and inundation effects of Morella Basin on the upstream drain
- Meet the environmental water requirements of Morella Basin, by increasing water levels in Morella Basin to 4.0m AHD or above during mid-late spring, to provide an opportunity for biological and chemical wetland processes
- Release water in late summer/early autumn to draw down Morella Basin to:
    - Expose mudflats for feeding opportunities for migratory waders
    - Expose mudflats to oxidise nutrients to be utilised and support productivity in Morella
- Delay releases from Morella Basin to the CSL as late in the season as possible, to coincide with high salinity in summer in the CSL.

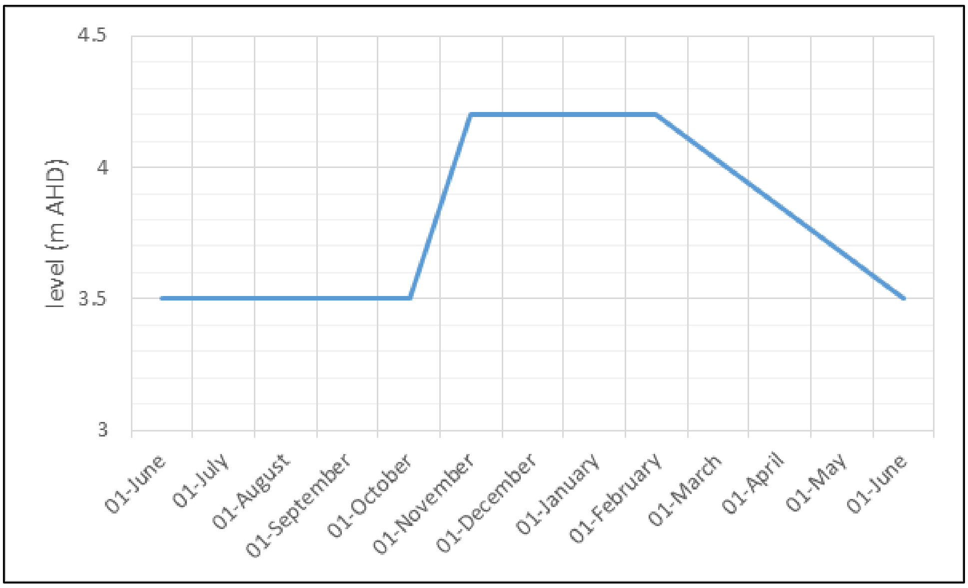

Figure 3: Morella target level assumed for the SEFRP

7. References

AWE (2011) CSLFRP Extension of Existing Modelling. Final Report. Department for Water, Adelaide, South Australia.

AWE (2012) South East Flows Restoration Project, Blackford Extension Alignment Yield Analysis. Prepared for Department of Environment, Water and Natural Resources. Australian Water Environments, Eastwood, South Australia.

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Wood G. and Way D., 2011, Development of the Technical Basis for a Regional Flow Management Strategy for the South East of South Australia, DFW Report 2011/21, Government of South Australia, through Department for Water, Adelaide

8. Appendices

Appendix 1: Murray Futures: Coorong, Lower Lakes & Murray Mouth Recovery Project South East Flows Restoration Project Phase 2 Business case

Appendix 2: Third Deed of Variation to the Project Schedule for the South Australian Priority Project SA – 07: Coorong, Lower Lakes and Murray Mouth Recovery Project

Appendix 3: Lester et al. 2011, Murray Futures: Lower Lakes, and Coorong Recovery. Specifying an environmental water requirement for the Coorong and Lakes Alexandrina and Albert: A first iteration. Summary of methods and findings to date. Department of Environment, Water and Natural Resources

Appendix 4: Montazeri et al. (2011). COORONG SOUTH LAGOON FLOW RESTORATION PROJECT– Hydrological modelling and transmission loss analysis

Appendix 5: AWE (2011) CSLFRP Extension of Existing Modelling. Final Report. Department for Water, Adelaide, South Australia

Appendix 6: Revised Budget – Bakers Range removed

Revised SEFRP Cost Details

Project Component	Financial Year of Expenditure ($)			Totals
	13/14	14/15	15/16	
Design	[redacted]			
Land Acquisition				
Heritage				
Environmental Management				
Construction				
Project Management				
GRAND TOTAL				

Appendix 7: Additions to the SEFRP Risk Register

Risk Area	Risk Issue	Causes	Likelihood	Consequences	Consequence Level	Risk Rating	Mitigation Measures	Likelihood	Consequences	Risk Rating	Responsibility
Legal	The SEFRP is determined to be a controlled action - should not proceed - by the Minister for Environment, Heritage, and Water under the EPBC Act.	Significant impacts to matter/s of National Environmental Significance are identified either through the assessment process, or during the decision process.	B	Project is unable to be delivered.	5	15	Rigorous impact assessments have been undertaken for matters of National Environmental Significance identified and indicate that no significant impacts are likely to result. Draft referral provided to the Environmental Assessment Branch of DSEWPaC for comment. Comment and suggestions incorporated accordingly.	A	5	5	DEWNR Project Team
Legal	The SEFRP is determined to be a controlled action requiring further assessment (such as an Environmental Impact Statement) by the Minister for Environment, Heritage, and Water under the EPBC Act.	Insufficient material is provided to the Australian Government to assess potential impacts to matters of National Environmental Significance, or impact assessments are not adequate. Significant concerns raised through	C	Project is unable to be delivered within the timeframe specified by the CLLMM Recovery Project Schedule.	4	12	Rigorous impact assessments have been undertaken for matters of National Environmental Significance identified and indicate that no significant impacts are likely to result. Draft referral provided to the Environmental Assessment Branch of DSEWPaC for comment. Comment and suggestions incorporated accordingly.	B	4	8	DEWNR Project Team

Risk Area	Risk Issue	Causes	Likelihood	Consequences	Consequence Level	Risk Rating	Mitigation Measures	Likelihood	Consequences	Risk Rating	Responsibility
		public consultation period.									
Legal	The Minister for Environment, Heritage, and Water "stops the clock" on the assessment process to request a substantial amount of additional information to make a decision as to whether the action is controlled or not under the EPBC Act.	Insufficient material is provided to the Australian Government to assess potential impacts to matters of National Environmental Significance. Significant concerns raised through public consultation period.	C	Project is unable to be delivered within the timeframe specified by the CLLMM Recovery Project Schedule.	4	12	Rigorous impact assessments have been undertaken for matters of National Environmental Significance identified and indicate that no significant impacts are likely to result. Draft referral provided to the Environmental Assessment Branch of DSEWPaC for comment. Comment and suggestions incorporated accordingly	B	4	8	DEWNR Project Team

Risk Area	Risk Issue	Causes	Likelihood	Consequences	Consequence Level	Risk Rating	Mitigation Measures	Likelihood	Consequences	Risk Rating	Responsibility
Legal	Native Vegetation Council does not approve management plan/s in a timely manner under the Native Vegetation Act.	Insufficient material is provided for the Native Vegetation Council to approve management plan/s.	C	Project is unable to be delivered within the timeframe specified by the CLLMM Recovery Project Schedule.	4	12	Management plan/s are developed in consultation with the Native Vegetation Council and officers to ensure that their requirements are satisfied, and reduce the possibility of additional information being required before a decision can be made.	B	4	8	DEWNR Project Team
Legal	The Minister for Aboriginal Affairs and Reconciliation does not grant an authorisation under section 23 of the Aboriginal Heritage Act.	Relevant Aboriginal groups do not support the Minister granting an authorisation under section 23 of the Aboriginal Heritage Act.	C	Project is unable to be delivered, or, if DEWNR decide to proceed regardless, that it is taking on a legal risk.	5	15	Relevant Aboriginal groups, (including the Ngarrindjeri Regional Authority, and the South East Aboriginal Focus Group) have been consulted on the project since 2008, and have provided in-principle support for the project. Aboriginal groups will continue to be engaged, including to undertake heritage surveys. Relevant Aboriginal groups have also been advised of DEWNR's intention to submit an application for a section 23 authorisation. DEWNR has also engaged AARD.	B	5	10	DEWNR Project Team

Risk Area	Risk Issue	Causes	Likelihood	Consequences	Consequence Level	Risk Rating	Mitigation Measures	Likelihood	Consequences	Risk Rating	Responsibility
Legal	Significant delays are experienced regarding the Minister for Aboriginal Affairs and Reconciliation granting an authorisation under section 23 of the Aboriginal Heritage Act.	Insufficient material is provided to the Minister/relevant Aboriginal groups, and/or there is insufficient consultation with relevant Aboriginal groups.	C	Project is unable to be delivered within the timeframe specified by the CLLMM Recovery Project Schedule.	4	12	Relevant Aboriginal groups, (including the Ngarrindjeri Regional Authority, and the South East Aboriginal Focus Group) have been consulted on the project since 2008, and have provided in-principle support for the project. Aboriginal groups will continue to be engaged, including to undertake heritage surveys. Relevant Aboriginal groups have also been advised of DEWNR's intention to submit an application for a section 23 authorisation. DEWNR has also engaged AARD.	B	4	8	DEWNR Project Team

MURRAY FUTURES: COORONG, LOWER LAKES & MURRAY MOUTH RECOVERY PROJECT

Date of Issue
12 March 2013

SOUTH EAST FLOWS RESTORATION PROJECT

Phase 2 Business Case

Government of South Australia
Department of Environment, Water and Natural Resources

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List of Acronyms

AFM	Adaptive Flows Management
AWE	Australian Water Environments
BCR	Benefit Cost Ratio
BOM	Bureau of Meteorology
CAMBA	China-Australia Migratory Bird Agreement
CBA	Cost Benefit Analysis
CEWH	Commonwealth Environmental Water Holder
CLLMM	Coorong, Lower Lakes and Murray Mouth
COAG	Council of Australian Governments
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CSL	Coorong South Lagoon
DENR	Department of Natural Resource
DEWNR	Department of Environment, Water and Natural Resources
DSEWPaC	Department of Sustainability, Environment, Water, Population and Communities
DFW	Department for Water
DPTI	Department of Planning, Transport and Infrastructure
EPA	Environment Protection Authority
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999
EWRs	Environmental Water Requirements
FTE's	Full Time Equivalents
GDP	Gross Domestic Product
GL	Gigalitre
HRW	High Reliability Water
IGA	Intergovernmental Agreement
IPCC	Intergovernmental Panel on Climate Change
JAMBA	Japan-Australia Migratory Bird Agreement
MAT	Management Action Targets
MDB	Murray-Darling Basin
MDBA	Murray-Darling Basin Authority

MDBC	Murray-Darling Basin Commission
ML/day	Megalitres per Day
NES	National Environmental Significance
NPV	Net Present Value
NRA	Ngarrindjeri Regional Authority
NRM	Natural Resources Management
NRM Act	Natural Resources Management Act 2004
RCT	Resource Condition Targets
RCBC	Reinforced Concrete Box Culverts
REFLOWS	Restoring the flows of the South East
ROKAMBA	Republic of Korea-Australia Migratory Bird Agreement
SA MDB NRMB	South Australian Murray-Darling Basin Natural Resources Management Board
SEDS	South East Drainage System (incorporating the USEDS)
SEDSOM Bill	South East Drainage System Operation and Management Bill
SE DWM	South East Drainage and Wetland Management Program
SEAFG	South East Aboriginal Focus Group
SEFRP	South East Flows Restoration Project
SENRM	South East Natural Resources Management
SEWCD Act	South Eastern Water Conservation and Drainage Act 1992
SEWCDB	South Eastern Water Conservation and Drainage Board
SLSRS	South Lagoon Salinity Reduction Scheme
TEV	Total Economic Value
TLM	The Living Murray initiative
USE	Upper South East
USE Act	Upper South East Dryland Salinity and Flood Management Act 2002
USEDS	Upper South East Drainage System
USE Program	Upper South East Dryland Salinity and Flood Management Program
WMPA	Water Management Partnership Agreement

Executive Summary

Following the Australian Government due diligence assessment of the CLLMM Recovery Project Business Case in April 2011, an initial allocation of [redacted] for the South East Flows Restoration Project (SEFRP) Phase 1 Feasibility Study was supported to undertake a range of studies, modelling and investigations to inform planning and design. Phase 1 included the establishment of the preferred flow path alignment, community consultation, the development of a concept design and a fully costed proposal for Phase 2.

This Business Case seeks funding for SEFRP Phase 2 and demonstrates that the SEFRP will be designed, constructed and operated to provide significant long-term environmental outcomes for the Coorong South Lagoon and *en route* wetlands through the reinstatement of a natural South East flow path.

The water to be diverted into the Coorong South Lagoon as part of SEFRP originates in the catchments of the Blackford Drain. It is currently discharged to the ocean at Kingston where it is both a lost opportunity to improve ecological outcomes for the Upper South East and Coorong and is also degrading the marine environment at the discharge point.

The SEFRP project area extends 93.4 km southwards (upstream) from the outfall into the Coorong South Lagoon at Salt Creek to the existing Blackford Drain. It follows the existing Tilley Swamp and Taratap Drains (80.7 km). Twelve kilometres of new floodway is required to connect into the Blackford Drain. The project also involves a minor upgrade of the Bakers Range North watercourse.

The SEFRP channel capacity ranges from 1300 ML/day to 800 ML/day as it progresses southward and requires the excavation of approximately 3.48 million cubic metres of earth. The SEFRP channel design capacity is sufficient to accommodate additional volumes from the mid South East in the future. A 75 week construction window allows the SEFRP to be constructed ahead of the CLLMM Recovery Project end-date of 30 June 2016.

The SEFRP includes an environmental management program which covers water quality monitoring to ensure water entering the Coorong South Lagoon is of a suitable standard. Monitoring activities will also demonstrate that the outcomes of the SEFRP are quantifiable.

Implementation of the Basin Plan seeks to address over-allocation of water resources in the Murray-Darling Basin (MDB) and return the environment to health. Analysis undertaken by South Australia indicates that the Coorong remains at risk (albeit reduced) during drought despite the proposed recovery of 3200 GL. With the SEFRP providing an estimated median volume of 26.5 GL of additional water per year into the Coorong South Lagoon at Salt Creek, the risk of salinities in the Coorong exceeding upper limits that support the Coorong's ecology during drought is reduced. In combination with expected River Murray flows, following implementation of the Basin Plan, the additional input from the South East increases the likelihood that salinities in the Coorong will be maintained below the desired maximum of 100 g/L.

The analysis undertaken to support the development of the Business Case focuses on the management of salinity in the Coorong South Lagoon only and does not address the value or role releases of environmental water from the MDB have on water levels or water quality in the Coorong, the Lower Lakes or upstream environments. It should be acknowledged that improved River Murray environmental flows are needed to support other environmental assets across the MDB.

Studies undertaken by South Australia indicate that additional inputs from the South East could improve salinity outcomes in the Coorong, especially if the years of high South East volume coincided with periods of low barrage flow. The risk of excessive salinity in the Coorong is most likely to be mitigated by a combination of increasing the volume and improving the delivery of River Murray flows relative to historical flows, as well as the provision of additional volume of water from the South East via Salt Creek. Flows from the SEFRP have limited effects on water levels such that they are complementary to barrage flows in maintaining a healthy and resilient Wetland of International Importance.

Overall the SEFRP does not replace the requirements for barrage flows but is complementary. The evidence presented here supports the value of the SEFRP to complement potential Basin Plan outcomes and in combination, provide greater certainty to maintain the health of the Coorong South Lagoon.

The Basin Plan has recently been finalised. However, it remains unclear how the Murray-Darling Basin Authority (MDBA) would treat water from outside the Basin in accounting for water recovery under the Basin Plan. This lack of clarity means it is not possible to determine the water recovery associated with this project. The South Australian Government is open to further discussions with the Commonwealth and the MDBA on this issue, recognising that it may involve technical and scientific analysis, which would be subject to the provision of additional funding.

In conjunction with the implementation of the Basin Plan, the SEFRP gives greater confidence that the objectives of the Water Act and the CLLMM Recovery Project ecological objectives for the Coorong will be achieved by mitigating maximum salinities in the South Lagoon of the Coorong.

It is anticipated that the South Eastern Water Conservation and Drainage Board (SEWCDB), or its successor board under the South East Drainage System Operation and Management (SEDSOM) Bill 2012, will be the relevant authority for the management of the channel once construction is complete, as it will form part of the wider South East Drainage system. The State Government will work closely with the SEWCDB to determine ongoing operation and maintenance requirements.

An operating procedure will be developed in consultation with the SEWCDB that will form a module under the overarching Site Operations Manual for the CLLMM Site, to ensure smooth transition once construction is complete.

The communities of the South East and the Coorong have been consulted extensively during the feasibility assessment of the SEFRP and have significantly influenced the project scope and design. Traditional Owners have also been engaged in the development of the SEFRP and have provided in-principle support to the fundamental intention to redirect water back through historical flow-paths to the Coorong (Kurangk). Ongoing consultation and engagement is proposed as part of Phase 2.

The cost of the SEFRP is [redacted] for DEWNR Project Management (consistent with the CLLMM Recovery Project).

The results of the Cost Benefit Analysis show a Net Present Value (NPV) for the SEFRP of [redacted] over the 20 year timeframe of the analysis, with a corresponding Benefit Cost Ratio (BCR) of 3.69. This result indicates that the SEFRP yields a positive economic benefit.

Although, the annual operating and maintenance cost for the SEFRP is estimated at $900,000, 87 per cent of the SEFRP replaces existing channels with new, lower maintenance infrastructure. In this sense the ongoing project liability can be considered cost-neutral as new operation and maintenance costs will be offset by savings in existing liabilities.

It is assumed that legislative approvals, land acquisition discussions, and detailed design will progress in parallel with Commonwealth consideration of the Business Case, with a funding agreement for the project finalised before 30 June 2013.

The funding agreement with the Australian Government will trigger a revision to Attachment M to the CLLMM Recovery Project Schedule SA-07.

Figure 1: Map showing the key elements of the SEFRP

1. Introduction

1.1. Business Case Context

Purpose

The South East Flows Restoration Project (SEFRP) will use a combination of natural watercourses, newly constructed floodways and existing drains to divert water currently flowing out to sea through the Blackford Drain in the Upper South East into the Coorong South Lagoon.

The project presented in this Business Case can be designed, constructed and operated to provide substantive and demonstrable long-term environmental outcomes for the Coorong South Lagoon and *en route* wetlands through the reinstatement of a more natural South East flow path.

This SEFRP Business Case has been prepared following an extensive period of technical investigations into the feasibility, costs and benefits of the project (Phase 1), funded as part of the *Murray Futures* Coorong, Lower Lakes and Murray Mouth (CLLMM) Recovery Project.

The Business Case summarises the findings of the feasibility investigations and community consultation, and provides a detailed justification, consistent with Australian Government *Water for the Future* State Priority Project investment principles and due diligence criteria *(Water for the Future Basin State Priority Projects: Business Case Information Requirements*), for implementation of Phase 2.

Traditional Owners of the SEFRP area have been engaged in the development of the Project since 2008 and have provided in principle support to the fundamental intention to redirect water back through historical flow-paths to the Coorong (Kurangk).

Murray Futures

In recent time climate change, record low rainfall and over-allocation of water contributed to unprecedented environmental and economic stress within the Murray-Darling Basin (MDB). This situation drove an urgent need to identify, plan and implement actions and programs that provide the best chance for Basin-wide recovery.

In 2008 the Basin States signed an Inter-Governmental Agreement (IGA) on MDB Reform. The IGA provides for Commonwealth/State Water Management Partnership Agreement (WMPA) arrangements whereby the Commonwealth has agreed, in-principle, to make available some $3.7 billion in *Water for the Future* funds for priority projects in Basin States.

The IGA allows for up to $530 million of Commonwealth investment towards South Australia's priority project *Murray Futures* – an integrated package to sustain, support and reinvigorate communities and industries within the MDB in South Australia.

The Australian Government's investing principles for priority projects within the package provide that cost sharing arrangements are on the basis of funding to a maximum proportion of 90:10 (Commonwealth : State/other). Funding is subject to due diligence and projects must: be able to secure a long-term sustainable future for irrigation communities, in the context of climate change and reduced water availability in the future; deliver substantial and lasting returns of water to the environment to secure real improvements in river health; and be value for money in the context of the first two tests.

The Commonwealth, through its *Water for the Future* initiative, committed up to [redacted]n, subject to due diligence, to the South Australian Government to develop an enduring response to the environmental problems facing the CLLMM region.

The CLLMM Recovery State Priority Project, one of five *Murray Futures* Projects managed by the Department of Environment, Water and Natural Resources (DEWNR), was established to provide a suite of medium to long-term management actions at the CLLMM region to secure a future for the region as a healthy, productive and resilient wetland system that maintains its international importance.

CLLMM Long-Term Plan

On 18 February 2009 a funding agreement was signed under the Commonwealth-South Australian WMPA to provide [redacted] [redacted] Commonwealth: [redacted] South Australia) to undertake studies, initial works, and consultations required to develop a long-term plan for the CLLMM region.

The long-term plan was developed in stages, and included significant consultation and input from the community, scientists, industry and Government. This plan was publicly released on 4 June 2010 by the then Minister for Climate Change, Energy Efficiency and Water, Senator the Hon Penny Wong, and the then South Australian Minister for Water, the Hon Paul Caica MP.

The goal of the Long-Term Plan is for the region to be a healthy, productive and resilient wetland system that maintains its international importance.

The Plan outlines priority actions to prevent irreversible ecological damage to the region and to address social and economic problems through an adaptive approach to management.

The plan envisages that:

- Lake Alexandrina and Lake Albert remain predominantly freshwater and operate at variable water levels;
- The Murray Mouth is predominantly kept open by end-of-system river flows;
- There is a return of salinity gradients along the Coorong that are close to historical trends with a corresponding response in species abundance;
- There is a dynamic estuarine zone;
- The biological and ecological features that give the CLLMM wetlands their international significance, albeit a changed and changing wetland are protected;
- There is a return of amenity for local residents and their communities;
- There are adequate flows of suitable quality water to maintain Ngarrindjeri cultural life;
- Tourism and recreation businesses can utilise the lakes and Coorong; and
- Productive and profitable primary industries continue.

When flows are adequate to maintain the Lower Lakes at or near an optimal operating range, as is the current case, minimal intervention is required and adaptation actions that aim to build and maintain a resilient ecology at the site are possible. These include:

- The management of the lakes at variable levels to achieve ecological improvement (developed in consultation with users of the lakes)
- The enhanced diversion of water from the south-east of South Australia to the South Lagoon of the Coorong (via wetlands and water courses where possible)
- Vegetation plantings to restore ecological processes
- The operation of fishways.

Achieving the outcomes of the Long-Term Plan directly supports the economic, cultural and social wellbeing of regional communities. Working in partnership with the Traditional Owners of the site, as well as the regional community, is critical to the successful development and implementation of the Plan.

CLLMM Recovery Project

In January 2010, due to the environmental risks resulting from very low inflows to the CLLMM region, the Australian and South Australian governments agreed to fund and implement a suite of ‘Early Works’ management actions until the full CLLMM Recovery Project Schedule could be finalised. These Early Works management actions were implemented through to June 2011.

On 30 June 2010 South Australia presented the CLLMM Recovery Project Business Case to the Australian Government.

On 17 May 2012 the *Coorong, Lower Lakes and Murray Mouth Recovery Project Schedule SA-07 to the South Australian and Commonwealth Water Management Partnership Agreement* was executed, enabling funding of up to [redacted] to be provided to undertake a range of management actions from 2011/12 to 2016/17. The aim of each management action within the CLLMM Recovery Project is to build ecological and community resilience in the site and mitigate the threat of serious environmental damage.

The CLLMM Recovery Project Schedule sets out the activities, milestones, payment schedules and reporting requirements for the CLLMM Recovery Project. A Project Charter has also been agreed between the Australian and South Australian governments to facilitate the parties’ working relationship and provide operational guidelines for the CLLMM Recovery Project.

The CLLMM Recovery Project consists of 20 management actions (including the SEFRP) which will contribute to one or more of the following outcomes:

a) Improve the Ecological Features of the CLLMM site to deliver a healthy and resilient wetland;

b) The CLLMM ecosystem can adapt to a variable climate and variable water levels;

c) The environmental values that give the Coorong, Lower Lakes and Murray Mouth wetland its international significance are protected;

d) The CLLMM site maintains salinity gradients close to historic trends and an open Murray Mouth;

e) The culture of the traditional owners, the Ngarrindjeri, is preserved and promoted through partnerships and involvement in projects;

f) The local communities that depend on the health of the site are supported with a view to improving their resilience; and

g) Capacity, knowledge and understanding are increased across communities.

The collection of management actions that aim to reset and support salinity levels more appropriate for reinstating the ecological health of the Coorong are grouped under a *Restoring the Coorong* theme, which includes two inter-related compliant but conditional management actions totalling up to [redacted] (excluding project management):

- South Lagoon Salinity Reduction Scheme (SLSRS); pumping hypersaline water from the South Lagoon to the Southern Ocean [redacted]); and
- SEFRP; restoring natural flow paths in the South East [redacted] Phase 1; [redacted] Phase 2);

CLLMM Recovery Project Due Diligence Assessment

In April 2011, the CLLMM Recovery Project was assessed against the Australian Government Due Diligence criteria as a complementary and inter-related set of management actions. The results of that due diligence assessment are found in the *South Australian State Priority Project Coorong, Lower Lakes and Murray Mouth Recovery Project Due Diligence Assessment Report: April 2011* (DDAR 2011).

> *The CLLMM Recovery Project Due Diligence Assessment Report explains that:*
>
> *"Unlike most other State Priority Projects (SPPs), recovering water entitlements is not a feature of this project. While the project does include one component that is capable of redirecting water to the Coorong South Lagoon, this water is not held as an extractive or an environmental entitlement and the salinity levels are too high for agricultural use. As such, this water has little economic value, but high ecological value for the Coorong South Lagoon."*
>
> *The CLLMM Recovery Project Due Diligence Assessment Report also makes clear that:*
>
> *"The CLLMM Recovery Project is quite different from most other SPPs agreed in principle at the time of the IGA. Some of the due diligence criteria are not relevant to this [the CLLMM Recovery Project] Business Case. The management actions contained in the CLLMM Business Case have outcomes focussed on environmental improvement and managing the ecological character of the CLLMM Site. Most other SPPs relate to works to improve water efficiency and recover water for the Commonwealth for environmental use. This assessment of CLLMM was, therefore, conducted using a modified set of criteria that maintained the intent of the original criteria."*
>
> *(DSEWPaC 2011)*

Despite some of the criteria not being deemed relevant by the Australian Government, the CLLMM Recovery Project Due Diligence Assessment Report considered information relevant to the intent of some of the criteria:

> ***Economic and Social Criteria*** *– The CLLMM project does not directly contribute to the long-term sustainability of irrigation communities, in the context of climate change and reduced water availability. In this case, a more general interpretation relating to the contribution to the community in general has been taken.*
>
> ***Environmental Criterion*** *– No water is recovered as part of this project. The South East Flows component results in the redirection of water, but this water is not held as an entitlement and it has no economic value due to its quality. As such, it is not possible to transfer this water to the Commonwealth. In this due diligence assessment the environmental criterion has been considered in terms of the project's contribution to improving the ecological health and character of the CLLMM ecosystem.*
>
> ***Value for Money*** *– It is not possible to value the water redirected to the Coorong South Lagoon through the South East Flows component against a dollar per megalitre benchmark due to the nature and quality of this water (as noted above in the Environmental Criterion). However, the overall benefits to the region, including by way of improved ecological health, can be considered.*
>
> ***Water Reform Criteria*** *– The majority of the criteria in this section relate to water market reform and best practice water modelling, which are not relevant to this project.*
>
> *Other due diligence criteria – As no irrigation works are to be conducted in this project the criteria relating to hotspot assessments and modernisations plans are not relevant."*
>
> *(DSEWPaC 2011)*

The CLLMM Recovery Project (including the SEFRP) was evaluated more rigorously against the remaining criteria:

> ***Economic and social***
>
> - *projects must contribute towards regional investment and development, secure regional economies and support the local community.*
> - *projects must demonstrate a long-term economic and environmental benefit that can be sustained over a 20-year horizon.*
>
> ***Environment***
>
> - *projects must contribute to improvements in the ecological heath and character of the CLLMM ecosystem.*
>
> ***Value for money***
>
> - *projects must demonstrate a positive cost-benefit outcome for a range of investment scenarios, compared with a no change option*
> - *there must be clearly defined, and agreed, cost sharing arrangements*
>
> ***Water reform***
>
> - *all activities associated with the funding of projects must be in accordance with COAG and National Water Initiative agreements*
>
> ***Other***
>
> - *projects must be consistent with best practice and other national approaches and standards being adopted for planning and implementation of Water for the Future*
> - *projects will need to integrate with Basin state water planning documents and processes*
> - *funding will be provided for on-ground works related expenditure only and not for financial restructuring or other purposes*
> - *suitable project management capability and capacity must be demonstrated*
> - *project specifications, including appropriate governance arrangements, compliance with relevant state legislation and the EPBC Act*
>
> *(DSEWPaC 2011)*

The 20 management actions comprising the CLLMM Recovery Project were assessed by the Commonwealth due diligence process as either:

- Compliant – elements of the business case that passed due diligence and were supported for funding; or
- Compliant but Conditional – elements of the business case that passed due diligence, but were subject to triggers, such as low water levels, increased salinity or the results of investigations.

SEFRP Due Diligence Assessment

A summary of the CLLMM Recovery Project Due Diligence Assessment Report findings for the SEFRP are provided below:

> ***Due Diligence Finding:*** *This management action is complementary to the South Lagoon Salinity Reduction Scheme management action and would provide a holistic approach to salinity issues within the South Lagoon and would facilitate better (and quicker) ecological outcomes for the Ramsar site…*
>
> *…The South East Flows Restoration management action is the only proposal that would provide additional water to the CLLMM and would reduce the reliance on River Murray inflows via the barrages for maintaining water quality in the South Lagoon…*
>
> *…The South East Flows Restoration is contingent on South Australia providing a technically feasible path alignment to the drains. South Australia has narrowed the options for the preferred flow path alignment and plan to submit their preferred option for Australian Government approval…*
>
> *…The Department supports a two phase approach to funding…*
>
> *…Phase I is an investigative stage for the South East Flows Restoration and would focus on establishing the preferred flow path alignment, establish the technical feasibility of the project, identify potential River Murray system offsets and address any ecological concerns with increased USE water entering the South Lagoon…*
>
> *…The outcome of the investigative phase would be a fully costed and detailed proposal for works within the funding envelope of $[redacted] in Australian Government funding). The proposal would need to be in sufficient detail to establish technical feasibility of the project and be approved by the Australian Government. The fully costed proposal would include the preferred flow alignment with landholder support, detailed implementation timeframe and detailed budget. The proposal would also provide detail about the potential of this project to reduce dependency on the River Murray as well as a revised*

> *implementation timeframe and detailed budget. The investigative phase should also determine the ecological impacts on the South Lagoon…*
>
> *…Phase 2 is conditional on the outcomes of the investigative phase and is for the implementation of a work component. Funding for Phase 2 is subject to a further assessment by the Australian Government. Funding of up to [redacted] [redacted] in Australian Government funding) would be available if the Australian Government approves the project to proceed…*
>
> ***Due Diligence Assessment:** The South East flows Restoration Phase is assessed as Compliant but Conditional (Passed due diligence but subject to management triggers) for an investigative phase of up to [redacted] ($[redacted] in Australian Government funding) to determine the preferred flow alignment, establish the technical feasibility of the project and identify potential River Murray system offsets and is subject to South Australia providing a detailed and fully costed project plan.*
>
> *The South East Flows Restoration Phase 2 is assessed as Compliant but Conditional (Passed due diligence but subject to management triggers) for works of up to [redacted] [redacted] in Australian Government funding) pending the outcomes of Phase 1 and a fully costed proposal being approved by the Australian Government.*
>
> *(DSEWPaC 2011)*

Concurrent Decision

The CLLMM Recovery Project Due Diligence Assessment Report determined that two of the three *Restoring the Coorong* management actions would be considered concurrently.

> *"Given the direct relationship between the South Lagoon Salinity Reduction Scheme and the South East Flows Restoration management actions, the Department consider that these two management actions should be considered concurrently. Phase 1 would consist of the investigation stage into the South East Flows Restorations. Following Phase 1, South Australia would submit a single proposal detailing a compelling case as the whether both projects would proceed or whether it is more feasible and environmentally beneficial in the long term to expand the South East Flows Restoration project. This would be subject to an assessment and approval by the Australian Government. Phase 2 would consist of the works to either restore or maintain South Lagoon Salinity.*
>
> *The Phase 1 investigative stage would confirm value for money for Phase 2. As such [redacted] [redacted] in Australian Government funding) is supported for the investigative stage and a funding envelope of [redacted] ([redacted]*

> [redacted] in Australian Government funding) will be held in the forward estimates for Phase 2 works, subject to Australian Government approval."
>
> (DSEWPaC 2011)

The Australian Government previously provided [redacted] through the Early Works Priority Project to the SLSRS to complete a detailed engineering design, complete impact assessments, negotiate with the Ngarrindjeri Heritage Committee and undertake Commonwealth and State approvals.

SEFRP Requirements in the CLLMM Recovery Project Schedule

Following the Australian Government due diligence assessment, an initial allocation of [redacted] for the SEFRP Phase 1 Feasibility Study was supported to undertake a range of studies, modelling and investigations to inform planning and design. This included the establishment of the preferred flow path alignment, community consultation, the development of a concept design and a fully costed proposal for Phase 2.

The CLLMM Recovery Project Schedule sets out the SEFRP as follows:

> **Description:** The South East Flows Restoration (SEFR) Management Action will use a combination of natural watercourses, newly constructed floodways and existing drains to divert additional water from the Upper South East into the Coorong South Lagoon.
>
> **Outcomes:** Assist in managing salinity in Coorong South Lagoon through augmented Upper South East flows, in order to maintain a healthy ecosystem.
>
> ***Phase 1 Deliverables:***
>
> - Complete supporting studies, modelling and investigations to inform planning and design, in particular: establish the preferred flow path alignment; establish the technical feasibility of the project; identify potential River Murray system offsets; and investigate any ecological concerns with increased USE water entering the South Lagoon.
> - Develop a community engagement plan and facilitate consultation with landholders.
> - Develop a concept design.
> - Complete a fully costed proposal for Phase 2, including the preferred flow path alignment, details of landholder support, and a detailed implementation timeframe, budget and detail about the potential of this project to reduce the dependency on the River Murray.
>
> ***Phase 2 Deliverables:***

- Complete a final detailed design/construction drawing;
- Award contracts for infrastructure installation;
- Plan and complete an ecological and hydrological monitoring program;
- Complete infrastructure installation; and
- Complete final project closure report, including construction drawings.

(DSEWPaC 2011)

This Business Case demonstrates how Phase 1 deliverables have been met in order for the Australian Government to approve progression to Phase 2.

1.2. Key Outcomes of Phase 1

Works undertaken during Phase 1 have informed the development of this Business Case for Phase 2 works.

A range of supporting studies, modelling and investigations undertaken during Phase 1 were used to inform elements of planning and design, including: the determination of a preferred flow path alignment; the determination of technical feasibility of the project; identification of potential River Murray system offsets; investigation of any ecological concerns associated with increased Upper South East (USE) water entering the South Lagoon; and the development of a concept design.

The CLLMM Recovery Project Progress Reports demonstrate completion of Phase 1 deliverables, and this Business Case refers to studies and investigations where appropriate.

Project cost estimates, a cost benefit analysis and project risk assessment were also undertaken during Phase 1. Legal advice, policy development and approvals were also progressed. This included review and confirmation of landholder legal interests along the preferred alignment; a review of legislative requirements for the project and determination of the legislative framework under which the project will be implemented and operated; and the drafting of legislative approvals required for the project and commencement of approval processes, including a referral under the *Environment Protection and Biodiversity Act 1999* (Cth).

Community and stakeholder consultation was undertaken throughout Phase 1. Activities included information sessions (for the public, the South East NRM Board, South East Water Conservation and Drainage Board, five local Councils, special interest groups and consultative committees), as well as tours of the project area for affected aboriginal groups, and one-on-one meetings with affected landholders.

Phase 1 feasibility was informed by an advisory group which included representatives from various interest groups and landholder representatives.

In December 2011, the then Minister for Sustainability, Environment and Conservation endorsed a Communication and Community Engagement (CCE) Strategy to manage communications and engagement with landholders and other stakeholders impacted by the SEFRP. The CCE Strategy was structured to include the following key components:

- communication and engagement objectives;
- target audiences and key stakeholders;
- equity and access;
- key messages;
- issues and positions of stakeholders;
- project action plan;
- strategy management; and
- evaluation.

The Phase 1 CCE Strategy focused on the investigation into the feasibility and design concept of delivering water from the South East drainage system to South East wetlands and the Coorong South Lagoon via a constructed floodway and upgrade of existing infrastructure. At that stage of the development of the SEFRP, the project included a more extensive approach to providing an integrated flows management solution for water across the South East (which is currently discharged to the ocean at four sites) to be directed to the Coorong South Lagoon and hence consultation was conducted on a number of additional elements to those proposed in this Business Case. Several of these options remain technically feasible for future investment beyond the current CLLMM Recovery Project and could improve ecological outcomes for the Coorong South Lagoon and the wetlands of the South East

Concurrent Decision

Following the provision of environmental water from the MDB in 2012/13 and actual salinities observed by Coorong telemetered monitoring stations; the risk of salinities exceeding 100 g/L in the Coorong in 2012/13 is low regardless of the wind, evaporation and sea level conditions that occur during the remainder of the water year. This, in turn, reduces the likelihood that Coorong salinities will exceed 120 g/L in 2013/14 or 2014/15, which would trigger consideration of the SLSRS, assuming barrage flows continue similar to those modelled.

The worst case scenario for River Murray flows reaching the Coorong in subsequent years is to be wholly dependent on the provision of environmental flows to the site. With the recovery of environmental water entitlements by the Australian Government totalling in excess of 1500 GL as at 31 September 2012 (DSEWPaC, 2012), and the development and adoption of an interim environmental watering agreement between South Australia and the Australian Government, there is sufficient confidence that implementation of the SLSRS is no longer required for consideration during the life of the CLLMM Recovery Project (until 30 June 2016).

South Australia has separately notified the Commonwealth, with an associated position paper, that it now considers it more feasible and environmentally beneficial in the long-term to proceed (through this Business Case process) with the SEFRP.

1.3. SEFRP – Phase 2

This Business Case seeks funding for SEFRP Phase 2 as a revised Attachment to the CLLMM Recovery Project Schedule SA-07.

The project area extends 93.4 km southwards (upstream) from the outfall into the Coorong South Lagoon at Salt Creek to the Blackford Drain (Figure 1). It follows the existing Tilley Swamp and Taratap Drains (80.7 km). Twelve kilometres of new channel is required to connect the SEFRP channel into the Blackford Drain, as well as an upgrade to the Bakers Range North watercourse. The capacity reduces from 1300ML/day to 800ML/day as it progresses southward and requires the excavation of 3.48 million cubic metres of earth.

Modelling (AWE 2011) indicates the SEFRP will provide a median of 26.5 GL of additional water per year into the Coorong South Lagoon at Salt Creek. Modelling also suggests that 25 per cent of the time, up to 30 GL will be available.

Recent modelling (Lester *et al,* 2012) has suggested that when barrage flows are low and SEFRP flows are high, the SEFRP water will reduce the maximum salinity in the Coorong South Lagoon by up to 26 g/L.

The design of the SEFRP channel could also accommodate additional water sourced from further south of the proposed project area to be delivered to the Coorong South Lagoon in the future.

The Basin Plan has recently been finalised. However, it remains unclear how the Murray-Darling Basin Authority (MDBA) would treat water from outside the Basin in accounting for water recovery under the Basin Plan. This lack of clarity means it is not possible to determine the water recovery associated with this project. The South Australian Government is open to further discussions with the Commonwealth and the

MDBA on this issue recognising that it may involve technical and scientific analysis, which would be subject to the provision of additional funding.

Budget

The estimated cost of the SEFRP is [redacted] (Table 1).

Table 1: SEFRP Cost Details

Project Component (3% CPI adjusted)	Financial Year of Expenditure ($)			Totals
	13/14	14/15	15/16	
Detailed Design (3% CPI)	[redacted]			
Land Acquisition (3% CPI)				
Heritage (3% CPI)				
Environmental Management (3% CPI)				
Construction (3% CPI)				
Project Management (Nil CPI)				
GRAND TOTAL (3% CPI adjusted)				

Funding

The total funding available to South Australia for the SEFRP is outlined in Table 2 below.

This includes [redacted] available for *Restoring the Coorong* in the existing CLLMM Recovery Project Schedule and an additional [redacted] of unallocated State Priority Project funding (from the original [redacted] commitment to the CLLMM region) that has been requested for the SEFRP.

South Australia proposes that the [redacted] balance of available funds within in the *Restoring the Coorong* theme of the CLLMM Recovery Project Schedule be quarantined until 2015/16 to permit its application to other actions that demonstrably improve the condition of the Coorong or improve its resilience as outlined in the Long-Term Plan (DEH, 2009).

Table 2: Funding Overview

Funding	AG Funding (90%)	SA Funding (10%)	Total
SA-07 Project Schedule: South East Flows Restoration Project (Phase 2)	[redacted]		
SA-07 Project Schedule: South Lagoon Salinity Reduction Scheme			
SA-07 Project Schedule: Program Management & Corporate Overhead			
SA-07 Project Schedule: South Lagoon Salinity Reduction Scheme (Early Works Carryover)			
SA-07 Project Schedule Funds Available			
Unallocated SPP Funding Requested (from original $200 million CLLMM commitment)			
Sub-Total of Available Funding			
Total Funding Bid in this Business Case			
Residual Funding to be quarantined in SA-07 Project Schedule for future Restoring the Coorong management actions			

2. Background

This chapter describes the international, Murray-Darling Basin, CLLMM, and South East regional context of the SEFRP, including environmental, socio-economic and Aboriginal cultural overviews.

2.1. International Context

Australia has committed to protecting and conserving wetlands, migratory species and biodiversity under key international conventions and agreements. These include the *Convention on Wetlands of International Importance especially as Waterfowl Habitat* (Ramsar Convention); the *Convention on Biological Diversity*; and Migratory Bird Agreements with Japan, China and the Republic of Korea.

The Australian Government works in partnership with state and territory governments to ensure that it meets its obligations under these international conventions.

Ramsar Convention

The Coorong, and Lakes Alexandrina and Albert Ramsar Site was designated as a Wetland of International Importance under the Ramsar Convention in 1985, and satisfied at least eight of the nine criteria for listing when the site's ecological character description was completed in 2006.

The Ramsar Convention is an international intergovernmental treaty which aims to halt and, where possible reverse, the worldwide loss of wetlands and ensure the conservation of remaining wetlands through wise use and management.

The mission of the Ramsar Convention is "the conservation and wise use of all wetlands through local, regional and national actions and international cooperation, as a contribution towards achieving sustainable development throughout the world".

As a signatory to the Ramsar Convention the Australian Government has made a commitment to designate suitable wetlands for inclusion on the List of Wetlands of International Importance, and to formulate and implement planning to promote conservation of listed wetlands and as far as possible the wise use of all wetlands.

Key responsibilities of the South Australian Government include providing primary legislation and policy for wetland management within the state; reviewing the condition of Ramsar sites within the state; and reporting on the status of wetlands in the state.

Convention on Biological Diversity

The United Nations Convention on Biological Diversity came into force on 29 December 1993. The main objectives of the convention are:

- The conservation of biological diversity;
- The sustainable use of the components of biological diversity; and
- The fair and equitable sharing of the benefits arising out of the utilisation of genetic resources.

In line with Article 6 of the convention, the Australian Government has produced the *Australia's Biodiversity Conservation Strategy 2010-2030*. The strategy provides guidance for management and protection of Australia's plants, animals and ecosystems over the next 20 years. The Australian Government's *Environment Protection and Biodiversity Conservation Act 1999* has regard to these principles. This Act has direct relevance for the management of the CLLMM region and is discussed in more detail below.

Bilateral Migratory Bird Agreements

The Commonwealth of Australia is a signatory to three bilateral migratory bird agreements; with the Government of Japan (JAMBA); the People's Republic and China (CAMBA) and the Republic of Korea (ROKAMBA). These agreements provide a formal framework for cooperation between countries on efforts to conserve migratory birds of the East Asian - Australasian Flyway.

The SEFRP area is known to support 27 species listed under one or more of these agreements (Ecological Associates 2008a). Most of these species occur in the Coorong South Lagoon, however, other wetlands in the South East support significant populations.

Supporting Legislation

The Australian Government has enacted two key pieces of environmental legislation to support its obligations under international conventions. These include the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act), and the *Water Act 2007* (Cth).

Environment Protection and Biodiversity Conservation Act 1999

The EPBC Act provides a legal framework to protect and manage matters of national environmental significance (NES). Matters of NES include:

- Wetlands of International Importance;
- National threatened species and ecological communities;

- Migratory species protected under international agreements;
- The Commonwealth marine environment and the Great Barrier Reef Marine Park;
- World Heritage properties and National Heritage places; and
- Nuclear actions.

The EPBC Act regulates actions that will or are likely to have significant impacts on matters of NES.

The matters of NES protected and managed under the Act align with Australia's obligations under international conventions including those that support the conservation and wise use of Australian wetlands, the conservation of biodiversity in Australia, and the protection of migratory species. The SEFRP may impact upon national threatened species and will provide water to the Coorong (a Wetlands of International Importance). These factors require assessment under the EPBC Act through the submission of an associated referral for the SEFRP. The assessment process will evaluate if the SEFRP is likely to have a significant impact on matters of NES.

Water Act 2007

The *Water Act 2007* (Cth) (Water Act) establishes the legal framework for Basin-wide water resource planning and management. The Water Act provides for a Basin Plan to be developed to provide for the integrated management of the Basin water resources including protecting, restoring and providing for ecological values and ecosystem services of the Basin.

The Water Act and the Basin Plan are required to give effect to Australia's obligations under the Ramsar Convention, and other international environmental agreements such as the United Nations Convention on Biological Diversity and migratory bird agreements. Among other matters, the Act specifies that the Basin Plan must promote the conservation of declared Ramsar wetlands such as the Coorong, Lakes Alexandrina and Albert Wetland of International Importance.

2.2. Murray-Darling Basin

The Murray-Darling Basin covers more than one million square kilometres of south-eastern Australia (MDBA 2010) and the river system is among the longest in the world; River Murray 2530 km, Darling River 2740 km (Walker 2006). The Basin ranges from flat desert in the north and west to cool wet mountains in the south-east. The MDB has particular characteristics compared with other similar sized international river basins.

First, it is flat; after dropping rapidly from its major catchments, there is a gradient of only 200 m over the majority of its journey to the Murray Mouth (MDBA 2010). As a result, it can take many months for water that falls in the highlands to reach the mouth.

Second, the Murray has no delta or estuary in the normal sense. It terminates in the Lower Lakes (Lake Alexandrina and Lake Albert) before overflowing to its reverse estuary, the Coorong, and the Southern Ocean through the narrow Murray Mouth.

Third, for the majority of its length, the Murray is a dryland river passing through a semi-arid area where it provides the only significant source of freshwater in an otherwise dry environment. It is here that it interacts with highly saline regional groundwater.

The MDB extends over four Australian states and one territory: Queensland, New South Wales, Victoria and South Australia and the Australian Capital Territory (the Basin States). Over two million people inhabit the Basin and it supports one quarter of the nation's cattle and dairy farms, half the sheep and half the cropland (MDBA 2010). Irrigated agriculture is a significant industry in the Basin and accounts for 50 per cent of all irrigation water used in Australia (2007-08) (MDBA 2010). The Basin yields an annual average of $15 billion worth of produce to the national economy (MDBA 2010). In South Australia the River Murray is a major source of supply for Adelaide, the and also provides water for the domestic, industrial, livestock and irrigation requirements of the towns and farmlands both along its banks and further afield.

The 'health' of the River Murray is dependent on what is happening across the entire MDB and has been in decline for decades. With affects on waterbird populations, native fish communities, long lived vegetation and the loss of significant proportions of wetland habitats across the Basin resulting from river regulation and increasing water diversion for social and economic objectives (MDBA 2010).

The Basin Plan

The implementation of the Basin Plan and the return of up to 3200 GL of environmental water to the Basin's rivers and wetlands will significantly improve the ability to provide water to protect and restore key water dependent ecosystems including the Coorong, Lower Lakes and Murray Mouth, at the terminus of the River. Modelling undertaken by the MDBA indicates that implementation of the Basin Plan will lead to improved environmental outcomes across the Basin including benefits to abundance of native fish and water birds as well as improved condition of water dependent vegetation communities such as river red gums (MDBA 2011).

The Basin Plan incorporates provisions that return the Basin to sustainable levels of extraction through setting environmentally sustainable limits on the amount of water that can be taken from Basin water resources. The Plan identifies key environmental water assets and functions, and environmental water requirements across the Basin and includes an environmental watering plan that establishes environmental objectives, targets and an environmental water management framework for key water dependent ecosystems.

Basin States will be required to be compliant with the sustainable diversion limits (SDL) set under the Basin Plan from 1 July 2019. The Plan initially proposed a reduction in consumptive extraction of 2750 GL but includes a SDL adjustment mechanism that allows for the level of water recovered for the environment to be altered.

The Plan also includes specific objectives including objectives for the Lower Lakes and Coorong that will be pursued under the Commonwealth's program to recover up to 450 GL in addition to the 2750 GL benchmark in the Basin Plan.

2.3. Coorong Lower Lakes Murray Mouth (CLLMM) Region

The CLLMM region lies approximately 85 km south east of Adelaide. It is comprised of two lakes, Alexandrina and Albert, and the Coorong Lagoon, covering a total area of 140,500 ha. The Coorong itself can be separated into three sub-regions: the Murray Mouth/Estuary, and the North and South Lagoons. The River Murray flows into the northern end of Lake Alexandrina. Water can pass into and out of Lake Albert, which lies to the south east of Lake Alexandrina, through a restriction called Albert Passage, but more commonly known as the Narrung Narrows. This channel is about 8 km long and 1.5 km wide, although in places extensive reed growth reduces the effective width to a few hundred metres. Unlike Lake Alexandrina, Lake Albert is not physically connected to the Coorong, and experiences no through flow of river water (Ebsary, 1983).

Ecological values

The CLLMM area is a complex ecosystem that encompasses riverine, lentic, wetland, terrestrial, littoral, estuarine, marine, and hypersaline habitats. Phillips & Muller (2006) document that the site encompasses 23 different wetland types.

The CLLMM site was designated a 'Wetland of International Importance' under the Ramsar Convention on Wetlands in 1985 for its physical and biological diversity and spectacular populations of migratory shorebirds (Kingsford *et al.*, 2009). It is an Icon Site under The Living Murray Initiative, and is listed as a Key Ecological Asset in the Murray-Darling Basin Plan. For the Ngarrindjeri people, the area is recognised as the place where the fresh and salt waters meet and mix; an important place for the reproduction of life (MDBC, 2006).

Lakes Alexandrina and Albert

Lakes Alexandrina and Albert (the Lower Lakes) cover approximately 650 square kilometres which makes them the largest freshwater body in South Australia (DEH, 2000). The lakes receive freshwater inflows from the River Murray, the Eastern Mount Lofty Ranges tributaries, groundwater discharge, local run-off, and rainfall on the lakes surface.

The Lower Lakes contain a system of barrages, with 593 independently operated gates across five structures (MDBC, 2006). They were constructed between 1935 and 1940 to secure water for South Australian irrigation, stock and domestic purposes. These barrages can be operated to manage water levels and water quality in the Coorong and the Lower Lakes. Environmental improvements within the barrages include fishways and automated gates which enable greater flexibility for water delivery.

Fresh water impounded in Lakes Alexandrina and Albert by the barrages maintains a variety of permanent and ephemeral wetlands (DEH, 2000). The Lower Lakes provides habitat for a number of nationally and internationally significant species (Phillips & Muller, 2006). The extensive reedbeds provide shelter for a range of fish species, and are critical for threatened small-bodied freshwater fish such as Murray hardyhead, Yarra pygmy perch, and southern pygmy perch. They are also important habitat for the southern bell frog and provide rookery sites for ibis, spoonbill, and cormorants. During January 2012 over 74,000 waterbirds were counted in the Lower Lakes, with more than 30,000 using both Lake Albert and Lake Alexandrina (Paton, 2012). This included the nationally threatened species freckled duck (*Stictonetta naevosa*). Lake Albert also supports remnant patches of the threatened *Gahnia filum* sedgeland ecosystem, as well as significant orchids such as the metallic sun orchid in Waltowa Swamp.

Between 2006 and 2010, River Murray flows were at historically low levels due to over-allocation and drought across the MDB. As a result inflows into the Lower Lakes were not able to replenish evaporative losses and average lake levels dropped to unprecedented lows. In April 2009 average water levels were at their lowest in Lake Alexandrina, one metre below sea level. As a result, no water was able to be provided to the Coorong Lagoons.

Significant rainfall and flooding in the MDB throughout winter and spring 2010 greatly increased inflows and the Lower Lakes refilled quickly. Due to the volume of flows entering the region, habitats were hydrologically reconnected and in September 2010 water was released through the barrages for the first time since 2006/2007.

The Coorong

The Coorong is a large coastal lagoon complex situated at the mouth of the River Murray. It stretches for 140 km in a south-easterly direction. The Younghusband Peninsula, a Holocene barrier dune, separates the Coorong from the Southern Ocean. The Coorong consists of two main lagoons, the Northern Lagoon and Southern Lagoon, separated by a narrowing of the waterbody at Parnka Point. The Southern Lagoon is the larger of the two with a surface area of approximately 110 km^2 when full, compared to 85 km^2 for the Northern Lagoon.

The Coorong ecosystem is recognised nationally and internationally for the spectacular abundance and diversity of waterbirds it regularly supports (Kingsford *et al.* 2009, Rogers and Paton 2009b). Abundances of certain waterbird species can, at times, represent up to 10 per cent of the global population (Paton 2010). These include species protected under Commonwealth legislation (EPBC Act) and international agreements (JAMBA, CAMBA, ROKAMBA) due to their migratory and/or threatened status. The abundance and diversity of waterbirds combined with the permanence of water in the Coorong during drought reflects the importance of this wetland as a drought refuge and its critical role in supporting waterbird populations nationally and internationally (Paton 2010). The annual waterbird survey of the Icon Sites of the MDB regularly shows the Coorong and Lower Lakes supporting a large proportion of the Basin's waterbirds. For example, in the drought years of 2007, 2008 and 2009, the site supported 92 per cent, 96 per cent and 95 per cent respectively of total waterbird abundance across all MDB Icon Sites, as well as high species richness (Kingsford and Porter 2008, Kingsford and Porter 2009, Kingsford and Porter 2010). Within the Coorong and Lower Lakes site, the Coorong supported 61 per cent, 44 per cent and 79 per cent of the waterbirds counted in those years respectively. Due to its ecological significance the Coorong was established as a National Park in 1966.

The Coorong receives inflows from the River Murray via the Lower Lakes and barrages, the ocean via the Murray Mouth, groundwater, precipitation, local runoff, and from the South East via Salt Creek and the South East drainage system. Inflows from all sources have been severely impacted upon by river regulation, periods of drought, and modified land use.

Effects of Drought

The lack of flows into the Coorong Lagoons during the period of 2006/2007 to 2010/2011 lowered water levels exposing large areas of shoreline and led to a significant increase in the salinity gradient of the region (Figure 2). In early 2010 the Coorong South Lagoon recorded extreme hypersaline conditions, five times the salinity of seawater (~35 g/L). Estuarine habitat effectively disappeared during this time, and hydrological connectivity was lost between the Lower Lakes and Coorong, impacting on diadromous and estuarine fish species and estuarine macroinvertebrates.

Connectivity with the Southern Ocean was only maintained through continuous dredging of the Murray Mouth which had been ongoing since 2003 due to low flow conditions. The previously estuarine Murray Mouth region became a marine embayment, and salinities in the North and South Lagoons increased dramatically. Pre-drought, the aquatic keystone plant *Ruppia tuberosa* was common in the South Lagoon region. However salinity levels beyond its thresholds and low water levels in the South Lagoon resulted in asexual colonisation of the North Lagoon which has acted as a refuge for this species during the drought period.

The Murray Mouth region represented the lowest salinities in the Coorong during the drought and has acted as refuge habitat for many macroinvertebrate, fish and bird species as conditions in both the South Lagoon and much of the North Lagoon resulted in species distributions contracting northwards.

High salinities in the South Lagoon saw the proliferation of brine shrimp, as well as a significant decline in small mouth hardyhead (a saline-tolerant fish species previously common in the region) and Chironomid larvae (previously abundant in the region). Chironomid larvae and turions (the sexual propagules of *R. tuberosa* that have essentially disappeared from the South Lagoon) are significant food sources for wading birds in the region. Bird numbers have declined substantially over the past 25 years, particularly during the recent drought period. Poor quality foraging habitat caused by a lack of food resources and low water levels are likely to have contributed to this decline.

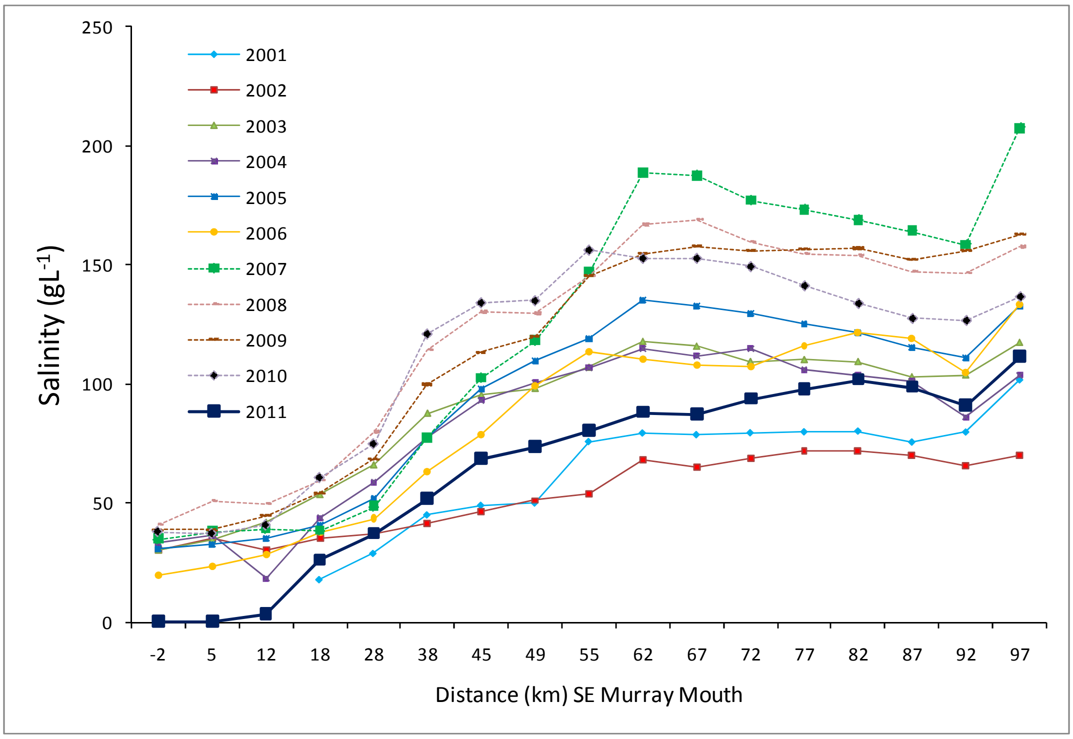

Figure 2: Salinity levels in the Coorong from 2001 to 2011.

Position along the Coorong is defined as the distance from the Murray Mouth, where negative values are northwest of the mouth and positive values are southeast. The junction of the North and South Lagoons (Parnka Point) is at 59 km. Source Paton and Bailey (2011).

Following the 2010 barrage flows, salinity in the South Lagoon reduced to below 100 g/L during winter 2011. This salinity is towards the upper threshold of many biota that inhabited the South Lagoon before the drought period. However the volume of salt that has been exported from the system is currently unknown. The large volumes of water released through the barrages following such a long period of drought have produced both positive and negative responses from the ecology of the Coorong. Due to the volume of water entering the system, water levels in the Coorong have remained elevated and only recently started to decline. This has rendered some previously suitable habitat for *R. tuberosa* and foraging areas for birds unsuitable due to increased water depths. Conversely salinities were greatly reduced in the Murray Mouth region, negatively impacting marine macroinvertebrate species for which the North Lagoon currently provides refuge. *Ruppia tuberosa* has been impacted in the North Lagoon by the low salinities, high turbidity, algal growth and high water levels. Despite this, the distribution range of some fish species has increased in comparison to drought years, with the small mouth hardyhead for example returning to the northern reaches of the South Lagoon.

Socio-economic values

The wetlands of the CLLMM region are an attractive backdrop to the towns of Goolwa, Clayton, Milang, Meningie, Wellington, Hindmarsh Island, Narrung, Langhorne Creek, Raukkan, and Salt Creek. The total population is approximately 30,000 (ABS, 2011), of which more than 4,000 are Ngarrindjeri people who live and work on their traditional land, primarily around Meningie, Raukkan, and Narrung.

In addition to being of central significance to the life and culture of the Ngarrindjeri people, who continue to live on their traditional country, the area is the basis for a local economy that has supported thriving communities, many with a focus on utilising the Coorong and Lower Lakes for tourism, recreation, or primary industries.

The River Murray is a critical source of water, and locally, the River Murray and Lower Lakes have provided water for agriculture and town drinking supplies for approximately 27,000 people, although the installation of potable and irrigation pipelines has reduced the reliance of communities on water from the Lower Lakes (DEH 2010b).

The CLLMM region has a mix of primary industries that are predominantly irrigated and dryland agriculture; manufacturing industries related to wine, machinery and equipment; boat building and maintenance; and recreation and tourism activity (DEH, 2010a). Sheep, beef and dairy cattle farming, grain, vegetable, fruit and nut growing, viticulture and fishing are the main primary industries in the area. There is also a significant urban population, with associated housing and service sectors.

In 2006/2007 the Gross Regional Product (GRP) of the CLLMM area was $700 million, including $145 million from primary industries, of which $70 million was from irrigated agriculture. This is approximately 1 per cent of Gross State Product. Primary industries account for 16 per cent of GRP, with flow-on contributions of 11.5 per cent. Tourism in the Fleurieu region generates approximately $326 million a year and attracts about 652,000 overnight visitors during the year. The services sector, supporting tourism and primary production, accounts for 8 per cent of GRP and 15 per cent of all employment (DEH, 2010b).

The CLLMM region is a popular destination for tourism and recreation in South Australia. Recreational activities include sightseeing, bird watching, camping, walking, picnicking, fishing, swimming, boating, canoeing, water-skiing, and four-wheel driving. The South Australian Tourism Commission estimated the number of visitors to the Coorong National park in 2008 at about 138,000 (DEH 2010a). The Murray Mouth and Sir Richard Peninsula are also key areas of interest.

2.4. South East Region

The South East Natural Resources Management (SENRM) Region covers an area of 21,330 square kilometres in south east South Australian (2.2 per cent of the State). It has a population of over 66,000 people, or 4.1 per cent of the State. The Indigenous population is 1.2 per cent (State 1.6 per cent).

The CLLMM Recovery Project Schedule defines the Upper South East as the section of south eastern Australia that is bound to the south by a line drawn from Kingston through Lucindale and Naracoorte to the South Australian/Victorian border, and to the north from Salt Creek through Keith to the South Australian/Victorian border.

Ecological values

The SENRM Region has many unique landforms and distinctive natural characteristics that have originated from a long, complex geological history. The region is characterised by a series of stranded dune ranges that rise between 20-50 metres above interdunal plains. These plains can be inundated over winter and host a variety of internationally recognised wetland systems including the Ramsar listed Bool and Hacks Lagoons and part of the Coorong and Lower Lakes wetlands and 12 additional wetland complexes listed in the Directory of Important Wetlands in Australia (ANCA 1996). The region also hosts an extensive network of limestone sinkholes and caves, which include the World Heritage, listed Naracoorte Caves.

Today the SENRM Region of South Australia is a highly modified landscape. Broad-scale land clearing and an extensive drainage network have converted what was once a wetland dominated landscape to agricultural production on a vast scale. The region contains very few surface water streams or rivers and water for industry, irrigation, livestock and domestic use is primarily sourced from the ground water system, which consists of extensive unconfined and confined aquifers.

Although only 13 per cent native vegetation cover remains (Foulkes and Heard 2003), the region has diverse flora and fauna and diverse habitats that include healthy woodlands and forests, grassy woodlands, dry heathlands and mallee, scattered trees, open water swamps and wetlands and rising springs. The coastline is largely undeveloped and has distinctive features which include coastal lakes and limestone cliffs. Significant areas of the coastline are protected areas under the *National Parks and Wildlife Act 1972*, with coastal scenery and beaches a major attraction of the region. The marine environment is mostly high energy and is significant for its high biodiversity and high productivity.

The climate of the SENRM Region is considered to be Mediterranean, with cool wet winters and mild to hot, dry summers. The highest annual rainfalls occur in the southern areas where the average precipitation is approximately 850 mm per annum (BOM 2011). A steady decrease northward in precipitation results in a mean annual rainfall of approximately 450 mm at the northern edge of the region. The majority of rain falls during the winter months particularly in the coastal zones, which generally receive less summer rainfall than those areas further inland. Conversely, annual pan evaporation is lowest in the south and greatest in the north.

Socio Economic Values

Eighty two percent of the SENRM Region is designated as agricultural land. Agriculture, forestry and fishing are significant industries for the SENRM Region, accounting for 20 per cent of all direct employment compared with a figure of five per cent for these industries for South Australia. Value adding industries such as timber, wine and potato processing as well as manufacturing and associated services provide considerable economic value to the South East. The region is also a popular area for tourism with over 600,000 visitors a year.

2.5. Project Area – Kingston to Salt Creek

The southern extent of the project area for the proposed SEFRP can be defined by Kingston Township and its northern boundary by Salt Creek settlement. Kingston is situated on Lacepede Bay, located 294 km from Adelaide and 44 km from Robe. Salt Creek is located at the south-eastern end of the Coorong.

Environmental Features

The SEFRP passes through two distinct landforms known as the Taratap Flat and Tilleys Swamp Flat. These landforms are located between Salt Creek in the north and the Blackford Drain to the South. The flats are bound to the east and west by low ranges. The flats fall gradually from east to west, with wetlands located on the western side of the flats at the foot of the western range. In pre-European times, these wetlands were more extensive than today, occupying the entire flats from west to east (Croft et al. 1999) and achieving depths of 1.8 m or more (SEDB 1980). Regional and local drainage has reduced their extent to the lowest lying areas. The flats also fall gradually from south to north, hence the natural direction of flow towards the Coorong.

Adjacent to the current drains, and directly connected via regulators and similar structures, are approximately 11,290 hectares of wetland habitat. This wetland habitat includes the following areas that are managed for conservation:

- Martin Washpool Conservation Park, 2851 hectares;

- Tilley Swamp Conservation Park, 1515 hectares;
- Seven Heritage Agreements (privately managed) totalling 4037 hectares; and
- Four Management Agreements (privately managed) totalling 1037 hectares.

It is important to note that the wetland habitats of the Taratap and Tilleys Swamp areas provide complementary habitat and ecological variety for wetland dependent biota, e.g. waterbirds, in close proximity to the Coorong South Lagoon. These wetlands are much fresher and support a very different vegetation than the Coorong yet are located only about 4 km inland. Very few waterbirds breed in the Coorong (Paton 2010), it is utilised mainly as summer feeding habitat, yet the sedgelands and inundated tea tree thickets of the Taratap and Tilleys Swamp areas provide breeding habitat for a variety of species, particularly waterfowl.

Morella Basin (also referred to as Martin Washpool Conservation Park) is a large (860 ha) brackish wetland that serves as the terminus of the existing Upper South East Drainage System, prior to discharge into the South Lagoon via Salt Creek. It was an important summer refuge for waterbirds during the Millenium Drought, when the ecosystem of the South Lagoon collapsed. Morella hosted a mixed population of 13,600 to 17,000 waterbirds from 2003 to 2006 during spring and early summer (DFW unpublished data).

The vegetation communities most likely to be found between Salt Creek and Kingston are *M. halmaturorum* low open forest in lower areas and *E. fasciculosa* woodland and *E. diversifolia* mallee on higher ground. The project area will include *G. filum* sedgeland at its southern end and the following vegetation communities in its middle and northern sections: *Selliera radicans* and *Wilsonia backhousei* herbland; *Melaleuca brevifolia* shrubland; and *Tecticornia* spp. low shrubland in depressions and *Eucalyptus incrassate*, *E. leptophylla* and *E. socialis* mallee; and *E. leucoxylon* woodland on rises.

The vegetation community most likely to be found along the drainage line at Morella swamp is *Tecticornia* spp. low shrubland and to a lesser degree *E. fasciculosa* woodland, *M. halmaturorum* low open forest and *E. diversifolia* mallee. At Tilley Swamp the main vegetation types in the depressions are likely to be *M. halmaturorum* low open forest and to a lesser degree *Selliera radicans* and *Wilsonia backhousei* herbland; and *M. brevifolia* shrubland. On higher ground *E. diversifolia* mallee; and *Eucalyptus incrassata*, *E. leptophylla* and *E. socialis* mallee is likely to be dominant.

Socio Economic Values

The population of Kingston is approximately 2,279. The main industries in the region are fishing, wine making, and sheep and cattle farming, and to a lesser extent minor cropping. Most farm units are large (400 - 500 hectares). Tourism and recreation is also an important industry, with a large influx of tourists visiting the region during holiday periods. Forestry is the other major land use in this zone.

Salt Creek is approximately 160 km south east from Adelaide. It marks the entrance to the more remote southern stretches of the Coorong National Park. It has an ageing and declining population, with the overall postcode population being approximately 1,500.

Key land uses within the Coorong District are urban settlement (<1 per cent), natural environment (~24 per cent), and agricultural use (~75per cent). Agriculture accounts for nearly 40 per cent of the District's economic output in 2010 ($152 million), 76 per cent of regional exports, and over 40 per cent of employment. The main sectors are grain, sheep, beef, and dairy cattle.

South East Drainage and Wetland Management Program

Before settlement of the region water flowed and pooled across the landscape between ancient dune corridors. These corridors are in a north-south alignment which enabled water to move in a north direction (Figure 3). The terminus of the natural drainage pattern is at Salt Creek. In order to create land suitable for agricultural use and to improve transport in the region, the surface water needed to be moved quickly out of the landscape. Artificial drainage in the South East commenced in 1863 with the cutting of the Maria Creek outlet at Kingston. Similar works were carried out at Narrow Neck between Mount Muirhead Flats and Lake Frome in 1864 and in 1865 the Cutting from Tilley's Swamp to Salt Creek on the Coorong. In the following two decades, around 40,000 ha of land was drained in the Millicent-Tantanoola area.

The success of the Millicent-Tantanoola system led to the construction of four main drains and their tributaries in the mid South East. Approximately 1,800 km of artificial drains were constructed, diverting the north-westerly flowing water through the dune ranges to the coast, with work completed in the 1970s. Some drainage was accomplished by reconstructing natural watercourses. However, most effective drainage occurred from construction of drains cut across the dune ranges. The 'benefits' of constructing such an extensive drainage system were that 381,000 ha of flood prone land became available for grazing sheep and cattle and cultivating crops (SEDB 1980).

Following land clearance in the south east, legume based pastures were created and large areas were sown to lucerne, a deep rooted perennial plant. In 1978 stands of the established Hunter River variety of lucerne were devastated by aphid attack. Of 300,000 hectares of lucerne that had been established in the USE, only 20,000 hectares of productive dryland lucerne survived. Attempts to replace the lucerne with aphid resistant varieties met with limited success due to the emergence of non wetting sands, increases in soil acidity, weed infestation, soil borne diseases and the lack of favourable seasons. The loss of pastures from such an extensive area contributed significantly to the local recharge of groundwater.

A series of extensive and prolonged flooding events in the 1980s and early 1990s resulted in a significant rise in saline groundwater in the Upper South East, the result of which was the onset of extensive tracts of dryland salinity across the landscape. The Upper South East Dryland Salinity and Flood Management Program (USE Program) was established as an integrated scheme, incorporating environmental and engineering sub-programs, designed to address flooding and salinity problems in the at-risk parts of the landscape, whilst at the same time providing for the conservation and enhancement of biodiversity assets across the region, with a particular focus on the delivery of environmental flows to key wetlands.

The USE Program was not simply a drainage scheme as commonly described. Its legacy is an integrated system of drains, flood-ways, natural watercourses and wetlands, through which flows of different natures can be manipulated, by a sophisticated arrangement of approximately 150 flow regulating structures, to achieve a variety of objectives. A broad program of work was undertaken to develop the infrastructure, knowledge-base, operating principles and Decision Support System to underpin the management of the USE Network.

In 2005, the South Australian Government initiated the REFLOWS project as an extension of scope of the USE Program. As a key part of the USE system the REFLOWS floodway was designed to partially restore the historical flow-path from key source water catchments in the Lower South East to the Upper South East. The REFLOWS floodway provides the capacity to capture some of the surface water currently drained to sea and divert it northwards (via a 50 m wide constructed floodway) to deliver more reliable and substantial environmental flow volumes to key wetland systems in the Upper South East; and in periods of high rainfall/run-off, once these wetlands are full, to the Coorong South Lagoon.

The REFLOWS floodway serves to partially restore historical surface water flows from key source water catchments in the Lower South East to provide more reliable and substantial environmental flow volumes to key wetland systems in the Upper South East. It diverts freshwater from Drain M at Callendale northwards along the Bakers Range Watercourse. Fresh water can then be directed through the existing drainage network to fill wetlands in the Bakers Range and West Avenue Watercourses in the Upper South East.

Marine Habitats

Prior to the construction of the South East drainage network there were very few locations along the South East coast where freshwater discharged directly to sea (SEDB 1980, Turner and Carter 1989). Today there are more than 20 man-made channels that, at times, discharge considerable quantities of fresh water into the marine environment. The degradation and loss of seagrass beds in the vicinity of marine discharge points from the South East drainage system is well documented (Seddon *et al.* 2003, Wear *et al.* 2006). The greatest documented losses have occurred in the vicinity of the Drain M outlet (Seddon et al. 2003), although some degradation has been documented at other outlets including the Blackford Drain outlet (Wear *et al*. 2006). Although the water quality parameter, or parameters, that causes seagrass degradation remains unclear, the timing and location of seagrass loss is strongly correlated with drainage discharge to sea (Seddon *et al.* 2003), providing convincing evidence that drain water is the cause.

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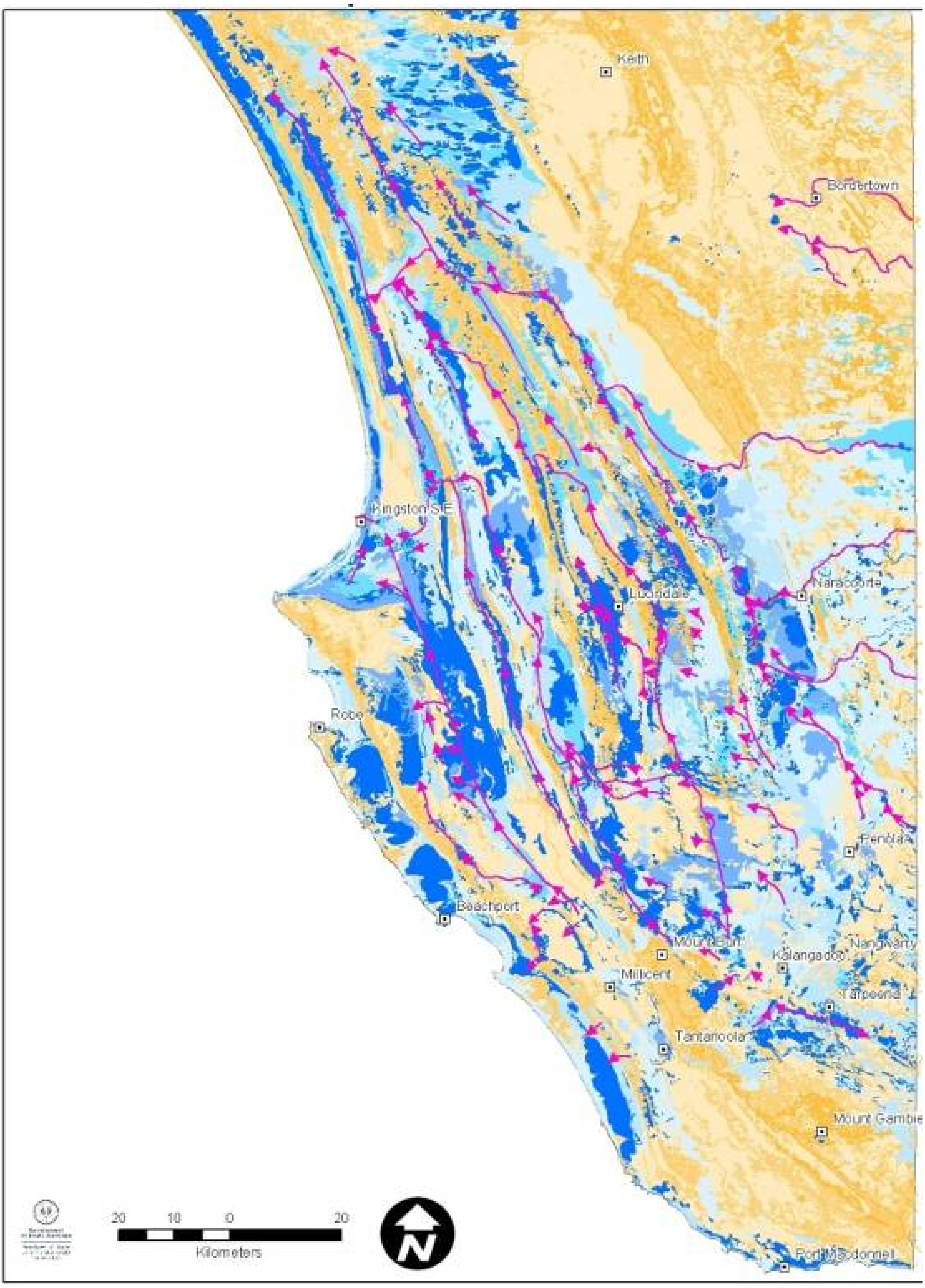

Figure 3: South East Pre-European flow paths (pink lines) and wetlands (blue areas) (source: SEDB (1980)).

2.6. Aboriginal Cultural Values

The SEFRP alignment is situated across the traditional lands and waters of the Ngarrindjeri and the South East Aboriginal people. Both Traditional Owner groups have been engaged in SEFRP planning since 2008. Traditional Owners have requested that their respective input to the SEFRP Business Case be separated given they have not finalised discussions about how they may work together. For the purposes of the SEFRP Business Case the Ngarrindjeri are represented by the Ngarrindjeri Regional Authority (NRA) and the South East Aboriginal people by the South East Aboriginal Focus Group (SEAFG). Both groups are strongly supportive of the SEFRP as it will enhance their cultural values by increasing connectivity between South East wetlands and contributes to their economic well-being. Since the initiation of the planning, other Traditional Owner organisations have been established and the Department will consult with these groups regarding the SEFRP prior to the construction phase and at the time the Department seeks authorisations under the Aboriginal Heritage Act.

Ngarrindjeri

Note: The information on Ngarrindjeri cultural values and aspirations expressed in this section are those directly provided by the NRA for inclusion in this document.

> The Ngarrindjeri people as descendants of the original indigenous inhabitants of the lands and waters of the Murray River, Lower Lakes and Coorong and adjacent areas assert control over the lands and waters by the continuation of their culture upon their traditional lands to pursue their economic, social, and cultural development of the land and waters within the Ngarrindjeri Native Title Claim area. The Ngarrindjeri people are the Traditional Owners of the land and according to their traditions, customs and spiritual beliefs its lands and waters remain their traditional country.
>
> The Ngarrindjeri approach the issue of water not based upon the notion of use but from a cultural perspective, which means that there is a need to discuss the translation of the notion of use and the cultural perspective in order to achieve outcomes which have integrity and demonstrate respect within Indigenous and non-Indigenous communities. The Ngarrindjeri want a future for the Coorong, Lower Lakes and Murray Mouth that maintains the continuation of their culture upon country, the national and international importance of the site, and that it continues to give life to the 4,000 Ngarrindjeri people who live and work in the region and to all Ngarrindjeri people. The Ngarrindjeri Vision for Country is outlined below:
>
> Our Lands, Our Waters, Our People, All Living Things are connected. We implore people to respect our Ruwe (Country) as it was created in the Kaldowinyeri (the creation). We long for sparkling, clean waters, healthy land and people and all living things. We long for

the Yarluwar-Ruwe (Sea Country) of our ancestors. Our vision is all people Caring, Sharing, Knowing and Respecting the lands, the waters and all living things.

Our goals are:

- For our people, children and descendants to be healthy and to enjoy our healthy lands and waters
- To see our lands and waters healthy and spiritually alive. For all our people to benefit from our equity in our lands and waters
- To see our closest friends – our Ngartjis (special animals) – healthy and spiritually alive
- For our people to continue to occupy and benefit from our lands and waters
- To see all people respecting our laws and living in harmony with our lands and waters.

(Ngarrindjeri Nation Yarluwar-Ruwe Plan, 2006)

The culture and economy of the Ngarrindjeri have always depended on Yarluwar-Ruwe and its resources. The land and waters are a living body and the Ngarrindjeri are part of its existence. For the Ngarrindjeri to be healthy, the land and waters of the Coorong, Lower Lakes and Murray Mouth region must also be healthy.

Human induced changes at the site and upstream along the River Murray post European settlement, combined with a drying of the land and waters, are causing the health of the region to change. Without action, the site could experience irreversible ecological and environmental changes and degradation. Yarluwar-Ruwe (Sea Country) cannot be lost to the Ngarrindjeri people and their Ngartjis.

The Ngarrindjeri support a range of actions in the Coorong, Lower Lakes and Murray Mouth to prevent, remediate, and build resilience at the site. These actions should strive to improve the health of the site and to increase freshwater flows. The Ngarrindjeri have established a new relationship, a strong partnership with governments and other stakeholders so that the land and waters can be healthy again. Kungun Ngarrindjeri Yunnan (KNY) agreements are used by Ngarrindjeri for establishing these partnerships.

The Lower Lakes, Murray Mouth and Coorong region is central to Ngarrindjeri culture and spiritual beliefs. This association is expressed through Creation stories (cultural and spiritual histories) about Yarluwar-Ruwe which reveals the significance of the relationship between the country and the people, both practically and spiritually.

Freshwater flows down the Murray-Darling system into the lands and water of the Ngarrindjeri are seen by the Ngarrindjeri as the life blood of the living body of the River Murray, Lower Lakes and Coorong. The Ngarrindjeri Yarluwar-Ruwe Plan, prepared by the Ngarrindjeri People in 2006, articulates a vision for caring for this country, emphasising that the river, lakes, wetlands/nurseries, Coorong estuary and sea have sustained us culturally and economically for tens of thousands of years'.

The Yarluwar-Ruwe Plan refers to Ngarrindjeri Creation stories which record dramatic changes in coastal sea levels in the icon site area. These Creations stories explain the richness of natural resources – especially a wealth of fresh and salt water marine life such as fish, shellfish, eels, waterbirds and water plants. They also provide Ngarrindjeri with the laws and lessons for sustainable use, care and management of these species. In fact, Ngarrindjeri Yarluwar-Ruwe supported amongst the highest density of Aboriginal People anywhere in Australia prior to European arrival.

Since the arrival of Europeans the Ngarrindjeri witnessed the draining of their wetlands along the rivers, and in the south east, and the disconnection of the living body of the River Murray, Lower Lakes and Coorong through the installation of locks, levee banks and barrages. They have watched their Ngartjis (totems) diminish, their lands cleared and the degradation of Yarluwar-Ruwe.

Ngarrindjeri economy has always been based on the sustainable use and trade of the natural resources. Since European settlement, many of the natural resources have deteriorated. The Ngarrindjeri understand that industries that have led to the unsustainable use of resources (e.g. irrigation) are here to stay, however, the Ngarrindjeri seek a just and rightful share in the economic benefits from our Country across all industries (Ngarrindjeri Nation Yaruwar-Ruwe Plan 2006). A proper relationship and role in the management of the land is a fundamental platform in building and maintaining Ngarrindjeri culture and self-respect. Ngarrindjeri believe that their future involvement in the management of the land and waters would be positive and beneficial to all members of the community, both Indigenous and non-Indigenous, and would represent a significant step in the process of reconciliation (see NRWG 1998, Ngarrindjeri Nation 2006; KNY 2009). The strengthening of Ngarrindjeri people and their culture requires a serious involvement in the management of their traditional lands and waters.

Ngarrindjeri cultural and community wellbeing has suffered through the rapid loss of ecological character of the Coorong (Kurangk), Lower Lakes, Murray Mouth, and South East. In recent years Ngarrindjeri leaders have worked with the South Australian Government and researchers to explain the link between Ngarrindjeri culture, people, lands, waters and the wellbeing of all living things (see Hemming, Trevorrow & Rigney 2002; Ngarrindjeri Nation 2006; Bell 2008; Hemming, Rigney & Berg 2008; Birckhead et al. 2011). This philosophical and spiritual connection (Ruwe (Country)/Ruwar (Body)) is reliant on healthy lands and waters, and the maintenance of connectivity between the Kurangk, Lower Lakes, Murray Mouth, and South East as created by Ngurunderi (see Hemming, Jones & Clarke 1989; Bell 1998).

This association is expressed through Creation stories (cultural and spiritual histories) about Yarluwar-Ruwe (Sea Country) which reveal the significance of the relationship between the country and the people, both practically and spiritually:

The land and waters is a living body. We the Ngarrindjeri people are a part of its existence. The land and waters must be healthy for the Ngarrindjeri people to be healthy. (MDBC 2002)

Freshwater flows down the Murray-Darling system and historically from the South East through the Southern Ephemeral Lakes and at Salt Creek are seen by the Ngarrindjeri as the life blood of the living body of the River Murray, Lower Lakes and Kurangk. Maintaining connectivity between parts of the living body is a Ngarrindjeri cultural priority. Reinstating the historical flow of surface and ground water from the South East north towards the Kurangk is strongly supported by Ngarrindjeri.

Ngarrindjeri believe the ecological character of the Kurangk will be improved through management that incorporates Ngarrindjeri knowledge and expertise.

Ngarrindjeri regional governance and engagement

Ngarrindjeri input into governance, policy and planning is framed by the 2009 KNY Agreement which recognises the NRA as the Ngarrindjeri peak body. The KNY agreement establishes the monthly KNYA Taskforce meetings between NRA and relevant State Government officers, and commits to quarterly Leader (Ngarrindjeri Leadership) to-Leader (State Minister) meetings. The NRA propose Ngarrindjeri engagement in the development of the SE Flows Restoration Project Business Case be facilitated through a working group comprising NRA representatives and DEWNR SE Flows Restoration Project officers. NRA preferred process is to establish a working group to facilitate Ngarrindjeri engagement and consultation in the development of the Business Case.

The Ngarrindjeri Regional Authority (NRA) was incorporated in 2007. The NRA members include the Ngarrindjeri Nation communities and organisations as well as the Ngarrindjeri native title claimants and the Ngarrindjeri Heritage Committee. The NRA Board has established a sub-committee responsible for coordinating and supporting Ngarrindjeri heritage and caring for Country activities. The Ngarrindjeri Yarluwar-Ruwe (NY-R) Program Group is working with government and local communities to develop new forms of NRM governance that recognise Ngarrindjeri values and incorporate Ngarrindjeri expertise and capacity. The NRA has also established a Research, Policy and Planning Unit (NRARPPU), based at Flinders University to support the development of its research and policy program.

The NY-R group will manage and oversee Ngarrindjeri input to the SEFRP as the project moves into implementation.

Ngarrindjeri Partnerships Project

The Ngarrindjeri Partnerships management action is a key component of the CLLMM Recovery Project, and links closely to its *Restoring the Coorong* theme. In developing the CLLMM Recovery Project Business Case, DEWNR worked closely with the NRA to develop a Ngarrindjeri engagement strategy. Ngarrindjeri Partnerships is a critical

CLLMM Recovery Project management action that seeks to support Ngarrindjeri engagement and participation across all CLLMM management actions, including the SEFRP and provides the capacity for Ngarrindjeri to be partners in the CLLMM Recovery Project delivery.

The management action seeks to build the core capacity of the Ngarrindjeri nation through the NRA, to engage in caring for their Yarluwar-Ruwe (Sea Country). The Ngarrindjeri Partnerships has four main objectives:

- Facilitate development of working partnerships between Ngarrindjeri and others;
- Protect the Ngarrindjeri people's unique relationship and responsibilities for the region;
- Enable Ngarrindjeri to play a major role in caring for Country; and
- Build professional and culturally appropriate capacity for Ngarrindjeri to engage meaningfully.

DEWNR and the NRA entered into a 4.5 year funding and service agreement in early 2012, and the NRA leads the project delivery. The NRA's Ngarrindjeri Yarluwar-Ruwe (NY-R) Program Group manages and oversees NPP delivery. The NRA utilise the Ngarrindjeri Partnerships funding to employ a number of NRM and research professionals, cultural advisors and a Heritage Management Team.

The South East Aboriginal People

Note: The information on the cultural values and aspirations of the South East Aboriginal People expressed in this section are those directly provided by the South East Aboriginal Focus Group's Position Paper on the SEFRP (Watson 2012).

South East Aboriginal Focus Group Charter June 2011

Vision

South East Aboriginal people will maintain and respect the natural resources of Mother Earth and surrounding waters to establish sustainable resources for everyone.

SEAFG - Statement of Reconciliation

In the spirit of our ancestors, with the wisdom of our Elders and the future of our children, the centerpiece of our Reconciliation vision is for the preservation of country and effective management of our natural resources through the sharing of culture, knowledge and a willingness to achieve our goal.

Role of the South East Aboriginal Focus Group

The SEAFG will take a lead role in Aboriginal natural resources management issues in the South East. The SEAFG will provide advice and input into regional natural resources management processes and provide a link to the wider Aboriginal community.

Aboriginal Peoples of the Coorong and South East, some of whom are also members of the SEAFG, have expressed concern for the future sustainability of the Coorong as well as the greater South East region given the possible effects of climate change. It is our hope and vision that both regions are revitalised and restored as sustainable ecosystems for future generations. Aboriginal Peoples who are members of the SEAFG are working towards reviving our core cultural principles of caring and sharing, so as to ensure the health of our ruwe (country) and the community of all of Aboriginal Peoples who are connected to ruwe through their ‘bloodlines back to country’.

The SEAFG represents the Aboriginal natural resource management opinion in respect of issues in the South East and the Coorong.

The SEAFG supports the principles and approach taken in the SE Flows Restoration – Project Plan in respect of the management of salinity in the Coorong and the proposal to restore water flow paths approximating the traditional ones, which would work towards correcting the impact of salinity on the Coorong.

Aboriginal members of the SEAFG have traditional ties to the SE region and in particular, to the Coorong South Lagoon and the associated Ephemeral Lakes and wetlands. The health and revitalisation of these regions is of cultural, spiritual, social and economic significance to the Aboriginal members.

The revitalisation of the Coorong and other wetlands in the South East will be of benefit to the Aboriginal Peoples of this region and would support the critical significance of an environmentally sustainable region. The revival of the Coorong and some of the SE wetlands would benefit future generations through strengthening and revitalising the foundation of Indigenous knowledges, which is the ruwe-land. The future sustainability of Indigenous knowledge and its incorporation across broader cultural and educational exchanges with non-Aboriginal communities will provide an ongoing basis of cross cultural educational opportunities. The South East is rich in Aboriginal culture and the stories of that culture and history are embedded in the ruwe-the land. The sustainability of the environment will also ensure sustainability of Aboriginal culture and Aboriginal knowledge in the South East region.

3. Project Rationale

This section describes the ecological drivers of the Coorong, salinity target values and threshold values to support Coorong biota and the potential for salinity reduction which can be achieved in the Coorong South Lagoon through the reinstatement of flows from the South East. Additional benefits and implications for South East wetlands *en route* are also discussed.

The ecological health of the Coorong South Lagoon is largely dependent upon flows delivered down the River Murray. The recent 'Millennium' Drought demonstrated the fragility of this relationship and the consequences when insufficient water reaches the Coorong.

Recent history has shown that the South Lagoon is particularly susceptible to significant increases in salinity, during periods of reduced barrage flows, causing environmental degradation, as discussed previously in the CLLMM Region - Effects of Drought section (2.3). Water quality monitoring by DEWNR indicates that the Coorong South Lagoon environmental conditions are slow to improve when River Murray flows return i.e. salinities do no 'reset' immediately upon return of flows.

Hydrodynamic modelling of the Coorong which considers inputs from the ocean, barrage flows and Upper South East Drainage Scheme was undertaken in 2012 (Webster 2012 and BMT WBM, 2012). This has shown that South Lagoon salinities and water levels were largely driven by barrage outflows, the timing of a hydrologic disconnection between the North and South Lagoons brought about by seasonal sea level changes, and local winds.

When the timing of the hydrological disconnection between the two lagoons is delayed, either due to high summer sea levels or substantial barrage flows, the South Lagoon had lower salinities and higher water levels. The provision of additional flows from the South-East Drainage Scheme can potentially be effective at preventing the highest salinities that are most likely to cause ecological damage in the Coorong South Lagoon, especially if these flows coincide with periods of low barrage flow (Lester, *et al.*, 2011). Thus, there is positive ecological benefit to the Coorong South Lagoon from additional fresh water entering the Coorong via the SEFRP.

Ecological Drivers of the Coorong

Salinity, water level and Murray Mouth openness are important ecological drivers in the Coorong and the Ecological Character of the site (Phillips and Muller 2006; Higham 2012).

Salinity is a major determinant of the ecology of the Coorong because it has been demonstrated to influence key biota including the abundance and distribution of fish (Brookes et al. 2009), the aquatic plant *Ruppia tuberosa* (Rogers and Paton 2009), macroinvertebrates in the Coorong (Rolston and Dittmann 2009), and indirectly through food availability for waterbirds (Rogers and Paton 2009).

Water levels are also a major ecological determinant of the Coorong, having been demonstrated to influence submerged aquatic plant community structures (Rogers and Paton 2009) and macroinvertebrate distribution and abundance (Rolston and Dittmann 2009). Water levels also inundate mudflats and alter access to feeding habitats and food availability for migratory wading birds (Rogers and Paton 2009), as well as affecting mixing processes and therefore salinity in the Coorong (Webster 2007).

The 'openness' of the Murray Mouth has been demonstrated to interact with water levels by the way it moderates sea level variations from Encounter Bay into the Coorong, longitudinal (along the Coorong) mixing and therefore salinity (Webster 2007).

Environmental Water Requirements for the Coorong and Lower Lakes Region

DEWNR and researchers from Deakin University, Flinders University, Kerri Muller NRM, with assistance from local experts, undertook investigations to specify the environmental water requirements (EWRs) of the CLLMM region. This work was independently reviewed by Professor Ed Maltby of Liverpool University and Dr Dugald Black of CSIRO Land and Water as part of a scientific review by the Goyder Institute for Water Research. Ecological objectives and outcomes were set based on the aim to maintain a healthy, productive and resilient wetland of international importance under the Ramsar Convention.

Flow-related requirements were identified for a wide range of indicator plants, animals, assemblages and processes, each of which were linked to the ecological outcomes for the site described by Lester *et al*., (2011).

Salinity thresholds to support the key biota of the Coorong and Lower Lakes region were determined using published literature. Modelling identified sequences of barrage flows required to keep salinities below these levels. In conjunction with higher flows, thresholds were therefore determined to avoid the degradation of the site's ecology.

This research describes a flow regime, with a defined minimum volume rather than a fixed volume of water that should be delivered to the region to secure a healthy, sustainable wetland system. These sequences of low and high barrage flows, as well as water level targets, form the environmental water requirements for the site.

This regime as expressed through the EWRs aims to ensure:

- the River Murray should flow out to sea every year, without the need for dredging;
- sufficient water should flow over the barrages to export salt and maintain salinity in Lake Alexandrina below 1,000 µS cm^{-1} electrical conductivity (EC) 95 per cent of the time;
- water levels in the lakes should vary seasonally and between years; and
- higher flows should be delivered as often as was historically the case, to keep the Coorong's South Lagoon healthy.

The EWRs will support the described ecological character of the wetland into the future.

To maintain salinity in Lake Alexandrina below 1,000 µS cm-1 EC for 95 per cent of the time, at least 6,000 GL of water should flow out through the barrages within each three year period. This is an average of over 2,000 GL per year. If 2,000 GL cannot be achieved in any one year, salinity targets can still be met by providing extra water to make up the short fall within the next two years.

In addition to these low flow requirements, high flows of 6,000 and 10,000 GL per year should be maintained at their historical frequency of every three and seven years to maintain a healthy Coorong.

Ecological Objectives – CLLMM Environmental Water Requirements (Lester *et al.* 2011)

In a highly modified system like the CLLMM system, the parts of the flow regime required to support the desired ecological character need to be identified and preserved in order to maintain ecological character (as described above).

By meeting the environmental water requirements of the site, the following ecological objectives are considered to constitute a healthy, productive and resilient wetland of international importance.

1. The region supports a range of taxa that persist without major and/or ongoing management intervention.
2. A range of taxa are able to successfully breed and recruit in the region without interruption.
3. Water links the various habitats and management units at the site.
4. A range of habitats exist within the region.
5. A suitable salinity gradient is maintained across the site.
6. Both flows and water levels vary through time.
7. A variety of ecological functions are supported at appropriate levels.
8. Links exist between aquatic and terrestrial ecosystems.

Salinity Target Values and Threshold to Support Coorong Biota

An ecologically healthy South Lagoon requires the ongoing maintenance of both salinity and water level within their target ranges. Studies to date (e.g. Lester *et al.* 2011 and Lester *et al.* 2012) indicate that the delivery of flows from the South East have a greater impact on salinity than water levels, with water levels remaining largely constant regardless of the volume from the South-East investigated (Lester *et al.* 2012).

Water levels within the Coorong South Lagoon are influenced primarily by barrage flows, the openness of the Murray Mouth, seasonal changes in sea level and local meteorological conditions (wind, net evaporation) (Webster 2005). As such, the SEFRP has been developed to specifically address the other driver affecting ecological health in the Coorong: salinity.

The salinity of the Coorong generally increases with increasing distance from the Murray Mouth, but varies over time, mainly in response to barrage outflows from the MDB (MDBC 2006). The salinity variation – representing estuarine, marine and hypermarine habitats – supports different ecological communities (Brookes *et al.* 2009). Salinity therefore has ecological significance, and based on preferred or lethal concentrations of key biota and the historical distribution of the biota in the Coorong, an assessment of the implications to the Coorong biota of the SEFRP can be made.

The proposed salinity target range to support a healthy ecosystem in the Coorong South Lagoon is between 60 g/L and a maximum of 100 g/L, (i.e. less than three times seawater salinity). Keeping salinity below 100 g/L supports an ecosystem optimal for its distinct waterbird community by supporting the insect component of the macroinvertebrate community (Chironomids), small mouthed hardyhead (*Atherinosoma microstoma*), a food species for piscivorous birds such as fairy terns (*Sternula neris neris*) and *Ruppia tuberosa* growth and reproduction (Higham, 2012). The target minimum salinity of ~60 g/L is derived from salinities that do not favour an undesirable competitor species; *Enteromorpha* sp. (CLLAMM ecology Research Cluster, 2008)

Lester *et al*. (2011) developed a linked suite of species and assemblages for the Coorong and Lakes Alexandrina and Albert site as part of a process to determine the Environmental Water Requirements for a healthy and resilient Wetland of International Importance. Through this work, a broader evidentiary base for determination of upper maximum target salinity that would support key indicator biota was identified, including *Ruppia tuberosa*, small-mouthed hardyhead and Chironomids.

This enables the consideration of important sub-lethal impacts and determination of thresholds. The identified lethal maximum and preferred maximum target salinities for South Lagoon biotic indicators include:

Ruppia tuberosa	Lethal Maximum	~230 g L-1	(Brock, 1982)
Small-mouthed hardyhead	Lethal Maximum	~108 g L-1	(Lui, 1969)
Chironomids	Lethal Maximum	~100 g L-1	(Kokkinn, 1986)
Ruppia tuberosa	Preferred Maximum	~110 g L-1	(Paton, 2010)
Small-mouthed hardyhead	Preferred Maximum	~94 g L-1	(Molsher et al 1994)
Chironomids	Preferred Maximum	~90 g L-1	(Geddes & Butler 1994)

Additionally, growth, flowering, seed set, and turion growth in *R. tuberosa* is severely curtailed at salinities above 120 g/L (Paton and Bailey 2010), at which point the mobile species would have been excluded from the relevant habitat.

The published literature indicates that the target salinity threshold for the South Lagoon should not exceed 100 g/L so as to avoid lethal effects on target biota.

Salinity of 60 g/L – 100 g/L represents the desirable range for South Lagoon salinities to be maintained in all years to support the ecology of the Coorong.

120 g/L represents a maximum salinity that should not be exceeded to avoid harm to the ecology of the South Lagoon.

Basin Plan modelling and its implications for Coorong South Lagoon salinity

Modelling of different water recovery scenarios generated and provided by the MDBA, Gibbs *et al.* (2012) were analysed and interpreted for key environmental assets in the South Australian River Murray. This analysis focused on the following modeled scenarios:

- BP2800: representative of the Basin Plan with a water recovery volume of 2800 GL (expressed as 2750 GL in the current proposed Basin Plan document);
- BP2800RC: a water recovery volume of 2800 GL with key constraints relaxed;

- BP3200: a water recovery volume of 3200 GL, i.e. an increase of 450 GL compared to the current proposed Basin Plan scenario (BP2800); and
- BP3200RC: both an increase in the water recovery volume and relaxation of key constraints compared to the current proposed Basin Plan scenario (BP2800).

In the MDBA's modelling of environmental water, the CLLMM site is not included as a demand in the model that determined watering decisions. As such, the site does not drive upstream modeled outcomes and outcomes at the site are predominantly influenced by watering decisions made for upstream sites (Gibbs *et al.* 2012).

Analysis for the CLLMM site focussed on the assessment and comparison of the water levels and salinity of Lake Alexandrina, Lake Albert, Coorong North and Coorong South Lagoons, as well as barrage outflow and Mouth openness.

Analysis of average daily salinities in the Coorong South Lagoon provides an assessment of the potential habitat suitability for target biota. The number of events and the duration they exceed the identified thresholds provides an indication of relative improvement and risk posed to the Coorong South Lagoon ecology.

Given the indicative nature of the MDBA modelling and the range of untested assumptions used, the most robust use of the findings in Gibbs *et. al.,* (2012) is comparative between scenarios rather than focusing on the absolute values, especially given the outcomes are also positively or negatively affected by local climatic conditions, as outlined in Higham (2012).

The assessment of the number and relative duration of events exceeding a given threshold in the Coorong South Lagoon, despite the uncertainty inherent in the modelled outcomes, provides insights into the ecological outcomes that could manifest under the proposed Basin Plan recovery volume, if delivered as modeled. It is noted that in reality different watering decisions are likely to be made, dependent on environmental water planning and prioritisation under the Basin Plan Environmental Watering Plan.

Gibbs *et. al.,* (2012) indicate that water levels, salinity, mouth openness and barrage releases all improve (compared to the Baseline scenario) with increasing recovery volume. For the Coorong South Lagoon the analysis indicates that:

- Maximum average salinity in the South Lagoon is improved as volume increases above 2800 GL with the number of exceedance events and duration of the events decreasing (improving) compared to the Baseline (do nothing) scenario.

- The number of exceedance events and their duration under the BP 2800 and 2800 RC scenarios is significantly reduced from baseline. However, there still remain a number of years, during drought events, where lethal and sub-lethal salinity thresholds for keystone species are exceeded over the 114 years modelled. Keystone species are critical to the Coorong South Lagoon food chain.
- Under water recovery scenarios of 3200 and 3200 RC, the sub-lethal threshold (90 g/L) is exceeded once with a maximum duration of 78 days under BP3200 and 80 days under 3200 RC.
- Overall, the 3200 GL scenarios reduce the risk of average salinity exceeding the tolerance of key species in the Coorong South Lagoon but did not prevent all impacts.

Importantly, the analysis shows that outcomes for the site are particularly sensitive to not only the volume of water recovered but also to upstream watering decisions about how that water is delivered as well as assumptions in the MDBA modelling. For example, changes to modeled flow delivery sequences under the relaxed constraints scenarios altered the timing of flow reaching the site, and resulted in both positive and negative changes compared to scenarios with constraints.

The difference between modeled outcomes and the actual outcomes that will be achieved by the implementation of the Basin Plan is recognised. The MDBA modelling assumes the delivery of water to the Coorong at Lake Alexandrina levels below 0.4m AHD. In reality there are often difficulties in releasing water through the barrages at this level, particularly in winter (Heneker and Higham, 2012) resulting in changes to the timing and volume of water reaching the Coorong, potentially altering Coorong South Lagoon salinities further from those outlined in Gibbs *et al.,* (2012). Recent modelling undertaken by CSIRO (Webster, 2012) reinforced previous investigations and highlighted the impact of timing and volume of barrage flows on Coorong salinities and water levels and therefore ecosystem health.

In addition, the MDBA modelled outcomes do not fully account for the effects of local climate. Webster (2012) demonstrated that local climate (winds and tides experienced in the region) can affect average Coorong South Lagoon salinities by as much as 14 g/L in a given year (standard error from the mean). This further emphasises that actual outcomes are likely to differ from MDBA modelled estimates. Nevertheless, the 3200 GL water recovery scenarios represent the lowest risk to maintaining the Coorong as a healthy and resilient wetland of international importance.

Given the inherent model uncertainties, the importance of barrage flow timing and delivery volume, and the additional uncertainty of the effect of local climate on salinity outcomes in the Coorong, it is considered that the site remains at risk during drought, as highlighted by Higham (2012) and Gibbs *et. al.,*(2012). Lester *et. al.,* (2011) have indicated that additional inputs from the South East could improve salinity outcomes in the Coorong, especially if the years of high South East volume coincided with periods of low barrage flow. The risk of excessive salinity in the Coorong is most likely to be mitigated by a combination of increasing the volume and improving the delivery of River Murray flows relative to historical flows as well as the provision of an additional volume of water from the South East via Salt Creek.

Overall the evidence supports the value of the South East flows project to complement potential Basin Plan outcomes and in combination, provide greater certainty to maintain the health of the Coorong South Lagoon. The SEFRP does not replace the requirements for barrage flows but is instead complementary.

Comparative Benefit of Water from the South East: Coorong Salinity

In order to assess the likely outcomes of potential barrage and South East flow types upon Coorong salinity, a hydrodynamic model developed by CSIRO was applied to a set of possible scenarios for the Coorong (Lester *et al.* 2012).

The model is a one-dimensional hydrodynamic model developed by the CSIRO which has been published in peer reviewed journals and used by the MDBA in Basin Plan modelling (Webster 2005, 2007, 2010, Higham 2012, Higham and Heneker 2012).

The base hydrodynamic model simulates water motions and water levels along the Coorong from the Murray Mouth to the southern end of the South Lagoon as these respond to driving forces associated with water level variations in Encounter Bay, the wind blowing over the surface, barrage inflows, flows in Salt Creek (via the Upper South East Drainage Scheme), and evaporation from the water surface (Webster 2007, 2010). The model domain extends from the Mouth to the southern end of the South Lagoon (~5 km past Salt Creek) and is divided into 102 cells each 1 km long, in which a momentum equation describing conservation of mass is solved. Major channel constructions occur at the Mouth and in the channel connecting the two lagoons past Parnka Point.

These scenarios contained a series of combinations of barrage volumes between 0 and 10,000 GL/year and South East volumes between 10 GL and 90 GL/year. In each scenario, flow volumes, timing and salinities were held constant year-to-year, while meteorological conditions varied according to the historical record over a period of 25 years (1/1/1983 to 3/12/2007), in order to investigate the impact of each variable on the hydrodynamics of the Coorong under quasi-steady state conditions. In simple terms, the study permits an assessment of the effect that minimum flows will have on the Coorong's hydrodynamics and therefore the minimum benefits.

Figure 4 shows the results of one scenario to illustrate the impact of increased flows from the South-East. Barrage flows were maintained at 2,000 GL while the South East inflow salinity is 10 g/L and the volume is either 10 GL, 50 GL or 90 GL per annum. Inflows from both sources have a historical distribution pattern. The solid line represents the salinity at the northern end and dashed line is salinity at the southern end of the South Lagoon to indicate the range of salinities present in the lagoon.

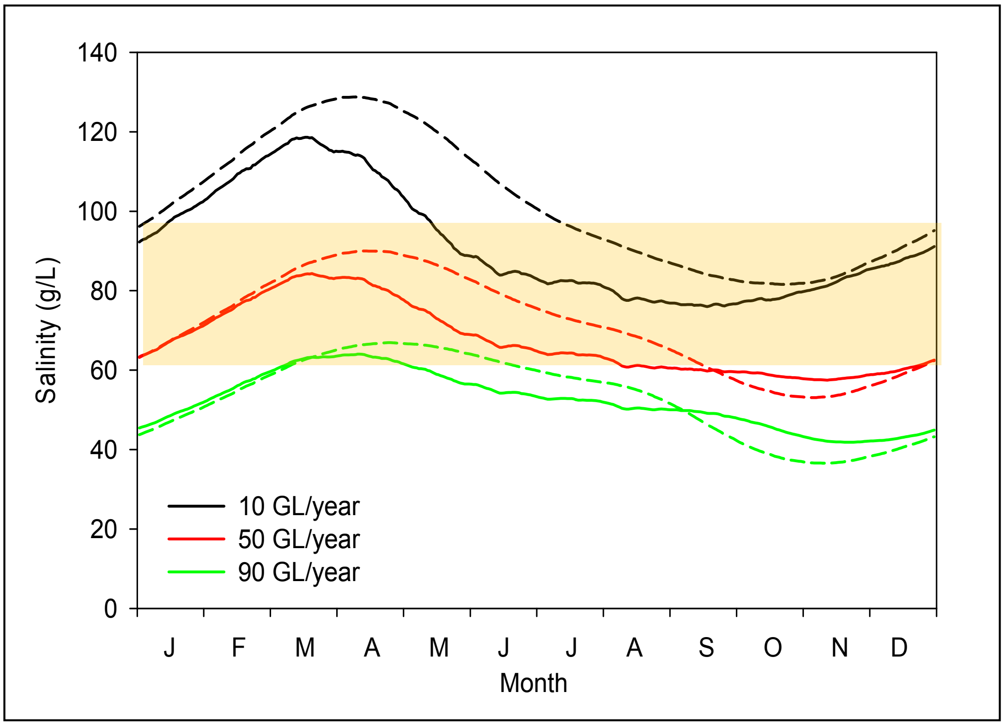

Figure 4: Modelled annual salinity cycle in the Coorong South Lagoon for three scenarios of South East inflow volumes with a barrage inflow of 2,000GL/annum.

The target salinity range for the South Lagoon (60-100 g/L) is indicated by the orange band. The solid line represents the salinity at the northern end of the South Lagoon and the dashed line is salinity at the southern end of the South Lagoon (source: Lester *et al*. 2012)

This scenario indicates that peak (summer) salinities were up to 40 g/L lower in the South Lagoon when an annual volume of 50 GL/year was discharged from the South East compared to annual flows of 10 GL per year (Figure 4). If inputs from the South-East were increased to 90 GL/year, peak salinities would further reduce by 25 g/L, illustrating the benefit of additional flows from the South East on South Lagoon salinity.

Comparative Benefit of Water from the South East: Barrage Flows

In order to assess the likely outcomes and interaction between potential barrage and South East flows (including volumes, salinity and timing) upon Coorong salinity and water level, the CSIRO hydrodynamic model was again applied to a range of possible scenarios for the Coorong.

Figure 5 illustrates that both barrage and South East flow volumes were found to influence salinity in the Coorong South Lagoon, in particular flows from the South East were indicated to have a greater impact when barrage flows were low, reducing the range of salinity values by having the ability to effectively prevent the highest salinities that are most likely to cause ecological damage in the Coorong (i.e. >100 g/L).

This suggests there is the potential for significant environmental benefit that can be realised through additional flows from the South East entering the Coorong.

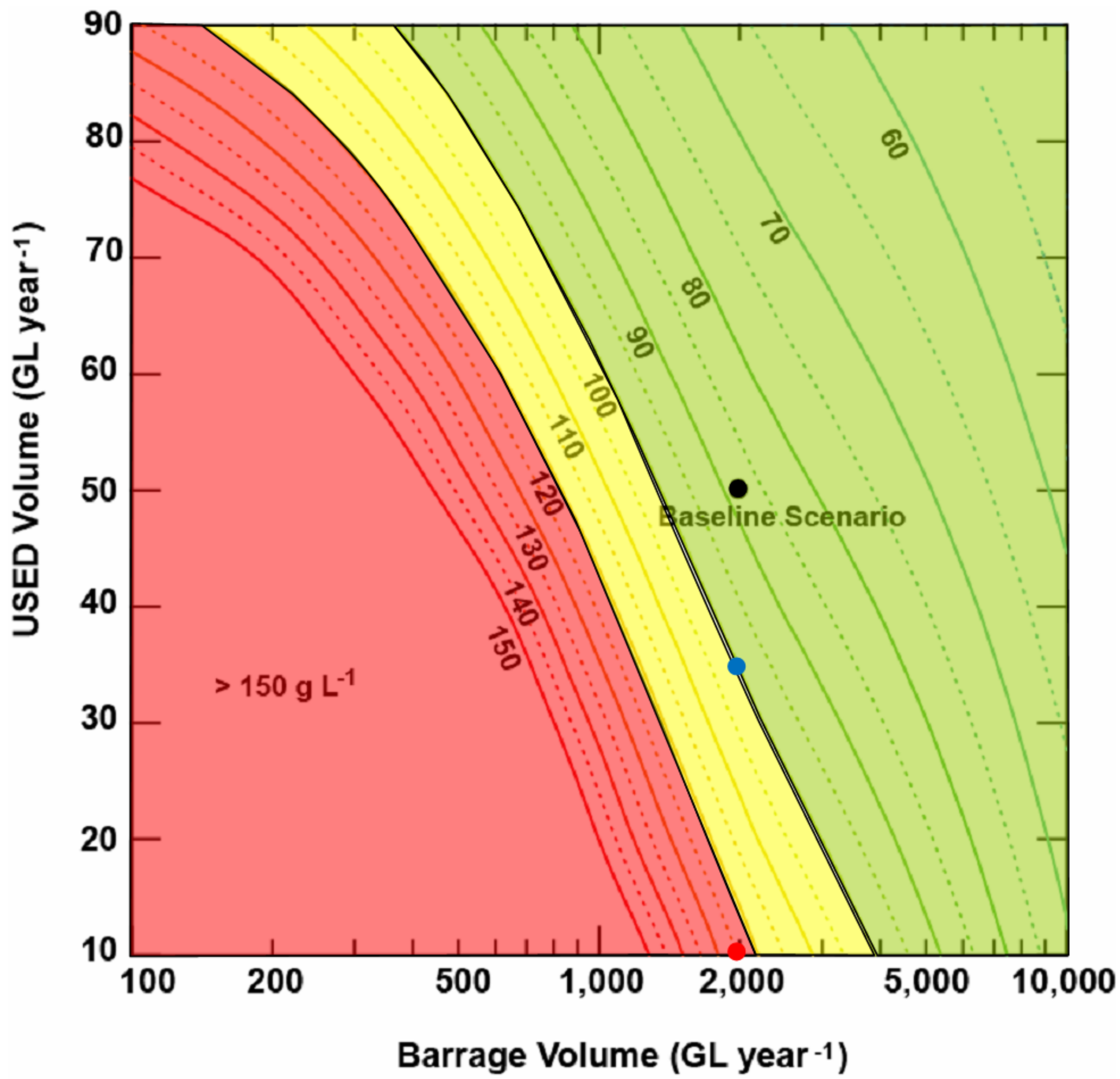

Figure 5: Maximum average salinity in the South Lagoon as a function of South East (USED) and barrage flow volumes.

The desirable salinity range in the South Lagoon is indicated by green, lethal impacts on biota as yellow, with additional undesirable impacts at salinities indicated by red shading. South East salinity is fixed at 10 g/ L

Assuming 2,000 GL /year minimum barrage outflows, the red dot indicates the expected salinity outcome from 10 GL from the South East, the blue dot illustrates the effect of 35 GL from the South East and the black dot the outcome resulting from 50GL from the South East. Note: the x-axis is a log scale (adapted from Lester et al. 2012).

Assuming no less than a three year rolling average of 2,000 GL/yr flows over the barrages as expected following implementation of the Basin Plan with the recovery of 3200 GL (Gibbs *et al.,* 2012), Figure 5 shows that if approximately 10 GL/yr of water from the South East (with a salinity of 10g/L) is provided, maximum average salinity exceeds 120 g/L (red dot). An increase of barrage flow from 2,000 GL/yr to 4,000 GL/yr would result in a reduction of the maximum average salinity from 125 g/L to 100 g/L.

This reduction in maximum average salinity supports the ecological outcomes for the Coorong. Figure 5 also indicates that the provision of:

- 35 GL from the South East results in maximum average salinity below 100 g/L (blue dot) and
- 50 GL from the South East results in average maximum salinity less than 90 g/L (black dot).

This illustrates the additional benefit from increasing yields from the South East. The likelihood of higher volumes being consistently available or during periods of low run off and inflows in the Murray-Darling Basin is modest based on Lester *et al.* (2011) which indicated that additional flows from the USED scheme appear possible in 44 per cent of years when barrage flows are low.

Importantly, this analysis only focuses on the management of salinity in the Coorong South Lagoon and does not address the value of providing environmental water from the Murray-Darling Basin to manage water levels or water quality in the Coorong, the Lower Lakes or upstream environments. The analysis should not be misinterpreted as implying that South East flows can substitute for flows over the barrages as barrage flows provide for multiple outcomes including Murray Mouth openness, Coorong water levels, provision of nutrients, propagules and food to the Coorong, fish passage, ecosystem processes and management of North Lagoon and Lower Lakes salinity.

This analysis demonstrates that although the SEFRP can be beneficial to managing Coorong South Lagoon salinities, the River Murray must continue to be the primary source of fresh water to the Coorong to maintain ecological condition.

4. Phase 1 Feasibility Outcomes

Historically, the SEFRP was first introduced as the Coorong South Lagoon Flow Restoration Project (CSLFRP), which assessed the feasibility of restoring freshwater flows from the Upper and Lower South East to the Coorong South Lagoon. The project followed the success the REFLOWS Project which diverts flows from Drain M at Callendale to the wetlands of the Upper South East (discussed in Section 2.5).

Pre-Phase 1 Investigations

The concept of a proposal to drain water from the South East into the Coorong was initiated by the SA MDB NRM Board in 2007 and received initial funding from the Murray-Darling Basin Commission through the Living Murray Program. The project was developed with the objective of restoring fresh water flows to the Coorong South Lagoon from the South East Drainage System. A project Steering Committee was established to provide support and direction to the project and to select a preferred alignment for the SEFRP channel through the South East landscape. The Steering Committee was composed of government and non-government stakeholder representatives, including South East landholders and Traditional Owners.

Pre-feasibility investigations into the Project began with the completion of a preliminary hydrological study (Way and Heneker 2007) and the preparation of an inventory of potentially affected wetlands and ecological assets within the study area (Ecological Associates 2008a, Ecological Associates 2008b). Consultant Engineers KBR conducted a preliminary engineering feasibility investigation (KBR 2008) followed by a more detailed study (KBR 2009). Consultant hydrologists AWE undertook the first yield modelling (AWE 2009b).

Phase 1 SEFRP Investigations

During Phase 1 of the SEFRP, more detailed feasibility investigations considered a number of refined alignment options (Figure 6) and yield calculations.

Phase 1 Alignment Investigations

Assessment of alignment options focussed on the relative benefits of the Southern Ephemeral Lakes (SELs) options (Flowpath 03 SELs, Flowpath 03 Floodway and Flowpath 03 Biscuit Floodway) and the more inland route of the Taratap and Tilley Swamp flats (Flowpath 02).

The SELs comprise a series of hydrologically isolated lakes in an area, unusually for the South East, without drainage infrastructure. Of the 59 km of the flowpath between the Blackford Drain and the Coorong South Lagoon, 22 km lies within the Coorong

National Park, the extent of which corresponds with the Ramsar boundary. In the National Park the SELs lie within a matrix of intact native vegetation. South of the National Park the SELs are grazed by sheep and cattle but retain relatively intact riparian and aquatic vegetation. Traditional Owners and some colonial historical accounts indicate that water historically flowed through the SELs from south to north, contributing surface inflows to the Coorong South Lagoon (England 1993, Hemming and Rigney 2008a).

There was considerable debate within the Steering Committee regarding this notion. Some members suggested that the current hydrological isolation of the SELs contributes to their physico-chemical and biological uniqueness and that hydrological connection would homogenise them and put at risk internationally recognised values (Ecological Associates 2008a). Those opposed to flow reinstatement also pointed out that the lack of grade in the area meant that considerable excavation and disturbance would be required, including within Coorong National Park, to facilitate flows. The SELs flowpath has a natural gradient of 1:55,000, which is exceptionally flat. By way of comparison, the bed of Lake Eyre has a slope of approximately 1:50,000. The completion of hydrological and hydraulic modelling of Flowpath 03 SELs (Montazeri *et al*. 2011) revealed that, without considerable earthworks within the Coorong National Park, flows of >1,000 ML/day through Flowpath 03 SELs would inundate large areas of private agricultural land and require approximately 5 km of the Princes Highway to be raised higher than its current elevation. When earthworks to lower sills through the SELs were included, the inundation of private agricultural land remained a significant problem and the raising of the Princes Highway was still required for a distance of approximately 0.5 km. Given the environmental sensitivity of the area, the spoil created by these earthworks would be required to be removed from the site, significantly increasing project costs. Flowpath 03 SELs appeared to be unfeasible.

This led to development of options involving the containment of flow through the SELs within a double-banked floodway (Flowpath 03 Floodway and Flowpath 03 Biscuit Floodway). These options avoided the necessity to raise the Princes Highway and prevented the inundation of private land, however losses to groundwater were modelled to be higher, and yields to the Coorong lower, than Flowpath 02 (AWE 2011, Montazeri *et al.* 2011). Additionally, the double-banked floodway had a channel footprint of approximately 80 m width, requiring considerable earthworks and major disturbance within the Coorong National Park, and in native vegetation and wetlands between the National Park and the Blackford Drain. All options utilising the SELs required excavation of a channel of approximately 200 m width for the final 4 km before entering the Coorong South Lagoon.

In comparison to options utilising the SELs, the Taratap and Tilley Swamp flats alignment (Flowpath 02) has a steeper grade (average 1:9230), meaning a narrower channel can be used. This option is also able to utilise 80 km of existing channels, requiring only 13 km of "greenfields" channel construction, as opposed to greenfields construction required for the entire length of options utilising the SELs. The vegetation clearance required for Flowpath 02 is less than for the SELs floodway options (KBR 2012a) , the yield to the Coorong is considerably greater (AWE 2011, Montazeri *et al*. 2011) and the preliminary cost estimate is marginally lower (KBR 2012a).

In summary, the options comprised:

- **Flowpath 02** – diversion from the Blackford Drain and the construction of 12.6 km of new channel to connect to the existing Taratap Drain. Widening, and limited deepening, of the Taratap drain and widening of the existing Tilley Swamp Drain as far north as Morella Basin. A footprint of 80 m width required along most of the alignment (includes existing drain footprint of 30 m). Channel capacity of 1,000 ML/day plus existing from Blackford to "S-bend" confluence, 1500 ML/day from S-bend to Coorong was assessed for this option.
- **Flowpath 03 SELs** – diversion from the Blackford Drain into the natural watercourse of the Southern Ephemeral Lakes, with high ground (sills) between the lakes excavated (and spoil removed from the area) to facilitate flows without causing undesirable flooding of adjacent land and infrastructure. A range of potential channel capacities, from 200 to 2,000 ML/day, were assessed for this option.
- **Flowpath 03 floodway** – diversion from the Blackford Drain into a constructed floodway following approximately the Southern Ephemeral Lakes natural flowpath. The bed of the floodway would be the natural surface, with water confined within levees up to 1.5 m high. A footprint of 80 m width was required along most of the alignment. A floodway capacity of 1,000 ML/day was assumed.
- **West Avenue flowpath** – diversion from the Fairview Drain and the construction of approximately 4 km of new channel to connect to the natural West Avenue watercourse and Henry Creek. From Henry Creek to the Coorong the alignment matches that for Flowpath 02.
- **Biscuit Flat -** This option followed the SEL's alignment to the north, but cut across the Biscuit Flat over areas where no current drainage exists.

Hydrological modelling to estimate the yield to the Coorong from the SEFRP has taken into consideration:

- Historical gauged drain flows at relevant locations in the existing South East Drainage System;
- Run-off from the additional local catchments that the SEFRP would direct towards the Coorong;
- Losses to groundwater from the SEFRP Channel (channel seepage) and gains from groundwater where the water table is higher than the bed of the channel;
- Evaporation from the SEFRP Channel; and
- The impact of climate change upon all of the above.

Options Assessment

Throughout pre-feasibility and Phase 1, DEWNR and consultant hydrologists AWE developed a more detailed approach to yield calculations. The hydraulic conductivity of soil in the project area was ground-truthed to increase confidence in channel seepage estimates for modelling (AWE 2009a). A new approach to calculating channel seepage was developed, externally peer reviewed and incorporated into the hydrological model (Morgan *et al*. 2011). DEWNR undertook detailed hydrological modelling of the options to provide a comparison of yield to the Coorong (Montazeri *et al*. 2011). Finally, AWE further refined the DEWNR model and provided revised potential yield estimates (AWE 2011).

Furthermore, a quantitative ecological assessment was undertaken to rank the options according to their relative environmental benefits, specifically the wetlands, of the South East region (Farrington 2010). The assessment scored potentially affected wetlands according to size, the amount of buffering terrestrial vegetation, the degree of connectivity to other wetlands, the intactness of the catchment, the intactness of hydrology at the site and the presence of threatened and/or protected species (with increasing value for state, nationally and internationally significant species). Scores for each wetland were then multiplied by an impact coefficient which was >1 (max. 1.5) for wetlands positively affected by the SEFRP, and <1 (min. 0.5) for wetlands negatively affected. Cumulative scores for each option were then calculated, enabling the options to be ranked.

KBR were engaged in 2011 to review and update cost estimates for two potential alignments, Flowpath 02 and Flowpath 03 Biscuit Floodway (which also apply to Flowpath 03 Floodway north of the Blackford Drain).

Alignment Assessment

The SEFRP Steering Committee met on 9 November 2011 to review all available information and select its preferred option. Taking in into account potential yield, environmental impacts, cost, and technical feasibility, Flowpath 02 was selected. Conditions for endorsement of Flowpath 02 provided by Steering Group members included:

- that the views of Traditional Owners be duly considered;
- that management arrangements for some privately owned wetlands in the Tilley Swamp will need to be revised to complement the project; and
- that the wetland ecosystems of the South East must not be sacrificed for the sake of the Coorong.

The Steering Committee was subsequently disssolved.

During the period February – May 2012, a detailed topographic survey was undertaken and in April 2012, KBR commenced hydraulic modelling of the alignment for preparation of a Preliminary Design Report.

During one-on-one meetings with directly affected landholders on the alignment from the Blackford Drain to Drain M, an alternative proposal was commonly touted as worthy of further investigation. This option involved extension of the Blackford Drain along the Avenue Flat further to the east.

On completion of the hydraulic modelling of Flow Path 02, it became evident that major earthworks and local farming disruption were required to proceed with the Reedy Creek option. The alternative alignment, known as the Blackford Extension (Figure 6), was investigated and diversion scenarios equivalent to the Reedy Creek alignment were modelled.

In October 2012, the SEFRP area was reduced in extent to involve the existing Blackford Drain (including Fairview Drain) catchment, meaning that only the northern section of Flow Path 02 from the Blackford Drain to Salt Creek was required. The hydrological modelling that had already been completed was used to re-estimate the SEFRP yield to the Coorong under this revised project extent. Consequently, further investigations were conducted to determine whether the initial design 1,000 ML/day diversion capacity still represented best value for money.

All modelling of the northern part of Flow Path 02 from the Blackford Drain, along the Taratap Drain and Tilley Swamp Drain suggested that this section of Flow Path 02 could be constructed to efficiently deliver water from the Blackford Drain to the Coorong South Lagoon via Salt Creek.

Preferred Alignment from Phase 1 Investigations

The preferred alignment is the flow path from the Blackford Drain, along the Taratap and Tilley Swamp Drains to Salt Creek.

From the Blackford Drain to Salt Creek, the SEFRP involves the construction of 12.6 km of new channel and the enlargement of 72.2 km of existing channel (sections through Morella Basin to Salt Creek require no construction and accounts for the shortfall from 93.4 km overall). This preferred alignment is described in more detail in Chapter 5.

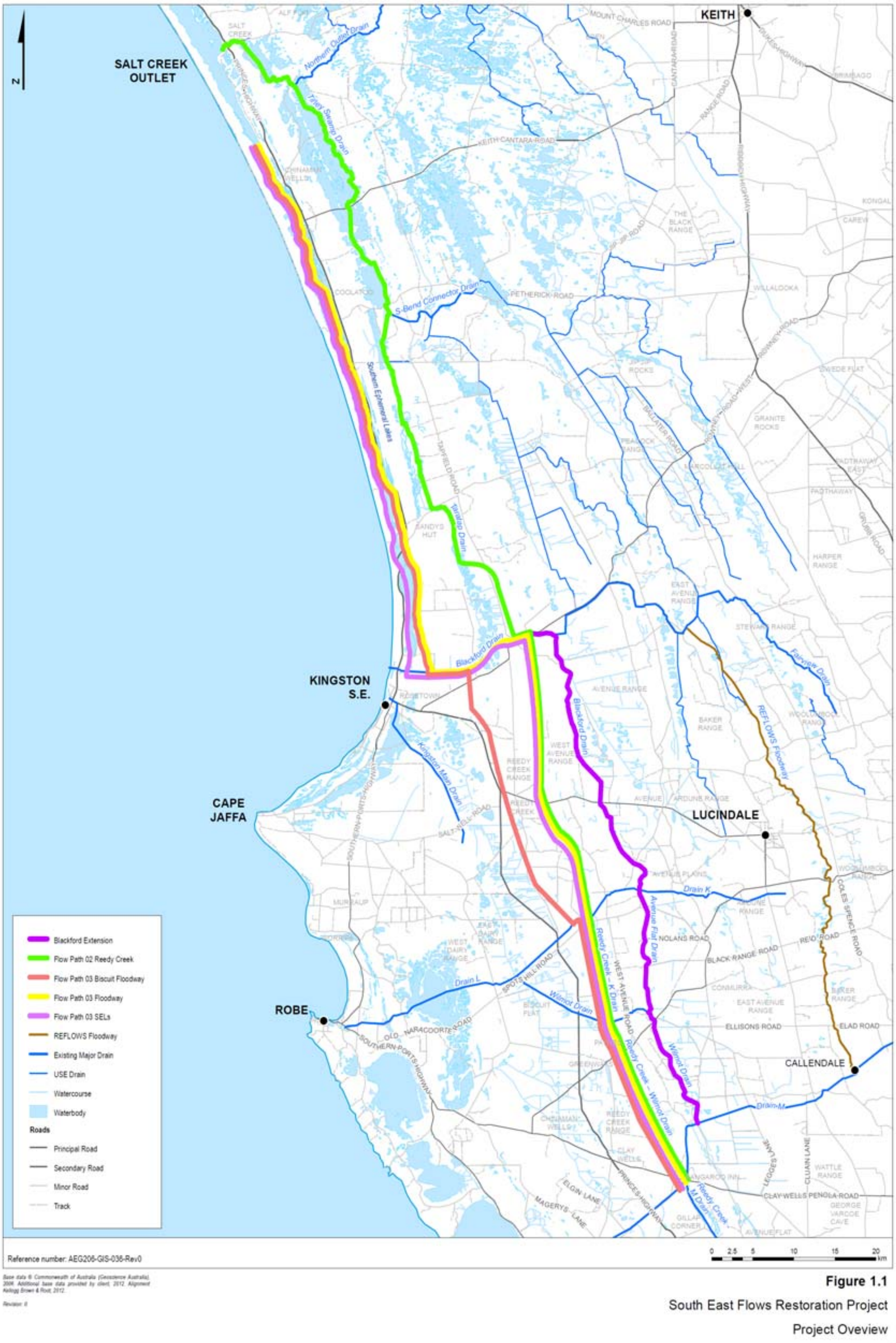

Figure 6. SEFRP Overview of options assessed

Phase 1 Chanel Capacity Investigations

During Phase 1 of the SEFRP, hydrological analysis was undertaken by AWE to determine the optimum size of the channel downstream of the Blackford Drain (current SEFRP proposal) based upon Flow Path 02 (including the Reedy Creek component). Some earlier work had also been undertaken by Montazeri *et al.* (2011) using different diversion criteria along the same alignment.

Using appropriate diversion rules, AWE took into account the water diverted up Reedy Creek from Drain M, Drain L/K and Wilmot Drain, the losses experienced between these diversion points and Blackford Drain as well as the flows available for diversion from the Blackford or Blackford + Fairview catchment.

Both AWE (2011) and Montazeri *et al.* (2011) concluded that, from a hydrological perspective, selection of 1,000 ML/d as the maximum daily diversion of flows at the Blackford Drain was optimal under the modelled conditions.

While the preceding analysis relates to the Flow Path 02 Reedy Creek option, further work undertaken by AWE (2012) to assess the potential yields for the Blackford Extension option concluded that similar divertible volumes would be available at the Blackford Drain diversion point.

Additional statistical analysis on the effect of channel size was undertaken by M. Gibbs 2013 (pers.comms) to provide further confidence. Gibbs looked at the relationship between average annual diversion from the Blackford Drain and channel capacity immediately north of the diversion point. His results show that a channel capacity of 800 ML/day is also hydrologically appropriate and hence a range of channel capacities were further investigated.

Figure 7 illustrates this relationship and shows the proportion of average volume that can be diverted to the Coorong as a function of channel capacity. Notably, diversion capacity below 800ML begin to show reduced yield, whilst larger capacities provide almost no additional water for diversion towards the Coorong.

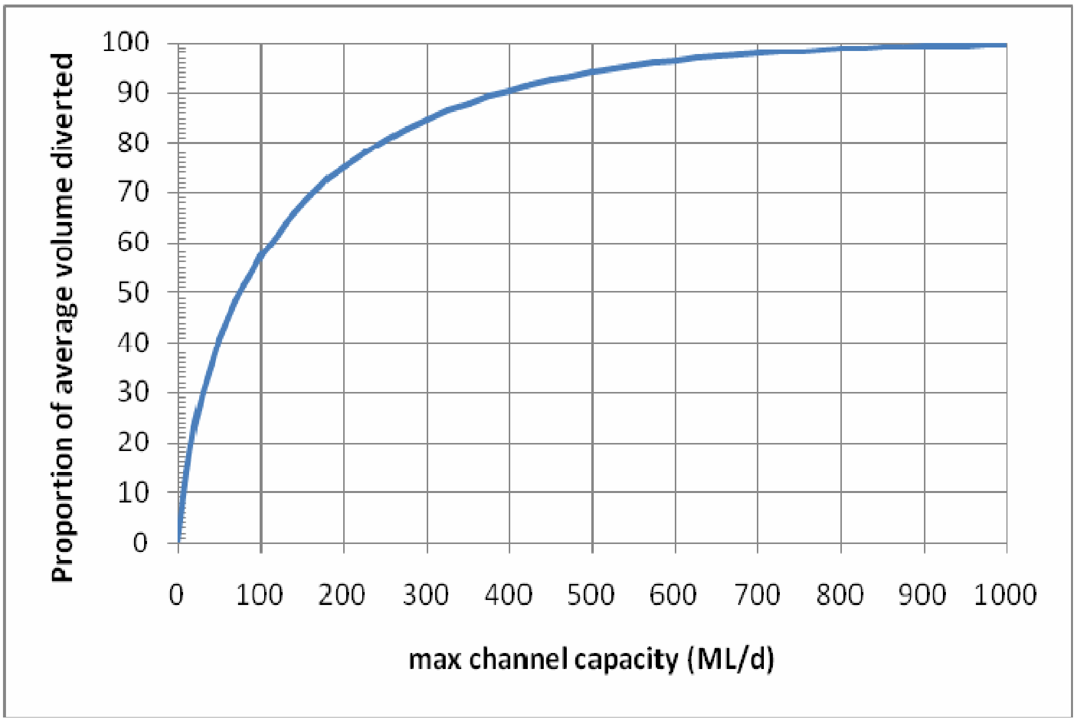

Figure 7. Proportion of average volume that can be diverted to the Coorong as a function of channel capacity (1971/72-2000/2001).

A channel capacity of 800 ML/day (at the Blackford Drain diversion point) was further investigated. Figure 8 presents the difference in annual diversions between 800 and 1,000 ML/d at the Blackford Drain and illustrates that a diversion volume of 800 ML/d results in negligible decrease in divertible volumes.

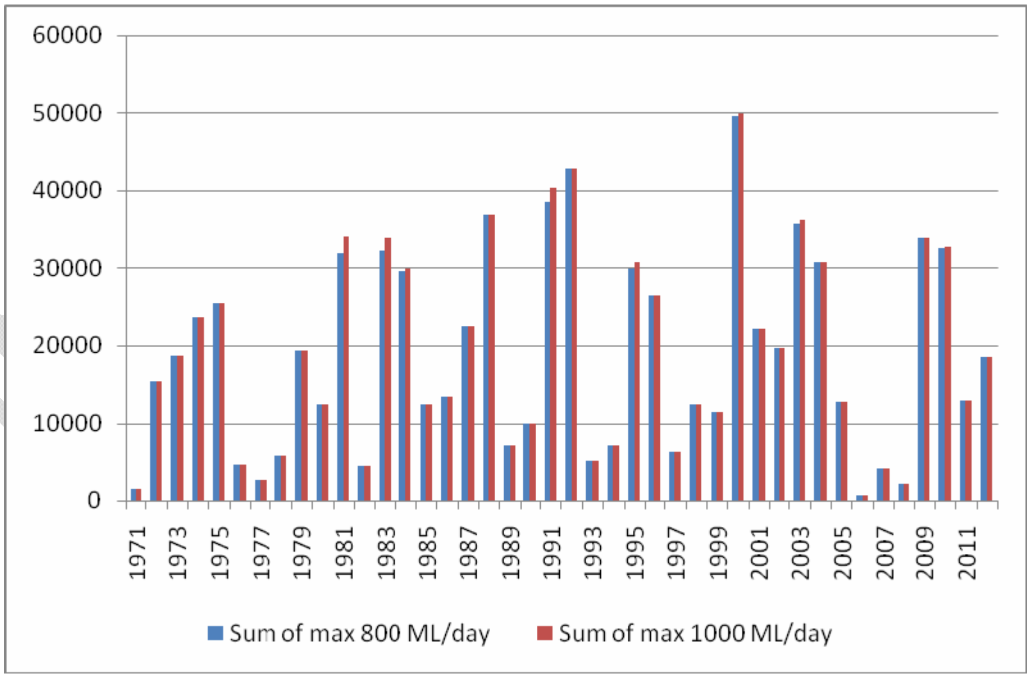

Figure 8 Comparison of resultant annual diversion volumes using 800 ML/d and 1,000 ML/d capacity channels.

Cost Comparisons for Different Chanel Capacities

Total project cost (based upon 3 per cent CPI) has been calculated for a range of channel capacities, as follows:

- 1,000 ML/day plus existing capacity from Blackford Drain to "S-bend" confluence, 1,500 ML/day from S-bend to Salt Creek - PROJECT COST: [redacted]
- 900 ML/day plus existing capacity from Blackford Drain to "S-bend" confluence, 1,400 ML/day from S-bend to Salt Creek - PROJECT COST: [redacted]
- 800 ML/day plus existing capacity from Blackford Drain to "S-bend" confluence, 1,300 ML/day from S-bend to Salt Creek - PROJECT COST: [redacted]
- 700 ML/day plus existing capacity from Blackford Drain to "S-bend" confluence, 1,200 ML/day from S-bend to Salt Creek - PROJECT COST: [redacted]

Landholder support

Landholders between the Blackford Drain and Salt Creek were engaged in discussions on the 1,000ML/day option and generally were very supportive, with some caveats. Concerns were expressed regarding the amount of land taken up and the retention of adequate drainage service. The proposed drainage corridor will expand from as little as 10 m (and zero where no current drain exists) up to 100 m (i.e. 10 Ha of land per km).

A reduction in channel capacity to 800 ML/day is likely to result in an average reduction of project corridor width of approximately 10 m. This equates to 1 Ha/km of alignment. While it is not anticipated that the issues of compensation and drainage will be problematic, the reduction in corridor width is likely to be viewed as more favourable.

A reduction in channel width will result in approximately 21 Ha less native vegetation disruption.

Potential for future projects

There is potential to increase yields to the Coorong South Lagoon by extending the Blackford Drain to connect through to the Wilmot Drain in the future.

Hydrological modelling has shown that the difference in annual diversion flows between 800 ML/d and 1,000 ML/d capacity channels at the Blackford Drain diversion location is less than 1 GL for annual flows greater than 30 GL per year. This is supported by the comparison of high flow events in Figure 8 which also show that negligible reductions result from a channel capacity of 800 ML/d for annual diversion volumes greater than 40 GL.

Thus it can be reasonably concluded that the 800 ML/d diversion option provides significant opportunity for additional input from an extension of the scheme at some time in the future.

Summary of preferred alignment and channel capacity from Phase 1 Investigations

The Salt Creek to Blackford alignment, via the Tilly Swamp and Taratap Drains at a capacity of 800 ML/d (at the Blackford Drain) represents the preferred option for Phase 2 of the SEFRP. It balances:

- Existence of existing drainage infrastructure;
- water yield to the Coorong;
- project cost;
- environmental impact / extent of native vegetation clearance;
- landholder support, which may decline for a larger channel with a large footprint, but may also decline if the channel capacity is deemed inadequate to prevent flooding of agricultural land; and
- implications for potential future enlargement of the project (public consultation was undertaken on a larger version of this project that included the Blackford Extension, which has the potential to yield an extra 23.5 GL/year (median) to the Coorong (AWE 2012)).

5. Description of SEFRP

The SEFRP will use a combination of natural watercourses, newly constructed floodways and existing drains to divert additional water that currently flows to sea from the Blackford Drain in the Upper South East into the Coorong South Lagoon.

It is anticipated that, except in very high flow conditions (flows greater than 800 ML/day; representing 0.4 per cent of days), all of the current outflows from the Blackford system will be redirected northward to the Coorong South Lagoon via Salt Creek. Based on hydrological modelling, the SEFRP has the potential to deliver an additional 26.5 GL/year (median, historic climate scenario), almost doubling the median yield of the existing drainage network (29.7 GL/year).

The purpose of the works in the Bakers Range North watercourse is to enhance the flow of surface water and water from REFLOWS events (in the mid Bakers Range) to major wetlands in the Bakers Range North watercourse and the Coorong South Lagoon in wet years.

By reinstating the 'natural' movement of water from the Upper South East to the Coorong, with opportunities to potentially water en-route wetlands, the SEFRP can mitigate the impact of reduced flows from the MDB on salinity in the Coorong South Lagoon to a greater extent than the existing drainage network. The project does not replace the requirement for flows from the MDB but acts complimentarily to them in ensuring the salinity in the South lagoon remains below the desirable targets following the implementation of the Basin Plan. Without the implementation of the SEFRP, the ability to achieve the Basin Plan's salinity outcomes in the Coorong is expected to be more difficult, particularly during periods of low MDB inflow.

This section describes the spatial extent of the project, its technical design and design rationale, how the scheme would interact with existing drainage and other regional infrastructure, yields that would result from its implementation and expected environmental benefits that would result in the Coorong.

5.1. The spatial extent of the SEFRP

The SERFP consists of the construction of the SEFRP Channel and a small component of works to restore flows to wetlands *en route* in the Bakers Range North watercourse (Figure 9).

Figure 9. SEFRP Alignment and scope of works to increase flows to the Coorong

Salt Creek to Blackford

The proposed channel extends 93.4 km southwards along an alignment from the outfall into the Coorong South Lagoon at Salt Creek to the Blackford Drain (Figure 9).

From the Salt Creek outfall, the channel:

- Passes under the Princes Highway and along Salt Creek with minimal channel modifications;
- Follows the existing channel though Morella Basin, without modification;
- Follows along the existing Tilley Swamp and Taratap Drains (80.7 km) with increased channel width to obtain the required capacity;
- Crosses the Murrabinna Flats to the Blackford Drain in a new channel along the western side rather than the eastern as had been modelled during the pre-feasibility investigations; and
- Connects to the Blackford Drain at the 'Blackford weir' downstream of the Keith-Kingston Road.

The channel alignment intersects two dune ridges, one in the Martin Washpool Conservation Park and the other near Cantara Road. For a significant portion of the route north of Cantara Road, it runs close to the base of the dunes along the eastern side of the flats, following the fence line along the east of the tea tree scrub, entering the scrub to skirt dunes which protrude into the tea tree scrub. South of Cantara Road, the proposed alignment wanders across the Tilley Swamp, approaching areas of dunes only where it crosses Petherick Road in the vicinity of Litigation Lane.

Existing Infrastructure

The SEFRP proposes works that will replace a significant amount of existing infrastructure between Salt Creek and the Blackford Drain. Whilst the Crown holds most of the proposed alignment in various forms, the scale of the proposed construction will require an expansion of the Crowns interests. The southernmost 12.4 km of the project is held privately as freehold titles. Existing assets, rights and liabilities currently reside with the Minister for Sustainability, Environment and Conservation. However, it is anticipated that these will be transferred to a statutory entity, the South East Water Conservation and Drainage Board prior to June 2013. This statutory Board, or its successor board under the SEDSOM Bill 2012, will be the relevant managing authority once construction is complete. The current SEWCDB has been briefed regarding the SEFRP proposal throughout the Phase 1 work program.

Northern Bakers Range Watercourse

As part of the SEFRP works, some minor construction works are proposed to upgrade the flow capacity of the North Bakers Range Watercourse from the Fairview Drain / Bakers Drain Crossover to Hirst's Fire Track (24 km) - to approximately 500 ML/day.

The North Bakers Range Watercourse contains a substantial area of significant wetlands. Studies that underpinned the REFLOWS proposal (Harding 2007) identified 12,250 ha of mapped wetlands of which 11,834 ha were considered to be impacted by the REFLOWS project. A number of these wetlands, including Cortina Lakes, Mandina Marshes, Bonney's Camp and the Watervalley wetlands complex are of high conservation value. Wetlands and Wildlife - a philanthropic body that holds a portfolio of Upper South East properties for purely environmental purposes - is considering seeking Ramsar listing for part of this substantial complex of Upper South East wetlands (E Pettingill pers coms). Prior to drainage, the Bakers Range Watercourse was the natural flowpath for a significant portion of the South East with these wetlands periodically receiving substantial flows. In wet years, once the wetlands reached capacity, these flows continued to the Coorong South Lagoon via Salt Creek.

Part of the mid Bakers Range Watercourse was recently restored by the REFLOWS project which has improved flows along this watercourse from Callendale on Drain M in the south to the Fairview Drain in the north. Infrastructure constructed as part of the REFLOWS project allows water to be directed into either the Fairview Drain or left to flow northwards along the natural flowpath to the northern wetlands. However, restrictions along the North Bakers Range watercourse limit flows to these wetlands and the Coorong South Lagoon.

Cost estimates to upgrade this section to 700 ML/day were originally prepared as part of the USE Program and were estimated to be approximately [redacted]. However, an upgrade to 500 ML/day as part of the SEFRP can be achieved for approximately [redacted]. The required works are:

- construction of a double bank channel for the first 14 km to G-Cutting Bridge so as to prevent flooding of agricultural land (this approach was successful in the REFLOWS Floodway),
- increasing the capacity of the North Bakers Range Watercourse north of G-Cutting, to 500 ML/day -existing capacity ranges between 60 and 480 ML/day (AECOM 2010).

Whilst these upgrades are not expected to directly increase yields to the Coorong South Lagoon in years of average runoff, they will enhance the capacity of the system to deliver flows in substantially wet years.

All of the required works to upgrade to 500 ML/day can be contained within Statutory Easements held in favour of the Minister for Sustainability, Environment and Conservation for most of its length, or on properties where affected landholders have indicated total support for the project (without caveats). Only minor disturbance to native vegetation (all classified as partly intact) is required with those areas to be rehabilitated in the same manner as described for the main SEFRP Channel.

The works in the North Bakers Range Watercourse will be complemented by proposed upgrades to the Fairview Drain. This will increase the flexibility of the management of this region of the South East Drainage Network allowing more effective delivery of saline groundwater and/ or surface water runoff and/or water from REFLOWS events to the Coorong South Lagoon and south east wetlands.

Failure to improve flows to these wetlands as part of the SEFRP is likely to create community angst that the SEFRP is simply harvesting water for the Coorong at the expense of regional wetlands. It is expected that improved wetland habitat regionally, will provide improved resilience to wetland communities, providing alternate habitats for mobile species such as waterbirds that inhabit and stopover in the district.

5.2. Design of the SEFRP

This section summarises the preliminary technical design of the SEFRP, based on the KBR Preliminary Design Report (2012).

Design Flows

The design flows for the channel are summarised in Table 4 and include consideration of the existing capacity of Taratap Drain and Tilley Swamp Drain to ensure that local drainage is maintained. The distances are described as chainages (ch) in metres measured from the downstream end of flows (Salt Creek – Coorong South Lagoon Outfall).

Table 4: Summary of design flows for the Salt Creek-Blackford Channel

Chainage (m)	Section	Flow capacity (ML/day)	
0- 8700	Salt Creek Outfall (CSL) – Morella Basin inlet	1,000	1300
8700- 12600	Morella Basin inlet – Martin Washpool inlet	520	1300
12600-47100	Martin Washpool inlet - to S-Bend	130	1300

	junction		
47100-53100	S-Bend junction – Henry Creek Road (start Taratap Drain)	130	930
53100-63000	Taratap Drain	90	890
63000-72500	Taratap Drain - Taratap Road	45	845
72500-80700	Taratap Drain - end	30	830
80700-93400	Murabinna Flats	-	800

SEFRP Channel Details

In the design of the channel, consideration has been given to maintaining the existing drainage of the landscape through which it flows. The design has aimed to keep the water surface below ground level where reasonably and practically possible. Where this could not be achieved, flows in the floodway will be contained by levees and catch drains will be provided to deal with drainage from the local catchment.

The design philosophy of the floodway has altered significantly from the modelling philosophy used during the options development phase (AWE 2011, Montazeri *et al*. 2011). That modelling did not take into account the need to maintain the existing design water level at the junction with the S-Bend Drain, as well as maintaining a drainage service along the length of the Tilley Swamp and Taratap Drains. As a result a peak water level at the junction of the S-Bend Drain was permitted some 0.7 m higher than the design water level. This would be expected to significantly compromise the drainage function of the S-Bend Drain which is the outfall for over 300 km of drains constructed under the USE Program. Additionally, water was allowed to flow unconfined and above ground along the Tilley Swamp and Taratap flats on the eastern side resulting in flooding of pasture land (developed and undeveloped) up to two kilometres from the channel.

The result of these earlier modelling assumptions, that water was largely allowed to flow above ground in an unconfined manner, reduced earthworks volumes to that required to construct levee banks and far less than the volume required for the excavation of below ground drains.

Drain invert

The following principles were applied in finalising the vertical alignment of the channel:

- where there is an existing drain, the drain invert was maintained in most cases, and the width increased to provide the required additional capacity;

- where there was no existing drain, the invert was determined based on consideration of:
    - o the upstream and downstream inverts of existing drains;
    - o a preference to balance cut and fill volumes for construction of floodway levees;
    - o the width of the flow path corridor; and
    - o topographic features.

There were some exceptions to the above principles, where the hydraulics of the system required the invert of existing drains to be lowered.

In the final invert consideration, groundwater interception and potential drawdown of the water table was assessed to minimise any adverse effects upon soil moisture retention and wetting up of the profile to maintain runoff potential for local surface water flows for nearby wetlands.

The resultant inverts are shown in the long sections (Figures 14, 15, 16)

Cross sections

The channel cross sections vary depending on the requirements for levees on one or both sides and the specific requirements of each reach.

A summary of the design features for the proposed channel is provided in Table 5. For the purposes of the preliminary design, drain and levee batters are assumed to be 1V:3H. In the detailed design phase, levee batter slopes may be varied according to local conditions or landholder requirements.

Areas of native vegetation have been identified and consideration has been given to minimising disruption to these areas.

Table 5: Assumed floodway cross section details by reach.

Design feature	Salt Creek (Ch 0) – Henry Creek Road (Ch 53250)	Henry Creek Road – Blackford Drain (Ch 93400)
Base width	Varies	Varies
Drain batters	1V:3H	1V:3H
Levee top minimum width (trafficable)	3 m	3 m
Levee batters	1V:3H	1V:3H

Maximum levee height	1.9 m (incl. freeboard)	1.7 m (incl. freeboard)
Freeboard (levee)	0.8 m	0.6 m
Freeboard (drain)	0.2 m	0.2 m
Maximum height of floodway (invert to top of levee)	2 m Greater than 2 m requires benching	2 m Greater than 2 m requires benching
Corridor width	varies	varies

A number of typical cross sections have been applied along the alignment. The two most common are shown below, where Figure 12 illustrates contained flow (above ground) with a catch drain to deal with local drainage and Figure 13 for below ground flow.

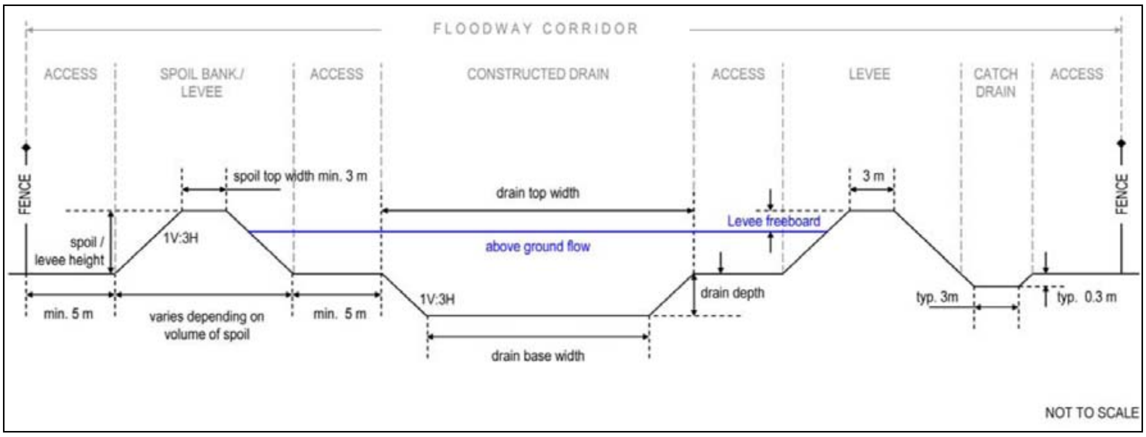

Figure 12: Channel for contained above ground flow

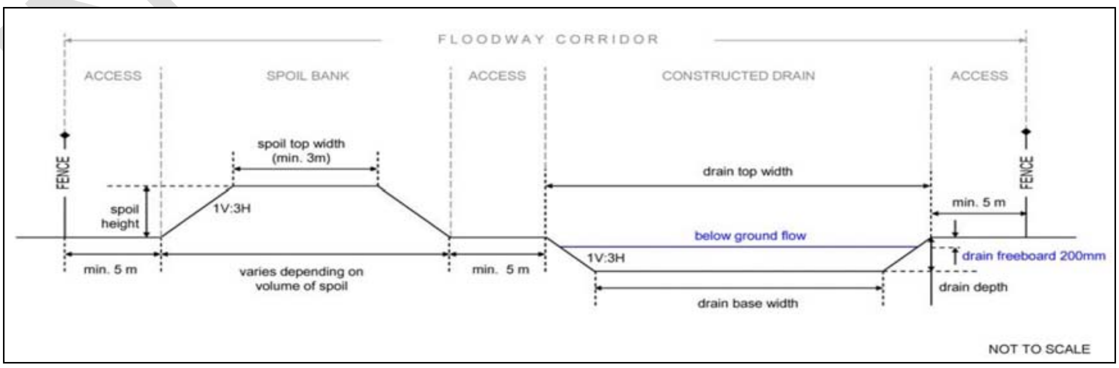

Figure 13: Channel for below ground flow

Design long section

Long sections of the preliminary design for the SEFRP (Salt Creek – Blackford) channel are shown in Figure 14, Figure 15 and Figure 16. The long sections show the modelled water levels in the SEFRP channel for the design diversion flows. They compare the SEFRP design with the existing design flows and inverts and show how the water levels compare with the natural surface levels. The changes in channel width are noted on the long sections as geometry changes to the channel base width. It must be noted that, at this point in time, the design is only conceptual. However, whilst the design will be refined, and the SEFRP water levels may change during the detailed design phase, the changes are not expected to be significant.

Interpreting the long sections

The concept modelling (Figure 14, Figure 15 and Figure 16) for the SEFRP channel from Salt Creek to the Blackford Drain is based on a SEFRP diversion flow of 1,000 ML/d from the Blackford Drain. The design flow increases progressively (to accommodate the existing drain capacity) along the Taratap and Tilley Swamp Drains to the S-Bend Drain (CH 47100), thereafter it is a constant 1500 ML/d downstream to the Salt Creek-Coorong South Lagoon Outfall.

With the reduction in channel capacity to a SEFRP diversion flow of 800 ML/d from the Blackford Drain, the reduction of 200 ML/day (from the 1,000 ML/day originally proposed) has been applied to the entire length resulting in a final channel capacity of 800-1300 ML/day. It is proposed that the final design will maintain the water surface level elevation (WSEL) as for 1,000 ML/day capacity with the reduced capacity achieved by reducing the overall channel width only. Therefore, when reading the long sections, all except the geometry data will be the same.

Definitions

The following definitions may help in understanding the long sections:

- WSEL: water surface elevation level.
- Floodway design WSEL: the modelled water surface elevation for the SEFRP concept design.
- Existing design WSEL: the water levels corresponding to the flows that the drains were originally designed for (pre-SEFRP). These flows were obtained from SEWCDB design drawings.
- Existing invert: the bed level of the existing drains.
- Design invert: the bed level for the SEFRP concept design. It should be noted that along most of the floodway the invert of the existing drains has

been retained. The design invert level is only shown where the invert of an existing channel is changed or where there is a section of new channel (i.e. at the upstream end of the existing drains).

- Left and right overbank: the overbank levels refer to the natural surface level and are representative of the top of the excavated channel. Left and right are taken to be as you are standing in the channel looking downstream (i.e. facing north for north-south sections of the floodway and facing west for east-west sections of the floodway).
- Left and right levees: the levee height shown on the long sections refers to the top of the excavated soil heaps. Left and right are taken as you are facing downstream (as per the overbanks). The left levees are typically representative of the top of existing spoil heaps. The right levees, where required, are typically new levees which are required to prevent water overtopping from the channel.

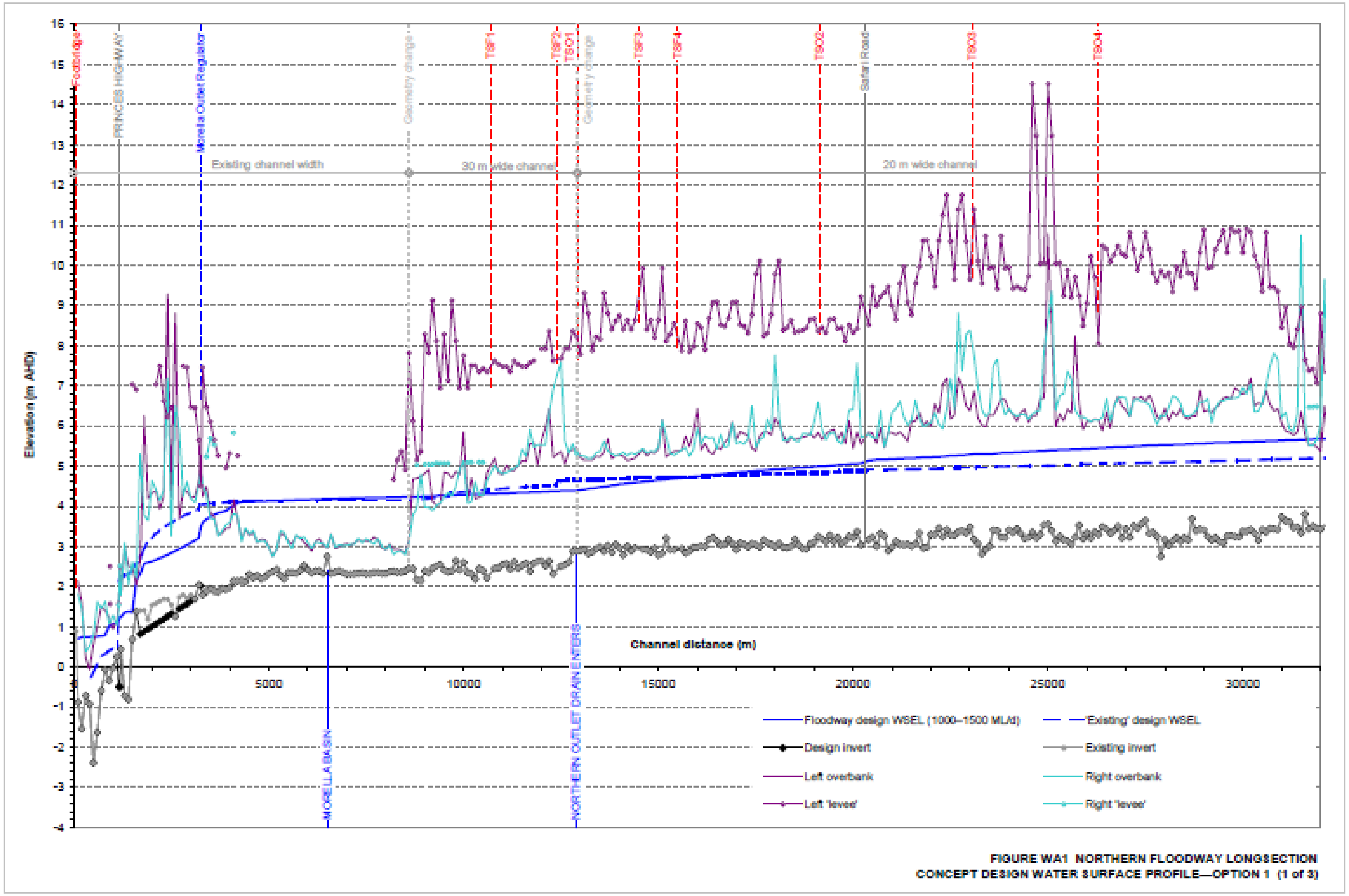

Figure 14: Longsection 1

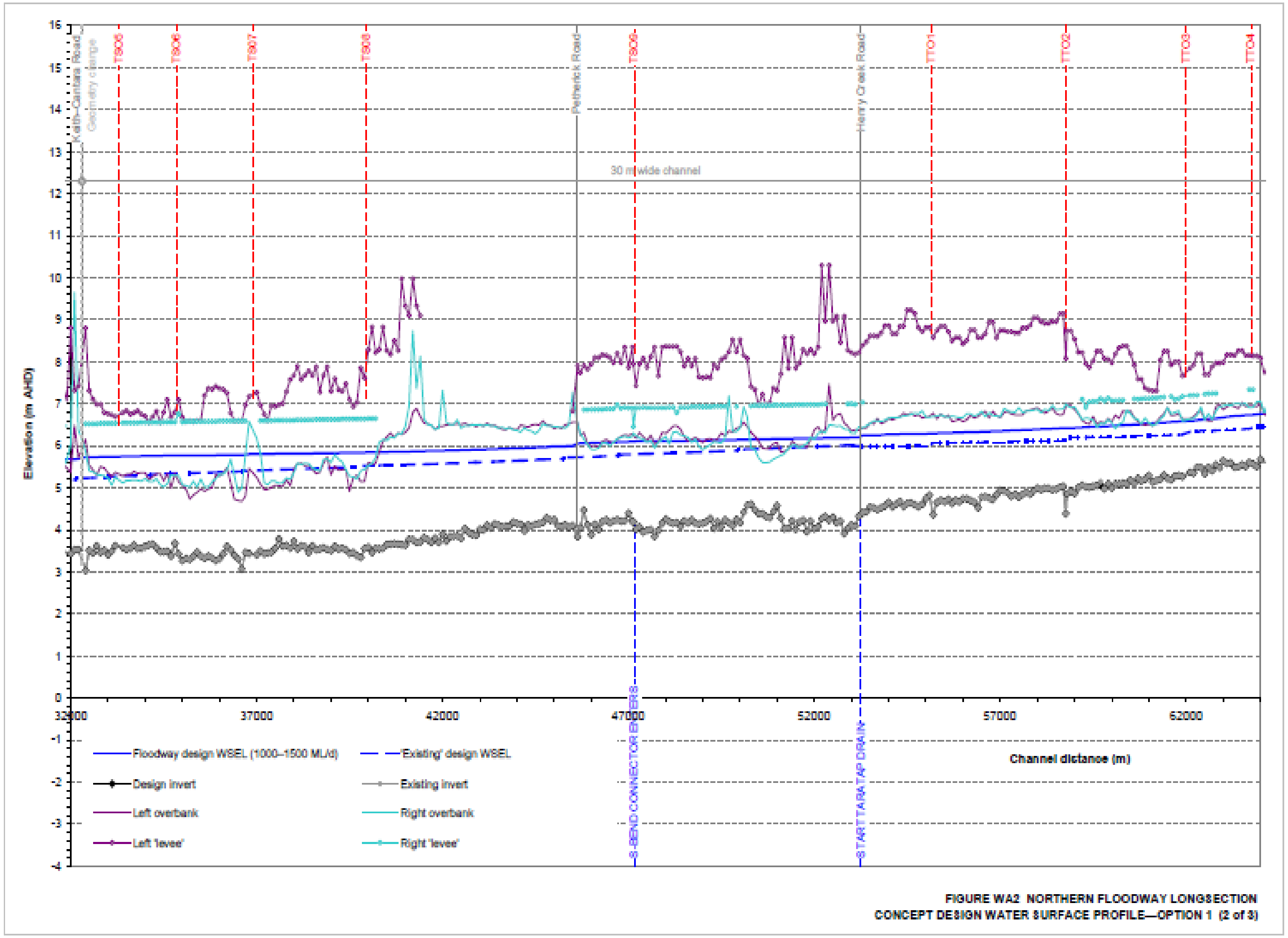

Figure 15: Longsection 2

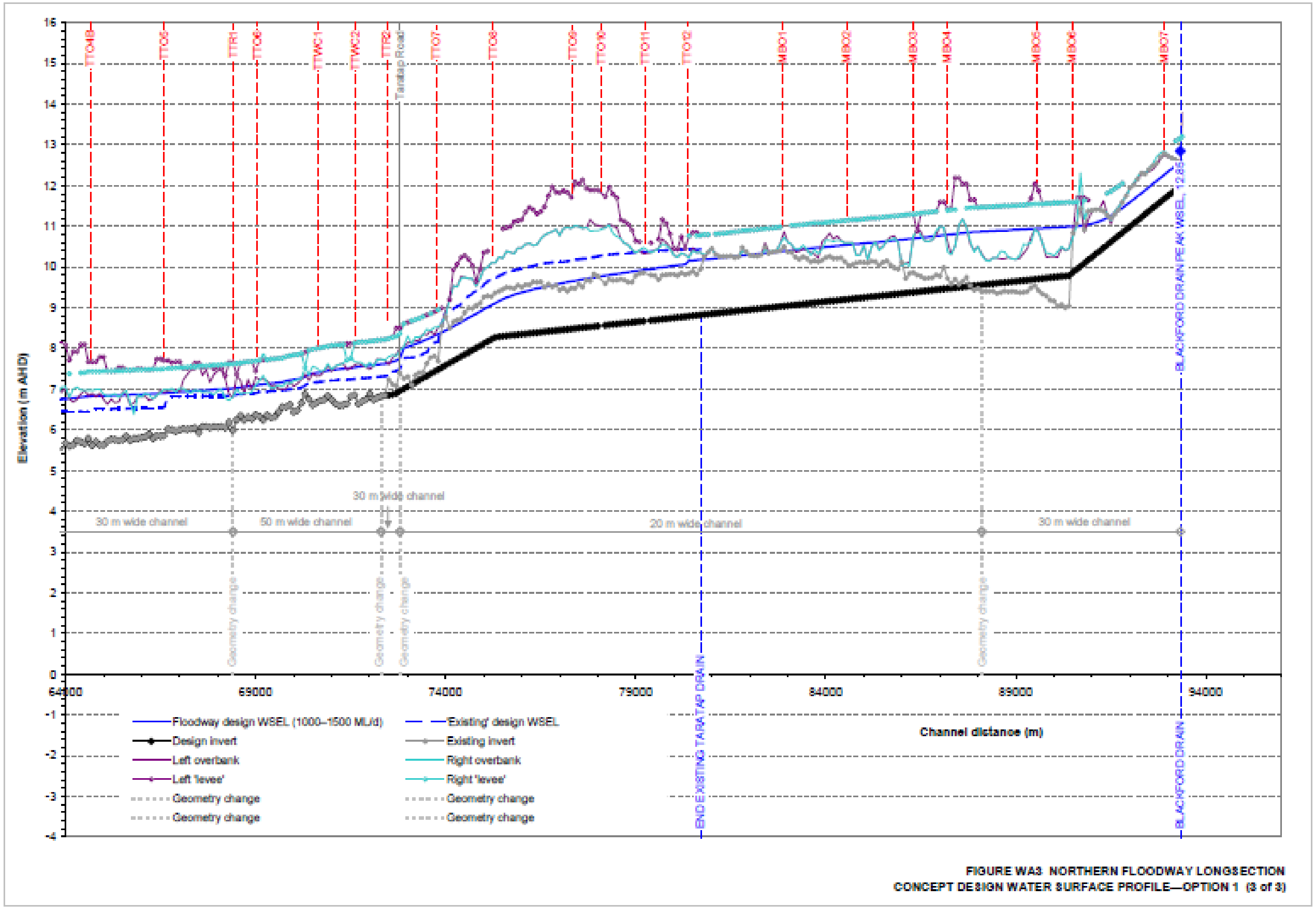

Figure 16: Longsection 3

Crossings

There are numerous crossings (existing and new) along the SEFRP channel alignment. These been categorised as follows:

- Occupational crossings – on-farm crossings generally used by landholders to cross the floodway. Occupational crossings have been placed at existing crossing locations and where there are obvious tracks intersecting the proposed alignment. In the absence of these features, allowance has been made for one crossing per title, as identified on the cadastral database, with a maximum spacing of 2 km. The assumed locations of the occupational crossings are indicative only, and will be confirmed following landholder consultation during the detailed design phase.
- Road crossings (sealed and unsealed) – where the proposed channel intersects an existing public road reserve as identified in the cadastral database.
- Fauna crossings – 50 m wide crossings designed to enable wildlife to cross the floodway in areas of significant habitat.
- Regulator/weirs – typically pipes with drop boards, which are designed to control flows along the alignment.
- Water cross over structures – two locations have been identified along the existing Taratap alignment where there are currently siphon structures to convey water from the eastern side of the floodway to the west. These structures will be replaced by 'at grade' water crossings.

A summary of the crossings along the SEFRP channel is contained in Table 6.

Table 6: Summary of crossings along the channel

Type	Existing crossings	New crossings	Total
Sealed Road	2	-	2
Unsealed Road	4	-	4
Occupational	24	9	33
Fauna	4	-	4
Regulator/weir	3	6	9
Other	4	2	6

Crossing sizes

Road crossings

Where an existing road crossing requires upgrading, it is assumed that the length of culverts and the design of the crossing will be maintained. This is based on the assumption that the existing crossings meet the relevant safety requirements and regulations.

Where a new road crossing is required, allowance will be made for pavement width, adequate shoulder and safety buffer width to any headwall or drain. Consistent with previous work undertaken, a total culvert length of 21.6 m will be assumed (based on 15 lengths of 1.44 m long pipe). This approach will be reviewed during the detailed design phase to determine Council and/or the Department of Planning, Transport and Infrastructure (DPTI) preference for wide formations versus narrower formations with guard rails.

Where practicable, effort will be made to maintain design water surface levels in the vicinity of road crossings at a suitable freeboard below road level. Where this cannot be achieved and peak water levels are expected to be above ground, the road will need to be reconstructed at a higher level to provide necessary freeboard.

During the final design, a more detailed design of the reconstructed road will be undertaken. For the purposes of concept design, it has been assumed that the road will need to be reconstructed over a maximum length of 100 m either side of the floodway to maintain appropriate vertical road alignment and sight distances. This is based on a maximum rise of 1.5 m with ramp grades of 1.5 per cent.

Reinforced concrete box culverts (RCBC) are considered to be most suitable for road crossings based on cost, constructability and cover required for design vehicle loadings.

The Princes Highway upgrade will remain at 1500 ML/d capacity, for added risk management and to maintain uniformity in the culvert sizes. No cost saving is achieved by altering the culvert dimensions at this location.

Occupational Crossings

New and upgraded occupational crossings are generally assumed to have a minimum trafficable width of 4.8 m. Where existing crossings exceed 4.8 m, a 6.0 m culvert length has been assumed (five lengths of box culvert) as an alternate width.

Regulators

Two types of regulators are envisaged to be required:

- ‘major’ regulator on Blackford Drain; and

- ‘minor’ or ‘other’ regulators on the floodway to enable control of diversions and to allow diversion of water elsewhere in the system (e.g. into wetlands).

Major regulators

A regulator structure will be required at the location of the existing ‘Blackford weir’ in the Blackford Drain, to hold up water and enable diversion northwards. The existing ‘Blackford weir’ creates a permanent weir pool upstream and the new regulator has been designed to maintain the character of this weir pool during periods of low or no flow. It is anticipated that in-line structures will be installed to maintain a constant pool level within the drains to provide sufficient head to flow over lateral weir structures and into the 800 ML/day channel heading north.

Preliminary hydraulic calculations have determined that nine regulator gates 1800 mm wide should be adequate to ensure that under flood or peak flow conditions it is capable of passing the peak design flow (2,800 ML/day) in the drain with minimal impact on existing hydraulics. Under diversion conditions the regulator must be capable of passing the full range of design flows (from minimum flow to peak design flow), whilst maintaining a fixed head or pool level upstream of the regulator. This will ensure that a constant northerly diversion is maintained over the lateral weir.

Gates are assumed to be overshot/lay-flat gates (considered best for upstream water level control) and will be fitted to a crossing structure (9 × 1800 mm × 1800 mm RCBC × 6 m long) to enable vehicle access across the drain and for operation and maintenance of the regulator structure.

The final details and level of automation will be determined during detailed design upon consultation with the SEWCDB and DEWNR.

Minor regulators

Lateral diversion regulator

A lateral diversion regulator will be constructed at the Blackford regulator to prevent or permit diversions when required. The structure will consist of an occupational crossing with penstock (undershot) gates fixed to the culvert headwall. It is assumed that no water level control is required as this function will be performed by the main regulator in the Blackford Drain.

Preliminary hydraulic calculations for 1,000 ML/d have determined that 12 culvert cells comprising 1500 mm × 900 mm RCBC x 6 m long are required for the ‘crossing’. This reduces to 10 culvert cells for 800 ML/d diversion. Flow gates are required for risk management to prevent flooding in the system if more northerly drains are already flowing at capacity or subject to other flow restrictions.

Other minor regulators

Other minor regulator structures, such as those installed on the existing Tilley Swamp and Taratap Drains, will be required to enable water to be diverted elsewhere into the system, such as into wetlands. These structures are fitted to the culvert upstream headwall at a crossing point.

For the purposes of preliminary design, it has been determined that these structures include a combination of penstock/undershot gates and aluminium drop boards. It has been assumed that one culvert cell will be fitted with drop boards to enable water level control within the drain during low/no flows. The remaining culvert cells will be fitted with penstocks/undershot gates to enable the gates to be efficiently opened under full diversion flow conditions.

Morella Outfall regulator and fish passage

The existing regulator structure at the Morella outlet will be upgraded to 1500 ML/d capacity which necessitates duplication of the existing regulator capacity with new penstock gates fitted to two culvert cells comprising 1700 mm × 1700 mm RCBC x 12 m long. One of the two new cells may be fitted with an overshot/lay-flat gate for water level control in Morella Basin. While the desired capacity has been reduced to 1,300 ML/d, the Morella outlet will be retained at 1,500 ML/d due to the impracticability of inconsistent sizing for the additional culverts and regulators.

As part of the upgrade, a fishway will also be constructed to facilitate upstream fish movement around this structure under variable flow conditions. Morella Basin, and other wetlands and drains further upstream, provide habitat for several species of fish that also occur in the Coorong including Congolli (Ecological Associates and Aquasave Consultants, 2012) a diadromous species that is likely to require access to freshwater habitat to complete its breeding cycle. Unrestricted fish passage between the Coorong and the South East Drainage System also allows Morella Basin and other upstream sites to act as a drought refuge when conditions in the Coorong are unfavourable.

Salt Creek – Coorong South Lagoon Outfall regulator and fish passage

Salt Creek is a natural channel of approximately 7 m width at the point it enters the Coorong South Lagoon. At this location a low (approx. 0.5 m) permanent weir currently exists. The purpose of the weir is to maintain target water levels in Salt Creek immediately upstream of the Coorong. The SEFRP necessitates this weir be restructured with removable boards so that high flow rates (up to 1300 ML/d) can be passed without causing an undesirable backwater effect that could inundate the Princes Highway and Salt Creek township. As part of the restructure, a fishway will be incorporated to facilitate upstream fish movement around this structure when it is in the closed position, during low/medium flows. Target species include congolli, small-mouthed hardyhead and flathead gudgeon.

Geotechnical Information

No geotechnical investigations have been necessary for the purposes of the preliminary design. This approach is considered appropriate as previous investigations have been undertaken for the Taratap and Tilley Swamp Drains and excavation conditions encountered during construction have verified the reports.

Existing local drains from Taratap to Blackford Drain were inspected to determine sub-surface conditions and since it is not proposed to excavate below the drain inverts along that section, a good level of confidence exists for calculation of excavation costs.

Earthworks

Estimates of cut volumes were obtained from the HEC-RAS model using the channel modification tool which compares the ‘existing’ ground surface and the ‘modified’ ground surface and determines the volumetric difference between the two (Table 7).

The earthworks volumes for the SEFRP (800 ML/d) were calculated by KBR performing a number of check calculations to obtain a high-level estimate of the volumes required for the revised channel capacity and provided a percentage reduction to be applied to the 1,000 ML/day quantities for an estimate of the 800 ML/day version. It was considered that this would be appropriate for budget purposes.

Table 7: A summary of SEFRP earthworks for Salt Creek to Blackford Channel

Option	Excavation Required	Benefits	Risks / Costs
SEFRP (800 ML/d)	3.48 million m^3	Local drainage services maintained and improved. Functionality of 300 km of drains upstream of S-Bend junction maintained with reduced construction costs and landscape disruption. Negligible change in yields for CSL.	Minimal reduction in diversion capacity for future complementary works.

Other infrastructure

Fencing

Much of the existing Tilley Swamp Drain and Taratap Drain are currently fenced to exclude stock and restrict public access. Generally, sections of drain which traverse agricultural land are fenced and those through native vegetation, unless a property boundary, are not. The proposed channel will be subject to the same philosophy.

The extent of disruption during the construction phase is such that it will, in most cases, be more economical to remove the existing fencing to facilitate construction plant movement and replace it on completion of the works.

The new channel will cross a large number of existing fences; both internal paddock fences as well as boundary fences. Where new longitudinal fencing is constructed, internal fences will terminate at the junction with the new fence. Only boundary fences will need to span the channel. In sections where there is no longitudinal fencing, internal fencing will need to span the channel.

In addition, there are many locations where internal paddock fences join existing longitudinal fences on one side of the channel. These will need to be cut and repaired during the works.

It is estimated that 120 km of longitudinal fencing, 52 boundary/internal cross fences and an additional 49 repairs to existing fences will be required.

Local drainage

A range of local drainage issues will need to be addressed in the final design of the SEFRP Channel. In particular, where flow in the channel is above the natural surface level and continuous levees are required on both sides of the drain, catch drains will be required to deal with drainage flows from the local catchment.

During the preliminary design phase no detailed assessment of catch drain location or size has been undertaken. It has been assumed, that catch drains will be constructed where levees are used for flow containment. These are assumed to be placed only on the eastern side of the channel, as local drainage flows are generally from east to west across the flats. During the detailed design phase an assessment will be made to determine how these catch drains operate and any locations where they may be required on both the eastern and western sides of the channel.

Farm drainage inlets are required to allow local catchment flows to enter the channel or drain. Farm drain inlets are assumed to be required:

- Where channel flows are above ground, contained by levees. A pipe will penetrate the levees to allow drainage of local surface water once hydraulic conditions within the drain permit; and
- Where the channel intersects an existing local drain. It has been assumed that all local drains terminate prior to their junction with the channel and are connected to the channel via a pipe. This reduces the possibility of bank erosion at the junction and allows vehicles to cross the local drains.

All farm drainage inlets will be fitted with flap gates to prevent back-flow out of the channel.

The location of farm drainage inlets has been determined by inspection of the detailed survey, aerial photographs and GIS drainage layers. Where no local drains exist it has been assumed that penetrations will be placed through levees at 500 m intervals.

It is estimated that 36 km of catch drains and 71 farm drainage inlets will be required.

Water cross-over structures

There are a number of locations along the existing Taratap Drain where structures are in place to allow local surface water from the east to cross over the drain and flow into the Taratap Watercourse to the west. At some of these locations water is taken across the drain at crossing points in pipes co-located in the crossing formation. In two locations siphons have been placed under the drain.

The existing water cross-over locations which will be retained include:

- water cross-over structures at occupational crossings: 7; and
- additional water cross-over structures (not at crossings): 3.

Where cross-over locations coincide with occupational crossings it has been assumed that the current arrangement of pipes located within the (extra wide) crossing formation will be retained. Where the locations of the cross-over do not coincide with crossings (at the existing siphon locations) it has been assumed that a surface drainage structure (2 m wide) will be constructed. These will not be vehicular crossings.

5.3. Yield to the Coorong

The potential yield to the Coorong South Lagoon from the Blackford Drain, via the preferred alignment, represents the synthesis of a number of modelling studies undertaken during Phase 1 with a final estimate of yields undertaken by contract hydrologists Australian Water Environments (AWE 2012). The AWE estimates were based on a previous study (Montazeri *et al.* 2011), which incorporated a new approach to the estimation of groundwater losses and gains within drainage channels in the

South East (Morgan *et al*. 2011) and were informed by ground-truthing of soil hydraulic conductivity in the project area (AWE 2009). The approach also included catchment models to determine local run-off (Watercress), hydraulic models (HecRas) and water balance models (AWE 2011).

Table 3 states that the preferred option has the potential to deliver an additional 26.5 GL/year (median) compared to the existing drainage scheme.

Table 3: SEFRP Yields to the Coorong South Lagoon (historic climate) (source: AWE 2012)

Staging	SERFP reach	Median Yield to Coorong (GL/year)
Existing	Existing Drainage Network (EDN)	29.7
SEFRP	Blackford (including Bakers Range)	26.5
Total	EDN + Blackford	56.2

The annual exceedance curve of SEFRP expected yield to the Coorong is shown in Figure 10. The light blue line is the curve for the SEFRP (i.e. diversion from the Blackford Drain to the Coorong South Lagoon). The SEFRP curve indicates that, in combination with the existing drainage scheme, it will deliver at least

- 14 GL in 90 per cent of years,
- 25 GL in 75 per cent of years, and
- 55 GL in 50 per cent of years.

In addition, at the wetter end of the spectrum, 97 GL would be received by the Coorong South Lagoon in 10 per cent of years.

This is in contrast to the existing scheme whereby approximately

- 7 GL is provided in 90 per cent of years,
- 17 GL in 75 per cent of years, and
- 30 GL in 50 per cent of years.

At the wetter end of the spectrum, less than 50 GL would be delivered to the Coorong South Lagoon in 10 per cent of years, demonstrating the limited ability of the existing infrastructure to influence Coorong salinities at a given barrage outflow.

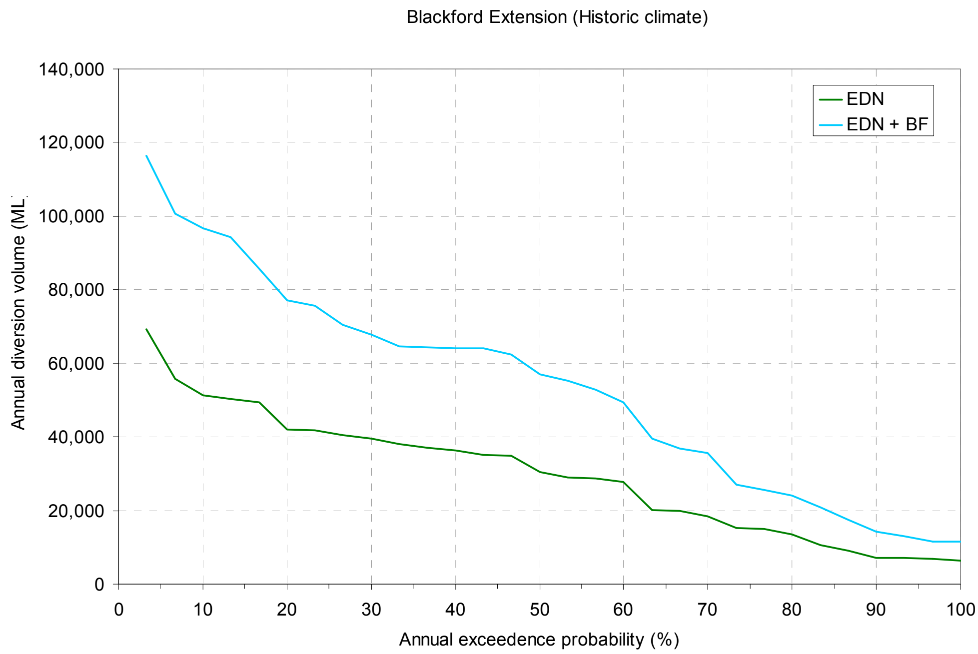

Figure 10: Annual exceedance curves for expected yield to the Coorong at Salt Creek.

The preferred option is represented by the light blue line, i.e. the existing drainage network plus Blackford Drain (EDN+BF). Both yield estimates are based on rainfall from 1971-2000 (source: AWE 2012).

5.4. Environmental Benefits

As outlined in Section 3 (to investigate the potential benefits of implementing the SEFRP on the maximum salinity in the South Lagoon) an examination of the interactions between barrage and South East flows (including volumes, salinity and timing) was undertaken using the CSIRO 1-D hydrodynamic model (Lester *et al.*, 2012).

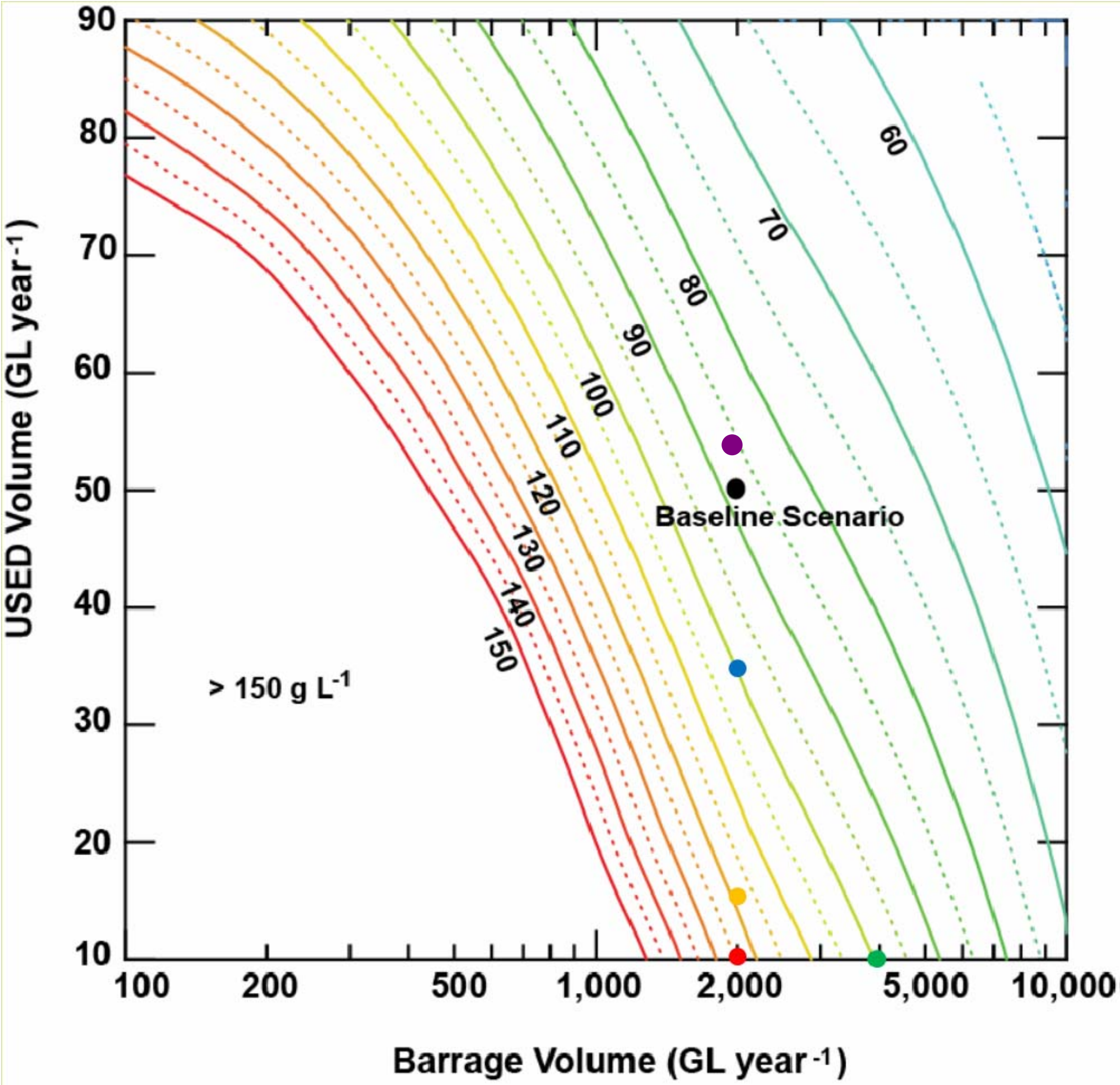

Figure 11: Maximum average salinity in the South Lagoon as a function of South East (USED) and barrage flow volumes.

South East salinity is fixed at 10 g/L.

Assuming a minimum barrage outflow of 2,000 GL/annum, the red dot indicates the expected worst case salinity outcome with the existing drainage network (90th percentile). The orange dot indicates the expected worst case salinity outcome following implementation of the SEFRP (90th percentile combined flows). The blue dot illustrates the effect of increasing the total flows from the South East to 35 GL (70th percentile) resulting in salinities remaining below 100 g/L, with the purple dot indicating the expected salinity outcome with a median inflow from the SEFRP and existing drainage network. Note: the x-axis is a log scale (source: Lester et al. 2012).

Figure 11 shows a summation of the interaction of MDB volumes and SEFRP yield volumes upon salinity in the Coorong South Lagoon. In order to illustrate the potential benefits of the SEFRP, the South Australian Government is assuming minimum barrage flow of 2,000 GL per year. This is assumed to be an effective minimum MDB release volume since it relates to the estimated minimum 3-year rolling average flow expected from the MDB to the Coorong through the recovery of 3200 GL under the Basin Plan (Gibbs *et al.,* 2012). This rolling average would also support maintenance of Lake Alexandrina salinities and water levels as outlined in the EWR for the site (Lester *et al.* 2011).

Assuming 2,000 GL minimum barrage outflow post Basin Plan implementation, Figure 11 indicates that salinity in the South Lagoon would be affected as follows:

- with the existing scheme in place, worst case yield (90 per cent of the time) will deliver 7GL such that salinity would exceed 120 g/L in some years (red dot);
- with the addition of the SEFRP, worst case yield (90 per cent of the time) will deliver approx 15 GL which will place salinity below 120 g/L (orange dot);
- the median scenario (50 per cent of the time) SEFRP will deliver approx 56 GL which will place salinity between 60-100g/L; and
- best case scenario (1 per cent of the time) SEFRP will deliver approx 90 GL which will place salinity below 60 g/L.

It is important to focus on the outcomes that result from 90th percentile yields from the SEFRP as this provides an indication of the **minimum** benefit that could be expected from implementation of the project on maximum South Lagoon salinity. The likelihood of higher volumes being consistently available or during periods of low run off and inflows in the MDB is modest based on Lester *et al.* (2011) which indicated that additional flows from the USED scheme appear possible in only 44 per cent of years when barrage flows are low.

The median and 70th percentile SEFRP and existing drainage scheme yield estimates provide a useful indicator of the benefit of years where flows are greater. Figure 10 indicates approximately 56 GL will be received 50 per cent of the time, and over 35 GL 70 per cent of the time with the SEFRP implemented. If this volume was received 100 per cent of the time, salinities would be no greater than 85 g/L and less than 100 g/L. Given the SEFRP yields these or greater volumes more consistently than the existing drainage scheme, it is more likely that maximum salinity will be less than 100 g/L and always below the upper maximum of 120 g/L than without it.

The SEFRP increases the frequency that significant yields can be expected to reach the Coorong to have environmental benefit. With smaller minimum MDB flows over the barrages, the required flows from the SE must increase in order to achieve the desired salinity targets. The SEFRP almost doubles that minimum and is more likely to be able to provide larger volumes during periods of low MDB inflows, While not certain to prevent exceedance of thresholds, the potential for flows from the SE is increased to an extent that they mitigate the risk South Lagoon salinities will exceed thresholds even with the full implementation of the Basin Plan.

This analysis focuses on the management of salinity in the Coorong South Lagoon only and does not address the value of providing environmental water from the MDB to water levels or water quality in the Coorong, the Lower Lakes or upstream environments. It is stressed that improved River Murray environmental flows are needed to support other environmental assets across the Murray-Darling Basin.

This analysis demonstrates that although the SEFRP can be beneficial to managing Coorong South Lagoon salinities, the River Murray must continue to be the primary source of fresh water to the Coorong to maintain ecological condition, although there are likely to be benefits from SEFRP that increase the confidence in implementation of the Basin Plan achieving its stated objectives.

Potential for future yield

In November 2011 the then Minister for Sustainability, Environment and Conservation approved a public consultation program that envisaged a more extensive program of works than that suggested herein. The more extensive program envisaged delivering larger flows to the Coorong South Lagoon by connecting several other drains into the SEFRP Channel.

During consultation, the South East community expressed a clear desire to first improve the water management capabilities of the existing drainage system in the South East to:

1. improve aquifer recharge;
2. prolong elevated soil moisture levels in spring; and
3. re-hydrate local wetlands prior to supporting water being considered ‘surplus’ to the needs of the South East.

While the Blackford Drain to Salt Creek (and the minor works in the Bakers Range North watercourse) are proposed in this Business Case, a significant bundle of interrelated works remain technically feasible and represent significant future opportunities. These include:

- The Blackford Extension

  To harvest water from the southern reaches of the mid South East. It would effectively reconnect natural flowpaths by connecting four existing drainage systems (the Blackford, K, Avenue Flat and the Wilmot Drains), would have a total length of 70 km. Modelling indicates the Blackford Extension would increase median yield to the Coorong South Lagoon by 23.5 GL/annum (AWE 2012).

- An upgrade of the Fairview Drain

  To increase flows into the Blackford Drain and hence the Coorong South Lagoon, via the SEFRP Channel, from less than 200 ML/day to 500 ML/day.

- An upgrade to the Mt Hope-Reedy Creek drain

  To increase median flows to Lake George by approximately 14.1 GL/annum (Gibbs 2012).

6. Phase 2 Implementation

Sequence of Activities

This section discusses the high-level sequence of activities required to implement Phase 2 of the SEFRP. A summary Project Delivery Schedule is provided at Attachment A. It assumes that legislative approvals, land acquisition discussions, and detailed design will progress in parallel with Commonwealth consideration of this Business Case, and that a variation to the CLLMM Recovery Project Schedule will be finalised prior to 30 June 2013.

A 75 week construction window will allow the SEFRP to be constructed ahead of the CLLMM Recovery Project end-date of 30 June 2016.

The SEFRP implementation framework sequence, as discussed through this section, will be:

- Project Management;
- Detailed Design;
- Legislative Approvals;
- Land Acquisition;
- Aboriginal Involvement;
- Construction;
- Environmental Management; and
- Completions.

Communications, stakeholder, and Traditional Owner engagement activities will continue throughout implementation are discussed later in the Business Case.

6.1. Project Management

The SEFRP will be delivered by DEWNR and project managed as part of the CLLMM Recovery Project.

Project Management funding will be assigned to labour directly attributed to scope, plan, manage and report on the delivery of individual project tasks.

Corporate Overheads funding will be assigned to costs associated with employing project management staff to deliver the program (and their associated on-costs), such as financial management, accommodation, human resources, facilities management, ICT and other business services.

Consistent with the CLLMM Recovery Project, DEWNR may use existing staff to deliver expert (non-project management) services and outputs for the SEFRP if it is more efficient than outsourcing them to external providers. Examples of this include, but are not limited to: legal advice, legislative approvals, scientific and technical advice, cross-cultural engagement and facilitation, and communications.

Unlike other CLLMM Recovery Project management actions, the SEFRP will be delivered in a region that is not commutable from Adelaide. SEFRP staff will be required to work in the South East for extended periods, particularly during construction. A Regional Operating Allowance will be applicable to relevant SEFRP staff to cover travel, accommodation, meals and regional operating expenses above existing Corporate Overheads.

6.2. Detailed Design

Following on from acceptance of the Preliminary Design, the Detailed Design will be developed for construction. The Detailed Design component will be broken into several phases:

- Scope definition and engineering execution strategy;
- Commencement of detailed design;
- Initial design development and issue identification;
- Initial design review & audit;
- Approval for design;
- Approval for construction;
- Design close-out;

Some activities can be undertaken concurrently, but normally as the deliverables and activities in each phase are completed, work transitions into the next phase. Situations will arise when work will need to be undertaken out of sequence, typically to meet a demanding project schedule.

Construction tender documents cannot be prepared until the design has reached near completion so that accurate quantities can be provided for submission of construction bids. Incomplete or inadequate specifications and quantities generally results in higher variations and construction cost “blowouts”.

From commencement of detailed design, the minimum time required for a project of this nature to provide documentation for construction tender is approximately four months. Considerable resources, contractor and departmental, are required during this stage. Design modifications once commenced are disruptive, and result in increased cost and delay. It is therefore imperative that specifications and the budget are finalised before commencement.

Following preparation of quantities and general specifications for the construction tender, final checking of the design, preparation of construction cross-section drawings (minimum of 50 m intervals or around 2,000 for this project), detailed construction drawings for every crossing and other infrastructure, and provision of the survey GENIO file to enable setting out of the construction works. While provision of this can be staged, most is required before the tender contract commences. Detailed design input is required throughout most of the construction phase to verify any variations to the construction.

To facilitate timely commencement of construction, the detailed design process needs to be commenced as early in the process as possible – as it is also necessary to inform the land acquisition process. It is therefore ideal to commence procurement of the design contractor immediately the Business Case has been approved to limit the departmental risk associated with the SEFRP.

6.3. Legislative Approvals

Legislative Framework

This section discusses the legislative framework for delivery of the SEFRP and ongoing operation and maintenance of the proposed drainage scheme.

South Eastern Water Conservation and Drainage Act 1992 (SA)

The *South Eastern Water Conservation and Drainage Act 1992 (SA)* provides for the conservation and management of water and the prevention of flooding of rural land in the South East of the State of South Australia. It also establishes the South Eastern Water Conservation and Drainage Board (SEWCD Board).

Certain powers of the SEWCD Board will need to be utilised in order to deliver the SEFRP, particularly in relation to acquiring an interest in land and undertaking works. This may require certain delegations from the SEWCD Board to DEWNR staff. The SEFRP will be delivered in close collaboration with the SEWCD Board.

The SEFRP will need to be recognised in the Board's Management Plan as the SEWCD Board must not, except with the approval of the Minister, undertake any works that are not contemplated by the Board's approved Management Plan.

All land interest requirements for the SEFRP are proposed to be managed in accordance with the provisions of this Act or other Acts as appropriate. DEWNR will work collaboratively with the SEWCD Board to ensure they are satisfied with the

SEFRP proposal. The SEWCD Board will need to be engaged to determine their role in project implementation and acquiring any interests in land.

Any assets constructed under the SEFRP will be operated and maintained by the SEWCD Board under the administrative objectives associated with this Act (and inter-related Acts).

Upper South East Dryland Salinity and Flood Management Act 2002 (SA)

The *Upper South East Dryland Salinity and Flood Management Act 2002* (SA) expired on 18 December 2012. This Act provided for the protection and improvement of the environment and agricultural production in the Upper South East through the conservation and management of water across the landscape.

Upon its expiration, all operational and management requirements for the drainage system delivered under this Act were vested into the SEWCD Board, to be managed under the *South Eastern Water Conservation and Drainage Act 1992* (SA).

The SEFRP will include widening an existing drainage corridor constructed under this Act.

Specific provisions of this Act continue to apply - the *South East Drainage Network Management Strategy* is required to continue until 2015 and is binding on the SEWCD Board.

This strategy is linked to certain objectives of the *Natural Resources Management Act 2004* (SA), the *Environment Protection Act 1993* (SA) and the *River Murray Act 2003* (SA).

Proposed SEDSOM Legislation

To provide for the effective ongoing operation and management of the entire South-Eastern drainage network, the South Australian Parliament will, during 2013, debate the South Eastern Drainage System Operation and Management Bill 2012 (SEDSOM Bill). This Act will seek to repeal the SEWCD Act.

The proposed SEDSOM Bill provides for multiple objectives in managing the drainage system water, wetlands and other environmental assets that includes:

- Protection of infrastructure, land soils and ecosystems from flooding;
- Provision of water for environmental purposes and the enhancement of the natural environment, inclusive of wetlands;
- Protection and enhancement of agricultural lands for productive purposes; and
- Conservation and management of water.

These objectives support and reinforce the SEFRP in the delivery of additional fresh water into the Coorong environment.

Legislative Approvals

Assessments of the proposed project works and activities undertaken during Phase 1 have enabled the identification of a range of approvals required under Commonwealth and State legislation. Processes to obtain required approvals commenced during Phase 1, including liaising with key agencies and drafting approval application documents. The SEFRP intends to obtain all necessary project approvals prior to on-ground works commencing.

All on-ground infrastructure works will be undertaken in accordance with the *Work Health and Safety Act 2012* (SA) to ensure that safe work practices are used. Compliance with other relevant acts including the *Survey Act 1992* (SA), the *Electricity Act 1996* (SA), and local government acts and policies will also be ensured.

Table 8 below provides a summary of key approvals required under Commonwealth and State legislation relating to proposed project activities, and the current status. These approvals will continue to be progressed through the various administrative processes required under each act.

Table 8: Approvals required for the SEFRP under Commonwealth and State Legislation

Approval/Act	Activity to be undertaken	Details	Status
Commonwealth Approvals			
Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)	Preparing the site and on ground earthworks.	Matters of National Environmental Significance (NES) relevant to the SEFRP area include the Coorong, and Lakes Alexandrina and Albert Ramsar Site; a range of threatened species (including the Southern Bell Frog (*Litoria raniformis*) and Orange bellied Parrot (*Neophema chrysogaster*)); and ecological communities (including the Seasonal Herbaceous Wetlands (Freshwater) of the Temperate Lowland Plains) protected under the *EPBC Act*; and a range of migratory species protected under the *EPBC Act.* In accordance with the *EPBC Act*, the State is required to prepare a referral of the proposed action which assesses the SEFRP against relevant matters of national environmental significance.	Preparation of a referral for the SEFRP under the EPBC Act commenced during Phase 1 and is expected to be submitted to the Australian Government soon after this Business Case is considered. The draft referral has assessed the SEFRP against relevant matters of NES and it is unlikely that the project will result in any significant impacts. Consistent with the CLLMM Recovery Project Schedule, the SEFRP will be carried out in accordance with the *EPBC Act*. On-ground works will not commence until a referral has been submitted and assessed.
Water Act 2007	Preparing the site and on ground earthworks.	The *Water Act 2007* provides for the management of the MDB and other matters of national interest with respect to water and water information. While the SEFRP does not, in itself, physically reside within the borders of the MDB, the objective intent is to support the provision of fresh water flows into that environment via the Coorong at Salt Creek. Under section 18E of the Act, the MDBA has the functions, power and duties which are expressed to be conferred on it by	The MDBA has been involved with negotiations surrounding the SEFRP and will be notified should the project proceed.

		the Murray-Darling Basin Agreement (Schedule 1). Under clause 49 of the Agreement, the State is required to inform the MDBA of certain proposals which may significantly affect the flow, use, control or quality of any water in the River Murray in South Australia. This includes water in the Coorong.	
Native Title Act 1993	Preparing the site and on ground earthworks.	The *Native Title Act 1993* establishes a process through which claims for recognition of native title can be lodged and assessed. The Act requires that native title claim groups are notified of future acts that may affect the land or waters over which native title is claimed. Pursuant to section 24KA of the *Native Title Act* the State is required to provide notifications to relevant native title claim groups regarding works that may affect the land/waters over which native title is claimed.	Notifications to relevant native title claim groups will be finalised and provided prior to on-ground works commencing. A minimum period of 2 months will be given for native title claim groups to comment on the notification. Consistent with the CLLMM Recovery Project Schedule, the SEFRP will be carried out in accordance with the *Native Title Act*.
State Approvals			
Aboriginal Heritage Act	Preparing the site and on ground earthworks.	This Act provides a legislative basis for recognising and protecting Aboriginal heritage, specifically in relation to culturally significant sites, objects or remains on all land and waters. Section 23 of the Act requires persons to seek authorisation from the relevant Minister (or delegate) to damage, disturb or interfere with Aboriginal sites, objects or remains. The Act requires the Minister to undertake consultation with Aboriginal organisations, traditional owners, and/or other Aboriginal persons when carrying out certain functions and powers under the Act, including granting authorisations under section 23. Under the Act the Minister may delegate certain powers and functions assigned, including the power to grant authorisations	The engagement with traditional owners proposed under this business case will seek to manage potential impacts of the project on Aboriginal sites, objects or remains. DEWNR proposes to apply to the Minister for Aboriginal Affairs and Reconciliation seeking an authorisation under s 23 of the Act. This application needs to be discussed in more detail with Traditional Owners

		under section 23. The Act must be considered prior to on-ground works occurring along the project site or making management decisions that may impact on Aboriginal sites, objects or remains.	
Development Act 1993	Preparing the site and on ground earthworks.	The *Development Act 1993* provides the legal framework for the regulation and management of developments in South Australia. Under the Act no development may be undertaken unless approved or exempted in accordance with the Act. The SEFRP falls within the definition of development under the *Development Act* and will require assessment by the Development Assessment Commission.	This approval will be obtained prior to on-ground works commencing.
Environment Protection Act 1993	• Preparing the site and on ground earthworks. • Water quality	The *Environment Protection Act 1993* provides for the protection of the environment. The objects of the Act include coordinating action to minimise or avoid environmental harm, and ensure effective environmental harm, and ensuring effective environmental protection, restoration or enhancement. Section 25 of the Act creates a general environmental duty for persons not to undertake an activity that pollutes, or might pollute, the environment unless all reasonable and practicable measures are taken to prevent or minimise harm. The Act also provides a set of environment protection policies which relate to water quality, noise and air quality. Of particular relevance to the SEFRP is the *Environment Protection (Water Quality) Policy 2003* which sets out water quality criteria for the protection of waters within South Australia.	DEWNR will work with the SA Environment Protection Authority (EPA) to ensure compliance during implementation of the SEFRP. This may include the EPA assessing the proposed action to determine whether an exemption should be granted.
National Parks and Wildlife Act 1972	• Preparing the site and on ground earthworks within National and Conservation parks	The *National Parks and Wildlife Act 1972* provides a framework for reserves to be established and managed, and provides for the conservation of wildlife in a natural environment.	Exemptions or approvals (as applicable) under the *National Parks and Wildlife Act* will be finalised and obtained prior to on-

	• Harassing or interfering with native animals in the course of construction	Under the *National Parks and Wildlife Act* and associated regulations, the written permission of the Director, National Parks and Wildlife is required to enter and use a National Park for specified purposes, to dig or disturb soil, to use vehicles or boats, or to use generators. Implementation of the SEFRP will involve on-ground works in the Coorong National Park, the Martin Washpool Conservation Park, and the Tilley Swamp Conservation Park. On-ground works, specifically vehicle use and digging, being undertaken in the Coorong National Park, Martin Washpool Conservation Park, and Tilley Swamp Conservation Park will require approval under the *National Parks and Wildlife Act.*	ground works commencing.
Native Vegetation Act 1991	Clearing native vegetation to prepare the site.	This Act serves to conserve, protect and enhance native vegetation in the State and, in particular, remnant native vegetation, in order to prevent further reduction of biological diversity and degradation of the land and its soil; and loss of quantity and quality of native vegetation in the State; and loss of critical habitat. the existing drain is being expanded, and may be required if native vegetation is located where the new drain is to be constructed. Clearance of native vegetation will be required where the footprint of the drain is expanding. Exemptions for clearance of native vegetation are available for the SEFRP under Part 2 of the *Native Vegetation Regulations 2003*. A native vegetation management plan will be prepared and approved by the Native Vegetation Council, in accordance with the regulations.	Liaison with native vegetation officers commenced during Phase 1 to determine requirements for native vegetation clearances under the Act. The management plan will be finalised and submitted prior to on-ground works commencing. Liaison with native vegetation officers will continue as management plans are being finalised so as to ensure that they are to the satisfaction of the Native Vegetation Council.
Natural Resources Management Act 2004	All proposed works and operations.	This Act provides for the promotion of sustainable and integrated management of the State's natural resources and for the protection of those resources. The Act seeks to protect biological diversity; provide for the sustainable use of water	Liaison with relevant NRM regional staff will continue.

		resources; prevent the impacts of pest plants and animals; and give consideration to Aboriginal Heritage. The Act also establishes Natural Resources Management (NRM) regions, each of which has an NRM Board. Of specific relevance to this project are the South East Natural Resources Management region and the South Australian MDB Natural Resources Management region. The SEFRP will be undertaken in accordance with the duties established by the Act, including where approval for undertaking water affecting activities is required.	
Parliamentary Committees Act 1991	All proposed construction works	This Act provides for the establishment of various Parliamentary Committees in the South Australian Parliament, including the Public Works Committee. The Act also defines the functions, powers and duties of those committees. The Act requires that public works are referred to the Public Works Committee if the total amount for the construction of the work will exceed $4,000,000. The SEFRP will need to be referred to the Public Works Committee in accordance with the Act, at which point the Public Works Committee will inquire into, consider and report on the project.	A report to the Public Works Committee on the SEFRP will be finalised and submitted as soon as funding has been secured and prior to on-ground works commencing.

6.4. Land Acquisition

The proposed alignment of the SEFRP generally follows the existing Tilley Swamp Drain and Taratap Drain, except for the southernmost section of 12.7 km from the end of Taratap Drain to Blackford Drain where only local drains exist.

The current Tilley Swamp Drain has an average width of 40 metres and is held by the Minister for Sustainability, Environment and Conservation under several freehold titles. The current Taratap Drain provides a width of between 30 metres and 40 metres and is comprised of privately owned land that is subject to a statutory easement in favour of the Minister for Sustainability, Environment and Conservation for its entire length under the *Upper South East Dryland Salinity and Flood Management Act 2002* (SA).

The extent of SEFRP construction works is proposed to include the channel, access tracks and formed excavated spoil along the alignment within an 80 - 100 metre wide corridor. To enable the construction to proceed, land additional to that which the Minister for Sustainability, Environment and Conservation has an interest in is required.

The Minister for Sustainability, Environment and Conservation has no current land interest in the final 12.7 km linkage between the end of the Taratap Drain and the Blackford Drain. To facilitate SEFRP construction the acquisition of a full width of 100 metres will be required, subject to detailed design.

The *South Eastern Water Conservation and Drainage Act* (SEWCD Act) provides for the SEWCD Board to acquire interests in land by either negotiation or compulsorily by the use of the *Land Acquisition Act 1969* (SA). The acquisition of land interests is required to be progressed "by agreement" but in accordance with the provisions of the *Land Acquisition Act*. This legislation requires the acquisition to be progressed on the basis of a "Heads of Agreement" that incorporates provisions for the actual value of the land interest to be acquired and losses attributed to severance, disturbance or injurious affection.

The acquisition strategy to be implemented and progressed will have regard to general community support and directly affected landholder engagement with compulsory processes only being envisaged as a last resort. Any acquisition proposal will be undertaken in accordance with all appropriate legislative process by having regard to the nature of the different class of tenures involved. It is unlikely that a 'one fits all' approach for the acquisition of land interests will be sufficient.

Landholder Engagement

All landholders along the proposed alignment have been individually engaged, and their views recorded, as part of the SEFRP Phase 1 community consultation process.

Whilst the position of all landholders is still informal, all but two of 18 landholders have indicated their general support for the aims of the SEFRP and a general acceptance of the Crowns intention to acquire the proposed alignment – subject to the payment of a fair compensation for the land acquired (discussed in SEFRP Costs and Budget sections). As indicated above, formalisation of landholders intention to sell (or otherwise) is seen as a required component of the SEFRP.

Access (Land Management Agreements)

Practical access to undertake all operational and maintenance requirements may need to be established across land adjacent to the corridor as established. This may require the establishment of individual arrangements with landholders through Land Management Agreements.

In order to plan this effectively, the SEFRP recognises the need to understand the range of potential options and approaches available and the requirements under each of these. It is intended that each of these individual arrangements will be managed through Land Management Agreements initiated as part of a general land interest acquisition strategy.

In broad terms, the intent of a Land Management Agreement is a contract or binding agreement between a landholder/manager and third party regarding the ability to access infrastructure that may reside on, or be practically accessed by the use of, their land.

It is intended that these agreements will be initially discussed with landholders/owners through the community consultation strategy of the SEFRP with formal agreements negotiated and agreed through the appropriate channels under the guidance of the Crown Solicitor's Office as part of the overall acquisition strategy required for the drainage network requirements.

Under the SEFRP, agreements may take many forms depending on existing ownership, land tenure, access and operational requirements. Such agreements may address easements for operation and maintenance of infrastructure, access agreements to access infrastructure across private land, operation and maintenance agreements, leases, cost share stewardship agreements and many other forms.

6.5. Aboriginal Involvement

Ngarrindjeri Involvement

The SEFRP is complementary to the CLLMM Recovery Project's Ngarrindjeri Partnerships management action.

The delivery model being supported by this Business Plan is a mixed fee for service and other possible engagement arrangements that aim to support SEFRP delivery. DEWNR acknowledges the Ngarrindjeri interests in the long-term maintenance, monitoring and management of the South East Drainage System.

The State and NRA acknowledge the long-term interest is outside the scope of the SEFRP, but believes these long-term economic development opportunities are central to a stronger future for Ngarrindjeri working on their Yarluwar-Ruwe (Sea Country). The Ngarrindjeri Regional Authority (NRA) will be the lead entity responsible for the delivery of this component of the SEFRP.

The NRA is funded until 2015/16 to implement the Ngarrindjeri Partnerships, and support Ngarrindjeri engagement across CLLMM Recovery Project. The Ngarrindjeri Partnerships will support the NRA's engagement in the SEFRP. However, there are some key limitations to effective and efficient engagement (discussed as part of the risk assessment) including:

- NRA is currently close to capacity on other CLLMM Recovery Project management actions and this will affect its ability to respond to SEFRP requests;
- Heritage Management Team close to capacity, and likely to be engaged across Vegetation Program sites during peak SEFRP construction periods; and
- NRA lacks specialist skills in aquatic ecology and water resource management to consider the cultural water requirements of wetlands on the historical flow paths of the South East and the outlet design on Salt Creek.

The proposal seeks to address the limitations in the Ngarrindjeri Partnerships management action and ensure Ngarrindjeri are supported to deliver the cultural heritage assessment requirements for the SEFRP. The Business Case addresses the Department's statutory obligations under the *Aboriginal Heritage Act 1988* (SA) and adheres to the Attorney General's *Guidelines for Aboriginal Heritage Payments; 2011*.

The SEFRP offers a range of direct and indirect opportunities for Ngarrindjeri participation and engagement. The Business Case deals with the direct opportunities in heritage survey, heritage monitoring and advice on culturally appropriate operations at *en route* wetlands and design of the Salt Creek outlet. Indirect opportunities, including sub-contracted fencing or water quality monitoring for example, are not addressed by this Business Case and will be subject to South Australian Government's procurement processes.

The NRA acknowledges that the SEFRP is a three year construction project operating along a 93.4 km linear alignment, and that at the end of this period, the infrastructure established will be handed over to the South East Water Conservation and Drainage Board (or its successor) for operation and maintenance. NRA also understands that the SE NRM Board will be responsible for developing a high level strategy for the operation of the South East Drainage System, including the newly re-established flow path to the Kurangk, through the South East Drainage and Wetland Management Strategy.

The Ngarrindjeri Partnerships management action seeks to support the development and maintenance of these long-term partnerships.

The NRA will participate in the SEFRP within and across the boundaries of the Ngarrindjeri and Others Native Title Claim area. The SEFRP Team estimates 76 km of SEFRP alignment occurs within the Native Title claim area. This proposal enables the NRA to participate in heritage assessment activities along 90 km of alignment to account for Ngarrindjeri interests and family connections that extend beyond the Native Title claim area. The South East Aboriginal Focus Group, made up of South East Aboriginal families including Ngarrindjeri, will also be engaged in the SEFRP activities. An agreed strategy will be developed with Aboriginal peoples across the project area regarding participation in different project components.

The objectives of the proposal are as follows:

- Protect: Protect and manage the Ngarrindjeri people's unique relationship with, and responsibilities for, the lands and waters within and flowing into, the Project area including assessment, survey, monitoring and input to project design and implementation. This will also meet the State's statutory responsibilities under the Aboriginal Heritage Act, 1988; and
- Support informed decision making: Provide cultural advice and support to the NRA in the fields of aquatic ecology, water resource management and planning so Ngarrindjeri can make informed decisions about the cultural water requirements of the historical flow paths from the South East to the Kurangk.

These objectives align with the CLLMM Long-Term Plan, the KNY Agreement, 2009 and contribute to the Australian Government's Closing the Gap reform.

Ngarrindjeri Cultural Knowledge and expertise will be invaluable to the development and implementation of the SEFRP. Ngarrindjeri seek to build their cultural perspectives and values into the design and construction of the proposed floodway, and associated structures and note the Cultural Knowledge clause signed between the NRA and DEWNR for the CLLMM Recovery Project. The NRA propose to integrate a process of intergenerational knowledge sharing, cultural revitalisation, and learning around the re-instatement of water along historic flow paths and into the Kurangk.

Table 9 provides the output framework for the proposal.

SEAFG Involvement

DEWNR and the SEAFG engage on small scale environmental restoration activities. SE NRM Board funds also support bi-monthly SEAFG meetings to assist South East Aboriginal people engaging in Caring for Country. The SEAFG has collaborated with the NRA in developing an Aboriginal position paper on the SEFRP in 2008. The SEAFG recently amended the position paper, but reiterated its interest in being engaged in the following ways:

- Representation on any management or project committee;
- Involvement in all future consultations to ensure that the project progresses in an inclusive and ethical direction;
- Ongoing reporting to the SEAFG;
- Opportunity to read and comment on draft reports; and
- Engagement in employment opportunities for Aboriginal Peoples as traditional owners and where the opportunities arise.

Given the structure of the SEAFG, it is proposed that this proposal and fee for service engagement is administered through a regional organisation with the capacity to support this activity.

The SEAFG will participate in the SEFRP outside and across the boundaries of the Ngarrindjeri and Others Native Title Claim area. The SEFRP Team estimates 52 km of SEFRP alignment occurs outside of the Native Title claim area. This proposal enables the SEAFG to participate in heritage assessment activities along 90 km of alignment to account for South East Aboriginal people's interests and family connections that extend across the Native Title claim (discussed in risk assessment) area.

Given negotiations between DEWNR and the SEAFG have not progressed significantly; this proposal seeks to utilise the objectives and the following output framework in Table 9 below.

Table 9. NRA and SEAFG Involvement Output Framework

	Project Component	Description	Outcomes
Protect	**Heritage Clearance**	• Desktop assessment of cultural heritage matters for the proposed alignment. • Undertake pre-dig heritage survey of 90 km of alignment by vehicle and stopping at certain sections of cultural heritage interest, supported by fee for service archaeologist. • Heritage assessments and associated reports for project design and implementation, approvals with conditions or alternative actions required, and identification of significant Aboriginal heritage sites, objects or remains that have a high risk of being damaged, disturbed or interfered with by the SEFRP.	• Pre-dig cultural heritage survey focuses upon areas with higher likelihood of Aboriginal sites. • Protection of Ngarrindjeri and South East Aboriginal peoples cultural heritage both physical and spiritual. • Project design and implementation has limited impacts on Ngarrindjeri and South East Aboriginal people's cultural heritage.
	Heritage Monitoring	• Cultural heritage monitoring at known Aboriginal sites during construction period based on Heritage assessments and associated reports.	• DEWNR meets its statutory obligations under the Aboriginal Heritage Act, 1988.
Support informed decision making	**Support informed decision making**	• Support assessment and relevant consultation with Ngarrindjeri and South East Aboriginal Leadership and relevant specialists to develop culturally appropriate outlet designs and operating procedures for components of the SEFRP.	• Project design and implementation addressed cultural heritage impacts • Increased transmission of South East Aboriginal peoples cultural knowledge between generations and SEAFG capacity to plan and respond.

6.6. Construction

SEFRP construction will take place over a 75 week window (weather permitting) and will comply with the *National Code of Practice for the Construction Industry* and the Australian OHS Accreditation Scheme.

Phases

The construction component comprises several phases.

- Tender documentation. Prior to completion of the detailed design to construction call standard, tender documentation is prepared in consultation with the design consultants and finalised when the relevant quantities and specifications have been checked and verified for "construction tender call only". The tender documents are prepared in accordance with the Department of Premier and Cabinet Circular No 28 (DPC 028) which requires DPTI to be responsible for the management of construction projects in the civil and building (commercial) construction sectors either directly or through review of all documentation if managed independently.
- Tender Call and Award. The tender call is subject to the International Obligations Policy (State Procurement Board, 2012) which requires that all construction tenders comply with:
    - The Australian and New Zealand Government and Procurement Agreement (ANZGPA);
    - The Australia – United States Free Trade Agreement (AUSFTA); and
    - The Australia – Chile Free Trade Agreement (ACIFTA).

These agreements apply where the value of the procurement (including GST) of construction services is estimated to equal or exceed A$9,514,000 (for the AUSFTA) and A$9,570,000 (for the ACIFTA).

The AUSFTA and ACIFTA require that a minimum of 30 (calendar) days is to elapse between the advertising of a tender and the closing date.

The structure of the tender document will be developed with DTPI and will be reviewed by the same for finalisation by DEWNR. In conjunction, the request for tender will utilise the facilities of Tenders SA to ensure transparency and that information is adequately distributed to all participants simultaneously through the following web site:

https://www.tenders.sa.gov.au/tenders/tenders/index.do

Besides pricing and staffing detail, tenders must include:

- A full description and explanation of the intended method to carry out the Project Requirements;
- A Programme of Works;
- An outline of the Tenderer's Occupational Health and Safety Plan and a statement of the Company's Occupational Health & Safety Record over the preceding two years, including details of lost time incidents and deaths;
- An outline of the Tenderer's Environmental Management Plan (EMP); and
- Evidence of economic capacity and financial stability.

The minimum anticipated duration from calling the tender to letting the contract is 10 weeks.

Construction

- <u>Preliminaries</u>. Relates specifically to construction and includes preliminary, support and finalisation activities such as:

    1. Mobilisation and demobilisation of plant, equipment and personnel;
    2. Survey: survey control, alignment survey, topographic survey, "as constructed" data and volume calculations;
    3. Site establishment: accommodation, compound office and storage (including temporary services);
    4. Site inductions and heritage awareness training;
    5. Testing and quality assurance control;
    6. Site management and supervision; and
    7. Service truck and support plant.

    This activity is undertaken immediately following award of the construction contract and, unless otherwise agreed, facilitates commencement of the earthworks within three weeks. Currently, this scheduled activity coincides with the 2013 Christmas break and may be renegotiated.

- <u>Bulk earthworks and structure installation</u>. Includes all construction earthworks activities such as:

    1. Vegetation clearance and rehabilitation;

2. Topsoil management (often included with vegetation clearance and rehabilitation for light vegetation and treated separately with heavy vegetation);
3. Bulk excavation;
4. Bulk placement of spoil (excavated material);
5. Profiling of spoil and final trimming including rehabilitation and access track provision; and
6. Installation of all associated structures (e.g. crossings and flow regulators).

The anticipated time for this activity is 75 weeks (plus 3 weeks for Preliminaries) from award of the contract.

- Demobilisation. Includes site clean up and removal of all plant, equipment and support facilities and the "making good" of all affected facilities not directly part of the construction works e.g. local landholder access tracks.

  This work is usually a staged process and completed within two weeks of the main construction activities.

Proposed methodology

As part of the tender submission and pre-contract negotiations the prospective contractor is required to submit the following:

- A full description and explanation of their intended methods to carry out the Project Requirements; and
- A Programme of Works.

The Project Requirements will require the following objectives to be met:

- Commencement of the earthworks at the downstream end of the works corridor (Salt Creek and Morella);
- A programme of works that:
  - Facilitates construction of the SEFRP channel to the S-Bend Drain junction by 30 June 2014; and
  - Ensures operational completion of the SEFRP channel to the Blackford Drain diversion location by 30 June 2015.

The general approach to construction is for crews (most likely two) to be concentrated at working fronts not more than 5 km apart. This facilitates more effective management of staff and results in less overall disruption to the community. Crews will commence installation of crossings and other infrastructure within one week of completion of the bulk channel excavation to minimise disruption to local landholders.

Where native vegetation clearance has been undertaken and rehabilitation is proposed, the operation will be carried out as soon as the section has been re-profiled. This short duration of stockpiling will limit the potential degradation of the seed sources in the topsoil. It is proposed that material stockpiled for replacement will be respread within four weeks of removal. The programme of works will endeavour to have the majority of native vegetation rehabilitation completed by winter of 2014 to facilitate regeneration. Clearance of native vegetation will be managed to minimise clearance during the summer period.

To achieve the above objectives, and assuming that the bulk excavation commences early January 2014, the construction activity will require an average production rate of channel construction of approximately 1.5 km/week until 30 June 2014 and, thereafter, 1.1 km/week until 30 June 2015.

Post June 2015, construction activities will be limited to finalisation of any outstanding works following connection to the Blackford Drain, correction of any defects that may have become evident during the preceding two winters, demobilisation and delivery of the “as-constructed” survey data.

Impacts on Public Amenities

The potential impacts of drainage construction are not new to the landholders and the broader community in the general area. Over the last 15 years over 700 km of drain and floodway construction has been undertaken in the Upper South East. All landholders along the proposed construction alignment are familiar with drainage construction works. No major construction works are to be undertaken within built up areas.

The design was developed using modelling outcomes, community commentary (from the ongoing community consultation and more detailed engagement with directly affected landholders) and current on-site initiatives. Public amenity was a key consideration in the design and will be further fine-tuned during the construction phase and ongoing consultation and negotiation.

The following sub-sections present the assessment of impacts on public amenity associated with the proposed SEFRP, incorporating design modifications, mitigation and management measures applied to manage predicted impacts.

Public Access

Six public roads (two sealed and four unsealed) are affected by the project. Traffic management plans will be developed to ensure that no closures will be required. All sites can be managed through temporary diversion structures and traffic regulation and be subject to disruption for no greater than seven days.

With respect to OHS&W practices, no public access will be permitted to the construction site.

Landowner Impacts

- Landholder access – crossings

  Landholders will be advised of the proposed construction schedule several weeks before being affected to enable stock movements to be undertaken. All efforts will be made to adhere to the schedule with regular communication with the landholder. Generally, the duration of landholder (occupational) crossings installation is five days for operational completion.

- Fencing

  Fencing is required to be completed within three weeks of passage of the main excavation crew.

- Stock management

  In the past, landholders have been co-operative with respect to stock management along the works corridor. Where stock are not able to be moved for the construction period, temporary fencing has been installed to provide a safe working environment for both man and beast.

Dust

Amenity relates to both the aesthetic and lifestyle values inherent to a region and the perceived impacts on these values.

Prior to construction, a Construction Environmental Management Program will be established, incorporating dust controls such as restricting vehicle movements to established tracks and roads, watering unsealed roads and restricting vehicle speed.

Taking into account the proposed dust controls, the predicted minimal increase in dust levels and the rural, sparsely-populated community, the significance of the impact to public amenity arising from dust emissions from the construction and operation of the proposed SEFRP is considered to be minor.

Noise

Given the temporary nature of construction activities in a particular location, noise impacts on public amenity are expected to be minor. Furthermore, given the location of the proposed work is well away from domestic or public facilities, it is likely that the additional noise generated by the operation of construction and support equipment will have negligible impact on the community as a whole. However, a Construction Environmental Management Program will be implemented that will include:

- All construction activities being undertaken in accordance with environmental protection (noise) regulations 1997;
- All construction work carried out in accordance with the control of noise practices set out in AS 2436-1981 “guide to noise control on construction, maintenance and demolition sites”; and
- Regular monitoring and maintenance of equipment so that equipment remains in good working condition and noise emissions are kept to a minimum.

Visual amenity

The impact on visual amenity associated with the SEFRP has been considered. The design incorporates low profiling of excavated spoil material and rehabilitation with topsoil and vegetation in all areas and especially those visible from any public roads. This approach has been successful in similar works in the project area.

While the proposed SEFRP infrastructure will be visible within close proximity, the proposed mitigation and management measures are appropriate and their implementation will reduce any adverse visual impacts on the surrounding environment as low as reasonably practicable. Therefore, it is considered that the reduction in visual amenity will not be perceived as an issue by landholders or affected stakeholders and impacts on visual amenity arising from the presence of the proposed infrastructure will be negligible.

Environmental Impacts

As part of the tender process, Contractors are required to submit an Environmental Management Plan (EMP) to ensure that appropriate environmental management practices are followed during construction. It ensures:

- Application of best practice environmental management to the project;
- The implementation of a project’s EIA including it’s conditions of approval or consent;
- Compliance with environmental legislation; and

- That environmental risks associated with a project are properly managed.

No construction works will take place unless DEWNR is satisfied with the Contractor's EMP.

Potential risks

The environmental risks of construction of the SEFRP are dealt with in Appendix C.

Water related risks have been identified as having particular interest to the SEFRP. The majority of construction work is over an existing drainage scheme. No new (or unknown) surface or groundwater sources will be accessed during construction.

Potential contamination of existing water sources is considered very low risk and will be addressed as part of the EMP. Two concerns that have been raised are:

- sediment or colloidal mobilisation; and
- contamination by machinery fluids (e.g. oil, fuel).

<u>Sediment or colloidal mobilisation</u>

During construction where the water table is intercepted, particulate matter is created that has potential for mobilisation from the construction front. Experience in over 700 km of similar construction in the area has shown that the travel distance of any sediment is very short due to the very slow velocity of the drainage water. Colloidal material generally originates from clay materials. Due to the salinity of the drainage water along the SEFRP alignment, the clays also have a very short travel distance before settling through flocculation.

<u>Contamination by machinery fluids</u>

Fluid contamination originates from leakages or pipe ruptures during construction and from service compounds. Regular maintenance so that equipment remains in good working condition ensures that potential leakages and ruptures are kept to a minimum.

The size of the construction works for the SEFRP ensures that only larger firms with demonstrated economic capacity and financial stability will undertake the construction activities. It is unlikely that machinery with a high risk of mechanical failure will be utilised on the site. With respect to fluid losses from the service compound, a bund will be constructed around the site in accordance with the EMP.

6.7. Environmental Management

Ecosystem Monitoring

Ecosystem Monitoring will be undertaken at representative locations within the wetlands *en route* to the Coorong. Wetland sites are located on the Taratap and Tilleys Swamp flats, including Morella Basin, and in the Bakers Range North watercourse. This monitoring will determine construction impacts and inform the future environmental performance and adaptive management of SEFRP infrastructure. A survey methodology and database has already been established (Ecological Associates and Aquasave Consultants 2012) and is consistent with the approach adopted throughout the greater South East Drainage System. Additionally, monitoring sites have already been established, with baseline monitoring data obtained in November 2012, for eight wetlands between Salt Creek and the Blackford Drain (monitoring report pending). Note that a total of 9,440 hectares of wetlands are currently managed for conservation in the Salt Creek to Blackford reach of the SEFRP. Additional flora and fauna monitoring sites are required.

Some parameters monitored (e.g. vegetation) are relatively slow to respond to changed hydrology, with measurable changes unlikely for several years. However other parameters (e.g. fish species diversity and abundance) can change rapidly in response to altered management. Therefore, in addition to the collection of baseline data, follow up surveys of limited parameters at limited locations are proposed for years 2 and 3 to measure the early ecological outcomes of the SEFRP for *en route* wetlands.

Costings include:

- establishment of baseline wetland flora and fauna monitoring sites for key wetlands on the Salt Creek to Blackford and Bakers Range North watercourse sections;
- re-survey of some parameters at some sites in years 2 and 3, to measure early ecological outcomes of the SEFRP;
- entry of data into existing SEWCDB monitoring databases; and
- report preparation.

Native Vegetation Clearance Assessment

The maximum area of native vegetation that will be affected during construction is approximately 330 ha. This area has been estimated using GIS and guided by site observations. A more accurate area calculation will be determined following a formal vegetation assessment and detailed design completion.

During the preliminary design phase, all reasonable efforts were made to minimise disruption to native vegetation. However, where potential high construction costs and long-term maintenance issues (e.g. potential erosion of excavated or constructed slopes is high with resultant sediment transfer to wetlands) were apparent, the design was developed to be the most physically practical. Further reductions to the area of native vegetation clearance are anticipated following final landholder consultation and detailed design and refinement of construction methodology.

The design alignment has been determined with further consideration that:

- Where local areas of flooding are acceptable, the design will permit this activity to minimise native vegetation disruption or clearance; and
- Where open pasture land abuts native vegetation, the design will extend into open pasture rather than native vegetation.

It is proposed that all areas, except the channel, access tracks and fence lines will be rehabilitated using the approach outlined later in this section. The rehabilitated area will be finalised once the native vegetation assessment has been completed. A budget estimate of approximately 220 hectares has been accounted for based on GIS estimates. The final permanent clearance figure will be available once the native vegetation assessment has been completed.

A Native Vegetation assessment will be conducted and a management plan developed for the construction and post-construction phases in accordance with the *Native Vegetation Regulations 2003* (SA) – Regulation 5(1)(zl) to ensure native vegetation is conserved and enhanced post-construction of the channel.

Subject to the requirements of the Native Vegetation Management Plan, the general method for native vegetation clearance and rehabilitation is as follows:

- identify all areas that will be affected by channel excavation and spoil placement to minimise the area of disturbance;
- hydro-axe vegetation across the area destined for clearance and leave the debris in-situ;
- scalp the area by removing the debris and topsoil (up to 50 mm for light vegetation and 150 mm for heavy vegetation), taking care to ensure mixing of the soil and hydro-axed debris;
- stockpile the scalped material upon the cleared site until a previously cleared section has been completed (spoil placement and profiling); and

- spread soil/debris mixture evenly across the newly profiled spoil, except where revegetation is not desirable (e.g. access tracks, fence lines).

This approach:

- protects the soil from erosion and prevents runoff of sediment into the channel and subsequent deposition in wetlands;
- helps prevent compaction of the soil after a rain enabling better seed emergence;
- provides a compost thus enriching the soil;
- provides a natural seed source as seed is not removed from the site (seeds of many native species will successfully germinate and grow with this type of treatment);
- maintains soil moisture for improved vegetation regeneration and establishment.; and
- re-establishes a self-generating ecosystem comprising local native flora and vegetation which resembles the surrounding environment, as close as practical.

Much of the existing Tilley swamp alignment had cleared vegetation, burnt on-site and excavated spoil placed in unformed mounds adjacent the drain. Since 1999, some of these areas have revegetated but significant erosion with sediment transport into the channel is still prevalent. It is proposed to treat these spoil mounds in the manner described above to minimise the continued sediment movement.

Machinery will only be allowed to access areas of native vegetation that are directly affected by construction.

Native Vegetation Restoration

The South East region is substantially cleared, with 13 per cent native vegetation cover remaining. As a complementary activity to the native vegetation clearance and management, the SEFRP will target the re-establishment of up to 70 hectares of vegetation communities. Restoration efforts will focus on restoring poorly represented vegetation communities in the region that have been affected by the SEFRP. Although not a requirement under State legislation, this complementary activity will demonstrate to the community that a high standard of environmental management has been implemented through this joint State and Commonwealth project. The figure of up to 70 hectares will be revised once the native vegetation assessment has been completed. Land within existing conservation agreements and the reserve system will be targeted to ensure long-term management of this investment is realised.

Native Fauna Assessment

The native fauna assessment will confirm the likelihood of any impacts to fauna during construction. From preliminary desktop analysis of existing information, fauna impacts will be minimal as the home ranges of many animals will not be impacted upon. However, potential impacts could occur to burrowing animals such as the Common Wombat.

Common wombats are rated as rare under the *National Parks and Wildlife Act 1972* (SA) and are not listed under the EPBC Act. The *National Parks and Wildlife Act* protects animals but not their habitats, suggesting that wombat habitat including vacant burrows are not protected, however, active burrows can be assumed to contain wombats and therefore if the construction of the drain resulted in destruction of the burrow this would require approval under the *National Parks and Wildlife Act*.

Following the assessment of burrows within the proposed alignment, an impact of loss statement will be prepared that will consider the loss of wombat populations on the local and regional populations. The constructing contractors will be provided with guidelines on how to minimise and manage burrow disturbance.

Invertebrate Monitoring (sediment)

One of the key parameters of a healthy Coorong is the composition of the benthic (soil) communities. Monitoring the current condition of this community within the South Lagoon and Morella Basin will establish a baseline and contribute to our knowledge of how the Coorong responds to water flows and salinity. When the additional water is released into the Coorong from the SEFRP the invertebrate community will be one of the first to respond to the changing conditions (e.g. salinity range between 60-100 g/L). Comparison of the invertebrate community before the SEFRP delivers water and during SEFRP operation will enable managers to demonstrate that this management action is contributing to a healthy Coorong.

Five monitoring locations have been selected, four in the South Lagoon and one in Morella Basin. Sampling will occur once a year for the three year construction period. One of the outputs at the end of this period will be defined invertebrate indicators relating to the SEFRP, refined water quality guidelines for these indicators and design of a reduced sampling procedure for on-going monitoring.

Hydrological Monitoring

The monitoring of flow rates, water levels and water quality (basic parameters: salinity, dissolved oxygen, pH) throughout the South East Drainage System is critical to the efficient management of the System for its dual objectives of optimising agricultural productivity and protecting aquatic ecosystems. Hydrological monitoring stations provide this information. Much of the existing hydrological monitoring infrastructure is telemetered, with live, web-based data available for managers, enabling a rapid management response to issues and opportunities as they arise. For example, a pulse of fresh water through a typically saline area provides an opportunity to divert into wetlands, requiring a rapid response. In addition to the basic water quality parameters, some monitoring stations feature composite samplers, devices that enable the collection of water samples at specified times and/or frequencies. These samples are then manually collected, transported and laboratory analysed to measure a range of water quality parameters such as nutrients, pesticides and metals.

The SEFRP, by widening existing drains, will disturb four existing hydrological monitoring stations in the Salt Creek to Blackford area and one in the Bakers Range North watercourse upgrade area. The hydrological monitoring component of the project involves the reinstatement of these five stations to accommodate the new channel width. Additionally, four new hydrological monitoring stations are required between the Blackford Drain and Salt Creek to manage the expanded system (Table 10). A composite sampler, allowing for future detailed water quality analysis, already exists at Morella Basin. Two additional composite samplers will be added. One is located upstream of Morella, to better inform the role that Morella is playing in water quality improvement prior to release into the Coorong. A second is located on the SEFRP channel immediately downstream of the Blackford Drain diversion location (Taratap Drain DS Blackford diversion, Table 10) to enable the assessment of water quality entering the new SEFRP channel at its upstream end. A rainfall gauge is proposed at Morella to better inform net evaporation from this waterbody. Note that hydrological monitoring infrastructure additional to that listed (Table 10) exists within the project area but will be unaffected by the project.

Table 10. Hydrological monitoring infrastructure proposed for the SEFRP.

Project Area	Requirement	Site Description	Flow Rate	Water Level	EC	pH	DO	Composite Sampler	Rainfall
Salt Creek to Blackford	upgrade	Morella Basin		Y	Y	Y	Y		Y
Salt Creek to Blackford	upgrade	Taratap Drain @ Englands Crossing	Y	Y	Y				
Salt Creek to Blackford	upgrade	Taratap Drain @ Taratap Road	Y	Y	Y				
Salt Creek to Blackford	new	Taratap Drain DS Blackford diversion	Y	Y	Y			Y	
Salt Creek to Blackford	new	Tilley Swamp Drain US Morella	Y	Y	Y			Y	
Salt Creek to Blackford	new	Tilley Swamp wetland US Safari Rd		Y	Y	Y	Y		
Salt Creek to Blackford	upgrade	Taratap Drain US Henry Creek	Y	Y	Y				
Salt Creek to Blackford	new	Tilley Swamp Drain US Keith-Cantara Rd	Y	Y	Y				
Bakers Range North watercourse upgrade	upgrade	Bakers Range catch drain DS Fairview	Y	Y	Y				
TOTAL									

Water Quality Risk Management – Blackford to Salt Creek

Blackford to Salt Creek water quality monitoring involves the collection and analysis of water samples in the SEFRP area during construction. The objective is to detect any impacts from construction to the water quality within the SEFRP. Monitoring will occur monthly during the construction period (20 months). Some flexibility to this schedule may be required to address particular construction issues or timelines.

Water samples will be collected at five locations:

- within the existing Taratap/Tilley Swamp drain immediately upstream of the construction area (which will move progressively from north to south);
- within the newly completed SEFRP channel immediately downstream of the construction area;
- within the newly completed SEFRP channel 0.5 km downstream of the construction area;
- within the newly completed SEFRP channel 2 km downstream of the construction area; and
- the Morella Basin outlet.

Adverse water quality impacts through construction can be mitigated by changing construction techniques or implementing mitigation measures to stop sedimentation or other point source pollution issues.

Water Quality Risk Management – Coorong Lagoons

Defining the baseline water quality parameters within the Coorong Lagoons before additional flows commence is necessary to limit potential impacts through increased nutrients from the SEFRP by regulating releases from Morella Basin.

Eight representative sites from the North Lagoon to the South Lagoon will be sampled every quarter for the three year construction period. A total of 96 samples will be analysed by the Australian Water Quality Centre with interpretation and analysis firstly by the South Australian Environment Protection Authority.

A review by Adelaide University and the South Australian Environment Protection Authority identified the following water quality parameters to collect to detect changes in nutrients:

- Ammonia as N
- Phosphate as Filterable Reactive Phosphorous (FRP)
- Nitrate and Nitrite as Nitrogen

- Phosphate total
- Silica
- Total Kjehldahl Nitrogen (TKN) as Nitrogen
- Alkalinity
- Acidity
- Turbidity
- Conductivity & Total Dissolved Solids (TDS)
- Chloride
- Total Algae
- Chloraphyll a & b

Catchment Water Quality Processes

The understanding of the complex interplay between vegetation, salinity, nutrients, water depth and soils is required to mitigate environmental risks from additional nutrients, metals and other possible contaminants from the SEFRP. Through understanding how these processes work managers of the SEFRP can alter the delivery of water to the South Coorong by using Morella Basin as a retention area to ensure suitable water quality is obtained before releases into the Coorong can occur. Previous work by Haese, *et al.* in 2009 and Ford's 2007 study under the Water for a Healthy Country National Research Flagship support the need for this understanding.

Wetlands are well known for their capacity to purify water of sediments, pesticides, nutrients and heavy metals. Run-off events in the South East can be large and sudden, but water flows through 2,000 km of drains, floodways and wetlands. The potential for increasing the residence time of water in the landscape is significant. The South Australian Government currently has management rights over the Morella Swamp at the terminus of the wetland system which can hold up to a third the total volume of the South Lagoon. There are therefore real opportunities to manage run-off to ensure that the water supply that finally reaches the Coorong South Lagoon is low in nutrients, heavy metals, pesticides and sediments.

To maximise the operation of Morella Basin and the Coorong several areas require substantiation, these include:

A. How nutrients and other impurities interact in a fresh and saline environment;

B. What areas in the SEFRP act as a nutrient sink and source and how management can utilise these processes to mitigate risks to the Coorong and SE Wetlands; and

C. How to manage water flows and storages in the South East to ensure that the quality of water released into the South Lagoon enhances the ecological character.

This activity will collect up to 70 water quality samples to identify nutrient sources and sinks. As part of the analysis, soil samples will be collected to define soil process in relation to water. Management tools such as conceptual models will be developed to inform operations under different water quality and flow scenarios. This information will be displayed spatially where managers can understand the impacts from River Murray flows and South East flows. This coordination will enable salinity gradients, water levels to be managed and importantly the management of nutrients that will ensure that primary productivity is maintained for ecological processes.

Site Operations Procedures

Information synthesised from all Environmental Management activities will form the basis for concise operating rules for the SERFP.

The knowledge of nutrient processes, water quality and ecological process between Morella Basin and Blackford Drain will define water retention protocols before water is released into the Coorong Lagoons. The knowledge regarding how increased flow from the South East interacts with River Murray flows to affect salinity, nutrient availability and ecological processes will form the basis for protocols that maximise environmental outcomes. These protocols are essential for long-term management of the Coorong. The SEFRP operations procedures will form a module under the overarching Site Operations Manual for the CLLMM Site.

The Site Operations Procedures will also be incorporated into the Drainage Network Management Strategy by the SEWCDB.

6.8. Completions

The completions or handover phase includes:

- dealing with defects;
- ensuring clear accountability for ongoing operation and maintenance of the asset;
- asset capitalisation and updating of registers and asset databases;
- provision of certificates and documentation; and

- review.

Post implementation reviews will be conducted and a managed process of handover of information and responsibilities will occur.

In a major infrastructure project such as the SEFRP, which extends over a long period of time, sections of work become finalised well before the end date. The Completions Phase therefore commences informally around mid-term during construction and extends beyond the practical completion date.

The SEFRP will be finalised using DPTI guidelines and templates as required by Department of Premier and Cabinet Circular No 28 (DPC 028).

7. Cost Details

The SEFRP is estimated to cost [redacted] as per Table 11. Costs have been developed consistent with discussions in the Phase 2 Implementation chapter (Chapter 6) and are further detailed and substantiated at the component-level in Appendix B.

Table 11. SEFRP costs (adjusted for CPI per project component)

Project Component (3% CPI adjusted)	Financial Year of Expenditure ($)			Totals
	13/14	14/15	15/16	
Detailed (3% CPI)	[redacted]			
Land Acquisition (3% CPI)				
Heritage (3% CPI)				
Environmental Management (3% CPI)				
Construction (3% CPI)				
Project Management (Nil CPI)				
GRAND TOTAL (3% CPI adjusted)				

CPI

CPI has been applied to all elements of the budget with the exception of the Program Management component which remains constrained at 10 per cent of the total budget.

CPI is a retrospective measure of average change in price over a selected period and is used to quantify price changes associated with the cost of living and products/services. It is appropriate that escalation in prices is factored into a project which is scheduled to be delivered over several years to ensure that out-year budgets sufficiently cover the anticipated costs.

Further, several Producer Price Indexes (PPI's) are produced and published. Economy-wide indexes are calculated together with a set of indexes relating to specific industries (selected manufacturing, construction, mining and service industries). PPI's can be constructed as either output measures or input measures. Output indexes measure changes in the prices of goods and/or services sold by defined industry groupings, while input indexes measure changes in the prices of goods and/or services purchased by a particular industry grouping.

Within the construction industry the primary cost escalations are associated with wages, fuel and goods such as steel and concrete. In recent years, construction PPI has been as high as 6-10 per cent however in over the couple of years it is recognised that, with the contraction of available work in the construction industry, there has been a reduction in inflationary pressure in this area.

Current construction CPI is closer to 3 per cent:

- 2007 to 2011 CPI was 3.3 per cent; and
- 2011 to 2012 CPI was 2.6 per cent (ABS statistics for Adelaide).

DPTI Construction Market Commentary (October 2012 r9 v1-0) noted *"Building Management advises that the forecast tender price index allowances to be utilised when establishing initial budgets is 3 per cent per annum."*

SEFRP construction estimates are therefore based on KBR's 2012 (adjusted) figures (adjusted for 800 ML/day) with 3 per cent CPI applied from June 2012 (to yield the 2013/14 base figures).

For the non-construction budget components, a CPI of 3 per cent per annum was selected following review of a number of sources, including:

- 2.85 per cent University of Adelaide (http://www.adelaide.edu.au/saces/economy/lgpi/)
- 3.7 per cent Comment: Local Government Price Index (LGPI)
- 3.0 per cent Davis Langdon (an AECOM Company)

(http://www.aecom.com/deployedfiles/Internet/Geographies/Australia-New%20Zealand/PCC%20Projects/Davis%20Langdon%20-%20Market%20Pulse%20Australia%20-%20Commercial%20Q2%202012.pdf)

Detailed Design

Detailed Design cost estimates have been derived for the two following components as follows.

Survey

Rates were obtained through open tender January 2012 for initial topographic survey (200 km) of all SEFRP options and were still applicable in January 2013 for similar survey.

An approach to several contractors, familiar with the type of survey required, confirmed the rates used for budget purposes are still applicable and were unlikely to change for some time.

3 per cent CPI has been applied to the current rates to cover any escalations in price throughout the project. This is considered appropriate given the early conduct of these works in the project and the October 2012 published commentary (DPTI, 2012), that "current tender prices are suggesting lower allowances".

Detailed Design

The preferred industry standard for budgeting for detailed design is 5 per cent (pers comm. (2013) David Ellis, GHD) of construction costs but in 700 km of similar earthworks in the area from 1998-2011, detailed design costs have not exceeded 3 per cent and in larger projects have been closer to 2 per cent. Detailed design normally includes survey, which has been carried out as part of the SEFRP Preliminary Design process, and geotechnical investigations which have also been carried out previously. Therefore, the use of 3 per cent of the construction capital costs plus preliminaries is considered appropriate and has been supported by the KBR estimator.

Environmental Management

The upper budget limit of [redacted] for Environmental Management has been developed based on a range of recent market-tested experiences, including those from the SEWCDB (full substantiation in Appendix B).

Land Acquisition

The estimate of value for land proposed to be acquired has been based upon recent comparative land sales evidence within the proximity of the proposed project corridor having regard to various local factors. For budget forecasting purposes, a nominal construction corridor width of 100 m has been used to calculate the maximum area that is required for the works. This is a standard valuation practice involving comparison of like for like. In adopting this approach, it has been determined that the maximum acquisition area (which excludes current holdings/interests) is 520 ha.

The disparity in value from one property to another is indicative of the productive difference anticipated to apply to land at particular points along the corridor and takes into account provisions for whether a particular area of land is under vegetation (low value), subject to degrees of inundation (medium value range) or higher quality year round grazing capacity (high values).

Budget estimates have been made on a property by property basis with the acquisition cost of [redacted] and are summarised in Appendix B. Provisions have also been included for cadastral survey and titling costs of approximately [redacted]

The USE Completions Officer carrying out the compensation assessments for the USE Program in which over 700 km of drainage and SEFRP type constructions were carried out, has prepared the estimates with input from licenced valuers and is confident that the estimates provide a fair and reasonable forecast of anticipated acquisition cost at current market value.

Construction Costs

[redacted]

[redacted]

[redacted]

Table 12. Summary: Comment on construction rates used for 1,000 ML/day and 800 ML/day diversions

Aboriginal Involvement – Heritage Clearances

The upper limited budget of [redacted] for Aboriginal Involvement in the planning, approval and implementation of the SEFRP has been developed with the Ngarrindjeri Regional Authority and South East Aboriginal Focus Group, consistent with *South Australian Attorney General's Guidelines for Aboriginal Heritage Payments* (full substantiation in Appendix B).

Project Management

Consistent with the CLLMM Recovery Project Schedule, and following Australian Government confirmation, SEFRP Project Management has been costed to [redacted] per cent of the total budget, or [redacted].

7.1. Cost Sharing Arrangements

Consistent with the CLLMM Recovery Project Schedule, it is proposed that SEFRP cost sharing will be on the basis of a 90:10 (Commonwealth: State) split, with Commonwealth funding limited to only that specified in the final funding contract.

The State acknowledges that the provision of funding for the SEFRP does not give rise to any Commonwealth obligation to fund any other proposals or expenditure arising from or in relation to the SEFRP.

8. Budget Details

This proposed expenditure profile assumes implementation and delivery of the SEFRP over three years from 1 July 2013 to 30 June 2016. This time frame will allow for further stakeholder consultation and efficient delivery of the on ground works.

These cash flow estimates may change following the detailed design and land acquisition phases.

The following assumptions have been used in the expenditure profile.

[redacted]

[redacted]

[redacted]

[redacted]

9. Cost-Benefit Analysis

The aim of the Cost Benefit Analysis (CBA) is to demonstrate that the SEFRP will provide a net benefit to the Australian economy and the Australian public.

9.1. Approach

Environmental amenities like the Coorong are valuable natural assets in that they yield a flow of services and functions (Freeman 2003). A project like the SEFRP has the potential to change this flow of services and functions, thereby creating environmental and social benefits and costs. CBA provides a framework within which the project can be systematically appraised, taking into account this broader suite of social and environmental costs and benefits arising from the project. Economic efficiency requires that the benefits of a project exceed the costs of the project.

The CBA methodology applied in this study follows the standard approach to CBA set out in the Commonwealth Government's *Handbook of Cost Benefit Analysis* (Commonwealth of Australia 2006) and is summarised in the following schematic (Figure 17).

Figure 17. CBA methodology

Valuing benefits and costs

Where goods and services are exchanged through markets and therefore a market price exists (market goods), the market price is the accepted measure of economic value, because the number of dollars that a person is willing to pay for something tells how much of all other goods and services they are willing to give up to get that item.

Environmental amenities are generally different from market goods in that they are typically not divisible into discrete units and they are generally available to many people simultaneously (i.e. they exhibit public good characteristics) (Bockstael *et al*. 2000). Consequently, markets for environmental amenities usually do not exist (they are termed non-market goods or services) and so a market price cannot be relied upon as a measure of value associated with a change in the quality of an environmental amenity and hence the change in the well being of individuals.

The SEFRP is aimed at improving the resilience and hence the environmental quality of the Coorong ecosystem during drought by increasing inflows of water and decreasing salinity levels. This improvement in the environmental quality of the Coorong will lead to increased well being (utility) of individuals in the community. In the CBA framework this improvement represents the benefit of the project, which can be measured by individuals' 'willingness to pay' (WTP) to secure the improved environmental quality.

The sum of the individual WTPs defines the total economic value (TEV) of the change in well-being due to the project. TEV provides an all-encompassing measure of the economic value of any environmental amenity (Pearce *et al*. 2006).

TEV is usually divided into use and non-use (or passive use) values. Use values relate to actual use of the environmental amenity in question (e.g. visit to a wetland), planned use (a visit planned in the future) or possible use. Non-use values refer to the WTP to maintain an environmental amenity even though there are no actual, planned or possible uses. Non-use values are generally classified as:

Existence value – refers to the willingness to pay to keep an amenity in existence even though there is no intent to use the amenity

Altruistic value – where an individual is prepared to pay for the amenity to ensure that it is available to others in the current generation

Bequest value - is similar to altruistic value, except that the aim is to preserve the amenity for future generations.

Figure 18 summarises the components of TEV using the example of a wetland ecosystem, such as the Coorong. This diagram highlights the complexities associated with valuing multiple uses and shows the aggregation of use and non-use values.

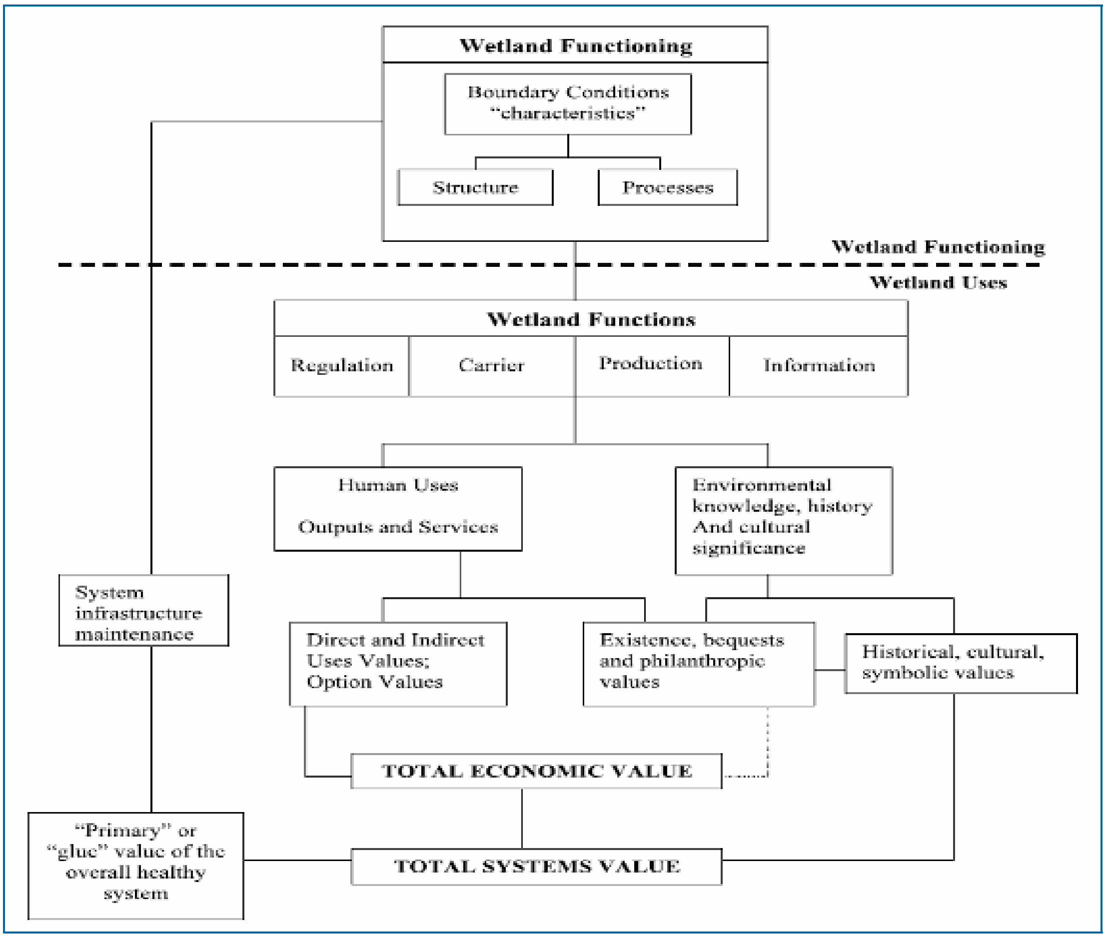

Figure 18. Total Value - Concept of economic value.

Source: Turner et al. (2003)

Non-market valuation techniques

A number of techniques have been developed to estimate the economic value of non-market goods and services. These non-market valuation techniques are designed to provide dollar value estimates of non-market goods and services that are consistent with the economic theory underpinning benefit cost analysis (Bennett *et al.* 2008). However, it is important to recognise that in a CBA what is measured is not the total value of each component of TEV, but rather the change in value (the marginal value) arising from a project (Campbell and Brown 2007). In terms of the SEFRP, the marginal change in the use and non-use values of the Coorong resulting from its improved resilience (due to additional water being supplied through the SEFRP) is what is being measured.

Non-market valuation techniques can be broadly separated into two categories revealed preference techniques and stated preference techniques.

Revealed preference techniques

Revealed preference techniques infer a value for a non-market good from people's expenditure on market goods that are related to the non-market good. Examples include hedonic pricing and the travel cost method. Hedonic pricing looks at variations in the price of housing or residential rental markets arising in part from change in environmental quality. The travel cost method derives values by inferring that the amount spent to participate in an activity is the value the participant places on the activity. For example, the cost of travelling to a site (e.g. national park) can be used as a proxy for the value a person places on the site.

Stated preference techniques

Stated preference techniques are used where market information is unavailable and involve direct questioning of the beneficiaries of a non-market good or service through structured surveys. The most well-known stated preference technique is contingent valuation. Contingent valuation uses an appropriately designed questionnaire, which describes a hypothetical market for the good or service, to obtain a participant's willingness to pay for a change in quantity or quality of a non-market good or service (Abelson 2012).

Another prominent stated preference technique that is growing in popularity is choice modelling. This is based on the idea that the individual derives satisfaction from the properties or attributes of consumer goods and services. However, the individual often faces trade-offs when considering the package of attributes versus the cost of each package. In a choice experiment individuals are presented with choices regarding a good or service and asked to indicate which one they prefer (Hatton MacDonald and Morrison 2005). The choices typically involve a number of attributes, including a monetary component, and therefore present the respondent with a trade-off between the attributes and the cost of the package.

Choice modelling is discussed further in Estimation of Benefits in relation to estimating the value of the Coorong.

Benefit transfer

Non-market valuation techniques can be time consuming and expensive to undertake (Abelson 2012). An alternative approach that is gaining prominence is benefit transfer.

Benefit transfer refers to the extrapolation of non-market values generated at a particular site (the study site), using one or more of the above non-market valuation techniques, to another site (the project site) (Morrison *et al*. 2002). This study used the marginal point value transfer approach, which allows for a single value to be transferred and adjusted for the size of the area to benefit from the project. This enables the monetary value of changes in environmental quality at the project site to be estimated relatively cheaply and easily. A earlier study (Morrison and Hatton MacDonald, 2010) explored environmental valuation techniques relating to the Coorong. This study estimated the 'aggregate value of improving the Coorong from poor to good quality…is $4.3 billion.' CSIRO (2012) undertook an assessment of the ecological and economic benefits of environmental water in the MDB and calculated 'the Basin-wide value of enhanced habitat ecosystems – arising from floodplain vegetation, waterbird breeding, native fish and the Coorong, Lower Lakes, and Murray Mouth – is potentially worth about AU$3 billion to AU$8 billion' under the baseline scenario for the Basin Plan. Further discussion of benefit transfer as applied in this analysis is provided in Estimation of Benefits.

9.2. Methodology

Standing

An important consideration in any CBA is whose benefits are to count in the summation of costs and benefits to individuals affected by a project or policy (Whittington and MacCrae 1986). The Coorong (and Lower Lakes) is designated as among the six most significant ecological assets under the Murray Darling Basin Commission's Living Murray initiative (Rolfe and Dyack 2011) and is an internationally important Ramsar wetland for bird migration, feeding and breeding (Phillips and Muller 2006). It is also an important recreation site, with visitor spending helping to contribute to the regional economies (Rolfe and Dyack 2011).In their study, Rolfe and Dyack (2011) estimated recreational values associated with the Coorong using a travel cost method to be $242.08 per adult visit. They then extrapolated this to 126,000 visitors per annum to estimate the value of recreation at the Coorong and surrounding area to be $30.5 million per annum. Given the ecological and recreational value of the Coorong it is considered appropriate to count the values placed on the Coorong by households, nation-wide. This is discussed further in Estimation of Benefits.

Base case

A critical element of any CBA is measuring the difference between the base case (i.e. the 'without project' scenario) and the 'with project' scenario. The difference between the base case and the 'with project' scenario represents the net benefit of the project.

Definition of the base case for this analysis is discussed further in Estimation of Benefits and is represented by S_1 in Figure 19, while the preferred case with project is represented by $S_2$and is further discussed below.

In this study it is assumed that without the SEFRP (the base case) there will continue to be:

1. 2,000 GL/yr delivered from the MDB through to the Coorong via Lake Alexandrina.
2. Median South East flow of 29.7 GL/yr through to the Coorong South Lagoon via Salt Creek.
3. Resultant salinity in the South Lagoon is above 100 g/L

The preferred case with the project will result in:

1. 2,000 GL/yr delivered from the MDB through to the Coorong via the Lake Alexandrina.
2. Median South East flow of 56.2 GL/yr through to the Coorong South Lagoon via Salt Creek.
3. Resultant salinity in the Coorong South Lagoon below is 100 g/L.

It is assumed that in the absence of this project the environmental health of the Coorong would not deteriorate any further. This is a conservative assumption as it ignores the potential benefit of avoiding further decline in the health of the Coorong, however it removes the need to predict what the magnitude of the decline might be.

Time frame of analysis

The time frame for the analysis was taken to be 20 years, with the stream of benefits and costs discounted back to a present value (2012 (today's) dollars) using a real discount rate of 6 per cent which is further discussed in Discount Rate. South Australian Department of Treasury and Finance *Guidelines for the Evaluation of Public Sector Initiatives* (2010) stipulate the evaluation period be no greater than 30 years.

Discount rate

The discount rate is the rate of interest used to discount (adjust) the flows of benefits and costs to their present values. The choice of discount rate is often controversial but should approximate the opportunity cost of capital. As mentioned above a real discount rate of 6 per cent was used, which is consistent with other studies of this nature (SKM

2010) and consistent with South Australian Department of Treasury and Finance *Guidelines for the Evaluation of Public Sector Initiatives* for low risk investments[1].

Decision criteria

In a CBA, a project is deemed economically justified if the present value of the benefits of the project exceeds the present value of the costs. That is, the net present value (NPV) (the present value of the benefits minus the present value of the costs) is positive.

An alternative decision rule to the NPV is the benefit cost ratio (BCR), defined as the present value of the benefits divided by the present value of the costs. Under the BCR decision rule a project is economically justified if the BCR is greater than one as the benefits exceed the costs over the life of the project.

In general the NPV is the preferred decision criterion as the BCR is biased towards smaller projects and projects with benefits earlier in the project life (Abelson, 2012)

Estimation of costs

The SEFRP will be delivered over a three year period with costs in the CBA broken down annually over this period. The summary of the full costs of this project are provided in Section 7of this Business Case.

Estimation of benefits

The water level and salinity regimes in the Coorong are key determinants of health of the Coorong ecosystem. The main sources of water flowing into the Coorong include freshwater flows from the Murray River across a series of barrages, tidal inflow through the Murray Mouth and fresh to brackish water from the Upper South East Drainage (USED) Scheme via Salt Creek, and localised rainfall and groundwater inputs (Webster 2006).

The SEFRP will provide additional water from the USED Scheme that will assist in reducing salinity levels in the Coorong, especially the South Lagoon. Reducing the salinity levels in the Coorong will increase the resilience of the ecosystem in times of drought by increasing the time taken for salinity levels to reach a critical threshold beyond which there is significant and irreversible species loss. The benefit of the SEFRP is therefore the benefit of improving the resilience of the Coorong during drought periods. This is seen as critical for ecosystem health as droughts are expected to become more frequent with climate change.

[1] The guidelines state ‘it is recommended that the ‘low risk’ discount rate of 6% per annum (real)…be applied. (SA Department of Treasury and Finance Guidelines (page 15).

Using the 'with and without project' approach described in Base Case and allowing salinity levels to be a proxy for ecosystem resilience, the benefits of the SEFRP can be conceptualised as follows. The base case ('without project' scenario) is represented by a salinity level S_1 and the 'with project' scenario is represented by a salinity level S_2, where $S_2 < S_1$. The difference between the base case and the 'with project' scenario represents the benefit of the SEFRP. This outcome is illustrated in Figure 19. The dotted line Y3 represents the end of the construction period with the benefits then being first realised at Y5assuming a two year lag in construction. The economic analysis has been undertaken up until Y20. The benefits are a linear relationship as the annual benefits are $34.8 million as discussed in the following section.

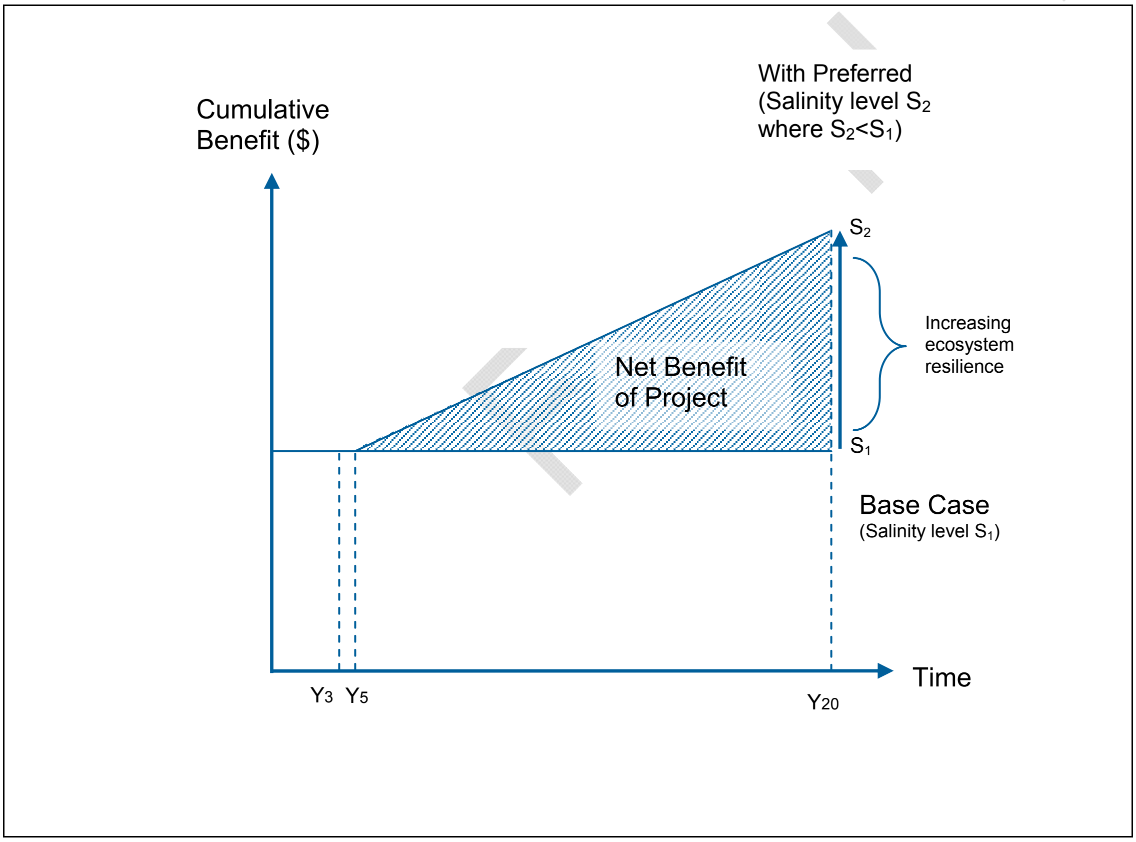

Figure 19. Net Benefit – 'With and without project'

In the absence of a dedicated study to estimate in dollar terms the benefits of the SEFRP using one of the non-market valuation techniques described in Non-market Valuation Techniques the approach used was to apply the results of a previous study and estimates of contingent values to derive an estimate of the value of the increased resilience of the Coorong to drought and the resulting impact on ecosystem health as a result of the SEFRP.

The primary study used for this purpose was a recent report by Hatton MacDonald *et al.* (2011), who used choice modelling to value improvements in water quality in the

Murray River and the Coorong. The decline in the River Murray and Coorong have been impacted by drought, irrigation reducing water available for the environment, dams disrupting the natural flow of water, competition from non-native species and land clearing. Funding for the research in the Hatton MacDonald *et al.* (2011) paper was provided by the CSIRO Water for a Healthy Country Flagship Research Program. The Flagship Research Program aims to provide Australians with solutions for water resource management, creating economic gains while protecting or restoring major water ecosystems.

The Hatton Macdonald *et al.* research focuses on four key River Murray environmental indicators:

- Frequency of water bird breeding along the River Murray
- Increasing native fish populations in the River Murray
- Increasing the area of healthy vegetation along the River Murray
- Restoring the water bird habitat in the Coorong

The survey questionnaire was designed to elicit willingness to pay for improvements in environmental quality, including in the Coorong. Respondents were provided with an information sheet that provided further detail of changes to each of the four environmental indicators. Photographs representing each of these indicators were included on the information sheet and the selection of photographs was guided by the focus groups. Respondents were told about ways that the quality of the Murray River and the Coorong could be improved, including the government purchasing water from irrigators, the government providing incentives to increase irrigation efficiency, habitat rehabilitation and engineering works. Respondents were also told each option had an annual household cost that would be paid each year for a 10 year period through increased taxes and higher prices for food. The survey was conducted Australia-wide and attracted over 3,000 responses.

Hatton MacDonald *et al*. (2011) used a panel multinomial logit error components (EC)[2] model to estimate household willingness to pay for the packages of environmental improvements proposed. The results showed the household willingness to pay each year for 10 years (the implicit price[3]) for improved waterbird habitat in the Coorong ranged from [redacted] in Victoria to [redacted] in the ACT. Table 14 highlights the willingness to pay for water bird habitat in the Coorong from respondents around Australia.

[2] The use of EC models is fairly common in the environmental economics literature where they have been used to test differences in error variances across subsets of alternatives (see Scarpa et al. 2008 for details of this approach)

[3] Implicit prices were calculated by dividing the coefficient for a given attribute by the negative of the coefficient for the cost variable in the estimated choice model.

Table 14. Implicit prices – household willingness to pay each year for 10 years

State	NSW	ACT	Victoria	SA	Rest of Australia
Waterbird breeding	[redacted]				
Native fish					
Healthy vegetation					
Waterbird habitat in the Coorong					

The aggregate willingness to pay to improve the habitat in the Coorong from poor to good totalled [redacted] at a real discount rate of 5 per cent[4]. The choice modelling study undertaken by Hatton Macdonald *et al.* (2011) demonstrates that there is a willingness by communities to pay 'substantial amounts to increase environmental flows and improve the quality of the Murray River and Coorong.' The following table shows the aggregate value to improve the Coorong from poor to good habitat using a discount rate of 5 per cent and an assumption that non-respondents have zero willingness to pay. The aggregation of these values to improve the Coorong from poor to good habitat is $5.8bn.

Table 15. Aggregate value by state for improvements to Coorong from poor to good

	NSW	ACT	Victoria	South Australia	Rest of Australia	Total
Improve Coorong from poor to good habitat	[redacted]					

Hatton MacDonald *et al.* justify the higher implicit prices and aggregate values they obtain in this study by attributing them to three factors, which include:

1. The unique ecological, historical and cultural importance of the River Murray and the Coorong for Australians;

[4] This result assumes that non-respondents had a zero willingness to pay. Morrison (2010) discusses alternative assumptions regarding the preferences of non-respondents.

2. Their research includes multiple year payments that may be more realistic and are examples of levies that occur over multiple years where as earlier choice modelling studies have used a one-off payment scenario; and

3. Increasing public awareness of the severe environmental degradation of the River Murray and Coorong.

Because the SEFRP is only one of a number of Commonwealth and State initiatives aimed at improving water quality in the Coorong, it was assumed in this CBA that only 10 per cent of this value should be ascribed to the SEFRP. Therefore, estimated total value of improvements to the Coorong environment (the benefit of the project) used in this analysis is [redacted]. The [redacted] was converted to an annual benefit of [redacted] per year and then discounted using a real rate of 6 per cent.

It was assumed that the benefits of the project would be realised two years after completion of construction, which is estimated to take around four years. Sensitivity analysis around the lag time in which benefits will be achieved is discussed further in Sensitivity Analysis.

In the absence of this project, Ruppia restoration activities in the South Lagoon would need to be carried out at regular intervals as any environmental benefit achieved from previous investments would be eroded as salinity levels move beyond the target range. The SEFRP will protect future investments in Ruppia restoration activities, as by maintaining salinity levels at S_2 over a 20 year period, only an initial investment in these activities will need to be carried out once managed flows are realised. Hatton Macdonald *et al.* (2011) note that 'hypersalinity in parts of the Coorong has reduced the main food source (Ruppia) for migratory waterbirds' with the consequence being the collapse in bird numbers.

9.3. Results

NPV and BCR

The results of the CBA, shown in Table 16, show a NPV for the SEFRP of [redacted] over the 20 year timeframe of the analysis. The corresponding BCR is [redacted] This result indicates that the SEFRP yields a positive economic benefit and warrants funding.

Table 16. NPV and BCR

	Present value benefits	Present value costs	Net present value	Benefit-cost ratio
SEFRP	[redacted]			

Sensitivity analysis

A sensitivity analysis was undertaken to test the robustness of the results to changes in two key assumptions in the CBA that were subject to uncertainty. These were:

- There would be a two-year time lag following construction before this improvement would be achieved
- The SEFRP would contribute to a 10 per cent improvement in the habitat of the Coorong

The sensitivity analysis examined the impact on the NPV and BCR of changing the lead time from two years to five years and ten years. This is illustrated in Figure 20.

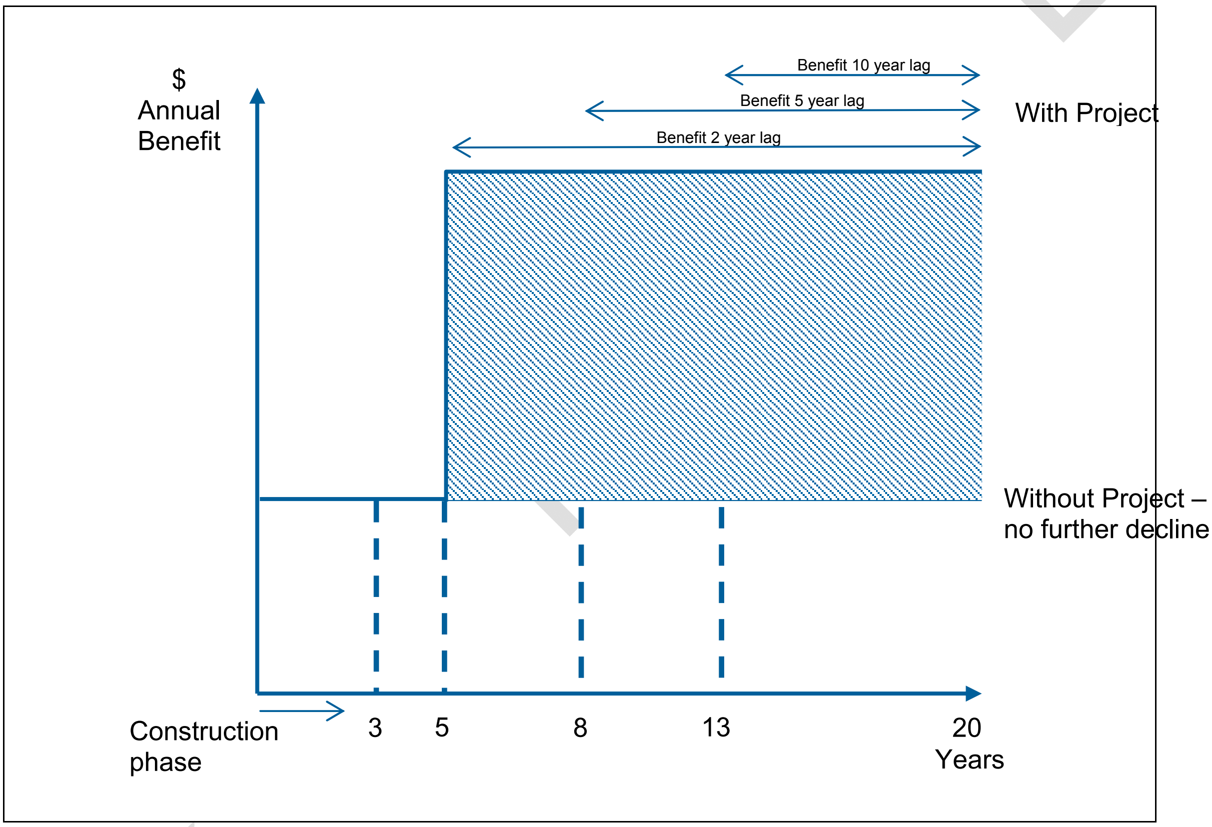

Figure 20. Environmental benefit lag

The results of the sensitivity analysis are shown in Table 17 and illustrated in Figure 20. The results are relatively insensitive to changes in these assumptions. Table 18 highlights the sensitivities associated with adjusting the percentage benefits attributed with an improvement in the habitat of the Coorong from 10 per cent to 7.5 per cent, 5 per cent, 12.5 per cent and 15 per cent) assuming the benefits will be realised two years after construction.

Table 17. Sensitivity analysis for time lag before benefits are realised after construction

	NPV	BCR
2 year lag	[redacted]	
5 year lag		
10 year lag		

Table 18. Sensitivity analysis for benefits from Coorong (%) realised 2 years after construction

Scenario	Benefit from Coorong	NPV	BCR
1	[redacted]		
2			
3			
4			
5			

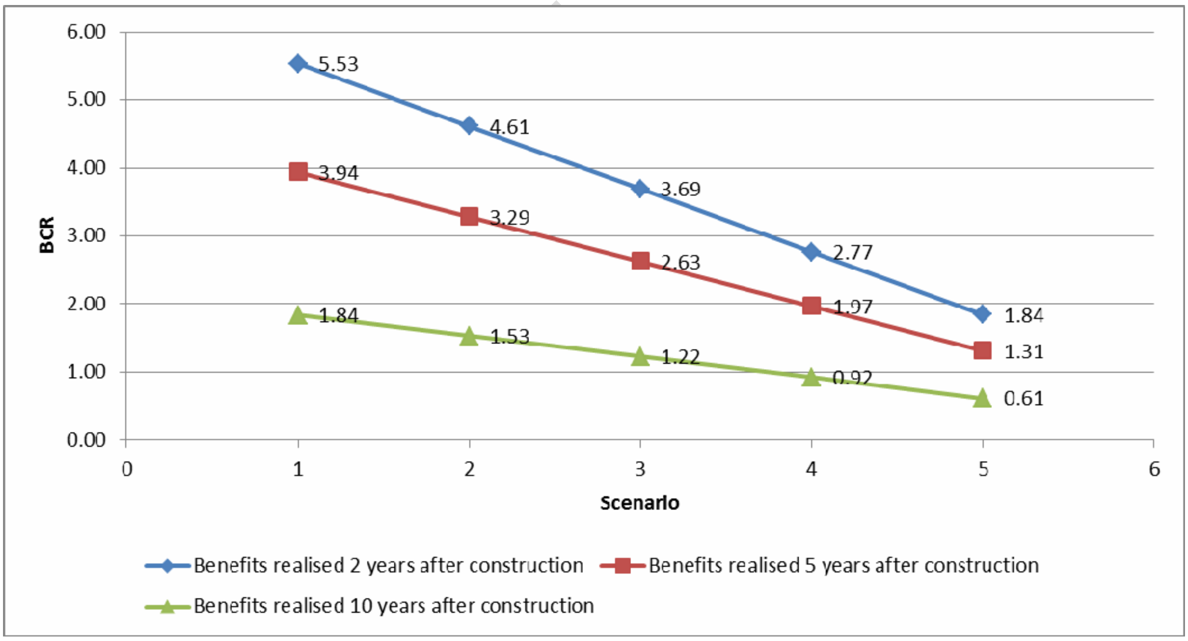

Figure 21. Sensitivity analysis

Figure 21 shows the effect that the delay of the construction period will have on the BCR of the SEFRP. If the environmental benefits are not realised for 2, 5 or 10 years after the completion of construction this decreases the BCR. For example for Scenario 3, attributing 10 per cent of the benefits from the study and if the benefits are realised 2 years after the construction period the corresponding BCR is 3.69, where if the benefits are realised 5 years after construction the BCR decreases to 2.63. Importantly, however, the BCR only falls below 1 if there is a 10 year time lag under Scenarios 4 and 5 (benefits realised 10 years after construction).

A horizontal shift along the lines represents a change in the contribution to habitat improvement while holding the time lag constant. Under the preferred option (scenario 3), if the change in the contribution to habitat improvement changes from 10 per cent to 5 per cent then the BCR decreases from 3.69 to 1.84 (assuming a 2 year time lag).

Sensitivity analysis was also undertaken for discount rates of 4 and 10 per cent and this was found to have little impact on the magnitude of the BCR and NPV for this project.

10. Value for Money

Both this section and Section 9 discuss the value and benefits of the SEFRP from a financial and economic perspective. However, it is important to note that choosing to not progress the SEFRP (i.e. a do nothing option) is not without costs and risks to the environment.

A Do Nothing Option would maintain the existing status quo, namely:

- The Coorong South Lagoon will remain exposed to the increased risk of ecological decline due to the impact of increased salinity (Ruppia stocks and hence all of the species that depend upon it can decline rapidly once salinity levels exceed its tolerance level) whenever there is a reduction in River Murray flows. Such events are still likely to occur until the implementation of the Basin Plan is complete and furthermore may occur beyond this time frame in times of drought.
- Approximately 20-25 GL per year that flow out to sea from the Blackford Drain will continue to do so and will continue to cause damage to near shore seagrass ecosystems, in Lacapede Bay (Kingston).

Economic & Social Benefits

The purpose of the SEFRP is to help maintain Coorong South Lagoon salinity within the target range for ecosystem health in the long-term through reducing and maintaining these salinity levels within the target range, mitigating the impact of sporadic flooding events and helping restore the south-east region to a more natural flow regime. The economic and social benefits of the SEFRP will be realised in both the South East and CLLMM regions.

In the South East, short term benefits from the SEFRP will occur as a direct result of the construction activities proposed. In addition to works actually taken up by local contractors, it is assumed that throughout the three years of the construction of the SEFRP the construction contractors will be based in the region. This will create a flow-on effect caused by the spending of construction firms and their employees in the local economy. Healthier *en route* wetlands are similarly expected to positively impact tourism.

In the longer term the CLLMM region will benefit, albeit indirectly, from the improved state of the Coorong. This project will result in other investment in the region as there will be more certainty around flow regimes. There is likely to be an associated increase in visitor numbers as the Coorong ecosystem is recognised nationally and internationally for its physical and biological diversity, in particular the abundance and diversity of it waterbirds.

The Coorong and Lower Lakes is designated as among the six most significant ecological assets under the Murray-Darling Basin Commission's Living Murray initiative (Rolfe and Dyack 2011) and is an internationally important Ramsar wetland for bird migration, feeding and breeding (Phillips and Muller 2006). This site is also an important recreation site, with visitor spending helping to contribute to the regional economies (Rolfe and Dyack 2011). In their study, Rolfe and Dyack (2011) estimated recreational values associated with the Coorong using a travel cost method to be $242.08 per adult visit. They then extrapolated this to 126,000 visitors per annum to estimate the value of recreation at the Coorong and surrounding area to be $30.5 million per annum. Given the ecological and recreational value of the Coorong it is considered appropriate to count the values placed on the Coorong by households, nation-wide. The investment in the SEFRP will continue to promote tourism in the region and attract visitors to this internationally recognised wetland.

MDBA commissioned CSIRO *et al.* (2012) to identify and qualify the ecological and ecosystem service benefits that are likely to arise under 2800 GL scenario for the Basin Plan. This report found that under the 2800 scenario that there is a 'strong positive relationship between adjusted overnight trips and lake level in the Lower Lakes and Coorong region' and that tourism will respond positively to higher river flows and lake levels. Even though this study is to examine the benefits that would occur under the Basin Plan, it demonstrates the benefits that would accrue from higher river flows and the subsequent benefits arising from tourism. Any increase in visitor numbers is likely to result in an increase local expenditure (e.g. for fuel, accommodation etc). However, It is not expected that over the 30 years of projected benefits that there will be any long-term regional employment creation.

11. Financial Viability

Operations & Maintenance

The SEFRP alignment mostly follows the Tilley Swamp Drain and Taratap Drain that were constructed in 2000 and 2006 respectively. Maintenance and operational issues have been observed throughout most of the period since construction. As a consequence, the design criteria have been developed in the following way:

- Channel erosion: areas have been identified and appropriate side slope gradients for the channel applied to reduce erosion and sediment mobilisation;
- Spoil erosion: the successful "trafficable" and rehabilitated spoil profiling approach used with more recent construction works in the project area has been applied to all constructed sites to significantly improve access and reduce erosion;
- Infrastructure degradation: past regulators utilised a combination of galvanised steel, aluminium and timber with a resultant 5-10 year life – all design equivalent infrastructure incorporated is constructed of marine grade aluminium with an expected design life of 30 – 50 years; and
- Infrastructure operation: design features ensure that all OHS&W requirements are met and infrastructure can be operated by one person (unlike similar existing structures that generally require two). New designs enable a "set and forget" approach to operation in many cases rather than intensive attendance as is currently required.

Considerable effort has been made to reduce ongoing operation and maintenance costs during the design phase.

It is considered that operating costs should not be greater than that currently associated with the operation of the existing system. While a small increase in the amount of infrastructure requiring operation is proposed with the SEFRP, the efficiency of the new designs and improved access is likely to offset the increase.

Annual Costs

Annual maintenance costs have been estimated from data supplied to KBR by the SEWCDB (2009) and upgraded by DEWNR in consultation with the SEWCDB to reflect more recent maintenance issues. The estimates provided by SEWCDB (2009) were based upon long-term averages (30 years) for works undertaken by them through management of over 2,000 km of drains and for a 50 m wide shallow floodway as was the approach undertaken for the project at that time. More recent observations of works completed in the project area have upgraded the estimated maintenance cost to reflect the changed channel geometry of the SEFRP.

Annual channel maintenance costs are estimated as follows:

- Channel capacity ≥ 1,000 ML/day: [redacted]
- Channel capacity ≥500 ML/day: [redacted]
- Channel capacity < 500 ML/day: [redacted]

With the improved channel design, maintenance requirements in the first 10 years are anticipated to be minimal. Thereafter, those sections in less stable soils will progressively require maintenance but other more stable areas may not require any maintenance for 20 years.

The channel maintenance costs allow for minor works at culvert and other infrastructure locations.

The annual Operating and Maintenance cost for the SEFRP channel is estimated at [redacted] per annum. This is composed of two components:

- An operational cost of [redacted] for the SEFRP Channel (Salt Creek to Blackford Drain) as a contribution to the annual on-cost of operating and maintaining the entire South East Drainage Network [redacted] per annum); and
- A [redacted] annuity for the replacement of all newly constructed infrastructure based on a 4 per cent interest above CPI on $[redacted] with average asset life of 50 years.

Given that 87 per cent of the SEFRP will replace existing drainage channels with new, lower maintenance infrastructure, it is effectively cost neutral with respect to ongoing operations and maintenance.

Ongoing Management

The State of South Australia is responsible for managing the South East Drainage Network (drains, wetlands and environmental assets) of the Upper and Lower South East. The replacement value of the total assets is in the order of [redacted]. As discussed previously, it is anticipated that the SEWCDB Board, or its successor board under the SEDSOM Bill 2012, will be the relevant managing authority once construction is complete. In either scenario the relevant authority is a statutory entity with a legislated mandate to operate the South East Drainage Network.

12. Risk Assessment

SEFRP – Risk Assessment

A comprehensive analysis of project risks has been conducted in accordance with the Australian/New Zealand Standard (AS/NZS 4360:2004).

Internal risk review workshops were held in October 2012 to identify all material risks relating to the implementation of the project.

At the workshops the risk areas, risks, causes, and consequences were identified. Ratings were given to the likelihood and consequence which resulted in an overall risk rating. Mitigation measures were then considered and the likelihood and consequence ratings re-evaluated in the context of these mitigation strategies.

The risks were evaluated using the DEWNR risk evaluation matrix shown in Figure 22.

Consequence					
5 Extreme	5	10	15	20	25
4 Major	4	8	12	16	20
3 Moderate	3	6	9	12	15
2 Minor	2	4	6	8	10
1 Insignificant	1	2	3	4	5
	A Rare	B Unlikely	C Possible	D Likely	E Almost Certain
	Likelihood				

Red	Extreme Risk
Yellow	High Risk
Green	Moderate Risk
Blue	Low Risk

Figure 22: DEWNR risk evaluation matrix shown

Risk Register

All risks are documented in a project risk register which is included in Appendix C. The project risk register is a 'live' document that will be maintained throughout project. planning and delivery. The risk register is categorised under the following areas:

- Design;
- Environment;
- Financial;
- Human Resources;

- Stakeholder Relations;
- Political;
- Strategic and Legal;
- Operations;
- Natural Resources; and
- Heritage Clearance.

A total of 73 risks have been identified for the SEFRP. The most notable SEFRP risks are identified in Table 19. The complete risk register is presented in Appendix C.

Risk Allocation

The allocation of risk primarily remains with the proponent (DEWNR) in South Australia, the SEWCDB and the SE NRM Board. The risks will be managed throughout the planning, design, integration and deployment phases of the project to achieve stakeholder approval, planning and to ensure other requirements are properly met.

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Table 19: Key risks rated high after mitigation

Risk Area	Risk Issue	Causes	Likelihood	Consequences	Consequence Level	Risk Rating	Mitigation Measures	Likelihood	Consequences	Risk Rating	Responsibility
Financial	Inability to deliver project within budget	Compounding impact of CPI increases and project delays on costs associated with construction and human resources	C	Increased costs, longer delivery timeframes	5	15	Robust project management processes in place. Seek approval from the Commonwealth to access interest earned on the project.	C	4	12	DEWNR Project Team
Legal	Difficulties gaining access to private land and associated issue of investing in infrastructure on private land.	USE Act which had favourable land acquisition powers has expired. Direct approach to landholders fails to achieve 100% of required land.	C	Inability to deliver project without protracted legal processes and increased costs.	5	15	Early engagement of government and private landowners, Aboriginal communities; provide regular communication to stakeholders at state and project level.	B	5	10	DEWNR Project Team

13. Governance Arrangements

Purpose of Governance Arrangements

The Due Diligence criteria state that the project must have 'Appropriate governance arrangements for the project to ensure it delivers on time, within budget and against all key objectives'.

The project governance arrangements for the SEFRP will ensure that:

- Accountability for delivery rests with a single organisation and is clear and transparent;
- Clear, relevant and timely communication across the project, between the Australian Government, the South Australian Government, Indigenous groups, other key stakeholders and the community;
- Alignment with Australian and South Australian Government objectives and priorities;
- Sound and responsible financial management over the life of the project;
- Identification and mitigation of risks throughout the life of the project;
- Sound scientific and technical information is gathered and used; and
- Value for money is delivered.

CLLMM Recovery Project Governance Structure

The SEFRP Phase 2, as set out in this Business Case, will form a revised Attachment to the CLLMM Recovery Project Schedule SA-07, and be managed consistent with all other CLLMM Recovery Project management actions, with activities managed through an annual workplan and bi-annual progress reporting process.

On this basis, the SEFRP will be managed under the existing CLLMM Recovery Project governance structure, as set out in the CLLMM Recovery Project Charter. The CLLMM Recovery Project Charter has been agreed by the Assistant Secretary Aquatic Systems Policy Branch, SEWPaC, and the Group Executive Director, Partnerships & Stewardship, DEWNR, to facilitate the parties' working relationship and provide operational guidelines for this Priority Project.

The governance structure is designed to ensure transparency and accountability at all levels of decision-making.

Inter-jurisdictional Governance

CLLMM Governance Committee

The CLLMM Governance Committee provides a high level consultative forum to discuss strategic issues that affect the CLLMM Recovery Project. Membership consists of senior executives from SEWPaC and DEWNR. Meetings are scheduled to take place twice yearly.

CLLMM Working Group

The CLLMM Working Group informs the CLLMM Governance Committee, and provides a productive and efficient working relationship, at an officer-level. CLLMM Working Group meetings are scheduled to take place quarterly, and address:

- progress of Management Actions;
- South Australia's draft Workplans;
- draft progress reports;
- any issues intended to be raised at the CLLMM Governance Committee; and
- any potential issues at an officer level.

Frequent informal discussions between the Australian and South Australian Governments will ensure Australian Government Officials remain informed between Working Group Meetings.

South Australian Governance

It is proposed that the established CLLMM Recovery Project governance processes be followed for the SEFRP, with increased regional linkages to the SE NRM Board and the SEWCDB, and the addition of a SEFRP Steering Committee.

Chief Executives Natural Resource Management Group (CEs NRM Group)

The Chief Executives NRM Group coordinates whole-of-government policy and strategy for the effective management of natural resources in South Australia. It agrees upon relevant strategies consistent with the State NRM Plan to resolve significant issues relating to the management of natural resources and the NRM system. It coordinates and agrees upon the State's position on major NRM policy matters including matters considered in national forums.

The CEs NRM Group will consider reports from the CLLMM Steering Committee as needed.

CLLMM Steering Committee

The CLLMM Steering Committee reviews progress of the CLLMM Recovery Project and provide high level cross-agency advice and endorsement on planning, operational delivery, integration and general Project matters to the Program Manager, Major Projects.

CLLMM Project Sponsor

The Group Executive Director, Partnerships and Stewardship is the Project Sponsor and is responsible for key project decisions and delivery of project outcomes. The Project Sponsor is the primary conduit between the CLLMM Recovery Project and the Chief Executive and Minister. The Project Sponsor is Chair of the CLLMM Steering Committee.

Program Manager, Major Projects

Acting as delegate for the Project Sponsor, the Program Manager, Major Projects has operational responsibility for the implementation of the CLLMM Recovery Project as well as corporate DEWNR responsibilities. Considering outputs from the CLLMM Management Team and the Project Control Group, the Program Manager, Major Projects will make decisions on which matters are referred to the CLLMM Steering Committee (through the Project Sponsor).

CLLMM Management Team

The CLLMM Management Team has been established to guide, monitor and manage effective people, business and corporate needs for the delivery of the CLLMM Recovery Project. It provides advice, guidance and direction for the implementation and conduct of the CLLMM Recovery Project's people, business and corporate activities, and acts as a forum for the discussion and analysis of issues and risks arising, including the escalation of matters as appropriate.

The CLLMM Recovery Project Control Group (PCG) is a sub-group of the CLLMM Management Team established to provide operational direction for the implementation and conduct of the CLLMM Recovery Project's project management activities. The PCG provides advice and direction to project managers on all aspects of project management and delivery, in accordance with the DEWNR Project Management Framework.

CLLMM Community Advisory Panel

The CLLMM Community Advisory Panel (CAP) is established as a voluntary, non-statutory, community-based advisory body. It provides input by working with DEWNR to facilitate the exchange of information for the development and implementation of CLLMM Recovery Project management actions and The Living Murray (TLM) Icon Site program.

KNYA Taskforce

The KNYA Taskforce was established to support coordinated State Government engagement with the Ngarrindjeri Nation under the terms of the Kungun Ngarrindjeri Yunnan Agreement, 2009. The monthly meetings provide a forum for information sharing, and consultation.

SEFRP Governance

The following will provide for SEFRP specific governance:

SEFRP Steering Committee

A SEFRP Steering Committee will be established to provide strategic and operational direction to the project team to ensure project outcomes are met. Membership from the SE NRM Region and the SEWCDB will ensure that operational procedures are appropriate and transition from project completion to ongoing operation is managed effectively.

The South East Natural Resources Management Board

The SE NRM Board is a legal entity established under the *Natural Resources Management Act (2004)* (the NRM Act) with membership from community and representation from relevant Government Agencies. The functions of the regional NRM board under section 29 of the NRM Act include:

- Take an active role for the management of natural resources within its region;
- Prepare, implement and review a Regional NRM plan;
- Provide advice with respect to the assessment of various activities or proposals referred to the Board under the NRM or any other Act; and
- Promote public awareness and understanding of the importance of integrated and sustainable NRM.

South Eastern Water Conservation and Drainage Board

The SEWCDB has a long history of local and regional management of flooding, surface water and drainage in the South East, and the first South Eastern Drainage Act was passed by Parliament in 1875.

Until 1992, the function of the South Eastern Drainage Board was to provide a drainage system to better agricultural productivity. In 1992, the current *South Eastern Water Conservation and Drainage Act 1992* was enacted, increasing the statutory responsibility of the Board to include water conservation, and broader ecosystem management.

Under the *South Eastern Water Conservation and Drainage Act 1992*, the Board has the following functions and obligations:

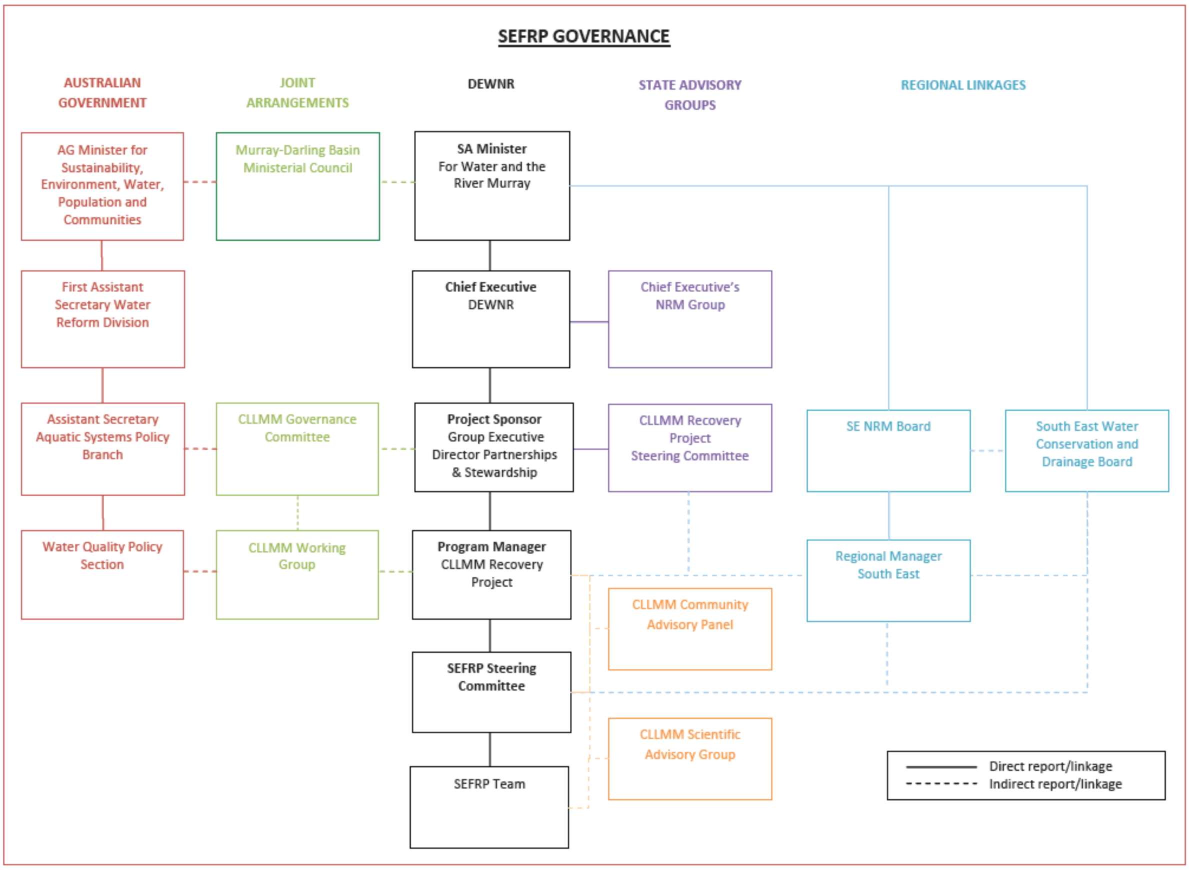
- to provide an effective and efficient system for managing the surface water of the non-urban lands in the South East, by conserving, draining, altering the flow of or utilising that water in any manner;
- to carry out works for the purpose of lowering the level of the water table of lands in the South East;

- to undertake, assist or promote research in the fields of water conservation, drainage and management;
- to give advice and assistance to others in the fields of water conservation, drainage and management; and
- the enhancement or development of natural wetlands and the natural environment generally in the South East.

The current SEWCDB has been fully briefed regarding the SEFRP proposal and will be fully engaged throughout the delivery of the SEFRP.

SEAFG

The South East Aboriginal Focus Group was established in 2005 to support South East Aboriginal families engaging in natural resource management. The SEAFG is supported by funding from the SE NRM Board, and it acts as the primary forum for the NRM Board to engage with the SE Aboriginal community.



Future Governance for Ongoing Management

It is anticipated that the future governance, operation and maintenance arrangements will be legislated via the South East Drainage System Operation and Management (SEDSOM) Bill 2012, which was introduced into Parliament on 31 October 2012. The Bill proposes that the

SE NRM Board will be responsible for setting the strategic direction for the management of water in the drainage system, wetlands and watercourses in the South East through the preparation of a South East Drainage and Wetland Management Strategy.

The Strategy will provide guidance and direction to:

- The South Eastern Drainage Management (SEDM) Board on the management of water in the drainage system, including flow management objectives and performance standards within an adaptive management framework; and
- Other persons or bodies (which may include the SEDM Board) to whom responsibility for the management of wetlands and watercourses is assigned.

The Strategy will complement the SE NRM Board's regional NRM Plan and must be consistent with the State NRM Plan. This role is seen to be complementary to the Board's existing role under the NRM Act for water resource planning and management.

The SEDM Board will be responsible for managing the drainage system to meet multiple objectives including protecting infrastructure from flooding, providing water for the environment, and protecting and enhancing agricultural lands, in accordance with the Strategy.

The SEDM Board will be responsible for general drainage maintenance (e.g. repair and cleaning of entire 2589 km of drainage system and floodways which exist across the South East), and the operation of regulating structures to manage water flows. The SEDM Board may also be responsible for managing wetlands and watercourses in the South East, if assigned to do so under the Strategy.

The collective skills, knowledge and experience proposed for SEDM Board membership reflects this broad purpose including the business acumen essential to undertake robust business planning processes and implement aspects of the Strategy for which the Board is responsible

14. Stakeholder Engagement

Following on from the extensive communication and engagement undertaken in Phase 1, the SE NRM Board has now indicated their willingness (in advance of legislative responsibilities which result from the SEDSOM Bill) to oversee the development and delivery of a Communications and Engagement Strategy, for implementation by the project team. The project will provide resources and support to the SE NRM Board to develop a Communications Strategy which will meet community expectations and information needs.

The SE NRM Board will be supported by the project to develop a Communications and Engagement Strategy which:

- Aligns with the IAP2 Spectrum of Public Participation to deliver best practice communications and engagement outcomes;
- Ensures adequate liaison and involvement with the CLLMM CAP to maximise the opportunities for collaboration and communication between community structures involved in natural resources management in the region;
- Ensures adequate liaison and involvement with the SEWCDB (and future SEDM Board) which improves and increases community ownership of project outcomes;
- Works closely with communities of interest to ensure that the benefits of the drainage network are known and understood by the citizens in the region
    - Specifically; Local Government (including Local Action Planning Groups) , Regional Development Australia, Natural Resources Management Groups, Community Groups (e.g. Threatened Species Network, Field Naturalists);
- Maximises opportunities for communities of interest to participate in native vegetation restoration;
- Ensures maximum opportunities for Aboriginal Engagement (see Traditional Owner Engagement Strategy). The broader Communications and Engagement Strategy will recognise that there are other aboriginal communities of interest and ensure they are adequately engaged with;
- Provides dedicated resources for:
    - Support and liaison for and between relevant community structures (SEWCDB, SE NRM Board and CLLMM CAP) to highlight synergies and realise opportunities for increased communication and collaboration;

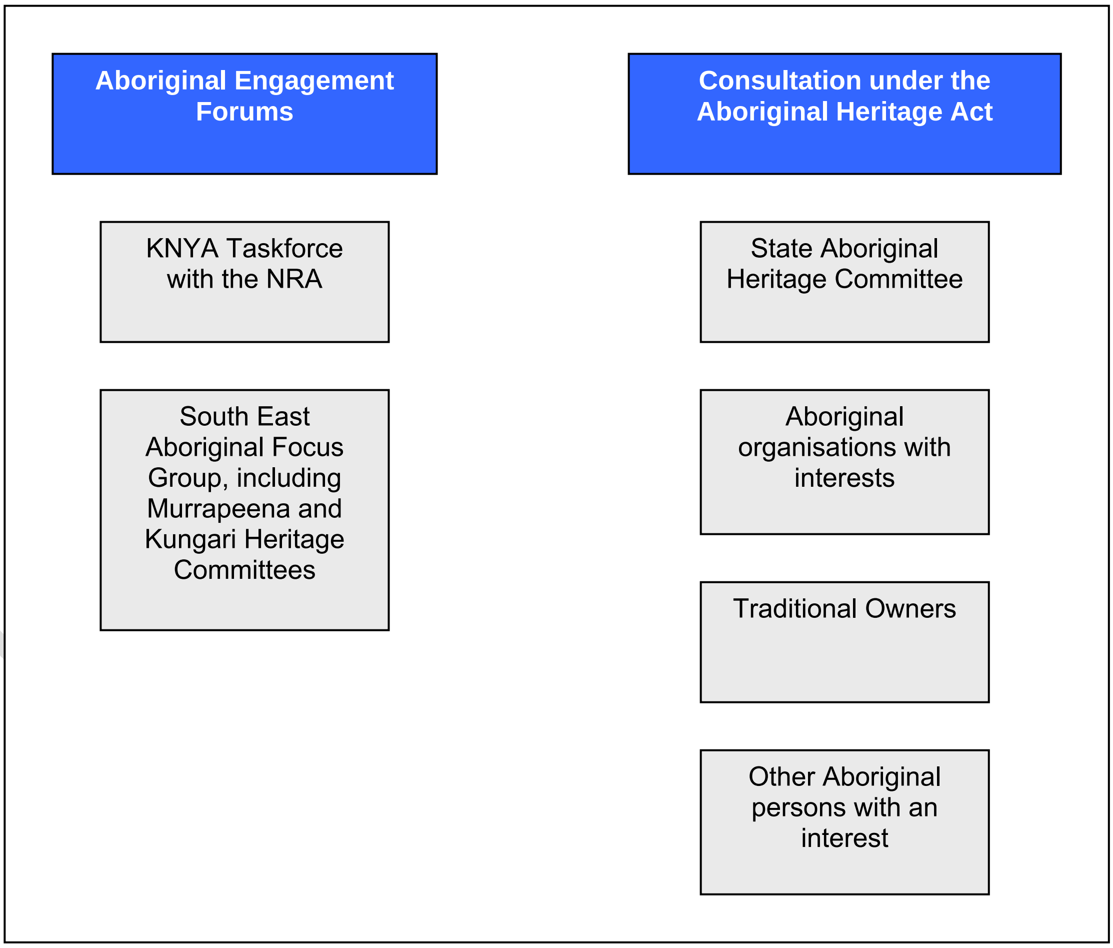
- Maximising and supporting traditional owner involvement and cultural partnerships;
- A series of community workshops which improve community understanding and involvement in the project; and
- A series of communications (fact sheets, media releases, newsletters) which provide a regular flow of information to the broader community regarding the scope, benefits and progress of the project, including promotion of the various initiatives and activities, but specifically designed to increase community involvement in project outcomes – e.g. native vegetation restoration.

15. Traditional Owner Engagement Strategy

Traditional Owner engagement has been incorporated as a critical component of the feasibility investigations for the SEFRP. The State Government has been discussing the Project with the NRA and the SEAFG, including the Murrapeena Heritage Committee, project since 2008.

The SEFRP offers a range of direct and indirect opportunities for Traditional owner participation and engagement. Direct opportunities include heritage survey, heritage monitoring and advice on culturally appropriate operations at *en route* wetlands. Indirect opportunities, including sub-contracted fencing or water quality monitoring for example, will be available but subject to South Australian Government's procurement processes.

The diagram below demonstrates the engagement and consultation components of the SEFRP with Traditional Owners and Aboriginal peoples with interest in the Project.



In 2008, the NRA, SEAFG, and Murrapeena Heritage Committee requested the NRA's Research, Policy and Planning Unit (RPPU), based at Flinders University, to support them in clarifying their position on the SEFRP to Government. The SA MDB NRM Board, on behalf of the former Department of Water, Land and Biodiversity Conservation (DWLBC), contracted the NRA RPPU to develop an Aboriginal nation position paper on the project. The NRA RPPU's 2008 report (Hemming and Rigney 2008b) provided in-principle support for the projects fundamental intention to redirect water back through historical flow-paths to the Coorong (Kurangk). Through consultation with the NRA, Murrapeena Heritage Committee and SEAFG, the NRA RPPU developed a proposed engagement strategy for the project, comprising principles, opportunities, and issues to be addressed.

More recently, the NRA has prepared material for the direct inclusion into this document, as indicated in relevant sections. The SEAFG have prepared a revised Position Paper on the Project (Watson 2012), sections of which have also been included in this document where indicated.

Ngarrindjeri

The following provides a summary, directly provided by the NRA, of the fundamental principles informing the proposed NRA engagement strategy for the Project, which are still supported by NRA:

- NRA should be a formal part of the project at all levels – conception, research, planning, inception and management and evaluation;
- Ngarrindjeri engagement requires informed decision-making and this requires appropriate resources flowing to regional Aboriginal organisations;
- A Ngarrindjeri/Aboriginal management plan should be developed in association with the Project as part of the Government's NRM process;
- Recognition and facilitation of the fundamental connection between NRM/Water management projects, cultural heritage, education, economic development, and capacity building;
- Engagement in government programs must benefit Aboriginal organisations, not be a drain on resources and this issue reviewed regularly;
- Formal protection of intellectual property and cultural knowledge is required;
- All research projects should include appropriate ethics clearances; and,
- A Kungun Ngarrindjeri Yunnan Agreement is required to ensure all the core principles of engagement and partnership are understood and secured.

NRA holds to their commitment to work collaboratively with the SEAFG on the Project and as per their customary responsibilities.

South East Aboriginal People

Note: The aspirations of the South East Aboriginal Community expressed in this section are those directly provided by the SEAFGs Position Paper on the SEFRP (Watson 2012).

This paper supports a position which will provide for the greatest representation and inclusion of Aboriginal Peoples who have a traditional connection to the Coorong and South East region. In particular it is recommended that there be involvement in the research, planning implementation and long term management of the project.

It is recommended that the SEAFG along with representatives from all Aboriginal Peoples with traditional connections to the region develop a strategy to secure employment opportunities arising out of the implementation of the SE Flows Restoration – Project Plan, 2012. Employment opportunities considered should go beyond heritage surveys and monitoring of work, to include employment at every stage and phase of the project's development and on-going management.

It is essential that the SEAFG and broader Aboriginal Peoples representatives be involved in providing advice on all matters concerning the environment and the cultural concerns that are likely to be impacted by the project, from the initial planning stages of the project, through to its conclusion. The inclusion and representation of Aboriginal peoples should comply with Article 18 of the UNDRIP as follows:

- Indigenous peoples have the right to participate in decision-making in matters which would affect their rights, through representatives chosen by themselves in accordance with their own procedures, as well as maintain and develop their own indigenous decision-making institutions.
- In considering Aboriginal procedures and Aboriginal decision-making institutions the inclusion of the Tanganekald, Meintangk and Bungditj peoples is essential to the development of a model of engagement and decision making.

Out of concern for equitable negotiations and arrangements the UNDRIP at Article 32 sets out how those engagements might be established as follows:

- Indigenous peoples have the right to determine and develop priorities and strategies for the development or use of their lands or territories and other resources.
- States shall consult and cooperate in good faith with the indigenous peoples concerned through their own representative institutions in order to obtain their free and informed consent prior to the approval of any project affecting their lands or territories and other resources, particularly in connection with the development, utilization or exploitation of mineral, water or other resources.
- States shall provide effective mechanisms for just and fair redress for any such activities, and appropriate measures shall be taken to mitigate adverse environmental, economic, social, cultural or spiritual impact.

Article 32 outlines minimum standards to be observed in any project consultations that impact upon Aboriginal ruwe. It is recommended that the SEAFG work to ensure that at all stages of the project the Tanganekald, Meintangk and Bunganditj Peoples are included and represented to engage with this project as follows*:*

- Represented on any management or project committee

- Are involved in all future consultations to ensure that the project progresses in an inclusive and ethical direction
- Ongoing reporting to the SEAFG
- The opportunity to read and comment on draft reports
- To advise on employment opportunities for Aboriginal Peoples as traditional owners and where the opportunities arise.

16. Recommendations

The SEFRP will use a combination of natural watercourses, newly constructed floodways and existing drains to divert water currently flowing out to sea through the Blackford Drain in the Upper South East into the Coorong South Lagoon.

This SEFRP Business Case has been prepared following an extensive period of technical investigations into the feasibility, costs and benefits of the project (Phase 1), funded as part of the CLLMM Recovery Project.

Based on the best available knowledge, this Business Case summarises the findings of the feasibility investigations and community consultation, and provides a detailed justification for implementation of Phase 2, consistent with Australian Government Water for the Future State Priority Project investment principles and due diligence criteria (Water for the Future Basin State Priority Projects: Business Case Information Requirements).

The project presented in this Business Case can be designed, constructed and operated to provide substantive and demonstrable long-term environmental outcomes for the Coorong South Lagoon and en route wetlands through the reinstatement of a more natural South East flow path.

It is recommended that the Commonwealth, following due diligence assessment, supports Phase 2 of the SEFRP as presented in this Business Case and approves a variation to the CLLMM Project Schedule that enables implementation from 1 July 2013.

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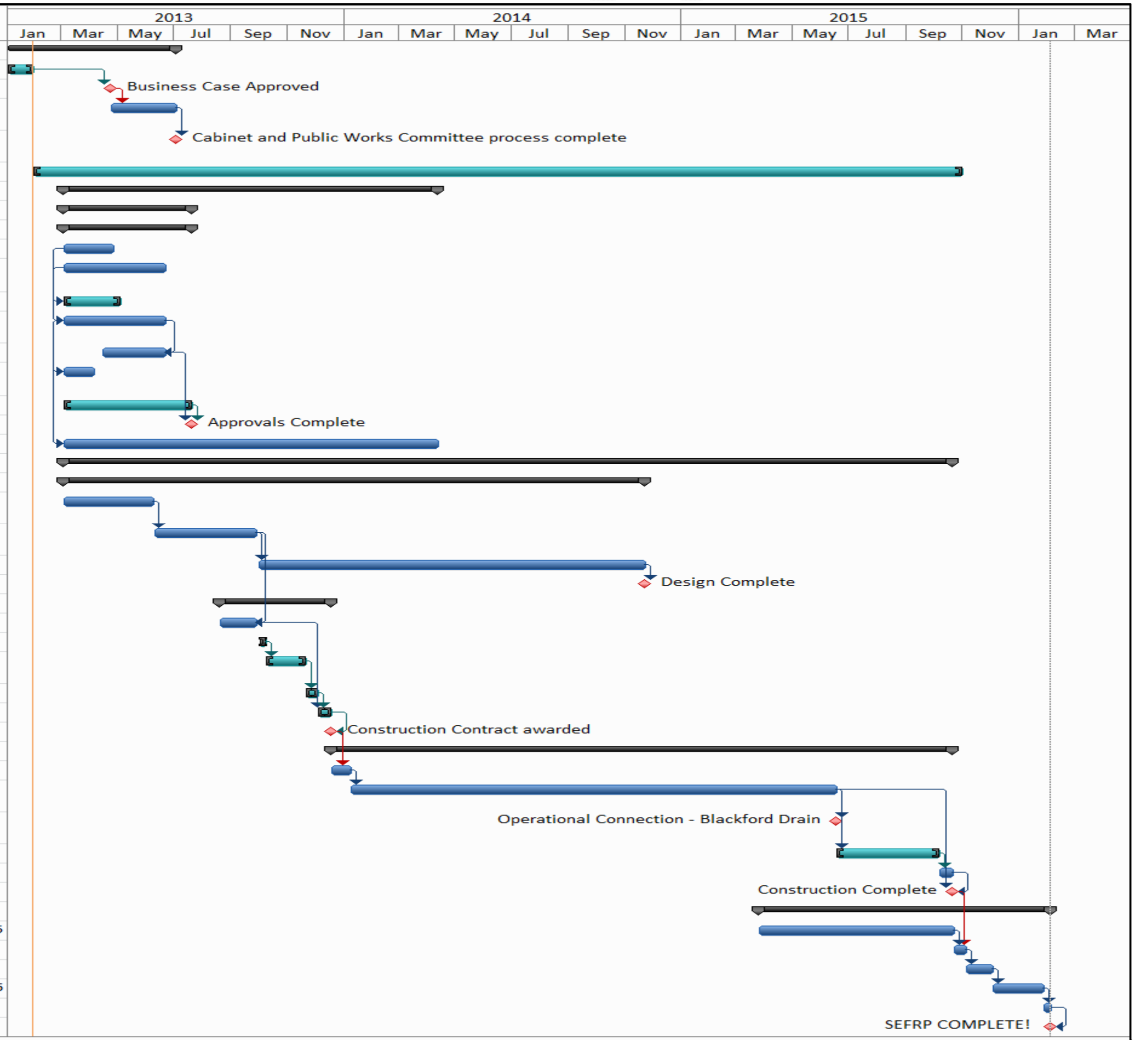
Appendix A – Program Delivery Schedule

ID	Task Mode	Task Name	Duration	Start	Finish
1		**1. PROJECT INITIATION PHASE**	**130 days**	**Wed 2/01/13**	**Tue 2/07/13**
2		Complete Business Case	4 wks	Wed 2/01/13	Tue 29/01/13
3		Business Case Approved	12 wks	Wed 30/01/13	Tue 23/04/13
4		**Submit to Cabinet & Public Works Committee (PWC) Process**	**10 wks**	**Wed 24/04/13**	**Tue 2/07/13**
5		Cabinet and Public Works Committee process complete	0 days	Tue 2/07/13	Tue 2/07/13
6		**2. CONSULTATION (ADVANCED) PHASE**	**718 days**	**Wed 30/01/13**	**Fri 30/10/15**
7		**3. PROJECT PLANNING PHASE**	**290 days**	**Mon 4/03/13**	**Fri 11/04/14**
8		**Approvals**	**100 days**	**Mon 4/03/13**	**Fri 19/07/13**
9		**Environmental**	**100 days**	**Mon 4/03/13**	**Fri 19/07/13**
10		Heritage Risk Management	8 wks	Mon 4/03/13	Fri 26/04/13
11		Aboriginal Heritage Act s23 authorisation	4 mons	Mon 4/03/13	Fri 21/06/13
12		Native Title	9 wks	Mon 4/03/13	Fri 3/05/13
13		Native Vegetation assessment and approval	16 wks	Mon 4/03/13	Fri 21/06/13
14		EPBC Referral	10 wks	Mon 15/04/13	Fri 21/06/13
15		National Parks & Wildlife Act referral	5 wks	Mon 4/03/13	Fri 5/04/13
16		**Development Act**	20 wks	Mon 4/03/13	Fri 19/07/13
17		Approvals Complete	0 days	Fri 19/07/13	Fri 19/07/13
18		**Land Acquisition**	**58 wks**	**Mon 4/03/13**	**Fri 11/04/14**
19		**4. IMPLEMENTATION PHASE**	**687 days**	**Mon 4/03/13**	**Tue 20/10/15**
20		**Design Tender & Documentation**	**450 days**	**Mon 4/03/13**	**Fri 21/11/14**
21		Design tender - prepare, call and award	14 wks	Mon 4/03/13	Fri 7/06/13
22		Detailed Design (for construction call)	16 wks	Mon 10/06/13	Fri 27/09/13
23		Detailed Design (Operational)	60 wks	Mon 30/09/13	Fri 21/11/14
24		Design Complete	0 days	Fri 21/11/14	Fri 21/11/14
25		**Construction Tender**	**87 days**	**Mon 19/08/13**	**Tue 17/12/13**
26		Tender - prepare documentation	6 wks	Mon 19/08/13	Fri 27/09/13
27		Approval to call	1 wk	Wed 2/10/13	Tue 8/10/13
28		Construction Tender Call and Assessment	6 wks	Wed 9/10/13	Tue 19/11/13
29		Approval to Let	2 wks	Wed 20/11/13	Tue 3/12/13
30		Contract Award	2 wks	Wed 4/12/13	Tue 17/12/13
31		**Construction Contract awarded**	**0 days**	**Tue 17/12/13**	**Tue 17/12/13**
32		**Construction (55,000m3/week)**	**480 days**	**Wed 18/12/13**	**Tue 20/10/15**
33		Preliminaries	3 wks	Wed 18/12/13	Tue 7/01/14
34		Bulk earthworks & structure installation	75 wks	Wed 8/01/14	Tue 16/06/15
35		Operational Connection - Blackford Drain	0 days	Tue 16/06/15	Tue 16/06/15
36		Construction finishing tasks	16 wks	Wed 17/06/15	Tue 6/10/15
37		Demobilisation	2 wks	Wed 7/10/15	Tue 20/10/15
38		Construction Complete	0 days	Tue 20/10/15	Tue 20/10/15
39		**5. COMPLETIONS**	**225 days?**	**Thu 26/03/15**	**Wed 3/02/16**
40		Preliminary Completions tasks	30 wks	Thu 26/03/15	Wed 21/10/15
41		Operational Handover	10 days?	Thu 22/10/15	Wed 4/11/15
42		Post-implementation Review	20 days?	Thu 5/11/15	Wed 2/12/15
43		Completions Report	40 days?	Thu 3/12/15	Wed 27/01/16
44		Final Handover	5 days?	Thu 28/01/16	Wed 3/02/16
45		SEFRP COMPLETE!	0 days	Wed 3/02/16	Wed 3/02/16



Task	External Milestone	Manual Summary Rollup	Summary	Inactive Summary	Finish-only
Split	Inactive Task	Manual Summary	Project Summary	Manual Task	Deadline
Milestone	Inactive Milestone	Start-only	External Tasks	Duration-only	Progress

Appendix B – Budget Spreadsheets

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Appendix C – Risk Register

5 Extreme	5	10	15	20	25
4 Major	4	8	12	16	20
3 Moderate	3	6	9	12	15
2 Minor	2	4	6	8	10
1 Insignificant	1	2	3	4	5
	A Rare	B Unlikely	C Possible	D Likely	E Almost Certain

	Extreme Risk
	High Risk
	Moderate Risk
	Low Risk

Design

Risk Area	Risk Issue	Causes	Likelihood	Consequences	Consequence Level	Risk Rating	Mitigation Measures	Likelihood	Consequences	Risk Rating	Responsibility
Design	Incorrect materials used or specified	Poor understanding of specific site and project requirements. Inexperienced/incorrect specifications.	B	Materials and/or infrastructure not fit for purpose. Reduced design life. Inefficient lifecycle costing.	2	4	Design and construction standards, design governance, reviews	A	2	2	DEWNR Project Team
Design	Damage to infrastructure and assets (natural and deliberate, vandalism)	Natural or deliberate damage.	A	Compromise to functionality of infrastructure. Possible environmental impacts.	3	3	Application of appropriate design considerations to minimise likelihood of occurrence.	A	2	2	DEWNR Project Team, SE NRM Region
Design	Design not reaching relevant standards	Poor definition or communication of design standards	B	Ineffective or compromised infrastructure that is not 'fit for purpose'	3	6	Design criteria to specify standards to which all projects within the program will adhere to.	A	2	2	DEWNR Project Team
Design	Failure of design to achieve proposed controls identified for environmental risks	Poor definition or communication of design standards	C	Implementation of design leads to environmental risk occurrence	3	9	Design criteria to specify standards to which all projects within the program will adhere to. Design allows for adaptive management	B	2	4	DEWNR Project Team
Design	Lack of design consideration of key operational and maintenance requirements (OHS, spatial considerations, key element location, and systems renewal)	Poor consultation, communication and agreement on design considerations	C	Compromises to operability and maintainability of assets. Service and cost inefficiencies.	3	9	Robust design planning involving all key parties. Knowledge transfer from prior projects	B	2	4	DEWNR Project Team
Design	Varying standards of design and infrastructure establishment with unclear functional requirements	Lack of agreed design and construction standards and decision makers not clear on what is required	C	Infrastructure not 'fit for purpose'	3	9	Setting and adhering to consistent design standards for the program to be used for all on ground	B	2	4	DEWNR Project Team

Risk Area	Risk Issue	Causes	Likelihood	Consequences	Consequence Level	Risk Rating	Mitigation Measures	Likelihood	Consequences	Risk Rating	Responsibility
							works				
Design	Functional requirements for asset planning and delivery not properly specified up front	Lack of appreciation for the functional requirements of infrastructure projects	C	Projects deliver infrastructure solutions that are not 'fit for purpose'	3	9	Clearly defining project objective, defining the specific outcomes required, governance arrangement with a single project decision maker (consideration of capital, operational and maintenance costs), stakeholder engagement and consultation throughout.	B	2	4	DEWNR Project Team
Design	SEFRP operational decision points not adequately represented in existing SE Decision Support System	Decision Support System not updated appropriately	C	Inadequate operation of SERFRP infrastructure	3	9	Model rules for inclusion into Decision Support System, update Decision Support System as required, train relevant staff	B	2	4	DEWNR Project Team, SE NRM Region

Environment

Risk Area	Risk Issue	Causes	Likelihood	Consequences	Consequence Level	Risk Rating	Mitigation Measures	Likelihood	Consequences	Risk Rating	Responsibility
Environment	Decisions and objectives not based on adequate information, science or knowledge	Lack of understanding of key issues surrounding SE Environment. Poor translation of issues into SERP objectives.	B	SEFRP does not address issues adequately. Actions misaligned to needs.	4	8	Ongoing research programs, continual development of knowledge and formulation of adaptive management approach.	A	3	3	DEWNR Project Team
Environment	Monitoring and evaluation system not effective, or not able to effectively report on outcomes	No baseline data, poor selection of parameters inability to measure parameters	C	Environmental outcomes are unable to be measured and reported.	4	12	Adaptive management approach. SEFRP Baseline Ecosystem Monitoring program. SEFRP Nutrient Risk Management program.	B	4	8	DEWNR Project Team
Environment	Alkalinity spikes in wetlands *en route* during and/or post construction	Poor quality water (high nutrient, sulphate) impacts high quality wetlands if water levels are low	B	Significant biotic stress	3	6	Existing SEWCDB environmental management program, SEFRP Nutrient Risk Management program, EPBC approval	A	2	2	DEWNR Project Team, SE NRM Region
Environment	Turbidity spikes in wetlands *en route* and Coorong South Lagoon during and/or post construction	Poor construction practices, mobilisation of channel sediment in high flow events	B	Reduced aquatic vegetation in wetlands *en route* and Coorong, sedimentation, recoverable ecological degradation	3	6	Water quality management criteria addressed in construction contracts, SEFRP Nutrient Risk Management Program, SEFRP Baseline Ecosystem Monitoring Program, Existing SEWCDB environmental management program	A	2	2	DEWNR Project Team, SE NRM Region
Environment	Adequate volumes of water are unavailable	low seasonal rainfall	C	Low rainfall - drying wetlands, low flows to Coorong, competing demands	3	9	Adaptive management of project site using existing SEWCDB environmental management program. (If there is a drought in the Murray Darling Basin, there is usually water available in the South East and vice	C	3	9	DEWNR Project Team, SE NRM Region

Risk Area	Risk Issue	Causes	Likelihood	Consequences	Consequence Level	Risk Rating	Mitigation Measures	Likelihood	Consequences	Risk Rating	Responsibility
							versa).				
Environment	Inappropriate saline water diverted into wetlands *en route*	Limitations in knowledge of salinity tolerance of wetlands *en route*	C	Wetland water quality is negatively impacted	3	9	Existing SEWCDB environmental management program - monitoring Decision Support System - computer based program decision tool Governance - Auditing	B	3	6	DEWNR Project Team, SE NRM Region
Environment	Inappropriate saline water diverted into wetlands *en route*	Poor decision making due to lack of monitoring data, failure to adhere to operating rules	C	Wetland water quality is negatively impacted	3	9	SEFRP hydrological monitoring infrastructure, Existing SEWCDB environmental management program - monitoring Decision Support System - computer based program decision tool Governance - Auditing	B	3	6	DEWNR Project Team, SE NRM Region
Environment	Inappropriate saline water going into wetlands	Illegal operation of controls	C	Wetland water quality is negatively impacted	3	9	Governance arrangements - Auditing	B	3	6	DEWNR Project Team, SE NRM Region
Environment	Eutrophication of Coorong South Lagoon	High nutrient load accumulation in Coorong South Lagoon	C	Ecological degradation - Algal bloom etc	4	12	SEFRP hydrological monitoring infrastructure, existing SEWCDB environmental management (includes management of Morella Basin releases), monitoring, water quality research program, EPBC approval	B	4	8	DEWNR Project Team, SE NRM Region

Financial

Risk Area	Risk Issue	Causes	Likelihood	Consequences	Consequence Level	Risk Rating	Mitigation Measures	Likelihood	Consequences	Risk Rating	Responsibility
Financial	Failure to achieve SEFRP planned outcomes	The project costs are underestimated.	C	Only parts of SEFRP may be able to proceed or only partial outcomes attainable.	4	12	Robust independent cost assessment undertaken as part of the Business Case development. Budget review by external and inte.rnal financial experts.	B	3	6	DEWNR Project Team
Financial	Movement in CPI is understated or overstated	Estimate of future CPI movements are inaccurate.	C	Actual project cost may be outside current CPI estimates	4	12	Undertake sensitivity analysis - access to contingency, Regular tracking of CPI and other relevant market indicators. Seek approval from the Commonwealth to access interest earned on the project.	C	3	9	DEWNR Project Team
Financial	Delays caused by an uninsurable event, environmental risk (e.g. storm) cause budget blow out	Unpredicted and uninsurable event	C	Delay to delivery of SERFP project and increased costs	4	12	Flexible delivery methodology that can account for unplanned events. Seek approval from the Commonwealth to access interest earned on the project.	C	3	9	DEWNR Project Team)
Financial	Significant project delays due to community backlash increasing management and construction costs	Objecting to catchment transfer and perceived risks to local wetlands and or Coorong	C	Delay to delivery of SERFP project and increased costs	4	12	Manage community perceptions through community engagement and consultation. Ongoing review of Communication and Engagement Strategy to inform activities. Seek approval from the Commonwealth to access interest earned on the project.	A	4	4	DEWNR Project Team
Financial	Market conditions increase project costs	Market forces	C	Increased costs, longer delivery timeframes	4	12	Timing project commencement to avoid market peaks. Procurement strategy in place	B	4	8	DEWNR Project Team

Risk Area	Risk Issue	Causes	Likelihood	Consequences	Consequence Level	Risk Rating	Mitigation Measures	Likelihood	Consequences	Risk Rating	Responsibility
Financial	Financial viability of key contractors	Market forces	C	Increased costs, longer delivery timeframes	4	12	Appropriate procurement and contract strategies in place - financial viability tests/ bonds/ insurance / bank guarantee.	B	4	8	DEWNR Project Team
Financial	Adverse ground conditions result in additional expenditure and delays to target project milestones (project specific)	Poor site conditions. Inadequate Geotechnical investigations.	D	Delays to program and possible cost increases due to site conditions.	4	16	Robust geotechnical investigations. Use of experienced contractors. Access to contingency funds.	B	4	8	DEWNR Project Team
Financial	Inability to deliver project within budget	Compounding impact of CPI increases and project delays on costs associated with construction and human resources	C	Increased costs, longer delivery timeframes	5	15	Robust project management processes in place. Seek approval from the Commonwealth to access interest earned on the project.	C	4	12	DEWNR Project Team

Human Resources

Risk Area	Risk Issue	Causes	Likelihood	Consequences	Consequence Level	Risk Rating	Mitigation Measures	Likelihood	Consequences	Risk Rating	Responsibility
Human Resources	Changes in key project personnel or parties, causes delays to project delivery and loss of corporate knowledge	Inability to retain key staff, or maintain involvement of existing staff or parties.	C	Impact on scope, budget, schedule. Poor continuity of program delivery.	4	12	Follow internal reporting procedures and controls Succession planning for key staff on the project	C	2	6	DEWNR Project Team
Human Resources	Length of time to recruit staff causes delays to delivery	Internal processes and consideration of all delivery options.	C	Failure to meet project milestones and excessive work load pressure existing staff	4	12	Identify key project delivery staff and strategies for back filling arrangements. Ensure recruitment processes are as streamlined as possible..	B	3	6	DEWNR Project Team
Human Resources	Insufficient or inadequate resources to complete program.	Inability to secure appropriate resources with relevant expertise and experience.	C	Impact on scope, budget, schedule and handover to managing authority Poor continuity of program delivery.	4	12	Identify alternative arrangements/sources to undertake project implementation. Provide appropriate induction for all staff into the program.	B	4	8	DEWNR Project Team
Human Resources	Cap on SA Government FTE's (linked to resource availability issue)	Lack of budget for, or State commitment to SEFRP resourcing	C	Compromises the delivery of desired SEFRP outcomes	3	9	Liaison with Agency HR and Finance divisions, and the Department of Treasury and Finance about SEFRP resourcing requirements.	B	3	6	DEWNR Project Team

Stakeholder Relations

Risk Area	Risk Issue	Causes	Likelihood	Consequences	Consequence level	Risk Rating	Mitigation Measures	Likelihood	Consequences	Risk Rating	Responsibility
Stakeholder Relations	Negative public perception of SEFRP (inaccurate perception of program objectives and included works)	Poor communication of project objectives and benefits	D	Negative perception of SEFRP and its associated managing partners	4	16	Ongoing engagement through the life of the project, management of media, managing community expectations of project objectives. Dedicated Consultation Officer and Communication Officer appointed for SEFRP.	C	2	6	DEWNR Project Team
Stakeholder Relations	Lack of or loss of Community Support	Insufficient consultation. Effective negative campaign by objectors Objectives not properly communicated and understood.	D	Media backlash, protests, negative lobbying to government	4	16	Stakeholder engagement and management strategy. Involvement of key stakeholders in key decision making. Transparency in decision making. Clear communication of project intent and progress against objectives. Effective public releases.	C	2	6	DEWNR Project Team
Stakeholder Relations	Lack of support from Aboriginal communities leading to unforseen legal and or political action.	Lack of early engagement and consultation. Potential for different approach with CLLMM Recovery Project.	C	Legal proceedings. Stop work on project. Damage to relationship with communities.	3	9	Early engagement of Aboriginal communities, keeping information flowing regularly, agreements, partnerships, negotiations at state and program level	B	3	6	DEWNR Project Team
Stakeholder Relations	Resistance from key Institutional stakeholders / partners	False expectations, misleading messages, poor engagement, poor communication	C	Lack of stakeholder confidence and/or assistance with planning and delivery of SEFRP	3	9	Stakeholder engagement and management strategy, and early implementation. Internal controls for consistency and robustness of messages communicated	B	2	4	DEWNR Project Team

Risk Area	Risk Issue	Causes	Likelihood	Consequences	Consequence level	Risk Rating	Mitigation Measures	Likelihood	Consequences	Risk Rating	Responsibility
Stakeholder Relations	Community & other stakeholder expectations differ to project outcomes	Poor identification and/or lack of communication of desired and actual project outcomes.	C	Lack of stakeholder confidence and/or assistance with planning and delivery of SEFRP	3	9	Robust stakeholder consultation program throughout project lifecycle. Realistic outcomes communicated	B	2	4	DEWNR Project Team
Stakeholder Relations	Not all key internal stakeholders are identified and engaged	Lack of knowledge or appropriate process for stakeholder identification	C	Compromises to stakeholder involvement and support for delivering SEFRP outcomes	3	9	Robust and responsive stakeholder engagement plan. Knowledge transfer from prior projects	B	2	4	DEWNR Project Team

Political

Risk Area	Risk Issue	Causes	Likelihood	Consequences	Consequence Level	Risk Rating	Mitigation Measures	Likelihood	Consequences	Risk Rating	Responsibility
Political	Competing interests within different areas of government. Conflict between different government agencies and/or conflict between stakeholder groups	Competing expectations, roles, objectives and responsibilities	C	Failure to convince all Stakeholders of the importance of the project Compromises to the successful delivery of SEFRP outcomes	4	12	Governance arrangements will represent all major stakeholders and be inclusive across state government. Effective Steering Committee Charter with clear reporting roles.	B	4	8	DEWNR Project Team
Political	Change in operating objectives by statutory authorities relating to operation of existing drainage network.	Operating rules do not support SEFRP intent	C	Compromises to the delivery of desired SEFRP outcomes	3	9	Appropriate stakeholder engagement to ensure that the SE Drainage Wetland Management Strategy, to be prepared under SEDSOM legislation, is reflective of the objectives of the SE Flows Project.	B	2	4	DEWNR

Strategic - Legal

Risk Area	Risk Issue	Causes	Likelihood	Consequences	Consequence Level	Risk Rating	Mitigation Measures	Likelihood	Consequences	Risk Rating	Responsibility
Legal	Difficulties gaining access to private land and associated issue of investing in infrastructure on private land.	USE Act which had favourable land acquisition powers has expired. Direct approach to landholders fails to achieve 100% of required land.	C	Inability to deliver projects on privately owned land. May compromise SEFRP benefits.	5	15	Early engagement of government and private landowners, Aboriginal communities; provide regular communication to stakeholders at state and project level.	B	5	10	DEWNR Project Team
Legal	Failure to get SEDSOM Bill passed by parliament	Failure to gain numbers to pass legislation	D	No legal mandate to require the preparation of a Drainage and Network Management Strategy to guide the operation of SE Flows.	3	12	Engage the parliamentary process to provide members with a clear understanding of the legislation. In the event that the legislation is not passed, ensure that the operation of SE Flows (in manner consistent with the funding principles) occurs under the existing legislative framework.	D	2	8	DEWNR Project Team

Operations

Risk Area	Risk Issue	Causes	Likelihood	Consequences	Consequence Level	Risk Rating	Mitigation Measures	Likelihood	Consequences	Risk Rating	Responsibility
Operations	Lack of direction and clarity around ongoing arrangements for operation and maintenance	Poor definition of operation and maintenance requirements, including roles and responsibilities	C	Reductions in asset service levels and inefficient asset lifecycle cost management and inefficient use of water	3	9	Clear and concise governance arrangements. Adaptive management of environmental program	B	2	4	DEWNR Project team, SE NRM Region
Operations	SEWCDB do not agree to take on ownership of new SEFRP	Lack of engagement and involvement in decision making	B	Lack of understanding of the project, unaware of underpinning principles and ineffective management of the system.	4	8	Frequent engagement throughout the life of the project and involvement in decision making and operational rules.	B	3	6	DEWNR Project team, SE NRM Region
Operations	Water delivery is not prioritised to maximise environmental outcomes	Poor management of water through the landscape	C	Inability to deliver all desired environmental outcomes and meet expectations.	4	12	Decision Support System to maximise water use and prioritise delivery of any available water to needed sites. Manage expectations through clear messaging.	B	4	8	DEWNR Project team, SE NRM Region

Risk Area	Risk Issue	Causes	Likelihood	Consequences	Consequence Level	Risk Rating	Mitigation Measures	Likelihood	Consequences	Risk Rating	Responsibility
Operations	Operational constraints of existing infrastructure	Existing infrastructure not suitable for project requirements	C	Compromises the ability to deliver desired outcomes.	3	9	Clear understanding of current infrastructure characteristics and potential risks and limitations.	B	3	6	DEWNR Project Team
Operations	Safety of contractors, staff and public at construction site.	Lack of adherence to OHS measures by contractors or staff. Access to construction area and machinery by public/landholders.	C	Injury or loss of time due to safety issues.	4	12	Appropriate procurement documentation regarding OHS policies and procedures. Induction of all contractors to site. Strong site presence by DEWNR Project Officers. Clear communication with landholders. Adherence to DEWNR OHS policies and procedures.	B	4	8	DEWNR Project Team

Natural Resources

Risk Area	Risk Issue	Causes	Likelihood	Consequences	Consequence Level	Risk Rating	Mitigation Measures	Likelihood	Consequences	Risk Rating	Responsibility
Natural Resources	Environmental outcomes not achieved.	Modelling not accurate. Insufficient baseline data. Shift in scientific thinking during project development and delivery.	B	Anticipated environmental outcomes are not achieved for the Coorong.	4	8	Robust and scientifically based Decision Support System and effective adaptive management implementation at whole of program level	A	4	4	DEWNR Project Team
Natural Resources	Environmental outcomes not achieved.	Water quality risk to Coorong not adequately managed.	C	Damage to, or loss of environmental / ecological assets	4	12	Water quality research program & Decision Support System/adaptive Management Program	B	3	6	DEWNR Project Team, SE NRM Region
Natural Resources	Unforseen adverse impacts resulting from the program design on environment (soil/groundwater)	Poor project planning or ability to anticipate adverse outcomes	B	Damage to, or loss of environmental / ecological assets.)	4	8	Robust investigations and project planning. Risk management approach to project delivery. Monitoring and adaptive management.	B	2	4	DEWNR Project Team
Natural Resources	Loss of environmental / ecological assets during construction activity (project level)	Poor site activity planning. Lack of contractor awareness.	C	Damage to, or loss of environmental / ecological assets	2	6	Robust procurement planning and strong site presence to maintain standards. Contractor site inductions.	B	2	4	DEWNR Project Team
Natural Resources	Increased level of contamination/pollutants entering the Coorong South Lagoon /wetlands	Increased connectivity of the system.	C	Damage to, or loss of environmental / ecological assets	4	12	Water quality research program & Decision Support System/adaptive Management Program	B	3	6	DEWNR Project Team, SE NRM Region

Heritage Clearance

Risk Area	Risk Issue	Causes	Likelihood	Consequences	Consequence Level	Risk Rating	Mitigation Measures	Likelihood	Consequences	Risk Rating	Responsibility
Heritage	Heritage sites are damaged, disturbed or interfered without authorisation	Works take place without authorisation under Section 23 of the Aboriginal Heritage Act	C	Major (potential litigation. 3mth application time would delay project delivery)	4	12	Apply upfront for an authorisation under Section 23 of the AHA for the entire alignment	A	4	4	DEWNR Project Team
Heritage	Aboriginal Groups oppose S23 under the Aboriginal Heritage Act	Aboriginal Groups disagree with the administration of the Aboriginal Heritage Act	D	Moderate (politically related issues)	3	12	DEWNR consults with Aboriginal Groups upfront and at regular intervals regarding an application	B	3	6	DEWNR Project Team
Heritage	Disagreement between Aboriginal groups as to Traditional Ownership	Internal politics between Aboriginal Groups and additional Aboriginal heritage authorities who are not Native Title claimants but have interests in the Ngarrindjeri and Others Native Title Claim area..	C	If authorisation under S23 of the Aboriginal Heritage Act isn't sought, DEWNR will not have legal protection. Heritage approvals may be contested.	4	12	Provide capacity for additional representatives to participate in surveys and monitoring within the Ngarrindjeri and Others Native Title claim area	B	4	8	DEWNR Project Team
Heritage	Heritage surveys not undertaken in a timely manner,	Adequate time not given to Aboriginal Groups to undertake pre-dig survey.	B	Delays occur to project delivery.	4	8	DEWNR plan adequate lead in time for pre-dig heritage surveys	A	3	3	DEWNR Project Team

Risk Area	Risk Issue	Causes	Likelihood	Consequences	Consequence Level	Risk Rating	Mitigation Measures	Likelihood	Consequences	Risk Rating	Responsibility
	causing delays.										
Heritage	Heritage assessment reports for monitoring sites not provided in a timely manner, causing project delays.	Adequate time not given to Aboriginal Groups to undertake heritage assessment reports for monitoring sites.	B	Delays occur to project delivery	4	8	DEWNR plan adequate lead in time for heritage assessment reports prior to construction activities.	A	3	3	DEWNR Project Team
Heritage	Aboriginal organisation isn't structured to effectively administer fee for service arrangement	Aboriginal organisation does not have an established governance structure	C	Delivery issues may arise	3	9	Liaise with Aboriginal organisations about arrangements that can support implementation of fee for service. Ensure DEWNR provide capacity to facilitate Aboriginal engagement.	B	2	4	DEWNR Project Team, SE NRM Region
Heritage	Heritage monitoring requirements not met.	Construction occurs at multiple locations requiring additional Cultural Monitors from Aboriginal Groups to undertake heritage	C	Construction is delayed.	4	12	Restructure Aboriginal Involvement budget to ensure additional Cultural Monitors can be available at	A	4	4	DEWNR Project Team

Risk Area	Risk Issue	Causes	Likelihood	Consequences	Consequence Level	Risk Rating	Mitigation Measures	Likelihood	Consequences	Risk Rating	Responsibility
		monitoring simultaneously.					multiple sites.				

DEED OF VARIATION

Third Deed of Variation to the Project Schedule for the South Australian Priority Project SA – 07: Coorong, Lower Lakes and Murray Mouth Recovery Project

Commonwealth of Australia as represented by the Department of the Environment ABN 34 190 894 983 (**Commonwealth**)

The Minister for Water and the River Murray, a body corporate pursuant to section 7 of the *Administrative Arrangements Act 1994* (SA) as represented by the Department of Environment, Water and Natural Resources ABN 36 702 093 234 (**State**)

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Details

Parties

1. Commonwealth of Australia as represented by the **Department of the Environment** ABN 34 190 894 983 of John Gorton Building, Environment Entrance, King Edward Terrace, Parkes ACT 2600, Australia (**Commonwealth**).

2. **The Minister for Water and the River Murray**, a body corporate pursuant to section 7 of the *Administrative Arrangements Act 1994* (SA) as represented by the Department of Environment, Water and Natural Resources ABN 36 702 093 234 of Level 1, 25 Grenfell Street, Adelaide SA 5000, Australia (**State**).

Recitals

A. The Commonwealth of Australia and the State (then using the name of the Minister for Water Security for and on behalf of the Crown in right of the State of South Australia acting through the Department of Water, Land and Biodiversity Conservation) are parties to a Water Management Partnership Agreement dated 4 November 2009 (**Agreement**).

B. In accordance with clauses 5.1.1.b and 16.2.1 of the Agreement, the Commonwealth and the State are parties to the *Coorong, Lower Lakes and Murray Mouth Recovery Project Schedule SA-07* dated 17 May 2012 (**Original Project Schedule**), thereby incorporating the Project Schedule into the Agreement

C. The Commonwealth and the State varied the Original Project Schedule on 15 April 2013 (**First Variation**) and 19 March 2014 (**Second Variation**)

D. The parties have agreed to further amend the terms of the Original Project Schedule and First Variation, as amended by the Second Variation (together comprising the **Project Schedule**) and in accordance with this deed of variation.

Agreed terms

1. Defined terms and interpretation

1.1 Defined terms

In this deed, except where the context otherwise requires, defined terms have the same meaning as given to them in the Agreement.

1.2 Interpretation

In this deed, except where the context otherwise requires:

(a) the singular includes the plural and vice versa, and a gender includes other genders;

(b) another grammatical form of a defined word or expression has a corresponding meaning;

(c) a reference to a clause, paragraph, schedule or attachment is to a clause or paragraph of, or schedule or attachment to, this deed, and a reference to this deed includes any schedule or attachment;

(d) a reference to a document or instrument includes the document or instrument as novated, altered, supplemented or replaced from time to time;

(e) a reference to AUD, A$, $A, dollar or $ is to Australian currency;

(f) a reference to time is to the local time in Canberra, Australia;

(g) a reference to a party is to a party to this deed, and a reference to a party to a document includes the party's executors, administrators, successors and permitted assigns and substitutes;

(h) a reference to a person includes a natural person, partnership, body corporate, association, governmental or local authority or agency or other entity;

(i) headings are for ease of reference only and do not affect interpretation;

(j) a reference to a statute, ordinance, code or other law includes regulations and other instruments under it and consolidations, amendments, re-enactments or replacements of any of them;

(k) a word or expression defined in the *Corporations Act 2001* (Cth) has the meaning given to it in the *Corporations Act 2001* (Cth);

(l) the meaning of general words is not limited by specific examples introduced by including, for example or similar expressions;

(m) any agreement, representation, warranty or indemnity by two or more parties (including where two or more persons are included in the same defined term) binds them jointly and severally;

(n) any agreement, representation, warranty or indemnity in favour of two or more parties (including where two or more persons are included in the same defined term) is for the benefit of them jointly and severally; and

(o) a rule of construction does not apply to the disadvantage of a party because the party was responsible for the preparation of this deed or any part of it.

2. Variation to Agreement

With effect from the date of this deed, the Agreement is varied by:

Replacing the "Coorong, Lower Lakes and Murray Mouth Recovery Project Schedule SA-07", Second Variation, dated 19 March 2014, with the Project Schedule as set out in Attachment A to this deed.

3. Payment acknowledgement

The parties acknowledge that the amount of [redacted] (GST exclusive) has already been paid to the State as part of the Funds payable under the Agreement.

4. Continued force and effect of Agreement

The Agreement continues in full force and effect, as amended by this deed.

5. Miscellaneous

5.1 Counterparts

This deed may be executed in counterparts. All executed counterparts constitute one document.

5.2 Governing law and jurisdiction

This deed is governed by the law of the Australian Capital Territory and each party irrevocably submits to the non-exclusive jurisdiction of the courts of the Australian Capital Territory.

5.3 Date of effect

The date of this deed will be on and from the date that the Commonwealth signs the deed.

Execution page

Executed as a deed

SIGNED SEALED AND DELIVERED for and on behalf of the Commonwealth of Australia as represented by the **Department of the Environment** by a duly authorised representative

[redacted]

SIGNED SEALED AND DELIVERED by the **Minister for Water and the River Murray**, a body corporate pursuant to section 7 of the *Administrative Arrangements Act 1994* (SA)

[redacted]

ATTACHMENT A

Attachment A to Third Deed of Variation

Coorong, Lower Lakes and Murray Mouth Recovery Project Schedule SA-07 to the South Australian and Commonwealth Water Management Partnership Agreement

Coorong, Lower Lakes and Murray Mouth Recovery Project Schedule SA-07

to the South Australian and Commonwealth Water Management Partnership Agreement

PROJECT SCHEDULE – SOUTH AUSTRALIAN PRIORITY PROJECT SA-07–COORONG LOWER LAKES AND MURRAY MOUTH RECOVERY PROJECT

A. Terminology used in this Project Schedule

A.1.1. Except where indicated in Item A.1.2 capitalised terms in this Project Schedule have the same meaning as in clause 18.4 of the Water Management Partnership Agreement between the Commonwealth and the State of South Australia dated 4 November 2009 (the Agreement).

A.1.2. For the purpose of this Priority Project and Project Schedule only, the terms specified in this item have the following meaning:

a. Activities: means, in respect of a Management Action, the Outcomes, deliverables, conduct, conditions or Management Action Milestones that are specified in or referred to in an attachment that are required to complete that Management Action;

b. Australian Height Datum (AHD) - national survey datum corresponding approximately to average sea level;

c. Bioremediation: means the management approaches that aim to promote microbial activity to convert dissolved sulfate to insoluble sulphide materials, while consuming acid, reversing the oxidation reactions that generated the acidity;

d. Business Case: means the Business Case submitted to the Commonwealth, including the Technical Feasibility Assessments (1 to 14), the amendments to this Business Case made through Supplementary Information A, B and C and the State's formal response to the Draft Due Diligence Report submitted to the Commonwealth under clause 5.1.2.c of the Agreement. Where there is a conflict between these documents, the last of these documents submitted to the Commonwealth will prevail to the extent of any inconsistency;

e. Compliant but Conditional Elements: means those elements listed in the Due Diligence Report as compliant but conditional (passed Due Diligence, but subject to Triggers), the implementation of which depends on Triggers, such as; low water levels, increased salinity, or the results of an investigation. The Compliant but Conditional Elements may not need to be implemented in the short-term, but may need to be implemented within the life of the Project if Triggers occur;

f. Compliant Elements: means those elements listed in the Due Diligence Report as compliant (passed Due Diligence) and supported for funding up to the approved amount (subject to any agreed variations);

g. Construction Contract: means any contract that the State has with its subcontractors for the construction of Works;

h. Coorong Lower Lakes and Murray Mouth (CLLMM) Site: means the land and water within the boundary as indicated on the map at Attachment A and, for the purposes of the south east flows restoration Management Action only, the Upper South East;

i. DoE: means the Commonwealth Department of the Environment (formerly Department of the Environment, Water, Heritage and the Arts; and the Department of Sustainability, Environment, Water, Population and Communities);

j. Due Diligence Report: means the DoE Report titled *South Australian State Priority Project Coorong, Lower, Lakes and Murray Mouth Recovery Project, Due Diligence Assessment Report April 2011* that was provided to the State on 10 May 2011;

k. Early Works Carryover: approved carryover of unspent Funds from the Early Works Project Schedule SA-03 - *Early Works for the Water for the Future, Enduring Response for the Coorong and Lower Lakes*, as approved by the Commonwealth on 5 December 2011;

l. Ecological Features: the physical, chemical and biological components of the ecological system, such as vegetation, species habitat, and soil and water quality;

m. Evaluation Period: means the period specified in Item B.1.5;

n. Financial Reporting Template: means the template referred to at Attachment B for the purposes of progress Reporting in accordance with the Workplans and in accordance with Items J.2.1.b and J.2.1.c;

o. Interest: interest accrued pursuant to clause 6.1.9 of the Agreement and forms part of the Funds.

p. Land Acquisition: means the acquisition of any legal estate or interest in land;

q. Long Term Plan: means the document developed by the State entitled *Securing the Future Long Term Plan for the Coorong Lower Lakes and Murray Mouth* dated June 2010;

r. Management Action: means the components as per Item B.1.6 and Attachments C to W;

s. Management Action Costs: means costs associated with Management Actions. They do not include Program Management and Corporate Overheads Costs and Early Works Carryover;

t. Management Action Deliverable: means any measurable, tangible, verifiable Output, result or item that must be produced to complete a Management Action or part of a Management Action;

u. Management Action Milestone: means a stage in the completion of a Management Action as specified in Attachments C to W of this Project Schedule;

v. Management Action Outcome: means the measurable benefits or other long term changes that are sought from undertaking the project or Management Action;

w. Meningie Wetland: means the wetland that will be constructed at Meningie, on the shores of Lake Albert;

x. Unused Funds: means the unused Funds provided for at Clause 6.3.1 of the Agreement;

y. Outcome: means the measurable benefits or other long term changes as per Item B.2 that are sought from undertaking the Priority Project and individual Management Actions;

z. Output: means the tangible products, business or management practices that are required to be produced to complete the identified Activities, Management Action Deliverables and/or Management Action Outcomes;

aa. Program Management and Corporate Overheads: means the costs associated with State Departmental overheads including Departmental operating costs, Departmental overheads and staffing (refer to chapter 9 of the Due Diligence Report for supported costs);

bb. Project Charter: means the document specified in Item B.5 of this Project Schedule;

cc. Trigger: means a condition that must be reached before Compliant but Conditional Elements can commence. Triggers can include environmental, management events and/or results of investigations. Commonwealth approval will be required under Item B.4;

dd. Upper South East (USE)*:* the section of south eastern South Australia that is bound to the south by a line drawn from Kingston through Lucindale and Naracoorte to the South Australian/Victorian border, and to the north from Salt Creek through Keith to the South Australian/Victorian border;

ee. Works: means any part of this Priority Project that comprises construction and building activities, including the construction and building activities specified in Attachments C to W to this Project Schedule;

ff. Works Locations: means the locations where the Works are to be undertaken including any premises in, or land on, which those Works are to be constructed;

gg. Workplan: means a document that states what activities will be undertaken to achieve identified Outputs, Management Action Deliverables and Management Action Outcomes. Item B.6 outlines the minimum requirements of a Workplan under this Project Schedule;

hh. Works Purposes: means use of the Works in a manner consistent with the aims and objectives of the Priority Project.

B. Priority Project SA-07

B.1. Summary and duration of the Priority Project

B.1.1. The Commonwealth has agreed to provide a maximum amount of [redacted] of Funding to the State under this Project Schedule for the Coorong, Lower Lakes and Murray Mouth Recovery Project (being the completion of the Management Actions in Attachments C to W of this Project Schedule).

B.1.2. Subject to Item B.1.1 the State is required to provide State Contributions to this Priority Project equal to 10 per cent of the Project Cost for this Priority Project specified in Item D.

B.1.3. The State also agrees to cover any Priority Project expenditure in excess of the Project Cost in Item D.

B.1.4. This Priority Project commenced on 1 July 2011 and is required to be completed by 31 December 2016.

B.1.5. The Evaluation Period is from 1 July 2011 to 30 June 2017.

B.1.6. This Priority Project requires the State to complete the following 19 distinct Management Actions:

a. Management Action 1: restoration through Wetland and terrestrial vegetation planting (Attachment D);

b. Management Action 2: vegetation fencing (Attachment E);

c. Management Action 3: vegetation pest management (Attachment F);

d. Management Action 4: community involvement in vegetation program (Attachment G);

e. Management Action 5: vegetation aboriginal heritage (Attachment H);

f. Management Action 6: vegetation monitoring and research (Attachment I);

g. Management Action 7: vegetation project management (Attachment J);

h. Management Action 8: construction of fishways (Attachment K);

i. Management Action 9: critical fish habitat (Attachment L);

j. Management Action 10: south east flows restoration (Attachment M);

k. Reserved;

l. Management Action 12: ruppia translocation (Attachment O);

m. Management Action 13: monitoring and adaptive management framework (Attachment P);

n. Management Action 14: managing acid sulfate soils (Attachment Q);

o. Management Action 15: research priorities (Attachment R);

p. Management Action 16: community engagement and communications (Attachment S);

q. Management Action 17: Ngarrindjeri partnerships (Attachment T);

r. Management Action 18: Meningie wetland (Attachment U);

s. Management Action 19: monitoring and adaptive management 1 July 2011 to 31 December 2011 (gap monitoring) (Attachment V); and

t. Management Action 20: Lake Albert Scoping Study (Attachment W).

B.2. Outcomes of the Priority Project

B.2.1. This Priority Project will contribute to managing the CLLMM site for ecological health and supports the implementation and objectives of the Long-Term Plan.

B.2.2. The Management Action Outcomes contribute to this overall Outcome by contributing to one or more of the following Outcomes:

a. improve the Ecological Features of the CLLMM site to deliver a healthy and resilient wetland;

b. the CLLMM ecosystem can adapt to a variable climate and variable water levels;

c. the environmental values that give the Coorong, Lower Lakes and Murray Mouth wetland its international significance are protected;

d. the CLLMM site maintains salinity gradients close to historic trends and an open Murray Mouth;

e. the culture of the traditional owners, the Ngarrindjeri, is preserved and promoted through partnerships and involvement in projects;

f. the local communities that depend on the health of the site are supported with a view to improving their resilience; and

g. capacity, knowledge and understanding are increased across communities.

B.2.3. The Management Action Outcomes and Management Action Deliverables are set out in Attachments C to W of this Project Schedule.

B.3. Priority Project Requirements

B.3.1. The State agrees that:

a. the Priority Project will be completed in accordance with the parts of the Business Case approved by the Commonwealth Minister, as described in the Due Diligence Report that relate to the Management Actions and modified by engineering specifications that does not adversely impact on the Commonwealth's Due Diligence requirements;

b. it is responsible for meeting the Project Milestones, Management Action Milestones, Management Action Outcomes and timeframes for this Priority Project that are specified in this Project Schedule;

c. it is responsible for ensuring the proper and efficient conduct of the Priority Project, in accordance with this Project Schedule;

d. it will ensure that the 19 Management Actions are delivered in accordance with the conduct and conditions and Management Action Deliverables as set out in Attachments C to W;

e. it will ensure monitoring of expenditure against the Project Cost to enable the Commonwealth to be informed on the progress and Outcomes of this Priority Project;

f. it will comply, and ensure its subcontractors comply, with all requirements of the *National Code of Practice for the Construction Industry* as set out in Attachment X to this Project Schedule;

g. it will ensure the requirements of the *Australian Government OHS* Accreditation Scheme as set out in Attachment Y to this Project Schedule are complied with;

h. if requested by the Commonwealth, it will facilitate the Commonwealth's access to the State's records, contracts and personnel to enable the Commonwealth to conduct its own independent audit or review of any aspect of the Priority Project; and

i. as Funding is based on the Commonwealth's Due Diligence Report, the acceptance of Funding represents the shared understanding of the Business Case, as outlined in the Due Diligence Report.

B.3.2. The State also agrees to:

a. ensure that the Works Locations and the completed Works are used for, and are fit to be used for, the purposes of meeting the Management Action Outcomes and Activities of this Priority Project specified in Item B.2.3 throughout the Evaluation Period;

b. ensure that the Works are constructed at the Works Locations specified in this Project Schedule;

c. ensure that the Works Locations and the Works (both during and after completion) are safeguarded against damage and unauthorised use at all times; and

d. use the Works for the purpose of meeting the Management Action Outcomes and Activities of this Priority Project as specified in Item B.2.3, and that it shall not encumber or dispose of the Works without the Commonwealth's prior written approval, which will not be unreasonably withheld and which may be given subject to any conditions the Commonwealth may determine, following consultation with the State. The State is fully responsible for, and bears all risks relating to, the encumbrance or disposal.

B.3.3. If a third party has proprietary or other rights or interests in relation to the Works Locations or the Works, the State agrees prior to commencing the Works to:

a. enter into binding written agreements under which all such third parties agree to the use of the:

i. Works Locations to complete the Works; and

ii. Works Locations and completed Works for the Works Purposes for the duration of the Evaluation Period; and

b. not do anything that would give any of these third parties a right to rescind their agreement to that use of the Works Location or the completed Works.

B.3.4. The State agrees to ensure that its subcontractors involved in the performance of the Works take out and maintain insurance that adequately covers the fixed and contingent obligations of those organisations under their Construction Contracts as well as liability for death and injury of persons employed by those organisations. The State agrees to ensure that each Construction Contract contains an undertaking on terms sufficient to ensure the due and proper performance of the Construction Contract and the State agrees to ensure that any such undertaking is enforced as and when necessary to ensure that the Construction Contract is so performed.

B.3.5. The Commonwealth and State agree that:

a. the Priority Project will be carried out, and the Works Locations and completed Works will be used in accordance with all applicable laws and regulations (including, but not limited to, planning, environmental, occupational health and safety, building and regulatory approvals) and in particular, the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) and the *Native Title Act 1993* (Cth) and all applicable Australian Standards;

b. the State has obtained, or agrees to obtain prior to commencement of any Activities or Works related to a Management Action, all rights, consents and permissions that are required under the *Native Title Act 1993* (Cth) to perform this Priority Project. If requested by the Commonwealth, the State will provide the Commonwealth with copies of any such rights, consents and permissions;

c. for the purposes of clause 16.1 of the Agreement, a variation to this Project Schedule SA-07 may be signed for and on behalf of the Commonwealth as specified in clause 16.1.2 and for and on behalf of the State by its relevant Minister or an authorised State official; and

d. this Priority Project, including all Management Actions, Program Management and Corporate Overheads and Early Works Carryover, will be managed by the State in accordance with this Project Schedule.

B.3.6. The State acknowledges that it, and not the Commonwealth, is responsible for managing and performing this Priority Project and that the Commonwealth has no responsibility for performing any aspect of this Priority Project, other than undertaking its part of approving Compliant but Conditional Elements, Workplans and access to contingency funds, during or after the Completion Date.

B.4. Compliant but Conditional Elements

B.4.1. The following Management Actions have Compliant but Conditional Elements:

a. Management Action 8: construction of fishways;

b. Management Action 10: south east flows restoration;

c. Management Action 12: ruppia translocation;

d. Management Action 13: monitoring and adaptive management framework;

e. Management Action 14: managing acid sulfate soils.

B.4.2. The Program Management and Corporate Overhead Costs that relate to Compliant but Conditional Elements of the Management Actions listed in Item B.4.1 are also Compliant but Conditional Elements.

B.4.3. The State must demonstrate in writing that the conditions for Compliant but Conditional Elements as per Attachments (K, M, O, P and Q) are met to the satisfaction of the Commonwealth and revised Workplans, consistent with Item B.6.2, are in place before undertaking Activities for Compliant but Conditional Elements.

B.4.4. The State must request in writing Commonwealth approval for Funding for Compliant but Conditional Elements up to the required amount that is necessary to address the conditions present in Item B.4.3.

B.4.5. Commonwealth approval of Funding and Activities, as described in revised Workplans (Item B.4.3), for Compliant but Conditional Elements must be in writing and will specify the approved amount and Activities as requested in Item B.4.4 up to the approved amount as per Attachments K, M, O, P and Q. Any additional Funding request for Compliant but Conditional Elements must adhere to Item B.4.3.

B.4.6. In approving Funding for Compliant but Conditional Elements the Commonwealth may have regard to Funding already provided towards the relevant Management Action and may direct how Funding is to be spent.

B.4.7. Compliant but Conditional Elements and Compliant Elements are based on the Due Diligence Report. Approving Compliant but Conditional Elements or Funding does not change the activity status to Compliant.

B.5. Priority Project Charter

B.5.1. A Project Charter for this Priority Project will be agreed and signed between the Commonwealth and the State within 60 Business Days of signing of this Project Schedule.

B.5.2. The intent of the Project Charter is to facilitate the parties' working relationship and provide operational guidelines for this Priority Project.

B.5.3. The parties agree that the Project Charter may be amended by the written agreement (including in an exchange of letters or emails) of:

a. the Assistant Secretary responsible for the Commonwealth's management of this Project Schedule currently the Assistant Secretary Aquatic Systems Policy Branch, DoE; and

b. the Group Executive Director, Partnerships and Stewardship, SA Department of Environment, Water and Natural Resources.

B.5.4. For the avoidance of doubt, if there is any inconsistency between the Project Charter and this Project Schedule, the Project Schedule prevails to the extent of the inconsistency.

B.5.5. The Project Charter does not form part of this Project Schedule.

B.6. Workplans

B.6.1. The State is required to prepare annual Workplans for all 19 Management Actions listed at B.1.6 except for Management Action 19: Monitoring and Adaptive Management 1 July to 31 December 2011 (Gap Monitoring).

B.6.2. The Workplans at a minimum must include:

a. a description of how the work is to achieve the Management Action Outcomes, in accordance with the attachments and Management Action Deliverables in the attachments;

b. Outputs for the reporting period that contribute to the achievement of Management Action Deliverables;

c. detailed budget for the relevant year that complies with the relevant Activities listed in the Management Action Costs in the corresponding attachment;

d. indicative budget for the outyears as per the Management Action Costs in the corresponding Management Action attachment to this Project Schedule;

e. Financial Reporting Template that meets the requirements of Items J.2.1.b and J.2.1.c based on the template at Attachment B; and

f. An overview that provides certainty that the timing of planned Activities for the relevant financial year contributes to both Activities achieved to date and for the outyears for the full Management Action. Depending on the Management Action this will be demonstrated through either a workflow diagram or Gantt chart; or if sufficiently suitable a program logic.

B.6.3. Workplans for the purposes of this Project Schedule must be approved by the Commonwealth.

B.6.4. The State agrees to provide to the Commonwealth annual Workplans for the relevant Management Actions by 31 March of each year for the work to be undertaken in the following financial year.

B.6.5. The Commonwealth agrees to consider the annual Workplans and provide the State with a response to those Workplans within 20 Business Days of the receipt of the Workplans.

B.6.6. For the avoidance of doubt, if there is any inconsistency between a Workplan and this Project Schedule, the Project Schedule prevails to the extent of the inconsistency.

C. Project Milestones

C.1. Project Milestones for Compliant Elements

C.1.1. The Project Milestones for the Compliant Elements of this Project Schedule are set out in the following table:

Project Milestone Number	Project Milestone	Completion Date for Project Milestone
1.	The State's completion of, to the satisfaction of the Commonwealth, the Management Action Milestones 1.A to 19.A, which are identified in Attachments D to V of this Project Schedule.	31 December 2011
2.	The State's completion of, to the satisfaction of the Commonwealth, the Management Action Milestones 1.B to 18.B, which are identified in Attachments D to U of this Project Schedule.	30 June 2012
3.	The State's completion of, to the satisfaction of the Commonwealth, the Management Action Milestones 1.C to 18.C, which are identified in Attachments D to U of this Project Schedule.	31 December 2012
4.	The State's completion of, to the satisfaction of the Commonwealth, the Management Action Milestones 1.D to 18.D and 20.D, which are identified in Attachments D to U and W of this Project Schedule.	30 June 2013

Project Milestone Number	Project Milestone	Completion Date for Project Milestone
5.	The State's completion of, to the satisfaction of the Commonwealth, the Management Action Milestones 1.E to 18.E and 20.E, which are identified in Attachments D to U and W of this Project Schedule.	31 December 2013
6.	The State's completion of, to the satisfaction of the Commonwealth, the Management Action Milestones 1.F to 18.F and 20.F, which are identified in Attachments D to U and W of this Project Schedule.	30 June 2014
7.	The State's completion of, to the satisfaction of the Commonwealth, the Management Action Milestones 1.G to 18.G, which are identified in Attachments D to U of this Project Schedule.	31 December 2014
8.	The State's completion of, to the satisfaction of the Commonwealth, the Management Action Milestones 1.H to 18.H, which are identified in Attachments D to U of this Project Schedule.	30 June 2015
9.	The State's completion of, to the satisfaction of the Commonwealth, the Management Action Milestones 1.I to 18.I, which are identified in Attachments D to U of this Project Schedule.	31 December 2015
10.	The State's completion of, to the satisfaction of the Commonwealth, the Management Action Milestones 1.J to 18.J, which are identified in Attachments D to U of this Project Schedule.	30 June 2016
11.	The State's provision of a satisfactory final Project Report for this Priority Project that demonstrates the State's completion of all the Management Action Milestones in accordance with Attachment D to W.	By the date required by Item J.3.2

C.2. Project Milestones for Compliant but Conditional Elements

C.2.1. The Project Milestones for the Compliant but Conditional Elements for this Project Schedule (excluding managing acid sulfate soils Item C.2.2) are set out in the following table:

Project Milestone Number	**Project Milestone**	**Completion Date for Project Milestone**
A.	The State's completion of, to the satisfaction of the Commonwealth, the Management Action Milestones 1.K to 18.K, which are identified in Attachments E to U (excluding Attachment Q) of this Project Schedule.	31 December 2011
B.	The State's completion of, to the satisfaction of the Commonwealth, the Management Action Milestones 1.L to 18.L, which are identified in Attachments E to U (excluding Attachment Q) of this Project Schedule.	30 June 2012
C.	The State's completion of, to the satisfaction of the Commonwealth, the Management Action Milestones 1.M to 18.M, which are identified in Attachments E to U (excluding Attachment Q) of this Project Schedule.	31 December 2012
D.	The State's completion of, to the satisfaction of the Commonwealth, the Management Action Milestones 1.N to 18.N, which are identified in Attachments E to U (excluding Attachment Q) of this Project Schedule.	30 June 2013
E.	The State's completion of, to the satisfaction of the Commonwealth, the Management Action Milestones 1.O to 18.O, which are identified in Attachments E to U (excluding Attachment Q) of this Project Schedule.	31 December 2013
F.	The State's completion of, to the satisfaction of the Commonwealth, the Management Action Milestones 1.P to 18.P, which are identified in Attachments E to U (excluding Attachment Q) of this Project Schedule.	30 June 2014

G.	The State's completion of, to the satisfaction of the Commonwealth, the Management Action Milestones 1.Q to 18.Q, which are identified in Attachments E to U (excluding Attachment Q) of this Project Schedule.	31 December 2014
H.	The State's completion of, to the satisfaction of the Commonwealth, the Management Action Milestones 1.R to 18.R, which are identified in Attachments E to U (excluding Attachment Q) of this Project Schedule.	30 June 2015
I.	The State's completion of, to the satisfaction of the Commonwealth, the Management Action Milestones 1.S to 18.S, which are identified in Attachments E to U (excluding Attachment Q) of this Project Schedule.	31 December 2015
J.	The State's completion of, to the satisfaction of the Commonwealth, the Management Action Milestones 1.T to 18.T, which are identified in Attachments E to U (excluding Attachment Q) of this Project Schedule.	30 June 2016
K.	The State's completion of, to the satisfaction of the Commonwealth, the Management Action Milestone 10.U, which is identified in Attachment M of this Project Schedule.	31 December 2016

Managing acid sulfate soils

C.2.2. The Project Milestones for the Compliant but Conditional Elements – Management Action 14: managing acid sulfate soils (Attachment Q) are subject to Triggers being met and limestone dosing events taking place, as per the agreed Workplans.

C.2.3. The State is to report on a limestoning event that occurs within a reporting period in the relevant progress Report. Once approved the State will separately invoice the Commonwealth for the Funding that will be added to the next payment.

D. Project Cost

D.1. Total Project Cost

D.1.1. The total Project Cost for this Priority Project is up to [redacted] excluding GST.

Total Project Cost of up to [redacted] is comprised of:	
Management Action Cost	Up to [redacted]
Program Management and Corporate Overheads	Up to [redacted]
Early Works Carryover	Up to [redacted]

D.2. Management Action Costs

D.2.1. The maximum Management Action Cost for this Priority Project is up to [redacted] (excluding GST), comprised of [redacted] in Compliant Elements and [redacted] in Compliant but Conditional Elements.

D.2.2. Management Action Costs do not include Program Management and Corporate Overheads Costs and Early Works Carryover (see Item D.4.1). Program Management and Corporate Overheads Costs are covered by Item D.3 and the Early Works Carryover amounts are covered by Item D.4.

D.2.3. The Management Action Costs are contained in the following table and Attachments D to W:

Management Action	Commonwealth Funding (up to) (GST exclusive)		State Contribution (up to) (GST exclusive)		Total Cost per Management Action (up to) (GST exclusive)	
	Compliant	Compliant but Conditional	Compliant	Compliant but Conditional	Compliant	Compliant but Conditional
1. Restoration planting	[redacted]					
2. Fencing						
3. Pest management						
4. Vegetation - community involvement						
5. Vegetation - Aboriginal heritage						
6. Vegetation - monitoring and research						
7. Vegetation - project management						
8. Construction of fishways						
9. Critical fish habitat						
10. South east flows restoration - phase 1						
10. South east flows restoration - phase 2						
10. South east flows restoration - phase 2 contingency*						

Management Action	Commonwealth Funding (up to) (GST exclusive)		State Contribution (up to) (GST exclusive)		Total Cost per Management Action (up to) (GST exclusive)	
	Compliant	Compliant but Conditional	Compliant	Compliant but Conditional	Compliant	Compliant but Conditional
12. Ruppia translocation - phase 2	[redacted]					
12. Ruppia translocation - phase 3						
13. Monitoring and adaptive management framework						
14. Managing acid sulfate soils						
15. Research priorities						
16. Community engagement and communications						
17. Ngarrindjeri partnerships						
20. Lake Albert Scoping Study						
TOTAL	as per Item K of this Project Schedule	as per Item K of this Project Schedule	as per Item D.7 of this Project Schedule	as per Item D.7 of this Project Schedule	as per Item D.2.1 of this Project Schedule	as per Item D.2.1 of this Project Schedule

* 10. South east flows restoration - phase 2 contingency does not attract Program Management and Corporate Overhead Costs

D.3. Program Management and Corporate Overhead Costs

D.3.1. In addition to the Management Action Costs listed in Item D.2.1 the following Program Management and Corporate Overheads apply:

	Commonwealth Funding (up to) (GST exclusive)		State Contribution (up to) (GST exclusive)		Total Program Management and Corporate Overheads (up to) (GST exclusive)	
	Compliant	Compliant but Conditional	Compliant	Compliant but Conditional	Compliant	Compliant but Conditional
TOTAL	[redacted]					

D.3.2. In accordance with the Due Diligence Report the maximum approved Program Management and Corporate Overheads Costs is [redacted] for Compliant Elements and $[redacted] for Compliant but Conditional Elements.

D.3.3. Funding is not available for Program Management and Corporate Overheads Costs with Compliant but Conditional Elements unless the corresponding Compliant but Conditional Elements under Item D.2.3 are also approved and will be proportional to the approval as calculated by the following formula:

Compliant but Conditional Program Managment and Corporate Overheads Costs equals:

$$\frac{\begin{array}{c}\mathit{Approved\ Compliant\ but\ Conditional\ Elements}\\ \mathit{minus\ South\ east\ flows\ restoration\ phase\ 2\ contingency}\end{array}}{\mathit{Total\ Compliant\ but\ Conditional\ Elements\ in\ Item}\ \mathrm{D.2.1}} \times \text{[redacted]}$$

D.3.4. Commonwealth approval to access partial Funding for Compliant but Conditional Elements for a Management Action does not give rise for the State to access all the Funding for Compliant but Conditional Program Management and Corporate Overhead Costs related to that Management Action. Commonwealth approval of Funding and Activities for Compliant but Conditional Elements is outlined in Item B.4.5.

D.3.5. The State is responsible for managing the Program Management and Corporate Overheads Costs listed in Item D.3.1 for all Management Actions in accordance with Items D.3.2, D.3.3 and D.3.4.

D.3.6. Program Management and Corporate Overheads Costs cannot be subsidised by the Management Action Costs listed in Item D.2.3 and the State is responsible for meeting all Program Management and Department Costs in excess of the amounts approved under this Item D.3.

D.4. Early Works Carryover

D.4.1. The following Early Works Carryover amounts are approved for the following Management Actions:

Management Action	Commonwealth Funding (GST exclusive)	State Funding (GST exclusive)	Early Works Carryover
1. Restoration planting	[redacted]		
11. South east flows restoration – phase 2			
18. Meningie wetland project			
19. Monitoring and adaptive management 1 July 2011 to 31 December 2011 (gap monitoring)			
TOTAL			

D.4.2. With the exception of the Management Action 18: Meningie Wetland and Management Action 19: monitoring and adaptive management 1 July to 31 December 2011 (gap monitoring), Early Works Carryover is only to be used for Management Action Costs and not Program Management and Corporate Overhead Costs.

D.4.3. Management Action 18: Meningie Wetland and Management Action 19: monitoring and adaptive management 1 July to 31 December 2011 (Gap monitoring) will include costs associated with Program Management and Corporate Overheads in the budget for this Management Action (see Attachments U and V).

D.5. Contingency amounts contained in the Project Cost

D.5.1. The Project Cost contains a maximum contingency amount as determined by Item D.5.2.

D.5.2. Maximum contingency amounts for the relevant Management Actions are outlined in the following table:

Management Action	Contingency provision for Management Action
10. South east flows restoration – phase 2	[redacted]

D.5.3. The contingency amounts in the above table include both Funding and State Contributions.

D.5.4. For each claim that contingency is required for amounts of or above [redacted], prior to expending or committing to spend the contingency amount the State must first obtain the Commonwealth's written approval to use the contingency amount from the person holding the position of First Assistant Secretary responsible for the Sustainable Rural Water Use and Infrastructure Program in DoE. In determining the availability of the contingency amount the Commonwealth may have regard to savings (i.e. whether all Funds from previous Management Actions have been fully expended).

D.5.5. Commonwealth approval to use contingency amounts will not be unreasonably withheld.

D.5.6. For each claim that contingency is required for amounts below [redacted], the State is required to notify the Commonwealth in writing but not obtain written approval before the expending or committing to spend a contingency amount.

D.5.7. In each Project Report, the State is required to report on any contingency amount it has spent on a Management Action during the relevant reporting period.

D.5.8. For expenditure of contingency amounts in accordance with D.5.4 or D.5.6, once the Commonwealth is satisfied with the evidence provided by the State in relation to the expenditure of the contingency amount, the Commonwealth will reimburse the State for 90 per cent of the contingency amount, with the State to contribute the remaining 10 per cent, as set out in Item K.

D.5.9. Contingency amounts are not transferable between budget Activity lines within a Management Action or between Management Actions.

D.5.10. Project savings whether actual or expected cannot be used as contingency amounts.

D.6. Contribution Components of Priority Project

D.6.1. The parties' GST exclusive contributions to the Project Cost for this Priority Project (including Early Works carryover in D.4.1) is set out in the following table:

Contribution	**Maximum Contribution** ($)
1. Commonwealth Funding	[redacted]
2. State Contributions	
Project Cost as set out in Item D.1	

D.6.2. If cost savings are achieved in the course of the Priority Project, the parties' new financial contributions to that reduced Project Cost for this Priority Project shall be calculated according to the following formula:

a. the State Contributions to the reduced Project Cost will be 10 per cent of that Project Cost; and

b. the Funding to the reduced Project Cost will be 90 per cent of the Project Cost.

D.6.3. As at 30 June 2013 the State had Unused Funds and Interest which formed part of Funds the Commonwealth provided to the State under the Feasibility Study for Long-Term Management of the Coorong, Lower Lakes and Murray Mouth project, the Early Works for the Water for the Future, Enduring Response for the Coorong and Lower Lakes project, and the Goolwa Channel Water Level Management Project.

D.6.4. As at 30 June 2013, the total Unused Funds and Interest provided by the Commonwealth to the State for the completed project was [redacted]

D.6.5. Pursuant to clause 6.3.1(e) of the Agreement the State agrees:

a. that the Unused Funds and Interest of [redacted] held by the State forms part of the Funds for this Priority Project;

b. to spend the Unused Funds and Interest on its performance of this Priority Project and to account for the Unused Funds and Interest as Funds provided by the Commonwealth under this Project Schedule for this Priority Project; and

c. as Unused Funds and Interest Amount is already held by the State, the maximum amount of Funds to be physically transferred by the Commonwealth to the State for the Priority Project is up to [redacted] (being [redacted] minus [redacted] of the Unused Funds and Interest already held by the State).

D.7. State Contributions

D.7.1. The State agrees to provide the following cash contributions to the total Project Cost for this Priority Project at the following times as per the following tables:

D.7.2. Compliant State Contributions will be provided at the following times:

Compliant State Contributions	
GST exclusive amount of State Contribution	**When State Contribution is to be provided**
$1,380,154	Upon execution of this Project Schedule
$758,191	Upon the completion of Milestone 1
$299,137	Upon the completion of Milestone 2
$500,620	Upon the completion of Milestone 3
$404,624	Upon the completion of Milestone 4
$598,366	Upon the completion of Milestone 5
$416,287	Upon the completion of Milestone 6
$559,168	Upon the completion of Milestone 7

[redacted]	Upon the completion of Milestone 8
	Upon the completion of Milestone 9
	Upon the completion of Milestone 10
	Upon the completion of the final project Report

D.7.3. Compliant but Conditional State Contributions will be provided at the following times:

Compliant but Conditional Element State Contributions	
GST exclusive amount of State Contribution	**Condition for Compliant but Conditional State Contributions**
[redacted]	Upon the Commonwealth's approval of the Compliant but Conditional Elements at Attachment P (Monitoring and Adaptive Management Framework) and Phase 1 of Attachment M (South East Flows Restoration).
	Upon the completion of Milestone A
	Upon the completion of Milestone B
	Upon the completion of Milestone C
	Upon the completion of Milestone D and approval of the Compliant but Conditional Element at Attachment O (Ruppia Translocation Phase 2).
	Upon the completion of Milestone E and approval of the Compliant but Conditional Elements at Attachment K (Construction of Fishways), Attachment O (Ruppia Translocation Phase 3) and Attachment M (South East Flows Restoration).
	Upon the completion of Milestone F
	Upon the completion of Milestone G
	Upon the completion of Milestone H
	Upon the completion of Milestone I
	Upon the completion of Milestone J
	Upon the completion of Milestone K
	Upon the completion of the final Project Report

D.7.4. Once the Commonwealth approves in writing for a Compliant but Conditional Management Action listed under Item B.4.1 to commence, the Commonwealth and State agree to vary this Project Schedule to amend the Compliant but Conditional State Contribution amounts at Item D.7.3 (excluding Management Action 14: managing acid sulfate soils).

D.7.5. State Contributions varied under Item D.7.4 are to include an upfront payment of 25 per cent of the State Contribution for the commencing Compliant but Conditional Management Action except for Management Action 14: managing acid sulfate soils.

D.7.6. For the purposes of Item D.7.5 Compliant but Conditional Management Actions can only commence once.

D.7.7. The State is to provide, for Commonwealth approval, cashflowed State Contributions as dollar amounts for the Compliant but Conditional Management Action in Item D.7.3 for the full State Contribution amount.

D.7.8. Cashflows are to take into account Program Management and Corporate Overheads under Item D.3 and a final payment equal to a minimum of 2.5 per cent of approved Compliant but Conditional State Contributions.

D.7.9. Commonwealth approved cashflows are to be added to scheduled contributions under Item D.7.3 without creating any additional contributions.

D.7.10. Contingency State Contributions will be provided at the following times:

Contingency State Contributions	
GST exclusive amount of State Contribution	**Condition for State Contribution for Contingency**
[redacted]	Upon the Commonwealth's approval of the State's requested contingency amount under item D.5 to the maximum State Contributions, equal to 10 per cent of the total listed in item D.5.2, listed in item D.5.1, after taking into account the maximum available contingency for each management action.
Total Contingency State Contributions [redacted]	

D.7.11. State Contributions for Management Action 14: managing acid sulfate soils will be provided at the following times:

Management Action 14: Managing acid sulfate soils State Contributions	
GST exclusive amount of State Contribution	**Condition for State providing contribution for Compliant but Conditional Funding – managing acid sulfate soils**
Up to a maximum of [redacted] as partial State Contributions towards the cost of the limestone dosing event, as per the annual Workplans.	Upon the Commonwealth's approval of Milestone C.2.2 either in full or part. Payments under this section will be up to the requested amount until the maximum State Contributions under the managing acid sulfate soils Management Action under Item D.2.3 (Managing Acid Sulfate Soils) has been met.
Total [redacted]	

D.7.12. The State agrees that its State Contributions will not include any financial assistance that the State has received from the Commonwealth for this Priority Project.

D.7.13. In Item D.7.12 ‘financial assistance’ means Commonwealth money received under any Commonwealth program.

D.7.14. Land Acquisition under Management Action 10: South east flows restoration – phase 2 will be funded from the State Contributions.

D.8. Other Contributions

D.8.1. There are no Other Contributions for this Priority Project.

D.9. Budget

D.9.1. The State agrees to spend only the Funding and the State Contributions in accordance with the Management Action Costs as specified in Attachments D to W and as detailed in an approved Workplan under Item B.6.

D.9.2. Funding is not transferable between Management Actions without an approved variation to this Project Schedule SA-07.

D.9.3. Commonwealth approval under Item B.4.4 is required in writing before the State can access Funding or State Contributions for Compliant but Conditional Elements.

D.9.4. Funding is not transferable between Compliant and Compliant but Conditional Element Activities without written approval from the Commonwealth.

D.9.5. Commonwealth approval of Compliant but Conditional Elements does not make that Compliant but Conditional Element a Compliant Element, as both elements have already passed Due Diligence.

D.9.6. The Commonwealth is not responsible for the provision of any money or resources in excess of the Funds and the State agrees to bear all costs of completing the Priority Project in accordance with this Project Schedule that exceed the amount of Funding payable by the Commonwealth under Items D.2, D.3, D.4 and D.6.1 of this Project Schedule.

D.9.7. The State acknowledges that the provision of Funding for this Priority Project does not give rise to any Commonwealth obligation to fund any other proposals or expenditure arising from or in relation to the Priority Project.

E. Transfer of Water Entitlements and Salinity Credits

E.1. Agreed Water Savings

E.1.1. Reserved

E.2. Transfer of Water Entitlements

E.2.1. Reserved.

E.3. Salinity credits

E.3.1. The Commonwealth and State agree that salinity credits may result from this Priority Project.

E.3.2. The State and the Commonwealth recognise that the State has undertaken to ensure that any significant salinity credits and/or debits from this Priority Project will be administered as accountable actions and entered into the Murray-Darling Basin Authority's Salinity Registers and will accrue to the Commonwealth and the State in proportion to their financial contribution to the whole Priority Project. Monitoring and reporting for this clause will be through the Basin Salinity Management Strategy reporting processes as required under the Schedule B of the Murray-Darling Basin Agreement and will be the subject of independent salinity auditing, Ministerial Council approval and annual reporting published on the Murray-Darling Basin Authority's web site.

F. Sharing Actual Water Savings additional to Agreed Water Savings

F.1.1. Reserved.

G. Agreement Material and Existing Material relating to this Priority Project

G.1.1. Reserved.

H. Indemnity

H.1.1. Notwithstanding any other provision of this Project Schedule, the State agrees to indemnify, and keep indemnified, the Commonwealth against any cost, liability, loss or expense incurred by the Commonwealth:

a. in rectifying any environmental damage; or

b. in dealing with any third party (including Commonwealth Personnel) claims against the Commonwealth, which includes without limitation the Commonwealth's legal costs and expenses on a solicitor/own client basis and the cost of time spent, resources used and disbursements paid by the Commonwealth,

arising from any act or omission by the State or its Personnel in connection with the Priority Project specified in this Project Schedule.

H.1.2. The State's liability to indemnify the Commonwealth under this Item H will be reduced proportionally to the extent that any fault on the Commonwealth's part contributed to the relevant cost, liability, loss or expense. In this Item H.1.2, 'fault' means any reckless, negligent or unlawful act or omission or wilful misconduct.

H.1.3. The right of the Commonwealth to be indemnified in this Item H is in addition to, and not exclusive of, any other right, power or remedy provided to the Commonwealth by law, but the Commonwealth is not entitled to be compensated in excess of the relevant cost, liability, loss or expense.

I. Insurance

I.1.1. Reserved.

J. Project Reports

J.1. Priority Project Reports

J.1.1. The State is required to prepare and provide the Commonwealth with the following project Reports:

Project Reports		
Report Type	**Details**	**Date Report Due**
Progress Report 1	A progress Report that contains the information specified in Item J.2 of this Project Schedule that demonstrates the completion of Project Milestone 1 and Compliant but Conditional Milestones A and Item C.2.2.	31 March 2012
Progress Report 2	A progress Report that contains the information specified in Item J.2 of this Project Schedule that demonstrates the completion of Project Milestone 2 and Compliant but Conditional Milestones B and Item C.2.2.	30 September 2012
Progress Report 3	A progress Report that contains the information specified in Item J.2 of this Project Schedule that demonstrates the completion of Project Milestone 3 and Compliant but Conditional Milestones C and Item C.2.2.	31 March 2013
Progress Report 4	A progress Report that contains the information specified in Item J.2 of this Project Schedule that demonstrates the completion of Project Milestone 4 and Compliant but Conditional Milestones D and Item C.2.2.	30 September 2013
Progress Report 5	A progress Report that contains the information specified in Item J.2 of this Project Schedule that demonstrates the completion of Project Milestone 5 and Compliant but Conditional Milestones E and Item C.2.2.	31 March 2014
Progress Report 6	A progress Report that contains the information specified in Item J.2 of this Project Schedule that demonstrates the completion of Project Milestone 6 and Compliant but Conditional Milestones F and Item C.2.2.	30 September 2014

Project Reports		
Report Type	**Details**	**Date Report Due**
Progress Report 7	A progress Report that contains the information specified in Item J.2 of this Project Schedule that demonstrates the completion of Project Milestone 7 and Compliant but Conditional Milestones G and Item C.2.2.	31 March 2015
Progress Report 8	A progress Report that contains the information specified in Item J.2 of this Project Schedule that demonstrates the completion of Project Milestone 8 and Compliant but Conditional Milestones H and Item C.2.2.	30 September 2015
Progress Report 9	A progress Report that contains the information specified in Item J.2 of this Project Schedule that demonstrates the completion of Project Milestone 9 and Compliant but Conditional Milestones I and Item C.2.2.	31 March 2016
Progress Report 10	A progress Report that contains the information specified in Item J.2 of this Project Schedule that demonstrates the completion of Project Milestone 10 and Compliant but Conditional Milestones J and Item C.2.2.	30 September 2016
Progress Report 11	A progress Report that contains the information specified in Item J.2 of this Project Schedule that demonstrates the completion of the Compliant but Conditional Milestone K.	31 March 2017
Final Project Report	A final Project Report as required by Project Milestone 11 that contains the information specified in Item J.3 of this Project Schedule.	By the date specified in Item J.3.2.
Audited Financial Report	An audited financial report as required by Item C of Schedule 4 of this Agreement that contains the information specified in that Item.	By the dates specified in Item C of Schedule 4 of the Agreement.
Evaluation Report	An Evaluation Report that contains the information specified in Item J.5 of this Project Schedule.	By the date specified in Item J.5.2.

J.1.2. The Commonwealth's approval of each project Report listed in Item J.1.1 is required.

J.2. Progress Reports

J.2.1. Each progress Report must include at a minimum:

a. a description of work undertaken in respect of the Priority Project up to and including the completion of the Project Milestone to which the Report relates that includes:

i. Priority Project achievements to date, including evidence that each of the Management Action Milestones specified in the relevant Project Milestone have been met and where relevant in accordance with agreed outputs as contained in the annual Workplans;

ii. in respect of each Proponent to whom a grant of Funds has been made, the work undertaken by that Proponent for the Priority Project;

iii. the Management Action Deliverables (as specified in Attachments D to W), as they relate to the Activities in the annual Workplans that have been achieved to date. This includes a discussion of the extent to which the completed Activities are being used for the purpose of progress towards the Management Action Deliverables and Management Action Outcomes under Item B.2;

iv. an explanation of any difficulties or delays encountered to date in the performance of the Priority Project, including the extent to which the Management Action Outcomes have not been met; and

v. any approved limestoning undertaken during the relevant reporting period for which the Commonwealth has made a payment under Item K;

b. a detailed statement of the State's receipt and expenditure of the Funds and the State Contributions to date for the Priority Project against each Management Action in accordance with the Financial Reporting Template in an approved Workplan that meets the requirements of Attachment B and Item B.6 including interest earned by the State on the Funds or State Contributions and any contingency Funds expended during the Report period;

c. a statement of the receipt and expenditure of the Funds and State Contribution by each Proponent for the Priority Project to date;

d. details of all promotional activities undertaken in relation to, and media coverage of, the Priority Project during the period that is the subject of the Report and any expected promotional opportunities, during the next reporting period of the Priority Project;

e. a description of the work that will be undertaken to complete the Priority Project;

f. a statement as to whether the Priority Project is proceeding within the Project Cost, and if it is not an explanation as to why the Project Cost is not being met and the action the State proposes to immediately take to address this; and

g. any other items that are agreed by the State and the Commonwealth to be included in the progress Reports.

J.3. Final Project Report

J.3.1. The final project Report must be a stand-alone document that can be used for public information dissemination purposes regarding this Priority Project.

J.3.2. The final project Report for the Priority Project is due within 80 Business Days of the earliest of:

a. the completion of the Priority Project; or

b. the termination of the Agreement or this Project Schedule.

J.3.3. The final project Report must contain the following information:

a. a description of the conduct, benefits and outcomes of the Priority Project as a whole;

b. an analysis of this Priority Project, including assessing the extent to which the Outcomes of the Priority Project (as specified in Item B.2 of this Project Schedule) have been achieved and explaining why any aspect of the Priority Project was not achieved;

c. high level financial information regarding the State's receipt and expenditure of the Funds and State Contributions to date, a summary of contingency amounts expended, including any interest earned by the State on the Funds, for the entire period of the Priority Project;

d. a summary of all promotional activities undertaken in relation to, and media coverage of, the Priority Project;

e. a discussion of any other matters, relating to the Priority Project, which the Commonwealth notifies the State should be included in this final project Report at least 20 Business Days before it is due; and

f. any other information that is agreed by the State and the Commonwealth to be included in the final project Report.

J.3.4. The final project Report should be accompanied by a separate document that contains a certified income and expenditure statement signed by the Chief Finance Officer, SA Department of Environment, Water and Natural Resources that clearly identifies:

a. the State's receipt and expenditure of the Funding for this Priority Project, that separately identifies the contingency expenditure paid for by the Funding and confirms the amount of Funding that was expended by the State in accordance with this Project Schedule;

b. the receipt and expenditure of any interest earned by the State on the Funding and State Contributions;

c. the receipt and expenditure of any State Contributions provided by the State for the Priority Project that separately identifies the contingency expenditure paid for by the State Contributions;

d. any cost savings or cost overruns for the Priority Project; and

e. the amount, if any, of Funds paid to the State that the State has not spent on this Priority Project in accordance with this Agreement.

J.4. Audited Financial Reports

J.4.1. Audited financial Reports are to be provided for the Priority Project as specified in Schedule 4 Item C of the Agreement.

J.5. Evaluation Report

J.5.1. An Evaluation Report is to be provided by the State, building on information provided in progress Reports for the Priority Project, that clearly demonstrates:

a. the extent to which the completed Works are being used for the Outcomes throughout the Evaluation Period;

b. the extent to which the Priority Project has met, exceeded or fallen short of the Priority Project Outcomes during the Evaluation Period; and

c. any other items that are agreed by the State and the Commonwealth to be included in the Evaluation Report.

J.5.2. The Evaluation Report is due within 40 Business Days after the earlier of:

a. the expiry of the Evaluation Period; or

b. the termination of the Agreement or this Project Schedule.

K. Payment Schedule for Commonwealth Funding for this Priority Project

K.1.1. Subject to the terms of clauses 6 and 17 of the Agreement, the maximum GST exclusive amount of Funds payable by the Commonwealth to the State in respect of this Priority Project is [redacted] which comprises the Unused Funds and Interest Amount of [redacted] specified in Item D.6.4 (which is already held by the State) and [redacted] of Funds payable by the Commonwealth to the State, which shall be paid in the instalments, and on the completion of the Payment Preconditions, specified in the following tables at Items K.2.1; K.3.1; K.4.1 and K.5.1.

K.2. Payment Schedule for Compliant Commonwealth Funding

K.2.1. The payments for Compliant Funding will be paid in the instalments, and on the completion of the Payment Preconditions, specified in the following table:

Payment Schedule for Compliant Commonwealth Funding		
Funding Payment Number	**Funding instalment (GST exclusive)**	**Payment Preconditions for Funding instalment**
1.	[redacted]	Execution of this Project Schedule by the parties. The State's provision of an invoice for this payment of Funds and acceptance of that invoice by the Commonwealth.
2.	[redacted]	The State's completion of Project Milestone 1 and its provision of progress Report 1 and the Commonwealth's acceptance of the State's completion of that Project Milestone and approval of the progress Report. The State's provision of an invoice for this payment of Funds and the Commonwealth's acceptance of that invoice.
3.	[redacted]	The State's completion of Project Milestone 2 and its provision of progress Report 2 and the Commonwealth's acceptance of the State's completion of that Project Milestone and approval of the progress Report. The State's provision of an invoice for this payment of Funds and the Commonwealth's acceptance of that invoice.
4.	[redacted]	The State's completion of Project Milestone 3 and its provision of progress Report 3 and the Commonwealth's acceptance of the State's completion of that Project Milestone and approval of the progress Report. The State's provision of an invoice for this payment of Funds and the Commonwealth's acceptance of that invoice.

Payment Schedule for Compliant Commonwealth Funding		
Funding Payment Number	**Funding instalment (GST exclusive)**	**Payment Preconditions for Funding instalment**
5.	[redacted]	The State's completion of Project Milestone 4 and its provision of progress Report 4 and the Commonwealth's acceptance of the State's completion of that Project Milestone and approval of the progress Report. The State's provision of an invoice for this payment of Funds and the Commonwealth's acceptance of that invoice.
6.	[redacted]	The State's completion of Project Milestone 5 and its provision of progress Report 5 and the Commonwealth's acceptance of the State's completion of that Project Milestone and approval of the progress Report. The State's provision of an invoice for this payment of Funds and the Commonwealth's acceptance of that invoice. The invoice must clearly note that this payment is $4,895,395.50 rather than $5,385,298 because $489,902.50 of Funds has already been provided to the State as per Item D.6.4 of this Project Schedule.
7.	[redacted]	The State's completion of Project Milestone 6 and its provision of progress Report 6 and the Commonwealth's acceptance of the State's completion of that Project Milestone and approval of the progress Report. The State's provision of an invoice for this payment of Funds and the Commonwealth's acceptance of that invoice.

Payment Schedule for Compliant Commonwealth Funding		
Funding Payment Number	**Funding instalment (GST exclusive)**	**Payment Preconditions for Funding instalment**
8.	[redacted]	The State's completion of Project Milestone 7 and its provision of progress Report 7 and the Commonwealth’s acceptance of the State’s completion of that Project Milestone and approval of the progress Report. The State's provision of an invoice for this payment of Funds and the Commonwealth’s acceptance of that invoice.
9.	[redacted]	The State's completion of Project Milestone 8 and its provision of progress Report 8 and the Commonwealth’s acceptance of the State’s completion of that Project Milestone and approval of the progress Report. The State's provision of an invoice for this payment of Funds and the Commonwealth’s acceptance of that invoice.
10.	[redacted]	The State's completion of Project Milestone 9 and its provision of progress Report 9 and the Commonwealth’s acceptance of the State’s completion of that Project Milestone and approval of the progress Report. The State's provision of an invoice for this payment of Funds and the Commonwealth’s acceptance of that invoice.
11.	[redacted]	The State's completion of Project Milestone 10 and its provision of progress Report 10 and the Commonwealth’s acceptance of the State’s completion of that Project Milestone and approval of the progress Report. The State's provision of an invoice for this payment of Funds and the Commonwealth’s acceptance of that invoice.

Payment Schedule for Compliant Commonwealth Funding		
Funding Payment Number	**Funding instalment (GST exclusive)**	**Payment Preconditions for Funding instalment**
12.	[redacted]	The State's completion and provision of the final Project Report and the Commonwealth's approval of that final Project Report. The State's provision of an invoice for this payment of Funds and the Commonwealth's acceptance of that invoice.
Total Compliant	[redacted]	

*The maximum total Compliant Commonwealth Funds for the Priority Project includes the Unused Funds and Interest Amount of [redacted] already held by the State as per Item D.6.4, and [redacted] of Funds payable by the Commonwealth under Item K.2.1.

K.3. Compliant but Conditional Funding payments

K.3.1. The payments for Compliant but Conditional Funding, with the exception of Management Action 14: managing acid sulfate soils and Contingency Funding will be paid in the instalments, and on the completion of the Payment Preconditions, specified in the following table:

Payment Schedule for Compliant but Conditional Commonwealth Funding		
Funding Payment Number	**Funding instalment (GST exclusive)**	**Payment Preconditions for Funding instalment**
A.	[redacted]	Upon the Commonwealth's approval of the Compliant but Conditional Elements at Attachment P (Monitoring and Adaptive Management Framework) and Phase 1 of Attachment M (South East Flows Restoration). The State's provision of an invoice for this payment of Funds and the Commonwealth's acceptance of that invoice.

Payment Schedule for Compliant but Conditional Commonwealth Funding		
Funding Payment Number	**Funding instalment (GST exclusive)**	**Payment Preconditions for Funding instalment**
B.	[redacted]	The State's completion of Project Milestone A and its provision of progress Report 1 and the Commonwealth's acceptance of the State's completion of that Project Milestone and approval of the progress Report. The State's provision of an invoice for this payment of Funds and the Commonwealth's acceptance of that invoice.
C.	[redacted]	The State's completion of Project Milestone B and its provision of progress Report 2 and the Commonwealth's acceptance of the State's completion of that Project Milestone and approval of the progress Report. The State's provision of an invoice for this payment of Funds and the Commonwealth's acceptance of that invoice.
D.	[redacted]	The State's completion of Project Milestone C and its provision of progress Report 3 and the Commonwealth's acceptance of the State's completion of that Project Milestone and approval of the progress Report. The State's provision of an invoice for this payment of Funds and the Commonwealth's acceptance of that invoice.
E.	[redacted]	Upon the approval of the Compliant but Conditional Element at Attachment O (Ruppia Translocation Phase 2), and the State's completion of Project Milestone D and its provision of progress Report 4 and the Commonwealth's acceptance of the State's completion of that Project Milestone and approval of the progress Report. The State's provision of an invoice for this payment of Funds and the Commonwealth's acceptance of that invoice.

Payment Schedule for Compliant but Conditional Commonwealth Funding		
Funding Payment Number	**Funding instalment (GST exclusive)**	**Payment Preconditions for Funding instalment**
F.	[redacted]	Upon the approval of the Compliant but Conditional Element at Attachment K (Construction of Fishways), Attachment O (Ruppia Translocation Phase 3) and Attachment M (South East Flows Restoration), and the State's completion of Project Milestone E and its provision of progress Report 5 and the Commonwealth's acceptance of the State's completion of that Project Milestone and approval of the progress Report. The State's provision of an invoice for this payment of Funds and acceptance of that invoice by the Commonwealth.
G.	[redacted]	The State's completion of Project Milestone F and its provision of progress Report 6 and the Commonwealth's acceptance of the State's completion of that Project Milestone and approval of the progress Report. The State's provision of an invoice for this payment of Funds and the Commonwealth's acceptance of that invoice.
H.	[redacted]	The State's completion of Project Milestone G and its provision of progress Report 7 and the Commonwealth's acceptance of the State's completion of that Project Milestone and approval of the progress Report. The State's provision of an invoice for this payment of Funds and the Commonwealth's acceptance of that invoice.
I.	[redacted]	The State's completion of Project Milestone H and its provision of progress Report 8 and the Commonwealth's acceptance of the State's completion of that Project Milestone and approval of the progress Report. The State's provision of an invoice for this payment of Funds and the Commonwealth's acceptance of that invoice.

Payment Schedule for Compliant but Conditional Commonwealth Funding		
Funding Payment Number	**Funding instalment (GST exclusive)**	**Payment Preconditions for Funding instalment**
J.	[redacted]	The State's completion of Project Milestone I and its provision of progress Report 9 and the Commonwealth's acceptance of the State's completion of that Project Milestone and approval of the progress Report. The State's provision of an invoice for this payment of Funds and the Commonwealth's acceptance of that invoice.
K.	[redacted]	The State's completion of Project Milestone J and its provision of progress Report 10 and the Commonwealth's acceptance of the State's completion of that Project Milestone and approval of the progress Report. The State's provision of an invoice for this payment of Funds and the Commonwealth's acceptance of that invoice.
L.	[redacted]	The State's completion of Project Milestone K and its provision of progress Report 11 and the Commonwealth's acceptance of the State's completion of that Project Milestone and approval of the progress Report. The State's provision of an invoice for this payment of Funds and the Commonwealth's acceptance of that invoice.
M.	[redacted]	The State's completion and provision of the final Project Report and the Commonwealth's approval of that final Project Report. The State's provision of an invoice for this payment of Funds and the Commonwealth's acceptance of that invoice.
Total Compliant but Conditional	[redacted]	

K.3.2. Once the Commonwealth approves in writing for a Compliant but Conditional Management Action listed under Item B.4.1 to commence, the Commonwealth and State agree to vary this Project Schedule to amend the payment schedule at Item K.3.1, excluding Management Action 14: managing acid sulfate soils.

K.3.3. Funding amounts varied under Item K.3.2 are to include an upfront payment of 25 per cent of the Funding for the commencing Compliant but Conditional Management Action except for Management Action 14: managing acid sulfate soils.

K.3.4. For the purposes of Item K.3.3 Compliant but Conditional Management Actions can only commence once.

K.3.5. The State is to provide, for Commonwealth approval, cashflowed Funding payments as dollar amounts for the Compliant but Conditional Management Action in Item K.3.1 for the full Funding amount.

K.3.6. Cashflows are to take into account Program Management and Corporate Overheads under Item D.3 and a final payment equal to a minimum of 2.5 per cent of approved Compliant but Conditional Funding.

K.3.7. Commonwealth approved cashflows are to be added to existing scheduled payments under item K.3.1 without creating any additional payments.

K.4. Contingency Funding Payments

K.4.1. The payments for Contingency Funding will be paid in the instalments, and on the completion of the Payment Preconditions, specified in the following table:

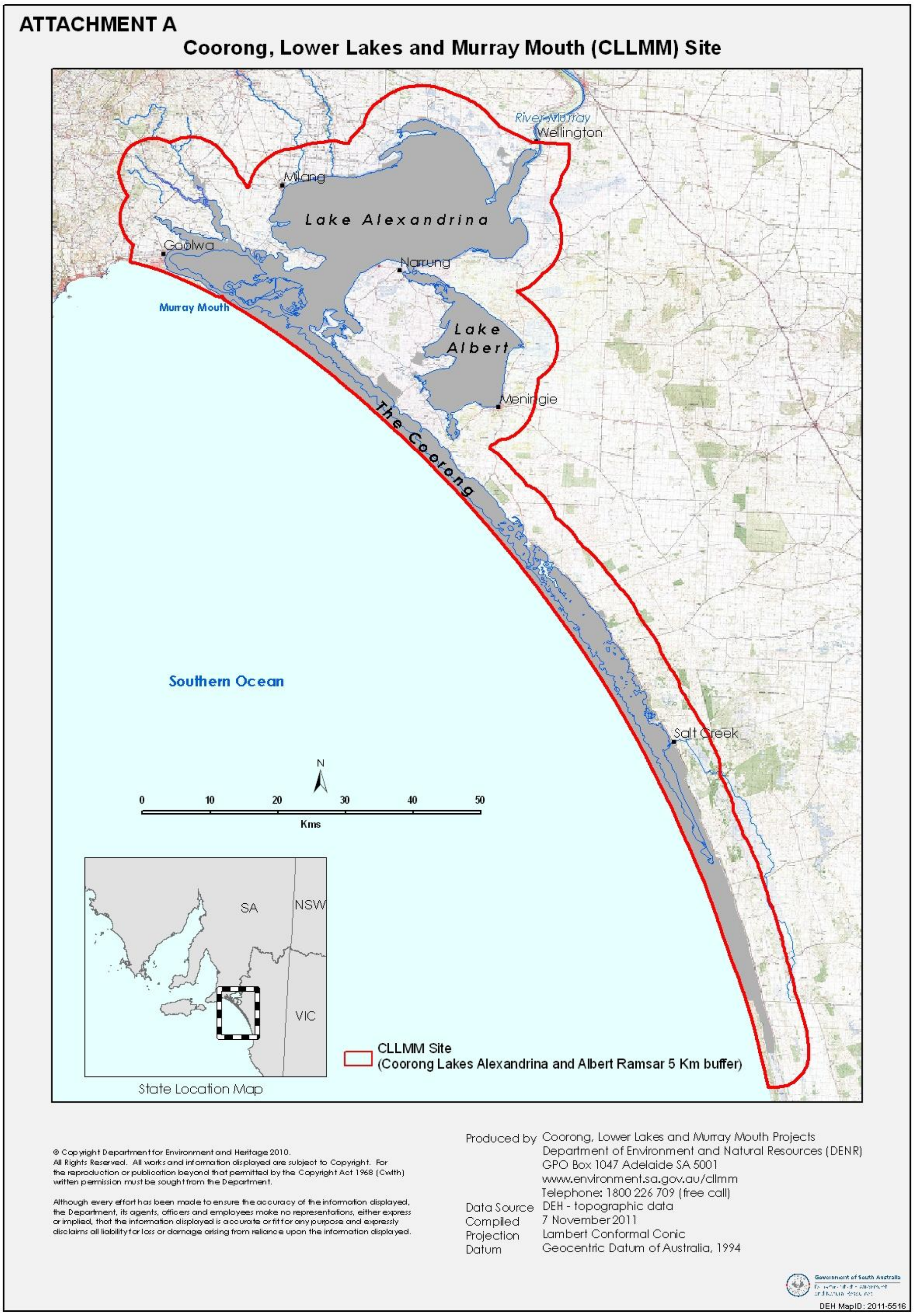
Payment Schedule for Contingency Funding		
Funding Payment Number	**Funding instalment (GST exclusive)**	**Payment Preconditions for Funding instalment**
N.	[redacted]	Upon the Commonwealth's approval of the State's requested contingency amount under item D.5 to the maximum Funding, equal to 90 per cent of the total listed in item D.5.2, after taking into account the maximum available contingency for each Management Action. Payments under this section N will be added to the next scheduled payment.
Total available contingency Funding	[redacted]	

K.5. Managing Acid Sulfate Soils Funding payments

K.5.1. The payments for Management Action 14: managing acid sulfate Soils will be paid in the instalments, and on the completion of the Payment Preconditions, specified in the following table:

Payment Schedule for Management Action 14: Managing Acid Sulfate Soils Funding		
Funding Payment Number	**Funding instalment (GST exclusive)**	**Payment Preconditions for Funding instalment**
O.	Up to a maximum of [redacted] to be paid as partial payments of the Commonwealth Funding towards the cost of the limestone dosing event, as per the annual Workplans.	Upon the Commonwealth's approval of Milestone from Item C.2.2 either in full or part. Payments under this section O will be up to the requested amount until the maximum Funding under the managing acid sulfate soils Management Action under Item D.2.3 (managing acid sulfate soils) has been met. Payments under this section O will be added to the next scheduled payment.
Total Managing Acid Sulfate Soils Funding	[redacted]	

ATTACHMENT A



ATTACHMENT B

Department of Environment, Water and Natural Resources

South Australian Priority Project SA-07 - Coorong, Lower Lakes and Murray Mouth Recovery Project

Statement of Income and Expenditure Template

For the Period Project Commencement to *(reporting date)*

Budget ($)		Actual ($)					
	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	Total
Income							
Commonwealth Funding							
- 1. Payment on signature							0
- 2. Progress Payment							0
- 3. Progress Payment							0
- 4. Progress Payment							0
- 5. Progress Payment							0
- 6. Progress Payment							0
- 7. Progress Payment							0
- 8. Progress Payment							0
- 9. Progress Payment							0
- 10. Progress Payment							0
- 11. Progress Payment							0
- 12. Compliant Final Payment							0
- Commencement Payment - Monitoring and Adaptive Management							0
- Commencement Payment - Fishways							0
- Commencement Payment - South East Flows Restoration							0
- Commencement Payment - Ruppia Translocation							0
- A. Progress Payment							0
- B. Progress Payment							0

- C. Progress Payment							0
- D. Progress Payment							0
- E. Progress Payment							0
- F. Progress Payment							0
- G. Progress Payment							0
- H. Progress Payment							0
- I. Progress Payment							0
- J. Progress Payment							0
- K. Progress Payment							0
- L. Progress Payment							0
- M. Compliant but Conditional Final Payment							0
- N. Contingency							0
- O. Managing Acid Sulfate Soils							0
Sub-total	0	0	0	0	0	0	0

Budget ($)				**Actual ($)**			
	2011-12	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**Total**
State Contributions							
- 1. Payment on signature							0
- 2. Progress Payment							0
- 3. Progress Payment							0
- 4. Progress Payment							0
- 5. Progress Payment							0
- 6. Progress Payment							0
- 7. Progress Payment							0
- 8. Progress Payment							0
- 9. Progress Payment							0
- 10. Progress Payment							0
- 11. Progress Payment							0
- 12. Compliant Final Payment							0
- Commencement Payment - Monitoring and Adaptive Management							0
- Commencement Payment - Fishways							0
- Commencement Payment - South East Flows Restoration							0

	- Commencement Payment - Ruppia Translocation								0
	- A. Progress Payment								0
	- B. Progress Payment								0
	- C. Progress Payment								0
	- D. Progress Payment								0
	- E. Progress Payment								0
	- F. Progress Payment								0
	- G. Progress Payment								0
	- H. Progress Payment								0
	- I. Progress Payment								0
	- J. Progress Payment								0
	- K. Progress Payment								0
	- L. Progress Payment								0
	- M. Compliant but Conditional Final Payment								0
	- N. Contingency								0
	- O. Managing Acid Sulfate Soils								0
		Sub-total	0	0	0	0	0	0	0
	Interest								
	- Interest earned on Commonwealth Funding								
	- Interest earned on State Contributions								
		Sub-total	0	0	0	0	0	0	0
0	***TOTAL INCOME***		0	0	0	0	0	0	0

Budget ($)		Actual ($)						
		2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	Total
	Expenditure *							
	1. Restoration planting							0
	2. Fencing							0
	3. Pest management							0
	4. Vegetation - community involvement							0
	5. Vegetation - Aboriginal heritage							0
	6. Vegetation - monitoring and research							0
	7. Vegetation - project management							0
	8. Construction of fishways							0
	9. Critical fish habitat							0
	10 a. South East flows restoration - Phase 1							0
	10 b. South East flows restoration - Phase 2							0
	12 a. Ruppia Translocation - Phase 2							0
	12 b. Ruppia Translocation - Phase 3							0
	13. Monitoring and adaptive management framework							0
	14. Managing acid sulfate soils							0
	15. Research priorities							0
	16. Community engagement and communications							0
	17. Ngarrindjeri partnerships							0
	18. Meningie wetland							0
	19. Monitoring and adaptive management - gap monitoring							0
	20. Lake Albert Scoping Study							0
	Program Management and Corporate Overheads							0
0	***TOTAL EXPENDITURE***	0	0	0	0	0	0	0
0	**Net Surplus/(Deficit)**	0	0	0	0	0	0	0

* Refer to attached detailed expenditure statements

Certification Statement

On behalf of the Department of Environment and Natural Resources, I hereby certify that:

all Funding and State Contributions and Other Contributions were spent in accordance with the Project Schedule SA-07 and the Water Management Partnership Agreement

Signature of Project Director	**Signature of Chief Financial Officer**
Date:	**Date:**

Management Action 1
Income and Expenditure Statement

Budget			**Actual** 1/7/2011 - 31/12/2011		**Actual** 1/01/2012 - 30/06/2012	**Total Received 2011-12**
	Income					
	Commonwealth Funding					0
	State Contribution					0
0			0		0	0

Budget ($)			**Budget** 1/7/2011 - 31/12/2011	**Actual ($)** 1/7/2011 - 31/12/2011	**Budget** 1/01/2012 - 30/06/2012	**Actual ($)** 1/01/2012 - 30/06/2012	**Total Actual 2011-12**
	Expenditure						
	Activity 1	Reporting Line 1 (insert as per agreed)					0
		Reporting Line 2 (insert as per agreed)					0
		Reporting Line 3 (insert as per agreed)					0
	Activity 2	Reporting Line 1 (insert as per agreed)					0
		Reporting Line 2 (insert as per agreed)					0
		Reporting Line 3 (insert as per agreed)					0
	Activity 3	Reporting Line 1 (insert as per agreed)					
		Reporting Line 2 (insert as per agreed)					
		Reporting Line 3 (insert as per agreed)					
0			0	0	0	0	0
0		Net Surplus/Deficit		0		0	0

Actual 1/7/2012 - 31/12/2012	Actual 1/01/2013 - 30/06/2013	Total Received 2012-13	Cumulative Total Received
		0	0
		0	0
0	0	0	0

Actual 1/7/2013 - 31/12/2013	Actual 1/01/2014 - 30/06/2014	Total Received 2013-14	Cumulative Total Received
		0	0
		0	0
0	0	0	0

Budget 1/7/2012 - 31/12/2012	Actual 1/7/2012 - 31/12/2012	Budget 1/01/2013 - 30/06/2013	Actual 1/01/2013 - 30/06/2013	Total Actual 2012-13	Cumulative Actual
				0	0
				0	0
				0	0
				0	0
				0	0
				0	0
0	0	0	0	0	0
	0		0	0	0

Budget 1/7/2013 - 31/12/2013	Actual 1/7/2013 - 31/12/2013	Budget 1/01/2014 - 30/06/2014	Actual 1/01/2014 - 30/06/2014	Total Actual 2013-14	Cumulative Actual
				0	0
				0	0
				0	0
				0	0
				0	0
				0	0
0	0	0	0	0	0
	0		0	0	0

Actual 1/7/2014 - 31/12/2014	Actual 1/01/2015 - 30/06/2015	Total Received 2014-15	Cumulative Total Received
		0	0
		0	0
0	0	0	0

Actual 1/7/2015 - 31/12/2015	Actual 1/01/2016 - 30/06/2016	Total Received 2015-16	Cumulative Total Received
		0	0
		0	0
0	0	0	0

Budget 1/7/2014 - 31/12/2014	Actual 1/7/2014 - 31/12/2014	Budget 1/01/2015 - 30/06/2015	Actual 1/01/2015 - 30/06/2015	Total Actual 2014-15	Cumulative Actual
				0	0
				0	0
				0	0
				0	0
				0	0
				0	0
0	0	0	0	0	0
	0		0	0	0

Budget 1/7/2015 - 31/12/2015	Actual 1/7/2015 - 31/12/2015	Budget 1/01/2016 - 30/06/2016	Actual 1/01/2016 - 30/06/2016	Total Actual 2015-16	Cumulative Actual
				0	0
				0	0
				0	0
				0	0
				0	0
				0	0
0	0	0	0	0	0
	0		0	0	0

Actual 1/7/2016 - 31/12/2016	Actual 1/01/2017 - 30/06/2017	Total Received 2016-17	Cumulative Total Received
		0	0
		0	0
0	0	0	0

Budget 1/7/2016 - 31/12/2016	Actual 1/7/2016 - 31/12/2016	Budget 1/01/2017 - 30/06/2017	Actual 1/01/2017 - 30/06/2017	Total Actual 2016-17	Cumulative Actual
				0	0
				0	0
				0	0
				0	0
				0	0
				0	0
0	0	0	0	0	0
	0		0	0	0

Management Action Name
Vegetation program (Management Actions 1 to 7)
Management Action Description
The *vegetation program* consists of seven separate but related Management Actions: • *Management Action 1: Restoration through Wetland and Terrestrial Vegetation Planting* • *Management Action 2: Vegetation Fencing* • *Management Action 3: Vegetation Pest Management* • *Management Action 4: Community Involvement in Vegetation Program* • *Management Action 5: Vegetation Aboriginal Heritage* • *Management Action 6: Vegetation Monitoring and Research* • *Management Action 7: Vegetation Project Management.* The detail of each Management Action within the vegetation program is described in Management Action 1 to Management Action 7. Vegetation program Activities can only occur within the CLLMM Site and not the Upper South East.
Management Action Outcome
The overarching outcome of the *vegetation program* is to stabilise the ecological decline of the CLLMM region and to deliver a healthy and resilient wetland and community that is able to adapt to changing water levels. The Management Actions that sit within the vegetation program each have a Management Action Outcome that contributes to the achievement of the overarching vegetation program outcome as described in this attachment.

Management Action Name

Management Action 1: *Restoration through Wetland and Terrestrial Vegetation Planting*

Management Action Description

Planting of the lakebed, littoral and terrestrial zones using a combination of plant species to stabilise exposed acid sulfate soils, support aquatic-terrestrial connectivity, self-sustaining populations and habitat complexity.

Management Action Outcomes

To support the restoration of the ecological character of the CLLMM Site and support populations of plants and animal species important for maintaining biological diversity.

Management Action Deliverables

The *Restoration through Wetland and Terrestrial Vegetation Planting* Management Action requires the State to:

- Develop revegetation site plans for commercially managed revegetation areas based on the vegetation program planning process (funded as part of Management Action 7 - *Vegetation Project Management*), which is based on:
    - a vegetation strategy and project plan;
    - a regional vegetation plan;
    - annual Workplans; and
    - revegetation/restoration site action plans.
- Conduct lakebed, littoral and terrestrial planting Activities in five areas around the CLLMM Site:
    - Lake Albert;
    - Lake Alexandrina;
    - Goolwa Channel;
    - Barrages and islands; and
    - Coorong.
- Conduct lakebed, littoral and terrestrial priority planting to restore ecological function through habitat reconstruction and improvement in habitat biodiversity.
- Ngarrindjeri to conduct seed collection, propagation and planting of native plants for the protection of culturally significant sites across the CLLMM Site.

Management Action Conduct and Conditions

Conduct:

- All Activities are to be in accordance with an approved Workplan as described in Item B.6 of this Project Schedule to achieve the Management Action Deliverables listed above.
- Subject to lake water levels, planting in lakebed, littoral and terrestrial zones will be prioritised to manage acid sulfate soils.
- This Management Action runs over an 18-month planting cycle. A ‘planting cycle’ means the 18-month (autumn one year to spring of the following year) period required to collect seed, propagate plants, prepare planting sites and complete planting.
- Lakebed planting occurs below +0.6 m AHD, littoral planting occurs between +0.6 m AHD and +1.5 m AHD depending on local conditions and terrestrial planting occurs above +1.5 m AHD.

Management Action Milestones

Compliant Elements		Completion date
1.A	Completion of restoration Activities in accordance with agreed 2011/12 Workplan.	31 December 2011
1.B	Completion of restoration Activities in accordance with agreed 2011/12 Workplan.	30 June 2012
1.C	Completion of restoration Activities in accordance with agreed 2012/13 Workplan.	31 December 2012
1.D	Completion of restoration Activities in accordance with agreed 2012/13 Workplan.	30 June 2013
1.E	Completion of restoration Activities in accordance with agreed 2013/14 Workplan.	31 December 2013
1.F	Completion of restoration Activities in accordance with agreed 2013/14 Workplan.	30 June 2014
1.G	Completion of restoration Activities in accordance with agreed 2014/15 Workplan.	31 December 2014
1.H	Completion of restoration Activities in accordance with agreed 2014/15 Workplan.	30 June 2015
1.I	Completion of restoration Activities in accordance with agreed 2015/16 Workplan.	31 December 2015
1.J	Completion of restoration Activities in accordance with agreed 2015/16 Workplan.	30 June 2016

Compliant but Conditional Elements

Management Action Milestones 1.K to 1.T are not applicable for this Management Action

Management Action Costs

Activity	Compliant	Compliant but Conditional	Total
Seed collection and propagation	[redacted]		
Planting			
Lakebed seeding			
Sub-total			
Ngarrindjeri involvemen			
Seed collection and propagation			
Planting			
Sub-total Ngarrindjeri Involvement			
TOTAL (as per Item D.2.3 of this Project			

Schedule)	[redacted]
Early Works Carryover	
Planting	
Early Works Carryover (as per Item D.4.1 of this Project Schedule)	
Expected Management Action completion date	30 June 2016

Management Action Name
Management Action 2: *Vegetation Fencing*
Management Action Description
Construct up to 200km of fencing and stock watering points over three years for shoreline boundaries of Lake Albert, Lake Alexandrina, the tributaries of Currency Creek and Finniss River, and islands as well as to protect revegetation from stock grazing.
Management Action Outcomes
The protection of shoreline, lakebed and revegetation sites from stock.
Management Action Deliverables
The *Vegetation Fencing* component of the vegetation program requires the State to: • Develop a fencing strategy (funded under Management Action 7 - *Vegetation Project Management*). • Liaise with landholders to maximise uptake. • Seek appropriate heritage clearances (funded under Management Action 5 - *Vegetation Aboriginal Heritage)* and approvals. • Construct up to 200km of fencing in accordance with annual Workplans. • Install water points for stock where new fencing prevents access to a lake, river or creek.
Management Action Conduct and Conditions
Conduct: • All Activities are to be in accordance with an approved Workplan as described in Item B.6 of this Project Schedule to achieve the Management Action Deliverables listed above. Conditions for Compliant but Conditional Elements: • Nil
Management Action Milestones

Compliant Elements • Management Action Milestones 2.G to 2.J are not applicable for this Management Action		**Completion date**
2.A	Completion of vegetation fencing Activities in accordance with agreed 2011/12 Workplan.	31 December 2011
2.B	Completion of vegetation fencing Activities in accordance with agreed 2011/12 Workplan.	30 June 2012
2.C	Completion of vegetation fencing Activities in accordance with agreed 2012/13 Workplan.	31 December 2012
2.D	Completion of vegetation fencing Activities in accordance with agreed 2012/13 Workplan.	30 June 2013

2.E	Completion of vegetation fencing Activities in accordance with agreed 2013/14 Workplan.	31 December 2013
2.F	Completion of vegetation fencing Activities in accordance with agreed 2013/14 Workplan.	30 June 2014
2.G	Completion of vegetation fencing Activities in accordance with agreed 2012/13 Workplan.	31 December 2014
2.H	Completion of vegetation fencing Activities in accordance with agreed 2012/13 Workplan.	30 June 2015
2.I	Completion of vegetation fencing Activities in accordance with agreed 2013/14 Workplan.	31 December 2015
2.J	Completion of vegetation fencing Activities in accordance with agreed 2013/14 Workplan.	30 June 2016

Compliant but Conditional Elements	**Completion date**
Not applicable. • Management Action Milestones 2.K to 2.T are not applicable for this Management Action.	

Management Action Costs

Activity	**Compliant**	**Compliant but** [redacted]	**Total**
Fencing installation	[redacted]		
TOTAL (as per Item D.2.3 of this Project Schedule)			
Expected Management Actio			

Management Action Name

Management Action 3: *Vegetation Pest Management*

Management Action Description

Undertake pest and weed management Activities through control techniques such as manual removal, hand or aerial spraying, burning, slashing and established techniques for feral pest removal.

Management Action Outcomes

Minimise the impact of feral pests and weeds that impact on vegetation within CLLMM Site.

Management Action Deliverables

The *Vegetation Pest Management* Management Action of the vegetation program requires the State to:

- Develop a *pest and weed management plan* and update regularly by periodic surveying and mapping (funded under Management Action 7 - *Vegetation Project Management*).
- Treat revegetation sites (including areas within the CLLMM Site that impact revegetation sites) for feral pest animals and weeds as defined in pest and weed management site plans.
- Feral pest animals that impact on vegetation include:
  - rabbits,
  - hares,
  - pigs,
  - goats, and
  - deer.
- Feral animals that do not impact on the vegetation program and are excluded from this Management Action include cats and foxes.

Management Action Conduct and Conditions

Conduct:

- All Activities are to be in accordance with an approved Workplan as described in Item B.6 of this Project Schedule to achieve the Management Action Deliverables listed above.

Conditions for Compliant but Conditional Elements:

- Nil.

Management Action Milestones

Compliant Elements		**Completion date**
3.A	Completion of vegetation pest management Activities in accordance with agreed 2011/12 Workplan.	31 December 2011
3.B	Completion of vegetation pest management Activities in accordance with agreed 2011/12 Workplan.	30 June 2012
3.C	Completion of vegetation pest management Activities in accordance with agreed 2012/13 Workplan.	31 December 2012
3.D	Completion of vegetation pest management Activities in accordance with agreed 2012/13 Workplan.	30 June 2013

3.E	Completion of vegetation pest management Activities in accordance with agreed 2013/14 Workplan.	31 December 2013
3.F	Completion of vegetation pest management Activities in accordance with agreed 2013/14 Workplan.	30 June 2014
3.G	Completion of vegetation pest management Activities in accordance with agreed 2014/15 Workplan.	31 December 2014
3.H	Completion of vegetation pest management Activities in accordance with agreed 2014/15 Workplan.	30 June 2015
3.I	Completion of vegetation pest management Activities in accordance with agreed 2015/16 Workplan.	31 December 2015
3.J	Completion of vegetation pest management Activities in accordance with agreed 2015/16 Workplan.	30 June 2016
Compliant but Conditional Elements		**Completion date**

Not applicable.

- Management Action Milestones 3.K to 3.T are not applicable for this Management Action.

Management Action Costs

Activity	Compliant	Compliant but Conditional	Total
Pest management	[redacted]		
TOTAL (as per Item D.2.3 of this Project Schedule)			
Expected Management Action completion date			30 June 2016

ATTACHMENT G

Management Action Name		
Management Action 4: *Community Involvement in Vegetation Program*		
Management Action Description		
Engage the community in Activities such as ecological monitoring (e.g. success rate of plantings), training, revegetation and pest management control.		
Management Action Outcomes		
Increased public awareness and understanding of the vegetation program through contracting, engaging and working with the local community to contribute to the ecological health and character of the CLLMM Site.		
Management Action Deliverables		
The *Community Involvement in Vegetation Program* Management Action of the vegetation program requires the State to: • Propagate plants (through contracts with community and Ngarrindjeri nurseries). • Produce revegetation site plans for community managed revegetation actions (through contracts with community groups). • Conduct community planting activities • Facilitate community involvement in pest control. • Provide training in seed collection, nursery operations, planting, pest management, monitoring and plant identification.		
Management Action Conduct and Conditions		
Conduct: • All Activities are to be in accordance with an approved Workplan as described in Item B.6 of this Project Schedule to achieve the Management Action Deliverables listed above. Conditions for Compliant but conditional funding elements: • Nil.		
Management Action Milestones		
Compliant Elements		**Completion date**
4.A	Completion of community involvement in vegetation program Activities in accordance with agreed 2011/12 Workplan.	31 December 2011
4.B	Completion of community involvement in vegetation program Activities in accordance with agreed 2011/12 Workplan.	30 June 2012
4.C	Completion of community involvement in vegetation program Activities in accordance with agreed 2012/13 Workplan.	31 December 2012
4.D	Completion of community involvement in vegetation program activities in accordance with agreed 2012/13 Workplan.	30 June 2013

4.E	Completion of community involvement in vegetation program activities in accordance with agreed 2013/14 Workplan.	31 December 2013
4.F	Completion of community involvement in vegetation program activities in accordance with agreed 2013/14 Workplan.	30 June 2014
4.G	Completion of community involvement in vegetation program activities in accordance with agreed 2014/15 Workplan.	31 December 2014
4.H	Completion of community involvement in vegetation program activities in accordance with agreed 2014/15 Workplan.	30 June 2015
4.I	Completion of community involvement in vegetation program activities in accordance with agreed 2015/16 Workplan.	31 December 2015
4.J	Completion of community involvement in vegetation program activities in accordance with agreed 2015/16 Workplan.	30 June 2016

Compliant but Conditional Elements	**Completion date**
Not applicable. • Management Action Milestones 4.K to 4.T are not applicable for this Management Action.	

Management Action Costs

Activity	Compliant	Compliant but Conditional	Total
Community nursery	[redacted]		
Community involvement – on ground activities			
TOTAL (as per Item D.2.3 of this Project Schedule)			

Expected Management Action completion date	30 June 2016

Management Action Name

Management Action 5: *Vegetation Aboriginal Heritage*

Management Action Description

Engage with the Traditional Owners, the Ngarrindjeri, to undertake heritage assessments for vegetation program Activities.

Management Action Outcomes

The protection of Aboriginal heritage, through involvement of the Ngarrindjeri, as it relates to vegetation program Activities at the CLLMM Site.

Management Action Deliverables

The *Vegetation Aboriginal Heritage* Management Action of the vegetation program requires the State to:

- Assess revegetation sites for cultural heritage clearance and approval (through the Ngarrindjeri).
- Assess fencing sites for cultural heritage clearance and approvals (through the Ngarrindjeri).

Management Action Conduct and Conditions

Conduct:

- All Activities are to be in accordance with an approved Workplan as described in Item B.6 of this Project Schedule to achieve the Management Action Deliverables listed above.
- This Management Action is limited to the vegetation program with all other cultural heritage clearances required for the program to be conducted under Management Action 17 – *Ngarrindjeri Partnerships.*
- This management action relies on the outcomes of the vegetation and pest management planning processes to establish sites requiring cultural heritage clearances.

Conditions for Compliant but conditional funding elements:

- Nil.

Management Action Milestones

Compliant Elements		**Completion date**
5.A	Completion of vegetation Aboriginal heritage Activities in accordance with agreed 2011/12 Workplan.	31 December 2011
5.B	Completion of vegetation Aboriginal heritage Activities in accordance with agreed 2011/12 Workplan.	30 June 2012
5.C	Completion of vegetation Aboriginal heritage Activities in accordance with agreed 2012/13 Workplan.	31 December 2012
5.D	Completion of vegetation Aboriginal heritage Activities in accordance with agreed 2012/13 Workplan.	30 June 2013
5.E	Completion of vegetation Aboriginal heritage Activities in accordance with agreed 2013/14 Workplan.	31 December 2013

5.F	Completion of vegetation Aboriginal heritage Activities in accordance with agreed 2013/14 Workplan.	30 June 2014
5.G	Completion of vegetation Aboriginal heritage Activities in accordance with agreed 2014/15 Workplan.	31 December 2014
5.H	Completion of vegetation Aboriginal heritage Activities in accordance with agreed 2014/15 Workplan.	30 June 2015
5.I	Completion of vegetation Aboriginal heritage Activities in accordance with agreed 2015/16 Workplan.	31 December 2015
5.J	Completion of vegetation Aboriginal heritage Activities in accordance with agreed 2015/16 Workplan.	30 June 2016

Compliant but Conditional Elements	**Completion date**
Not applicable. • Management Action Milestones 5.K to 5.T are not applicable for this Management Action.	

Management Action Costs

Activity	**Compliant**	**Compliant but**	**Total**
Cultural heritage clearances	[redacted]		
TOTAL (as per Item D.2.3 of this Project Schedule)			
Expected Management Action completion date			30 June 2016

Management Action Name

Management Action 6: *Vegetation Monitoring and Research*

Management Action Description

Monitoring and research to optimise the success of seedlings and plantings across all vegetation projects and determine the effectiveness of the vegetation program in mitigating and remediating the negative impacts of acid sulfate soils.

Management Action Outcomes

Increased knowledge and understanding from monitoring and research is used to optimise the success of the vegetation program.

Management Action Deliverables

The *Vegetation Monitoring and Research* Management Action of the vegetation program requires the State to:

- Undertake research and monitoring Activities to assess the success of the vegetation program and to continuously improve the delivery of the vegetation program.
- Produce monitoring and research reports to improve the knowledge base for planning and management decisions.

Management Action Conduct and Conditions

Conduct:

- All Activities are to be in accordance with an approved Workplan as described in Item B.6 of this Project Schedule to achieve the Management Action Deliverables listed above.

Conditions for Compliant but conditional funding elements:

- Nil.

Management Action Milestones

Compliant Elements		**Completion date**
6.A	Completion of vegetation monitoring and research Activities in accordance with agreed 2011/12 Workplan.	31 December 2011
6.B	Completion of vegetation monitoring and research Activities in accordance with agreed 2011/12 Workplan.	30 June 2012
6.C	Completion of vegetation monitoring and research Activities in accordance with agreed 2012/13 Workplan.	31 December 2012
6.D	Completion of vegetation monitoring and research Activities in accordance with agreed 2012/13 Workplan.	30 June 2013
6.E	Completion of vegetation monitoring and research Activities in accordance with agreed 2013/14 Workplan.	31 December 2013
6.F	Completion of vegetation monitoring and research Activities in accordance with agreed 2013/14 Workplan.	30 June 2014

6.G	Completion of vegetation monitoring and research Activities in accordance with agreed 2014/15 Workplan.	31 December 2014
6.H	Completion of vegetation monitoring and research Activities in accordance with agreed 2014/15 Workplan.	30 June 2015
6.I	Completion of vegetation monitoring and research Activities in accordance with agreed 2015/16 Workplan.	31 December 2015
6.J	Completion of vegetation monitoring and research Activities in accordance with agreed 2015/16 Workplan.	30 June 2016
Compliant but Conditional Elements		**Completion date**

Not applicable.

- Management Action Milestones 6.K to 6.T are not applicable for this Management Action.

Management Action Costs

Activity	Compliant	Compliant but Conditional	Total
Monitoring for the Vegetation Program	[redacted]		
Research for the Vegetation Program			
TOTAL (as per Item D.2.3 of this Project Schedule)			
Expected Management Action completion date			30 June 2016

Management Action Name
Management Action 7: *Vegetation Project Management*
Management Action Description
This Management Action involves coordinated project management for the vegetation program that is based on structured, technically based planning, that focuses on specific targets to guide effort, investment and action.
Management Action Outcomes
The management and implementation of the vegetation program is conducted in an efficient and effective manner.
Management Action Deliverables
The *Vegetation Project Management* Management Action of the vegetation program requires the State to: • Award and manage contracts to community, Ngarrindjeri and commercial providers to: o propagate plants (community, Ngarrindjeri and commercial nurseries) o produce revegetation plans for community managed revegetation actions (community) o assess revegetation sites for cultural heritage clearance and approvals (Ngarrindjeri) o assess fencing sites for cultural heritage clearance and approvals (Ngarrindjeri) o undertake annual planting, including holding stations for distribution (commercial) o undertake annual feral pest that impact on vegetation (identified in Attachment F), and weed control programs (commercial). • Develop the following project plans: o Detailed Workplans and budgets linked to vegetation program planning documents o *Regional revegetation plan* identifying priorities and targets to guide *revegetation site plans* o *Regional pest management plan* to guide *pest management site plans* o *Fencing strategy* o *Monitoring framework* for vegetation program actions o Annual operational plans with budgets, governance arrangements and program delivery strategies, to inform annual Workplans. • Undertake annual reviews of the vegetation program. • Undertake periodic reviews of the *regional pest management plan* and *regional revegetation plan*.
Management Action Conduct and Conditions
Conduct: • All Activities are to be in accordance with an approved Workplan as described in Item B.6 of this Project Schedule to achieve the Management Action Deliverables listed above. Conditions for Compliant but Conditional Elements: • Nil.

Management Action Milestones		
Compliant Elements		**Completion date**
7.A	Completion of vegetation project management Activities in accordance with agreed 2011/12 Workplan.	31 December 2011
7.B	Completion of vegetation project management Activities in accordance with agreed 2011/12 Workplan.	30 June 2012
7.C	Completion of vegetation project management Activities in accordance with agreed 2012/13 Workplan.	31 December 2012
7.D	Completion of vegetation project management Activities in accordance with agreed 2012/13 Workplan.	30 June 2013
7.E	Completion of vegetation project management Activities in accordance with agreed 2013/14 Workplan.	31 December 2013
7.F	Completion of vegetation project management Activities in accordance with agreed 2013/14 Workplan.	30 June 2014
7.G	Completion of vegetation project management Activities in accordance with agreed 2014/15 Workplan.	31 December 2014
7.H	Completion of vegetation project management Activities in accordance with agreed 2014/15 Workplan.	30 June 2015
7.I	Completion of vegetation project management Activities in accordance with agreed 2015/16 Workplan.	31 December 2015
7.J	Completion of vegetation project management Activities in accordance with agreed 2015/16 Workplan.	30 June 2016
Compliant but Conditional Elements		**Completion date**
Not applicable. • Management Action Milestones 7.K to 7.T are not applicable for this Management Action.		

Management Action Costs

Activity	Compliant	Compliant but Conditional	Total
Management, operations and administration	[redacted]		
Planning, research and publishing			
TOTAL (as per Item D.2.3 of this Project Schedule)			
Expected Management Action completion date			30 June 2016

Management Action Name
Management Action 8: *Construction of Fishways*
Management Action Description
Design, construction and installation of new fishways in the barrages between Lake Alexandrina and the Coorong, and across Mundoo and Ewe Islands.
Management Action Outcomes
Improved connectivity and supported lifecycles and populations of fish within the CLLMM Site.
Management Action Deliverables
This Management Action requires the State to: • Determine the number, location and preferred design of fishways to be installed in the CLLMM Site. • Seek agreement of the Australian Government and the Murray-Darling Basin Authority on the cost sharing arrangements, asset management and a detailed project proposal. • Complete detailed designs and costings for fishways. • Construct, install and commission fishways.
Management Action Conduct and Conditions
Conduct: • The State will seek agreement with the Murray-Darling Basin Authority (MDBA) (to the Australian Governments satisfaction) on cost sharing arrangements, asset management and a detailed project proposal. • A Steering Committee comprising representatives of SA Water, Department for Water, MDBA and Department of Environment and Natural Resources will oversee direction of the *Construction of Fishways* Management Action, including the location, design and construction of new fishways. • *As per the due diligence the State will provide a revised costing for planning and design of the fishways after considering whether to use existing fishway designs or more innovative designs. The revised costing will not exceed $120,000 with the balance to be used towards the infrastructure installation activity line. The final amount for planning and design will be agreed in writing between the parties and will be reflected in any subsequent variation to this project schedule. All Activities are to be in accordance with the detailed project proposal and an approved Workplan as described in Item B.6 of this Project Schedule to achieve the Management Action Deliverables listed above. Conditions for Compliant but Conditional Elements: • Funding for construction and installation of fishways is conditional on an agreement between the Australian Government, MDBA and the South Australian Government on cost sharing arrangements, asset management and a detailed project proposal.

Management Action Milestones		
Compliant Elements		**Completion date**
Not applicable. • Management Action Milestones 8.A to 8.J are not applicable for this Management Action		
Compliant but Conditional Elements		
8.K	Subject to Conditions for Compliant but Conditional Elements in this Attachment K completion of *Construction of Fishways* Management Action Activities in accordance with agreed 2011/12 Workplan.	31 December 2011
8.L	Subject to Conditions for Compliant but Conditional Elements in this Attachment K completion of *Construction of Fishways* Management Action Activities in accordance with agreed 2011/12 Workplan.	30 June 2012
8.M	Subject to Conditions for Compliant but Conditional Elements in this Attachment K completion of *Construction of Fishways* Management Action Activities in accordance with agreed 2012/13 Workplan.	31 December 2012
8.N	Subject to Conditions for Compliant but Conditional Elements in this Attachment K completion of *Construction of Fishways* Management Action Activities in accordance with agreed 2012/13 Workplan.	30 June 2013
8.O	Subject to Conditions for Compliant but Conditional Elements in this Attachment K completion of *Construction of Fishways* Management Action Activities in accordance with agreed 2013/14 Workplan.	31 December 2013
8.P	Subject to Conditions for Compliant but Conditional Elements in this Attachment K completion of *Construction of Fishways* Management Action Activities in accordance with agreed 2013/14 Workplan.	30 June 2014
8.Q	Subject to Conditions for Compliant but Conditional Elements in this Attachment K completion of *Construction of Fishways* Management Action Activities in accordance with agreed 2014/15 Workplan.	31 December 2014
8.R	Subject to Conditions for Compliant but Conditional Elements in this Attachment K completion of *Construction of Fishways* Management Action Activities in accordance with agreed 2014/15 Workplan.	30 June 2015
8.S	Subject to Conditions for Compliant but Conditional Elements in this Attachment K completion of *Construction of Fishways* Management Action Activities in accordance with agreed 2015/16 Workplan.	31 December 2015
8.T	Subject to Conditions for Compliant but Conditional Elements in this Attachment K completion of *Construction of Fishways* Management Action Activities in accordance with agreed 2015/16 Workplan.	30 June 2016

Management Action Costs			
Activity	**Compliant**	**Compliant but Conditional**	**Total**
Planning and design	[redacted]		
Infrastructure installation			
Monitoring - compliance			
TOTAL (as per Item D.2.3 of this Project Schedule)			
Expected Management Action completion date			30 June 2016

ATTACHMENT L

Management Action Name		
Management Action 9: *Critical Fish Habitat*		
Management Action Description		
Translocation of threatened small-bodied freshwater fish populations into suitable CLLMM Site release locations.		
Management Action Outcomes		
The protection of critical environmental assets through the active management of threatened small bodied freshwater fish populations in the CLLMM Site.		
Management Action Deliverables		
This Management Action requires the State to: • Develop a reintroduction plan for threatened small-bodied fish releases into the CLLMM Site outlining methodology and origin of fish for release into the wild. • Translocate multiple populations of four threatened small bodied fish species into suitable CLLMM Site locations: - Yarra pygmy perch *(Nannoperca obscura)* - southern purple spotted gudgeon *(Mogurnda adspersa)* - Murray hardyhead *(Craterocephatus fluviatilis)* - southern pygmy perch *(Nannoperca australis).* • Develop annual reintroduction reports outlining the processes and techniques used and identifying numbers and origin of fish released into the wild.		
Management Action Conduct and Conditions		
Conduct: • The duration of this Management Action is two years. • Fish species will be released to suitable locations within the CLLMM Site. • This Management Action is the reintroduction phase of the *Critical Fish Habitat* project only. All Activities are to be in accordance with an approved Workplan as described in Item B.6 of this Project Schedule to achieve the Management Action Deliverables listed above. Conditions for Compliant but Conditional Elements: • Nil.		
Management Action Milestones		
Compliant Elements • Management Action Milestones 9.E to 9.J are not applicable for this Management Action		**Completion date**
9.A	Completion of *Critical Fish Habitat* Management Action Activities undertaken in accordance with agreed 2011/12 Workplan.	31 December 2011

9.B	Completion of *Critical Fish Habitat* Management Action Activities undertaken in accordance with agreed 2011/12 Workplan.	30 June 2012
9.C	Completion of *Critical Fish Habitat* Management Action Activities undertaken in accordance with agreed 2012/13 Workplan.	31 December 2012
9.D	Completion of *Critical Fish Habitat* Management Action Activities undertaken in accordance with agreed 2012/13 Workplan.	30 June 2013

Compliant but Conditional Elements

Not applicable.

- Management Action Milestones 9.K to 9.T are not applicable for this Management Action.

Management Action Costs

Activity	Compliant	Compliant but Conditional	Total
Planning and preparation	[redacted]		
Fish translocation and on ground works			
Captive fish maintenance pending translocation			
TOTAL (as per Item D.2.3 of this Project Schedule)			

Expected Management Action completion date — 30 June 2013

ATTACHMENT M

Management Action Name
Management Action 10: *South East Flows Restoration*
Management Action Description
The South East Flows Restoration (SEFR) Management Action will use a combination of natural watercourses, newly constructed floodways and existing drains to divert additional water from the Upper South East into the Coorong South Lagoon.
Management Action Outcomes
Assist in managing salinity in the Coorong South Lagoon through augmented Upper South East flows, in order to maintain a healthy ecosystem.
Management Action Deliverables
This Management Action requires the State to: • Develop a project plan and budget for Phase 1 for Australian Government approval. PHASE 1 • Complete supporting studies, modelling and investigations to inform planning and design, in particular: - establish the preferred flow path alignment; - establish the technical feasibility of the project; - identify potential River Murray system offsets; and - investigate any ecological concerns with increased USE water entering the South Lagoon. • Develop a community engagement plan and facilitate consultation with landholders. • Develop a concept design. • Complete a fully costed proposal for Phase 2, including the preferred flow path alignment, details of landholder support, and a detailed implementation timeframe, budget and detail about the potential of this project to reduce dependency on the River Murray. PHASE 2 • Complete a Phase 2 Communications and Engagement Strategy. • Complete a final detailed design. • Complete Land Acquisition. • Complete cultural heritage clearances. • Award contracts for construction. • Plan and complete an environmental management program. • Complete construction. • Complete final construction closure report, including construction drawings. • Submit a phase one (feasibility study) supply measure proposal for this management action under the Sustainable Diversion Limit (SDL) Adjustment Mechanism of the Murray-Darling Basin Plan to the SDL Adjustment Assessment Committee by 1 July 2014

Management Action Conduct and Conditions

Conduct
• The SEFR Management Action will be conducted over two phases:
  o Phase 1 means the initial investigative stage focussing on establishing a preferred flow path alignment, technical feasibility and potential River Murray system offsets of the SEFR Management Action. A decision on whether to proceed with the SLSRS will be delayed until the concurrent decision point following completion of this phase, and meeting of water quality Triggers.
  o Phase 2 means the implementation of works to either restore or maintain South Lagoon salinity, dependent on the outcomes of Phase 1.
• Landowner commitments should be progressed sufficiently prior to any construction contracts being awarded.
• Funding for ongoing operations and maintenance of the SEFR Management Action will be the responsibility of the South Australian Government.
• Property interests for the floodways and associated structures will be negotiated with landholders, and where necessary, land will be acquired under the *South Eastern Water Conservation and Drainage Act 1992*.
• * Land Acquisition activity costs will be covered by State Contributions.
• ** Construction Activity includes [redacted] Early Works carryover (as per Item D.4.1 of this Project Schedule)
• South Australia must comply with any *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) conditions before commencing construction.
• The Communications and Engagement Strategy, developed by Natural Resources South East, must be reviewed by the Australian Government.
• All Activities are to be in accordance with the approved project plan, and an approved Workplan as described in Item B.6 of this Project Schedule, to achieve the Management Action Deliverables listed above.
• The development of any phase 2 supply measure business case for this management action under the SDL Adjustment Mechanism of the Murray-Darling Basin Plan will be funded by assistance already provided to the State under the National Partnership Agreement on Implementing Water Reform in the Murray-Darling Basin.
Conditions for Compliant but Conditional Elements:
1. Funding for Phase 1 is subject to the State's submission of a detailed project plan for Phase 1 with sufficiently detailed information to justify a budget of up to [redacted]
2. Approval by the Australian Government to proceed to Phase 2 of the Management Action 10: *South East flows restoration* (SEFR) and/or the Management Action 11: *South Lagoon salinity reduction scheme* is dependent on South Australia submitting a single fully-costed proposal, following SEFR Phase 1, detailing a compelling case as to whether both Management Actions should proceed or whether it is more feasible and environmentally beneficial in the long-term to expand the SEFR Management Action.

Management Action Milestones	
Compliant Elements	**Completion date**
Not applicable.	

• Management Action Milestones 10.A to 10.J are not applicable for this Management Action.		
Compliant but Conditional Elements		
10.K	Subject to Conditions for Compliant but Conditional Element 1 in this Attachment M completion of *South East Flows Restoration* Management Action Activities in accordance with the agreed 2011/12 Workplan.	31 December 2011
10.L	Subject to Conditions for Compliant but Conditional Element 1 in this Attachment M completion of *South East Flows Restoration* Management Action Activities in accordance with the agreed 2011/12 Workplan.	30 June 2012
10.M	Subject to Conditions for Compliant but Conditional Element 1 in this Attach*ment M completion of South East Flows Restoration* Management Action Activities in accordance with the agreed 2012/13 Workplan.	31 December 2012
10.N	Subject to Conditions for Compliant but Conditional Element 1 in this Attachment M completion of *South East Flows Restoration* Management Action activities in accordance with the agreed 2012/13 Workplan.	30 June 2013
10.O	Subject to Conditions for Compliant but Conditional Element 2 in this Attachment M completion of *South East Flows Restoration* Management Action Activities in accordance with the agreed 2013/14 Workplan.	31 December 2013
10.P	Subject to Conditions for Compliant but Conditional Element 2 in this Attachment M completion of *South East Flows Restoration* Management Action activities in accordance with the agreed 2013/14 Workplan.	30 June 2014
10.Q	Subject to Conditions for Compliant but Conditional Element 2 in this Attachment M completion of *South East Flows Restoration* Management Action Activities in accordance with the agreed 2014/15 Workplan.	31 December 2014
10.R	Subject to Conditions for Compliant but Conditional Element 2 in this Attachment M completion of *South East Flows Restoration* Management Action Activities in accordance with the agreed 2014/15 Workplan.	30 June 2015
10.S	Subject to Conditions for Compliant but Conditional Element 2 in this Attachment M completion of *South East Flows Restoration* Management Action Activities in accordance with the agreed 2015/16 Workplan.	31 December 2015
10.T	Subject to Conditions for Compliant but Conditional Element 2 in this Attachment M completion of South East Flows Restoration Management Action Activities in accordance with the agreed 2015/16 Workplan.	30 June 2016

10.U	Subject to Conditions for Compliant but Conditional Element 2 in this Attachment M completion of South East Flows Restoration Management Action Activities in accordance with the agreed 2016/17 Workplan.	31 December 2016

Management Action Costs

Activity	Compliant	Compliant but [redacted]	Total
PHASE 1		[redacted]	
Planning and design	N/A		
Community engagement	N/A		
Impact assessment	N/A		
Modelling and surveys	N/A		
Legal	N/A		
Sub-total for Phase 1	*N/A*		
PHASE 2	N/A		
Planning and design	N/A		
Land Acquisition*	N/A		
Cultural heritage clearances - Ngarrindjeri	N/A		
Cultural heritage clearances - SEAFG	N/A		
Environmental management	N/A		
Construction**	N/A		
Construction contingency	N/A		
Sub-total for Phase 2	*N/A*		
TOTAL (as per Item D.2.3 of this Project Schedule)	**N/A**		
Expected Management Action completion date			31 December 2016

* Land Acquisition activity costs will be covered by State Contributions.

** Construction Activity includes [redacted] Early Works carryover (as per Item D.4.1 of this Project Schedule)

ATTACHMENT N

This Attachment has intentionally been left blank, as Management Action 11: South Lagoon Salinity Reduction Scheme was withdrawn on 26 April 2013.

ATTACHMENT O

Management Action Name
Management Action 12: *Ruppia Translocation*
Management Action Description
The physical translocation of *Ruppia tuberosa*, a keystone aquatic plant, to the Coorong South Lagoon.
Management Action Outcomes
The restoration of ruppia species to the Coorong to improve the CLLMM Site's ecological character and provide long-term environmental benefit to the ecosystem.
Management Action Deliverables
This Management Action requires the State to: Phase 2 • Deliver a reintroduction strategy for ruppia • Undertake initial translocation of *Ruppia tuberosa* in the Coorong South lagoon as part of Management Action Milestones 12.M to 12.N (subject to Compliant but Conditional Elements). The activities and outcomes of Phase 2 translocation activities will inform larger scale translocation in Phase 3. Phase 3 • Undertake large scale translocation of ruppia species in the Coorong South Lagoon as part of Management Action Milestones 12.O to 12.S (subject to Compliant but Conditional Elements).
Management Action Conduct and Conditions
Conduct: • Large scale translocation of ruppia can only occur once favourable conditions return to allow ruppia to successfully flourish. • The State acknowledges that this Management Action may not occur within the life of this project schedule. Funding or State contributions under this Priority Project should not be expensed or committed beyond the life of this project schedule. • The development of a reintroduction strategy will be completed once the State has sufficient knowledge to undertake the works or if ruppia naturally recolonises. • Ruppia monitoring and research undertaken from 1 July 2011 to 31 December 2011 (Phase 1) is to be undertaken as part of Management Action 19: *Monitoring and Adaptive Management 1 July 2011 to 31 December 2011 (gap monitoring)* (Attachment V). • Any continued ruppia monitoring and research (translocation trials) beyond 31 December 2011 are undertaken as part of Management Action 13: *Monitoring and Adaptive Management Framework* (Attachment P). • All Activities are to be in accordance with an approved Workplan as described in Item B.6 of this Project Schedule to achieve the Management Action Deliverables listed above. • Phase 1 means the ruppia monitoring and research undertaken as part of Management Action 19 Monitoring and Adaptive Management 1 July 2011 to 31 December 2011 (gap monitoring) (Attachment V) • Phase 2 means translocation of *Ruppia tuberosa* in the Coorong South lagoon as part of Management Action Milestones 12.M to 12.N.

- Phase 3 means larger scale ruppia translocation in the Coorong South Lagoon (informed by Phase 2) as part of Management Action Milestones 12.O to 12.S.

Conditions for Compliant but Conditional Elements:

Funding for Phase 2 is subject to:

- Technical feasibility is established through the reintroduction strategy using the result of ruppia monitoring and research (trials) undertaken as part of the feasibility study and Management Actions 13 and 19;
- Coorong South Lagoon target salinities of 60-100gm/L and water levels are reached and maintained for long enough to allow ruppia to successfully flourish;
- That ruppia species do not naturally recolonise on a large scale in the Coorong.

Funding for Phase 3 is subject to:

- Coorong South Lagoon target salinities of 60-100gm/L and water levels are reached and maintained for long enough to allow ruppia to successfully flourish;
- That ruppia species do not naturally recolonise on a large scale in the Coorong.
- South Australian submitting a fully-costed proposal detailing a compelling case to proceed with Management Action 10: South East Flows Restoration and/or Management Action 11: South Lagoon salinity reduction scheme or whether it is more feasible and environmentally beneficial in the long-term to expand SEFR Management Action (Attachment M and N).

Management Action Milestones		
Compliant Elements		**Completion date**
Not applicable • Management Action Milestones 12.A to 12.J are not applicable for this Management Action.		
Compliant but Conditional Elements • Management Action Milestones 12.T is not applicable for this Management Action.		
12.K	Subject to Conditions for Compliant but Conditional Elements in this Attachment O completion of *Ruppia Translocation* Management Action Activities in accordance with the agreed 2011/12 Workplan.	31 December 2011
12.L	Subject to Conditions for Compliant but Conditional Elements in this Attachment O completion of *Ruppia Translocation* Management Action Activities in accordance with the agreed 2011/12 Workplan.	30 June 2012
12.M	Subject to Conditions for Compliant but Conditional Elements in this Attachment O completion of *Ruppia Translocation* Management Action Activities in accordance with the agreed 2012/13 Workplan.	31 December 2012
12.N	Subject to Conditions for Compliant but Conditional Elements in this Attachment O completion of *Ruppia Translocation* Management Action Activities in accordance with the agreed 2012/13 Workplan.	30 June 2013

12.O	Subject to Conditions for Compliant but Conditional Elements in this Attachment O completion of *Ruppia Translocation* Management Action Activities in accordance with the agreed 2013/14 Workplan.	31 December 2013
12.P	Subject to Conditions for Compliant but Conditional Elements in this Attachment O completion of *Ruppia Translocation* Management Action Activities in accordance with the agreed 2013/14 Workplan.	30 June 2014
12.Q	Subject to Conditions for Compliant but Conditional Elements in this Attachment O completion of *Ruppia Translocation* Management Action Activities in accordance with the agreed 2014/15 Workplan.	31 December 2014
12.R	Subject to Conditions for Compliant but Conditional Elements in this Attachment O completion of *Ruppia Translocation* Management Action Activities in accordance with the agreed 2014/15 Workplan.	30 June 2015
12.S	Subject to Conditions for Compliant but Conditional Elements in this Attachment O completion of *Ruppia Translocation* Management Action Activities in accordance with the agreed 2015/16 Workplan.	31 December 2015

Management Action Costs

Activity	Compliant	Compliant but [redacted]	Total
PHASE 2	[redacted]		
Planning	[redacted]		
Field collection	[redacted]		
Planting	[redacted]		
Monitoring - compliance	[redacted]		
Phase 2 sub-total	[redacted]		
PHASE 3	[redacted]		
Planning	[redacted]		
Field collection	[redacted]		
Planting	[redacted]		
Monitoring - compliance	[redacted]		
Phase 3 sub-total	[redacted]		
TOTAL (as per Item D.2.3 of this Project Schedule)	[redacted]		
Expected Management Action completion date			31 December 2015

Management Action Name

Management Action 13: *Monitoring and Adaptive Management Framework*

Management Action Description

Monitoring and Adaptive Management Framework Activities to enable the CLLMM Site to be managed proactively, and provide an opportunity to focus on actions that contribute to key ecological objectives and achieve the long-term goal of a healthy productive and resilient wetland.

This Management Action requires the State to undertake monitoring in accordance with a monitoring framework approved by the Australian Government. Information gained from undertaking this Priority Project will be used to revise and update the ecological character description for the Coorong, Lakes Alexandrina and Albert Ramsar site and develop site operations manual to assist with for the future management of the CLLMM Site.

Management Action Outcomes

The outcomes of this Management Action are:

- Ecological Character Description:
  - Update and consolidate known information on the ecological character of the Coorong, Lakes Alexandrina and Albert Ramsar site in accordance with the *National Framework and Guidance for Describing the Ecological Character of Australian Ramsar Wetlands - Module 2 of the National Guidelines for Ramsar Wetlands* or any subsequent updates.
- Monitoring and Adaptive Management Framework:
  - The development of a monitoring and adaptive management framework to inform monitoring Activities to be undertaken over the life of the program.
- Site Operations Manual:
  - Improved guidance on how to manage the ecological character of the CLLMM Site under state, national and international obligations, including post the State Priority Project.
- Monitoring:
  - Improved knowledge of the recovery potential of biota, abiota, and processes and associations through supported monitoring Activities.
  - Increased ability to assess the potential impact of Management Actions.

Management Action Deliverables

This Management Action requires the State to:

- Develop a monitoring framework by 31 October 2011 that may include the following monitoring Activities:
  - Ecological monitoring:
    - Zooplankton
    - Aquatic invertebrates
    - Revegetation monitoring
    - Ruppia monitoring
  - Acid sulfate soil monitoring
- Undertake monitoring and research to inform ruppia translocation/reintroduction strategy

including:

- Undertake ruppia translocation trials
- Report on the effectiveness of ruppia translocation trials.

- Undertake acid sulfate soil monitoring to inform limestone dosing under the Managing Acid Sulfate Soils Management Action including:
  - Event based water quality monitoring to inform limestone dosing under the Managing Acid Sulfate Soils Management Action
  - Soil monitoring
  - Surface water monitoring
  - Regional groundwater monitoring.
- Update the ecological character description for the site and Ramsar information sheet.
- Develop a site operations manual.
- Develop an integrated ecosystem response forecasting tool.
- Produce reports from monitoring and adaptive management Activities.

Management Action Conduct and Conditions

Conduct:

- All Activities are to be in accordance with an approved Workplan as described in Item B.6 of this Project Schedule to achieve the Management Action Deliverables listed above.
- Monitoring Activities in a Workplan is to be conducted in accordance with an approved monitoring framework.
- The monitoring framework and annual Workplans submitted for Commonwealth approval should focus on ecological and acid sulfate soil monitoring Activities and supported by the Due Diligence.
- The ecological character description and site operations manual may be developed over the life of the Project Schedule to utilise both known information and information gained from undertaking all management actions.
- The revised ecological character description and site operations manual is required to be submitted for Commonwealth approval prior to June 2016.
- Funding for revising the ecological character description, developing a site operations manual or the monitoring framework is not to be used for additional monitoring and research. Information that is not known is to be listed as monitoring needs or knowledge gaps within the ecological character description.

Conditions for Compliant but Conditional Elements:

- Monitoring activities are subject to Commonwealth approval of a monitoring framework in accordance with the Due Diligence.
- The monitoring framework to be developed by the State is to provide sufficient information on scope, budget, quantity, additionality to other monitoring activities undertaken at the CLLMM Site, frequency and benefits of the monitoring Activities.

Management Action Milestones

Compliant Elements		**Completion date**
13.A	Completion of monitoring and adaptive management (ecological character description, monitoring framework	31 December 2011

	development and site operations manual) Activities in accordance with agreed 2011/12 Workplan. A monitoring framework is required to be developed by 31 October 2011.	
13.B	Completion of monitoring and adaptive management (ecological character description and site operations manual) Activities in accordance with agreed 2011/12 Workplan.	30 June 2012
13.C	Completion of monitoring and adaptive management (ecological character description and site operations manual) Activities in accordance with agreed 2012/13 Workplan.	31 December 2012
13.D	Completion of monitoring and adaptive management (ecological character description and site operations manual) Activities in accordance with agreed 2012/13 Workplan.	30 June 2013
13.E	Completion of monitoring and adaptive management (ecological character description and site operations manual) Activities in accordance with agreed 2013/14 Workplan.	31 December 2013
13.F	Completion of monitoring and adaptive management (ecological character description and site operations manual) Activities in accordance with agreed 2013/14 Workplan.	30 June 2014
13.G	Completion of monitoring and adaptive management (ecological character description and site operations manual) Activities in accordance with agreed 2014/15 Workplan.	31 December 2014
13.H	Completion of monitoring and adaptive management (ecological character description and site operations manual) Activities in accordance with agreed 2014/15 Workplan.	30 June 2015
13.I	Completion of monitoring and adaptive management (ecological character description and site operations manual) Activities in accordance with agreed 2015/16 Workplan.	31 December 2015
13.J	Completion of monitoring and adaptive management (ecological character description and site operations manual) Activities in accordance with agreed 2015/16 Workplan.	30 June 2016
Compliant but Conditional Elements		
Management Action Milestone 13.K is not applicable for this Management Action		
13.L	Subject to Conditions for Compliant but Conditional Elements in this Attachment P completion of monitoring and adaptive management (monitoring) Activities in accordance with agreed 2011/12 Workplan.	30 June 2012
13.M	Subject to Conditions for Compliant but Conditional Elements in this Attachment P completion of monitoring and adaptive management (monitoring) Activities in accordance with agreed 2012/13 Workplan.	31 December 2012
13.N	Subject to Conditions for Compliant but Conditional Elements in this Attachment P completion of monitoring and adaptive management (monitoring) Activities in accordance with	30 June 2013

	agreed 2012/13 Workplan.	
13.O	Subject to Conditions for Compliant but Conditional Elements in this Attachment P completion of monitoring and adaptive management (monitoring) Activities in accordance with agreed 2013/14 Workplan.	31 December 2013
13.P	Subject to Conditions for Compliant but Conditional Elements in this Attachment P completion of monitoring and adaptive management (monitoring) Activities in accordance with agreed 2013/14 Workplan.	30 June 2014
13.Q	Subject to Conditions for Compliant but Conditional Elements in this Attachment P completion of monitoring and adaptive management (monitoring) Activities in accordance with agreed 2014/15 Workplan.	31 December 2014
13.R	Subject to Conditions for Compliant but Conditional Elements in this Attachment P completion of monitoring and adaptive management (monitoring) Activities in accordance with agreed 2014/15 Workplan.	30 June 2015
13.S	Subject to Conditions for Compliant but Conditional Elements in this Attachment P completion of monitoring and adaptive management (monitoring) Activities in accordance with agreed 2015/16 Workplan.	31 December 2015
13.T	Subject to Conditions for Compliant but Conditional Elements in this Attachment P completion of monitoring and adaptive management (monitoring) Activities in accordance with agreed 2015/16 Workplan.	30 June 2016

Management Action Costs

Activity	Compliant	Compliant but Conditional	Total
Ecological Character Description, monitoring framework development and site operations manual	[redacted]		
Integrated ecosystem response forecasting tool			
Monitoring			
TOTAL (as per Item D.2.3 of this Project Schedule)			
Expected Management Action completion date			30 June 2016

ATTACHMENT Q

Management Action Name
Management Action 14: *Managing Acid Sulfate Soils*
Management Action Description
The treatment of acid sulfate soils is undertaken by applying limestone to neutralise the acid to assist in preventing potentially severe environmental degradation. Limestone dosing methods include large scale aerial dosing and the application of limestone slurry.
Management Action Outcomes
Neutralisation of acidified soil and water through the application of limestone to assist in preventing potentially severe environmental degradation arising from acid sulfate soils.
Management Action Deliverables
This Management Action requires the State to: • Subject to Triggers apply limestone (aerial or slurry), following planning, to identified high-risk acidified areas • source limestone from quarry site. • transport limestone from source sites, stockpile locations and application zone. • storage (stockpiling). • contract machinery. • site remediation of stockpiled sites and access tracks. • monitor the impacts of limestone dosing. • produce reports from limestone application Activities.
Management Action Conduct and Conditions
Conduct: • All Activities are to be in accordance with an approved Workplan as described in Item B.6 of this Project Schedule to achieve the Management Action Deliverables listed above. • The commencement Triggers for limestone dosing are based on a result of either: - alkalinity >100 mg/L and a >20% fall in alkalinity compared to lake concentrations, - alkalinity <25 mg/L and acidity present in the waterbody, or - acidity >100 mg/L, calculated over a minimum of two locations for two consecutive days and where pH <7.5 • The termination Triggers for limestone dosing are based on a result of either acidity <100 mg/L, alkalinity >100 mg/L, or a 20% difference in lake alkalinity, recorded at monitored sites for a minimum of 5 days or 5 monitoring events, and where pH >7.8. • Acid sulfate soil water quality monitoring (ambient and event) to inform limestone dosing is funded under the Management Action 13: *Monitoring and Adaptive Management Framework* (Attachment P and Management Action 19: *Monitoring and Adaptive Management 1 July to 31 December 2011 (Gap monitoring)* (Attachment V) and is not part of this Management Action. • The State will consider the resources required for this project on a year to year basis based on current and projected water levels. The State is required to assess the likelihood of any underspends by no later than 30 June 2015. • Mobilisation of equipment and stockpiling should only occur if a limestoning event is likely to occur

within 20 business days.

- The Workplan for this Management Action needs to reflect that only a fraction of limestone dosing may be required within a reporting period and payment will be in arrears for the relevant reporting period as part of the next scheduled payment.

Conditions for Compliant but Conditional Elements:

- Commencement Triggers are reached and a limestone dosing event takes place.
- The Australian Government is to fund in arrears 90 per cent of the actual costs of a limestoning action as listed in the Management Action Deliverables that occurs within a reporting period up to the budgeted amount for that activity contained within an approved Workplan.
- The State is to report on a limestoning activity that occurs within a reporting period in the relevant progress report. Once approved the State will separately invoice the Commonwealth contribution to be added to the next payment.

Management Action Milestones		
Compliant Elements		**Completion date**
Not applicable • Management Action Milestones 14.A to 14.J are not applicable for this Management Action.		
Compliant but Conditional Elements		
14.K	Subject to Conditions for Compliant but Conditional Elements in this Attachment Q completion of acid sulfate soils Activities in accordance with agreed 2011/12 Workplan.	31 December 2011
14.L	Subject to Conditions for Compliant but Conditional Elements in this Attachment Q completion of acid sulfate soils Activities in accordance with agreed 2011/12 Workplan.	30 June 2012
14.M	Subject to Conditions for Compliant but Conditional Elements in this Attachment Q completion of acid sulfate soils Activities in accordance with agreed 2012/13 Workplan.	31 December 2012
14.N	Subject to Conditions for Compliant but Conditional Elements in this Attachment Q completion of acid sulfate soils Activities in accordance with agreed 2012/13 Workplan.	30 June 2013
14.O	Subject to Conditions for Compliant but Conditional Elements in this Attachment Q completion of acid sulfate soils Activities in accordance with agreed 2013/14 Workplan.	31 December 2013
14.P	Subject to Conditions for Compliant but Conditional Elements in this Attachment Q completion of acid sulfate soils Activities in accordance with agreed 2013/14 Workplan.	30 June 2014
14.Q	Subject to Conditions for Compliant but Conditional Elements in this Attachment Q completion of acid sulfate soils Activities in accordance with agreed 2014/15 Workplan.	31 December 2014
14.R	Subject to Conditions for Compliant but Conditional Elements in this Attachment Q completion of acid sulfate soils Activities in accordance with agreed 2014/15 Workplan.	30 June 2015
14.S	Subject to Conditions for Compliant but Conditional Elements in this Attachment Q completion of acid sulfate soils Activities in accordance with agreed 2015/16 Workplan.	31 December 2015

14.T	Subject to Conditions for Compliant but Conditional Elements in this Attachment Q completion of acid sulfate soils Activities in accordance with agreed 2015/16 Workplan.	30 June 2016

Management Action Costs			
Activity	**Compliant**	**Compliant but Conditional**	**Total**
Limestone sourcing	[redacted]		
Limestone application			
TOTAL (as per Item D.2.3 of this Project Schedule)			
Expected Management Action completion date			30 June 2016

Management Action Name		
Management Action 15: *Research Priorities*		
Management Action Description		
Undertake research Activities related to acid sulfate soil processes (acid sulfate soils, metal mobilisation, ecological risks and health hazards) to provide a foundation for decision making and lead to an improved understanding of the CLLMM Site's ecological character.		
Management Action Outcomes		
Key acid sulfate soil knowledge gaps will be filled to inform management of the CLLMM Site for managing variable lake levels and if low inflows return.		
Management Action Deliverables		
This Management Action requires the State to: • Finalise the acid sulfate soil research to provide further understanding of: - Acid sulfate soils - Metal mobilisation - Ecological risks and health hazards associated with acid sulfate soils - In situ neutralisation processes - Bioremediation - Contaminant mobilisation, transport to water bodies and deoxygenation - Key acid sulfate soil hazards associated with managing variable lake levels such as exposure and rewetting. • Develop research and technical reports with the knowledge gained to be used for adaptive management of the CLLMM Site.		
Management Action Conduct and Conditions		
Conduct: • All Activities are to be in accordance with an approved Workplan as described in Item B.6 of this Project Schedule to achieve the Management Action Deliverables listed above. Conditions for Compliant but Conditional Elements: • Nil.		
Management Action Milestones		
Compliant Elements		**Completion date**
15.A	Completion of acid sulfate soil research in accordance with agreed 2011/12 Workplan.	31 December 2011
15.B	Completion of acid sulfate soil research in accordance with agreed 2011/12 Workplan.	30 June 2012
15.C	Completion of acid sulfate soil research in accordance with agreed 2012/13 Workplan.	31 December 2012
15.D	Completion of acid sulfate soil research in accordance with agreed 2012/13 Workplan.	30 June 2013
15.E	Completion of acid sulfate soil research in accordance with agreed 2013/14 Workplan.	31 December 2013

15.F	Completion of acid sulfate soil research in accordance with agreed 2013/14 Workplan.	30 June 2014
15.G	Completion of acid sulfate soil research in accordance with agreed 2014/15 Workplan.	31 December 2014
15.H	Completion of acid sulfate soil research in accordance with agreed 2014/15 Workplan.	30 June 2015
15.I	Completion of acid sulfate soil research in accordance with agreed 2015/16 Workplan.	31 December 2015
15.J	Completion of acid sulfate soil research in accordance with agreed 2015/16 Workplan.	30 June 2016
Compliant but Conditional Elements		
Not applicable • Management Action Milestones 15.K to 15.T are not applicable for this Management Action		

Management Action Costs

Activity	Compliant	Compliant but Conditional	Total
Research - Acid Sulfate Soil	[redacted]		
TOTAL (as per Item D.2.3 of this Project Schedule)			
Expected Management Action completion date			30 June 2016

ATTACHMENT S

Management Action Name		
Management Action 16: *Community Engagement and Communications*		
Management Action Description		
Engagement of the local community and management of *community hubs* and a *community advisory panel*.		
Management Action Outcomes		
To create an informed supportive and involved community for future management of the CLLMM Site through *community hubs* and a *community advisory panel*.		
Management Action Deliverables		
This Management Action requires the State to: • Conduct a *community hubs* performance review. • Support the *community hubs* to provide employment, information and coordinate Activities in the region. • Develop a terms of reference for the *community advisory panel* for approval by the Australian Government. • Establish and support a *community advisory panel*.		
Management Action Conduct and Conditions		
Conduct: • All Activities are to be in accordance with an approved Workplan as described in Item B.6 of this Project Schedule to achieve the Management Action Deliverables above. Conditions for Compliant but Conditional Elements: • Nil.		
Management Action Milestones		
Compliant Elements		**Completion date**
16.A	Completion of *Community Engagement and Communications* Activities in accordance with agreed 2011/12 Workplan.	31 December 2011
16.B	Completion of *Community Engagement and Communications* Activities in accordance with agreed 2011/12 Workplan	30 June 2012
16.C	Completion of *Community Engagement and Communications* Activities in accordance with agreed 2012/13 Workplan.	31 December 2012
16.D	Completion of *Community Engagement and Communications* Activities in accordance with agreed 2012/13 Workplan.	30 June 2013
16.E	Completion of Community Engagement and Communications Activities in accordance with agreed 2013/14 Workplan.	31 December 2013
16.F	Completion of *Community Engagement and Communications* Activities in accordance with agreed 2013/14 Workplan.	30 June 2014
16.G	Completion of *Community Engagement and Communications* Activities in accordance with agreed 2014/15 Workplan.	31 December 2014

16.H	Completion of *Community Engagement and Communications* Activities in accordance with agreed 2014/15 Workplan.	30 June 2015
16.I	Completion of *Community Engagement and Communications* Activities in accordance with agreed 2015/16 Workplan.	31 December 2015
16.J	Completion of *Community Engagement and Communications* Activities in accordance with agreed 2015/16 Workplan.	30 June 2016
Compliant but Conditional Elements		
Not applicable • Management Action Milestones 16.K to 16.T are not applicable for this Management Action		
Management Action Costs		

Activity	Compliant	Compliant but Conditional	Total
Community Hubs – office	[redacted]		
Community Hubs - staffing			
Community Hubs – community engagement			
Community Hubs sub total			
Community Advisory Panel			
CAC sub total			
TOTAL (as per Item D.2.3 of this Project Schedule)			
Expected Management Action completion date			30 June 2016

ATTACHMENT T

Management Action Name
Management Action 17: *Ngarrindjeri Partnerships*
Management Action Description
Active participation of Ngarrindjeri people in all aspects of natural and cultural resource management through strategic planning, training and capacity building. This aims to establish the foundation Activities for the long-term Ngarrindjeri aspirations of co-management of the CLLMM Site.
Management Action Outcomes
To support the active, long-term participation of Ngarrindjeri people in natural and cultural resource management in the CLLMM Site.
Management Action Deliverables
This Management Action requires the State to: • Promote Ngarrindjeri participation in CLLMM Site governance and management through: - The development and implementation of policies and procedures which provide for cooperative working relationships between the *Ngarrindjeri Regional Authority* (NRA) and all levels of government; - Delivery of relevant Ngarrindjeri on ground works; and - The application of Ngarrindjeri cultural and ecological knowledge through the development of management plans, protocols and cultural knowledge transmission programs. • Manage and protect Ngarrindjeri Aboriginal heritage through: - Heritage assessments (not including the vegetation program) and heritage surveys; and - Providing an educational role in relation to cultural and ecological knowledge. • Build the capacity of Ngarrindjeri to participate in the CLLMM management through: - The development and delivery of relevant training programs for Ngarrindjeri community members and NRA staff for the restoration and rehabilitation of lands and waters of the region; - Supporting the Ngarrindjeri involvement and employment in natural resource management in the CLLMM Site; and - Supporting the work of the NRA governing committee to ensure professional engagement with government and the community. • Identify synergies between existing Australian Government projects and the management action. • Submit a full Workplan for the above deliverables and a detailed budget in relation to that Workplan.
Management Action Conduct and Conditions
Conduct: • The State will develop structures and processes to ensure a constructive working relationship between the *Department of Environment and Natural Resources* (DENR) and NRA to support the deliverables of the Management Action. • All Activities are to be in accordance with an approved Workplan as described in Item B.6 of this Project Schedule to achieve the Management Action Deliverables above.

- The Management Action is relevant across all proposed Management Actions.
- This Management Action supports heritage approvals required for this Priority Project except for the vegetation program.

Conditions for Compliant but Conditional Elements:

- Nil.

Management Action Milestones

Compliant Elements		**Completion date**
17.A	Completion of *Ngarrindjeri Partnerships* Activities in accordance with agreed 2011/12 Workplan.	31 December 2011
17.B	Completion of *Ngarrindjeri Partnerships* Activities in accordance with agreed 2011/12 Workplan.	30 June 2012
17.C	Completion of *Ngarrindjeri Partnerships* Activities in accordance with agreed 2012/13 Workplan.	31 December 2012
17.D	Completion of *Ngarrindjeri Partnerships* Activities in accordance with agreed 2012/13 Workplan.	30 June 2013
17.E	Completion of *Ngarrindjeri Partnerships* Activities in accordance with agreed 2013/14 Workplan.	31 December 2013
17.F	Completion of *Ngarrindjeri Partnerships* Activities in accordance with agreed 2013/14 Workplan.	30 June 2014
17.G	Completion of Ngarrindjeri Partnerships Activities in accordance with agreed 2014/15 Workplan.	31 December 2014
17.H	Completion of *Ngarrindjeri Partnerships* Activities in accordance with agreed 2014/15 Workplan.	30 June 2015
17.I	Completion of *Ngarrindjeri Partnerships* Activities in accordance with agreed 2015/16 Workplan.	31 December 2015
17.J	Completion of *Ngarrindjeri Partnerships* Activities in accordance with agreed 2015/16 Workplan.	30 June 2016

Compliant but Conditional Elements

Not applicable

- Management Action Milestones 17.K to 17.T are not applicable for this Management Action.

Management Action Costs

Activity	**Compliant**	**Compliant but Conditional**	**Total**
Policy and site planning response	[redacted]		
Monitoring and evaluation			
Heritage management and protection			
Specialist advice			
Community government and stakeholder partnerships			
Education and extension			
TOTAL (as per Item D.2.3 of this Project Schedule)			
Expected Management Action completion date			30 June 2016

Management Action Name
Management Action 18: *Meningie Wetland*
Management Action Description
Restoration of the Meningie foreshore through infrastructure installation, bank stabilisation and planting Activities, in conjunction with the local community.
Management Action Outcomes
The stabilisation of the banks of Lake Albert at Meningie, increased habitat for flora and fauna, increased local and wider community knowledge on management of acid sulfate soils, and improved amenity for the Meningie township.
Management Action Deliverables
This Management Action requires the State to: • Consult with the local community and Ngarrindjeri in development of the *Meningie Wetland*, including Aboriginal Heritage matters regarding lake bed modification. • Create a small scale artificial wetland at Meningie (Lake Albert) following planning with Ngarrindjeri Regional Authority on appropriate flora and fauna for the site. • Award contracts for wetland works including infrastructure installation based on the approved Final Design. • Complete wetland construction including infrastructure installation - viewing platforms, bird hide, signage, culvert naturalisation and bank stabilisation. • Monitor ecological outcomes and community impacts of the works. • Involve local community, schools and non-government organisations in the Management Action implementation. • Finalise a technical report from a non-government organisation experienced in wetland restoration. • Complete site preparation, including weed control and tree removal. • Complete propagation and planting subject to suitable water level.
Management Action Conduct and Conditions
Conduct: • All Activities are to be in accordance with an approved Workplan as described in Item B.6 of this Project Schedule to achieve the Management Action Deliverables listed above. • All Activities are to be conducted in accordance with the Commonwealth approved construction design submitted under management action milestone 5B of *SA-03 Early Works for Water for the Future, Enduring Response for the Coorong and Lower Lakes*. Conditions for Compliant but Conditional Elements: • Nil.
Management Action Milestones

Compliant Elements		**Completion date**
18.A	Completion of Meningie Wetland Project Activities in accordance with agreed 2011/12 Workplan.	31 December 2011
18.B	Completion of Meningie Wetland Project Activities in accordance with agreed 2011/12 Workplan.	30 June 2012
18.C	Completion of Meningie Wetland Project Activities in	31 December 2012

	accordance with agreed 2012/13 Workplan.	
18.D	Completion of Meningie Wetland Project Activities in accordance with agreed 2012/13 Workplan.	30 June 2013
18.E	Completion of Meningie Wetland Project Activities in accordance with agreed 2013/14 Workplan.	31 December 2013
18.F	Completion of Meningie Wetland Project Activities in accordance with agreed 2013/14 Workplan.	30 June 2014
18.G	Completion of Meningie Wetland Project Activities in accordance with agreed 2014/15 Workplan.	31 December 2014
18.H	Completion of Meningie Wetland Project Activities in accordance with agreed 2014/15 Workplan	30 June 2015
12.I	Completion of Meningie Wetland Project Activities in accordance with agreed 2015/16 Workplan	31 December 2015
12.J	Completion of Meningie Wetland Project Activities in accordance with agreed 2015/16 Workplan	30 June 2016

Compliant but Conditional Elements

Not applicable

- Management Action Milestones 18.K to 18.T are not applicable for this Management Action.

Management Action Costs

Activity	Compliant	Compliant but Conditional	Total
Infrastructure installation and bank stabilisation	[redacted]	[redacted]	[redacted]
Community involvement	[redacted]	[redacted]	[redacted]
Program management and corporate overheads	[redacted]	[redacted]	[redacted]
Habitat restoration plantings and weed control	[redacted]	[redacted]	[redacted]
TOTAL (as per Item D.2.3 of this Project Schedule)	[redacted]	[redacted]	[redacted]
Expected Management Action completion date			30 June 2016

ATTACHMENT V

Management Action Name
Management Action 19: *Monitoring and Adaptive Management 1 July 2011 to 31 December 2011 (Gap monitoring)*
Management Action Description
Undertake ecological and acid sulfate soil monitoring from 1 July 2011 to 31 December 2011. Monitoring under this management action is gap monitoring pending Commonwealth approval of the monitoring and adaptive framework under Management Action 13: *Monitoring and Adaptive Management Framework* (Attachment P). Due to separate approval processes Management Action 19 is separate and independent of monitoring undertaken as part of Management Action 13 *Monitoring and Adaptive Management Framework*.
Management Action Outcomes
Undertake critical ecological and acid sulfate soil monitoring from 1 July 2011 to 31 December 2011 to avoid monitoring gaps between the Early Works and Monitoring and Adaptive Management Framework.
Management Action Deliverables
This Management Action requires the State to undertake the following monitoring Activities from 1 July 2011 to 31 December 2011: Acid Sulfate Soil: • Water monitoring (surface water, regional groundwater) • Soil monitoring (acid base accounting, hotspot). Ecological: • Benthic ecology • Macroinvertebrates • Zooplankton • Fish recruitment and habitat assessment (excluding acoustic fish tagging or monitoring of fish through the barrages) • Birds • Amphibia. Ruppia translocation Phase 1: • Ruppia project inception • Annual monitoring from 1 July 2011 to 31 December 2011 • Filamentous algae assessment.
Management Action Conduct and Conditions
Conduct: • A workplan is not required for this Management Action. • Monitoring undertaken as part of this Management Action is separate and independent of monitoring Activities undertaken as part of the Monitoring and Adaptive Management Framework. • Funding is not transferable between Activities or to the Monitoring and Adaptive Management Framework. As such this management action must be reported separately to the Monitoring and Adaptive Management Framework Management Action against the Management Action Costs in this attachment. • All Activities are to be completed by 31 December 2011 and will not be extended beyond 31 December 2011. Conditions for Compliant but conditional funding elements:

- Nil.

Management Action Milestones

Compliant Elements		**Completion date**
• Management Action Milestones 19.B to 19.J are not applicable for this Management Action		
19.A	Completion of gap monitoring Activities as per the Management Action Deliverables.	31 December 2011
Compliant but Conditional Elements		
Not applicable • Management Action Milestones 19.K to 19.T are not applicable for this Management Action.		

Management Action Costs

Activity	Compliant	Compliant but Conditional	Total
Surface water monitoring (ambient and event)	[redacted]		
Regional groundwater monitoring			
Acid base accounting			
Acid sulfate soil hotspot monitoring			
Benthic ecology monitoring			
Macroinvertebrate monitoring			
Zooplankton monitoring			
Fish monitoring			
Bird monitoring			
Amphibia monitoring			
Ruppia project inception			
Ruppia monitoring			
Ruppia filamentous algae assessment			
Project management			
TOTAL (as per Item D.2.3 of this Project Schedule)			
Expected Management Action completion date			31 December 2011

Management Action Name		
Management Action 20: *Lake Albert Scoping Study*		
Management Action Description		
Investigate potential options for the long-term management of Lake Albert water quality and the Narrung Narrows.		
Management Action Outcomes		
The identification of flow and water level targets under different climatic scenarios to sustain water quality and ecological health in Lake Albert, including summarising environmental condition targets in a future directions paper. Preparation of a Business Case for the long-term management of Lake Albert and the Narrung Narrows, including the State's position on preferred management action(s).		
Management Action Deliverables		
The *Lake Albert Scoping Study* Management Action requires the State to: • Produce a literature review of existing information and reports related to Lake Albert and the Narrung Narrows, including the consideration of historic environmental conditions and present conditions. • Develop a future directions paper on Lake Albert and the Narrung Narrows environmental condition targets to ensure feasibility of management actions. • Undertake hydrological, hydrodynamic and sediment transport modelling and geotechnical studies of Lake Albert and the Narrung Narrows. • Undertake community and Ngarrindjeri consultation. • Identify and evaluate potential management actions for Lake Albert and the Narrung Narrows, including potential benefits, costs, timeframes for implementation and the ecological, water quality/quantity, legislative and social impacts. • Prepare a Business Case suitable for Commonwealth Government consideration that seeks funding to implement the preferred management action(s).		
Management Action Conduct and Conditions		
Conduct: • All Activities are to be in accordance with an approved Workplan as described in Item B.6 of this Project Schedule to achieve the Management Action Deliverables listed above. Conditions for Compliant but Conditional Elements: • Nil.		
Management Action Milestones		
Compliant Elements • Management Action Milestones 20.A to 20.C and 20.G to 20.J are not applicable for this Management Action		**Completion date**
20.D	Completion of *Lake Albert water quality and the Narrung Narrows* Management Activities undertaken in accordance with agreed 2012/13 Workplan.	30 June 2013

20.E	Completion of *Lake Albert water quality and the Narrung Narrows* Management Activities undertaken in accordance with agreed 2013/14 Workplan.	31 December 2013
20.F	Completion of *Lake Albert water quality and the Narrung Narrows* Management Activities undertaken in accordance with agreed 2013/14 Workplan.	30 June 2014
Compliant but Conditional Elements		
Not applicable. • Management Action Milestones 20.K to 20.T are not applicable for this Management Action		
Management Action Costs		

Activity	Compliant	Compliant but Conditional	Total
Planning and Design	[redacted]		
Research			
Community Engagement			
TOTAL (as per Item D.2.3 of this Project Schedule)			
Expected Management Action completion date			30 June 2014

National Code of Practice for the Construction Industry

In this Attachment X to the Project Schedule:

Code	means the *National Code of Practice for the Construction Industry* 1997, a copy of which can be downloaded from www.deewr.gov.au/building.
Guidelines	means the *Australian Government Implementation Guidelines for National Code of Practice for the Construction Industry*, August 2009, a copy of which can be downloaded from www.deewr.gov.au/building.
Project Parties	means all contractors, subcontractors, consultants and employees who perform on-site work in relation to the Priority Project Component.

1. Where the Funding specifically relates to building and construction activity, subject to the thresholds specified in the Guidelines, the State must comply and ensure that the Project Parties comply with the Code and Guidelines.
2. The Guidelines require the State to ensure that:
   a. all requests for tender, expressions of interest, submissions and invitations to join Common Use Arrangements in relation to the Project Activities made by it or any of the Project Parties contain the commitment to apply the Code and Guidelines as set out in the model tender documents available at: http://www.deewr.gov.au/WorkplaceRelations/Policies/BuildingandConstruction/Pages/ModelTender.aspx; and
   b. all contracts entered into in relation to the Project Activities by it or any of the Project Parties contain the commitment to apply the Code and Guidelines as set out in the model contract clauses available at: http://www.deewr.gov.au/WorkplaceRelations/Policies/BuildingandConstruction/Pages/ModelTender.aspx.
3. The State must maintain adequate records of compliance by it and each of the Project Parties with the Code and the Guidelines. The State must permit the Commonwealth or any person authorised by the Commonwealth, including a person occupying a position in the Office of the Australian Building and Construction Commissioner, full access to premises and records of the State and the Project Parties to:
   a. inspect any work, material, machinery, appliance, article or facility;
   b. inspect and copy any record relevant to the Priority Project Component and works governed by this Project Schedule;
   c. interview any person,

   as is necessary to monitor compliance with the Code and the Guidelines. Additionally, the State undertakes that it and each of the Project Parties will agree to a request from the Commonwealth, including a person occupying a position in the Office of the Australian Building and Construction Commissioner, to produce a specified document within a specified period, in person, by fax, or by post.

4. The Commonwealth and those authorised by it may publish or otherwise disclose information in relation to compliance by the State and the Project Parties with the Code and the Guidelines. The State must obtain the consent of the Project Parties to the publication or disclosure of information under this item.

5. While acknowledging that value for money is the core principle underpinning decisions on Government procurement, when issuing tenders the State may preference contractors, subcontractors and consultants that have a demonstrated commitment to:

   a. adding and/or retaining trainees and apprentices;

   b. increasing the participation of women in all aspects of the industry; or

   c. promoting employment and training opportunities for Indigenous Australians in regions where significant indigenous populations exist.

6. The State must not appoint a contractor, subcontractor or consultant in relation to the Project Activities where:

   a. the appointment would breach a sanction imposed by the Minister for Employment and Workplace Relations; or

   b. the contractor, subcontractor or consultant has had a judicial decision against them relation to employee entitlements, not including decision under appeal, and has not paid the claim.

ATTACHMENT Y

Australian Government Building and Construction OHS Accreditation Scheme

1. In this Attachment Y to the Project Schedule:

    c. 'the Act' means the *Fair Work (Building Industry) Act 2012* (Cth);

    d. 'Builder' has the same meaning as it has in section 35 of the Act;

    e. 'Building Work' has the same meaning as it has in section 5 of the Act;

    f. 'the Regulations' means the *Fair Work (Building Industry - Accreditation Scheme) Regulations 2005*; and

    g. 'Scheme' means the Australian Government Building and Construction OHS Accreditation Scheme established under the Act.

2. Subject to exclusions specified in the Regulations, construction projects that use funds provided under this Project Schedule are bound by the application of the Scheme.

3. The State must ensure that all contracts that it enters into, and all contracts that its subcontractors enter into, for Building Work as a part of the Activities that are valued at $3 million or more:

    h. are notified to the Office of the Federal Safety Commissioner at the earliest possible opportunity (that is, when approaching the market); and

    i. contain a requirement that the Builder:

        i. is accredited under the Scheme;

        ii. maintains Scheme accreditation for the life of the contract; and

        iii. must comply with all conditions of the Scheme accreditation.

4. The State agrees to notify the Commonwealth immediately if that Builder has ceased, or is likely to cease, to meet the accreditation requirements in paragraph 3(b) above.

5. The State must maintain adequate records of compliance by it, and each of its subcontractors, with the Scheme.

Department for Water

Coorong South Lagoon Flow Restoration Project Extension of Existing Modelling

CSLFRP EXTENSION OF EXISTING MODELLING

Final Report

December 2011

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Executive Summary

Introduction

The Coorong South Lagoon Flows Restoration Project is an investigation into the feasibility of a scheme to provide fresh water flows to the southern lagoon of the Coorong from the south east drainage network. A number of studies have been completed on the Coorong South Lagoon Flows Restoration Project over the last 5 years.

This study involved the review and extension of the most recent and largest piece of work to date by Montazeri et al (2011). This study was initially requested to address 5 questions:

- **Question 1**: Develop a flow record for Blackford Drain including flows from Fairview Drain.
- **Question 2**: What is the Optimum Size of the Channel Downstream of Blackford Drain?
- **Question 3**: Why is there a significant difference between the maximum daily diversion at Wilmot Drain and Drain L/K?
- **Question 4**: Assess the Losses to Groundwater Predicted between Blackford and Salt Creek and the Application of the Groundwater Calculation Methodology.
- **Question 5**: What difference is there between using Biscuit Flat or Reedy Creek between Drain L/K and Blackford Drain.

During the analysis an additional two tasks were requested, namely:

- Refinement of hydraulic designs for some of the channels;
- Analysis of the causes of uncertainty in losses to groundwater from the channel.

This study was based on the work product of Montazeri et al (2011) including Watercress models, HecRas models and water balance and loss to groundwater spreadsheet models. The theoretical basis for the analysis is outlined in Montazeri et al (2011)

The overall objective of this study was to provide revised estimates of yield at the Salt Creek on the southern lagoon of the Coorong.

Study Area

This study assessed four flow paths, all with diversion points on Drain M, Wilmot Drain, Drain L/K and Blackford Drain.

Reaches	Flow Path			
	Flow Path 02	**Flow Path 03 SELS**	**Flow Path 03 Floodway**	**Flow Path 03 Biscuit Floodway**
Drain M- Wilmot Drain	Reedy Creek	Reedy Creek	Reedy Creek	Reedy Creek
Wilmot Drain – Drain L/K	Reedy Creek	Reedy Creek	Reedy Creek	Reedy Creek
Drain L/K - Blackford Drain	Reedy Creek	Reedy Creek	Reedy Creek	Biscuit Flat
Blackford Drain- Salt Creek	Taratap Tilley Swamp Morella Basin	Blackford Drain Southern Ephemeral Lagoons (4)	Blackford Drain Floodway Southern Ephemeral Lagoons (3+4)	Blackford Drain Floodway Southern Ephemeral Lagoons (3+4)

Question 1: Develop a flow record for Blackford Drain including flows from Fairview Drain.

Previous studies assumed that the flows from the Fairview catchment did not contribute to the flows available for diversion at Blackford Drain but were instead diverted down Bald Hills Drain. This study estimated the additional volume of water available for diversion if the Fairview Drain flows were directed down Blackford Drain. Under historical conditions median annual flows from Blackford Drain catchment are increased by 66% (median year) with the addition of Fairview Drain catchment.

	Climate (Historical)			Climate Change (Median)		
	B &F (ML)	**B Only (ML)**	**% Diff**	**B &F (ML)**	**B Only (ML)**	**% Diff**
Mean	22,264	13,634	63%	18,285	10,657	72%
Median	23,734	14,272	66%	19,954	11,586	72%

B= Blackford Drain, B&F= Blackford + Fairview Drains

Question 3: Why is there a significant difference between the maximum daily diversion at Wilmot Drain and Drain L/K in the Montazeri et al (2011) work?

The following questions were addressed in this section:

- Why are the estimated annual flows available for diversion at Wilmot Drain significantly different between the AWE (2009) and the Montazeri et al (2011) work;
- Why the maximum daily diversion selected for Wilmot Drain in the DfW work is larger than Drain L/K if the annual flows available for diversion at Wilmot Drain and Drain L/K are similar.

The AWE (2009) study estimated flows diverted at Wilmot Drain under a maximum daily diversion scenario of 500ML/d. The AWE (2009) estimate was 44% greater (Average annual, historic climate) than that of Montazeri et al (2011).

The difference in approaches between the two studies was assessed. The AWE (2009) work was found to be robust. The difference in estimates was found to be product of the difference in approach. AWE (2009) used a regional Tanh method to estimate runoff from rainfall on a seasonal basis. This approach was in line with the requirements of the study brief. The methodology used by Montazeri et al (2011) was found to be more sophisticated and considered the catchment characteristics in more detail than those used in AWE (2009). Therefore the results of Montazeri et al (2011) are expected to be more reliable than those of the previous AWE (2009) study given good calibration of their model.

Montazeri et al (2011) determined the maximum daily diversion from Drain L/K and Wilmot Drain and assigned maximum daily diversions of 250 ML/d for Drain L/K and 500 ML/d Wilmot Drain. The difference in the optimum maximum daily diversion rate assigned by Montazeri et al (2011) to Wilmot Drain in comparison to Drain L, which has similar average annual yields, is a result of the interpretation of the significance of the increased yield expected.

This study analysed the Montazeri et al (2011) data and found the yield from Wilmot Drain in comparison to Drain L suggests that the selection of 250 ML/d as the optimum maximum daily diversion rate over 500 ML/d for Wilmot Drain.

Question 2: What is the Optimum Size the Channel Downstream of Blackford Drain?

Two questions were considered for this section:

- What is the optimum size of the flow path downstream of Blackford Drain if flows from Fairview Drain are included in the scheme and the Wilmot Drain maximum daily diversion is 250 ML/d?
- What is the capacity of the flow path assumed in the analysis of Montazeri et al (2011).

Flows available for diversion at Blackford Drain under historic climate conditions were assessed using the same approach as taken by Montazeri et al (2011). The optimum size of the channel downstream of Blackford Drain was calculated, taking into account all the water diverted into Reedy Creek from Drain M, Drain L/K and Wilmot Drain, the losses experienced between these diversion points and Blackford Drain as well as the flows available for diversion from the Blackford + Fairview catchment was considered.

The incremental benefit of increasing the maximum daily diversion up from the 1000ML/d due to the addition of Fairview Drain flows was assessed. Increasing the maximum daily diversion at Blackford Drain from 1000 ML/d to 1250 ML/d was found to increase the average annual flows diverted by less than 1 GL/a.

Based on this analysis, a maximum daily diversion of 1000 ML/d was recommended for Blackford Drain. 1000 ML/d was considered the hydrologic optimum and did not consider the cost or environmental benefit implications of further increasing the maximum daily diversion at Blackford Drain.

Downstream of Blackford Drain on Flow Path 02 there are significant flow contributions from the existing drainage network. This input occurs at the beginning of Tilley Swamp. From the historic climate conditions flow record the peak flow in the 30 year record was 515ML/d. Therefore the flow path downstream of Henry Creek requires a capacity of 515 ML/d plus the maximum daily diversion from Blackford Drain.

The hydraulic model developed by Montazeri et al (2011) was run with the peak flows expected and found to have capacity to convey the flows from Blackford Drain and the Henry Creek flows.

Question 4: Assess the Losses to Groundwater Predicted between Blackford and Salt Creek and the Application of the Groundwater Calculation Methodology.

AWE analysed the methodology and the implementation of the methodology used in the draft work by Montazeri et al (2011). The methodology applied by Montazeri et al (2011) was based on components of the Morgan et al (2011) work which outlined a simple analytical methodology for estimation of seepages losses from the channels.

Analysis completed as part of this study found an error in the implementation of the methodology by Montazeri et al (2011)(the spreadsheet calculation) which was subsequently corrected.

The majority of the work of this study on Loss to Groundwater focused on the identification of opportunities for improvement of the application of the methodology and a sensitivity analysis on the inputs to the calculations to facilitate a better understanding of the uncertainty surrounding the loss to groundwater estimates.

The method used by Montazeri et al (2011) to determine the distance from the channel where the hydraulic head in the aquifer is unaffected by the channel (i.e. L, zone of impression) was assessed. Montazeri et al (2011) assumed this to be a fixed width of 250m. This approach was found to have the potential to cause the over or under estimate of seepage losses depending on the characteristics of the aquifer. This study offered an alternative approach to calculating L based on the Theis non-equilibrium formula using the hydrogeological characteristics to determine the value of L.

This study also provided a qualitative discussion on the potential impact of a clogging layer within the channel, which was not considered in the seepage loss calculations by Montazeri et al (2011) or any of the previous studies. The assessment found clogging is important and can significantly reduce surface water – groundwater interactions. Clogging is site-specific and dynamic and therefore it is difficult, if not impossible to predict the effects of clogging using regional data. The quantitative assessment of clogging would require significant and additional investigations.

Qualitative comment was also made on the risk in using regional groundwater data to model the water table at a local scale. The loss to groundwater calculations used by Montazeri et al (2011) and this study use regional data. The discussion highlighted the real possibility of misinterpreting the groundwater level such that the interaction with the surface water predicted by the model is significantly different to actual site conditions. The only way to resolve this issue is to augment regional data with local investigations.

Sensitivity Analysis

After a discussion with the client and Department for Water representatives, a decision was made to analyse results for the eight scenarios to quantify the uncertainty surrounding the following inputs to the loss to groundwater modelling. The following characteristics were assessed:

- The value adopted for high aquifer conductivity;
- The number of cases outlined in Morgan et al (2011) for characterising seepage losses adopted for the analysis;
- Either a fixed or variable zone of influence

The sensitivity analysis was conducted on the following scenarios:

Scenario	Aquifer K (m/d)	Seepage Loss Method*	Zone of Influence (L)
1	80	2	Variable with physical properties
2	80	123	250 m
3	80	123	Variable with physical properties
4	8	2	250 m
5	8	2	Variable with physical properties
6	8	123	250 m
7	8	123	Variable with physical properties
8	80	2	250 m

*Refers to the 'scenarios' of Morgan et al. (2011). 123=variable, 2= the minimum of 2 or 3 used (equivalent to Montazeri et al (2001) approach).Scenario 8 is equivalent to the approach adopted by Montazeri et al., (2011). The values calculated in the Montazeri et al., (2011) were used for comparison.

The estimated total potential loss to groundwater was found to be most sensitive to the assumed aquifer hydraulic conductivity and the seepage loss calculation method and least sensitive to the zone of influence adopted.

When the sub reaches of the flow paths were analysed separately Reedy Creek , in particular the third section between Drain L/K and Blackford Drain, was found to have high potential seepage loss. The floodway subreach was also found to have high potential for seepage losses in comparison to other sections of the flow path.

Scenario 7 was recommended for all further analysis of seepage loss in the study because Scenario 7 imposes the least control, combined with a realistic hydraulic conductivity representation for the entire thickness of the Tertiary Limestone Aquifer.

Question 5: What difference is there between using Biscuit Flat or Reedy Creek between Drain L/K and Blackford Drain.

The Biscuit flat subreach is an alternative flow path to the third section of Reedy Creek. It conveys flows between the diversion point on Drain L/K to Blackford Drain. It was investigated as an alternative as it was thought that a flow path to the west of Reedy Creek may have fewer seepage losses.

The Biscuit flat reach had not previously been assessed therefore this study developed a Watercress model to determine the local catchment contribution to the route, developed a hydraulic design for the channel and determined the hydrogeological characteristics of the flow path.

The channel was designed as floodway with two levees on either side of a shallow channel.

The analysis of the potential loss to groundwater from the channel found that the Biscuit Flat reach has much lower potential for loss to groundwater than the equivalent reach in Reedy Creek.

When the overall water balance results are considered it was found that Flow Path 03 Biscuit Floodway provides an additional 1.5 GL/a (median year) to the Southern Lagoon of the Coorong in comparison to Flow Path 03 Floodway which uses the third section of Reedy Creek.

The primary difference in the performance of the flow paths is in the loss to groundwater experienced. The loss to groundwater in an average year in Biscuit flat is less than half that of Reedy Creek (3).

Channel Refinement

Some of the initial designs by Montazeri et al (2011) for the channels were found to be overcapacity for the adopted maximum daily diversion rates used.

The channel designs in the hydraulic models inform both the loss to groundwater calculation and the water balance. The use of oversized channels in the hydraulic model reduces the driving head forcing loss to groundwater and alters the surface area assumed to interact with rainfall and evaporation on the flow path.

The hydraulic models have also being used as the basis for initial estimates of cost and vegetation clearance, as such if the channels are oversized these factors may be overestimated.

The hydraulic models for the following reaches were refined:

- Reedy Creek (Drain M to Blackford Drain);
- Taratap/Tilley Swamp (Blackford Drain to Morella Basin); and
- Floodway (Aligned to the east of the Southern Ephemeral Lagoons, Blackford Drain to the third lagoon of the Southern Ephemeral Lagoons).

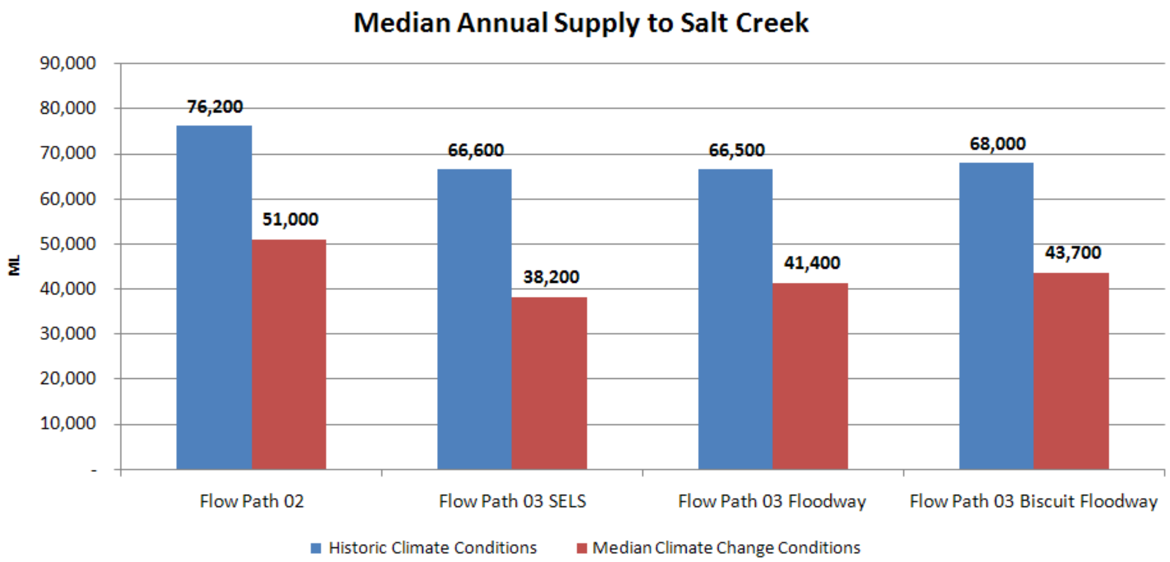
A design basis was documented for each reach and a coarse cut and fill analysis completed to broadly optimise the depth and width of the channel. The refined channel designs were used to inform the seepage loss and water balance analysis.

Water Balance Analysis Results

This study was asked to calculate the volume of water delivered to Salt Creek on the Southern Lagoon of the Coorong for a range of flow path and climate scenarios. The scenarios are summarised below.

Flow Path	Climate Scenario(s)	Loss to Groundwater Calculation Methodology
Flow Path 02	Historic + Climate Change Median	Scenario 7
Flow Path 03 SELS	Historic + Climate Change Median	Scenario 7
Flow Path 03 Floodway	Historic + Climate Change Median	Scenario 7
Flow Path 03 Biscuit Floodway	Historic + Climate Change Median	Scenario 7
Flow Path 02	Historic	Scenario 6
Flow Path 03 Biscuit Floodway	Historic	Scenario 6

All results include the existing drainage network (EDN) which includes the existing flows into Tilley Swamp from Henry Creek and the S bend. The median annual yield to Salt Creek is summarised in the figure below.



The Flow Paths can be ranked based on the largest median annual yield at Salt Creek in the following way:

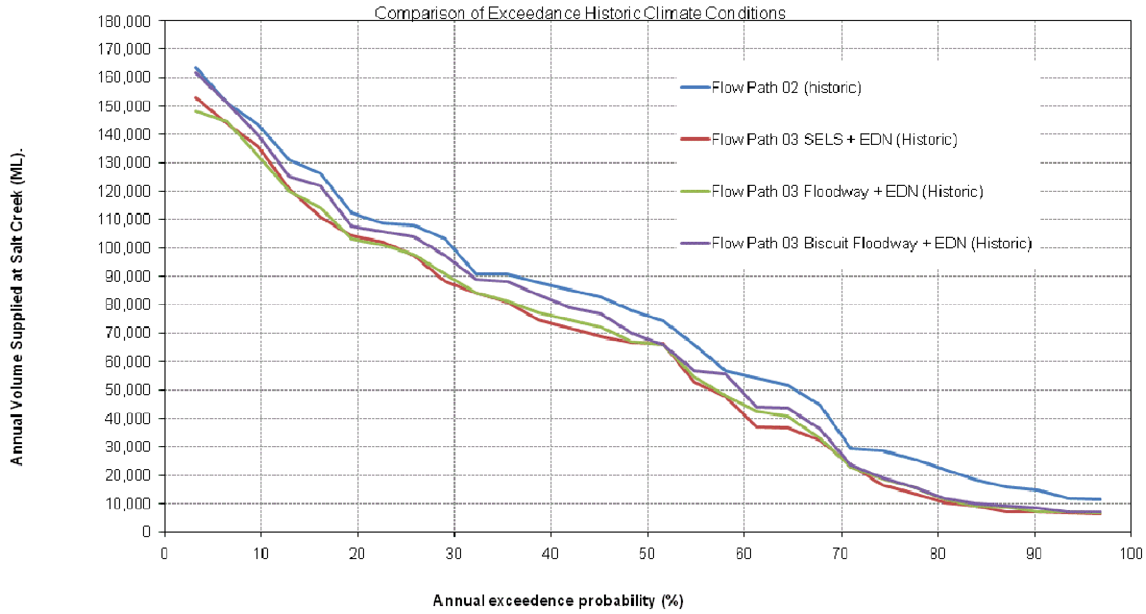
1. Flow Path 02
2. Flow Path 03 Biscuit Floodway
3. Flow Path 03 SELS
4. Flow Path 03 Floodway

Flow Path 02 provides the greatest yield to Salt Creek in a median year. Flow Path 02 is also expected to supply greater yield during drier years than the Flow Path 03 options. Flow Path 02 is expected to provide greater than 60 GL/a in 4 out of 10 years (Historic Conditions).

Flow Path 03 Biscuit Floodway provides the next greatest median annual yield, in comparison to the other Flow Path 03 options. This is due to the reduction in losses to groundwater expected through the use of Biscuit Flat rather than the third section of Reedy Creek as a flow path.

The reduction in flows due to climate change varies between 33% for Flow Path 02 and 42% for Flow Path 03 SELS.

The annual exceedance probability for yield at Salt Creek was calculated. Annual exceedance probability can be interpreted as a measure of reliability. The results are summarised in the following table and graph.



Flow Path	Historic Climate Condition		
Flow Path 02 Historic	Volume (>ML)	No. Years	Frequency in 10 years
	15000	27	9
	30000	21	7
	45000	20	7
	60000	17	6
	75000	15	5
	90000	11	4
Flow Path 03 SELS + EDN Historic	Volume (>ML)	No. Years	Frequency in 10 years
	15000	25	8
	30000	25	8
	45000	21	7
	60000	16	5
	75000	13	4
	90000	5	2
Flow Path 03 Floodway + EDN Historic	Volume (>ML)	No. Years	Frequency in 10 years
	15000	27	9
	30000	25	9
	45000	21	7
	60000	16	6
	75000	13	5
	90000	6	2
Flow Path 03 Biscuit Floodway + EDN Historic	Volume (>ML)	No. Years	Frequency in 10 years
	15000	27	9
	30000	25	9
	45000	21	7
	60000	16	6
	75000	13	5
	90000	8	3

The annual exceedance analysis shows that Flow Path 02 is more reliable than the other three options in dry years (when flows are low)

Under historic conditions there is an 80% change of Flow Path 02 supplying at least 22GL/a to Salt Creek where the best of the other Flow Path 03 options is expected to supply at least 11.7GL/a. That is in drier years Flow Path 02 would supply almost twice the volume of flow to the Coorong as the next best performing flow path.

Comparison with Montazeri et al (2011)

There are a number of differences between this study and the work of Montazeri et al (2011). The key differences are summarised below.

- The maximum daily diversion at Wilmot Drain was set at 250ML/d;
- The new flow path Flow Path 03 Biscuit Floodway was assessed;
- The addition of the Fairview Drain flows to the Blackford Drain diversion;
- A number of the designs for the flow path channels were refined; and
- The loss to groundwater analysis methodology was altered.

The following table summarises the differences between the results.

Flow Path	Montazeri et al (2011)	This study	% Difference
Flow Path 02	49,406	72,900	48%
Flow Path 03 Floodway	40,664	63,400	56%
Flow Path 03 SELS	43,937	62,600	42%

When Flow Path 02 is considered the majority of the difference between the results is due to the change in the way seepage loss is calculated (20% due to channel refinement and 80% due to the seepage loss calculation method adopted). 35% of the difference is a result of changes in the diversions contributing to the scheme, primarily the addition of Fairview Drain.

Uncertainty

The key uncertainty around the estimate of yield at Salt Creek is the loss to groundwater expected along the flow path.

The loss to groundwater still provides the largest magnitude of uncertainty in the estimate of yield expected at Salt Creek. A difference in yield of 8 GL/a (median year) was found when comparing the results at Salt Creek when using one alternate calculation method for loss to groundwater (Scenario 6 vs Scenario 7). From the analysis of the difference between the work of Montazeri et al (2011) and this study a difference in average annual yield in the order of 12 GL/a can be attributed to the difference in loss to groundwater calculation methodology.

This uncertainty can only be overcome with additional local scale monitoring of the hydrologeological characteristics.

Recommended Refinements

There are a number of areas which are considered worthy of further evaluation as part of the design phase once a preferred diversion route has been selected. These are:

1. The Watercress models, developed to inform the water balance modelling of the scheme, be further refined during concept design of the preferred option.
2. The hydraulic modelling will also need to be further refined to take into account site constraints and the preferred design diversion and outlet infrastructure.
3. If the Reedy Creek reach is part of the selected flow path the water balance modelling and in particular the estimates of seepage losses should be refined.
4. Additional measurement of local scale hydrologeological characteristics should be completed to improve the robustness of the loss to groundwater estimates.

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Appendices

1 Introduction

1.1 Scope of Works

A number of studies have been completed on the Coorong South Lagoon Flows Restoration Project that explore the supply of fresher water to the southern lagoon of the Coorong from the south east drainage network. These studies include:

- *Way, D and Heneker, T.M. (2007) Preliminary Hydrological Investigations for Diversion of Drainage from the South East to the Coorong South Lagoon, DWLBC Technical Note 2007/06, Department of Water, Land and Biodiversity Conservation, Government of South Australia*
- *AWE (2009). Coorong South Lagoon Restoration Project Hydrological Investigation, Final Report, June 2009 for the Department of Water, Land and Biodiversity Conservation.*
- *Montazeri, M., Way, D., Gibbs, M., Bloss, C. And Wood C. (2011) Coorong South Lagoon Flow Restoration Project- Hydrological modelling and transmission loss analysis*.

In their most recent work AWE were requested to address a number of questions based on the work of Montazeri et al (2011). These questions involved interrogation and extension of the models which formed the basis of Montazeri et al (2011).

The questions that were investigated are summarised below:

- **Question 1**: Develop a flow record for Blackford Drain including flows from Fairview Drain.
- **Question 2**: What is the Optimum Size the Channel Downstream of Blackford Drain?
- **Question 3**: Why is there a significant difference between the maximum daily diversion at Wilmot Drain and Drain L/K?
- **Question 4**: Assess the Losses to Groundwater Predicted between Blackford and Salt Creek and the Application of the Groundwater Calculation Methodology.
- **Question 5**: What difference is there between using Biscuit Flat or Reedy Creek between Drain L/K and Blackford Drain.

Subsequent to the original request, two further tasks were undertaken as flows:

- Refinement of hydraulic designs for some of the channels;
- Analysis of the causes of uncertainty in losses to groundwater from the channel.

The overall objective of this study was to provide revised estimates of the yield of flows diverted for the drainage network to the southern lagoon of the Coorong.

1.2 Approach

This most recent work was required to build on the earlier work, hence watercress, Hec Ras and spreadsheet models developed by Montazeri et al (2011) were used and adapted where appropriate. In some instances a change in approach was considered warranted. These changes of approach were also described in the sections that follow.

1.3 Study Area

The study area is the south east of South Australia between Salt Creek in the north and Drain M in the south. This study has considered four flow paths summarised in Table 1-1. The alignment of the flow paths is illustrated in Figure 1-1 and Figure 1-2

Each flow path receives flows from drains in the current drainage network. These diversion points are:

- Drain M (at Reedy Creek);
- Wilmot Drain (at Reedy Creek);
- Drain L/K (at Reedy Creek) ;
- Blackford Drain (at Reedy Creek- Flow Path 02) ;
- Blackford Drain (at the Floodway junction- Flow Path 03 Floodway and Flow Path 03 Biscuit Floodway); and
- Blackford Drain (at Southern Ephemeral Lagoons- Flow Path 03 SELS).

TABLE 1-1SUMMARY OF FLOW PATHS CONSIDERED

Reaches	**Flow Path**			
	Flow Path 02	**Flow Path 03 SELS**	**Flow Path 03 Floodway**	**Flow Path 03 Biscuit Floodway**
Drain M- Wilmot Drain	Reedy Creek	Reedy Creek	Reedy Creek	Reedy Creek
Wilmot Drain – Drain L/K	Reedy Creek	Reedy Creek	Reedy Creek	Reedy Creek
Drain L/K - Blackford Drain	Reedy Creek	Reedy Creek	Reedy Creek	Biscuit Flat
Blackford Drain- Salt Creek	Taratap Tilley Swamp Morella Basin	Blackford Drain Southern Ephemeral Lagoons (4)	Blackford Drain Floodway Southern Ephemeral Lagoons (3+4)	Blackford Drain Floodway Southern Ephemeral Lagoons (3+4)

Montazeri et al (2011) provides further information on the development and details of the models used as basis for this work.

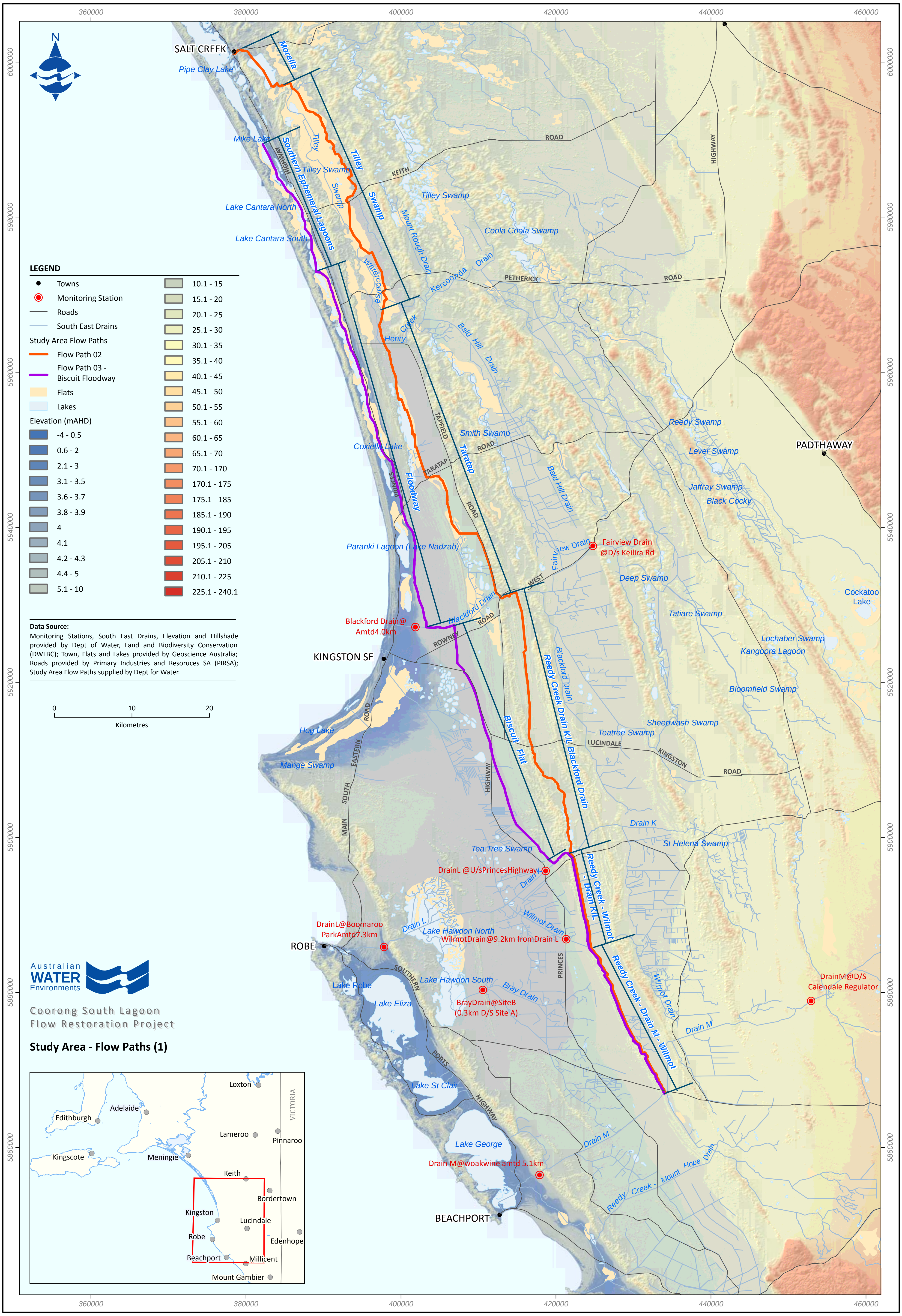

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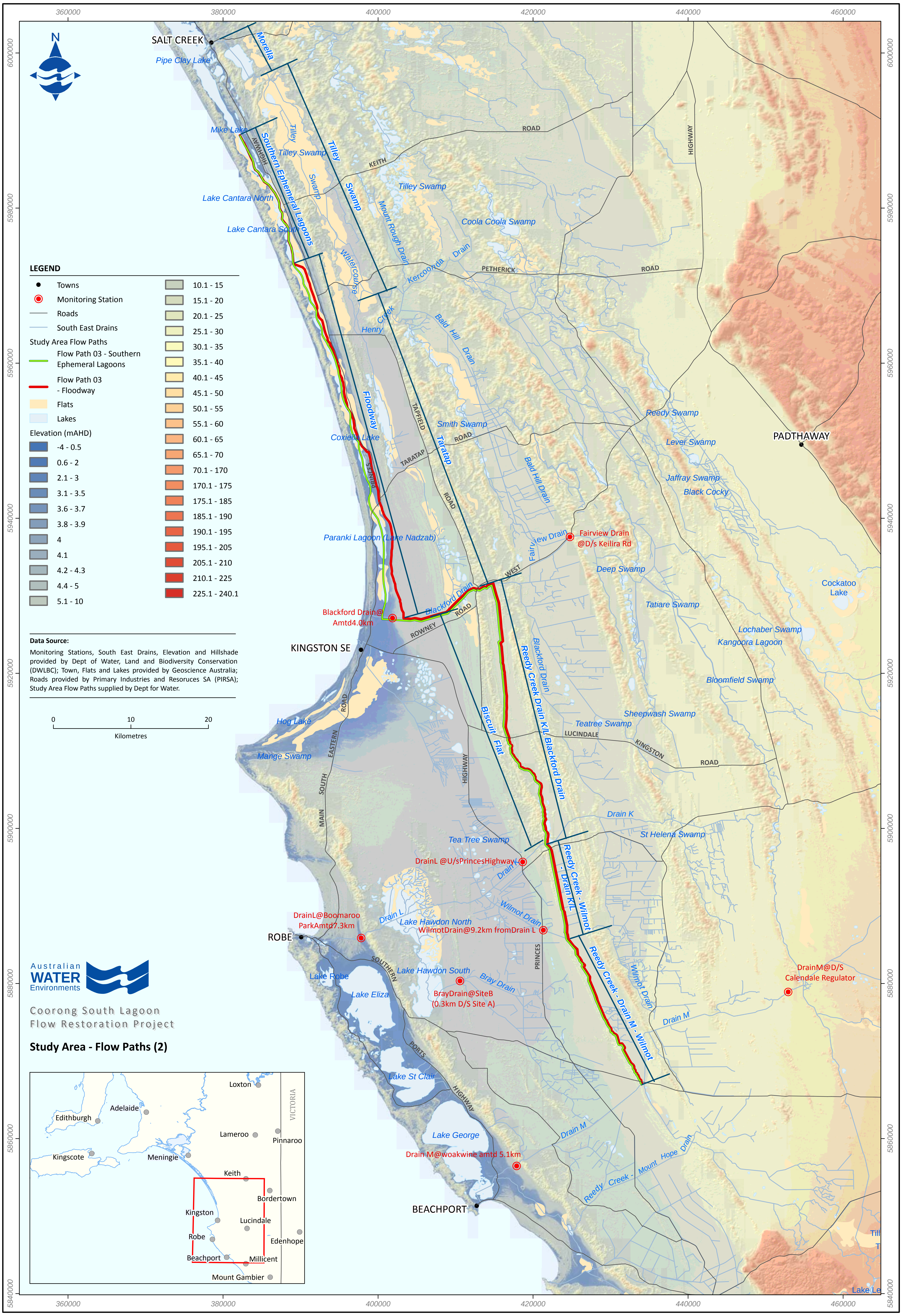
Figure M.1



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2 Question 1 - Ascertain the Fairview Drain Operating Rules

2.1 Understanding of the Questions

This component of the study investigated the following:

- Ascertain the Fairview Operating Rules.

Blackford and Fairview are adjoining catchments/drainage systems and are integral to the Coorong South Lagoon Flow Restoration Project (refer to Figure 2-1). The historical operating rules for each system warranted modelling the two systems such that they were independent of each other. The modelling undertaken by Monatzeri et al (2011) has assumed that 100% of the flows from Fairview Drain are directed towards Bald Hills Drain rather than into the Blackford system. The operating system on the Fairview Drain allows for the diversion of flows into the Blackford Drain. The aim of this component of works was to ascertain whether the addition of the Fairview system into the Blackford drainage system would materially increase the volume of water available for the Coorong South Lagoon Flow Restoration Project.

2.2 Analysis Methodology

The following tasks were undertaken to gain a better understanding of the operating rules for the Fairview Drain we completed the following:

- Review of the existing information on the Fairview Drain diversions;
- Review of the existing record at theKeilira monitoring station;
- Confirmation of the system capacities, intended and historic operation of the drainage network with relevant Drainage Board and Department for Water (DfW) staff; and
- Determing the surface water yield from redirecting flows from the Fairview catchment to the Blackford (rather than Bald Hills) drain via a review and update of the Wood and Way (2011) Blackford/Fairview WaterCress modelling framework.

2.3 Understanding of Previous Work

Understanding the nature of the respective systems (Blackford and Fairview Drains operating systems) is important in developing a robust hydrological model. Critically, the existing Montazeri et al (2011) Blackford/Fairview WaterCress modelling framework, developed as part of the Wood and Way (2011) work assumed that all of the water from Fairview Drain was diverted to Bald Hills Drain rather than to the Blackford system. The updated modelling framework was designed to determine the total yield when directing Fairview Drain flows to the Blackford Drain catchment, based on calibration with the in situ data.

AWE reviewed the data available from Blackford and Fairview to ascertain the key characteristics of the catchment. Liaisons took place with a range of organisations (including South East Water Conservation and Drainage Management Board (Drainage Board) and DfW to determine the operating rules, particularly when, where and why diversions occur. These rules enabled a determination of what data could feasibly be used for calibration of the model.

The key outcomes from the data and information gathering phase were:

- There is a diversion threshold (the operating rules) within the Fairview system, which determines the path of water;
- The threshold relates to the salinity concentration (6000 EC) at the watercourse gauging site, *Fairview Drain (A2390569)*, which is downstream of Keilira Road (this station was opened in 2000);
- Since 2000, the water has been diverted based on this threshold;
- During the period 2000 to 2004, water was diverted before the Fairview Drain (A2390569) gauging station;
- In contrast, during the period 2005 to 2010, the water was allowed to pass the gauging station; and
- The operating rules and the consequent diversions during the first ten years of the gauging station resulted in the Fairview Drain (A2390569) watercourse gauging site data only being representative of the catchment flow during the 2005 to 2010 time period.

2.4 Surface Water Yield Determination (WaterCress Model)

WaterCress (Water Community Resource Evaluation and Simulation System) is a PC based, continuous time series, total water cycle model, which simulates the passage of flows through natural and constructed water systems.

For this study, daily rainfall and watercourse gauging information was used to develop a surface water model to simulate runoff data for the Blackford and Fairview operating systems. This involved the following stages:

1. Model Construction
    a. Data acquisition;
    b. Catchment delineation; and
    c. Catchment node characterisation.
2. Model Calibration
3. Scenario Evaluation
    a. Climate (historical) and Climate Change (Median).

The process is detailed in the sections that follow.

2.4.1 Catchment Delineation

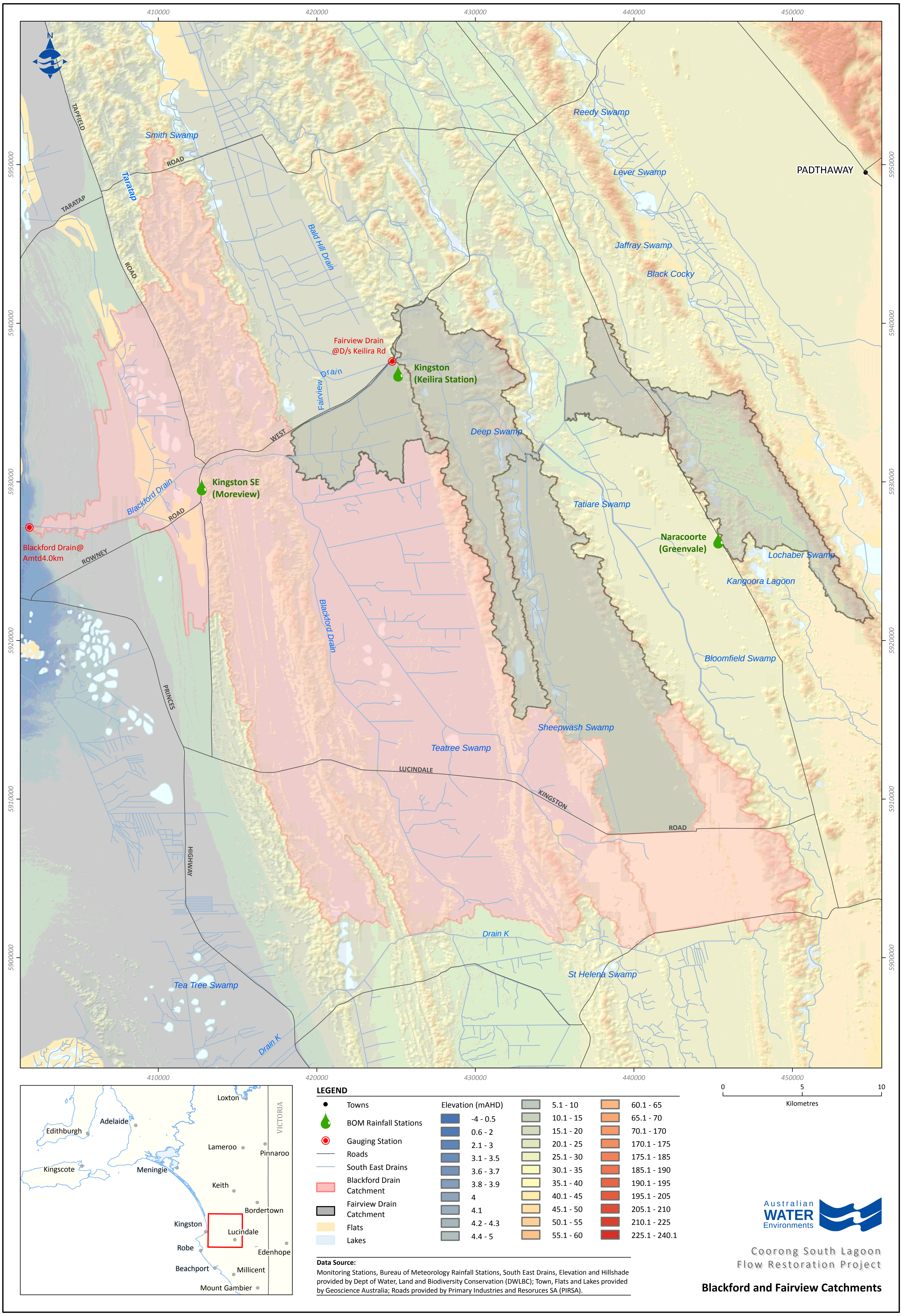
The subcatchments developed by Wood and Way (2011) were adopted.

2.4.2 Catchment Node Characterisation

AWE reviewed the Wood and Way (2011) Blackford and Fairview Catchment WaterCress models. Whilst the Wood and Way (2011) Blackford and Fairview Catchment WaterCress models were contained within the same framework, the two models were separated via a lack of linkage (drainage path). This reflected the diversion of Fairview catchment flow to Bald Hills. The input data files and characteristics of each node were reviewed. Using the Wood and Way (2011) models, AWE developed a new Blackford/Fairview model which incorporated the majority of the catchment node characteristics developed and calibrated within the DfW modelling framework. Minor adjustments to a few of the nodes were made based on the calibration process.

2.4.3 Model Calibration

The completed model was calibrated to determine the optimum values for the required model parameters. The calibration of the model was iterative, where different sets of combinations are trialled, and the results compared to produce the best possible fit between the observed (Fairview Drain (A2390569) data) and modelled data. The appropriateness of the calibrated parameters was assessed by comparing the values predicted by the model to observed data at annual, monthly and daily time scales. The calibration coefficient of determination R^2 was 0.72.



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2.5 Analysis Results

2.5.1 Surface Water Yield

The Fairview operating system contribution to the Blackford Drain system was estimated for the time period 1971–2000 (the standardised thirty year period as used by Wood and Way (2011) and Montazeri *et al* (2011)) for the following scenarios:

- Climate (Historical);
- Climate Change (Dry); and
- Climate Change (Median).

Table 2-1 and Figure 2-2 detail the annual average and median discharge for all of the scenarios.

TABLE 2-1 SURFACE WATER YIELD – BLACKFORD PLUS FAIRVIEW (B&F) AND COMPARISON WITH BLACKFORD ONLY (B ONLY)

	Climate (Historical)			Climate Change (Median)		
	B &F (ML)	B Only (ML)	% Diff	B &F (ML)	B Only (ML)	% Diff
Mean	22,264	13,634	63%	18,285	10,657	72%
Median	23,734	14,272	66%	19,954	11,586	72%

The diversion of the Fairview catchment flow into the Blackford catchment results in a 63% increase in the average annual yield under the historic climate conditions and 72% increase under the Climate Change (Median) scenario.

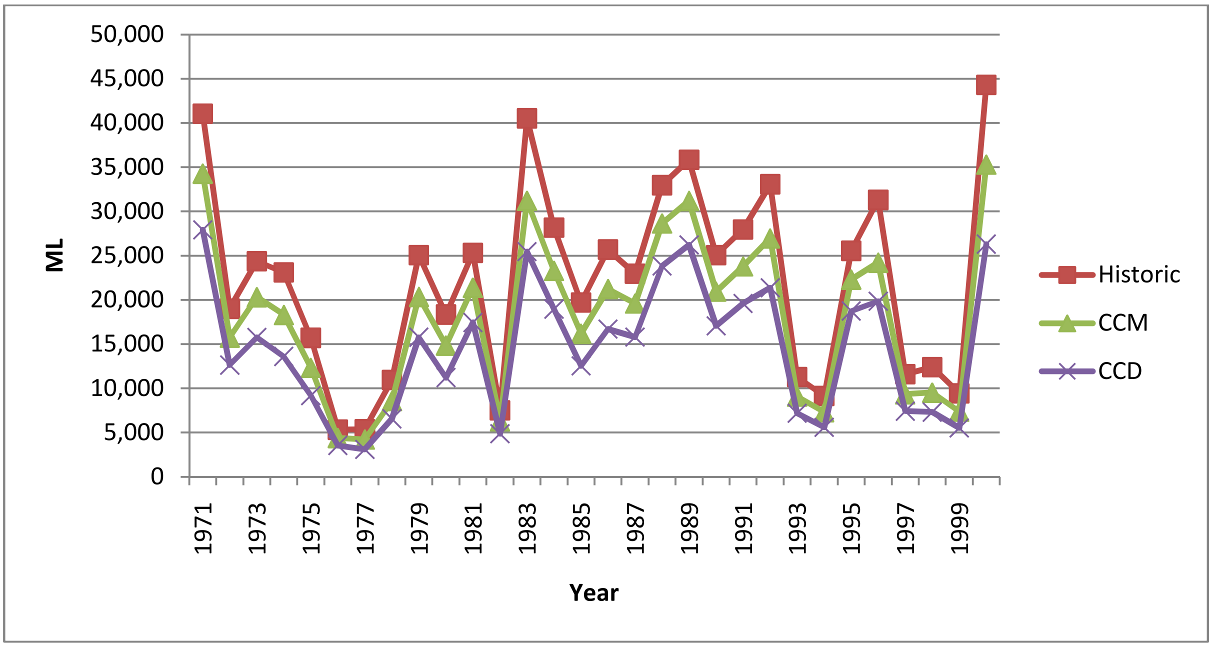


FIGURE 2-2 BLACKFORD/FAIRVIEW YIELD (ML)

3 Question 3: Why are there significant differences between the Optimum Daily Diversion at Drain L/K and Wilmot

3.1 Understanding of the Questions

The following aspects were investigated:

- Why the estimated annual flows available for diversion at Wilmot Drain are significantly different between the AWE (2009) and Montazeri et al (2011) work;
- Why the maximum daily diversion selected for Wilmot Drain in the DfW work is larger than Drain L/K if the annual flows available for diversion at Wilmot Drain and Drain L/K are similar.

3.2 Why are the Flows Estimated to be Available for Diversion Significantly Different?

The following section outlines the difference between the results for Wilmot Drain for the two studies and the potential source of the differences.

3.2.1 Comparison of Diversion Results

Table 3-1 compares the average annual and median annual diversion results from both Montazeri et al (2011) and AWE (2009). The results indicate that the average annual diversion estimated by AWE (2009) was significantly larger than that of Montazeri et al (2011). The median annual diversion results for Wilmot Drain indicate both studies estimate similar volumes. The difference between the average and the median results indicate that the AWE (2009) results could potentially be skewed by some larger events in the record.

Figure 3-1 illustrates the flow record available for diversion under historic climate conditions at Wilmot Drain as calculated by AWE (2009), Montazeri et al (2011) and compared with the recorded flow at the monitoring station approximately 3km downstream of the diversion location. From Figure 3-1 the data gap within the Wilmot monitored record is apparent.

AWE (2009) used a Tanh relationship, which estimates seasonal flow based on rainfall to patch the flow record during this period (1989 -1999). This Tanh relationship was developed based on the existing flow information on Wilmot Drain (A2390527) and rainfall information available for BOM station Greenways. This approach is consistent with that used by Way and Heneker (2007) for the initial assessment of the Coorong South Lagoon Flows Restoration Project (CSLFRP) and is considered the most reliable method to be applied without developing a numerical model of the catchment. It was also a feature of the project scope that a consistent method for data patching be applied in AWE (2009) to that which had previously been applied in Way and Heneker (2007).

During the flow data gap period the Figure 3-1 shows the AWE flow estimates for a number of years significantly higher than that of Montazeri et al (2011). These high flow years are the reason why the average annual flows from Wilmot Drain are much higher than that recorded by Montazeri et al (2011).

TABLE 3-1 COMPARISON OF VOLUMES DIVERTED FROM WILMOT DRAIN IN THE DFW AND AWE WORK (HISTORIC CLIMATE CONDITIONS)

Average Annual Volume Diverted (ML/d)						
Maximum Daily Diversion	Wilmot			Drain L/K		
(ML/d)	DfW	AWE	Difference (%)	DfW	AWE	Difference (%)
150	8,982	11,301	-26%	8,969	9,501	-6%
250	11,266	14,832	-32%	10,844	11,373	-5%
500	13,214	19,065	-44%	12,162	13,020	-7%
1000	13,477	21,643	-61%	12,307	13,300	-8%
Median Annual Volume Diverted (ML/d)						
	Wilmot			Drain L/K		
	DfW	AWE	Difference (%)	DfW	AWE	Difference (%)
150	9,536	8,800	8%	9,645	8,000	17%
250	11,720	9,600	18%	10,352	8,300	20%
500	12,797	9,800	23%	10,352	8,300	20%
1000	13,072	10,252	22%	10,352	8,315	20%

*Where DfW refers to the output of Montazeri et al (2011).

Further investigation into high flows estimated by AWE (2009) during the period where the Tanh relationship was used was completed the results are summarised below;

- The distribution of the rainfall between the dry and wet seasons as they were defined for the AWE (2009) study was checked. No trend in seasonality of rainfall with the high flow estimates was found.
- The performance of the AWE (2009) Tanh relationships during the period in which flow records area available for Wilmot Drain was also checked. In the 19 years of data for calibration of the Tanh relationship the flow was overestimated 63% of the time. The average overestimate was 29mm/a, which equates to 5.7 GL/a. The maximum overestimate in the 19 years available for calibration was 17.2GL/a.
- A comparison of the flows in Drain L as A2390510 (Drain L u/s of Princes HWY) with the flow record developed for Wilmot Drain shows larger flow events occurring in Drain L in the same years when larger flow events are predicted in Wilmot Drain in both the DfW and AWE data sets. The relative magnitude of the events between years is not consistent when comparing the Drain L and Wilmot data sets.

The Tanh relationships used in AWE (2009) are represented graphically in Figure 3-2. The r^2 value (a measure of goodness of fit where a value closer to 1 represents a perfect fit) for the AWE Tanh relationship for the wet season was r^2= 0.618. We completed a review of the fit of the curve to test if it could be improved. The revised relationship achieved a fit of r^2=0.619, which is a slight improvement. The resulting flow record available for diversion at Wilmot Drain is summarised in Figure 3-1. The median annual flow available for diversion, in comparison to the AWE (2009) results, was unchanged however the average flow available for diversion, has been reduced by approximately 3.4GL/a on average 6% per year over the study period.

During our review it was also noted that the flow record results for Wilmot Drain as described in Wood and Way (2011) page 171 does not appear consistent with the flow record for Wilmot Drain at A2390527 (Wilmot @ 9.2 km from Drain L). From our review of Wood and Way (2011) it is not clear why this is the case.

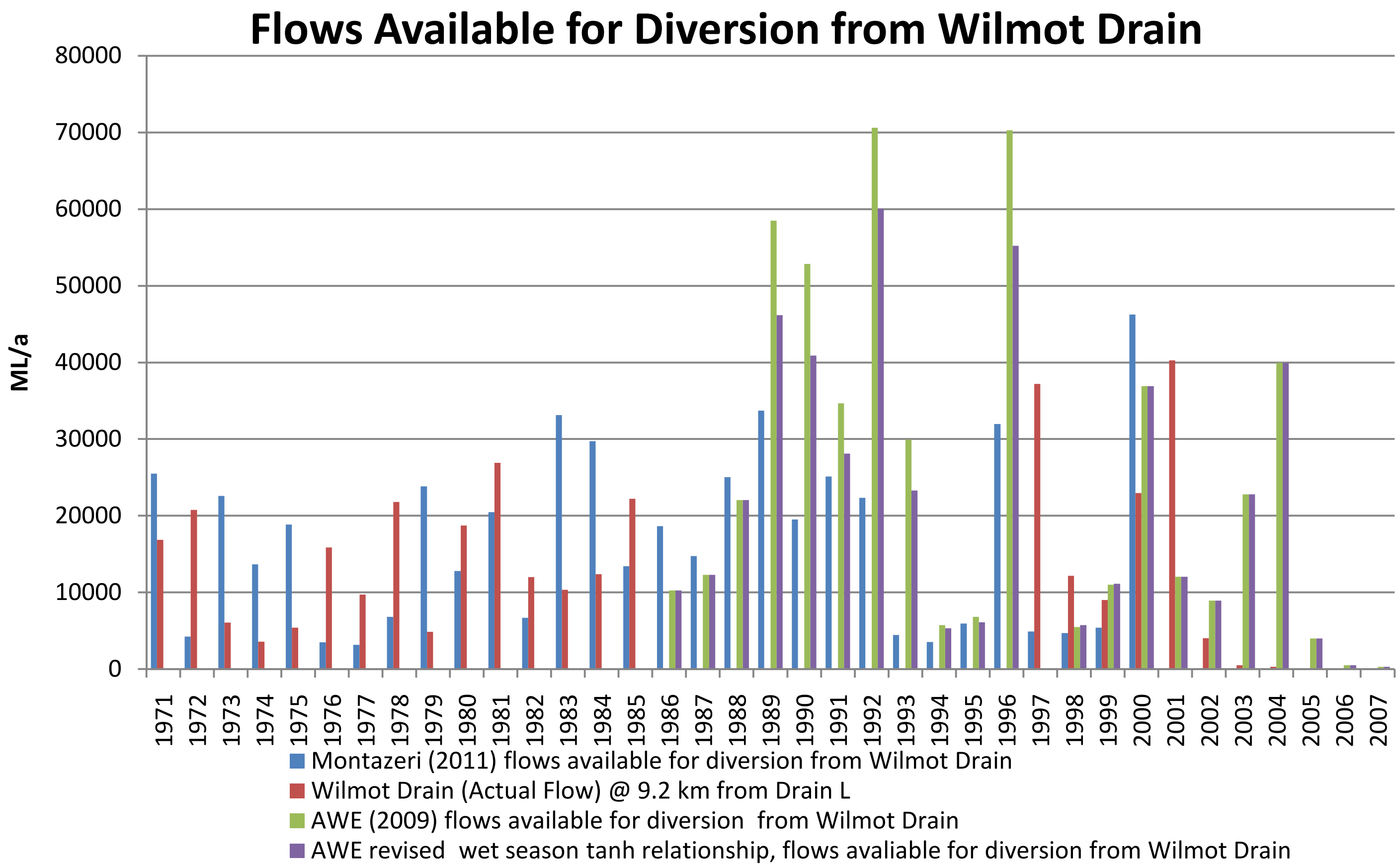


FIGURE 3-1 FLOWS AVALIABLE FOR DIVERSION FROM WILMOT DRAIN

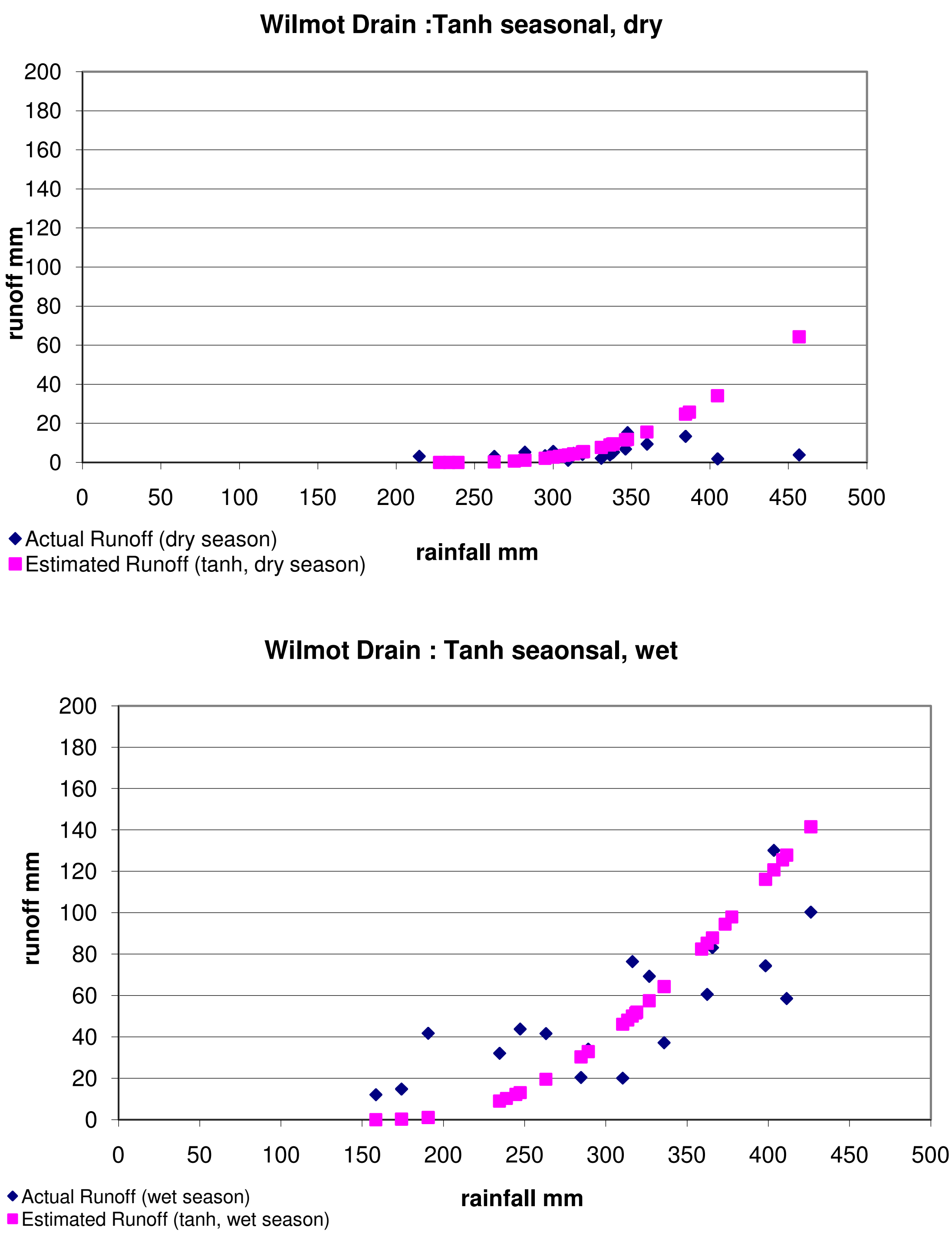


FIGURE 3-2 TANH RELATIONSHIPS ADOPTED BY AWE (2009) TO PATCH WILMOT DRAIN FLOW DATA SET

3.2.2 Comparison of AWE and DfW Modelling Approach and Rainfall Records

Table 3-2 summarises some of the key characteristics in the modelling approaches. The rainfall record during the two study periods are difficult to compare given the rainfall records available to AWE and the variations in records at local stations. Figure 3-3 illustrates the rainfall records in the region available in comparison to the rainfall record used in the Montazeri et al (2011) Wilmot catchment WaterCress model.

TABLE 3-2 BASIC MODELLING APPROACH COMPARISON

Variable	AWE (2009)	Montazeri et al (2011)
Study Period	1986-2007 (22)	1971-2000 (30)
Hydrological analysis approach	Flow at the Wilmot diversion point (7) was based on the flow record at A2390527 (Wilmot @ 9.2 km from Drain L). This record was patched for approximately 11.5 years (Feb 1989-July 1999) of the study period. The record was patched using the Tanh relationships (wet and dry season) developed for the remaining data series at the monitoring station using rainfall from Greenways.	The catchment draining to the Wilmot diversion point was modelled as one catchment using the Watercress model. The model was calibrated against A2390527 (Wilmot @ 9.2 km from Drain L).
Catchment Area (Diversion point)	25,398 ha	27,096 ha
Average Annual Rainfall in the respective study period	• 619 mm BOM site Greenways (1986-2003, missing 93-95 and 97-99), 9km west of Wilmot catchment centroid. • 614mm BOM site Robe (1986-2007) approximately 44km west of Wilmot catchment centroid.	• 653 mm Rainfall from Wilmot WaterCress model (1971-2000). • 653mm Rainfall from BOM site Greenways (1971-2000, missing71-73, 93-95 and 97-99). • 640 mm BOM site Robe (1971-2000, missing 1971). Approximately 44km west of Wilmot catchment centroid. • 563mm BOM site Naracoorte (#026023), approximately 51 km north east of Wilmot catchment centroid.

Figure 3-4 illustrates the long term average rainfall in the south east of South Australia. The period of record is the same for the Montazeri et al (2011) study. The long term average rainfall for the Wilmot catchment area looks to be between 600-700mm which is supported by the average annual rainfall recorded at local stations of similar latitude (e.g. Greenways and Robe), as summarised in Table 3-2

To provide a comparison of the general trends in rainfall between the two study periods the rainfall at Robe during the Montazeri et al (2011) study period was approximately 640mm. During the AWE study period the average annual rainfall was 614mm (Approximately 4% lower). The average annual rainfall based on the Wilmot WaterCress model was 653mm which is 2% higher than the rainfall at Robe during this period.

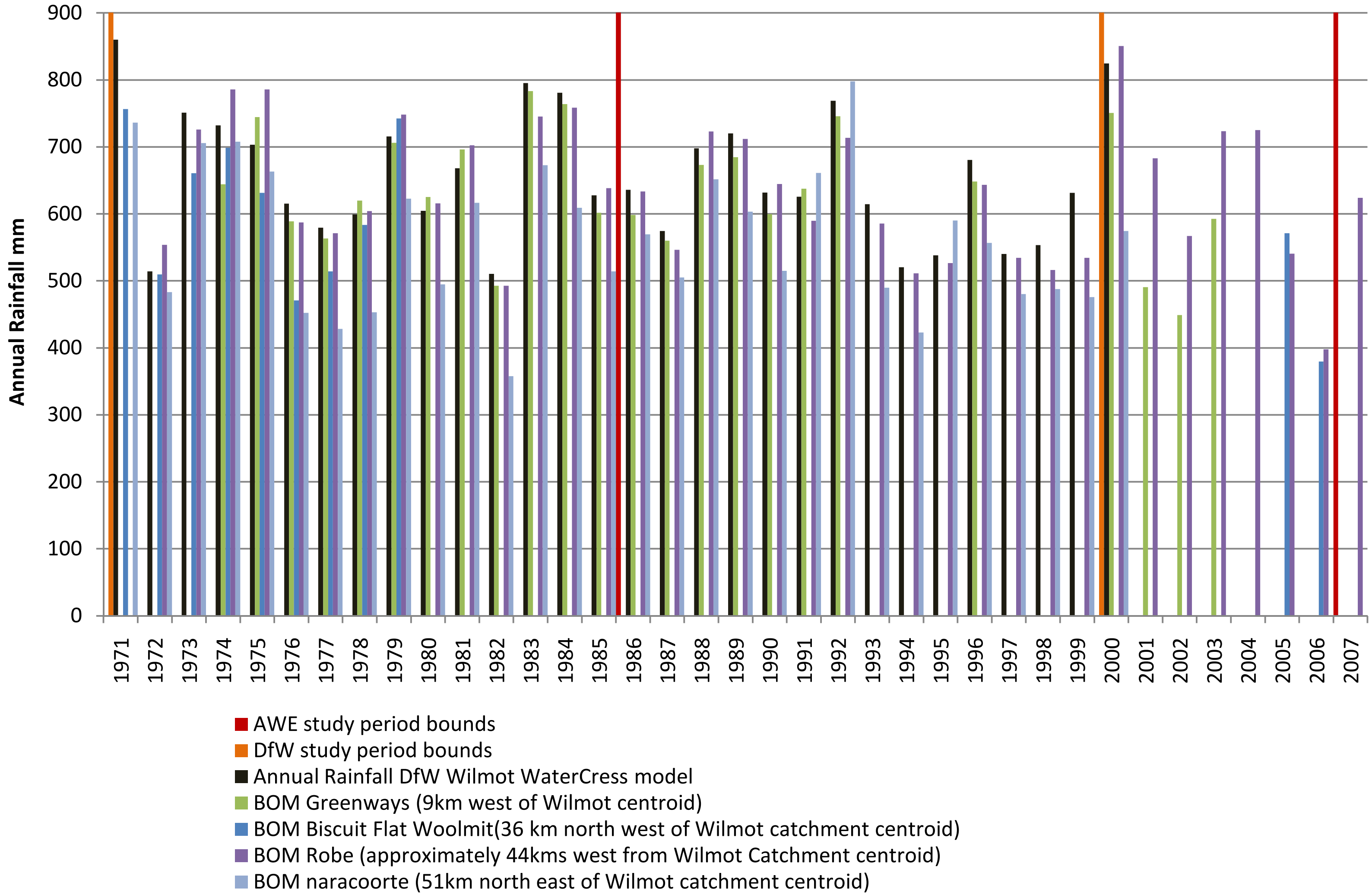


FIGURE 3-3 ANNUAL RAINFALL SURROUNDING THE STUDY AREA IN COMPARISON TO THE RAINFALL USED IN THE DFW MODEL

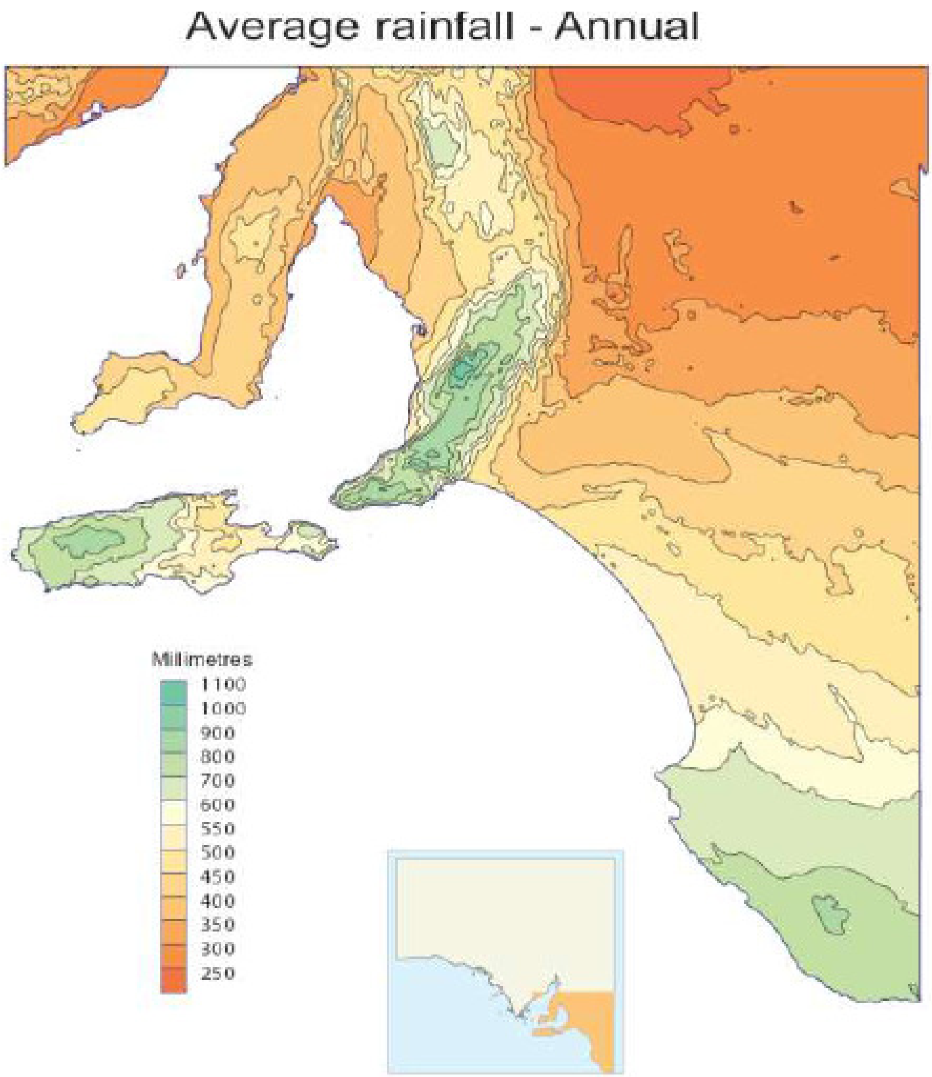


FIGURE 3-4 LONG TERM AVERAGE (1971-2000) RAINFALL FOR THE STUDY AREA (FAWCETT ET AL, 2006) AS REFERENCED IN DEPARTMENT FOR WATER, 2010)

3.2.3 Summary

3.2.3.1 Difference in Annual Average Diversion Yield between AWE (2009) and Montazeri (2011)

The difference between, in particular, the annual average diversion yield at Wilmot Drain between the AWE (2009) work and the work of Montazeri et al (2011) is caused by the different methods used by each study to estimate flows available for diversion. AWE (2009) based their work on the flow record at Wilmot Drain. Where there was no record a Tanh relationship was used to estimate the runoff for each season (wet and dry). Montazeri et al (2011) used a calibrated WaterCress model to estimate flows in Wilmot Drain. The model was calibrated to the available record near the diversion point on Wilmot Drain. The model was then used to ‘patch’ the missing record.

The investigation outlined above demonstrates the limitations of the regional Tanh method. The development and calibration of a modelled approach as used by Montazeri et al (2011) is a more sophisticated and detailed approach to the problem. As such, assuming the model is well calibrated, we would expect a more robust estimate of flows based on climate data from this approach.

3.2.3.2 Comparison of the Rainfall Records during the Two Study Periods

Comparison of the rainfall records during the AWE (2009) and Montazeri et al (2011) study periods found that during the AWE (2009) study period the average annual rainfall was lower (in the order of 5%).

The comparison of the rainfall records also found that the rainfall record used as the basis of the Montazeri et al (2011) WaterCress model appeared to be in line with comparable records of existing stations at similar latitudes and in comparison to the long term average annual rainfall statistics for the south east of South Australia.

3.3 Why is the Maximum Daily Diversion Selected for Wilmot Drain Larger than Drain L/K if the Annual Flows Available are Similar?

Table 3-3 summarises the annual diversion volumes expected from both Drain L and Wilmot Drain from Montazeri (2011). The flows expected from diversion from Wilmot Drain are generally more than Drain L up to a maximum of 20% at 1000 ML/d maximum daily diversion limit.

The recommended optimum maximum daily diversion from Wilmot Drain by Montazeri (2011) is 500 ML/d. For Drain L the recommended optimum is 250 ML/d.

TABLE 3-3 SUMMARY OF ANNUAL DIVERSION VOLUMES FROM DRAIN L AND WILMOT DRAIN FROM MONTAZERI ET AL (2011)

Average Annual Volume Diverted (ML/d)			
Maximum Daily Diversion(ML/d)	Wilmot	Drain L/K	Difference (%) Wilmot – Drain L
150	8,982	8,969	0.1%
250	11,266	10,844	3.7%
500	13,214	12,162	8.0%
1000	13,477	12,307	8.7%
Median Annual Volume Diverted (ML/d)			
150	9,536	9,645	-1.1%
250	11,720	10,352	11.7%
500	12,797	10,352	19.1%
1000	13,072	10,352	20.8%

3.3.1 Analysis of Diversion Optimisation Approach

Table 3-4 presents a comparison of the expected increase in yield with increasing maximum daily diversion rate from both the AWE (2009) and Montazeri et al (2011). The table shows that the when considering the results of Montazeri (2011) that the increase in yield between 250 ML/d and 500 ML/d the percentage increase in yield for Wilmot and Drain L is similar (within 5%).

When considering the previous AWE (2009) results the expected average increase in yield was 29% which was 15% more than for Drain L.

Figure 3-5 presents the average annual yield information in a graphical form. The graph shows that the results from Montazeri et al (2011) for Drain L and Wilmot Drain are quite similar. It also shows the difference between the previous AWE (2009) analysis for Wilmot Drain and the more recent, and as discussed above, more robust results of Montazeri et al (2011).

TABLE 3-4 COMPARISON OF INCREASE IN DIVERSION YIELD WITH INCREASING MAXIMUM DAILY DIVERSION RATE (AWE, 2009 AND MONTAZERI ET AL ,2011)

Increase in yield with increase in maximum daily diversion (AVERAGE)					
Wilmot Drain			**Drain L**		
DfW			DfW		
150 to 250	25%	2,300.00 ML/d	150 to 250	21%	1,900.00 ML/d
250 to 500	17%	1,900.00 ML/d	250 to 500	12%	1,300.00 ML/d
500 to 1000	2%	300.00 ML/d	500 to 1000	1%	100.00 ML/d
AWE			AWE		
150 to 250	31%	3,500.00 ML/d	150 to 250	20%	1,900.00 ML/d
250 to 500	29%	4,200.00 ML/d	250 to 500	14%	1,600.00 ML/d
500 to 1000	14%	2,600.00 ML/d	500 to 1000	2%	300.00 ML/d
Increase in yield with increase in maximum daily diversion (MEDIAN)					
DfW			DfW		
150 to 250	23%	2,200.00 ML/d	150 to 250	7%	700.00 ML/d
250 to 500	9%	1,100.00 ML/d	250 to 500	0%	0 ML/d
500 to 1000	2%	300.00 ML/d	500 to 1000	0%	0 ML/d
AWE			AWE		
150 to 250	9%	800.00 ML/d	150 to 250	4%	300.00 ML/d
250 to 500	2%	200.00 ML/d	250 to 500	0%	0 ML/d
500 to 1000	5%	500.00 ML/d	500 to 1000	0%	0 ML/d

*Where DfW refers to Montarzeri et al (2011), AWE refers to AWE (2009)

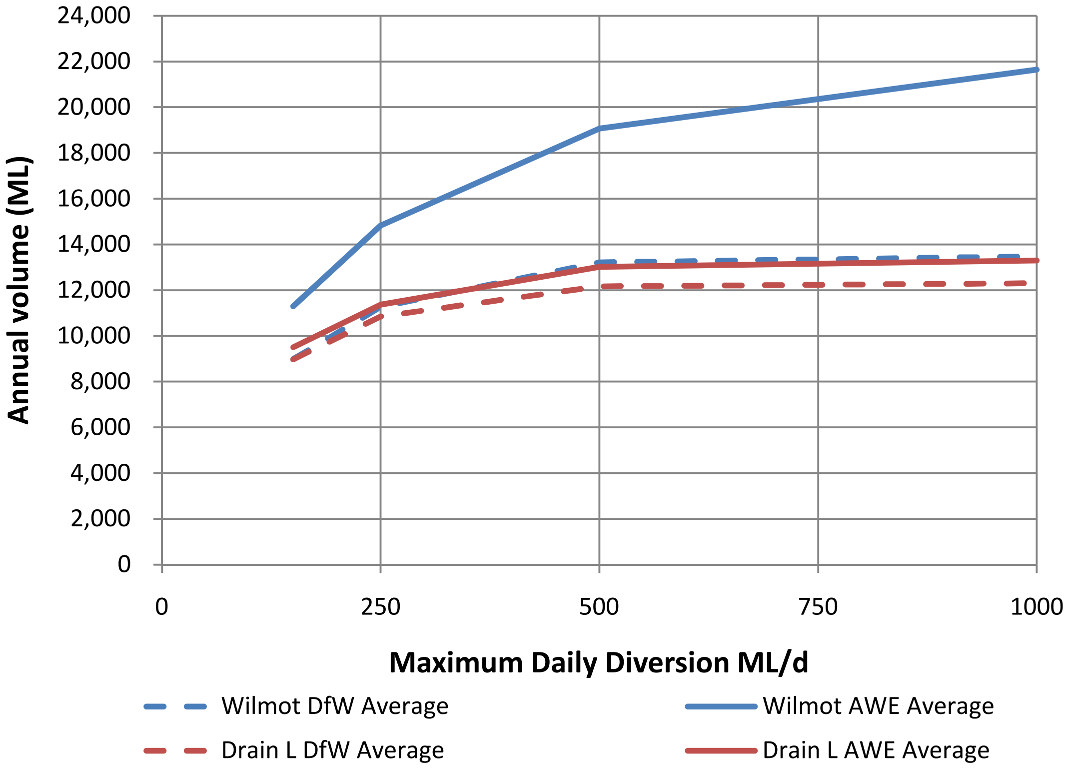


FIGURE 3-5 ANNUAL AVERAGE YIELD BASED ON MAXIMUM DAILY DIVERSION FOR DRAIN L AND WILMOT DRAIN

*Where DfW refers to Montarzeri et al (2011), AWE refers to AWE (2009)

3.3.2 Diversion Calculation Methodology Check

As part of the investigation of the optimisation of the maximum daily diversion for Wilmot Drain a difference in the diversion calculation methodology for the drain was identified.

AWE (2009) assumed a minimum supply to node C (Lake Hawdon) of 22ML/d but assumed the catchment between the Wilmot and Drain L diversion point and the Lake itself contributed evenly to both the Drain L and Wilmot Drain minimum supply to Lake Hawdon. That is, this water was allowed to form all or some of the 22ML/d required. Therefore the minimum flow downstream of the diversion point on Wilmot Drain could be less than 22ML/d.

Investigation of the Montazeri et al (2011) approach at the Wilmot diversion point found that the contribution of the catchment between the diversion point and Lake Hawdon was not taken into account. Instead Montazeri et al (2011) assumed a 22 ML was required to be passed each day downstream. The resultant difference in diversion assuming the two different approaches was found to be 48 938 ML more water diverted using the AWE methodology over 30 years (1,630 ML/a on average).

Another small difference in the application of the diversion methodology was also found. When the flows reach the maximum diversion AWE (2009) assumed that for the maximum flows to be diverted that the flows available need to be equal to the maximum daily diversion volume plus the minimum flow that must be allowed to pass. E.g. If the maximum daily diversion scenario is 500 ML/d for the maximum diversion to occur the flow must be greater than or equal to 522 ML/d.

Montazeri et al (2011) assumed that for the maximum daily diversion to occur a flow of greater than or equal to 500 ML/d needs to occur. This difference in diversion analysis results in a small difference in overall diversion volume i.e. < 200 ML over a 30 year period.

3.3.3 Summary

From the discussion above it is clear that there are minor differences in the diversion calculation methodologies used by AWE (2009) and Montazeri et al (2011). These differences are unlikely to cause a significant change in the results.

From considering both the AWE (2009) and Montazeri et al (2011) data sets it is clear that the evidence for increasing the maximum daily diversion rate from 250ML/d (equivalent to Drain L) to 500 ML/d for Wilmot Drain, with the revised analysis of Montazeri et al (2011) is not as strong as the evidence was for the AWE (2009) recommendation.

3.4 Question 3 Conclusion

The difference in the results for the estimate of flows available for diversion from Wilmot Drain between the previous AWE (2009) study and the current study of Montazeri et al (2011) is a result of the method used to patch the missing data within the flow record for the Drain. The methodology used by Montazeri et al is more sophisticated and considers the catchment characteristics in more detail than those used in AWE (2009) (which are consistent with those used in Way and Heneker (2009) which was a requirement of the AWE (2009) project).Therefore the results of Montazeri et al are expected to be more reliable than those of the previous AWE (2009) study.

The difference in the optimum maximum daily diversion rate assigned to Wilmot Drain in comparison to Drain L, which has similar average annual yields, is a result of the interpretation of the significance of the increased yield expected. Our assessment of yield from Wilmot Drain in comparison to Drain L using the Montazeri et al (2011) data suggests that the selection of 250 ML/d as the optimum maximum daily diversion rate over 500 ML/d for Wilmot Drain.

It is difficult to provide a definitive recommendation on the maximum daily diversion capacity for Wilmot Drain because we are not privy to the costs of providing the additional capacity, nor are we able to advise on the potential benefits from the additional water. However, based on DfW's analysis methodology a maximum daily diversion capacity of 250 ML/d will reduce the median annual volume of water diverted at Wilmot by 1.1GL/a. We would expect that this will equate to less than a 1.1GL/a reduction at Salt Creek (due to losses in the flow path) which is less than 2% of the median annual volume estimated at Salt Creek under historic conditions for Flow Path 2.

The 80th percentile annual diversion from Wilmot Drain under 250ML/d is 2.7GL/a (15%) less than the under 500ML/a maximum daily diversion.

From a hydrological perspective a 250ML/d maximum daily diversion appears to be optimal but this does not consider the cost or environmental benefit implications. If the main benefits to the Coorong are achieved through the higher flow events (rather than the low to medium flow events) then the change in 80th percentile flows should be considered further.

For the purposes of further analysis we have adopted a maximum daily diversion rate of 250 ML/d at Wilmot Drain.

4 Question 2: What is the Optimum Size of the Channel Downstream of Blackford Drain

4.1 Understanding of the Question

The following aspects were investigated:

- What is the optimum size of the flow path downstream of Blackford Drain if flows from Fairview Drain are included in the scheme and the Wilmot Drain maximum daily diversion is 250 ML/d?
- What is the capacity of the flow path assumed in the analysis of Montazeri et al (2011).

4.2 Analysis Results

4.2.1 Additional Flows Available from Fairview Drain

The volume of water available for diversion under historic climate conditions at Blackford Drain (Flow Path 02), as presented by Montazeri, et al (2011), was compared with volume of water available when Fairview Drain flows were assumed to contribute to Blackford Drain. Table 4-1 summarises the differences in the volume of water available on an annual basis with addition of flows from Fairview drain and with the reduction of the maximum daily diversion (MDD) volume at Wilmot from 500ML/d (as in Montazeri et al, 2011) to 250 ML/d.

TABLE 4-1 FLOWS AVAILABLE FOR DIVERSON AT BLACKFORD DRAIN (FLOW PATH 02)

	Montazeri et al (2011)	AWE Blackford + Fairview (Wilmot MDD 250 ML/d)	Increase %	Increase (ML)
Average Annual (ML/a)	24,540	31,370	28	6,830
Min Annual (ML)	40	4,960	13100	4,930
Max Annual (ML)	75,560	76,720	2	1,150
Median Annual (ML)	23,090	31,080	35	7,990
80th Percentile Annual (ML)	41,830	47,910	15	6,080

The change in the annual flow record of flows available for diversion at Blackford Drain is summarised in Figure 4-1.

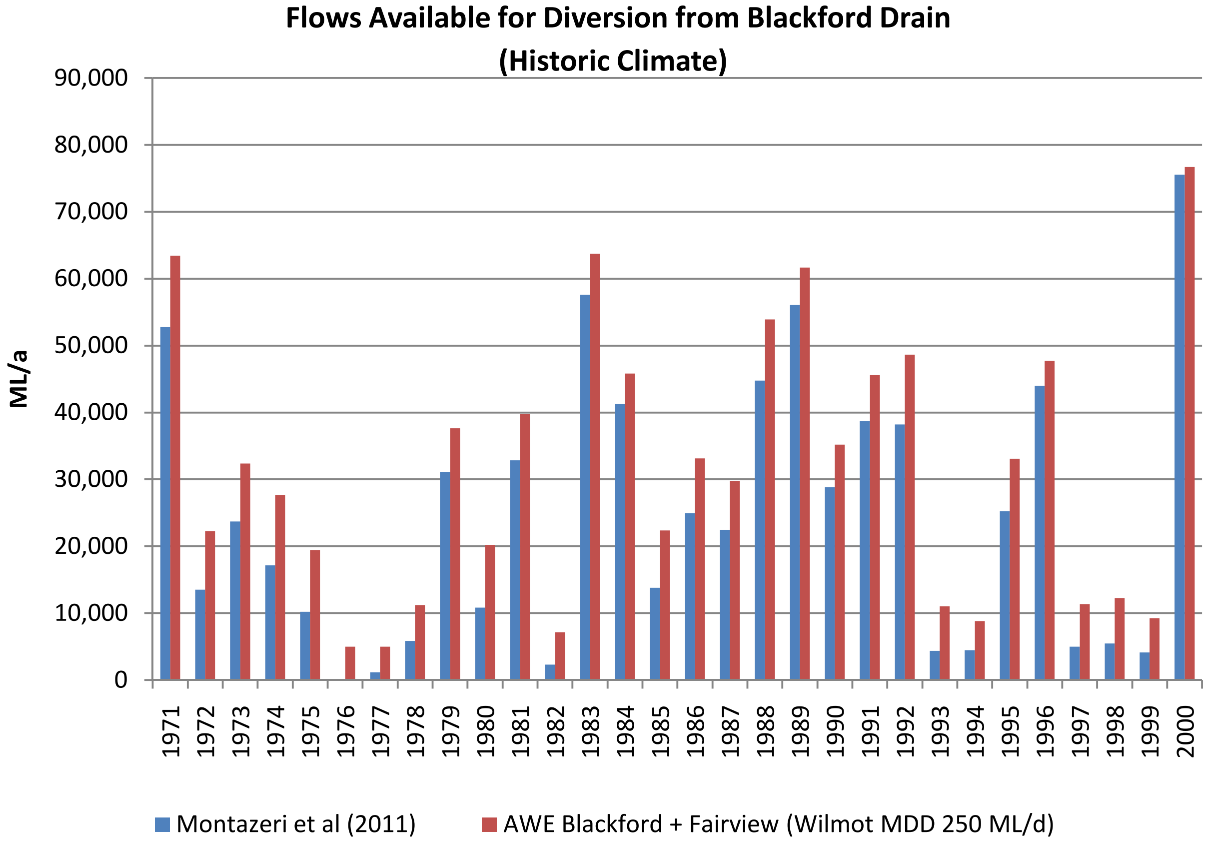


FIGURE 4-1 FLOWS AVAILABLE FOR DIVERSION FROM BLACKFORD DRAIN (HISTORIC CLIMATE)

4.2.2 Optimum Daily Diversion from Blackford Drain

Flows available for diversion at Blackford Drain under historic climate conditions have been assessed. The analysis has focused on the maximum daily diversions at Blackford Drain for Flow Path 02. This is consistent with Montazeri et al (2011) which found that the flows available for diversion for the Flow Path 03 diversion point on Blackford drain was approximately 2 GL/year (in a median year) more than the Flow Path 2. This is due to the greater local catchment contribution for Flow Path 03 along Blackford Drain. In essence this section is considering the optimum size of the channel downstream of Blackford Drain taking into account all the water diverted up Reedy Creek from Drain M, Drain L/K and Wilmot Drain, the losses experienced between these diversion points and Blackford Drain as well as the flows available for diversion from the Blackford or Blackford + Fairview catchment.

Figure 4-2 illustrates the difference in average annual volumes of water diverted at Blackford Drain based on the Montazeri et al (2011) work and assuming contributions from Fairview Drain.

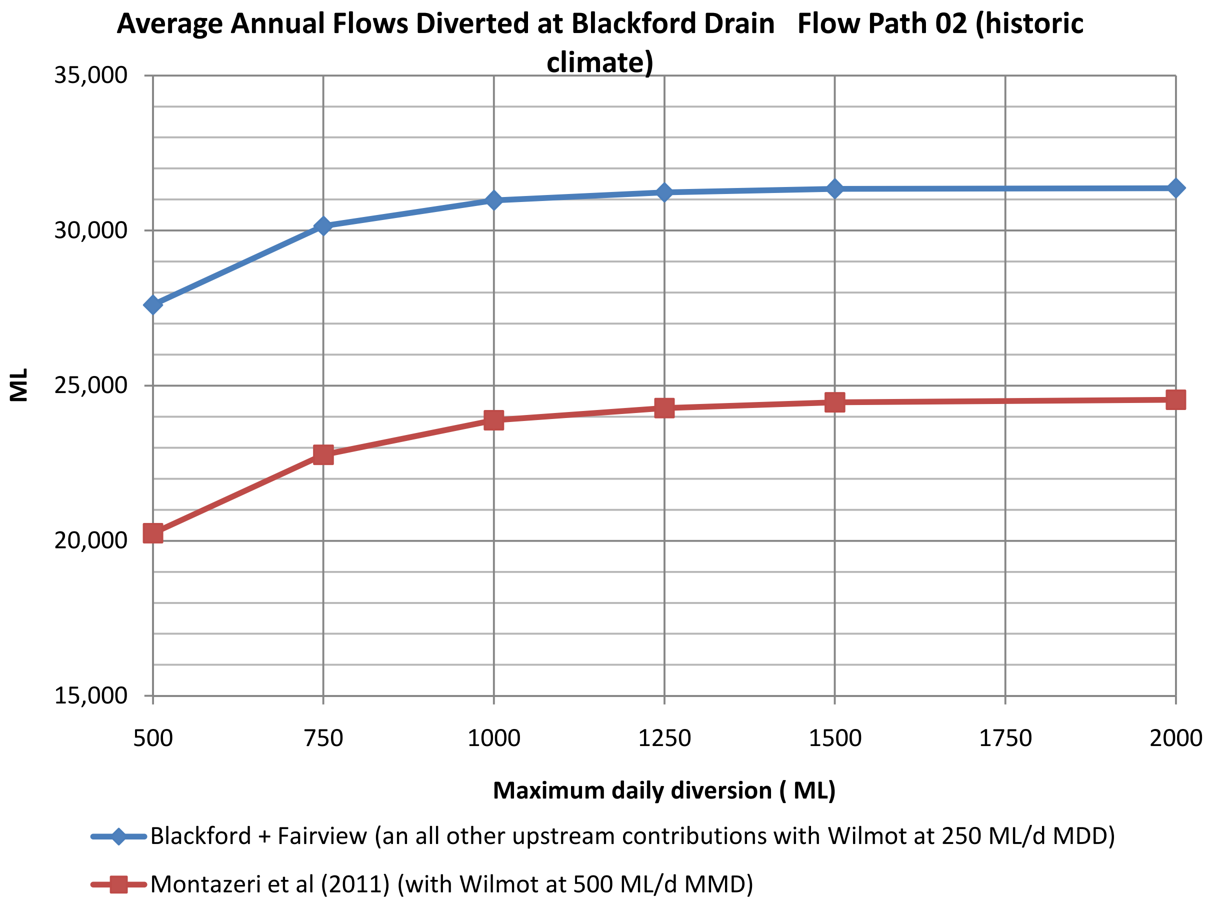


FIGURE 4-2 ANNUAL AVERAGE FLOWS DIVERTED AT BLACKFORD DRAIN (HISTORIC CLIMATE CONDITION, FLOW PATH 02) ASSUMING CONTRIBUTIONS FROM DRAIN M (250 ML/D MDD), WILMOT (250 ML/D MDD), DRAIN K/L (250 ML/D MDD)

Table 4-2 summarises the average, median and 80th percentile annual diverted flow increases expected with an increase in the MDD at Blackford Drain (including all upstream diversions with Wilmot MDD at 250 ML/d).

TABLE 4-2 STATISTICS ON THE BENEFIT OF INCREASING MAXIMUM DAILY DIVERSION AT BLACKFORD DRAIN (INCLUDING ALL UPSTREAM CONTRIBUTIONS (WILMOT MDD 250 ML/D))

Maximum Daily Diversion	% increase	Increase (ML/a)	% increase	Increase (ML/a)	% increase	Increase (ML/a)
	Average Annual	Average Annual	Median Annual	Median Annual	80th Percentile	80th Percentile
750-1000	2.7%	830	3.2%	957.8	3%	1,550
1000-1250	0.8%	260	0.0%	1.8	2%	890
1250-1500	0.4%	110	0.0%	-	1%	360
1500-2000	0.1%	30	0.0%	-	0%	-

With the addition of Fairview Drain flows, and reducing the MDD from Wilmot Drain to 250 ML/d whilst increasing the Blackford Drain diversion capacity from 1000ML/d to 1250 ML/d results in an increase in average annual flows of less than 1GL/a and no increase in the median annual diversions.

Increasing the MDD for Blackford Drain to 1250ML/d would however result in an increase in the 80th percentile (annual flow in large flow years) by 2%.

4.2.3 Optimum Maximum Daily Diversion Conclusion

The above analysis supports, from a hydrological perspective, the selection of 1000 ML/d as the maximum daily diversion of flows at Blackford Drain. This can also be expressed as the optimum maximum channel capacity downstream of Blackford Drain i.e. for the Tilley Swamp/Taratap Drain (Flow Path 02) and the Floodway (Flow Path 03 Floodway).

This is the same as the optimum maximum daily diversion recommended by Montazeri et al (2011).

The hydrologic optimum does not consider the cost or environmental benefit implications of further increasing the maximum daily diversion at Blackford Drain.

4.2.4 Review of Capacity of Channel downstream of Blackford in Montazeri et al (2011)

Downstream of Blackford Drain there are significant flow contributions from the existing drainage network. This input occurs at the beginning of Tilley Swamp. From the historic climate conditions flow record developed for the existing drainage network the peak flow in the 30 year record was 515ML/d. Therefore the flow path downstream of Henry Creek requires a capacity of 515 ML/d plus the maximum daily diversion from Blackford Drain. Where the maximum daily diversion from Blackford Drain is 1000 ML/d then Taratap swamp requires a maximum daily diversion of 1000 ML/d and the Tilley Swamp reach a maximum capacity of 1500 ML/d.

Montazeri et al (2011) notes that the flow path through Tilley Swamp and Taratap was designed for 1250 ML/d in the study. Analysis of the capacity of the flow path through Taratap found that the maximum flow depth above surrounding natural surface level (i.e. being controlled on the western side by the levee proposed) was 0.49m. In this reach in many cases the flow is well within the widen Taratap channel capacity.

In the Tilley Swamp reach the maximum flow depth above the natural surface level was 0.73m. For the majority of the reach the design flow of 1500 ML/d would be well within the capacity of the wider Tilley Swamp drain (i.e. flow control by the levee would not be required).

5 Question 4: Assess the Losses to Groundwater Predicted between Blackford and Salt Creek and the Application of the Groundwater Calculation Methodology

AWE analysed the methodology and the numerical implementation of the methodology used in the draft work by Montazeri et al (2011). Our analysis found an error in the implementation (the spreadsheet calculation) which was subsequently corrected. The following sections outline our understanding of the methodology and its implementation and identify opportunities for improvements in the methodology.

5.1 Understanding of Previous Work (Methodology)

Morgan et al. (2011) outline a simple analytical methodology for the estimation of seepage losses from proposed channels as part of the Coorong South Lagoon Flow Restoration Project (CSLFRP). The analytical models assume one dimensional, steady state flow to estimate the seepage losses for three scenarios:

1. Saturated flow in the aquifer intersected by the channel (Figure 5-1).
2. Saturated flow in soil and the aquifer, the soil is intersected by the channel (Figure 5-2).
3. Unsaturated flow: the channel is disconnected from the aquifer (Figure 5-3).

The scenarios refer to the relationship between water elevation in the channel with respect to that of the water table. Aquifer hydraulic conductivity and the combination of soil/aquifer hydraulic conductivities are used, for the saturated Scenarios 1 and 2, respectively. Scenario 3 refers to unsaturated flow, when the water in the channel is hydraulically separated from groundwater.

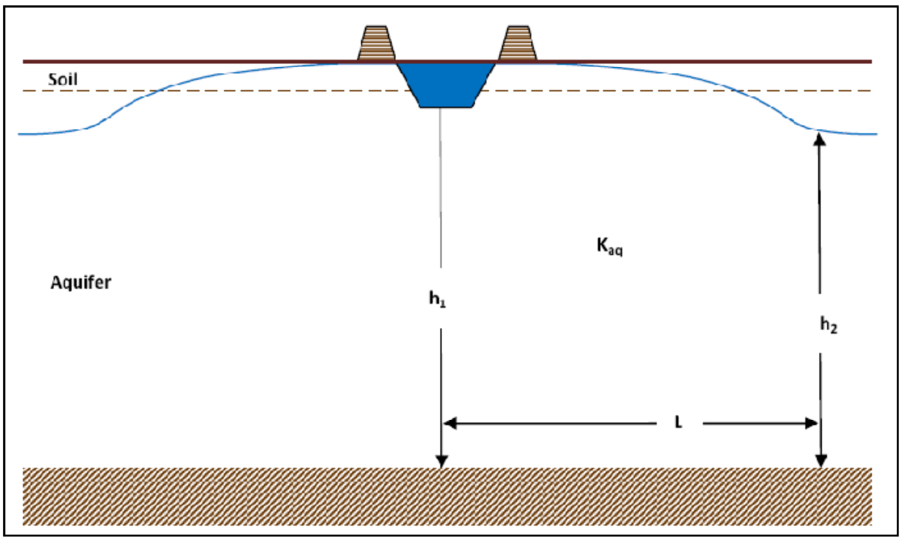


FIGURE 5-1 CASE 1 SATURATED FLOW- THE CHANNEL INTERSECTS THE AQUIFER AND THE WATERTABLE IS SHALLOW (FROM MORGAN ET AL. 2011)

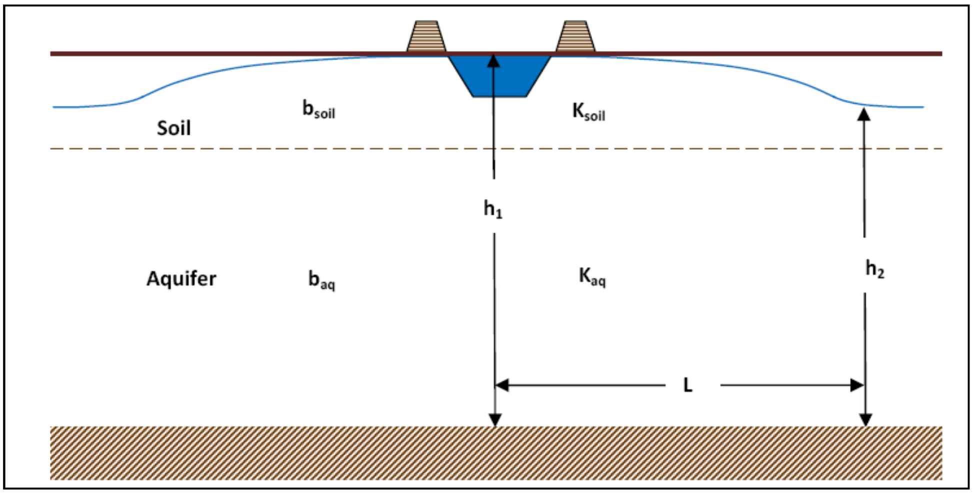


FIGURE 5-2 CASE 2 SATURATED FLOW –THE CHANNEL SITS WITHIN THE SOIL LAYER AND THE WATERTABLE IS IN THE SOIL LAYER (FROM MORGAN ET AL. 2011).

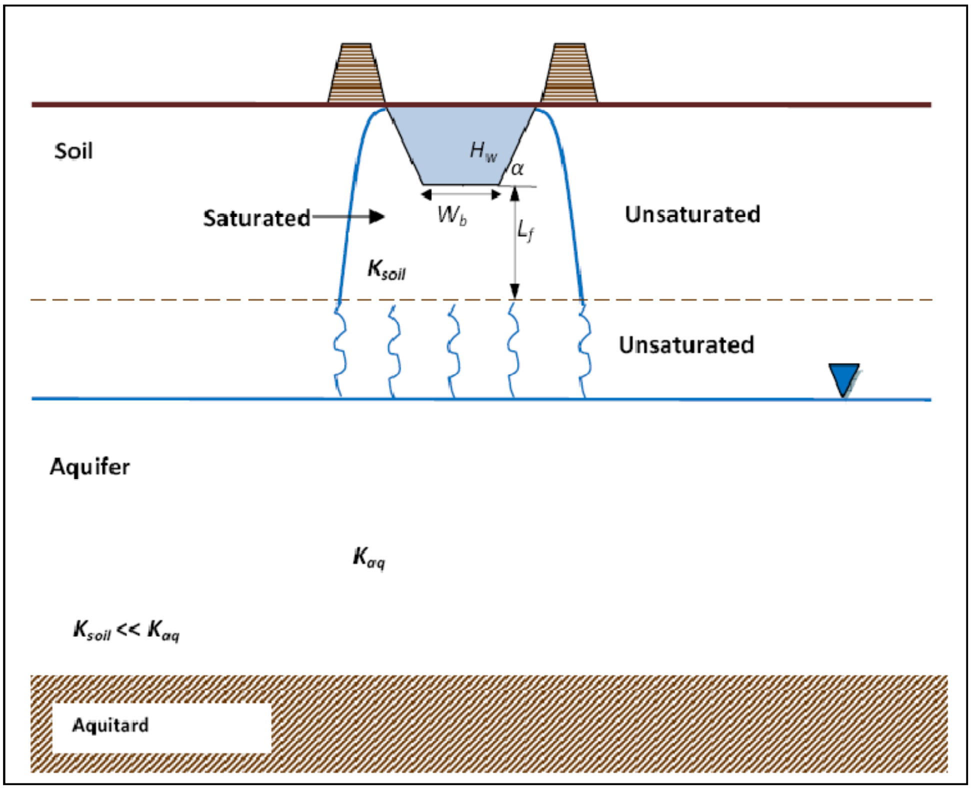


FIGURE 5-3 CASE 3 UNSATURATED FLOW – THE CHANNEL SITS WITHIN A LOW CONDUCTIVITY SOIL LAYER AND IS HYDRAULICALLY DISCONNECTED FROM THE WATERTABLE (FROM MORGAN ET AL. 2011)

5.2 Understanding of Previous Work (Implementation of the Methodology)

An excel spreadsheet, supplied by DfW, "*TransmissionLoss Analysis.xlsm*" was examined with the focus being on how closely the spreadsheet calculations follow the methodology described by

Morgan et al. (2010). It is understood that the spreadsheet was populated by mostly GIS data and was used to calculate transmission losses along several routes.

The worksheet "*Taratap-Tilley Swamp*", chosen because the calculated transmission losses appear to be high, contains many columns and 420 rows of data. It understood that the worksheet estimates transmission losses at several flow rates, between 0.01 and 150 ML/day. The Taratap-Tilley Swamp route is divided into 35 segments and transmission loss is estimated for every segment.

Montazeri et al. (2011) used one of the three scenarios of Morgan et al. (2010). Transmission losses were considered negative for gaining reaches (where modelled groundwater elevation was higher than that of the drain water) i.e. groundwater was added to the flows diverted in these reaches. The transmission loss for Scenario 2 (saturated conditions through soil and aquifer, Morgan et al., 2010) was concluded to be the most suitable for the region by Montazeri et al. (2011). Therefore only scenario 2 was used to assess the loss to groundwater in reaches which were losing streams.

5.3 Opportunity for Improvement of the methodology-The distance from the channel where the hydraulic head in the aquifer is unaffected by the channel flow

Morgan et al. (2011) use a constant L, the distance from the channel, where the hydraulic head in the aquifer is unaffected by the channel flow. As an estimate, L= 250 m is used for all aquifers by Morgan et al. (2011) referring to AWE (2009). AWE (2009, page 57) in turn described L as the zone of impression:

"This is the area where the effect of channel water transmission loss acts upon the groundwater table. The lateral extent of this zone of impression is unknown. For this assessment the initial value assigned to this value is 250 m. This value was chosen as a conservative estimate as it is estimated that the actual distance of impression may extend from between 50 to 1000 m depending on soil characteristics and the residence time of water flow within the channel."

The assumption of constant L could overestimate channel losses for high transmissivity aquifers and underestimate losses for low transmissivity aquifers (transmissivity is normally used for confined aquifers; however it could be used for unconfined aquifers as the product of the hydraulic conductivity and saturated thickness, ~$K(h_1+h_2)/2$).

In particular, if high transmissivity (T) is combined with high elevation of the water in the channel with respect to groundwater (h_1-h_2), assuming a fixed 250 m value for L would significantly overestimate the hydraulic gradient $(h_1-h_2)/L$. This is because a high T aquifer would disseminate the hydraulic loading created by excess water in the channel rapidly and would develop a comparatively flat hydraulic gradient. Using a fixed L=250 m would disregard this process.

Mathematically, this would result the channel loss:

$$Q = K(h_1^2-h_2^2)/2L = K(h_1+h_2)[(h_1-h_2)/2L]$$

being overestimated for high T aquifers because L=250 m, the denominator is kept artificially small. The first term in the right hand side, $K(h_1+h_2)$ represents T; the second term in square brackets the hydraulic gradient.

Instead of L=250 m, the Theis non-equilibrium formula may be used:

$$L = \sqrt{\frac{2.25\ Tt}{S}}$$

where:

L = radius of drawdown influence (m)

T = transmissivity (m^2/day)

t = time (days)

S = storativity (dimensionless)

Substituting the low (5m/d and 15 m thickness) and high ranges (150 m/d and 185 m thickness, from Morgan et al., 2010) and, for example 0.1 and 0.3 for S_y, respectively, would yield L=580 m and 6450m, both well above the assumed 250 m.

T and S are normally used for confined aquifers; however h_2K and S_y (specific yield) could be used for the unconfined situation. S_y could be estimated, normally easier than T, for most aquifers. For *t*, a time period that is representative to the time between consecutive channel flow events. The south-east has a regular winter-driven rainfall pattern between say May and September, and t=200 days is recommended. The above equation would then become:

$$Q = K(\mathrm{h}_1^2 - \mathrm{h}_2^2)/2\ \sqrt{\frac{2.25\ Kh_2 t}{S_y}}$$

5.3.1 The values used for the combination of hydraulic conductivity and thickness

The "high range" (150 m/d and 185 m thickness) used by Morgan et al. (2010) includes a very high conductivity for a thick aquifer – hence the very large L=6450m.

Mustafa and Lawson (2002; Figure 6) refer to a transmissivity range of 10 to 10000; most values fall within 100 to 1000 m^2/day. The k=150 m/day used by Morgan et al. (2010) is probably for karst features and hence may not realistically combine with the entire thickness of 185m Tertiary Limestone Aquifer (TLA). This is because, comparatively low k zones within the TLA may effectively limit the saturated thickness to <<185 m.

Williams and Cobb (1976; in Mustafa and Lawson, 2002) concluded that for the Snuggery area:

..."the Gambier Limestone (TLA) can be subdivided vertically into two distinct subaquifers (limestones) separated by a zone of much lower hydraulic conductivity (marls, calcisilitite etc.). This subdivision has also been recognised in previous works. The estimated aquifer characteristic values for T were between 150 and 600 m^2/d, with Sy of 0.075–0.30 for the phreatic or upper sub-aquifer; while for the lower or semi-confined aquifer, T was between 200 and 500 m^2/d, with S of 0.001–0.0001."

A T~ 1000 m^2/d and S_y=0.2 would be perhaps more characteristics of the TLA, yielding L=1500 m for Scenario 1; six times the 250 m used. All the 'high' and 'medium' reliability ratings of Mustafa and Lawson (2002; Table 3) relate to T< 560 m^2/day and all T> 1000 m^2/day have 'low' reliability ratings assigned.

For Scenario 2, essentially vertical groundwater movement through the soil is combined with lateral groundwater flow in the aquifer. The resultant weighted average for hydraulic conductivities of soil and aquifer tends to be numerically closer to the conductivity of the soil, rather than to the aquifer. Hence using the low range of Morgan et al. (2010), 0.1 m/day to an arbitrary 1 m/day with thicknesses of 15m and 30m, respectively would result in L=116 to 520 m(assuming s_y=0.05). These are equal to about half (116 m @ 0.1 m/day and 15m thickness) to twice (520 m @ 1 m/day and 30 m thickness) the value of the original constant 250 m value for L. Using s_y=0.30 results L= 47 m (@ 0.1 m/day and 15m thickness) to 212 m (@ 1 m/day and 30 m thickness).

The above examples illustrate that the use of constant L may underestimate (low transmissivity) or overestimate (high transmissivity) channel losses depending on the scenario used and aquifer properties. Using the numerical examples above, overestimation of channel losses is most likely for Scenario 1; using Scenario 2, both under- and overestimation is possible.

5.3.2 Hydrograph Analysis- to estimate actual L

Hydrographs supplied by Mark De Jong of South Eastern Conservation and Drainage Board, were examined to determine if they show the influence of a nearby drain. The objective was to assess if hydrographs, at different distances from a drain, could be used to estimate L, the distance from the channel, where the hydraulic head in the aquifer is unaffected by the channel flow.

Three related aspects of the hydrographs were analysed:

1. Changes in time-series groundwater elevations.
2. The amplitude of changes vs. the distance from the drain
3. Changes in groundwater head profiles.

Depth to groundwater data were supplied for six MSN bores and four NVL bores. The MSN and NVL bore series each were drilled perpendicular and to the west of Tilley Swamp Drain. As the main groundwater flow direction is east to west in the Tertiary Limestone Aquifer (TLA), horizontal groundwater movement is normally from the bore closest to the drain towards the bore that is situated furthest away from the drain.

5.3.2.1 MSN Bores

Six hydrographs, MSN28 to MSN33, at distances between 60 and 2100 m from the Tilley Swamp Drain were examined. Figure 5-4 shows the hydrographs, MSN28 (red) is the closest site to the Tilley Swamp Drain drain and MSN29 (brown) is the furthest to the west. The hydrographs show typical annual recharge-discharge cycles that are the most visible since 2007. The annual ranges in the hydrographs are between 0.3 and 1.2 m with annual maxima typically in August-October and minima in April-May. While the annual minima since 2007 are separated a noteworthy feature of Figure 5-4 is that annual maxima, with the exception of the furthest MSN29 and MSN33, are almost identical for the bores that are within ~ 1km of the drain.

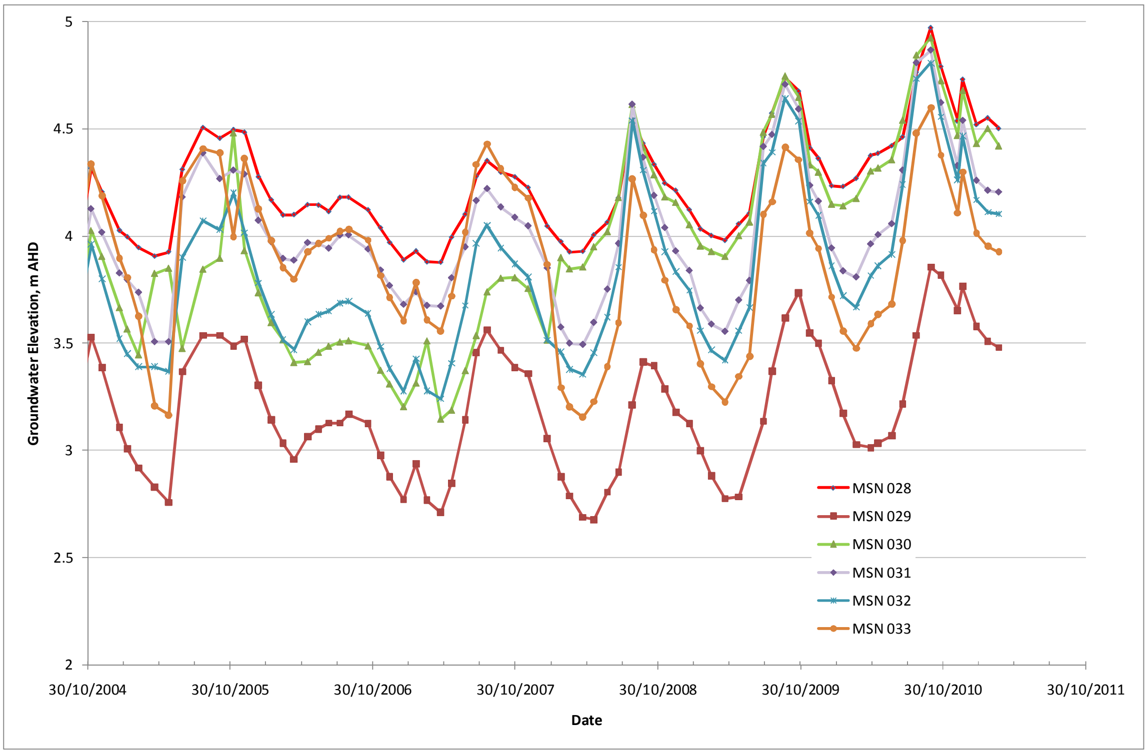


FIGURE 5-4: MSN HYDROGRAPHS

If drain-fed water was recharging these bores, it would be reasonable to assume that the changes would be most visible in MSN28 (being the closest to the drain) and least in MSN29 (being the furthest). Change in groundwater elevation, after a given time, as a response to a sudden rise in the drain that is hydraulically connected to the aquifer tapped by the MSN bores, would be proportional to the complementary error function of the distance from the drain.

Table 5-1 shows the MSN bores, distances from the drain, and expected relative rise after 45 days (arbitrary value) for each bore assuming a 1000 m^2/day hydraulic diffusivity (the ratio between transmissivity and storativity, reflecting on the aquifer's ability to transmit changes) using the complementary error function. The expected rises are provided relative to the changes in surface water. If the surface water in the drain level suddenly rose by 1 m, MSN29, for example, would be expected to show a 0.30 m rise after 45 days .

TABLE 5-1: EXPECTED AND ACTUAL RESPONSES IN MSN BORES

Bore ID	Distance from Tilley Swamp Drain, m	Expected 45 day change, m/m	Expected 15 day change, m/m	Actual change 21/6/-29/9/10, m
MSN 028	60	0.98	0.93	0.55
MSN 029	2100	0.30	0.00	0.79
MSN 030	110	0.97	0.88	0.57
MSN 031	540	0.79	0.43	0.81
MSN 032	910	0.66	0.18	0.89
MSN 033	1320	0.52	0.06	0.92

Figure 5-5 shows the expected pattern after 45 days (blue markers) with green markers that represent the expected pattern after 15 days. The emphasis is not on the values but the patterns indicating large changes near the drain degrading to small changes at larger distances. Red markers on the secondary (rhs) axis show actual changes observed between 29/9 and 21/6/2010. These red markers in Figure 5-5 indicate a different pattern from those expected (green and blue). MSN28 and MSN30, the nearest bores to the drain, show the *smallest* changes with no major differences between the rest of the bores. The period of 29/9 to 21/6/2010 was chosen because it exhibits one of the steepest increases in groundwater elevation for all MSN bores (Figure 5-5).

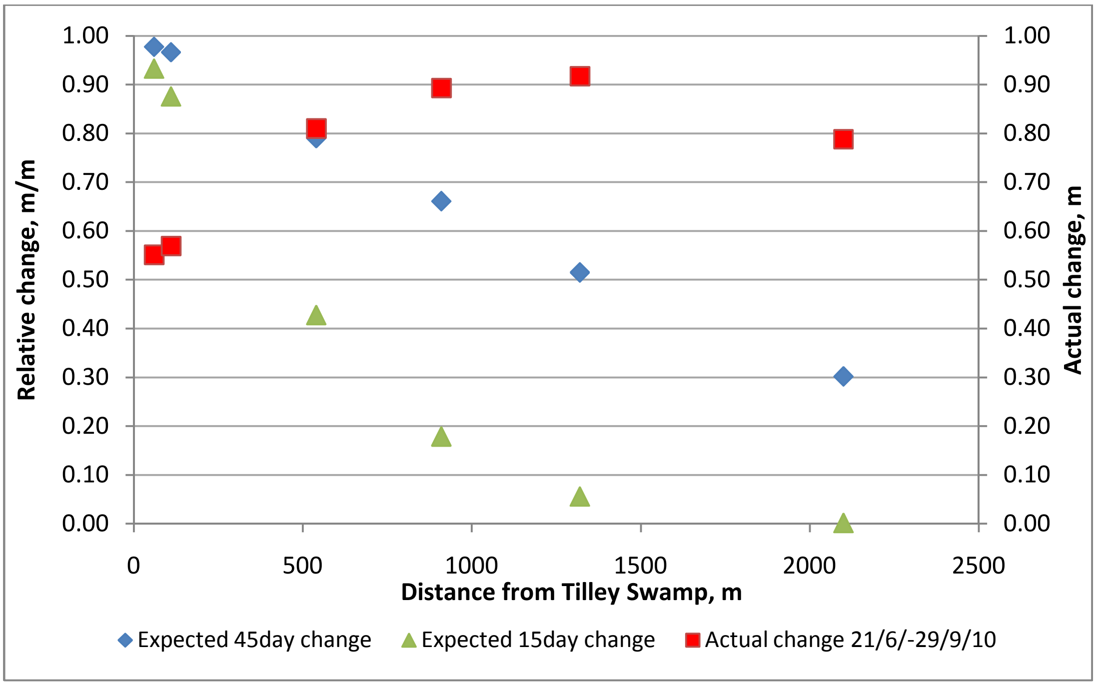


FIGURE 5-5: CHANGES IN GROUNDWATER ELEVATION (29/9 TO 21/6/2010) AND EXPECTED RESPONSES – MSN BORES

Figure 5-6 indicates groundwater elevation profiles at various times since 20/4/2009 (chosen to restrict the number of graphs and to focus on the 2009/2010 recharge cycle) against the distance from Tilley Swamp Drain. The main groundwater flow direction is east to west in the TLA, hence these profiles show the groundwater (head) elevation that drives groundwater westwards. The TLA is a high-transmissivity aquifer hence the groundwater profiles would be expected fairly flat near the drain if the drain was recharging groundwater; and moderately steep if the drain did not influence them. Away from the drain the profiles were expected to steepen.

The profiles were colour coded with red representing 'winter' (between May and October) and blue 'summer' conditions assuming that the drain operated mostly through the winter months and has a less subdued effect in the summer.

The colour coding of Figure 5-6 is, admittedly, crude, but appears to indicate that most winter profiles are flat to a distance just over 1 km while most summer profiles exhibit more gradual declines. This may be a semi-quantitative indication that the drain influence zone ('zone of impression' in Section 5.1) is close to 1km.

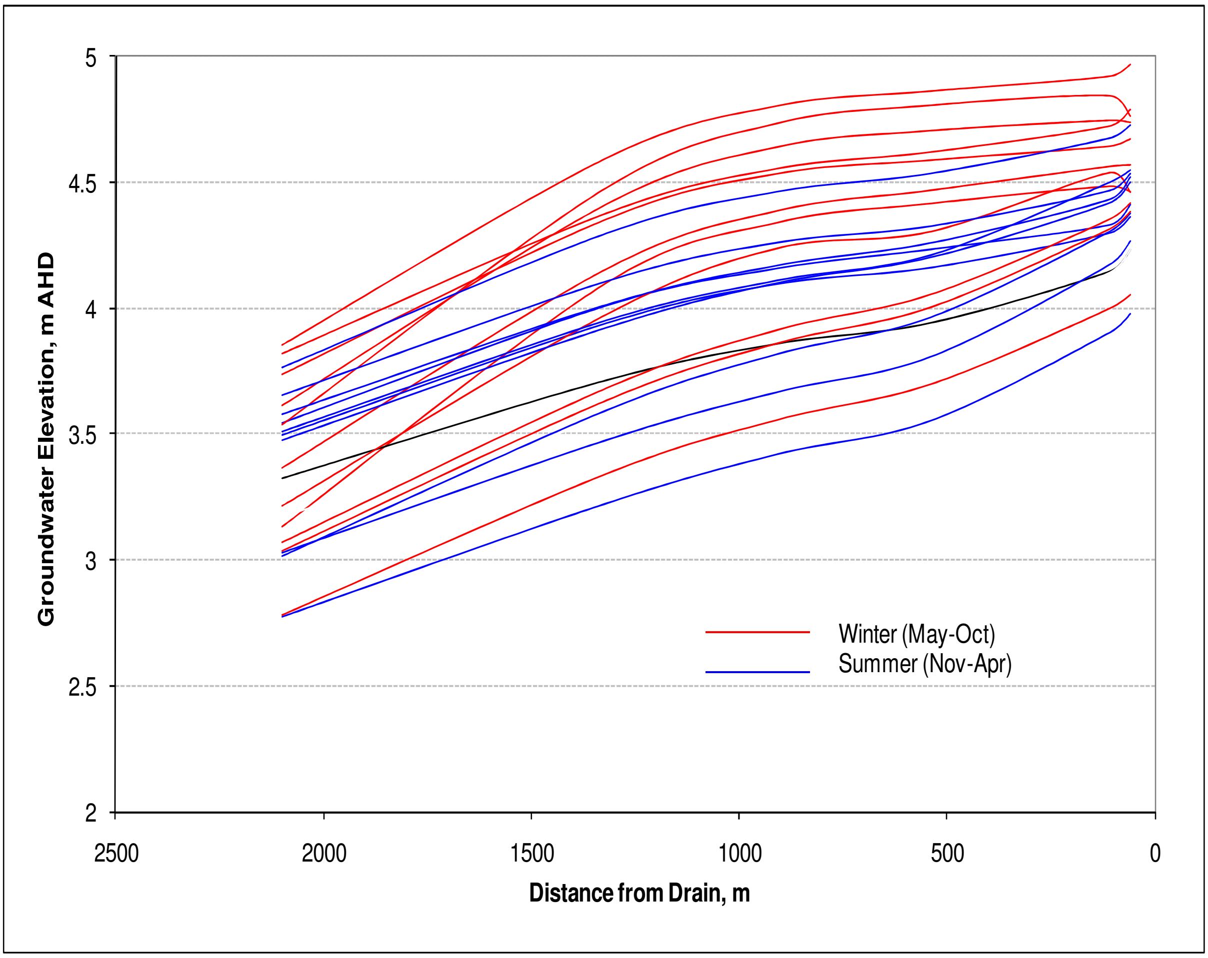


FIGURE 5-6: GROUNDWATER ELEVATION PROFILES SINCE 20/4/2009 - MSN BORES

5.3.2.2 NVL Bores

Figure 5-7 shows hydrographs for NVL the bores, NVL27 (purple) is the closest to Tilley Swamp Drain and NVL24 (red) is the furthest. The period 21/4 to 27/10/2009 was chosen for subsequent analysis because it shows the steepest increase in groundwater elevation. The hydrographs show typical annual recharge-discharge cycles that are the most visible since 2007. The annual ranges in the hydrographs are between 0.3 and 2 m with annual maxima typically in August-October and minima in April-May. As for the MSN bores, the annual minima since 2007 are separated but the annual maxima are almost identical for the bores that are within ~ 1.2 km of the drain.

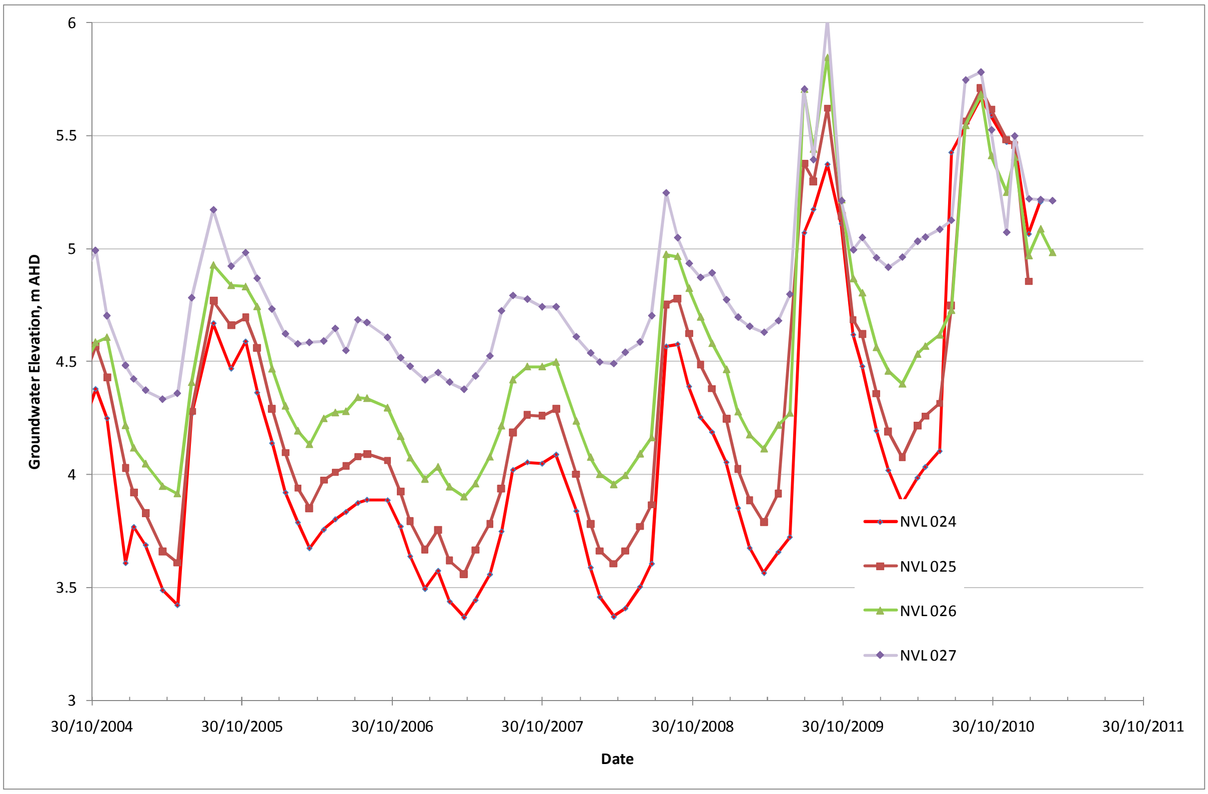


FIGURE 5-7: NVL HYDROGRAPHS

TABLE 5-2: EXPECTED AND ACTUAL RESPONSES IN NVL BORES

Bore ID	Distance from Tilley Swamp Drain, m	Expected 45 day change, m/m	Expected 15 day change, m/m	Actual change 21/4/-27/10/09, m
NVL 024	1220	0.55	0.07	1.54
NVL 025	850	0.68	0.21	1.26
NVL 026	500	0.81	0.46	1.10
NVL 027	125	0.96	0.85	0.58

Figure 5-8 indicates that the red markers depict a trend that is opposite to those of the blue and green markers. The actual changes in NVL bores are the largest away from the Tilley Swamp Drain and the smallest are adjacent to the drain.

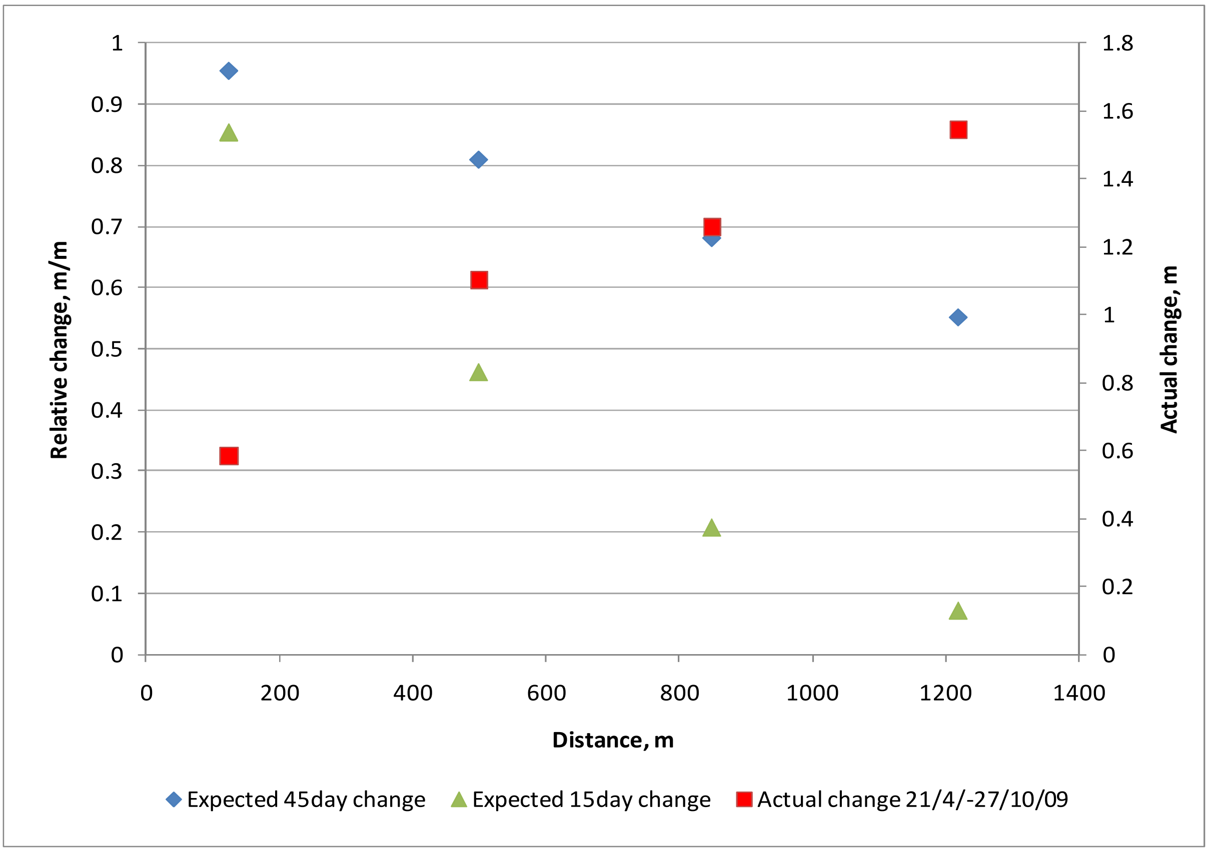


FIGURE 5-8: CHANGES IN GROUNDWATER ELEVATION (29/9 TO 21/6/2010) AND EXPECTED RESPONSES – NVL BORES

Figure 5-9 indicates groundwater elevation profiles at various times against the distance from Tilley Swamp Drain for the NVL bores since 21/4/2009. As for the MSN bores, the TLA is a high-transmissivity aquifer hence the groundwater profiles would be expected fairly flat near the drain if the drain was recharging groundwater; and moderately steep if the drain did not influence them. Away from the drain the profiles were expected to steepen. As for the MSN bores, the profiles were colour coded with red colour representing ‘winter’ (between May and October) and blue ‘summer’ conditions assuming that the drain operated mostly through the winter months and has a less subdued effect in the summer.

Figure 5-9 is less conclusive than Figure 5-5. Most but not all winter profiles are flat and most (but not all) summer profiles exhibit more gradual declines. Some of the curves indicate higher groundwater elevations further from the drain that may be due the presence of surface water in NVL024, the bore furthest from the drain.

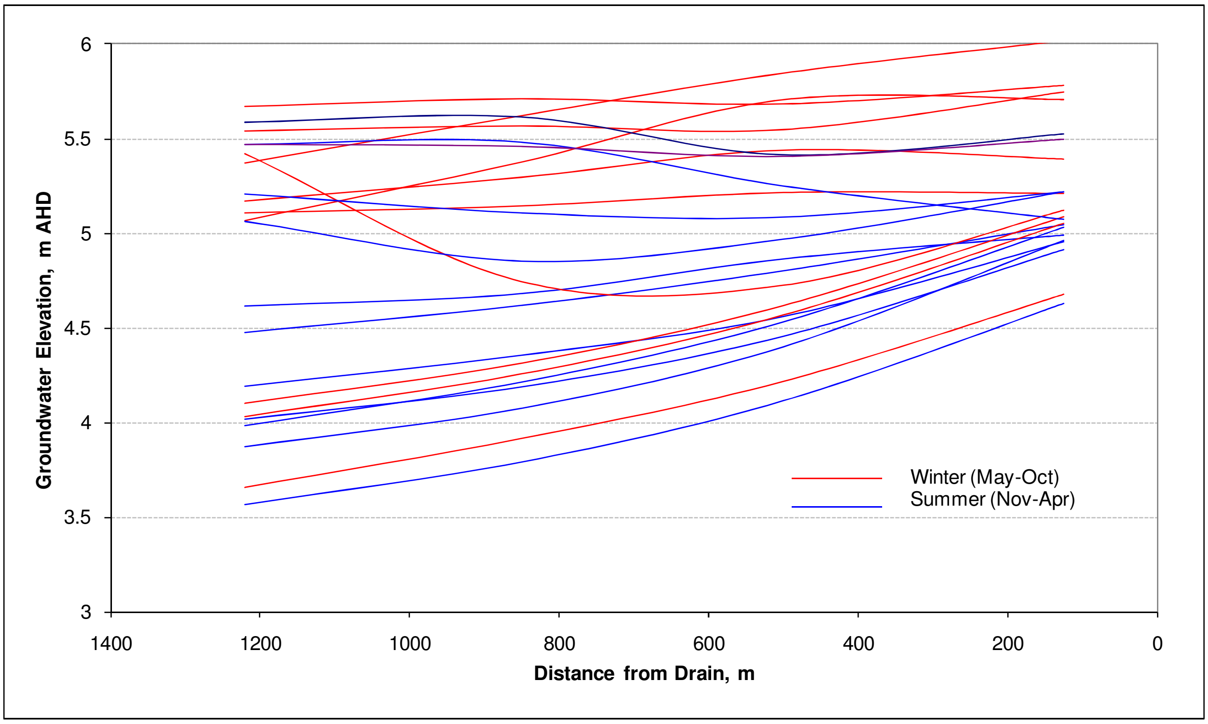


FIGURE 5-9: GROUNDWATER ELEVATION PROFILES SINCE 21/4/2009 - NVL BORES

5.3.2.3 Conclusion

In conclusion, data from the MSN bores may indicate a zone of influence around 1 km for Tilley Swamp Drain while the NVL data are inconclusive.

6 Examination of Uncertainty in Transmission Loss Analysis

6.1 Riverbed Clogging

Cook et al. (2010) and Brunner et al. (2009 and 2011) discuss the various states of river-groundwater flow regimes and use the terminology of connected, transition, and disconnected system. If the system is in transition or disconnected, an unsaturated condition may develop, and this in turn can create a low conductivity 'clogging' layer, significantly limiting the exchange of waters, shown in Figure 6-1

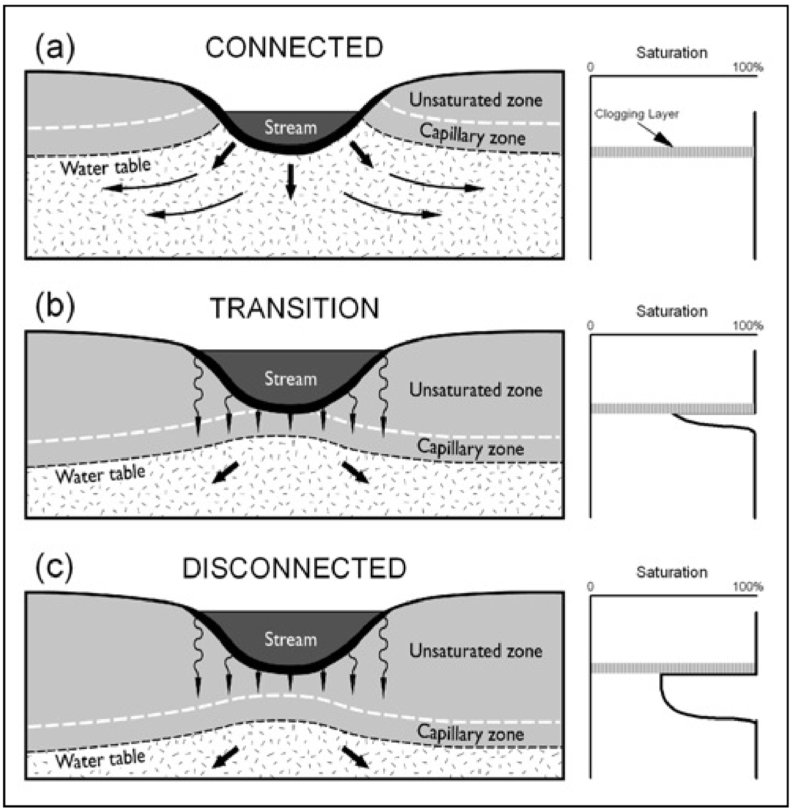


FIGURE 6-1: FLOW BETWEEN SURFACE AND GROUNDWATER AFTER COOK ET AL.(2010) AND BRUNNER ET AL. (2009 AND 2011).

6.1.1 The Importance of Clogging

Sophocleous et al (1995) comprehensively assessed an analytical stream depletion formula against numerical groundwater model predictions and the sensitivity of stream depletion to several input variables. These included stream penetration to the aquifer (the ratio between the depth of the stream and aquifer saturated thickness), aquifer heterogeneity, non-equilibrium loosing stream, storativity, conductivity, gaining stream, and partial well penetration. Streambed clogging was found the most important factor. Streambed clogging delineates limited hydraulic connection between the aquifer and stream due to the presence of a low hydraulic conductivity 'clogging' layer. The magnitude of reduction between river and groundwater interaction, due to clogging, can be significant. Sophocleous et al (1995) indicate significant reduction (58% to 71%) in modelled ground-surface water interaction once a clogging bed was introduced (with a hydraulic conductivity of 1% of that of the aquifer).

The low conductivity clogging layer may develop as a result of physical (sedimentation) or chemical/biological processes: micro-organisms and colloids, precipitation of iron and manganese oxy-hydroxides and calcium carbonates as well as gas bubbles (Hiscocka and Grischekb, 2002). Clogging has been observed beneath swamps, wetlands, rivers and streams; also in artificial recharge facilities (Bouwer, 2002) in well screens or open areas as well as particulate organic matter in bank infiltration systems (Schubert, 2002).

Packman and MacKay (2003) in Brunner et al. (2011) showed that even a relatively small amount of fine sediment can result in the clogging of the uppermost layer of the streambed.

6.1.2 The Site-specific Nature of Clogging

Assessing the existence of clogging requires generally local scale investigations, let alone the quantitative assessment of the flow regime. Brunner et al. (2009), for example, showed that the lowering of the water table can only lead to disconnection if the ratio of the conductivity of the clogging layer to that of the aquifer is less than or equal to the ratio of the clogging layer thickness to the sum of the clogging layer thickness and the stream depth. Of the variables referred to Brunner et al. (2009) above, the stream depth can be measured or modelled. The hydraulic conductivity of the aquifer may be known. The thickness and hydraulic conductivity of a clogging layer are, however, expected to change locally.

For a riverbed and bank infiltration system, Schubert (2002) has indicated that clogging of parts of the riverbed was unavoidable. Suspended solids, that cannot infiltrate the aquifer, tend to cause physical clogging; in addition, biodegradable substances can cause chemical clogging. Schubert (2002) noted that several attempts, to ‘predict’ clogging did not ‘surpass operational experience’.

Schubert (2002) also reports on the results of physical investigation of the Rhine riverbed revealing a physical clogging area on the riverbed surface and a chemical clogging layer about 0.1 m below. In addition, the clogged areas are reported to occur in distinct zones of the river.

Schubert (2002) also pointed out the dynamic nature of clogging. The hydraulic conductivity of clogged areas varies with the dynamic hydrology and cannot be regarded as constant. During floods with sufficient hydraulic transport energy, the river bed can be reworked and the clogging layer may be eroded. Schubert (2002) reported, that to find out the influence of the clogged area on the water yield of the wells, a 300 m by 70 m ‘window’ was dredged into the Rhine riverbed. As expected, the water yield of a riverbank filtration system increased significantly. But the effect was only temporary and a few weeks later, the dredged window was clogged as before.

6.1.3 Conclusions

Clogging is important and can significantly reduce surface water – groundwater interactions. Clogging is site-specific and dynamic and therefore it is difficult, if not impossible to predict the effects of clogging using regional data. Even showing the existence of clogging requires local scale investigations; the quantitative assessment would require significant and additional investigations.

Determining the thickness of the clogging layer, in particular, appears to be a considerable challenge. Blaschke (2003) in Brunner (2011) provide an example for site-specific measurements of the thickness of the clogging layer of undisturbed sediments in the Danube using a freeze-panel-sampling method.

6.2 Scale Effects on Water Table Modelling

There is a risk in using regional groundwater data to model the water table at a local scale that is necessary for the calculation of surface-groundwater interaction in the drains. The term 'model' is used here for a spatial interpolation process.

The water table may be modelled on the basis of groundwater elevation or depth to groundwater. The two datasets may differ and therefore a brief description of available regional datasets is provided below.

6.2.1 The Sources of Regional Data in South Australia

The SA Government maintains the regional Drillhole Enquiry System (DES) and OBSWELL, both as part of the SA Geodata system.

DES (https://des.pir.sa.gov.au/deshome.html), provides on-line access to South Australian Drillhole data. The DES contains drillhole construction details and general data on the location of wells and the aquifer intersected. Depth to water level observations are also included for drillholes, if available, with the corresponding date of observation recorded.

Several hundred bores that were drilled or chosen for regular monitoring of water levels are available in OBSWELL (https://obswell.pir.sa.gov.au/sys/aboutObswell.html). The observation bores have been established across the State strategically to monitor trends in water and/or salinity levels. Most OBSWELL records have reference level altitude available therefore modelling water table elevation, in m AHD, for a given time period or annual maxima/minima are both feasible using OBSWELL.

For many DES records, only a single water level measurement is recorded from the date of original drilling; for many others no water level data are available. The date of observation can vary over decades. Reference elevation (m AHD) is often not available in DES. Therefore these once-only records obtained at the time of bore construction appear to have limited value for supplementing the OBSWELL dataset.

Selecting a subset of data, restricted to a narrow time range may also be necessary for areas where the water table is known to have considerably changed. These may include areas with significant change in land use (native vegetation clearance, followed by establishment of shallow rooted crops for example), establishment of forestry, land drainage or changing water use.

6.2.2 Groundwater Depth or Elevation Modelling

The process of modelling and its effects are illustrated in conceptual cross-sections in Figure 6-2 and Figure 6-3. The cross-sections, in AWE's experience, represent reasonable common hydrogeological settings. In each cross-section, there are two bores, representing regional data, with groundwater flowing from both bores to a surface water feature (Figure 6-2) and from the surface water feature (Figure 6-3).

The top diagram represents the assumed hydrogeological setting, the red line in the middle diagram in each figure represents the modelled water table (depth to water) and the bottom section the modelled water table on the basis of groundwater elevation.

Figure 6-2 shows gaining surface water, because groundwater elevations are higher than that of the surface water. Modeling in terms of below ground would result in some interpolation between d1 and d2, and a water table model that would be sub-parallel to the surface. Beneath the surface water body, the depth to groundwater model would predict artificially deep groundwater and the overall effect would be incorrectly predicting a surface water loss.

Modelling in terms of groundwater elevation would result in an interpolation of the elevations that is approximated in Figure 6-2 by a line. The line would be significantly above the surface water and the effect would be an artificially exaggerated modelled surface water gain.

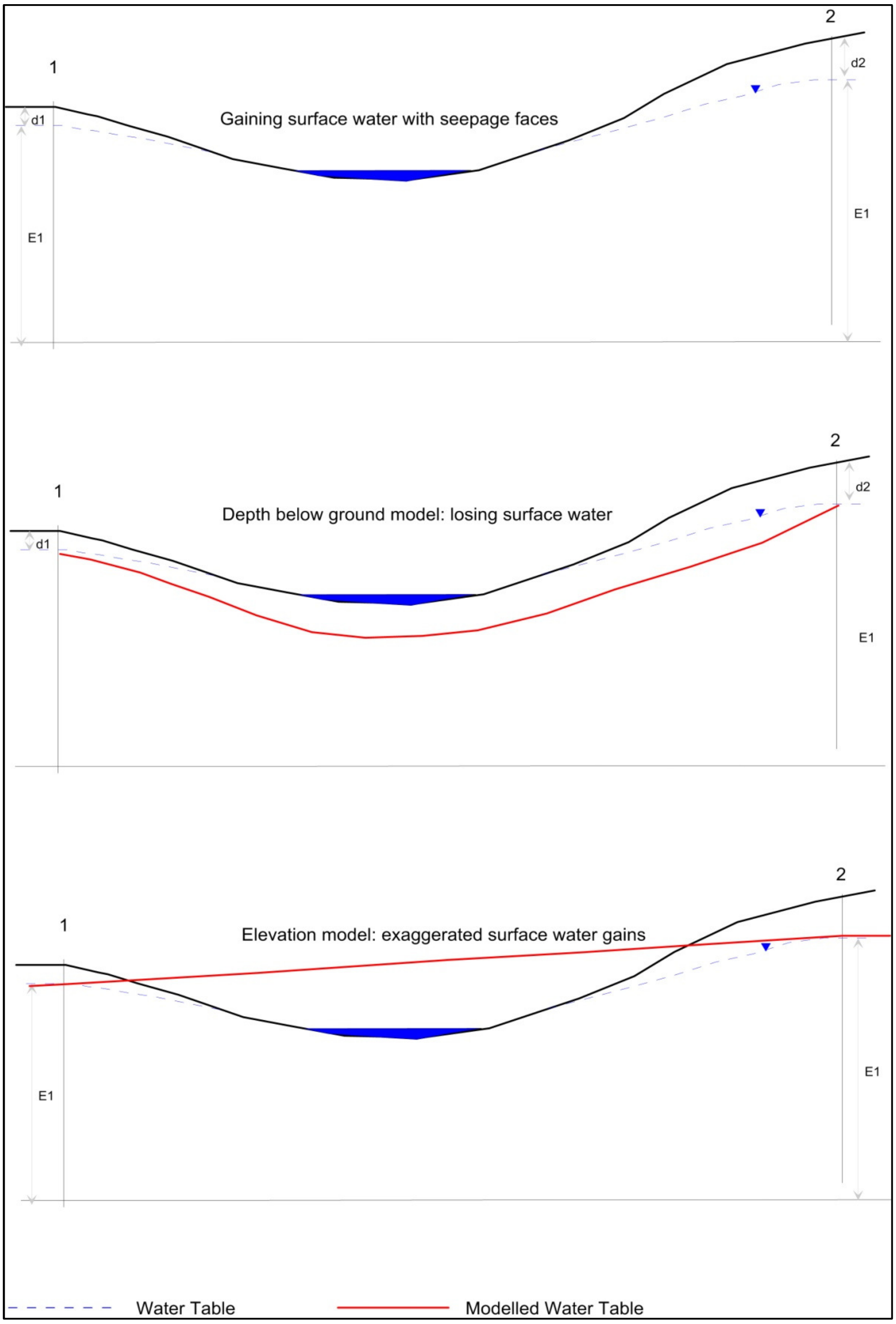


FIGURE 6-2 CONCEPTUAL CROSS-SECTION, MODELLING GROUNDWATER FLOW TO SURFACE WATER

Figure 6-3 indicates similar effects but for losing surface water. Modelling in terms of depth to water would predict an exaggerated loss of surface water; modelling based on groundwater elevations would suggest an incorrect surface water gain.

The examples presented highlight the risks of mis-interpreting groundwater-surface water interaction using regional data. In Figure 6-2 and Figure 6-3, the discrepancies between the various models and reality would diminish if bores 1 and 2 were close to the surface water feature. In other words, using local data the uncertainties would reduce.

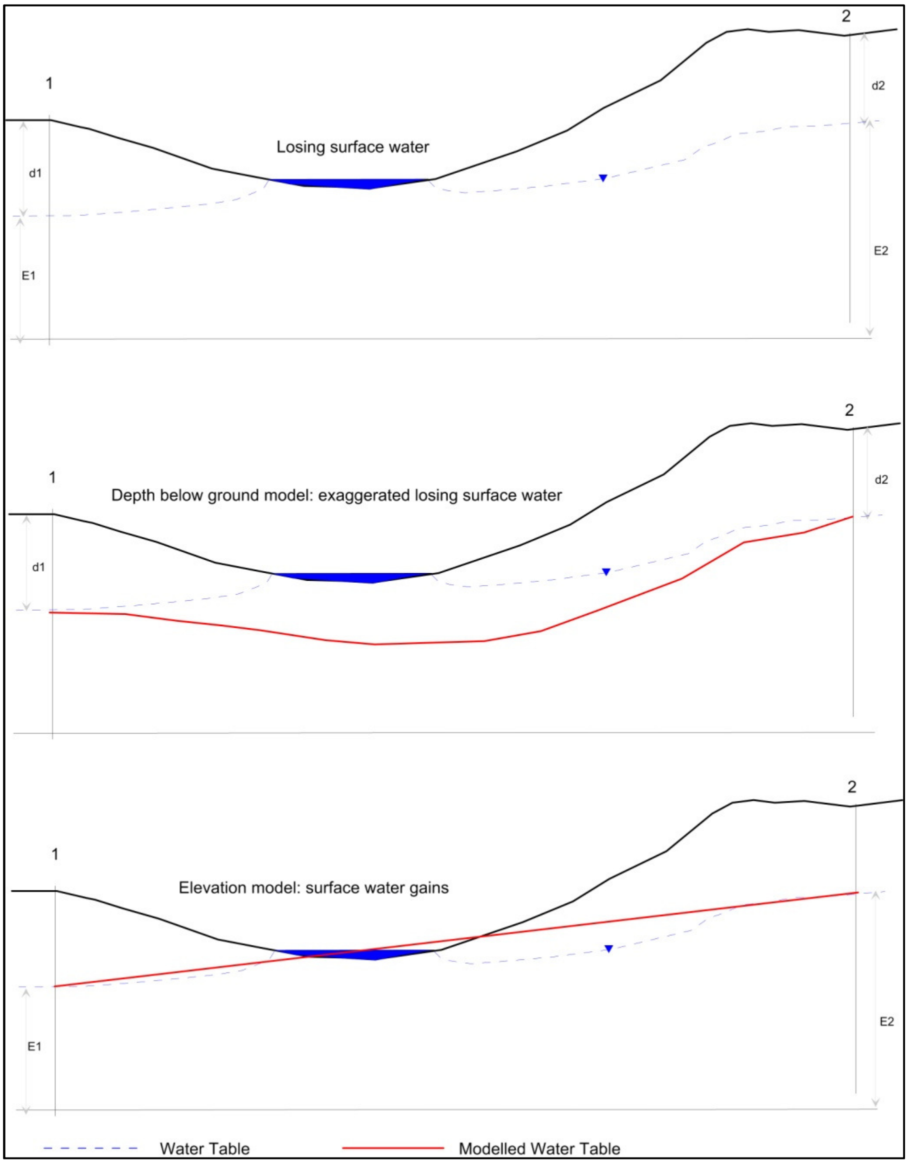


FIGURE 6-3 CONCEPTUAL CROSS-SECTION, MODELLING SURFACE WATER FLOW TO GROUNDWATER

The principles discussed above and the conclusions reached do not represent new ideas. The need to augment regional data with local investigations has been recognized, in all kinds of hydrogeological studies ranging from contaminated site to water supply investigations and groundwater modelling. The SA EPA, and other states, for example, requires contaminated site-specific drilling studies where human activities would warrant so or contamination has been detected. Such studies involve drilling of several monitoring bores and the analysis of both regional and newly acquired local data (SA EPA, 2009).

6.3 Further Investigation of Loss to Groundwater

Based on the analysis completed for Section 5, AWE was asked to further investigate a range of loss to groundwater calculation methodologies/variables to gain a better understanding of the uncertainty surrounding the magnitude of transmission losses through seepage.

6.4 Changes to Loss to Groundwater Methodology and Application Made by AWE

6.4.1 Transmission Loss Cases of Morgan et.al. (2011)

For some flow path segments none of the transmission loss cases, as described by Morgan et. al. (2011) appear to apply.

These segments generally occurred where:

- The channel base was close to the base of the soil layer, leaving a soil thickness of less than 0.5m.
- The groundwater level was below that of surface water but above the channel base.

The conditions described above apply to small segments of the Floodway, Reedy Creek 3, Taratap 6, Tilley 7, Kercoonda Drain, Blackford Upstream, Blackford Drain and Drain L reaches. Soil thicknesses < 0.5m below the channel occur generally infrequently in the original channel designs used by Montazeri et al (2011). These designs were used as the basis for the sensitivity analysis described in this chapter.

For soil thickness <0.5m below the channel and groundwater level below that of surface water but above the channel base, AWE selected 'Case 1' of Morgan et. al. (2011) as the most applicable. 'Case 1' was selected because the average soil thickness (for segments described by these conditions: 0.2m below the channel) was small with respect to that of the aquifer.

Therefore for the sensitivity analysis AWE adopted Case 1 where the conditions described above apply. The results of Scenario 8 (the groundwater analysis calculation approach adopted by Montazeri et al (2011)) were not altered as this approach applied ubiquitously across all reaches Case 2.

The adoption of Case 1 where the conditions described above occur was applied for loss to groundwater calculations completed for all new work completed (as described in the following chapters).

6.4.2 Reference Levels for Soil Thickness and Groundwater Level

6.4.2.1 Soil Thickness

When conducting the sensitivity analysis, AWE noted that the references used to calculate the base of the soil layer and spring groundwater levels were sometimes inconsistent and varied between natural surface and the drain invert in the working used by Montazeri et al (2011). This was raised with the authors of the report and a correction made.

For clarity this report used the datum assumed by Montazeri et al (2011) in the development of the sensitivity analysis. This allowed direct comparison with the Montazeri et al (2011) estimates of loss to groundwater which was the objective of the sensitivity analysis.

For the new channel designs and system yield analysis, discussed in later chapters, this report consistently used natural surface as a reference point to calculate soil thickness.

Channel losses to groundwater can be quite sensitive to changes in soil thickness. **FIGURE** 6-4 and **TABLE** 6-1 indicate how estimated losses vary with the thickness of the soil for Reedy Creek 1 and Scenario 7. This reach was chosen to illustrate the impact of soil thickness on estimated transmission losses as 'Case 3' analysis, yielding maximum losses, is applicable to a number of segments within the reach.

A negative value in **TABLE** 6-1 below indicates a decrease in the estimated loss. The relationship between soil thickness and transmission loss is not linear as the base of the soil layer, calculated by subtracting the soil thickness from the natural surface elevation, is a parameter which governs which analysis case is applied to each segment. For example using a uniform soil thickness of 1m results in either cases 2 or 3; however a 3m soil thickness changes the base of the soil layer so that case 2 (of Morgan et.al., 2011) is applicable to the entire reach. As losses for case 2 (saturated flow) are lower those for case 3 (unsaturated flow), the estimated losses for a 3m soil thickness are less than those for 1m.

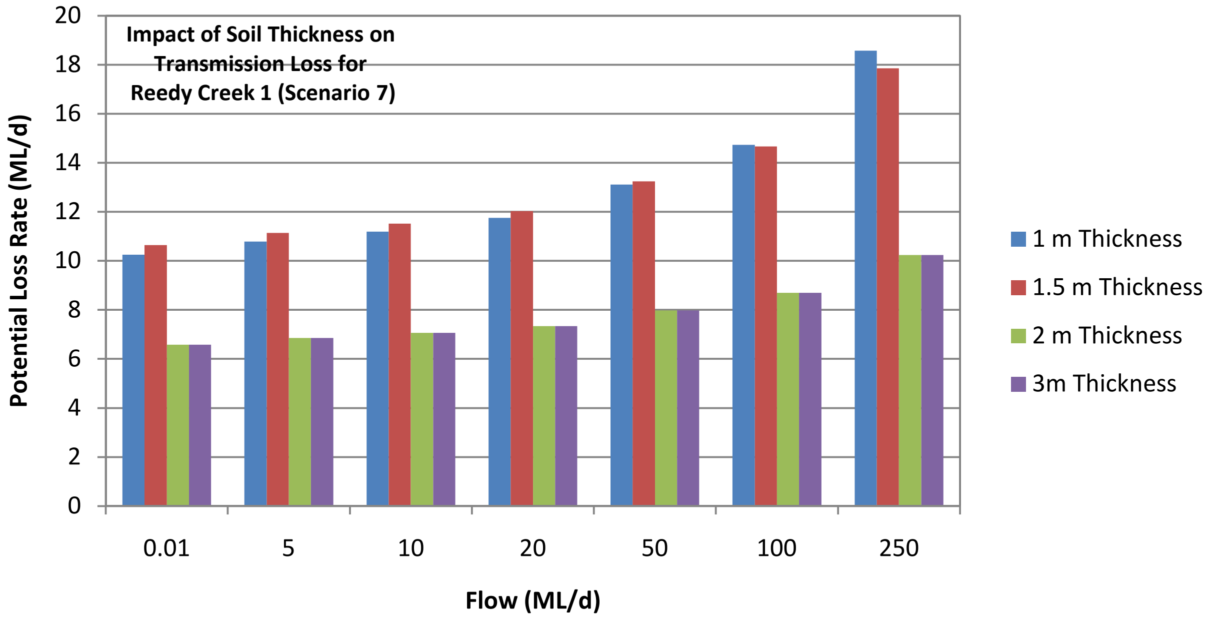


FIGURE 6-4: IMPACT OF SOIL THICKNESS ON CHANNEL LOSS FOR REEDY CREEK 1 (SCENARIO 7)

TABLE 6-1: IMPACT OF SOIL THICKNESS ON CHANNEL LOSS CALCULATIONS FOR REEDY CREEK 1 (SCENARIO 7)

Flow Rate (ML/d)	Percentage Change in Loss 1m to 1.5m Thickness	Percentage Change in Loss 1.5m to 2m Thickness	Percentage Change in Loss 2m to 3m Thickness
0.01	3.82	-27.47	-14.74
5	3.27	-27.76	-14.80
10	2.97	-27.98	-14.84
20	2.40	-28.34	-14.88
50	1.04	-29.14	-14.97
100	-0.48	-30.17	-15.05
250	-3.88	-32.41	-15.15

6.4.2.2 Groundwater Elevations

In the analysis developed by Montazeri et al (2011) the groundwater elevations were calculated in reference to the drain invert. Where the soil thickness datum was changed to natural surface the groundwater elevations were subsequently re-assigned using an interpolated groundwater surface for spring produced by SKM (2009), which uses the Australian Height Datum (mAHD).

The new groundwater elevations was also subsequently applied for segments where channel design was refined and also to new analysis for Biscuit Flat discussed below. The change in groundwater level reference was not applied to the sensitivity analysis.

6.5 The Scenarios Analysed

After a discussion with the client and DfW representatives, a decision was made to analyse results for the eight scenarios, listed in Table 6-2, for both Flow Path 02 and Flow Path 03 Floodway.

Of the eight scenarios listed in Table 6-2, four use the high aquifer conductivity (80 m/day) adopted by Montazeri et al. (2011). The other four scenarios (4 to 7) use a magnitude lower hydraulic conductivity that appears to be more representative to the entire aquifer, in agreement with the findings in Section 5.3.1. Similarly, four of the methods use the 'Case 2 transmission loss', concluded to be the most suitable for the region by Montazeri et al. (2011) the other four (2, 3, 6 and 7) allow the physical properties to determine the loss calculations in line with Section 5.2 (the approach described by Morgan et al). Finally, half the scenarios use a fixed zone of influence; the others (1, 3, 5, and 7) use a zone of influence that changes with the hydraulic conductivity (Section 5.3). The soil hydraulic conductivities used were those estimated by DfW (Montazeri et al., 2011).

TABLE 6-2: SCENARIOS USED FOR SEEPAGE LOSS CALCULATIONS

Scenario	Aquifer K (m/d)	Seepage Loss Method*	Zone of Influence (L)
1	80	2	Variable with physical properties
2	80	123	250 m
3	80	123	Variable with physical properties
4	8	2	250 m
5	8	2	Variable with physical properties
6	8	123	250 m
7	8	123	Variable with physical properties
8	80	2	250 m

*Refers to the 'scenarios' of Morgan et al. (2011). 123=variable, 2= the minimum of 2 or 3 used.

Scenario 8 is equivalent to the approach adopted by Montazeri et al., (2011). The values calculated in the Montazeri et al., (2011) were used for comparison.

6.5.1 Flow Path 02 (excluding Morella Basin)

Figure 6-5 indicates the total seepage losses calculated for the eight scenarios for Flow Path 02 (excluding the Morella Basin). Figure 6-5 represents a summary for all scenarios and for an entire flow path.

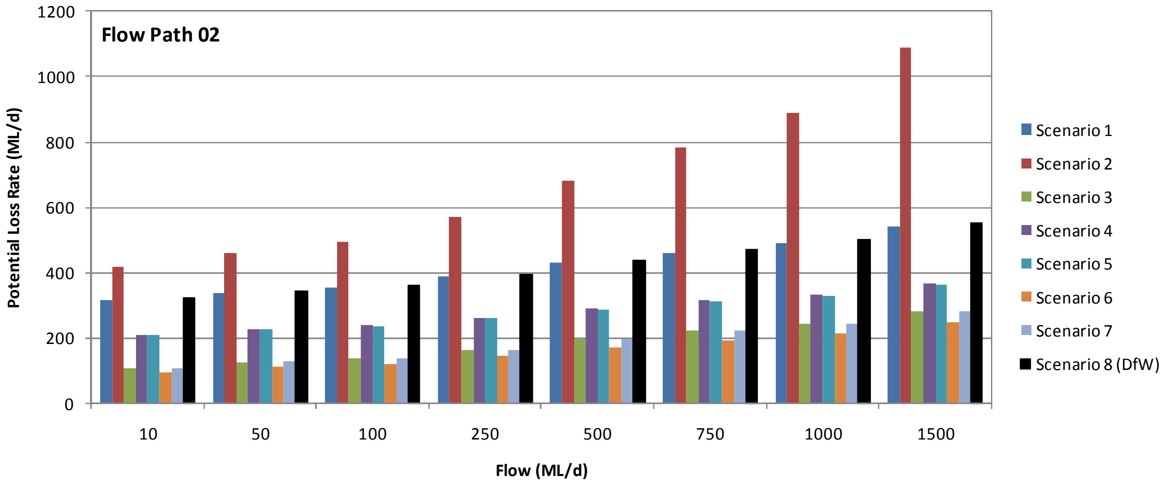


FIGURE 6-5 SUMMARY OF RESULTS : FLOW PATH 02

The following conclusions may be drawn from the analysis of Figure 6-5:

1. There is a systematic increase of the calculated losses with increasing flow for each scenario.
2. The relative magnitude for a scenario, with respect the results, does not seem to change. This allows a relative ranking of the scenarios, based on Figure 6-5, to three groups:
    a. The largest losses occur for Scenarios 2,1 and 8
    b. Medium losses occur for Scenarios 4 and 5

   c. Small losses occur for Scenarios 3, 7 and 6.

3. Results from Scenarios 1, 2 and 8 are consistently two to three times larger than those from the rest. These scenarios use high aquifer hydraulic conductivity.
4. If the high aquifer conductivity is combined with considering variable seepage loss methods and variable zone of influence, the predicted losses significantly decrease.
5. The losses at low aquifer hydraulic conductivity are (Scenarios 4 to 7) are generally low, especially if combined with variable seepage loss methods.
6. Comparing the results from Scenarios 2 and 3 suggest that the use of variable physical properties at high hydraulic conductivity reduces the losses. Comparing 6 and 7 suggest that the use of variable physical properties at low hydraulic conductivity increases the losses. These findings are consistent with the zone of influence being > 250 m for high, and < 250 m at low hydraulic conductivities.

Table 6-3 summarises the results for Flow Path 02. Scenarios are classified in rows, calculated losses to columns with the number of occurrences shown at the appropriate intersection. For example, three calculated losses are high (scenarios 1,2 and 8) and one is low (Scenario 3) for the four scenarios that use high aquifer conductivity. Based on Table 6-3, the highest calculated losses are at high aquifer conductivity, “2” seepage loss method and fixed zone of influence. The lowest losses occur at low aquifer conductivity and variable seepage loss and zone of influence.

Of the variables listed in Table 6-3, the aquifer hydraulic conductivity is on a continuum but the others are binary (either fixed or variable) hence ranking the variables is only possible on a semi-quantitative way described below.

Calculated losses in Table 6-3 are classified to low, medium and high (with relative weights 1, 2 and 3, respectively). The count is multiplied by the relative weight and summed for each row. For example, one loss from Scenarios 1, 2, 3 and 8 with high aquifer conductivity is classified as low (Scenario 3); the other three (Scenarios 1, 2 and 8) are high. The total loss score is calculated as 10=1×1+3×3. For low aquifer conductivity the score is 6, giving a difference of 10-6=4. The larger the difference, the higher the ‘sensitivity’ to the appropriate variable. Accordingly, the largest ‘sensitivity’ is indicated for aquifer hydraulic conductivity and the seepage loss method, the smallest for the zone of influence.

TABLE 6-3: SUMMARY OF RESULTS, FLOWPATH 2

Variable	Count of Calculated Loss			Total loss score	Difference
	Low (weight 1)	Medium (weight 2)	High (weight 3)		
Aquifer hydraulic conductivity					
High 80 m/d	1	0	3	**10**	**4**
Low 8 m/d	2	2	0	6	
Seepage Loss Method					
2 fixed	0	2	2	**10**	**4**
123 variable	3	0	1	6	
Zone of Influence					
Fixed	1	1	2	**9**	**2**
Variable	2	1	1	7	

The analysis of an individual scenario, in Figure 6-6, is provided as an example. Figure 6-6 allows, at various flows, the second-level analysis or the identification of anomalies related to particular segments of Flow Path 02. The sub reaches of the flow path are labelled as per the loss to groundwater and waterbalance analysis. The sub reaches are displayed in order from the most northerly aspect of the study area (for Flow Path 02, Tilley Swamp) to the southernmost end (for all Flow Paths – Reedy Creek 1). As Figure 6-6 indicates Reedy Creek reaches 3 and, to lesser extent 2, dominate the losses for all scenarios.

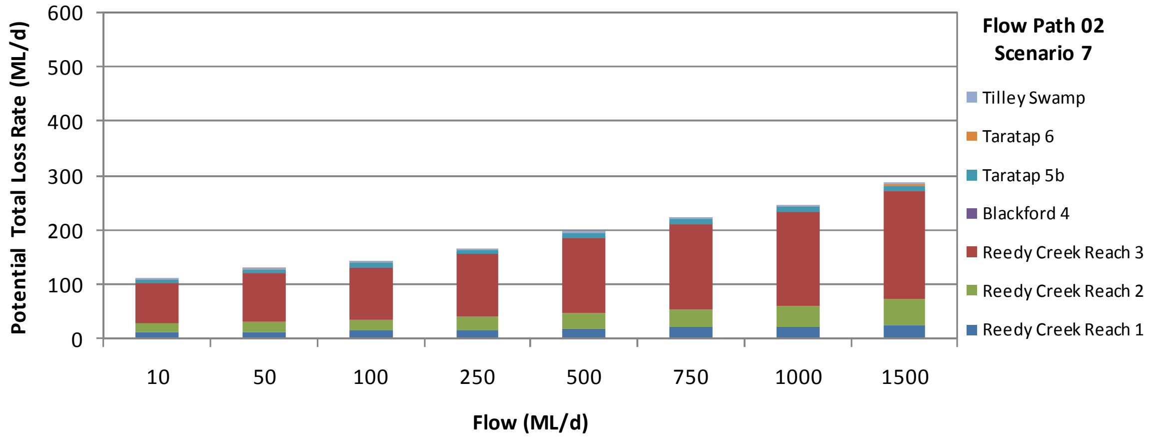


FIGURE 6-6: SUMMARY OF RESULTS : FLOWPATH 2, SCENARIO 7

Specific issues, such as Reedy Creek's contribution, can be examined using the third-level charts (an example is shown in Figure 6-7) depicting surface water and groundwater elevation, the soil base and the 'groundwater case' referring to the scenarios used by Morgan et al. (2011). Predicted seepage losses, corresponding to Figure 6-7 along Reedy Creek for Scenario 7 are shown in Figure 6-8. The distance displayed in the charts is from the downstream or northern end of Reedy Creek where it meets Blackford Drain.

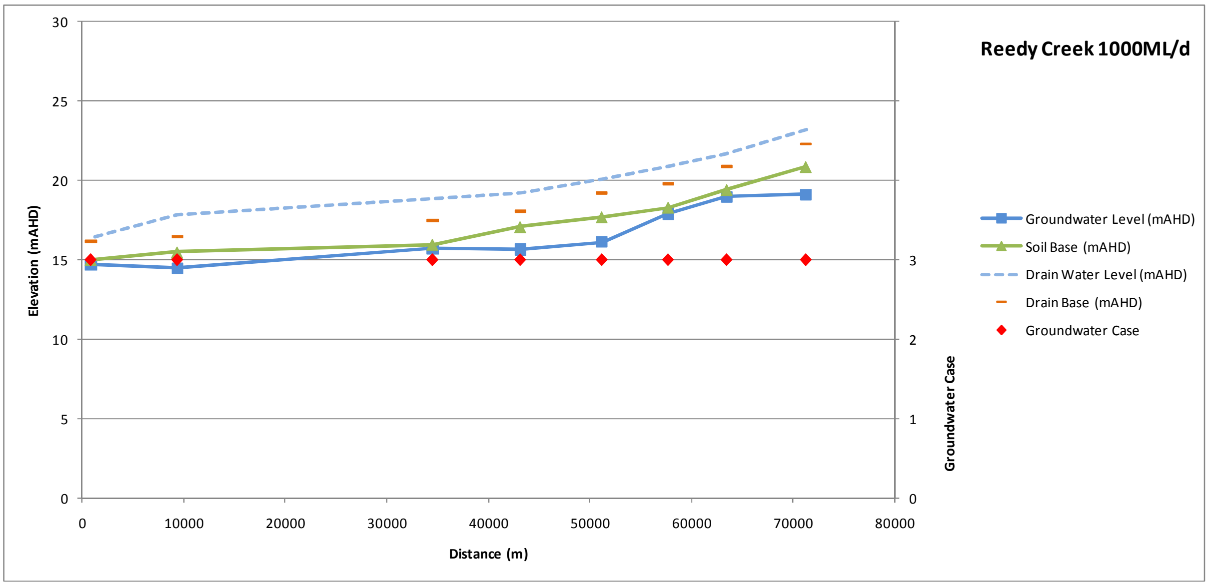


FIGURE 6-7: SURFACE AND GROUNDWATER CONFIGURATION AT REEDY CREEK AT 1000 ML/DAY

Figure 6-8 indicates that most of the predicted losses occur at 10000 m distance at a single node along Reedy Creek. This point is approximately 10 km upstream of the Reedy Creek /Blackford Drain junction. Judging from Figure 6-7 and Figure 6-8, a refinement (introducing more nodes and hence better defining the loss profile along Reedy Creek) would help in providing better estimates for seepage loss.

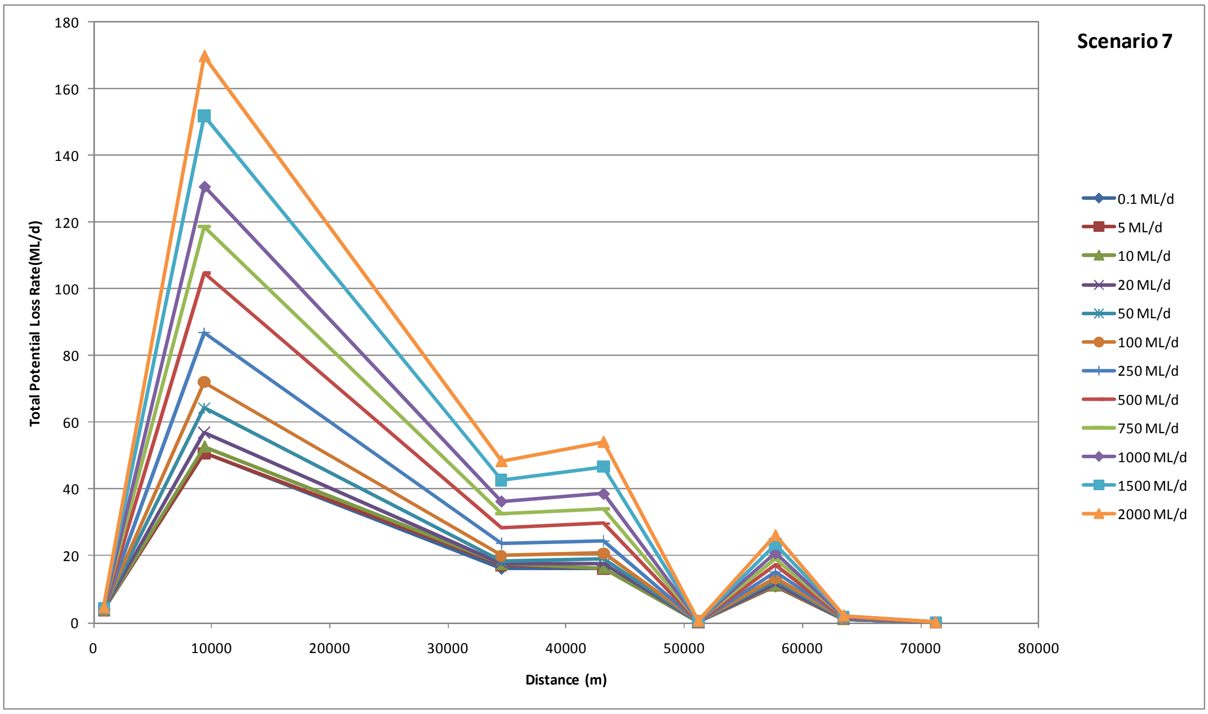


FIGURE 6-8 PREDICTED LOSSES ALONG REEDY CREEK, SCENARIO 7

6.5.1.1 Morella Basin

The Morella Basin represents a special part of Flow Path 02 that may be characterised by extreme sensitivity to the seepage loss calculations. This is because the basin is wide, covered by shallow water and even small changes in modelled groundwater elevation may cause significant differences in the calculated seepage losses.

AWE has checked the data supplied by DfW (Montazeri et al, 2011) for the Morella Basin. The two depth to groundwater values estimated for the Morella Basin appeared to be deep and hence AWE compared those with the water table model generated by SKM (2009).

SKM (2009) provided a preliminary wetland classification system for 16,000 wetlands in the south-east of SA, based on the regional evaluation of groundwater –surface water interaction. Regional groundwater (potentiometric) surfaces for shallow aquifers were intersected with wetlands using a GIS and the potential for groundwater – surface water interaction, groundwater system type and likelihood for regional TLA connection, groundwater flow regime, and the form of interaction were all evaluated on the basis of depth to water beneath the wetland. As part of the project two regional groundwater surfaces were produced. SKM (2009) has completed two groundwater maps: one for the spring seasonal high and one for autumn seasonal low.

AWE compared the depth to groundwater supplied by the DfW to those from SKM (2009). Depth-to groundwater from the SKM spring seasonal high model, averaged over the Morella Basin, was calculated as 0.9 m (1.6 and 4.0 m were supplied by the DfW). Depth to groundwater for most of the individual raster values within the basin varied between approximately 0.5 and 1.3 m, suggesting the groundwater *elevation* beneath the Morella Basin is a significantly higher than those predicted from the supplied DfW data.

For the reason described above AWE adopted 0.9 m depth to groundwater in subsequent calculations. This groundwater level, in turned, forced a change from Case 3 (Scenario 3 of Morgan et al. 2011, unsaturated flow) to case 2 (saturated flow through both the soil and aquifer). The net effect of this change was a reduction of approximately two orders of magnitude (from ~ 250 ML/day to ~ 2.5 ML/day) for the predicted seepage loss in the Morella Basin. **FIGURE** 6-9 shows the results on a scale directly comparable to those for Flow Path02 (**FIGURE** 6-5) at two operating surface water levels (3.1 and 4.5 m).

This change in groundwater level was adopted for the sensitivity analysis as well as subsequent system yield analysis discussed below.

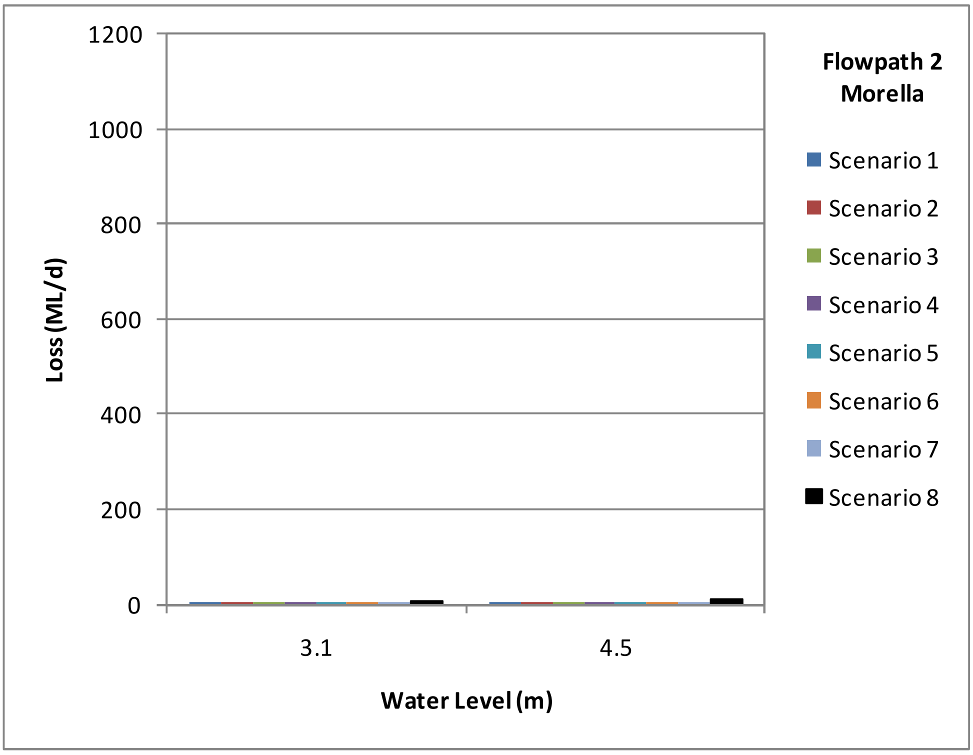


FIGURE 6-9: SUMMARY OF RESULTS : MORELLA BASIN SCENARIO 7

6.6 Flow Path 03 Floodway

FIGURE 6-10 indicates, in general agreement with the findings from Flow Path 02, that the largest losses are predicted by Scenarios 2, 8 and 1. The separation between medium and low losses is much more subtle than those for Flow Path 02. Results for Scenario 5 appear to be the lowest, although only marginally smaller than those for Scenarios 3, 4, 6 and 7.

Calculated losses at 500, 750 and 1000 ML/day are shown in FIGURE 6-11 from Flow Path 03 Floodway (excluding the Ephemeral Lagoons) are in general agreement with the results of FIGURE 6-10.

In terms of the loss contributions by individual segments, Reedy Creek Reach 3 appears to contribute one quarter (at high losses) to half (at low losses) of all predicted losses. Predicted losses for Reedy Creek 2 appear to vary considerably from significant losses (Scenarios 1, 2 and 8 at high aquifer hydraulic conductivity) to medium (Scenarios 4 and 5) to minimal (Scenarios 3, 6 and 7). As FIGURE 6-7 indicates, unsaturated conditions (Case 3) are predicted along the entire Reedy Creek reach. In unsaturated conditions, the height of surface water will drive water down and, as FIGURE 6-7 indicates, the node at 10000 m distance is predicted to have a dominant contribution.

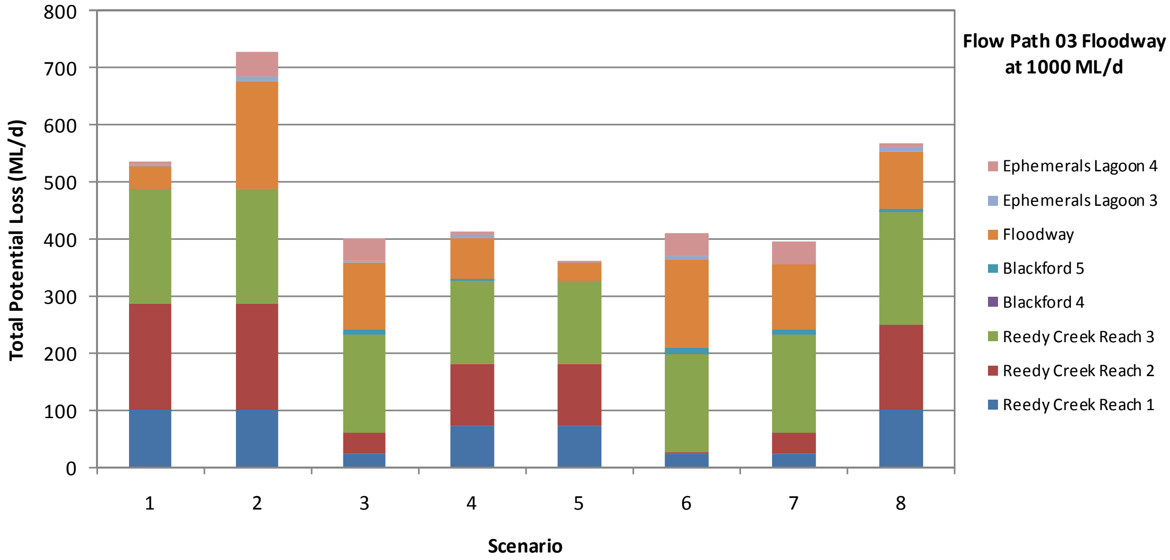


FIGURE 6-10: SUMMARY OF RESULTS : FLOWPATH 3 FLOODWAY

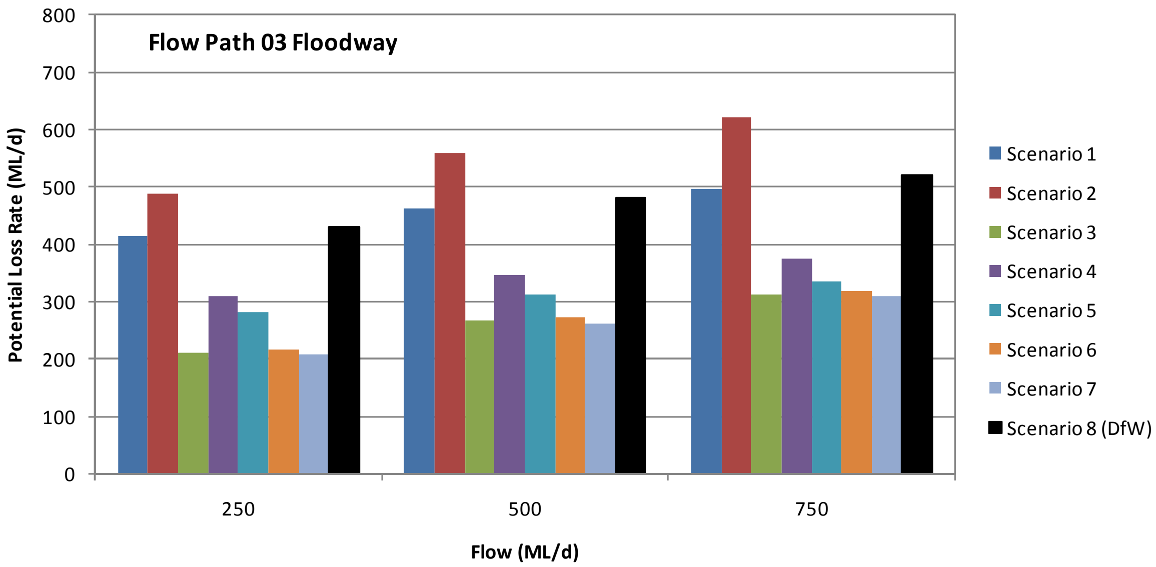


FIGURE 6-11 SUMMARY OF RESULTS FOR FLOWPATH 3 FLOODWAY SUB REACHES (EXCLUDING EPHEMERALS LAGOONS)

6.7 Comparing Groundwater Loss for Gaining Conditions

Gaining conditions occur along some sections of Flow Path 02 and 03 Floodway where groundwater levels are higher than water levels in the drain. Groundwater gains can be accounted for in two different ways:

1. In the channel loss calculations directly. Using this method a gain in a segment can be used to offset losses occurring in other segments. This method was adopted by Montazeri et al (2011).
2. Outside the channel loss environment and elsewhere in the modelling process. AWE have assumed that the WaterCress models used to estimate the local catchment contributions for the flow paths have been developed and calibrated against catchments which include a drainage network which receives groundwater (for example Drain L catchment). Therefore calculating a gain in groundwater to the flow path in the loss to groundwater calculations would essentially be a double counting of the groundwater expected to be intercepted by the flow path. Using this method gaining reaches identified in the loss to groundwater calculation approach were simply considered as having "0" water balance (no-loss). Using this method gaining reaches have no impact on the total groundwater loss calculated for a flow path.

AWE has compared the two methods using Flow Path 02. Figure 6-12 presents the results from the groundwater loss analysis of Flow Path 02 (as discussed above) as well as DfW Scenario 8 results with gains incorporated. Case 2 of Morgan et.al. (2011) was used to calculate the gains.

As Figure 6-12 indicates, the differences between the black (Scenario 8 no gain) and light grey (gain) coloured bars are insignificant. The total potential loss to groundwater along Flow Path 02 is reduced by between 0.46% for flows of 0.01ML/d and 0.002% for flows of 1500ML/d through the addition of groundwater gains.

The Reedy Creek, Floodway and Morella sections of the flow path always experience losing conditions under the set parameters therefore accounting for gains differently would make no difference for these reaches and Scenario 8.

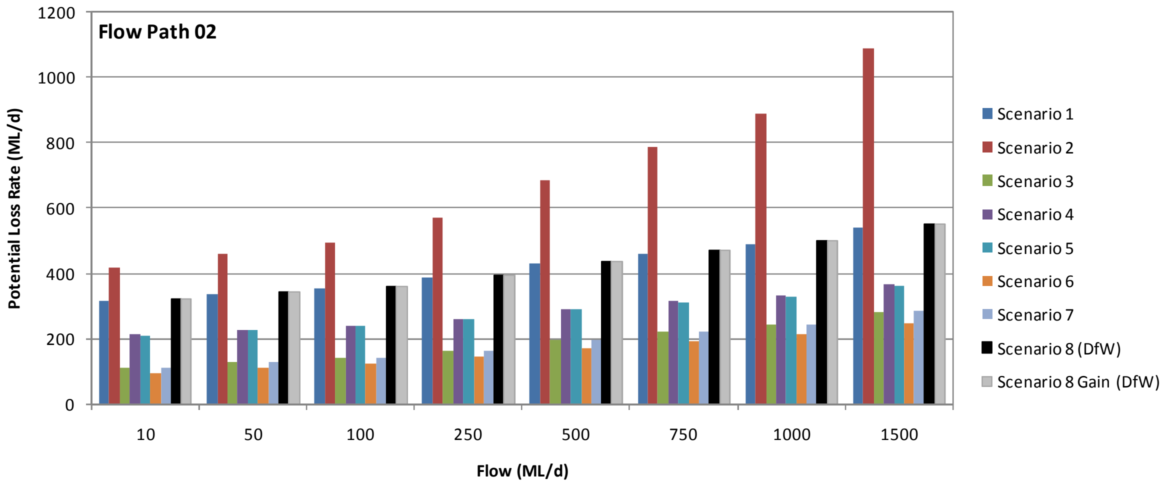


FIGURE 6-12: FLOWPATH 2 GROUNDWATER LOSSES ACCOUNTING FOR GAINS

6.8 Conclusions/Recommendations

For further analysis, AWE recommends the adoption of Scenario 7, based on the methodology outlined by Morgan et al. (2011). This is because Scenario 7 imposes the least control, combined with a realistic hydraulic conductivity representation for the entire thickness of the TLA.

Scenario 7 uses the more flexible seepage loss method where the physical setting (groundwater elevation vs. drain water elevation, and the position of soil and aquifer) determine the way seepage loss is calculated. The methodology described in Morgan et al. (2011) was also improved using a variable radius of influence (Section 5.3). An aquifer hydraulic conductivity of 8 m/day was used based on published reports by DfW (Williams and Cobb (1976) and Mustafa and Lawson, 2002).

The calculated losses corresponding to the preferred Scenario 7 were 'low' for both Flow Path 02 and 03 Floodway and constitute about one-third to one-half of the maximum losses (associated with Scenario 2). Losses estimated for Scenario 7 were similar to those of Scenario 3 and 6 (Flow Path 02) and Scenarios 3 to 6 (Flow Path 03 Floodway).

6.9 Clarifying Questions

The following questions were asked and addressed during the sensitivity analysis for the loss to groundwater calculations. The questions and subsequent answers are provided here as they may provide clarification to common questions regarding how the interaction between the flow in the channel and the groundwater may interact.

If Tilleys and Taratap and or SEL were hydrated more often from diversions from new floodway, would this increase groundwater mounding in the vicinity, hence reducing losses in the channel?

The transmission loss analysis adopted in this project uses either the difference between surface and groundwater elevations (cases 1 and 2) or surface water height above the base of the channel (case 3). The calculations are based on surface water elevations provided to AWE as a function of channel flow, and groundwater elevations that are based on bore data obtained prior to extra surface water diversions.

If excess surface water is diverted into the channels that will eventually increase the elevation (mounding) of groundwater adjacent to the channel. Hence for cases 2 and 3 (saturated flow through the aquifer, and the aquifer/soil, respectively) the difference between surface and groundwater elevation will reduce; so would transmission loss.

For case 3 (unsaturated flow) a change in the water table elevation would not influence the calculated transmission loss unless the change was sufficiently large to bring the water table into a saturated connection with the surface water. In other words, for case 3, groundwater mounding would not matter unless the water table increased to the extent that it would connected to surface water case and 1 or 2 would apply.

The drain adjacent to Tilley Swamp is reported to have a 1km zone of influence. Yet a floodway is much shallower, so for south of the Blackford, where most of new floodway construction is a floodway, the zone of influence is less? If so what does this mean for the analysis?

The zone of influence is calculated from the edge of the channel. The zone of influence plays a part in the calculated loss in Case 1 (saturated connection through an aquifer) and case 2 (saturated through the aquifer and soil) and can be assumed either fixed (DfW) or variable with hydraulic conductivity/transmissivity.

The zone of influence formulae (below), however, does not include (is independent of) the surface water depth:

$$L=\sqrt{\frac{2.25\ Tt}{S}}$$

where:

L	=	radius of drawdown influence (m)
T	=	transmissivity (m^2/day)
t	=	time (days)
S	=	storativity (dimensionless)

The zone of influence in the above equation is the function of aquifer parameters and time.

The excess surface water height (h_1) above the water table (h_2) is assumed to disseminate over the zone of influence (cases 1 and 2) and the channel loss, Q is calculated as:

$$Q = K(\mathrm{h}_1^2 - \mathrm{h}_2^2)/2\ \sqrt{\frac{2.25\ Kh_2t}{S_y}}$$

T, the transmissivity is now replaced with the product of hydraulic conductivity (K) and saturated aquifer thickness (h_2). If the surface water is shallower for a given groundwater elevation, h_1^2-h_2^2 above would reduce and therefore the calculated loss would also reduce for cases 1 or 2. For case 3 (unsaturated flow) the shallower surface water height above the base of the channel would suggest smaller loss; however the increased channel wetted perimeter may increase those. The net effect for case 3 will depend on the channel shape.

7 Question 5: Are there Material Differences Between the Reedy Creek and Biscuit Flat Flow Path Options between Drain L/K and Blackford

7.1 Understanding of the Questions

This question involved investigating the difference in conveyance performance of Biscuit Flat in comparison to the third reach of Reedy Creek, between the Drain L diversion point and Blackford Drain.

Reedy Creek (3) is a subreach of Flow Path 02, Flow Path 03 SELS, Flow Path 03 Floodway. Biscuit Flat is a subreach of the Flow Path 03 Biscuit Floodway.

This section provides a comparison of the performance of the Biscuit Flat sub reach in comparison to the Reedy Creek (3). The overall impact of the use of these alternate subreaches on the volume of water that can be delivered to Salt Creek is addressed in later sections.

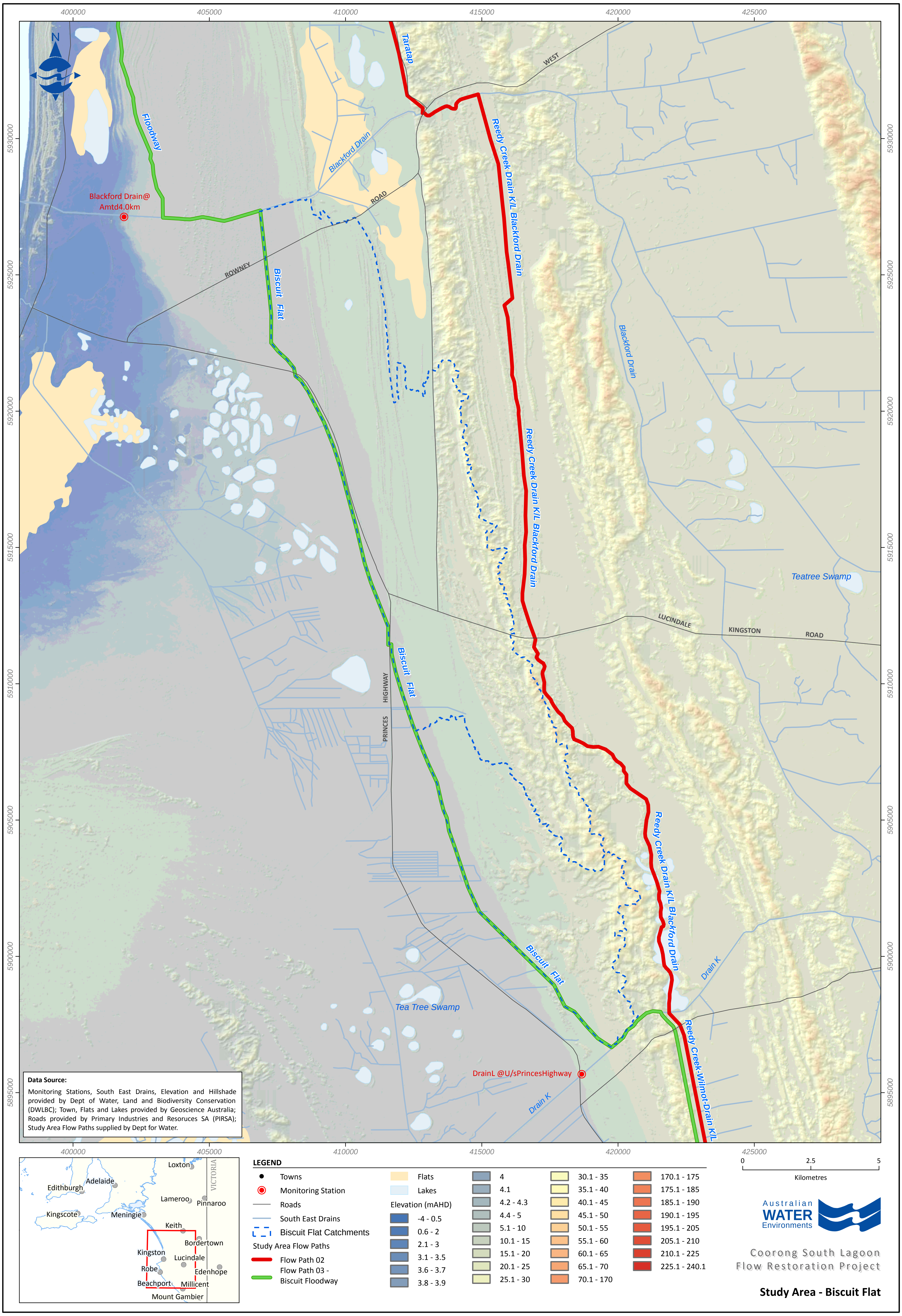
7.2 Understanding of Previous Work

The Biscuit Flat sub reach has not been analysed in any of the previous work.

7.3 Background of Biscuit Flat Investigation

The alignment of the Biscuit Flat floodway was agreed with a member of the project steering group and the client project team. This route was supplied to AWE for analysis. The proposed route is on the eastern side of the low lying area of Biscuit. The chief criteria used to develop the route was the grades between Drain L/K and Blackford Drain. It is noted that a minor variation on the route was preferred by the member of the Steering Group, but from a hydrological analysis perspective the slightly more western alignment would not materially affect the volumes at Salt Creek.

The flow path alignment and the contributing local catchment is summarised in Figure 7-1



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7.4 Local Catchment Contribution Estimation

7.4.1 Hydrological Understanding

7.4.1.1 Biscuit Flat Catchment

Biscuit Flat catchment is a complex inter-dunal system spanning 13,835 Ha. The entire catchment is typical of those in the South East region, with dry land farming mixed with irrigation of horticultural crops.

7.4.1.2 Rainfall

There are a number of Bureau of Meteorology (BoM) climate stations within and around the Biscuit Flat catchment. This includes the Biscuit Flat (Woolmit) station (number 26030) which was opened in 1901. The rainfall statistics for this station are comparable with the neighbouring catchments (see Table 7-1), with an average annual rainfall of 640 mm. Annual potential evaporation across the catchment is approximately 1400 mm.

TABLE 7-1 STATISTICS FOR BISCUIT FLAT (WOOLMIT) BOM STATION (26030)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean	19.0	23.3	24.7	48.6	73.8	88.1	97.2	79.7	65.8	46.8	34.9	28.9
Median	12.9	18.0	17.5	38.5	69.3	77.8	93.3	82.5	64.8	41.2	32.2	22.6

7.4.1.3 Data and Knowledge Resources/Gaps

There currently exists little information regarding the hydrology and hydrogeology of the Biscuit Flat catchment. AWE undertook an exhaustive review of the publicly available historical and existing data and literature to ascertain the key characteristics of the catchment that can influence the hydrology. Moreover, AWE liaised with a range of organisations (including South East Natural Resources Management Board (NRM Board); Department for Water (DfW); University of Adelaide; and South Eastern Water Conservation and Drainage Board (SEWCDB)) to understand aspects of the catchment relating to drainage rules, watercourse. The data and knowledge gaps relevant for this study include:

- Lack of surface water flow data for the catchment;
- Lack of detailed understanding of the hydrological processes in the catchment (e.g. surface water-groundwater interactions; surface water;
- Rainfall variability (spatially); and
- Detailed information regarding wetlands/storages in the catchment.

The suitability of a particular water balance model and the efficiency of the calibration process is highly dependent on data availability.

7.4.2 Analysis Methodology

7.4.2.1 WaterCRESS Modelling

WaterCress (Water Community Resource Evaluation and Simulation System) is a PC based, continuous time series, total water cycle model, which simulates the passage of flows through natural and constructed water systems.

For this study, daily rainfall was used to develop a surface water model to simulate runoff data for the Biscuit Flat Catchment. This involved the following stages:

4. Model Construction
    a. Data acquisition;
    b. Catchment delineation; and
    c. Catchment node characterisation.
5. Scenario Evaluation
    a. Climate (historical) and Climate Change Median.

Typically, a hydrological model is calibrated utilising observed hydrographs from recorded watercourse flow records, amongst other in situ data sources. The lack of data (outlined above) resulted in the catchment node characterisation process relying upon information and data from other catchments. This presented a number of limitations to the outputs of the model, not the least of which is certainty.

7.4.2.2 Catchment Delineation

Utilising the DfW DEM, we employed ArcHydro to delineate the Biscuit Flat catchment into sub catchments (refer to Figure 7-1). For the purpose of comparison with Reedy Creek (Montazeri et al 2011), the same methodology detailed in Wood and Way (2011) was implemented. The catchment itself falls towards the coast (from East to West), and incorporates the township of Kingston. The proposed Biscuit Flat drain runs from South to North. When considering the drain's alignment and the topography of the landscape, all of the catchment that sits on the western side of the propose drain slopes away from the drain to the coast. After consulting with DfW's project manager, it was agreed that due to financial and logistical constraints, it was unlikely that the entire Biscuit Flat catchment runoff would be directed towards the drain. Thus, the subcatchment modelled was that area on the Eastern side of the drain.

7.4.2.3 Catchment Node Characterisation

Based on the lack of available data for Biscuit Flat, a process was initiated whereby data sourced from adjoining and/or similar catchments was utilised to determine the characterisation of the Biscuit Flat catchment nodes. A comparison between the physical, climatic and hydrological catchment characteristics of Biscuit Flat and adjoining and/or similar catchments such as Reedy Creek and Drain L/K was made to determine the input requirement of the Biscuit Flat catchment nodes. These included:

- Catchment area;
- Topography;

- Rainfall;
- Landuse;
- Soil characteristics;
- Watercourse (including wetland size, depth/volume etc); and
- Drainage architecture and rules.

Within WaterCress, each node has a unique set of characteristics e.g. storage volumes, demands, seepage calculations etc that relate to the hydrological processes within the subcatchment the node represents. In order to provide technically robust outputs, the catchment characteristics of Biscuit Flat were compared against other similar catchments and where similarities occurred (e.g. similar catchment size, climate and wetland size/storage) the WaterCress node characteristics from the DfW models that have been calibrated via in-situ data, were used as a starting point for building the Biscuit Flat catchment node. Biscuit Flat was not directly comparable with only one catchment (i.e. not all catchment characteristics were similar with say Reedy Creek). Hence, a number of sub sets of characteristics were used for multiple comparable catchments (e.g. catchment size, land use and climate were similar to Reedy Creek; climate and watercourses were similar with subcatchments within the L/K system).

The lack of in-situ Biscuit Flat data to calibrate the model against is the major limitation associated with the outputs.

7.4.3 Local Catchment Contribution Analysis Results

7.4.3.1 Surface Water Yield

The local Biscuit Flat catchment contributions to the flow path were ascertained for the time period 1971–2000 (the standardised thirty year period as used by DfW) for the following scenarios:

- Climate (Historical); and
- Climate Change (Median).

Table 7-2 and Figure 8-2 detail the annual average and median discharge from Biscuit Flat for both of the scenarios.

TABLE 7-2 SURFACE WATER YIELD - BISCUIT FLAT

	Climate (Historical)	Climate Change (Median)
Median	4,379 ML	3,020 ML
Mean	4,856 ML	3,049 ML

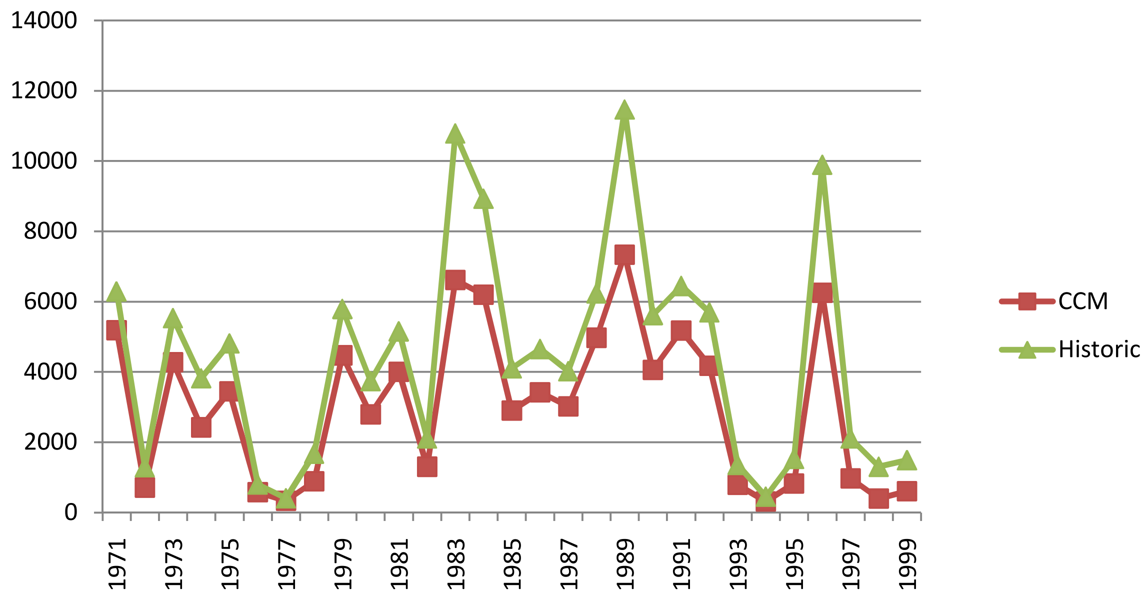

FIGURE 7-2 ANNUAL HISTORIC AND CLIMATE CHANGE (MEDIAN) YIELD

7.5 Channel Design

A design basis and basic hydraulic model was developed to inform the water balance analysis of the Biscuit Flat flow path because no design for the Biscuit Flat flow path had previously been developed.

7.5.1 Key assumptions in Channel Design

The following section outlines the key assumptions made in the development of the Biscuit Flat flow path design. These assumptions were used in the hydraulic model which informed the loss to groundwater and water balance analysis.

- The upstream invert level was made equal to the estimated invert level of Drain L (as per the 2m DEM of the region) at 14.36mAHD. Where invert level refers to the lowest point in the bottom of the channel i.e. the level at the base of the channel.
- The downstream invert of the channel was set at 6.3m AHD as directed by the DfW project manager. The invert of Blackford Drain at the proposed junction of Blackford Drain and Biscuit Flat appears to be in the order of 6.6-6.9mAHD based on interpretation of the drawings for the Drain. The DEM of the drain at this point indicates an invert of 7.6m AHD but discussions with South East Water Conservation and Drainage Board staff indicate that the DEM may have picked up the water surface in the channel on the day of the survey. In addition to the water in the channel, there is significant sedimentation in Blackford drain which would contribute to the significant difference between the aerial survey information and the design drawings.
- As there is locations with significant cut near the upstream and downstream ends of the flow path which are expected to produce large amounts of spoil, the cut along the

remainder of the channel was minimised to avoid large surpluses in spoil in comparison to the soil volume needed to form the levees. A minimum cut of 0.2m was assumed for each cross section with the exception of cross sections 6584 and 5500 which are at the lowest point along the flow path. At these locations the invert of the flow path is effectively at or very near natural surface level. This was necessary to maintain some, though very little, grade in the last section of the flow path.

- The assumption made to minimise cut where possible, rather than balancing cut and fill at each individual cross section, subsequently assumes that some carting of spoil to form levees in the middle reaches of the flow path will be more cost effective than disposing of large volumes of spoilt from the beginning and end of the flow path where large volumes of cut are required to meet the required invert levels.
- A maximum levee height of 1.5m above surrounding natural surface level was assumed. A freeboard of 0.4m was also assumed resulting in a maximum flow depth in the design of 1.1m.
- Normal flow conditions were assumed as a downstream boundary condition. The assumption of normal flow depth as the boundary condition represents a flow depth of 0.5m in Blackford Drain.

7.5.2 Typical Channel Cross Section and Long Section

Figure 7-3 illustrates the resulting design long section of the Biscuit Flat reach. Figure 7-4 illustrates a typical cross section of the Biscuit Flat Reach. The cross section clearly shows the two levees forming the floodway type design of the reach. The pink line represents the natural surface at the cross section.

A summary table of the features of the cross sections final design is provided in Appendix A.

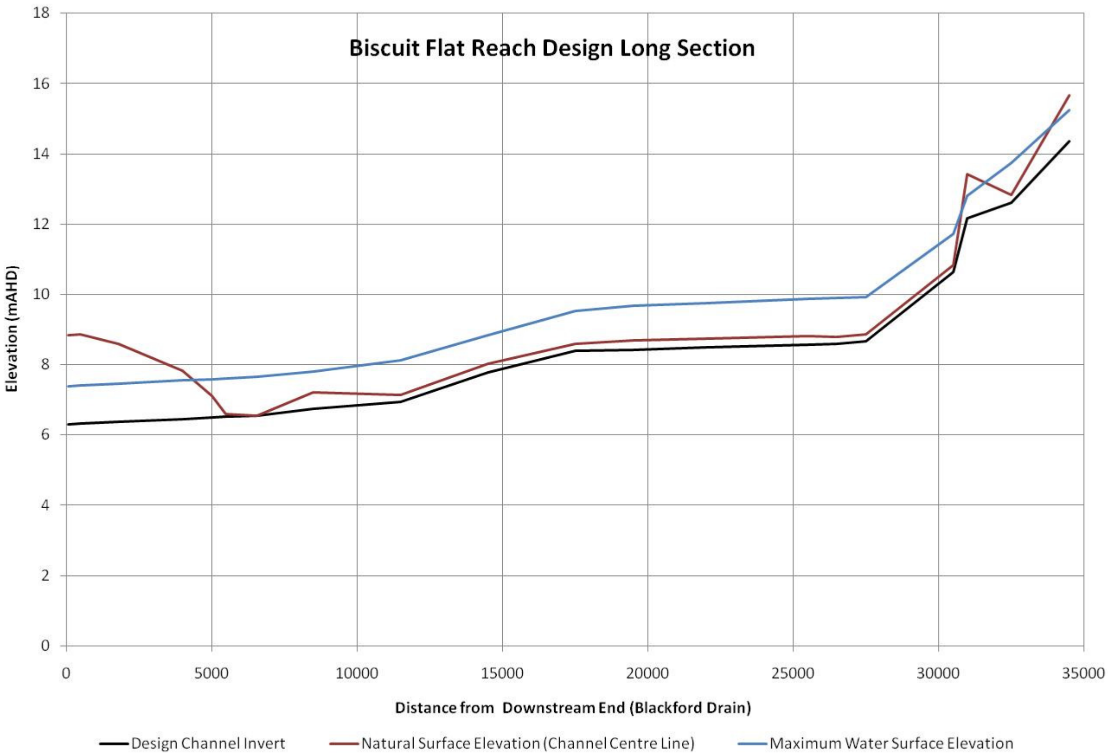

FIGURE 7-3 BISCUIT FLAT DESIGN LONG SECTION

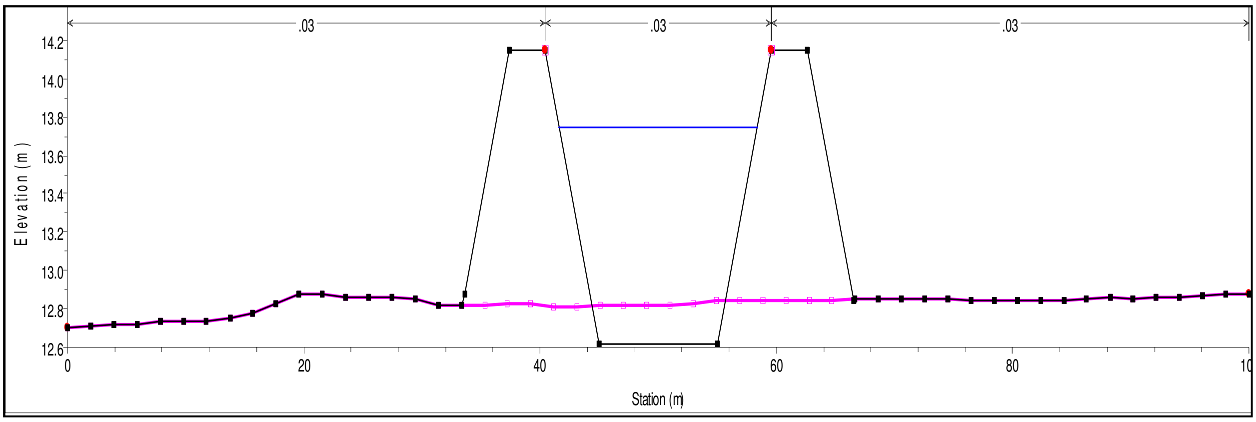

FIGURE 7-4 TYPICAL DESIGN CROSS SECTION OF THE BISCUIT FLAT REACH

7.5.3 Calculation of fill for levee for Biscuit Flat channel design and channel refinement

Fill volumes for the levees were calculated assuming a trapezoidal levee with a flat base. In some cases where the fall of the land away or toward the channel is significant the fill requirements may be under estimated. In cases where the land rises away from the edge of the channel the fill volume may be overestimated. As this design work is in the feasibility stage and the channel design work is meant to provide only an indication of what is reasonable this assumption is considered reasonable.

7.6 Biscuit Flat Water Balance Model

7.6.1 Associated Channel Modelling

The change in the flow path from Flow Path 02 to Flow Path 03 Biscuit Floodway not only required modelling of the Biscuit Flat reach itself but also the small section of Drain L/K from which the diversion to Biscuit Flat would occur as well. The length of Blackford Drain that would be used for Flow Path 03 Biscuit Floodway was also different to the other flow paths. The following sections detail the key assumptions made about these small reaches to enable the water balance modelling to occur.

7.6.1.1 Analysis of Drain L (Reedy Creek to Biscuit Flat Diversion)

To use the Biscuit Flat reach between Drain L and Blackford Drain the flows must be transferred down Drain L/K. This reach is approximately 2.6 km long. To estimate the transmission losses along this reach a coarse loss to groundwater model of the reach was developed, which required the development of a simple.HEC RAS model of the reach. The geometry of the channel was assumed to mirror that recorded in the 2m DEM for the area. There is potential for error in this assumption as the DEM may not have picked up the invert of the drain due to sediment build up or presence of water in the Drain when the DEM was developed. This approach to modelling the invert and the form of Drain L/K is consistent with approach taken for Blackford Drain by Montazeri et al (2011).

The HEC RAS model was used to develop the water level in the drain under different flow conditions up to the maximum design flow. The reach boundary conditions for this model were assumed to be normal depth. The Manning's in the model was 0.03 which is consistent with remainder of the hydraulic modelling for the project.

It was assumed there is no local catchment contribution for this small reach.

7.6.1.2 Blackford Drain (Biscuit Flat to Floodway)

The surface area of the channel was based on the HecRas model as developed by Montazeri et al.

- The local catchment for this reach of Blackford Drain was assumed to be 500ha in area. This is based on the (*Flow Path Catchments* file supplied by DfW). The flow path catchment for Blackford Drain from Reedy Creek to the Floodway is noted as 9465 ha in the DfW water balance model with an average annual yield under historic climate conditions of 1.9 GL/a. It was therefore assumed that the local catchment contribution for Blackford Drain from the junction with Biscuit Flat to the junction with the Floodway is equivalent to the local catchment for Blackford from Reedy Creek to Floodway prorated in proportion to catchment size (i.e. 5% of the larger flow path).
- Rainfall and evaporation incident on the flow path were assumed to be the same as those assumed for the Blackford Drain reaches modelled in Flow Path 02.

7.6.2 Rainfall and Evaporation on Biscuit Flat

It was assumed that the rainfall and evaporation active on the Drain L area and Biscuit Flat reaches was equivalent to that assumed for the third section of Reedy Creek in the Montazeri et al (2011) water balance modelling.

7.7 Loss to Groundwater Modelling

The hydrogeological characteristics of the catchment needed to be estimated prior to applying the loss to groundwater methodology because Biscuit Flat and the small section of Drain L that form part of Flow Path 03 Biscuit Floodway have not been previously modelled.

The loss to groundwater from Biscuit Flat and Drain L was calculated using Scenario 7 and Scenario 6 (see Figure 6-1 for description of these characteristics of these scenarios).

7.7.1 Input Data

Soil data, including soil type and thickness, was estimated from the Land and Soil Spatial Data for Southern South Australia (DWLBC, 2007).

Along each flow path and for each segment, the dominant soil was identified and assigned as the soil type. Soil thickness was estimated from the typical soil profile depth for each soil type. Hydraulic conductivity and negative pressure values were also assigned based on soil type following the methodology described by Montazeri et al (2011).

Spring groundwater elevation (m AHD) was obtained from the groundwater surface (m AHD) for the Tertiary Limestone Aquifer (TLA), produced by SKM (2009). The thickness of the TLA was calculated from data on the top of the confining layer, the latter was estimated from spot heights from borelogs provided by DfW. As most bores are situated a considerable distance from the drains and not all the drillholes have logs, the resultant TLA thickness should be considered as an estimate only.

The Wetted Perimeter i.e. the length of the perimeter of the cross section of the flow path which is wet for a given flow was exported from the hydraulic model developed for each reach.

7.8 Comparison of Performance of Reedy Creek (3) and Biscuit Flat

Figure 7-5 is a comparison between the channel loss estimates for Reedy Creek 3 and Biscuit Flat for Scenario 7. Losses from Biscuit Flat are consistently lower than those from Reedy Creek 3 for all the scenarios. When comparing losses from different flow paths, it is important to remember that differences not only occur due to different soil and aquifer hydraulics but are also caused by differences in the relationships between the elevations of surface water, groundwater, soil and the aquifer.

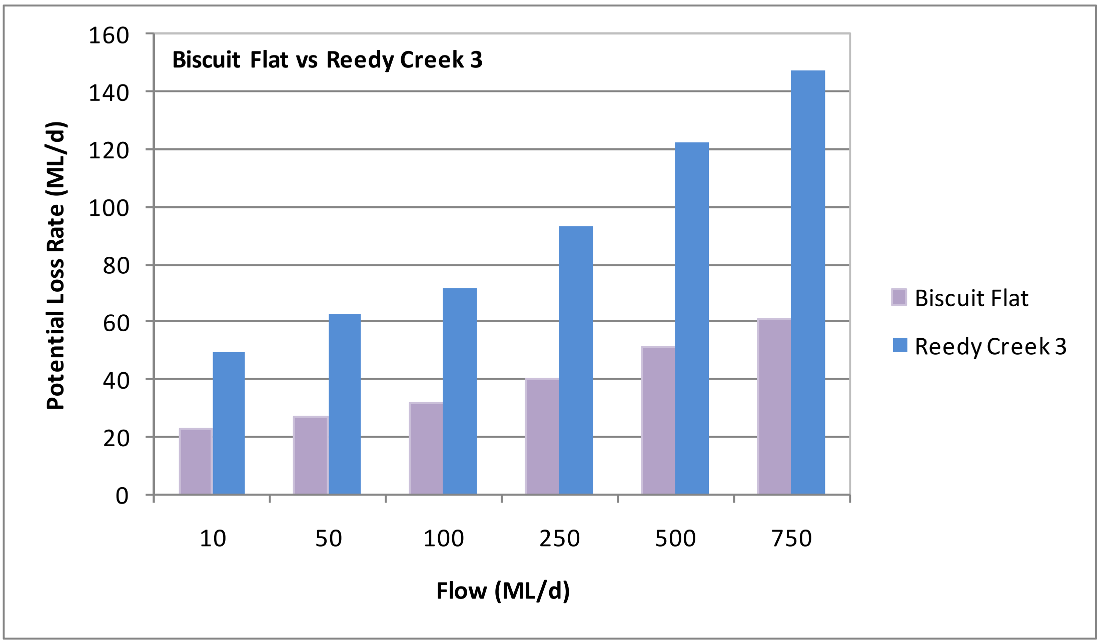

FIGURE 7-5: COMPARISON BETWEEN THE POTENTIAL CHANNEL LOSSES FOR REEDY CREEK 3 AND BISCUIT FLAT

Figure 7-6 (orange markers using the right axis) indicates that 'Case 2' is dominant at Biscuit Flat (almost half of the segments are predicted to have Case 2). In comparison Reedy Creek 3 (Figure 7-7) is dominated by 'Case 3 '. The larger variation in 'Cases' for Biscuit Flat, is partly due to the better resolution provided by numerous segments. In comparison, Reedy Creek 3 is discretised to four segments only. 'Case 3' is generally 'leakier' than 'Case 2'.

It is possible that if the modelling of Reedy Creek was refined and completed at a finer resolution that the marked difference in potential loss to groundwater between the two flow paths would not be as significant.

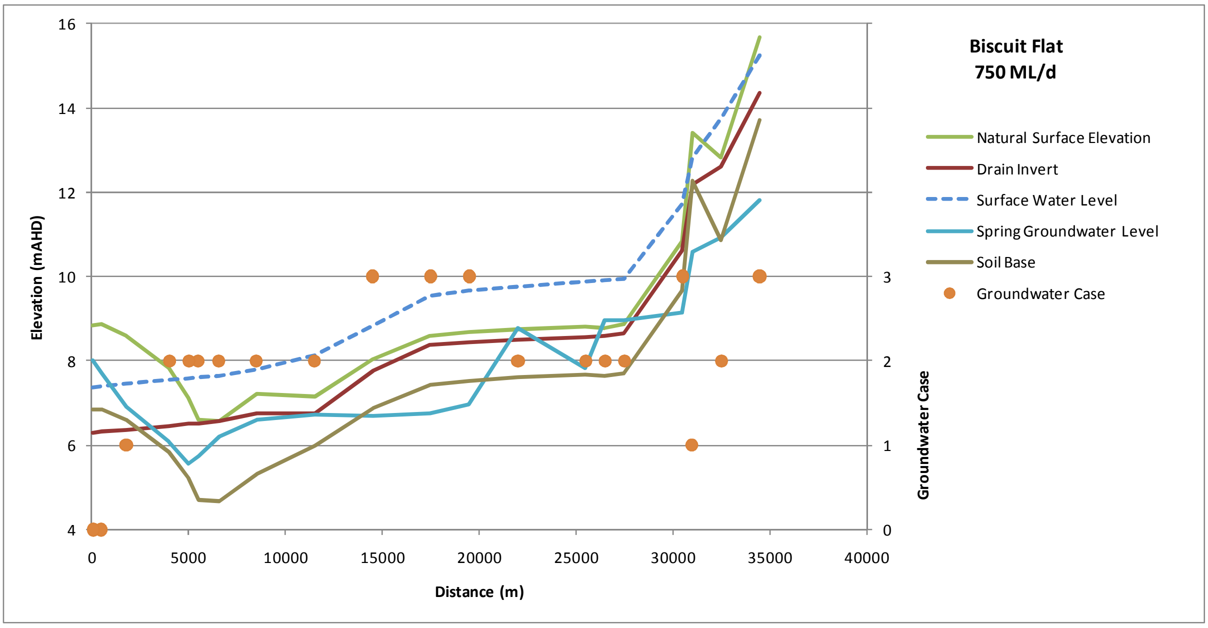

FIGURE 7-6: SURFACE AND GROUNDWATER CONFIGURATION AT BISCUIT FLAT AT 750 ML/DAY

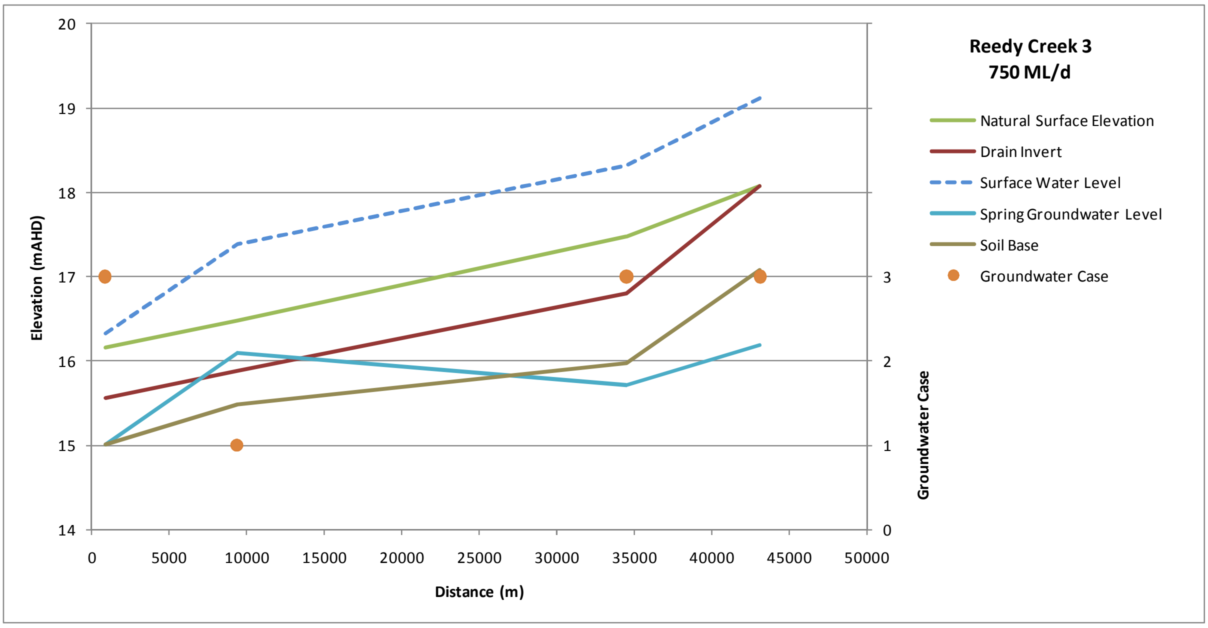

FIGURE 7-7: SURFACE AND GROUNDWATER CONFIGURATION FOR REEDY CREEK 3 AT 750 ML/DAY

Comparison of the water balance results for the flow paths that use Reedy Creek (02, 03 SELS and 03 Floodway) and the results for Flow Path 03 Biscuit Floodway show that the average annual loss to groundwater is twice as great in the third section of Reedy Creek as in Biscuit Flat i.e. The average annual loss to groundwater in Biscuit Flat is 5.2 GL/a and in the third section of Reedy Creek it is 10.9 GL/a.

7.9 Conclusions

The analysis has involved developing an initial design for the Biscuit Flat reach. Using the proposed alignment and initial hydraulic design of the reach as a basis, loss to groundwater and local catchment contributions to the reach were estimated. As there is no data available for calibration of the local catchment contribution model there is a large amount of uncertainty surrounding these results.

The analysis of the potential loss to groundwater from the channel found that the Biscuit Flat reach has much lower potential for loss to groundwater than the equivalent reach in Reedy Creek.

When the overall water balance results are considered Biscuit Flat was found that Flow Path 03 Biscuit Floodway provides an additional 1.5 GL/a (median year) to the Southern Lagoon of the Coorong in comparison to Flow Path 03 Floodway which uses the third section of Reedy Creek.

The primary difference in the performance of the flow paths is in the loss to groundwater experienced. The loss to groundwater in an average year in Biscuit flat is less than half that of Reedy Creek (3).

8 Channel Refinement

In section 4.2.4 the capacity of the flow paths in the hydraulic modelling used as a basis for Montazeri et al (2011) was reviewed. Some of the initial designs for the channels were found to be overcapacity for the adopted maximum daily diversion rates used in Montazeri et al (2011). The recommendation from this report to reduce the maximum daily diversion for Wilmot Drain to 250 ML/d also changes the maximum capacity of the channel required for the last two thirds of the Reedy Creek diversion.

The channel designs in the hydraulic models inform both the loss to groundwater calculation and the water balance. The use of oversized channels in the hydraulic model will reduce the driving head forcing loss to groundwater and will alter the surface area assumed to interact with rainfall and evaporation on the flow path.

The hydraulic models are also being used as the basis for initial estimates of cost and vegetation clearance, as such if the channels are oversized these factors may be overestimated.

Given the above, a refinement of the original designs developed by Montazeri et al (2011) was undertaken. The hydraulic models for the following reaches were refined:

- Reedy Creek (Drain M to Blackford Drain);
- Taratap/Tilley Swamp (Blackford Drain to Morella Basin); and
- Floodway (Aligned to the east of the Southern Ephemeral Lagoons, Blackford Drain to the third lagoon of the Southern Ephemeral Lagoons).

It should be noted that the designs for the reaches of the flow paths being assessed by this study are preliminary. Their primary purpose is to provide a reasonable basis for the water balance modelling which in turn provides information to determine the feasibility of the CSLFRP and the preferred route for the flow path. The models are coarse and do not take into account road crossing or other infrastructure. The details of the diversion points have also not been considered.

If the CSLFRP is found viable and a preferred flow path is selected additional topographical survey and much more detailed concept design work will be required to optimise the exactflow path and the design.

The channel refinement used the hydraulic models designed by Montazeri et al (2011) as a basis. The number and locations of the cross sections used by Montazeri et al (2011) was maintained to prevent significant additional modification of the loss to groundwater modelling. The flow path alignment used by Montazeri et al (2011) was also adopted.

The hydraulic models where developed using the 1 dimensional hydraulic model Hec Ras.

The following sections describe the assumptions made in refining the hydraulic models developed.

Summary tables of the final design cross section features are provided in Appendix A.

8.1 Reedy Creek Design Basis

The Reedy Creek reach is from Drain M to Blackford Drain, all or part of this reach is used in each of the four flow path options under consideration.

The Montazeri et al (2011) hydraulic model is based on the 10m DEM (as opposed to the 2m DEM on which all others are based). In addition the Reedy Creek model which has a length of 71,292m is divided into 8 cross sections. This is the coarsest model developed for the study area.

The Reedy Creek flow path was assumed to take the form of a floodway. In general this includes a shallow channel with continuous levees raised on each side to transfer flows along the flow path primarily above the surrounding natural surface.

8.1.1 Key Assumptions in Hydraulic Design

- The invert of Drain M is approximately 21.9mAHD based on 2m DEM for the region. It was assumed that the upstream end of Reedy Creek will be altered to match the Drain M invert. Given the limited number of cross sections, the cut and fill analysis may over estimate cut in this initial sub reach of Reedy Creek.
- Normal flow depth was assumed at the upstream end of the hydraulic model.
- Critical depth has been assumed at the downstream end of the channel. For the purposes of this design it was assumed that that the junction with Blackford Drain will take the form of a drop structure where the invert of the Reedy Creek will be higher than that of Blackford Drain. This will reduce earthworks but will introduce additional cost for the armouring of the channel at this junction.
- The assumption of critical depth at the downstream end of the reach results in a peak design water level of 15.97mAHD. This equates to a 1m flow depth approximately in Blackford Drain (assuming the invert of Blackford Drain is approximately 14.8mAHD).
- An additional cross section has been taken at Cross section128 in the hydraulic model (128 m from the DS end of the channel) to provide a more realistic water level in the channel in the last reach. This cross section was not used in the groundwater analysis.
- The invert of Blackford Drain is approximately 14.8mAHD at the junction of Reedy Creek and Blackford Drain according to the 2m regional DEM. The actual invert of the drain is likely to be lower due to sediment build up and water in the channel being present during the aerial survey.
- A maximum water depth above surrounding natural surface level of 1.1m was assumed. A freeboard of 0.4m above the design flow rate adopted. The maximum levee height above ground level in the final design is 1.2m.
- The design attempted to provide a coarse optimisation of cut and fill.
- For cross sections where an existing channel or depression exists, the existing invert was maintained.

8.1.2 Reedy Creek Design

The resultant design for the Reedy Creek flow path has a base width which varies between 5-22m wide with a maximum levee height of 1.2m. The design used in the Monatzeri et al (2011) analysis has a base width of between 40-60m.

Figure 8-1 illustrates the natural surface along the Reedy Creek flow path centre line and the design invert adopted. Where the design invert adopted is equal to the natural surface level an existing channel or natural depression exists. As discussed above, in these locations the design maintained the existing invert. Figure 8-2 illustrates a typical cross section. The pink line is the natural surface level at the cross section from the regional DEM. The blue line indicates the maximum water level.

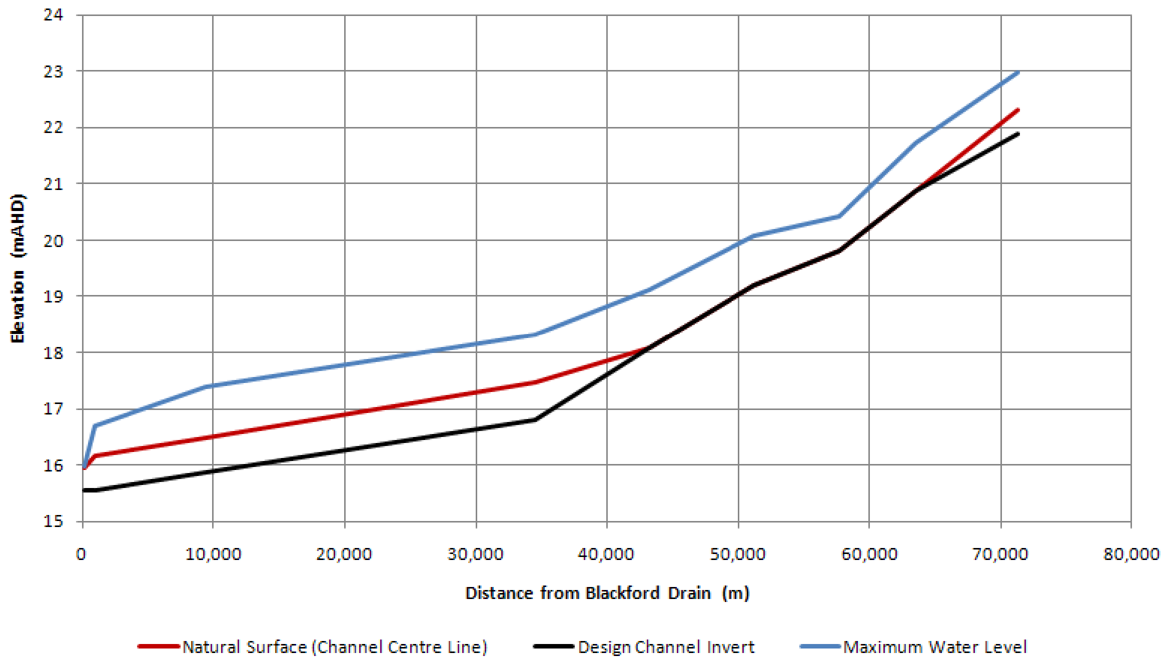

FIGURE 8-1 REEDY CREEK DESIGN LONG SECTION

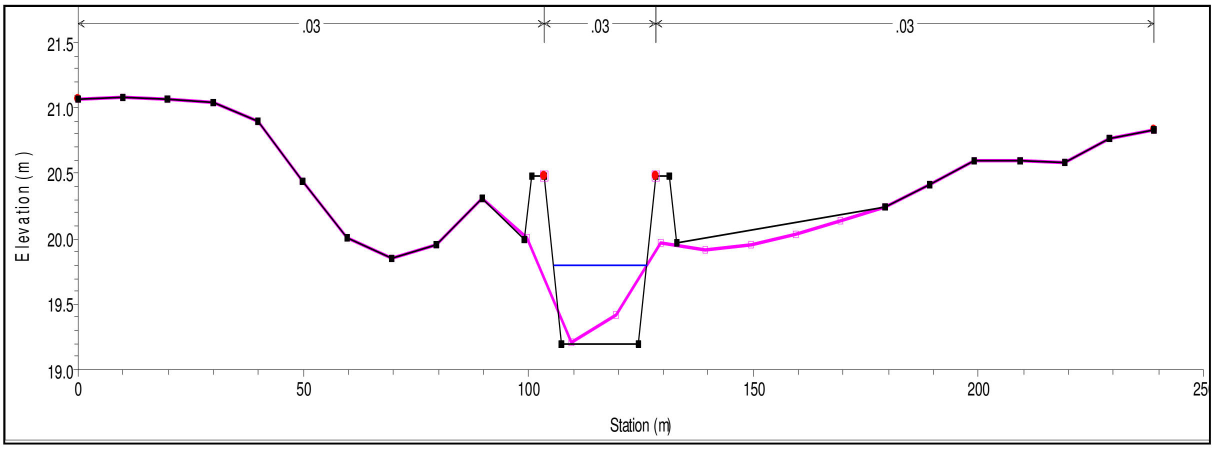

FIGURE 8-2 REEDY CREEK TYPICAL CROSS SECTION

8.2 Tartap/Tilley Swamp Design Basis

The Taratap/Tilley Swamp reach is only used by Flow Path 02. The reach begins at Blackford Drain and extends through the existing drainage alignment in Tartap and Tilley Swamps to Morella Basin.

It was assumed that where a channel already exists in either Taratap or Tilley Swamp that the invert level assumed for these cross sections by Montazeri et al (2011) in their hydraulic model is consistent with the as constructed drawings. AWE understands this to be the case from correspondence with DfW and from spot checks against the as constructed drawings.

The general form of the channel adopted for the refinement of the channel design was consistent with that adopted by Montazeri et al (2011). Where it exists the existing channel was widened and a levee placed on the western side of the channel.

In the upstream section where no channel currently exists the grade is low and limited excavation was possible. Based on a coarse cut and fill assessment in these cross sections, there is not sufficient spoil generated to supply spoil for the levee required without an unreasonably large channel width being assumed. It was therefore assumed the excess spoil from the remainder of the channel could be used in this area.

8.2.1 Key Assumptions in Hydraulic Design

- The upstream invert of the flow path is set at 12.6m AHD which is approximately the invert of Blackford drain at the upstream end of Taratap. There is potential for the invert of Blackford Drain to be lower than 12.6m as this level was taken from the regional 2m DEM. These levels in the DEM can be affected by water and sediment build up in the channel at the time of survey.
- The downstream boundary condition in the hydraulic model was assumed to be 4.5mAHD, which is consistent with the maximum water level assigned in the transmission loss model for operation of Morella basin. It is lower than the 5.46 mAHD assumed by Montazeri et al (2011) which is the maximum pool water level possible in Morella basin.
- Where no channel currently exists the invert is defined by the need to balance cut and fill and meet the up and downstream controlling cross sections (i.e. Blackford Drain invert and the beginning of the Taratap Drain).
- A minimum channel widening of 1m was assumed to allow for some spoil to form the western levee.
- The coarse cut and fill balancing conducted is limited by the detail of the channel picked up the 2m regional DEM. In many cases the DEM does not pick up the invert of the existing channel. The cut estimates may therefore be overestimated.
- At the downstream end of the flow path the channel width was driven by the maximum water level allowable above natural surface.
- Where the right bank (eastern side of the flow path) of the cross section did not have sufficient depth to contain a maximum water level above natural surface of 1.1m (plus 0.4m above the natural surface immediately adjacent to the channel) the maximum allowable water surface elevation was assumed to be the maximum right bank ground level (minus 0.4m free board).
- The modelling has found that, due to the natural water course capacity, when flows are out of the channel (i.e. up against the western levee) the capacity of the natural watercourse to the east is significant. Therefore the channel enlargement needed for much of the flow path is minimal. However, as the design assumes the use of the natural depression to the east of the existing channel is available to convey flow, the flow widths are for some sections of the channel extensive. The maximum flow width in the reach at peak is approximately 2km.

8.2.2 Taratap/Tilley Swamp Design

The final design of Taratap/Tilley Swamp has a resultant channel base with of between 3-19m with a maximum levee height of 1.5m. The design by Montazeri et al (2011) had a channel width of 50m.

Figure 8-3 illustrates the design long section, natural surface level and the maximum water level. As can be seen from the figure, for the majority of the flow path the design invert is defined by the existing channel invert. Figure 8-4 and Figure 8-5 illustrate two typical cross sections and show the variation between the maximum expected flow with under peak flow conditions. For both these figures the pink line is the natural surface level.

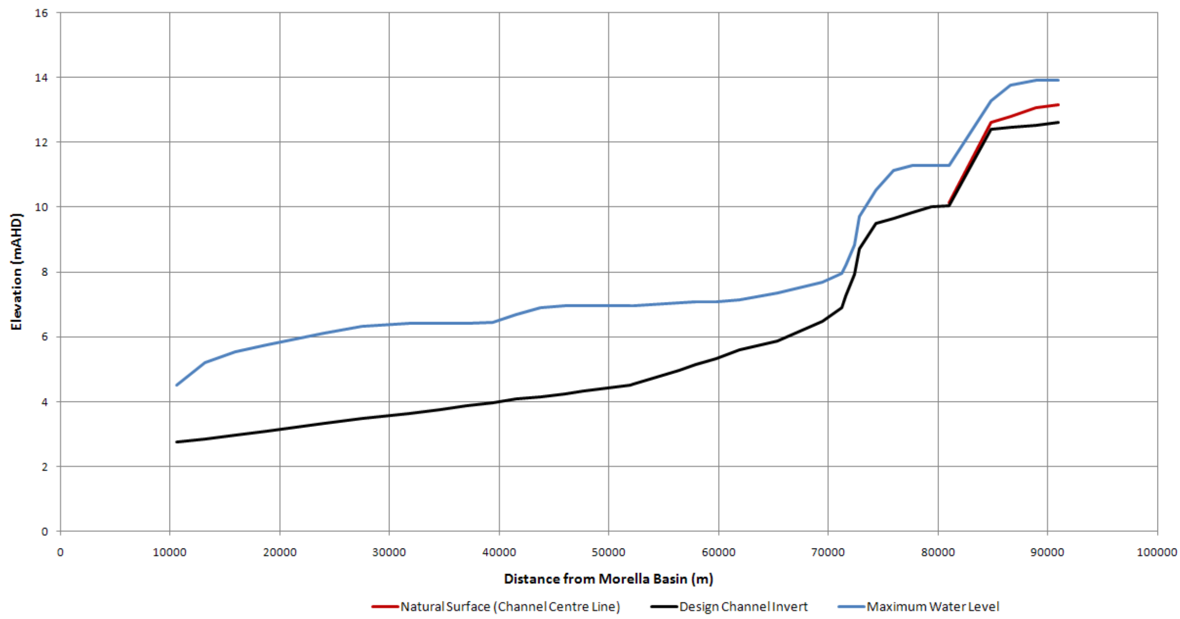

FIGURE 8-3 TARATAP/TILLEY SWAMP DESIGN LONG SECTION

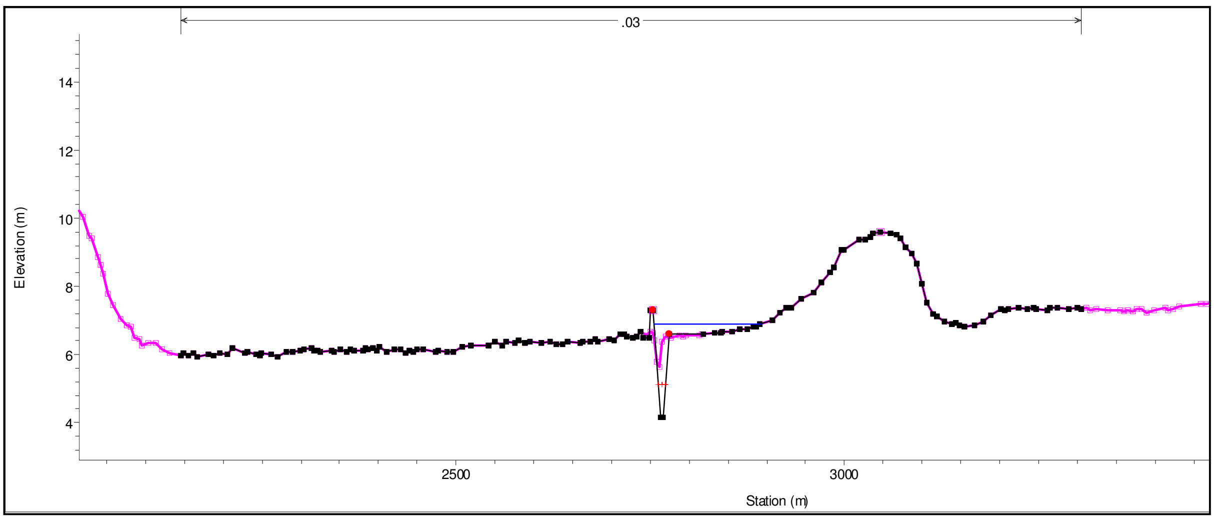

FIGURE 8-4 TARATAP/TILLEY SWAMP SAMPLE CROSS SECTION

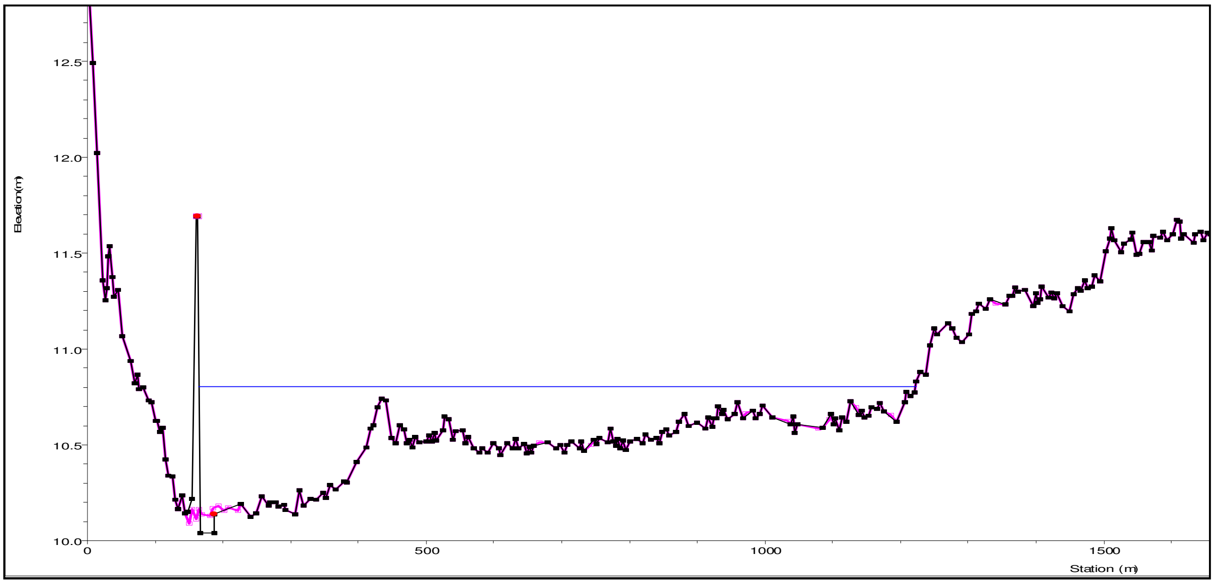

FIGURE 8-5 TARATAP/TILLEY SWAMP SAMPLE CROSS SECTION 2

The Montazeri et al (2011) design and model for Taratap/Tilley Swamp adopted an approach that developed a significantly wider channel than the one developed here based on the above key assumptions. Our approach sought to minimise earthworks and maximised driving head to loss to groundwater.

The resultant design, with the potential for extensive flood outs to the eastern side of the channel under high flow conditions is unlikely to be the final design progressed through the concept and final design stage should Flow Path 02 be progressed.

The design developed here is however considered hydrologically conservative and a reasonable basis on which to progress the water balance modelling at this feasibility stage of the CSLFRP project.

8.3 Floodway Design Basis

The Floodway forms part of Flow Path 03 Floodway and Flow Path 03 Biscuit Floodway. The Floodway reach runs between Blackford Drain on the eastern side of the Southern Ephemeral Lagoons and the third lagoon of the Southern Ephemeral Lagoons.

The general form of the Floodway was similar to Reedy Creek with shallow excavation and raised levee on each side of the flow path.

8.3.1 Key Assumptions in Hydraulic Design

- The downstream boundary condition was assumed to be critical depth.
- Invert of entry point to the third Southern Ephemeral Lagoon is 0.09 mAHD. The sill level of Lagoon 3 is 0.7mAHD. The design therefore assumed that the entry of the Floodway reach into the third SEL will be at 0.7mAHD. This will require a drop structure at the end of the floodway to prevent erosion as the water enters the lagoon.
- The upstream invert level was assumed to be natural surface level (allowing for excavation to win fill for levees). It is understood that it is intended that the water level in Blackford

Drain be backed up, using a wier to provide sufficient water level to cause spill into the Floodway.

- The natural surface of the flow path is undulating. The model by Montazeri et al (2011) allowed for sections of the Floodway channel not to be free draining. That is there were sections in which a shallow depth of water would pool before spilling into the remainder of the flow path. To minimise cut the design developed here also includes limited sections which are not free draining.
- The channel design was coarsely optimised to balance cut and fill where possible. The maximum level height was assumed to be 1.5m including an allowance of 0.4m for free board.

8.3.2 Floodway Design

The resultant design for the Floodway has a base width between 5-70m. The Montazeri et al (2011) design had a base width varying between 40-60m.

Figure 8-6 illustrates the design long section for the Floodway reach. The black line indicates the design channel invert. The Floodway is the only refined channel design that is not free draining. It has a short section in the middle of the reach where water will pool before spilling into the remainder of the reach.

Figure 8-7 Illustrates a typical cross section from the hydraulic model. The pink line is the natural surface level.

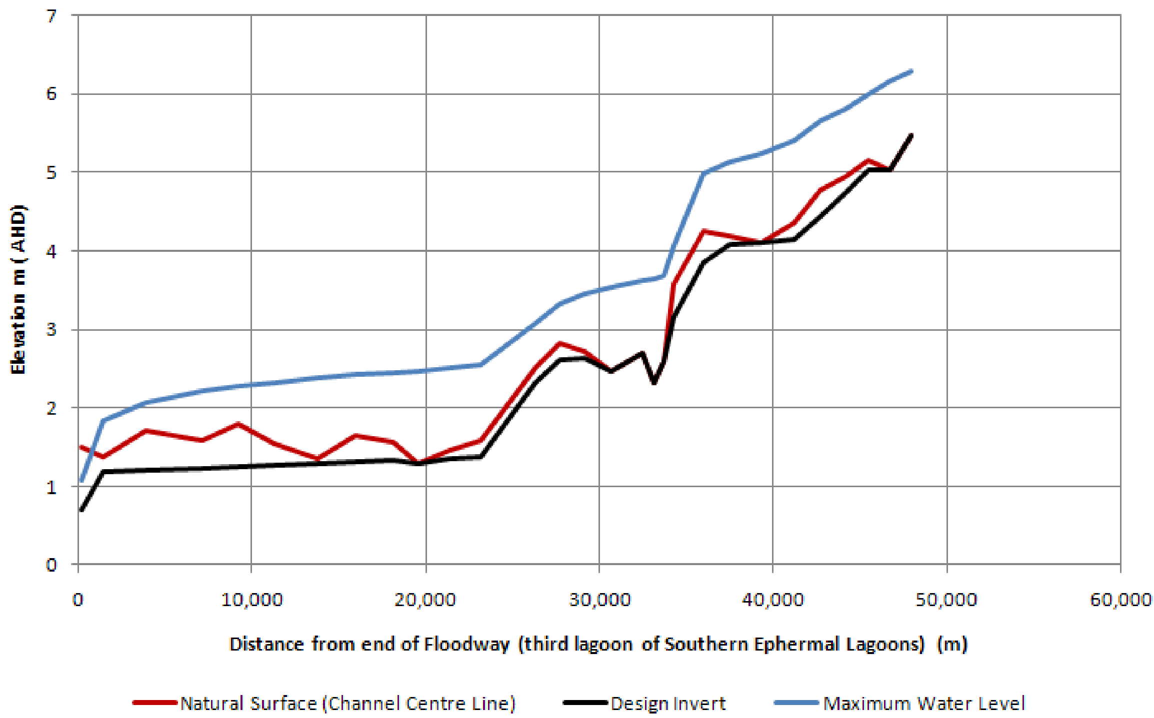

FIGURE 8-6 FLOODWAY DESIGN LONGSECTION

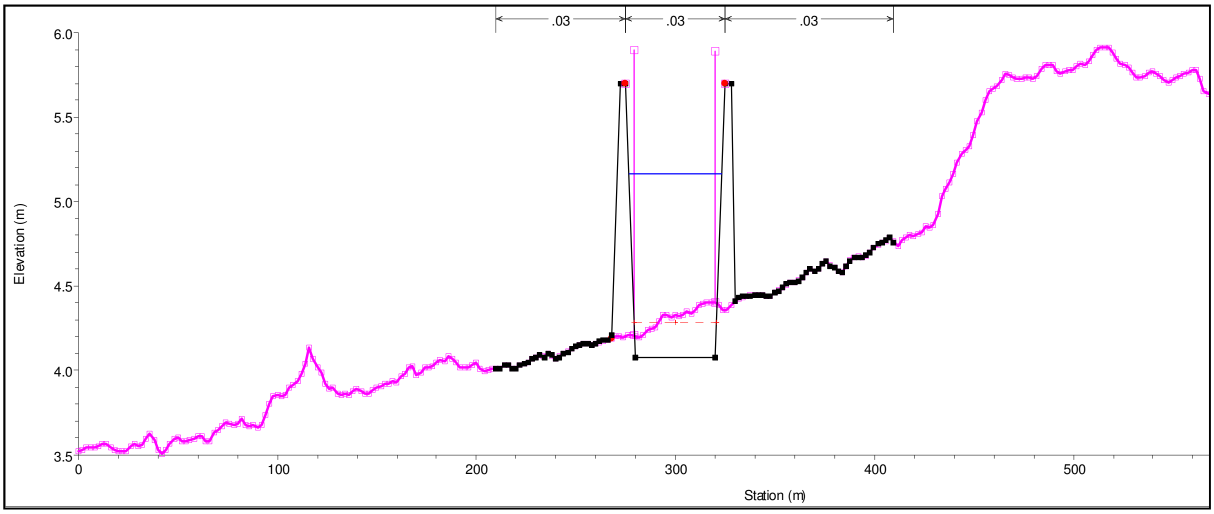

FIGURE 8-7 FLOODWAY DESIGN TYPICAL SECTION

8.4 Data from Design in Transmission Loss Model

The information from the refined hydraulic models was used in the loss to groundwater and water balance models. The following sections detail the assumptions made to do this and the impact of the channel refinement on expected loss to groundwater.

Two loss to groundwater scenarios where assessed. Scenario 7 (the scenario recommended by this work) and Scenario 6 (for comparison). The characteristics of these loss to groundwater scenarios are described in Table 6-2.

8.4.1 Channel Surface Area

The surface area of each reach was determined for each flow rate by determining the average of the flow top width at the up and downstream bounding cross sections and multiplying this by the length of the subreach. The channel surface area is used in the water balance model to determine the loss and gain driven by evaporation and rainfall directly on the water in the flow path.

8.5 Losses from Refined Channels

Channel losses were re-calculated for the sub reaches which were refined including:

- Reedy Creek 1, 2 and 3,
- Floodway,
- Taratap 5 and 6,
- Tilley 7.

Figure 8-8 to Figure 8-10 show the estimated groundwater losses for each flow path based on the refined channel design (blue columns) compared to those predicted using the channel designs of Montazeri et al (2011) The results may not be directly comparable to the graphs shown in Sections 6.5.1 and 6.6 as they contain different segments. Estimated channel losses are the highest for the previous analysis, which uniformly applied "Case 2'. As Figure 8-8 to Figure 8-10 indicates results from Scenario 7 with the refined channels provide the lowest estimates. The figures also indicate for example in the case of Flow Path 02 at 250 ML/d the total potential loss to groundwater possible is approximately 300ML/d less under AWE (2011) analysis in comparison to Montazeri et al (2011). Approximately 20% of this can be attributed to the refinement of the channels in Flow Path 02 (Reedy Creek and Taratap/Tilley Swamp) and approximately 80% of the reduction in loss to groundwater can be attributed to the change in the calculation methodology for loss to groundwater.

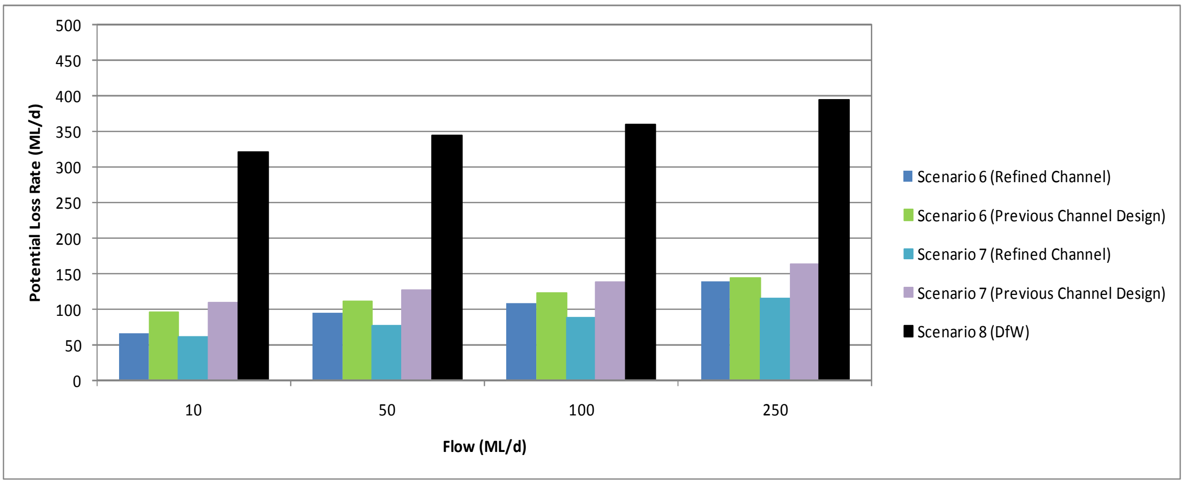

FIGURE 8-8 POTENTIAL LOSS RATE FOR FLOW PATH 02

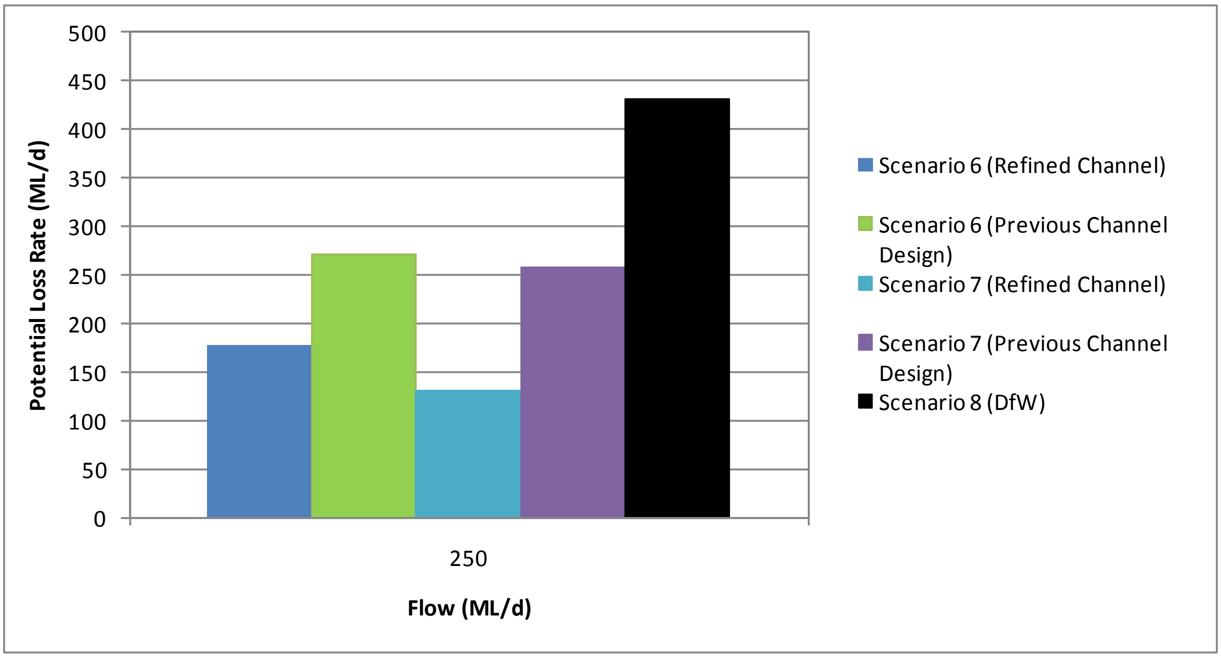

FIGURE 8-9 POTENTIAL LOSS RATE FOR FLOW PATH 03 FLOODWAY DOES NOT INCLUDE EPHEMERAL LAGOONS 3 AND 4 AS DATA ONLY AVAILABLE FOR 1000 AND 1500 ML/D FLOWS)

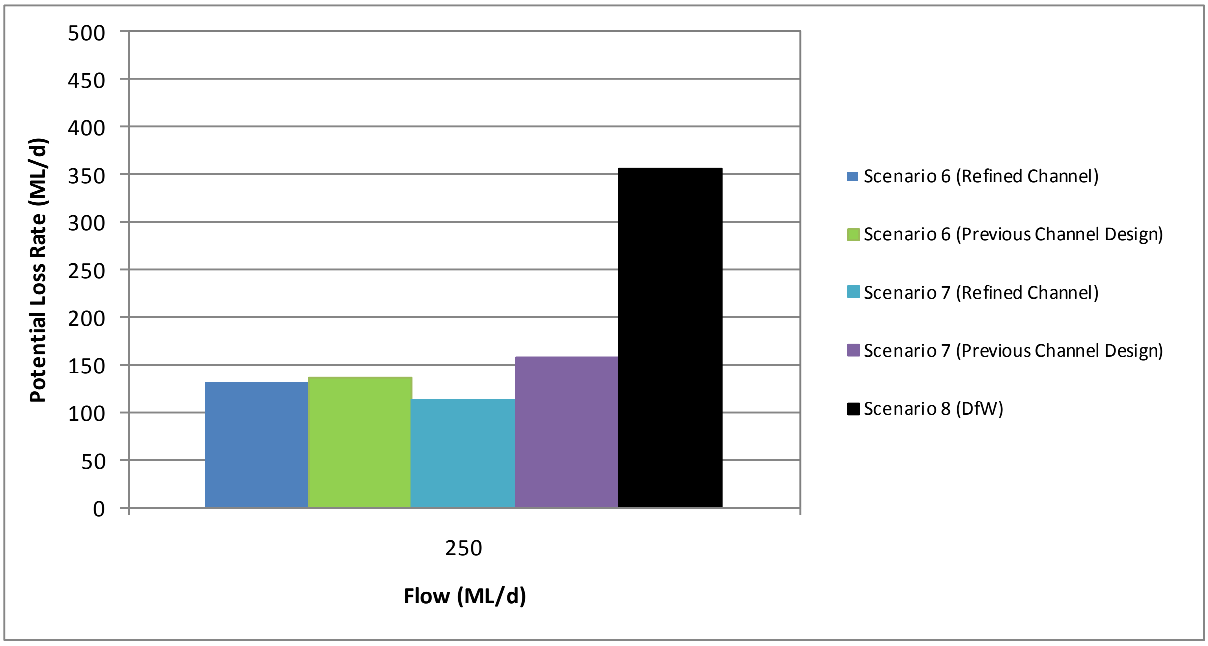

FIGURE 8-10 POTENTIAL LOSS RATE FOR FLOW PATH 03 SELS (DOES NOT INCLUDE LOSSES FROM EPHEMERAL LAGOONS 1 TO 4 AS DATA ONLY AVAILABLE FOR 1000 AND 1500 ML/D FLOWS)

9 Water Balance Analysis Results

The scenarios investigated as part of this more recent work are summarised in Table 9-1.

TABLE 9-1 FLOW PATH SCENARIOS ANALYSED

Flow Path	Climate Scenario(s)	Loss to Groundwater Calculation Methodology
Flow Path 02	Historic + Climate Change Median	Scenario 7
Flow Path 03 SELS	Historic + Clima9te Change Median	Scenario 7
Flow Path 03 Floodway	Historic + Climate Change Median	Scenario 7
Flow Path 03 Biscuit Floodway	Historic + Climate Change Median	Scenario 7
Flow Path 02	Historic	Scenario 6
Flow Path 03 Biscuit Floodway	Historic	Scenario 6

The key differences between the features of the water balance analysis completed by this study and the previous work by Montazeri et al (2011) were:

- The maximum daily diversion at Wilmot Drain was set at 250ML/d;
- The new flow path Flow Path 03 Biscuit Floodway was assessed;
- The addition of the Fairview Drain flows to the Blackford Drain diversion;
- A number of the designs for the flow path channels were refined; and
- The loss to groundwater analysis methodology was reviewed, refined and altered.

The water balance approach used by Montazeri et al (2011) was adopted herein. Where changes were made (as discussed previously) the spreadsheet water balance developed by Montazeri et al (2011) was altered.

9.1 Overall Results

The results for the flow paths using the Scenario 7 loss to groundwater analysis approach, being the preferred approach, are provided in the following sections.

Figure 9-1 summarises the median annual supply to Salt Creek results for the four flow paths. All results include the existing drainage network (EDN) which includes the existing flows into Tilley Swamp from Henry Creek and the S bend.

The analysis assumed that even if a version of Flow Path 03 is pursued the existing flows into Tilley Swamp will still be directed to Salt Creek. Therefore the total flows received at Salt Creek from any of the Flow Path 03 options include both the existing drainage network and the flows that are diverted from drains further south in the proposed scheme.

From these results the flow paths can be ranked based on their median annual supply of flows to Salt Creek under historic conditions in the following way.

1. Flow Path 02
2. Flow Path 03 Biscuit Floodway
3. Flow Path 03 SELS
4. Flow Path 03 Floodway

Under climate change median conditions Flow Path 02 is still the best performing flow path. Under median climate change conditions the volume of water delivered in a median year to Salt Creek would range between 51-38.2 GL/a depending on the flow path.

The reduction in flows due to climate change varies between 33% for Flow Path 02 and 42% for Flow Path 03 SELS.

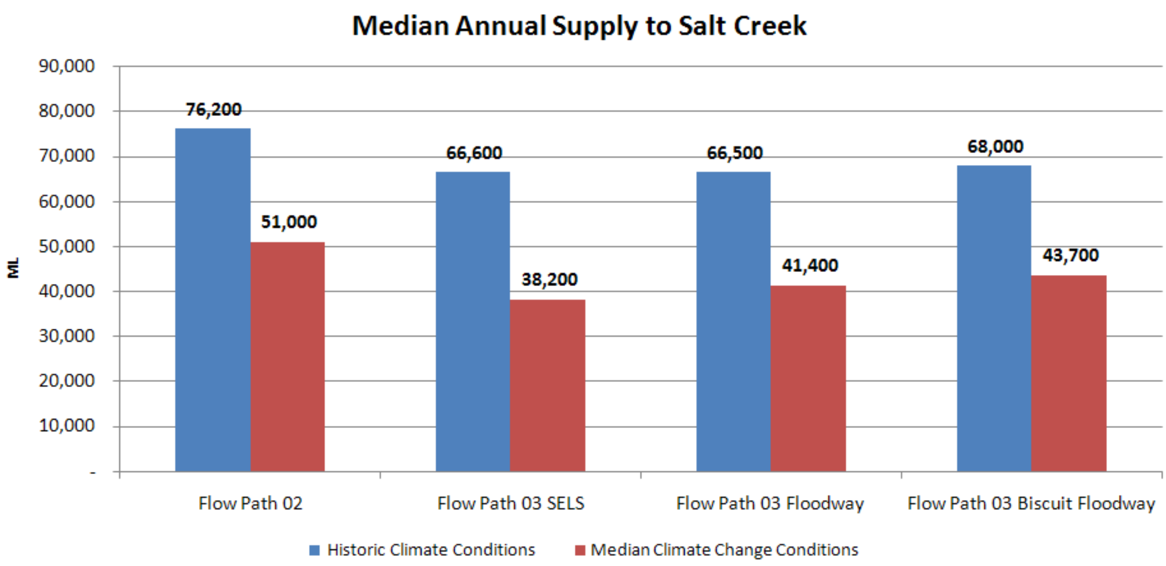

FIGURE 9-1 MEDIAN ANNUAL VOLUME AT SALT CREEK

9.2 Staged Delivery Results

Table 9-2 provides a summary of the mean and median annual volumes supplied to Salt Creek from each flow path. It also provides results on the delivery to Salt Creek assuming the project is built using a staged approach. I.e. the scheme components are built to a size assuming all four diversion points will eventually be connected but built in a staged approach.

This table also provides some indication of the proportional benefit of extending the scheme further south. The assessment of this proportional additional benefit is limited because for all scenarios with less than all four diversion points contributing, the downstream channel segments are essentially oversized.

If each smaller scheme (say EDN + Blackford) were designed and modelled explicitly a more robust analysis of the transmission losses could be completed and more confidence could be placed in the comparison between the cost and benefit of extending the scheme further south.

Never the less the analysis of Flow Path 02 under historic climate conditions shows that the addition of the Blackford Drain to the EDN would add an extra 26.5 GL/a in a median year. The further addition of flows from Drain L/K would add another 10.6 GL/a, the addition of Wilmot Drain would add another 9.4 GL/a in a median year extending the scheme to Drain M would provide very limited benefit.

TABLE 9-2 FLOWS DELIVERED TO SALT CREEK

Historic Climate Condition	**Flow Path 02**		**Flow Path 03 SELS**		**Flow Path 03 Floodway**		**Flow Path 03 Biscuit Floodway**	
Diversions	Median (ML/a)	Mean (ML/a)	Median (ML/a)	Mean (ML/a)	Median (ML/a)	Mean (ML/a)	Median (ML/a)	Mean (ML/a)
Existing Drainage Network (EDN)	29,700	29,500	29,700	29,500	29,700	29,500	29,700	29,500
EDN + BF	56,200	53,200	45,400	44,100	47,100	44,600	47,200	44,700
EDN + BF + K	66,800	60,800	55,300	51,200	56,900	51,700	60,000	54,600
EDN + BF + K + W	76,200	69,900	66,500	59,600	66,400	60,300	67,900	63,900
EDN + BF + K + W + M	76,200	72,900	66,600	62,600	66,500	63,400	68,000	67,200

Climate Change Median	**Flow Path 02**		**Flow Path 03 SELS**		**Flow Path 03 Floodway**		**Flow Path 03 Biscuit Floodway**	
Diversions	Median (ML/a)	Mean (ML/a)	Median (ML/a)	Mean (ML/a)	Median (ML/a)	Mean (ML/a)	Median (ML/a)	Mean (ML/a)
Existing Drainage Network (EDN)	20,600	20,700	20,600	20,700	20,600	20,700	20,600	20,700
EDN + BF	41,600	39,500	29,700	30,200	32,500	31,400	32,500	31,400
EDN + BF + K	45,400	43,600	33,100	34,100	36,300	35,200	38,000	37,200
EDN + BF + K + W	51,000	49,600	38,200	39,800	41,300	41,000	43,700	43,900
EDN + BF + K + W + M	51,000	51,700	38,200	41,700	41,400	43,100	43,700	46,200

END= Existing Drainage Network, BF= Blackford Drain , K= Drain L/K, W= Wilmot Drain, M= Drain M

9.3 Annual Exceedance

Table 9-3 and Table 9-4 describe the likelihood of different annual flow volumes at Salt Creek occurring. Both tables include the existing drainage network for the 3 different versions of Flow Path 03. Figure 9-2 and Table 1-1 display the same information in a graphical format.

Annual exceedance probability can be interpreted as a measure of reliability. An annual exceedance probability of 80% for a flow of 22GL/a can be interpreted as an 80% chance each year that a flow equal to or greater than 22GL/a will occur.

TABLE 9-3 ANNUAL EXCEEDANCE TABLE HISTORIC CLIMATE CONDITIONS

Flow Path	Historic Climate Condition		
Flow Path 02 Historic	Volume (>ML)	No. Years	Frequency in 10 years
	15000	27	9
	30000	21	7
	45000	20	7
	60000	17	6
	75000	15	5
	90000	11	4
Flow Path 03 SELS + EDN Historic	Volume (>ML)	No. Years	Frequency in 10 years
	15000	25	8
	30000	25	8
	45000	21	7
	60000	16	5
	75000	13	4
	90000	5	2
Flow Path 03 Floodway + EDN Historic	Volume (>ML)	No. Years	Frequency in 10 years
	15000	27	9
	30000	25	9
	45000	21	7
	60000	16	6
	75000	13	5
	90000	6	2
Flow Path 03 Biscuit Floodway + EDN Historic	Volume (>ML)	No. Years	Frequency in 10 years
	15000	27	9
	30000	25	9
	45000	21	7
	60000	16	6
	75000	13	5
	90000	8	3

TABLE 9-4 ANNUAL EXCEEDANCE TABLE CLIMATE CHANGE MEDIAN CONDITIONS

Flow Path	Climate Change Median		
Flow Path 02 + EDN CCM	Volume (>ML)	No. Years	Frequency in 10 years
	15000	24	8
	30000	19	7
	45000	17	6
	60000	11	4
	75000	9	3
	90000	5	2
Flow Path 03 SELS + EDN CCM	Volume (>ML)	No. Years	Frequency in 10 years
	15000	21	7
	30000	17	6
	45000	12	4
	60000	9	3
	75000	5	2
	90000	3	1
Flow Path 03 Floodway + EDN CCM	Volume (>ML)	No. Years	Frequency in 10 years
	15000	21	7
	30000	17	6
	45000	13	5
	60000	10	4
	75000	5	2
	90000	3	1
Flow Path 03 Biscuit Floodway + EDN CCM	Volume (>ML)	No. Years	Frequency in 10 years
	15000	21	7
	30000	17	6
	45000	15	5
	60000	10	4
	75000	7	3
	90000	5	2

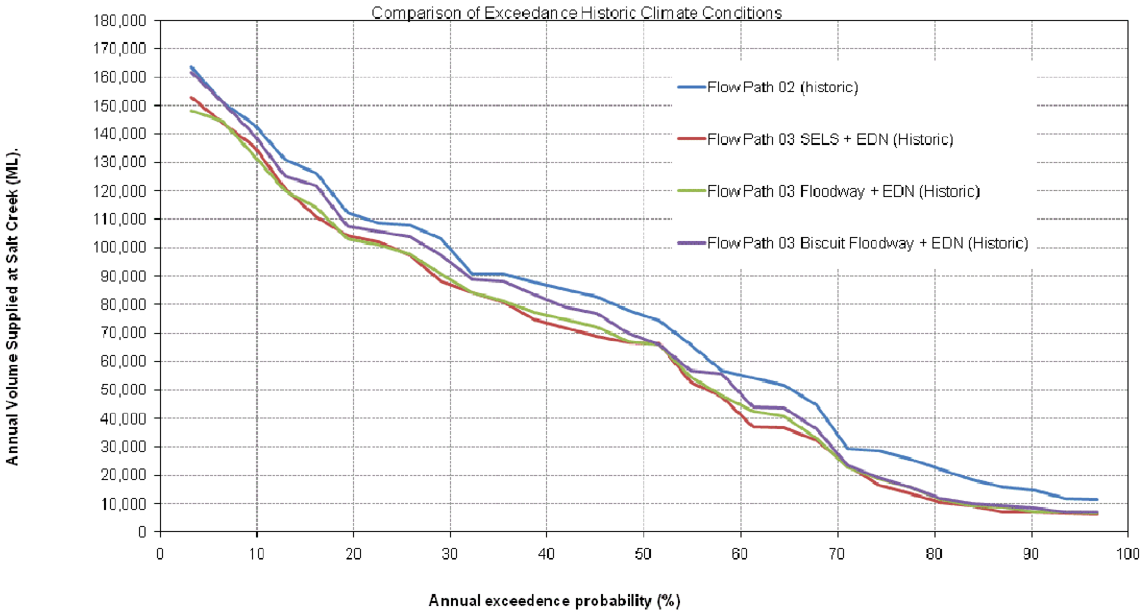

FIGURE 9-2 COMPARISON OF ANNUAL EXCEEDANCE PROBABILITY (HISTORIC CLIMATE CONDITIONS)

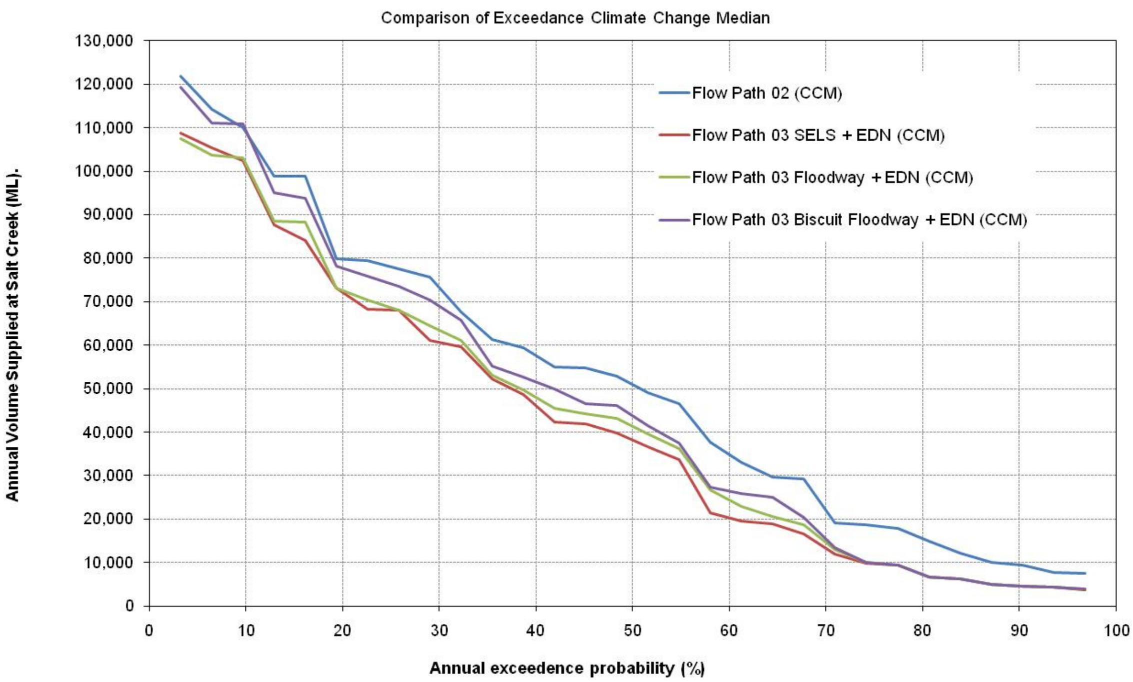

FIGURE 9-3 COMPARISON OF ANNUAL EXCEEDANCE (CLIMATE CHANGE MEDIAN CONDITIONS)

From the annual exceedance tables and graphs we can see that Flow Path 02 is more reliable than the other three options in dry years (when flows are low) though there is not a marked difference in the shape of the curves for each flow path.

Under historic conditions for 80% of years Flow Path 02 should supply at least 22GL/a to Salt Creek whereas the best of the other Flow Path 03 options is expected to supply at least 11.7GL/a. Hence in drier years Flow Path 02 could be expected to supply almost twice the volume of flow to the Coorong as the next best performing flow path.

Annual exceedance curves for the stage delivery scenarios summarised in Table 9-2 are provided in Appendix B.

9.4 Components of Loss and Gain

For each flow path the transmission loss and gain components were calculated. The volumes contributed from the diversion points (Drain M, Drain L/K and Wilmot) are not represented. The contribution from Blackford Drain is represented as a local catchment contribution (BF- TT). Rainfall Deficit is the sum of the impact of both rainfall and evaporation on the water surface within the flow path. Where rainfall deficit is negative the water loss to evaporation exceeds the water gained from rainfall directly on the water surface within the flow path.

Table 9-5 to Table 9-11 and Figure 9-4 to Figure 9-12 provide average annual contributions from local catchment contributions, loss to groundwater and rainfall deficit.

It is clear from the components of loss analysis that the contribution of the existing drainage network makes a significant contribution to the flow path. The loss to groundwater through the third section of Reedy Creek (K- BF) is the most significant contributor to loss along the flow path.

The floodway has significant losses to groundwater in comparison to other subreaches. In comparison, the SELs have greater losses due to evaporation.

Under climate change median conditions there is a general reduction in local catchment contributions. The rainfall deficit is generally more negative due to a reduction in rainfall. In cases where there appears to be an increase in rainfall deficit (positive- e.g. sub reach K- BF Flow Path 02) this is due to a reduction in the water available within the flow path on which evaporation can act. Losses to groundwater tend to be reduced under climate change median conditions. This is again because there is less water to which the losses are applied and due to the lower driving head in the channels.

TABLE 9-5 COMPONENTS OF LOSS AND GAIN - FLOW PATH 02 (HISTORIC)

Reach	M-Wilmot	Wilmot-K	K-BF	BF-TT	TT-TS	TS-SC
local catchment contribution, ML/a	0	0	5,205	22,246	1,535	29,338
Rainfall Deficit, ML/a	-8	15	-50	-17	363	103
Δ GW, ML/a	-618	-23	-10,920	-2	-548	-718

Where the columns represent the following sub reaches: M- Wilmot (Reedy Creek), Wilmot-K (Reedy Creek), Drain L/K- Blackford (Reedy Creek), Blackford- Taratap (Blackford), Taratap- Tilley Swamp (Taratap), Tilley Swamp- Salt Creek (Tilley Swamp and Morella).

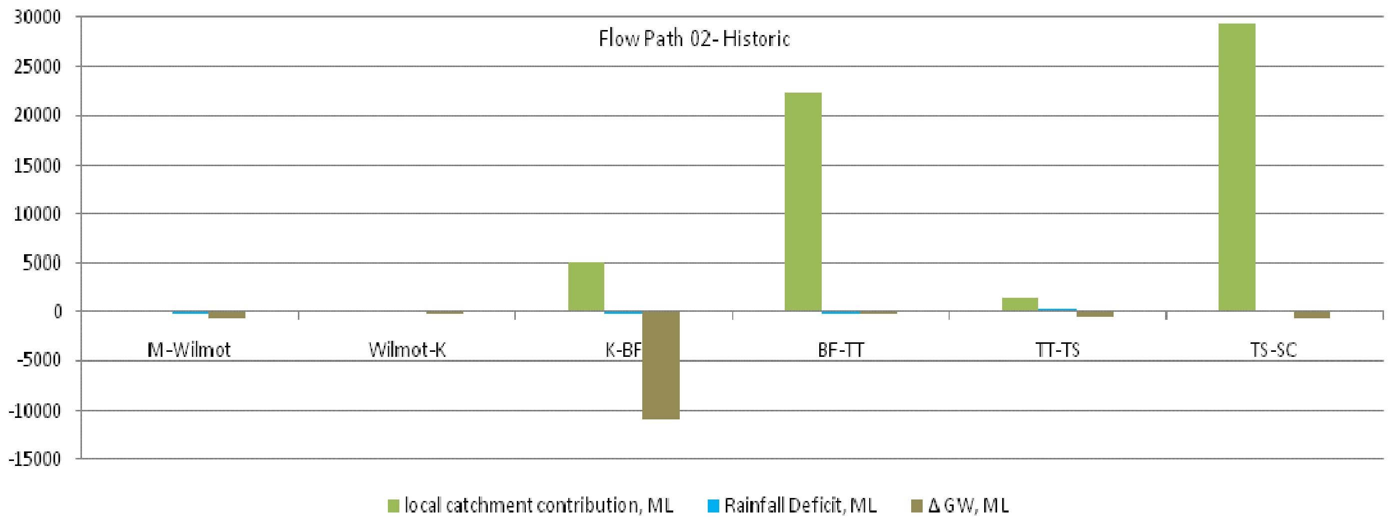

FIGURE 9-4 COMPONENTS OF LOSS AND GAIN - FLOW PATH 02 (HISTORIC)

FIGURE 9-5 COMPONENTS OF LOSS AND GAIN - FLOW PATH 03 FLOODWAY (HISTORIC)

Reach	M-Wilmot	Wilmot-K	K-BF	BF	Floodway	Lagoon 3	Lagoon 4	Existing Drainage Network
local catchment contribution, ML/a	0	0	5,205	23,892	0	309	329	29,500
Rainfall Deficit, ML/a	-8	15	-50	-81	-903	-2,102	-1,094	0
Δ GW, ML/a	-618	-23	-10,920	-593	-6,038	-456	-64	0

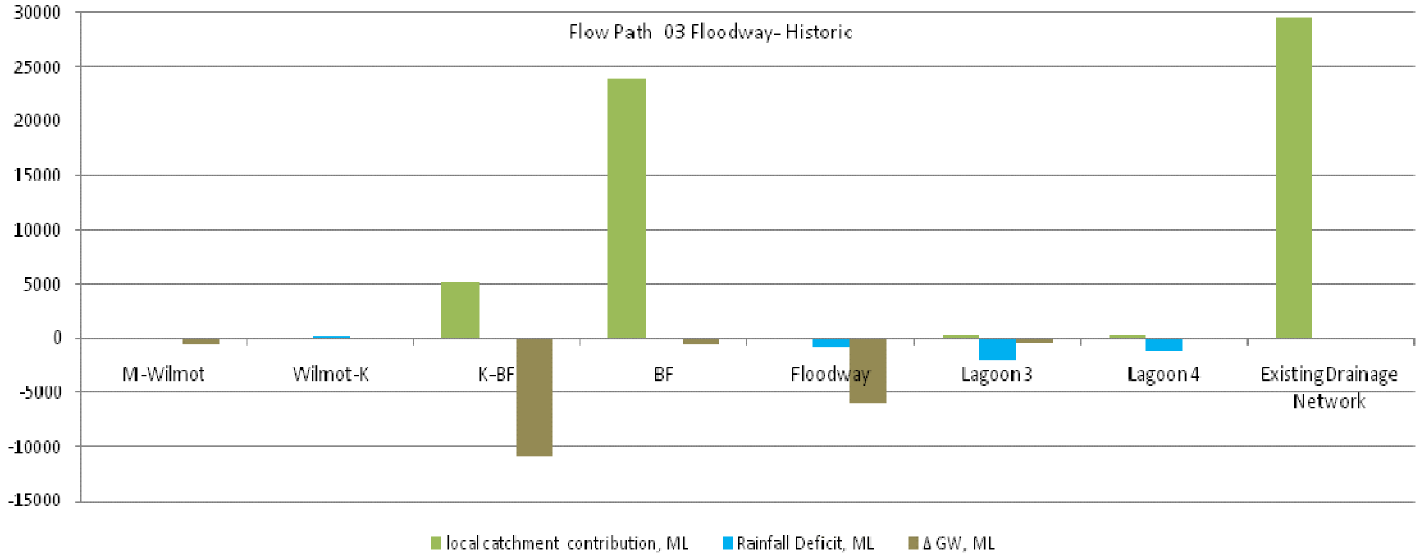

FIGURE 9-6 COMPONENTS OF LOSS AND GAIN -FLOW PATH 03 FLOODWAY (HISTORIC)

TABLE 9-6 COMPONENTS OF LOSS AND GAIN- FLOW PATH 03 SELS (HISTORIC)

Reach	M-Wilmot	Wilmot-K	K-BF	BF	Lagoon1	Lagoon2	Lagoon3	Lagoon4	Existing Drainage Network
local catchment contribution, ML/a	0	0	5,205	25,541	842	1,380	309	329	29,500
Rainfall Deficit, ML/a	-8	15	-50	-81	-1,464	-5,461	-3,885	-1,017	0
Δ GW, ML/a	-618	-23	-10,920	-593	-239	-1,518	282	139	0

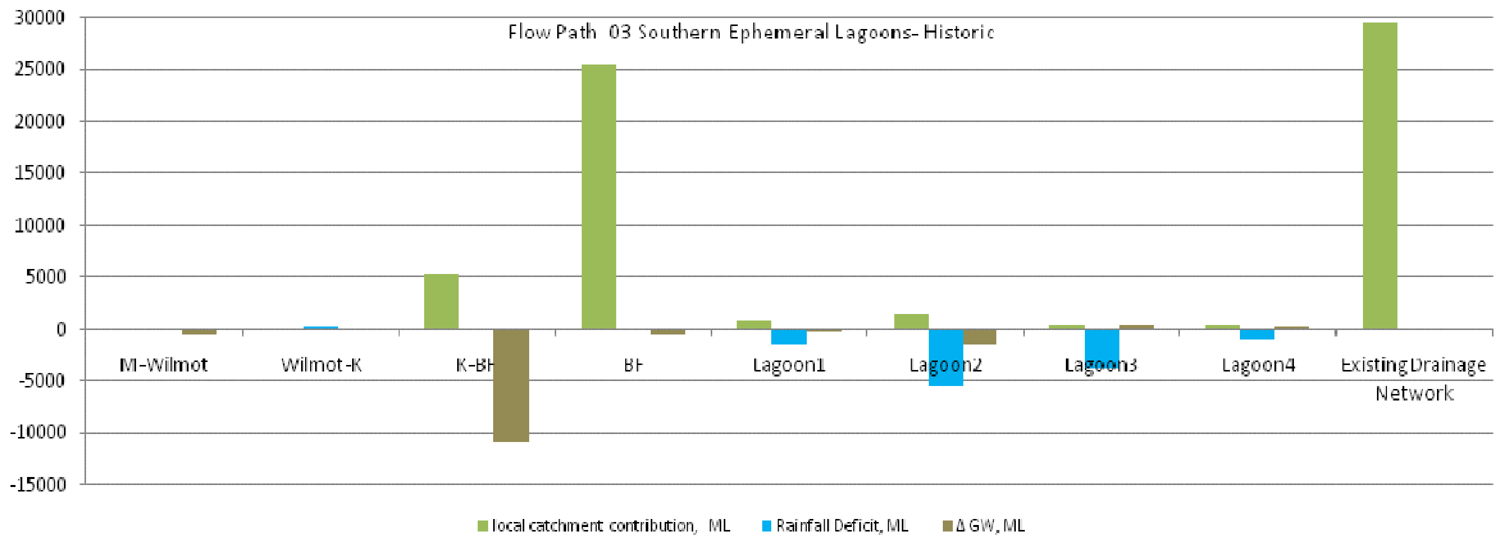

FIGURE 9-7 COMPONENTS OF LOSS AND GAIN - FLOW PATH 03 SELS (HISTORIC)

TABLE 9-7 COMPONENTS OF LOSS AND GAIN - FLOW PATH 03 BISCUIT FLOODWAY (HISTORIC)

Reach	M-Wilmot	Wilmot-K	Drain L	Biscuit	Blackford	Floodway	Lagoon 3	Lagoon4	Existing Drainage Network
local catchment contribution, ML/a	0	0	0	4,857	23,513	0	309	329	29,500
Rainfall Deficit, ML/a	-8	15	0	-95	-16	-918	-2,131	-1,132	0
Δ GW, ML/a	-618	-23	-1,291	-5,164	-444	-5,979	-477	-111	0

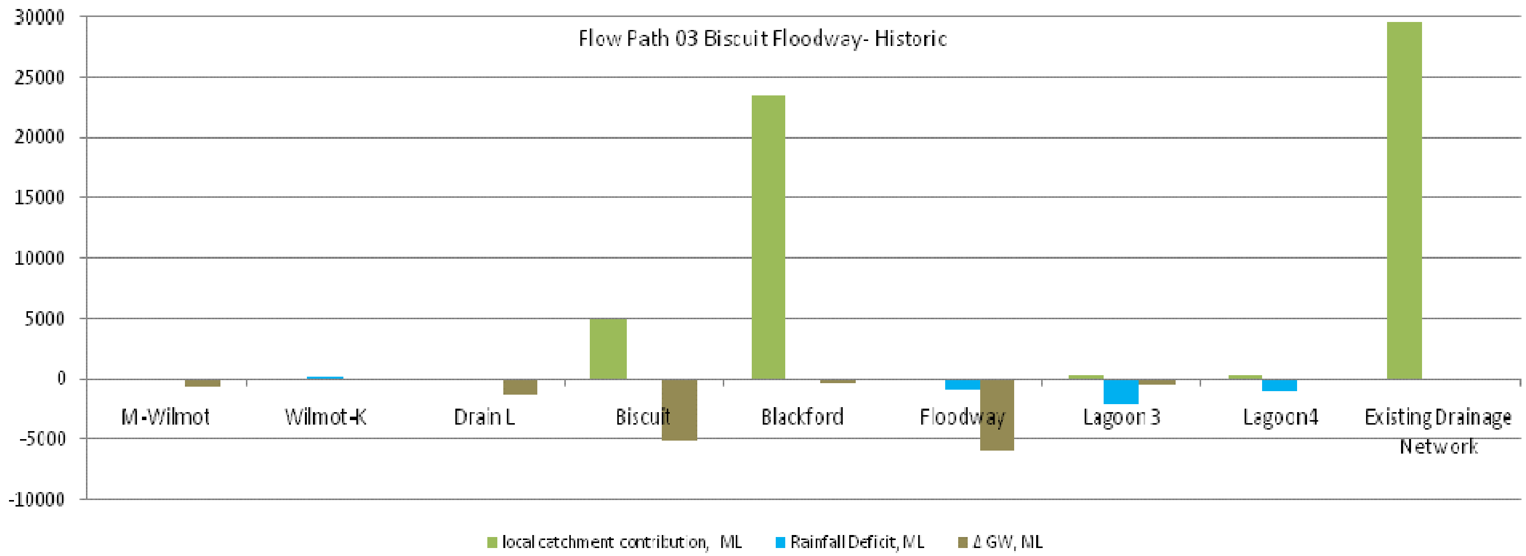

FIGURE 9-8 COMPONENTS OF LOSS AND GAIN - FLOW PATH 03 BISCUIT FLOODWAY (HISTORIC)

TABLE 9-8 COMPONENTS OF LOSS AND GAIN -FLOW PATH 02 (CLIMATE CHANGE MEDIAN)

Reach	M-Wilmot	Wilmot-K	K-BF	BF-TT	TT-TS	TS-SC
local catchment contribution, ML/a	0	0	3,902	19,118	1,191	22,736
Rainfall Deficit, ML/a	-9	14	-10	-18	76	-2,468
Δ GW, ML/a	-419	-21	-8,874	-2	-469	-694

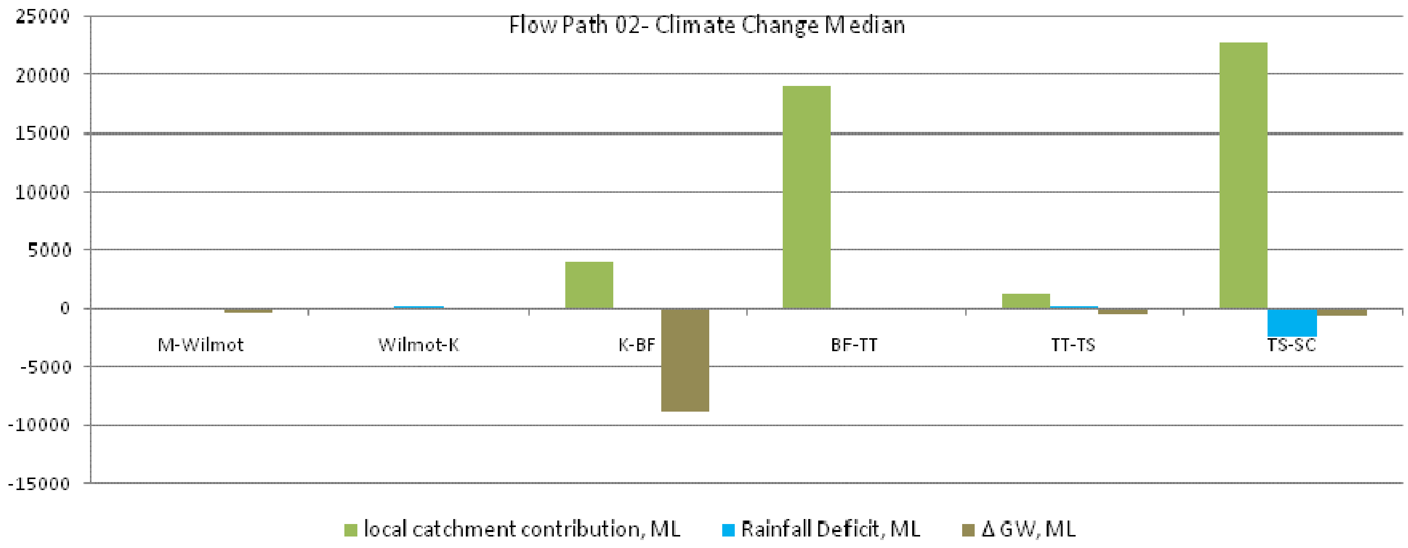

FIGURE 9-9 COMPONENTS OF LOSS AND GAIN - FLOW PATH 02 (CLIMATE CHANGE MEDIAN)

TABLE 9-9 COMPONENTS OF LOSS AND GAIN - FLOW PATH 03 FLOODWAY

Reach	M-Wilmot	Wilmot-K	K-BF	BF	Floodway	Lagoon 3	Lagoon 4	Existing Drainage Network
local catchment contribution, ML/a	0	0	3,902	20,398	0	208	222	20,700
Rainfall Deficit, ML/a	-9	14	-10	-85	-880	-2,159	-1,060	0
Δ GW, ML/a	-419	-21	-8,874	-476	-5,660	-429	36	0

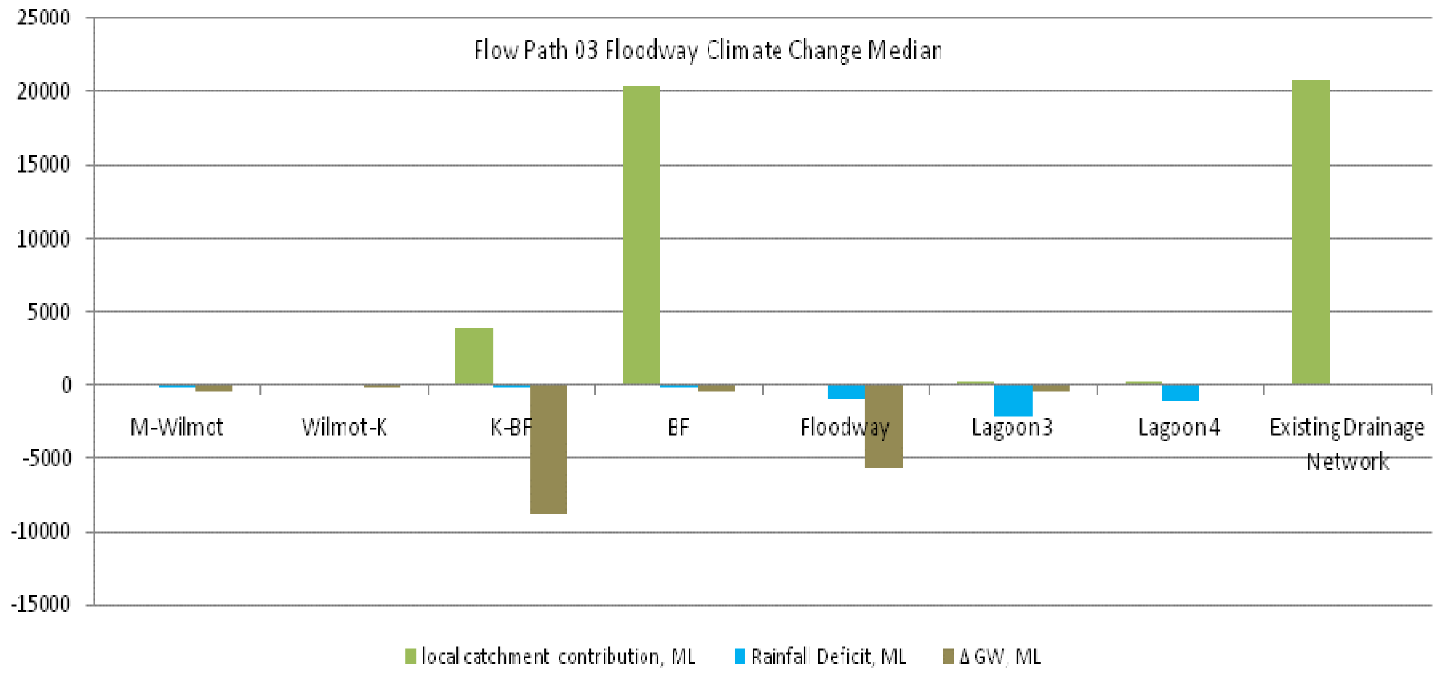

FIGURE 9-10 COMPONENTS OF LOSS AND GAIN - FLOW PATH 03 FLOODWAY (CLIMATE CHANGE MEDIAN)

TABLE 9-10 COMPONENTS OF LOSS AND GAIN- FLOW PATH 03 SELS (CLIMATE CHANGE MEDIAN)

Reach	M-Wilmot	Wilmot-K	K-BF	BF	Lagoon1	Lagoon2	Lagoon3	Lagoon4	Existing Drainage Network
local catchment contribution, ML	0	0	3902	20398	563	923	208	222	20700
Rainfall Deficit, ML	-9	14	-10	-85	-1523	-5760	-3759	-1019	0
Δ GW, ML	-419	-21	-8874	-476	-273	-1186	395	169	0

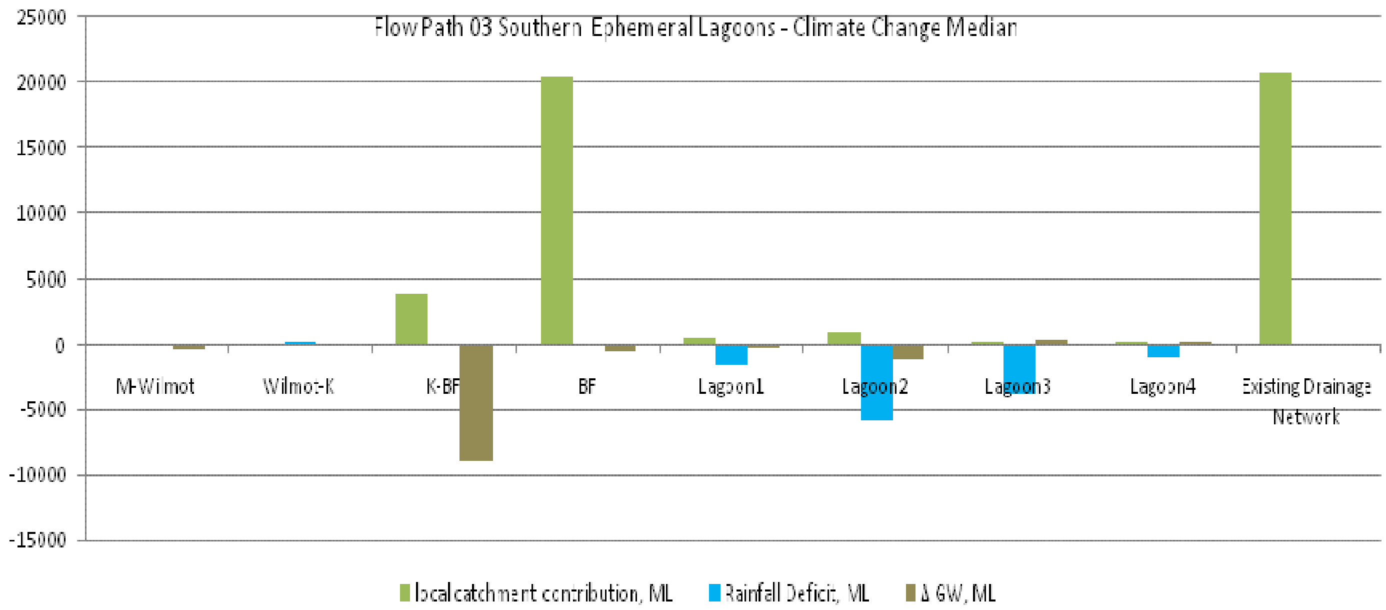

FIGURE 9-11 COMPONENTS OF LOSS AND GAIN - FLOW PATH 03 SELS (CLIMATE CHANGE MEDIAN)

TABLE 9-11 COMPONENTS OF LOSS AND GAIN- FLOW PATH 03 BISCUIT FLOODWAY

Reach	M-Wilmot	Wilmot-K	Drain L	Biscuit	Blackford	Floodway	Lagoon 3	Lagoon 4	Existing Drainage Network
local catchment contribution, ML	0	0	0	3377	20172	0	208	222	20700
Rainfall Deficit, ML	-9	14	1	-43	-18	-898	-2177	-1089	0
Δ GW, ML	-419	-21	-1053	-4080	-322	-5612	-439	3	0

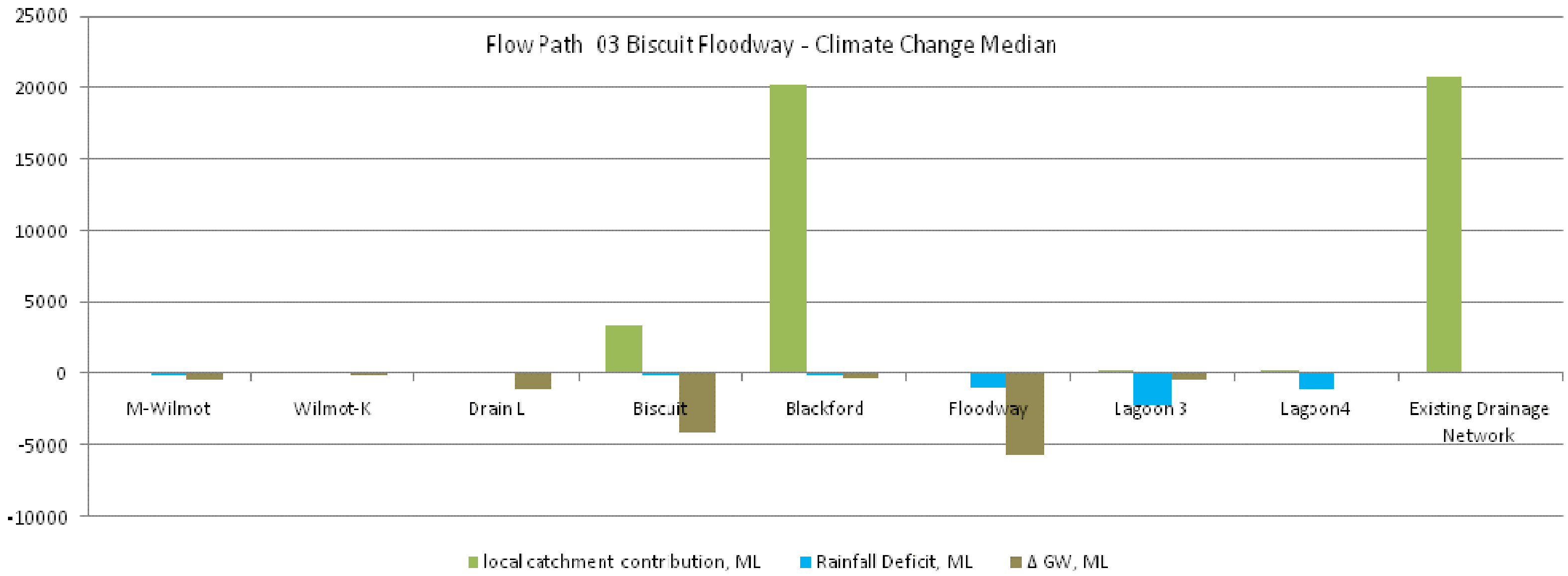

FIGURE 9-12 COMPONENTS OF LOSS AND GAIN - FLOW PATH 03 BISCUIT FLOODWAY (CLIMATE CHANGE MEDIAN)

9.5 Overall Results-Comparison of Changing Loss to Groundwater Assumptions.

The resultant flow at Salt Creek for Flow Path 03 and Flow Path 03 Biscuit Floodway was analysed using two different approaches to calculating loss to groundwater. The two scenarios were Scenario 6 and the preferred Scenario 7. The characteristics of these scenarios is summarised in the Table 9-12.

The two scenarios were considered to provide further quantification of the magnitude of the uncertainty regarding calculation of loss to groundwater on the supply to Salt Creek estimates.

The key difference between the scenarios is the assumption of the zone of influence. The preferred scenario (number 7) assumes the hydrogeological characteristics drive the length of the variable L. Scenario 6 uses a fixed L (250m) which is consistent with the approach taken to L by Montazeri et al (2011) and AWE (2009).

TABLE 9-12: SCENARIOS USED FOR SEEPAGE LOSS CALCULATIONS

Scenario	Aquifer K (m/d)	Seepage Loss Method*	Zone of Influence (L)
6	8	123	250 m
7	8	123	Variable with physical properties

***REFERS TO THE 'SCENARIOS' OF MORGAN ET AL. (2011). 123=VARIABLE, 2= THE MINIMUM OF 2 OR 3 USED.**

Figure 9-13 illustrates the difference in median annual volume at Salt Creek under the two different loss to groundwater approaches (assuming historic climate conditions). Under historic climate conditions the volume of water supplied to Salt Creek is reduced by 2.5GL/a in a median year when the analysis is completed using Scenario 6. The difference is more marked when considering Flow Path 03 Biscuit Floodway with a reduction in median annual flows of 8GL/a.

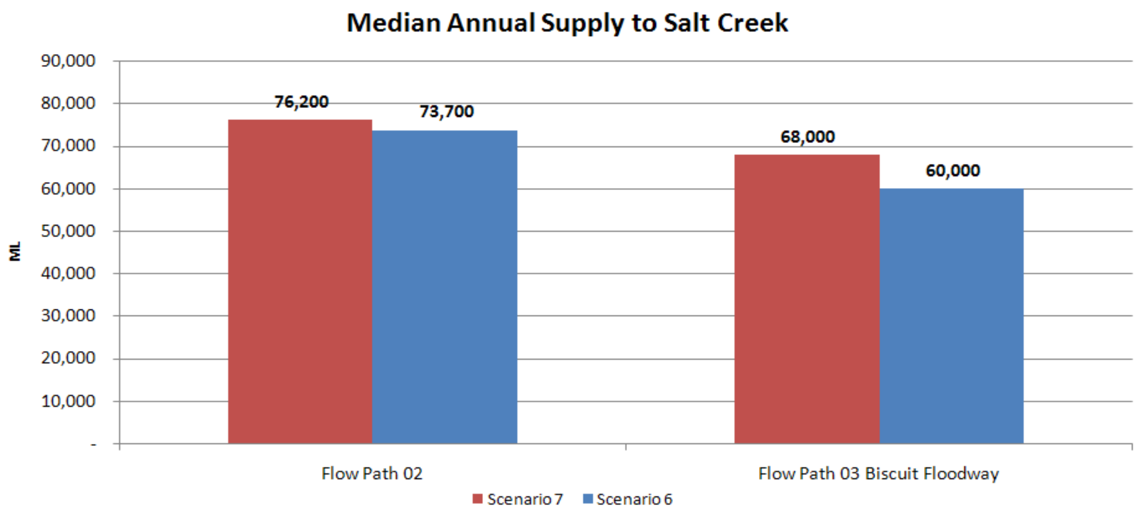

FIGURE 9-13 COMPARISON OF SCENARIO 6 AND SCENARIO 7 RESULTS AT SALT CREEK

Stage delivery, annual exceedance and components of loss and gain results for the scenario 6 results are provided in Appendix C.

10 Discussion of Results

10.1 Comparison with Montazeri et al (2011)

A number of changes to the calculation of the yield at Salt Creek have been made in this work in comparison to the Montazeri et al (2011). These differences are summarised in Section 9.

Table 10-1 summarises the difference between the results at Salt Creek from this study and those of Montazeri et al (2011)

TABLE 10-1 AVERAGE ANNUAL YIELD AT SALT CREEK

Flow Path	Montazeri et al (2011)	This study	% Difference
Flow Path 02	49,406	72,900	48%
Flow Path 03 Floodway	40,664	63,400	56%
Flow Path 03 SELS	43,937	62,600	42%

For Flow Path 02 (Historic) approximately 35% of the difference in results can be attributed to additional flows into the scheme from Fairview Drain (via Blackford Drain). There is also a difference in the volume of inflows into the scheme from Drain M, with an increase in flows of approximately 1000 ML/a. The reduction in contributions from Wilmot Drain due to the change in maximum daily diversion from 500ML/s t o 250 ML/a also reduces inflows into the scheme by approximately 2000 ML/a.

The majority of the difference between the two studies is a result of the change in loss to groundwater due to a change in calculation methodology. The refinement of the channels also effects the potential loss to groundwater. Analysis in Section 8.5 found that 20% of the change in total potential loss to groundwater was as a result of the refinement of the channel design. The remaining 80% of the change in loss to groundwater was due to adoption of an alternate calculation method.

There was a small change in the contribution of rainfall deficit to transmission loss between the two studies. The reach with the greatest magnitude of change was in Taratap and Tilley Swamp.

The revised design for Tilley Swamp has a water surface area which increases by a factor of 27 between a flow rate of 250 ML/d to 1000ML/d. In the Montazeri et al (2011) work model the surface area was more or less constant at 190 ha for all flow rates. This is due to the use of a narrow channel for low flows and the spread of flows to the east across the adjacent low lying area during higher flow under the refined channel design in this most recent work.

The rainfall deficit is more likely to be positive under the AWE (2011) analysis than the Monatzeri et al (2011) approach in Tilley and Taratap swamps due to the form of the revised channel design and the construction of the water balance which makes no allowance for travel time.

When there is high rainfall on the local catchment and the flow path, there is also high runoff from the diversion points. The model assumes that high flow rates from say Drain M will reach Tilley swamp on the same day that the same storm is over Tilley swamp local catchment. In Taratap and Tilley swamps where in high flows the water spills into the low lying land to the east of the main channel, this high rainfall from the storm impacts the large surface area causing a large positive rainfall deficit. Overestimates associated with this assumption is likely to be small provided the duration of diversion is not short (days) or provided that diversions are not frequently started and stopped from one day to the next.

If the surface area of the flow path was constant during the year then the rainfall deficit would always be negative as annual potential evaporation far outweighs rainfall, however in the water balance model the surface area of the flow path is more likely to be larger when the rainfall deficit is positive, therefore the annual contribution from rainfall/evaporation has greater potential to be positive under the AWE (2011) work than in Montazeri et al (2001).

When the flows in Taratap and Tilley swamps are low the rainfall deficit in the both cases is similar as the surface area is within a similar order of magnitude.

10.2 Comparison of Flow Paths

Flow Path 02 provides the greatest yield to Salt Creek in a median year. Flow Path 02 is also expected to supply greater yield during drier years than the Flow Path 03 options. Flow Path 02 is expected to provide greater than 60 GL/a in 4 out of 10 years (Historic Conditions).

Flow Path 03 Biscuit Floodway provides the next greatest median annual yield, in comparison to the other Flow Path 03 options. This is due to the reduction in losses to groundwater expected through the use of Biscuit Flat rather than the third section of Reedy Creek as a flow path.

The benefit in using Biscuit Flat rather than Reedy Creek (3) may become less pronounced if the hydraulic and hydrogeological analysis of the Reedy Creek (3) reach were completed at higher resolution.

The Montazeri et al (2011) results indicate that the Flow Path 03 Floodway is a poorer performer than Flow Path 03 SELS. In the AWE analysis this is reversed (though by a small margin).

In terms of the overall volume of water supplied at Salt Creek the Flow Path 03 Floodway and Flow Path 03 SELS perform similarly. The floodway has significant loss to groundwater however the evaporative losses in the southern ephemeral lagoons are significant. The floodway has no natural catchment, whereas the lagoons do.

10.3 Climate Change

Climate change conditions reduce yield for all flow paths. The greatest reduction in yield is for the Flow Path 03 SELS due to the high evaporative losses that will occur in the large open waterbodies of the southern ephemeral lagoons.

10.4 Stage Delivery Results

The staged delivery results indicate the volume of water expected if the scheme were designed for all four diversion points but was constructed in stages. The results also provide an initial indication of the benefit of extending the scheme to all four diversion points, finding that extension of the scheme to Drain M will offer no additional flow in a median year. Further analysis taking into account the smaller flow path capacity required if the scheme is not built for all four diversion points will be required to confirm this.

10.5 Transmission Loss

The local catchment contributions and the loss to groundwater are the two most important factors in the transmission loss along the flow paths.

10.6 Uncertainty

The analysis completed by Montazeri et al (2011) and this study was intended to provide information on the overall feasibility of providing flows to the southern lagoon or Coorong. As such the hydraulic design was completed with limited detail. Other key uncertainties are the loss to groundwater expected along the flow path and the local catchment contribution from Biscuit Flat.

The loss to groundwater provides the largest magnitude of uncertainty in the estimate of yield expected at Salt Creek. A difference in yield of 8 GL/a (median year) was found when comparing the results at Salt Creek when using one alternate calculation method for loss to groundwater (Scenario 6 vs Scenario 7). The difference in the methodology for calculating loss to groundwater between the work of Montazeri et al (2011) and this study results in a difference in average annual yield of in the order of 12 GL/a.

10.7 Recommended Refinements

This work has lead to a number of refinements to the assessment process and should provide greater clarity for ranking options based on their hydrological performance. Not with standing this there are a number of areas which are considered worthy of further evaluation as part of the design phase once a preferred diversion route has been selected. These are:

1. The Watercress models, developed to inform the water balance modelling of the scheme, be further refined during concept design of the preferred option.
2. The hydraulic modelling will also need to be further refined to take into account site constraints and the preferred design diversion and outlet infrastructure.
3. If the Reedy Creek reach is part of the selected flow path the water balance modelling and in particular the estimates of seepage losses should be refined.
4. Additional measurement of local scale hydrologeological characteristics should be completed to improve the robustness of the loss to groundwater estimates.

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Appendix A : Channel Design Summary Tables

Reedy Creek																	m2	m3
																Sum	5.59	9,475.90
River Station/Cross Section Name	Downstream reach length (m)	Natural Surface Channel Centre Line Elevation (mAHD)	Centre Line station	Defined reasonable width channel present?		Left bank Natural Surface (mAHD)	Right Bank Natural Surface (mAHD)	Min Channel Elevation (m AHD)	Base width (m)	Water Surface Elevation (mAHD)	Flow Depth (m)	Height of levee required including Free Board (m) Left Bank	Height of levee required incluing Free Board (m) Rigth Bank	Fill Area LB levee (m2)	Fill Areas RB levee (m2)	Cut for channel (m2)	(Cut- Fill) Differenc e (m2)	Cut-fill*length (m3)
71264.29	7795.04	22.31	60	Yes	Design Drain M invert and width	23	23.4	21.9	5	22.99	1.09	0.39	no levee required	1.63	-	3.98	2.35	18,347.19
63469.25	5762.39	20.87	80	Yes	Design width only	22.07	22.17	20.87	5	21.72	0.85	0.05	no levee required	0.16	-	0.433	0.28	1,587.54
57706.86	6526.96	19.8	116	Yes	Design width only	20.17	20.17	19.8	22	20.43	0.63	0.66	0.66	3.29	3.29	6.68	0.11	694.47
51179.9	8029.3	19.2	100	Yes	Design width only	19.84	20.04	19.2	17	20.08	0.88	0.64	0.44	3.15	1.90	4.72	- 0.33	- 2,646.46
43150.6	8641.55	18.08	119	Yes	Design width only	18.85	18.67	18.08	20	19.11	1.03	0.66	0.84	3.29	4.64	7.57	- 0.35	- 3,055.65
34509.05	25123.36	17.47	80	No	design invert and width	17.62	17.52	16.8	20	18.32	1.52	1.1	1.2	6.93	7.92	14.6	- 0.25	- 6,280.84
9385.706	8509.85	16.48	140	no	design invert and width	16.71	16.78	15.88	19	17.38	1.5	1.07	1	6.64	6.00	12.6	- 0.04	- 380.39
875.8585	875	16.16	67.5	No	Design invert and width	16.23	16.34	15.56	13	16.69	1.13	0.86	0.75	4.80	3.94	9.7	0.96	843.24
128	128	15.96	150.5	No	Design invert and width	16.03	16.12	15.56	10	15.97	0.41	0.34	0.25	1.37	0.94	5.17	2.87	366.81

Floodway

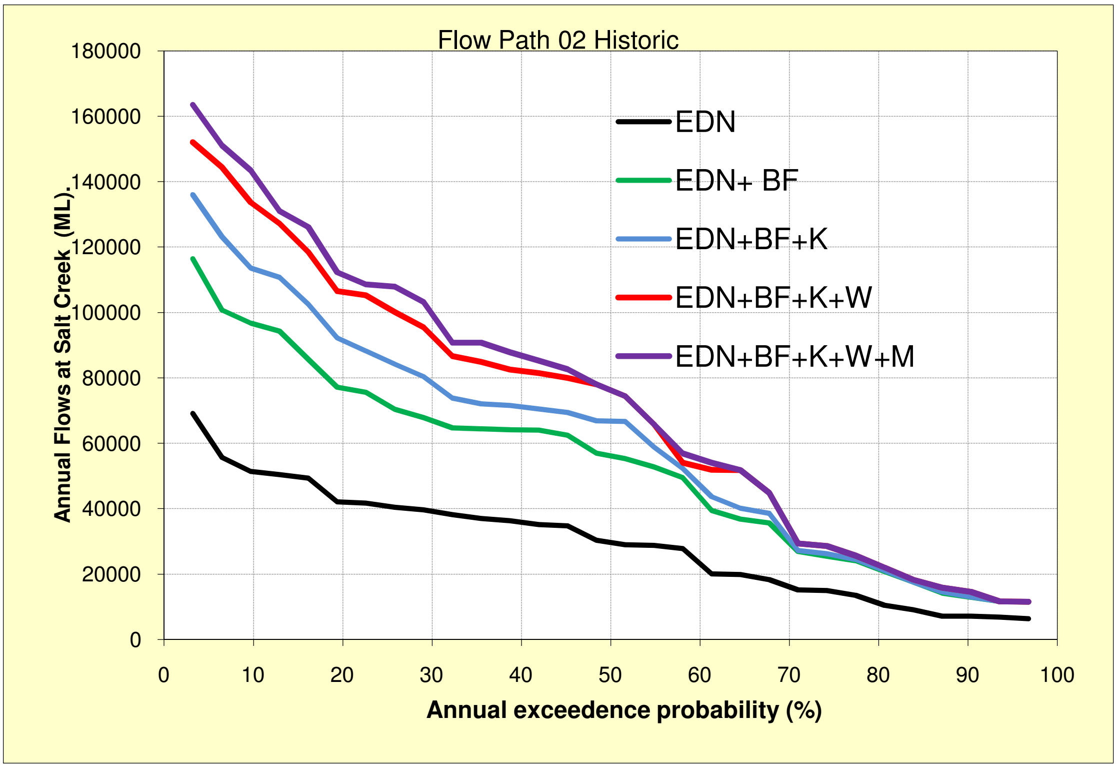
River Station/ Cross Section Name	Down Stream reach length (m)	Natural Surface Channel Centre Line Elevation (mAHD)	Centre Line station	Left bank Natural Surface (mAHD)	Right Bank Natural Surface (mAHD)	Min Chl EL (m AHD)	Base width	Water Surface Elevation (mAHD)	Flow Depth (m)	Height of levee required incluing Free Board (m) Left Bank	Height of levee required incluing Free Board (m) Right Bank	Fill Area Left Bank levee (m2)	Fill Areas Rank Bank levee (m2)	Cut for channel (m2)	(Cut- Fill) Difference (m2)	Cut-fill*length (m3)
														sum	**71**	**216,675**
47952	1215.01	5.48	334	5.91	5.8	5.48	40	6.43	0.95	0.92	1.03	5.30	6.27	5.94	- 5.63	- 6,842.81
46737.17	1278	5.03	372	5.58	5.77	5.03	30	6.31	1.28	1.13	0.94	7.22	5.47	7.24	- 5.45	- 6,967.02
45458.83	1317	5.16	240	5.77	5.16	5.04	25	6.14	1.1	0.77	1.38	4.09	9.85	11	- 2.94	- 3,874.48
44141.56	1417	4.94	280	5.01	5.3	4.74	35	5.97	1.23	1.36	1.07	9.63	6.64	11	- 5.27	- 7,472.55
42724.43	1543	4.77	400	5.15	5.35	4.45	20	5.83	1.38	1.08	0.88	6.74	4.96	9.36	- 2.34	- 3,614.32
41181.4	1843	4.35	300	4.46	5.84	4.15	15	5.57	1.42	1.51	0.13	11.37	0.44	26.1	14.29	26,334.63
39338.63	1877	4.11	300	4.25	4.47	4.11	40	5.4	1.29	1.55	1.33	11.86	9.30	9.96	- 11.19	- 21,011.51
37461.49	1434	4.19	300	4.21	4.4	4.08	40	5.3	1.22	1.49	1.3	11.13	8.97	9.63	- 10.47	- 15,014.41
36027.32	1729	4.26	319	4.26	4.48	3.86	20	5.15	1.29	1.29	1.07	8.86	6.64	20.7	5.19	8,978.70
34298.65	561	3.57	300	3.65	3.83	3.17	5	4.17	1	0.92	0.74	5.30	3.86	7.54	- 1.62	- 909.94
33737.65	578	2.6	290	2.7	2.65	2.6	40	3.8	1.2	1.5	1.55	11.25	11.86	2.48	- 20.63	- 11,922.70
33159.45	651	2.32	309	2.6	2.51	2.32	40	3.78	1.46	1.58	1.67	12.23	13.38	7.37	- 18.24	- 11,871.57
32508.43	1871	2.7	334	2.96	3.14	2.7	50	3.75	1.05	1.19	1.01	7.82	6.09	17	3.09	5,784.01
30636.97	1475	2.47	339	2.54	3.18	2.47	50	3.66	1.19	1.52	0.88	11.49	4.96	16.2	- 0.25	- 375.24
29161.84	1405	2.71	309	2.76	2.92	2.64	55	3.57	0.93	1.21	1.05	8.02	6.46	13.6	- 0.88	- 1,236.12
27757.24	1416	2.82	370	3.08	3.02	2.62	55	3.44	0.82	0.76	0.82	4.01	4.48	39.2	30.71	43,485.36
26340.8	3196	2.51	362	2.55	2.74	2.31	30	3.2	0.89	1.05	0.86	6.46	4.80	9.91	- 1.35	- 4,302.77
23145.19	1816	1.58	406	1.59	2.01	1.38	40	2.69	1.31	1.5	1.08	11.25	6.74	13.9	- 4.09	- 7,425.99
21329.03	1737	1.46	351	1.58	1.54	1.36	65	2.64	1.28	1.46	1.5	10.77	11.25	13.7	- 8.32	- 14,460.18
19592.05	1484	1.3	357	1.41	1.34	1.3	70	2.61	1.31	1.6	1.67	12.48	13.38	8.14	- 17.72	- 26,291.58
18108.53	2110	1.57	403	1.68	1.65	1.33	70	2.59	1.26	1.31	1.34	9.08	9.41	23.4	4.91	10,370.44
15998.33	2212	1.65	398	1.77	1.65	1.31	70	2.55	1.24	1.18	1.3	7.72	8.97	33.2	16.51	36,526.31
13786	2489	1.35	308	1.71	1.73	1.29	70	2.51	1.22	1.2	1.18	7.92	7.72	16.3	0.66	1,649.71
11297.12	2063	1.54	332	1.88	1.56	1.27	70	2.46	1.19	0.98	1.3	5.82	8.97	30.2	15.41	31,788.35
9233.713	2140	1.8	385	1.9	1.97	1.25	60	2.4	1.15	0.9	0.83	5.13	4.56	42.7	33.01	70,648.46
7093.547	3175	1.58	378	1.66	1.71	1.23	60	2.33	1.1	1.07	1.02	6.64	6.18	27.6	14.77	46,907.77
3918.411	2460	1.72	400	1.9	1.76	1.2	55	2.17	0.97	0.67	0.81	3.36	4.40	34.3	26.55	65,300.70
1458.045	1266	1.38	517	1.98	1.46	1.18	55	1.94	0.76	0.36	0.88	1.47	4.96	14	7.57	9,581.09
191.6446	191.64	1.5	398	1.58	1.65	0.7	15	1.14	0.44	no levee required	no levee required	0.00	-	15.2	15.20	2,912.93

Biscuit Flat Design

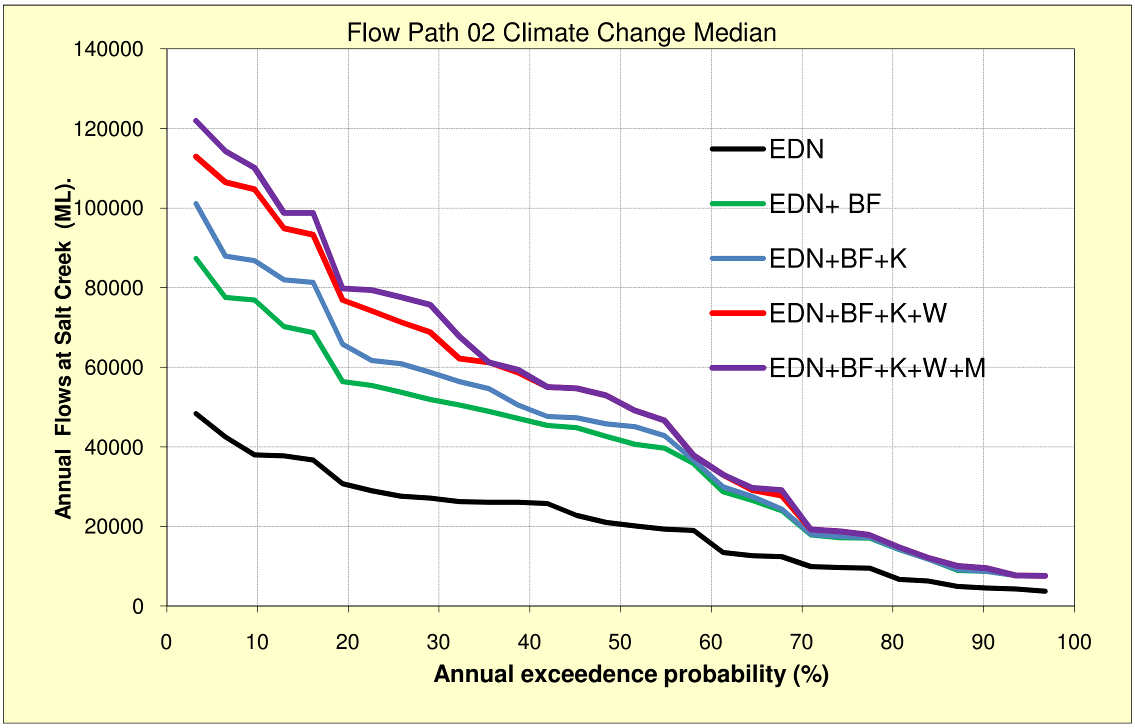
River Station /Cross Section name	Downstream reach length (m)	NS Channel Centre Line Elevation (mAHD)	Left bank Natural Surface (mAHD)	Right Bank Natural Surface (mAHD)	Design Min Channel Elevation (m AHD)	Base width (m)	Water Surface Elevation (mAHD)	Flow Depth (m)	Height of levee required inclu Free Board (m) Left Bank	Height of levee required inclu Free board (m) Right Bank	Fill Area Left Bank levee (m2)	Fill Areas Right Bank levee (m2)	Cut for channel (m2)	(Cut- Fill) Difference (m2)	Cut-fill*length (m3)
Design	V10													**m2**	**m3**
					*100m interpolation								**Sum**	**252.51**	**15,199.51**
34,495	1995	15.67	15.6	15.71	14.36	10	15.24	0.88	0.04	no levee required	0.12	-	18.1	17.98	35,860.52
32,500	1500	12.82	12.88	12.84	12.62	10	13.75	1.13	1.27	1.31	8.65	9.08	2.19	- 15.54	- 23,305.50
31,000	500	13.42	13.61	13.3	12.17	10	12.81	0.64	no levee required	no levee required	-	-	18.6	18.60	9,300.00
30,500	3000	10.83	10.79	10.95	10.63	5	11.72	1.09	1.33	1.17	9.30	7.62	1.26	- 15.65	- 46,960.20
27,500	1000	8.87	8.87	8.91	8.67	30	9.93	1.26	1.46	1.42	10.77	10.31	6.53	- 14.55	- 14,554.00
26,500	1000	8.79	8.78	8.82	8.59	30	9.9	1.31	1.52	1.48	11.49	11.01	6.25	- 16.25	- 16,252.40
25,500	3500	8.82	8.81	8.83	8.57	30	9.87	1.3	1.46	1.44	10.77	10.54	7.68	- 13.64	- 47,724.60
22,000	2500	8.75	8.68	8.78	8.49	30	9.76	1.27	1.48	1.38	11.01	9.85	7.82	- 13.04	- 32,611.00
19,500	2000	8.68	8.73	8.95	8.43	30	9.69	1.26	1.36	1.14	9.63	7.32	9.65	- 7.30	- 14,595.20
17,500	3000	8.59	8.55	8.61	8.39	15	9.54	1.15	1.39	1.33	9.97	9.30	3.09	- 16.17	- 48,519.00
14,500	3000	8.03	7.97	8.11	7.77	10	8.85	1.08	1.28	1.14	8.76	7.32	2.93	- 13.14	- 39,432.00
11,500	3000	7.14	7.04	7.26	6.94	21	8.14	1.2	1.5	1.28	11.25	8.76	4.28	- 15.73	- 47,175.60
8,500	1931	7.21	7.08	7.29	6.74	17	7.81	1.07	1.13	0.92	7.22	5.30	9.47	- 3.05	- 5,889.36
6,569	1068	6.56	6.49	6.58	6.56	35	7.65	1.09	1.56	1.47	11.98	10.89	0.501	- 22.37	- 23,893.83
5,500	500	6.6	6.6	6.69	6.52	35	7.61	1.09	1.41	1.32	10.19	9.19	3.58	- 15.80	- 7,900.75
5,000	1000	7.12	7.02	7.14	6.5	35	7.59	1.09	0.97	0.85	5.73	4.72	25.7	15.25	15,249.80
4,000	2215	7.84	7.81	7.92	6.46	35	7.55	1.09	0.14	0.03	0.48	0.09	55.5	54.93	121,666.63
1,784	1284	8.59	8.8	8.49	6.37	35	7.46	1.09	no levee required	no levee required	-	-	109	109.00	139,956.00
500	500	8.86	8.81	8.99	6.32	35	7.4	1.08	no levee required	no levee required	-	-	109	109.00	54,500.00
68	68	8.85	8.87	8.85	6.3	35	7.38	1.08	no levee required	no levee required	-	-	110	110.00	7,480.00

Tilley Taratap															**Sum**	**330.91**	**1,052,228.43**
River Station/ Cross Section Name	Down Steam reach length (m)	Natural Surface Channel Centre Line Elevation (mAHD)	Centre Line station	base width of existing channel	Existing Drain		Left bank Natural Surface (mAHD)	Max Water Level possible (highest Left Bank point-0.4m Free Board)	Min Channel Elevation (m AHD)	Base width (m)	Water Surface Level (m)	Flow Depth (m)	Height of levee required incluing Free Board (m) Left Bank	Fill Area LB levee (m2)	Cut for channel (m2)	(Cut- Fill) Difference (m2)	Cut-fill*length (m3)
90962.15	2076.69	13.16	3816	no channel	NO	Design with Blackford invert and width	13.04		12.6	14	13.92	1.32	1.28	8.76	8.29	- 0.47	- 966.08
88885.46	2305.3	13.08	3659	no channel	NO	Invert and Width	13.11		12.53	14	13.9	1.37	1.19	7.82	8.28	0.46	1,064.36
86580.19	1800	12.8	3448	no channel	NO	Invert and Width	12.88		12.45	18	13.76	1.31	1.28	8.76	10.8	2.04	3,680.64
84774.81	3800	12.6	3016	no channel	NO	Invert and Width	12.63		12.4	14	13.27	0.87	1.04	6.36	5.42	- 0.94	- 3,590.24
80979.71	1578	10.14	177.2	no channel	NO	Invert and Width	10.22		10.04	19	11.29	1.25	1.47	10.89	1.93	- 8.96	- 14,143.14
79401.7	1800		460.9	2	YES	Invert Fixed width only	10.26		10	19	11.29	1.29	1.43	10.42	2.09	- 8.33	- 15,002.46
77596	1700		866.5	2	YES	Invert Fixed width only	10.39		9.82	10	11.28	1.46	1.29	8.86	8	- 0.86	- 1,465.91
75884.42	900		472.5	2	YES	Invert Fixed width only	10.92		9.65	3	11.13	1.48	0.61	2.95	4.86	1.91	1,722.33
74345.93	1500		412	2	YES	Invert Fixed width only	10.39		9.5	3	10.52	1.02	0.53	2.43	7.45	5.02	7,525.95
72844.71	459.54		381	2	YES	Invert Fixed width only	9.42		8.71	3	9.71	1	0.69	3.50	3.85	0.35	161.62
72385.22	814.9		276	2	YES	Invert Fixed width only	8.56	9.25	7.93	3	8.83	0.9	0.67	3.36	3.97	0.61	499.78
71570.3	353		310	6	YES	Invert Fixed width only	8.07	8.53	7.25	7	8.2	0.95	0.53	2.43	4.75	2.32	818.01
71217.26	1807.91		387	6	YES	Invert Fixed width only	7.73	8.79	6.91	7	7.97	1.06	0.64	3.15	5.08	1.93	3,491.44
69409.37	4100		1073	6	YES	Invert Fixed width only	7.28		6.48	7	7.68	1.2	0.8	4.32	5.83	1.51	6,191.00
65342.09	3496.71		1432	6	YES	Invert Fixed width only	6.86	8.12	5.87	7	7.35	1.48	0.89	5.05	10.7	5.65	19,769.35
61845.38	2108.5		1264	6	YES	Invert Fixed width only	6.86	7.94	5.59	7	7.13	1.54	0.67	3.36	16.3	12.94	27,290.95
59736.87	1876		324	6	YES	Invert Fixed width only	6.47	7.37	5.34	7	7.09	1.75	1.02	6.18	8.11	1.93	3,618.43
57860.21	1524.7		256	6	YES	Invert Fixed width only	6.81	7.93	5.13	7	7.08	1.95	0.67	3.36	7.09	3.73	5,692.16
56335.53	4145.61		290.5	4	YES	Invert Fixed width only	6.85	8.12	4.97	5	7.04	2.07	0.59	2.81	8.08	5.27	21,829.54
52189.92	274.5		175.31	4	YES	Invert Fixed width only	6.39		4.54	5	6.97	2.43	0.98	5.82	18.4	12.58	3,452.88
51915.35	4250.42		622	3	YES	Invert Fixed width only	6.38		4.5	4	6.97	2.47	0.99	5.91	11.5	5.59	23,758.57
47665	1727.5		1682.5	3	YES	Invert Fixed width only	6.09		4.33	5	6.96	2.63	1.27	8.65	16.7	8.05	13,908.62
45937.46	2161.19		2696	3	YES	Invert Fixed width only	6.12		4.25	5	6.96	2.71	1.24	8.33	24.8	16.47	35,588.75
43776.27	2258.81		2765	3	YES	Invert Fixed width only	6.49		4.16	4	6.9	2.74	0.81	4.40	20.9	16.50	37,274.20
41517.53	2110.28		2905	3	YES	Invert Fixed width only	6.49		4.08	4	6.69	2.61	0.6	2.88	32	29.12	61,451.35
39407.24	2379.6		2085	3	YES	Invert Fixed width only	6.15		3.96	4	6.45	2.49	0.7	3.57	11.4	7.83	18,632.27
37027.64	2422.5		964	3	YES	Invert Fixed width only	5.56		3.87	4	6.4	2.53	1.24	8.33	7.91	- 0.42	- 1,024.23
34605.09	2861.69		1477	3	YES	Invert Fixed width only	5.29		3.76	10	6.4	2.64	1.51	11.37	27.1	15.73	45,013.53
31743.38	4221.01		2283	3	YES	Invert Fixed width only	5.49		3.64	10	6.4	2.76	1.31	9.08	20.7	11.62	49,055.31
27522.39	3733.19		3535	3	YES	Invert Fixed width only	6.41		3.47	8	6.33	2.86	0.32	1.27	26.3	25.03	93,452.20
24057.14	5330.02		3478	3	YES	Invert Fixed width only	6.42		3.32	8	6.12	2.8	0.1	0.33	61.5	61.17	326,037.32
18789.17	2836.03		3377	2	YES	Invert Fixed width only	5.75		3.1	8	5.76	2.66	0.41	1.73	35.6	33.87	96,044.14
15953.2	2920.8		2888	2	YES	Invert Fixed width only	5.71		2.98	8	5.53	2.55	0.22	0.81	38.6	37.79	110,391.05
13131.53	2974.98		2586	2	YES	Invert Fixed width only	5.08		2.86	6	5.21	2.35	0.53	2.43	26.3	23.87	71,004.74
10603.61	10603		3382	7.5	YES	Invert Fixed width only	5.4		2.76	7.5	4.5	1.74	no levee require	-	0	-	-

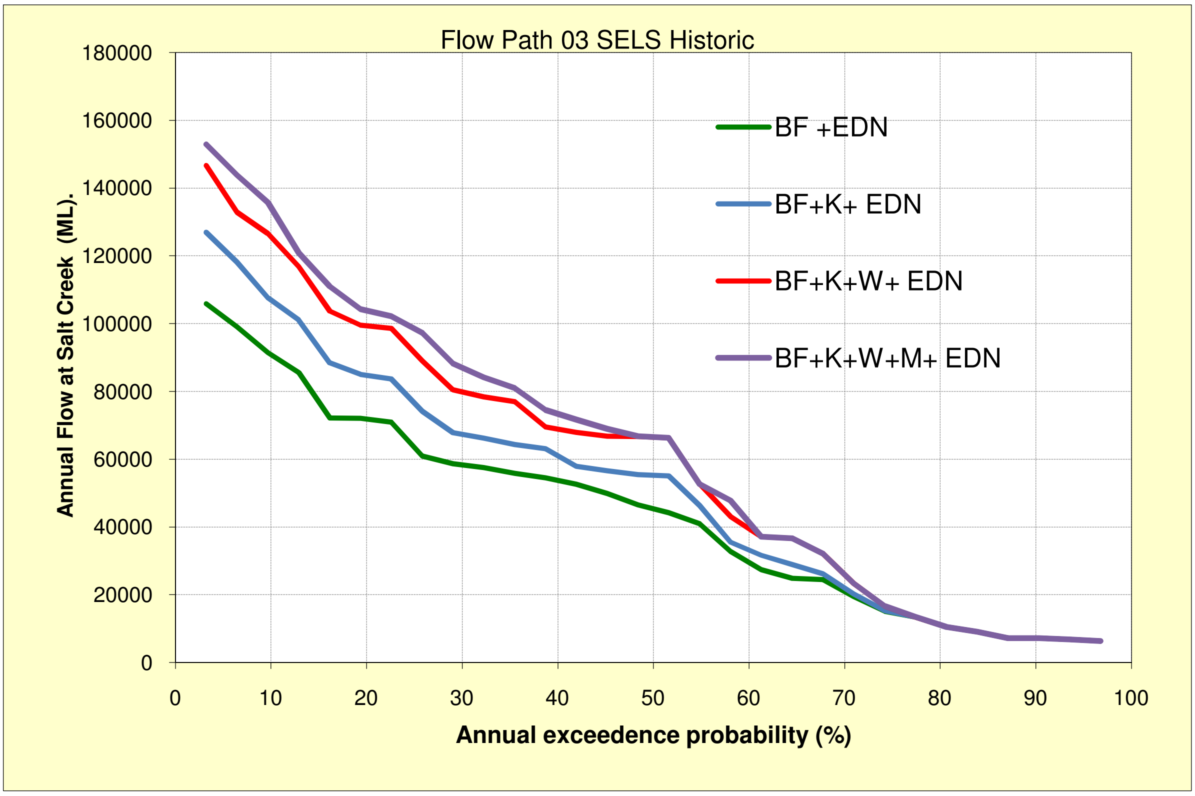
Appendix B : Stage Delivery Annual Exceedance Curves



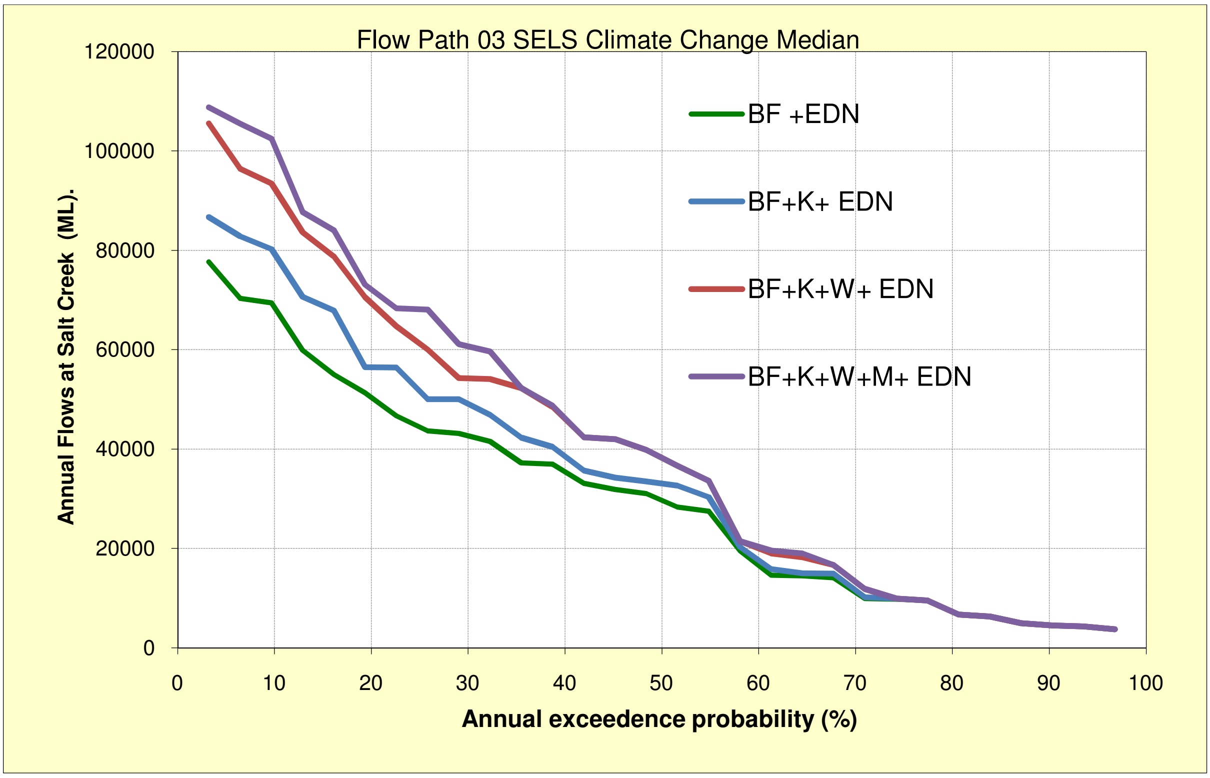
Flow Path 02 Historic
Annual Flows at Salt Creek (ML)
Annual exceedence probability (%)
EDN
EDN+ BF
EDN+BF+K
EDN+BF+K+W
EDN+BF+K+W+M
180000
160000
140000
120000
100000
80000
60000
40000
20000
0
0
10
20
30
40
50
60
70
80
90
100



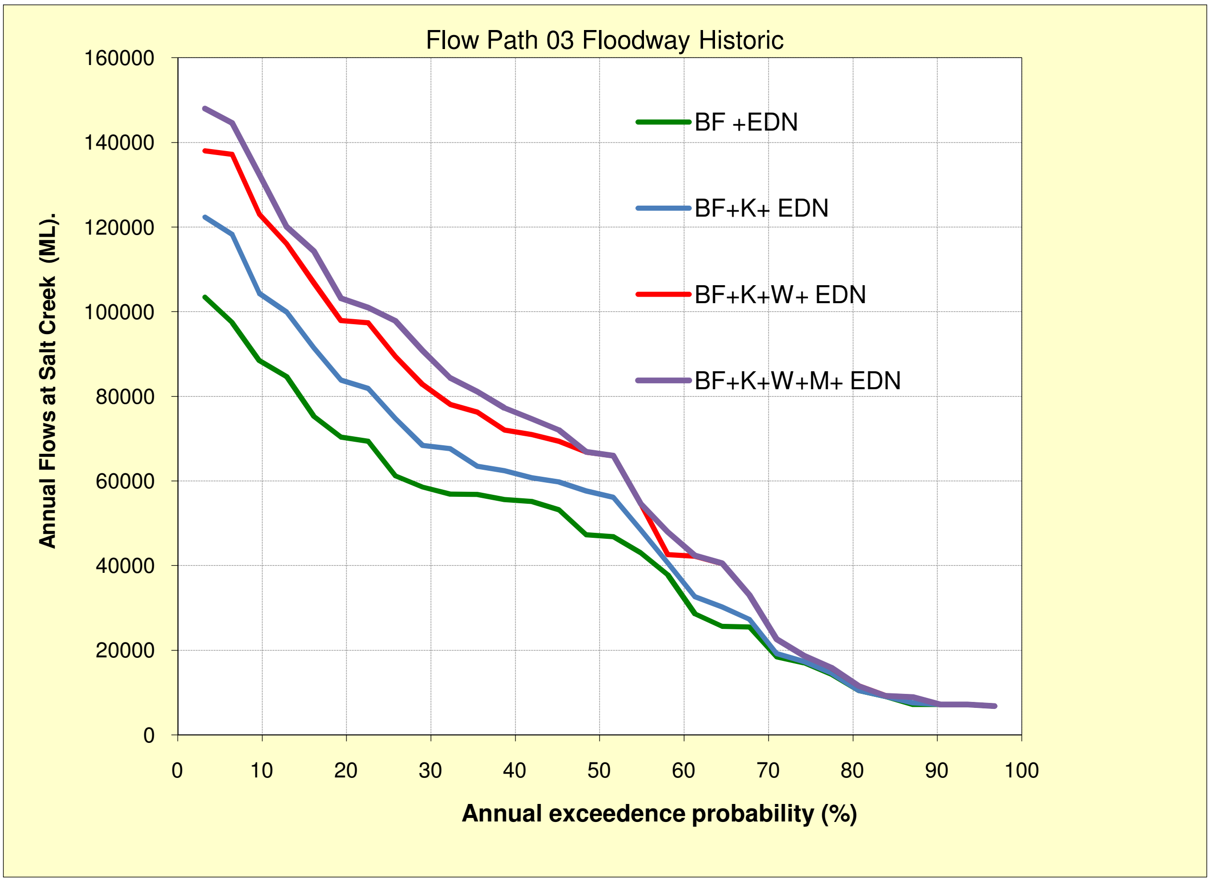
Flow Path 02 Climate Change Median
Annual Flows at Salt Creek (ML)
Annual exceedence probability (%)
EDN
EDN+ BF
EDN+BF+K
EDN+BF+K+W
EDN+BF+K+W+M
140000
120000
100000
80000
60000
40000
20000
0
0
10
20
30
40
50
60
70
80
90
100



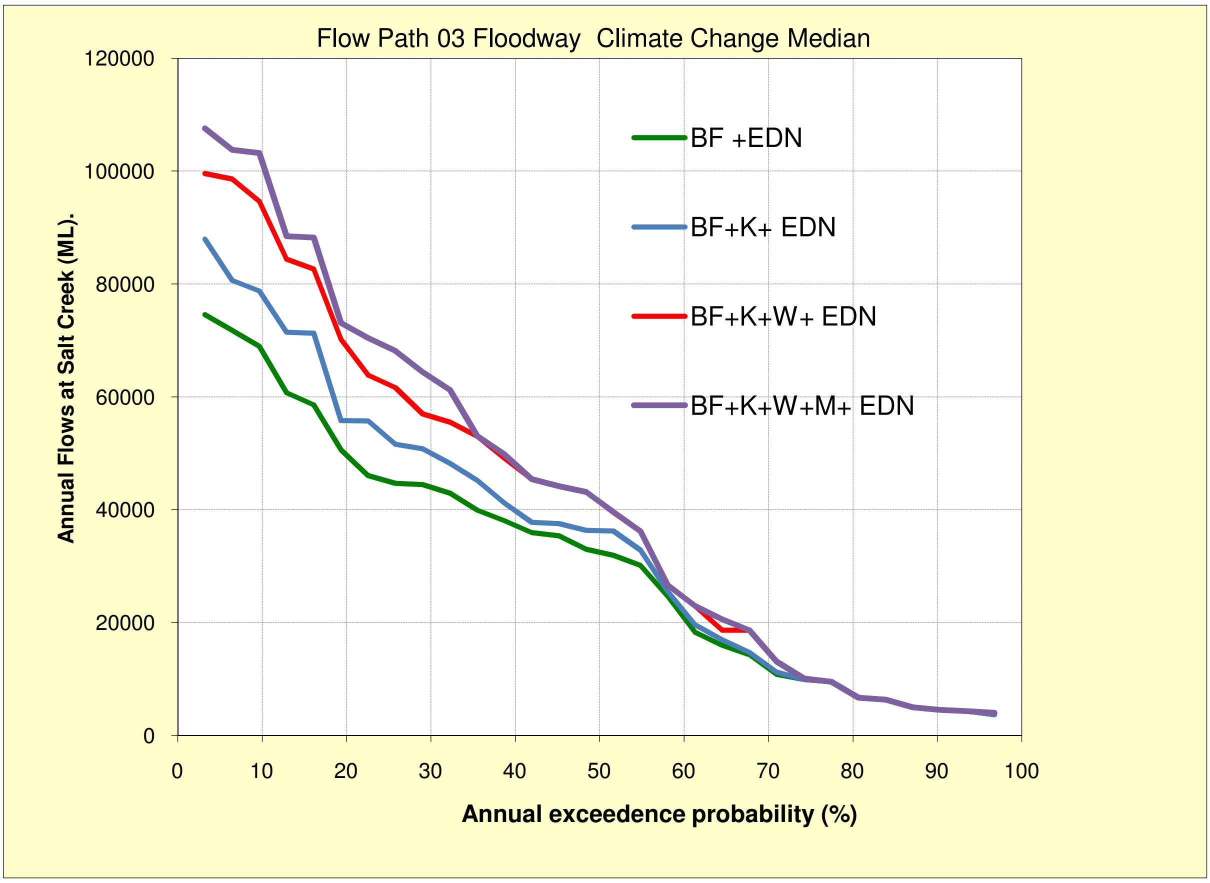
Flow Path 03 SELS Historic
Annual Flow at Salt Creek (ML).
Annual exceedence probability (%)
BF +EDN
BF+K+ EDN
BF+K+W+ EDN
BF+K+W+M+ EDN



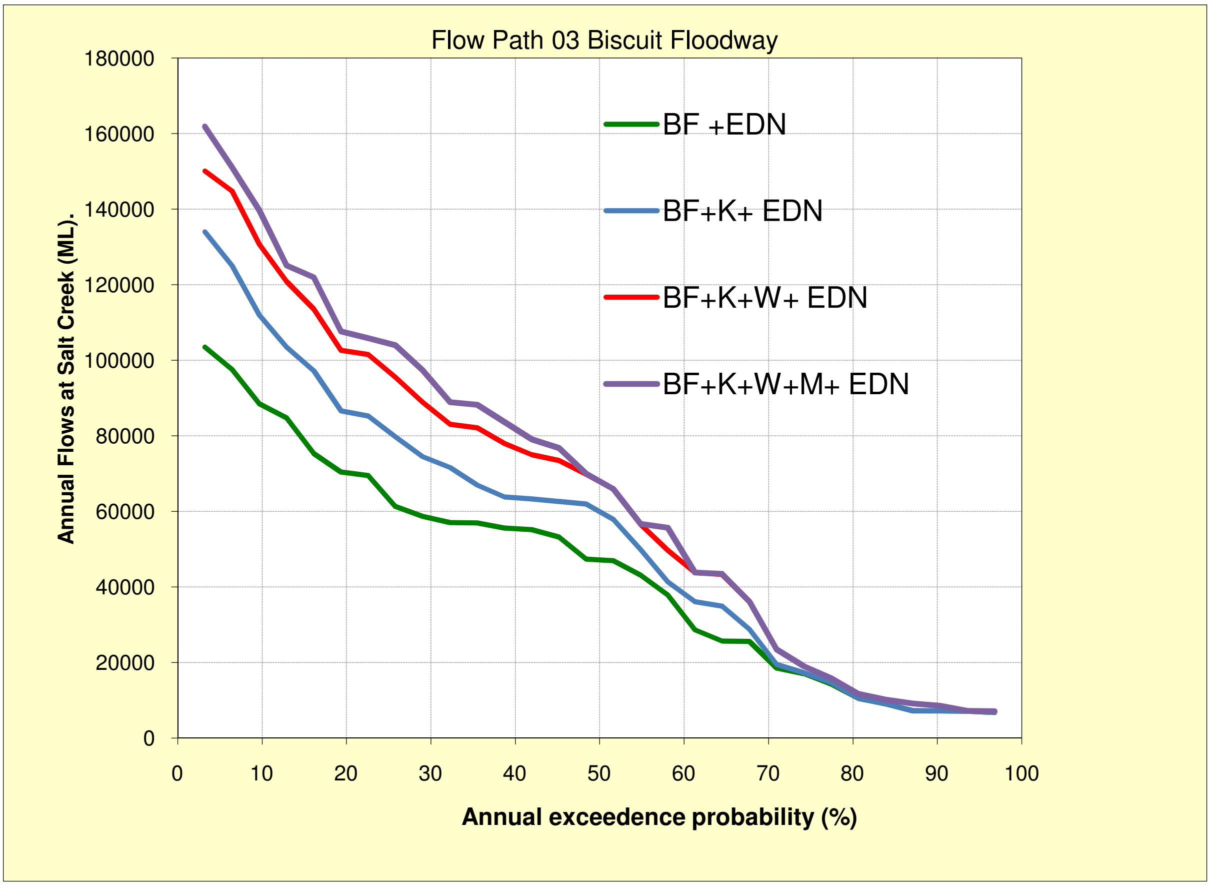
Flow Path 03 SELS Climate Change Median
Annual Flows at Salt Creek (ML).
Annual exceedence probability (%)
BF +EDN
BF+K+ EDN
BF+K+W+ EDN
BF+K+W+M+ EDN

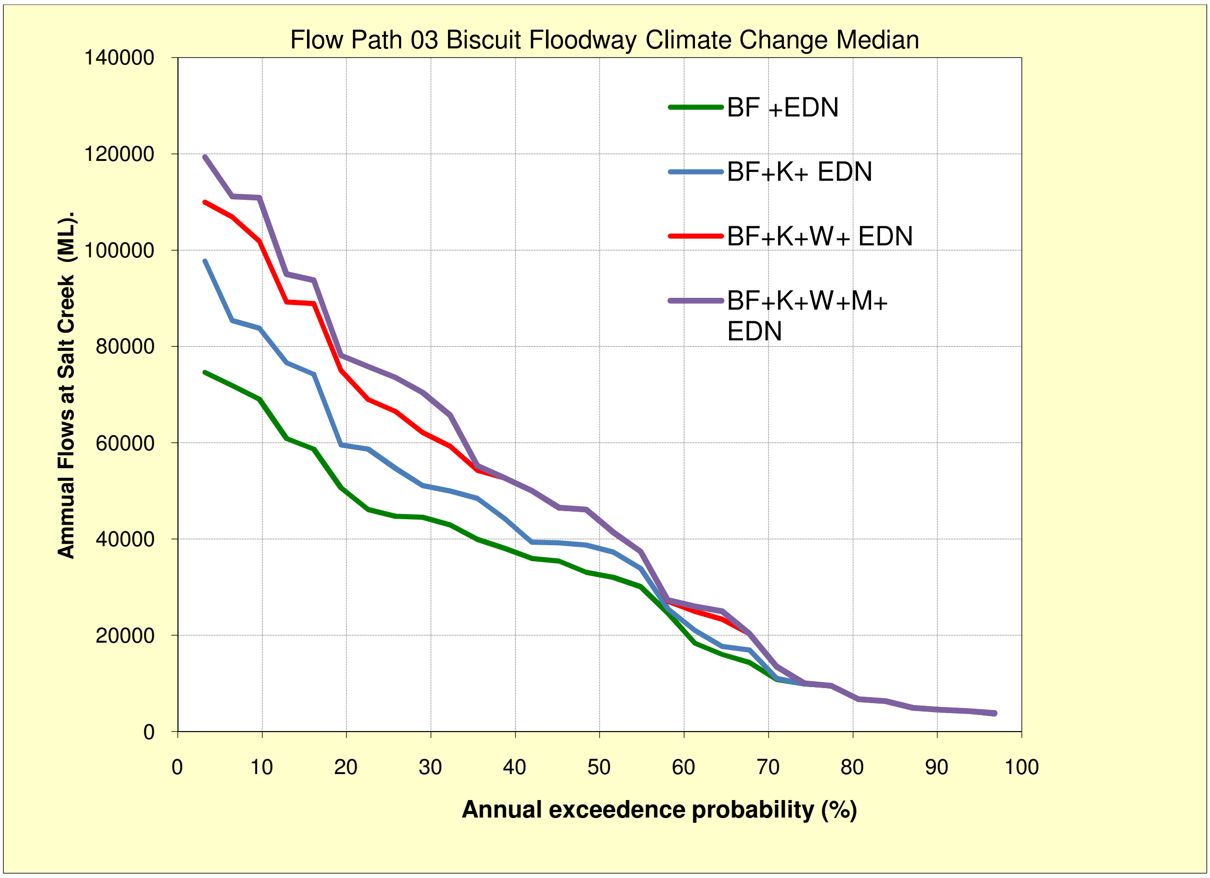


Flow Path 03 Floodway Historic
BF +EDN
BF+K+ EDN
BF+K+W+ EDN
BF+K+W+M+ EDN
Annual Flows at Salt Creek (ML).
Annual exceedence probability (%)
160000
140000
120000
100000
80000
60000
40000
20000
0
0
10
20
30
40
50
60
70
80
90
100



Flow Path 03 Floodway Climate Change Median
BF +EDN
BF+K+ EDN
BF+K+W+ EDN
BF+K+W+M+ EDN
Annual Flows at Salt Creek (ML).
Annual exceedence probability (%)
120000
100000
80000
60000
40000
20000
0
0
10
20
30
40
50
60
70
80
90
100

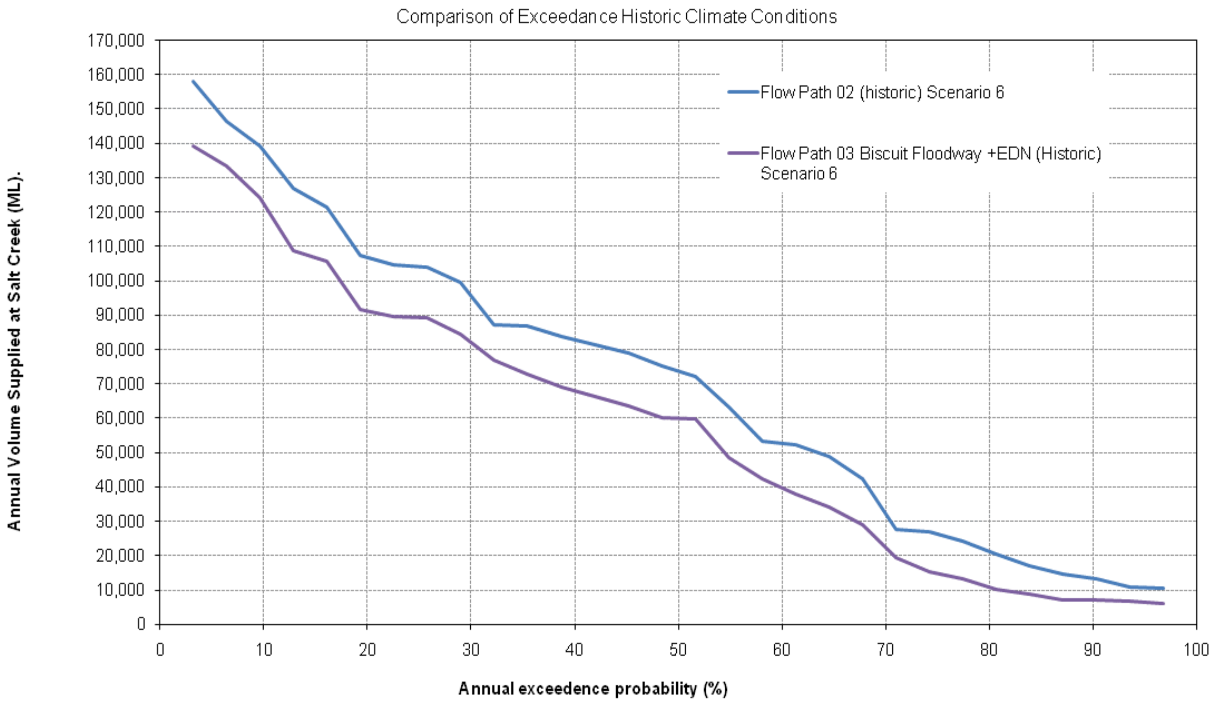

Flow Path 03 Biscuit Floodway
180000
160000
140000
120000
100000
80000
60000
40000
20000
0
Annual Flows at Salt Creek (ML).
0
10
20
30
40
50
60
70
80
90
100
Annual exceedence probability (%)
BF +EDN
BF+K+ EDN
BF+K+W+ EDN
BF+K+W+M+ EDN


Flow Path 03 Biscuit Floodway Climate Change Median
140000
120000
100000
80000
60000
40000
20000
0
Ammual Flows at Salt Creek (ML).
0
10
20
30
40
50
60
70
80
90
100
Annual exceedence probability (%)
BF +EDN
BF+K+ EDN
BF+K+W+ EDN
BF+K+W+M+
EDN

Appendix C : Scenario 6 Results

Historic Climate Condition	**FP2**		**FP3 Biscuit Floodway**	
Diversions	Median (ML/a)	Mean (ML/a)	Median (ML/a)	Mean (ML/a)
Existing Drainage Network (EDN)	29,300	29,100	64,000	58,400
EDN + BF	54,700	51,800	43,400	41,500
EDN + BF + K	64,000	58,400	50,700	47,000
EDN + BF + K + W	73,700	67,200	60,000	54,700
EDN + BF + K + W + M	73,700	69,900	60,000	57,300

FlowPath	Historic Climate Condition		
Flow Path 02 Historic Scenario 6	Volume (>ML)	No. Years	Frequency in 10 years
	15000	26	9
	30000	21	7
	45000	20	7
	60000	17	6
	75000	15	5
	90000	9	3
Flow Path 03 Biscuit Floodway + EDN Historic Scenario 6	Volume (>ML)	No. Years	Frequency in 10 years
	15000	23	8
	30000	20	7
	45000	17	6
	60000	15	5
	75000	10	4
	90000	6	2

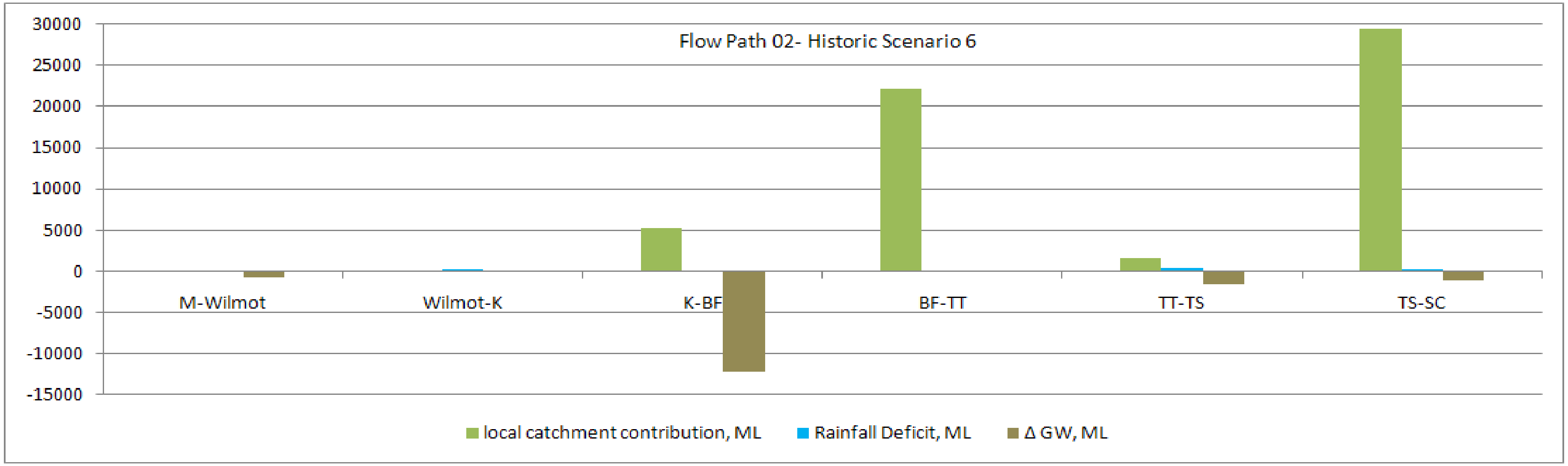

Comparison of Exceedance Historic Climate Conditions
Annual Volume Supplied at Salt Creek (ML).
170,000
160,000
150,000
140,000
130,000
120,000
110,000
100,000
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
0
10
20
30
40
50
60
70
80
90
100
Annual exceedence probability (%)
Flow Path 02 (historic) Scenario 6
Flow Path 03 Biscuit Floodway +EDN (Historic) Scenario 6

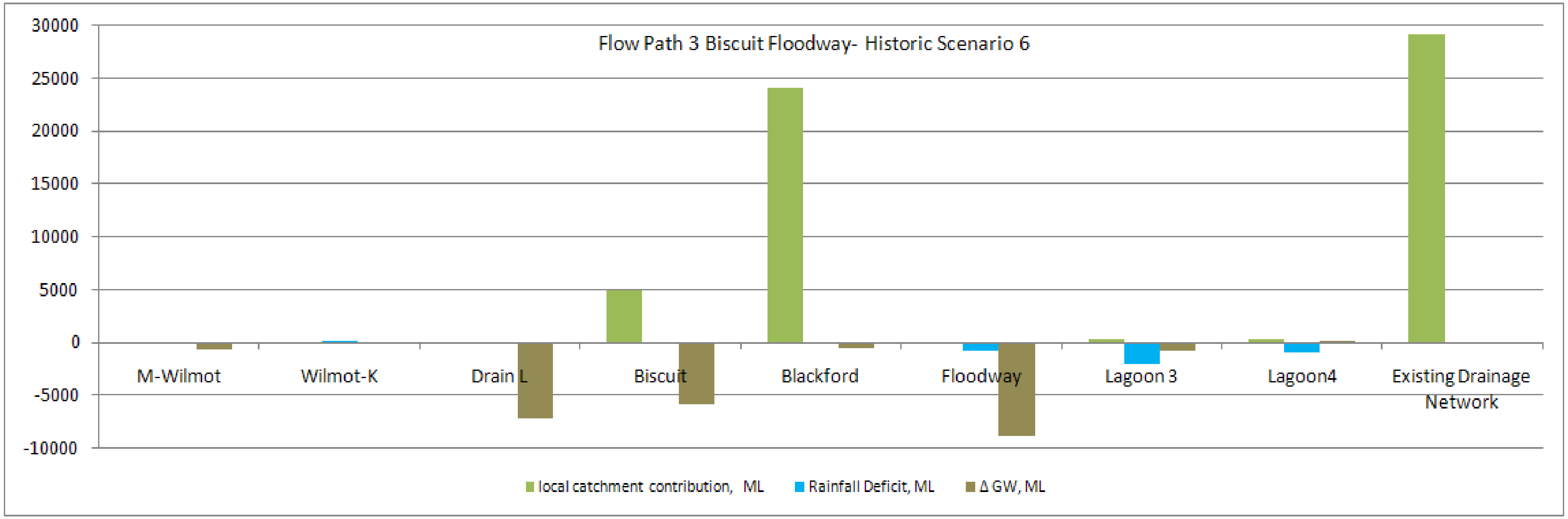
Flow Path 02 Historic Scenario 6

Reach	M-Wilmot	Wilmot-K	K-BF	BF-TT	TT-TS	TS-SC
local catchment contribution, ML/a	0	0	5,205	22,171	1,535	29,433
Rainfall Deficit, ML/a	-8	15	-50	-17	359	86
Δ GW, ML/a	-732	-23	-12,144	-7	-1,666	-1,067

Flow Path 03 Biscuit Floodway Historic Scenario 6

Reach	M-Wilmot	Wilmot-K	Drain L	Biscuit	Blackford	Floodway	Lagoon 3	Lagoon4	Existing Drainage Network
local catchment contribution, ML/a	0	0	0	4,857	24,112	0	309	329	29,100
Rainfall Deficit, ML/a	-8	15	0	-91	-16	-848	-2,021	-982	0
Δ GW, ML/a	-732	-23	-7,166	-5,880	-475	-8,845	-814	3	0


Flow Path 02- Historic Scenario 6
30000
25000
20000
15000
10000
5000
0
-5000
-10000
-15000
M-Wilmot
Wilmot-K
K-BF
BF-TT
TT-TS
TS-SC
local catchment contribution, ML
Rainfall Deficit, ML
Δ GW, ML


Flow Path 3 Biscuit Floodway- Historic Scenario 6
30000
25000
20000
15000
10000
5000
0
-5000
-10000
M-Wilmot
Wilmot-K
Drain L
Biscuit
Blackford
Floodway
Lagoon 3
Lagoon4
Existing Drainage Network
local catchment contribution, ML
Rainfall Deficit, ML
Δ GW, ML

Murray Futures: Coorong, Lower Lakes & Murray Mouth Recovery Project

South East Flows Restoration Project

Sustainable Diversion Limit Adjustment Supply Measure

ADDENDUM

Additional information to support the Phase 2 South East Flows Restoration Project (SEFRP) Submission to include "SEFRP Augmentation"

Government of South Australia
Department of Environment, Water and Natural Resources

Department of Environment, Water and Natural Resources
Government of South Australia
June 2017

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CONTENTS

1. Purpose

The purpose of this document is to present an extension to the *South East Flows Restoration Project (SEFRP) Sustainable Diversion Limit (SDL) Adjustment Supply Measure* (herein original SEFRP supply measure).

This addendum does not affect the original SEFRP supply measure, which was notified in the first notification and has been confirmed according to the phased assessment process outlined in the Sustainable Diversion Limit Adjustment Mechanism Finalisation Plan.

The changes proposed in this document are to enable the SDL Adjustment Assessment Committee (SDLAAC) and Basin Officials Committee (BOC) to assess and confirm the proposed extension of the SEFRP (herein SEFRP Augmentation).

2. SEFRP Augmentation

The SEFRP Augmentation would increase the volume, security and flexible delivery of water to the Coorong South Lagoon (CSL) via the SEFRP drain alignment by constructing new drains to redirect water from further south that currently flows out to sea (Figure 1).

Water from the South East region plays a particularly important role in salinity management in the Coorong (Lester et al, 2009). Maintaining salinity and water levels within target parameters is critical to improving the Coorong's ecosystem resilience (DEH 2000; DEWNR 2015; Lester et al, 2009 and 2011), including promoting the long-term survival of the aquatic plant *Ruppia tuberosa* and other keystone species (Brookes et al. 2009).

The original SEFRP supply measure is fully costed and funded through the *Coorong, Lower Lakes and Murray Mouth Recovery Project Schedule SA-07* to the *South Australian and Commonwealth Water Management Partnership Agreement* and construction commenced in March 2017.

Currently, median annual contributions from the South-East existing drainage network (EDN) to the CSL are estimated at 29.7 gigalitres (GL) (AWE, 2012). The original SEFRP supply measure was estimated to deliver a further 26.5 GL (AWE, 2011), but this was recently revised to 25.9 GL [redacted] after analysis of a longer time series (1891-2016).

The SEFRP Augmentation provides an opportunity to increase the SDL adjustment potential of the original SEFRP supply measure. SEFRP Augmentation is modelled to yield a median 15.6 GL per year [redacted] of additional water to the CSL.

The total additional median annual yield to the Coorong under the original SEFRP supply measure plus SEFRP Augmentation, would be approximately 41.5 GL [redacted]

Preliminary estimates place the total SEFRP Augmentation implementation cost in the order of [redacted] based on the construction estimate provided in Attachment 2 [redacted] and comparative project delivery costs with the original SEFRP supply measure.

Table 1: Median Annual Yield (ML/yr) to Coorong South Lagoon (CSL) and cost estimates for SEFRP and SEFRP Augmentation

Scenario	Release to CSL (ML/yr)	Cumulative Total Release to CSL (ML/yr)	Cumulative Increase in release to CSL above EDN (ML/yr)	Cost ($)
EDN	29,385	29,385	-	-
SEFRP	25,916	55,301	+25,916	[redacted]
SEFRPA	15,578	70,879	+41,494	[redacted]

This document outlines the changes to the original SEFRP supply measure, as outlined in the *SEFRP SDL Adjustment Supply Measure Phase 2 Business Case* (December 2014), that the SEFRP Augmentation would introduce. As such, this addendum should be read in the context of the original *SEFRP SDL Adjustment Supply Measure Phase 2 Business Case* and the *SEFRP Phase 2 Business Case* (March 2013).

Key documents that demonstrate the technical feasibility of SEFRP Augmentation are provided and discussed (Table 2 and provided in the List of Attachments).

Changes to the original SEFRP supply measure are highlighted in Table 3 and expanded upon in Section 5.

Technical investigations to further inform the implementation feasibility of the SEFRP Augmentation will be concluded by 30 June 2017.

Given the SDL adjustment process timeframes agreed to by the Murray-Darling Basin Ministerial Council, this addendum has been developed ahead of completion of the full SEFRP Augmentation feasibility assessment, and subsequent submission of any resultant business case for funding and implementation.

3. Proposed development of the SEFRP Augmentation

3.1 Context

Original SEFRP Supply Measure

The SEFRP is a $60 million investment made by the South Australian Government and the Australian Government to assist salinity management in the CSL, enhance flows to wetlands in the Upper South East and reduce drainage outflow at Kingston beach.

Historically, quantities of freshwater flowed into the CSL from the South East and this source of freshwater has been reduced by drainage works in the South East over the past 150 years. Salinity levels in the CSL are determined by flows from the River Murray through the barrages, and water from the south east via Salt Creek. To maintain a healthy ecosystem, the CSL requires a target maximum salinity range of 60g/L (winter) to 100g/L (summer) (Lester et al. 2009).

Reduced inflows from the River Murray have raised salinity in the CSL on occasions to a hypersaline range (>100 g/L), making it too salty to support important species. By restoring inflows from the South East, the SEFRP seeks to assist maintaining salinity in the CSL within the target range and prevent ecological degradation during periods of low flows from the River Murray.

Construction on SEFRP commenced in March 2017. The project includes construction of a new channel from the existing Blackford Drain to the southern end of the Taratap Drain (approximately 12 kilometres), widening of the existing Taratap and Tilley Swamp Drains (approximately 81 kilometres), and connection to Morella Basin before flowing into the Coorong via the Salt Creek outlet. These elements provide capacity to deliver a median volume of 25.9 GL per year [redacted] directly into the CSL.

SEFRP Augmentation

In 2012, prior to finalisation of the original SEFRP Business Case, South Australia developed the South East Solution proposal, which included options to divert water from south of the Blackford Drain. These options were designed to access surplus water from Drains L, K and possibly M which currently discharges into the ocean. Due to stakeholder concerns, funding constraints and the need for further community consultation, these elements were not included within the original SEFRP.

In March 2016, the Senate Select Committee on the Murray-Darling Basin Plan recommended that the Commonwealth fund and facilitate accelerated work on the restoration of surface flows from the south-east of South Australia into the lower Coorong, and undertake a feasibility study into the potential for redirecting all existing drainage discharges from the South East into the Coorong.

On 11 December 2016, the Department of Agriculture and Water Resources approved funding for the Coorong Investigations Project (CIP).

The CIP is investigating the technical and implementation feasibility, and individual and collective benefits and risks, of a number of possible works and measures for maintaining and enhancing the ecological character of the Coorong and Murray Mouth across all water availability scenarios. All investigations are expected to be complete by mid-2017. The findings and recommendations will then be presented to the South Australian Minister for Water and the River Murray for consideration.

Investigation of the potential increase in yield to the CSL from the South East Drainage Network through 'augmentation' of the original SEFRP supply measure was prioritised within the CIP.

3.2 Progressing SEFRP Augmentation

The technical feasibility investigations of the SEFRP Augmentation have showed the potential to provide a median extra 15.6 GL of water annually to the CSL at an estimated construction cost of [redacted] Technical feasibility is based on:

- [redacted]
- [redacted]

The results of these technical feasibility investigations undertaken to date form the technical basis of this addendum.

As noted in Section 2, given the SDL adjustment assessment process timeframes, this addendum has been developed ahead of completion of the SEFRP Augmentation feasibility assessment, and subsequent submission of any resultant business case for funding and implementation to the Australian Government.

By end June 2017, in addition to the completed hydrological and engineering preliminary design reporting, it is anticipated that the CIP will have completed:

- hydrodynamic and water quality modelling of the Coorong to understand the implications of SEFRP Augmentation;
- assessment of the ecological benefits and risks of SEFRP Augmentation; and
- preliminary assessment of the impacts of SEFRP Augmentation upon the community (including Aboriginal communities).

4. Changes to the SEFRP Phase 2 SDL Adjustment Evaluation Criteria

Key documents that demonstrate the technical feasibility of SEFRP Augmentation and support the project as an SDL Adjustment measure are outlined in Table 2 below.

Table 2 – SEFRP Augmentation – Technical Feasibility

Document	Purpose	Attachment
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
Effects of Morella Basin water releases on Coorong Water Quality **Mosley et al. 2017**. *Assessment and modelling of the effects of the 2013-2016 Morella Basin releases on Coorong water quality. Report to the Department of Environment, Water and Natural Resources (DEWNR). University of Adelaide, South Australia.*	Details the water quality benefits of water from the South East Drainage Network on the Coorong, in particular the Southern Lagoon.	Attachment 3
South East Flows Restoration Project: Water quality risk assessment for the Coorong **Wilson et al 2016**. *South East Flows Restoration Project: Water quality risk assessment for the Coorong. DEWNR Technical report 2016/01, Government of South Australia, through Department of Environment, Water and Natural Resources, Adelaide.*	This document formed part of the EPBC referral for the SEFRP project. It provides a detailed analysis of the risk to Coorong water quality from South East flows water. It essentially concludes that there is a low risk of negative water quality impacts from SEFRP.	Attachment 4

Changes to the original SEFRP Supply Measure against the *Phase 2 Assessment Guidelines for Supply and Constraint Measure Business Cases* resulting from the inclusion of SEFRP Augmentation are summarised in Table 3 below.

Table 3 – SEFRP Augmentation – Changes to SEFRP Supply Measure

Phase 2 Assessment Guideline Information Requirement	Relevant Information Requirement Number	Relevant section of the *SEFRP SDL Supply Measure Phase 2 Business Case* (*or supporting documentation*) (December 2014)	Changes documented in this addendum as a result of SEFRP Augmentation (this document)
Eligibility	Section 3	Section 3	No change to the criteria of a supply measure under Basin Plan cL7.03 and cL7.15. The delivery date will change. Construction of the SEFRP Augmentation is expected to be completed within time to meet Eligibility Criteria 3.3 (Operational by June 2024).
Project Details	Section 4.1	Section 3Section 4, Table 4: references the *SEFRP Phase 2 Business Case (DEWNR, 2013) sections 2,5,6.1, 7 and 13* Section 4, Table 4: references the *Third Deed of Variation to the Project Schedule for the South Australian Priority Project SA – 07: Coorong, Lower Lakes and Murray Mouth Recovery Project* Appendix 6: Revised SEFRP cost details	SEFRP Augmentation changes the Delivery Model, Schedule, Costs and Project Scope. See section 5.1 for details.
Ecological values of the site	Section 4.2	Section 4, Table 4: references the *SEFRP Phase 2 Business Case (DEWNR, 2013) section 2*	No change, as SEFRP Augmentation contributes to the same site (the Coorong) as SEFRP.

Ecological objectives and targets	Section 4.3	Section 4, Table 4: references the *SEFRP Phase 2 Business Case (DEWNR, 2013) section 3* Section 4, Table 4: references further details in *Lester et. al 2011]*.	No change. As with the existing SEFRP, the primary outcome for SEFRP Augmentation is to assist in managing salinity in the CSL in order to maintain a healthy ecosystem.
Anticipated ecological benefits	Section 4.4.1	Section 4, Table 4: references the *SEFRP Phase 2 Business Case (DEWNR, 2013) sections 3, 5.4 and 6.7*	Since the SEFRP Phase 2 Business Case (2013) and SDL Phase 2 Business Case (2014), further studies (e.g. Mosley et al. 2017) have improved knowledge of the impacts of water from the South East to the CSL. Further studies are currently being conducted as part of the CIP. Major changes to the anticipated ecological benefits to the CSL are not anticipated but some ecological benefits, including to *en route wetlands,* are likely to be enhanced by SEFRP Augmentation. See section 5.2 for details
Potential adverse ecological impacts	Section 4.4.2	Section 4, Table 4: references the *SEFRP Phase 2 Business Case (DEWNR, 2013) sections 6.6 and 6.7* Section 4, Table 4: references the *South East Flows Restoration Project EPBC Referral, Section 3*	While the major potential adverse ecological effects of SEFRP Augmentation are covered in the *SEFRP SDL Adjustment Supply Measure Phase 2 Business Case*, there are some additional environmental risks posed by SEFRP Augmentation dealt with in section 5.3.
Current hydrology and proposed changes to the hydrology	Section 4.5.1	Section 5 and included references	The current hydrology of the CSL remains unchanged from the descriptions provided in the SEFRP Phase 2 Business Case. SEFRP Augmentation introduces proposed changes to the hydrology beyond those listed in Section 5 of the SEFRP SDL Phase 2 Business Case, and these are documented below in section 5.4.
Environmental water requirements	Section 4.5.2	Section 4, Table 4: references the *SEFRP Phase 2 Business Case (DEWNR, 2013) section 3* Section 4, Table 4: references further details in *Lester et. al 2011*	The Environmental water requirements for the Coorong and SEFRP *en route* wetlands remain unchanged from SEFRP. Additional information regarding the environmental water requirements for SEFRP Augmentation *en route* wetlands (including but not limited to Lake Hawdon North and the Robe Lakes) is contained within sections 5.2 and 5.5.

Operating regime	Section 4.6	Section 4, Table 4: references the *South East Flows Restoration Project EPBC Referral, Section 3* Section 5	SEFRP Augmentation will increase the volume, security and delivery flexibility of water both within the affected sub-catchments, and through the SEFRP, to the CSL. See below, section 5.5.
Assessment of risks and impacts of the operation of the measure	Section 4.7	Section 4, Table 4: references the *SEFRP Phase 2 Business Case (DEWNR, 2013) section 12 and Appendix C* Appendix 7	At project and operational levels, the risks remain unchanged from the existing SEFRP.
Technical feasibility and fitness for purpose	Section 4.8	Section 4, Table 4: references the *SEFRP Phase 2 Business Case (DEWNR, 2013) sections 5.1, 5.2, 6.7, 7, 9, 11, 13* Section 4, Table 4: references pages 73 and 75 of the *Third Deed of Variation to the Project Schedule for the South Australian Priority Project SA – 07: Coorong, Lower Lakes and Murray Mouth Recovery Project* Appendix 6	A more detailed determination of technical feasibility and fitness for purpose requires a full SEFRP Augmentation Business Case. However, pre-feasibility hydrological modelling and construction design and costings suggest that it is feasible, subject to downstream wetland requirements, to deliver a median of 15.6 GL/year to the CSL, for an estimated cost of [redacted]. See Section 5.6.
Complementary actions and interdependencies	Section 4.9	Section 3	SEFRP Augmentation relies on the completion of SEFRP. See section 5.7

Costs, benefits and funding arrangement for new unfunded projects	Section 4.10.1	Not addressed in the SEFRP SDL Phase 2 Business Case, as it was fully funded through the *"Lower lakes and Murray Mouth Recovery Project Schedule SA-07 to the South Australian and Commonwealth Water Management Partnership Agreement"*	The benefits of SEFRP Augmentation are primarily to increase the volume, security and flexible delivery of water to the Coorong South Lagoon, as well as maintaining and improving environmental watering of *en route* wetlands. The anticipated cost of the project, based on a comparative cost breakdown of SEFRP, is approximately [redacted] (Table 5 below). Funding is sought through SDL Supply Measure Funding or State Priority Project (SPP) underspends, subject to further Commonwealth negotiation and SEFRP Augmentation Business Case process. See Sections 5.1 and 5.8
Costs, benefits and funding arrangement for Projects not seeking Commonwealth Supply or Constraint Measure Funding	Section 4.10.2	Section 4, Table 4: references the SEFRP Phase 2 Business Case (DEWNR, 2013) sections 7.1 and 11 Section 4, Table 4: references pages 6, 72-75 of the *Third Deed of Variation to the Project Schedule for the South Australian Priority Project SA – 07: Coorong, Lower Lakes and Murray Mouth Recovery Project*	Not applicable (see 4.10.1).

5. Amendments to the Original SEFRP Supply Measure Information Requirements

This section expands on the changes to the original SEFRP Supply Measure against the *Phase 2 Assessment Guidelines* resulting from the inclusion of the SEFRP Augmentation.

5.1 Information Requirement 4.1 - Project Details

SEFRP Augmentation proposes to increase the volume, security and delivery flexibility of water to the CSL via the original SEFRP drain alignment, with additional water from further south (Drain K, Avenue Flat K Drain and Wilmot Drain) that currently flows out to sea (Figure 1).

Pre-feasibility design indicates that SEFRP Augmentation would involve upgrades to 27 km of existing drain, construction of approximately 4.5 km of new drains to link the drain catchments, and the installation of 12 minor and 5 major regulating structures.

SEFRP Augmentation could yield an estimated 15.6 GL per annum to the CSL for an estimated total project cost of [redacted].

5.2 Information Requirement 4.4.1 - Anticipated Ecological Benefits

Coorong

By increasing the volume, security and delivery flexibility of water, SEFRP Augmentation is anticipated to support and enhance the ecological benefits of the original SEFRP supply measure outlined in section 5.4 of the *SEFRP Phase 2 Business Case*. The extent to which this is the case, and any additional benefits, are currently being explored through the CIP. The results from CIP modelling of any additional ecological benefits associated with SEFRP Augmentation will be included within the Business Case.

Drain catchments

SEFRP Augmentation will increase operational flexibility of the drainage network, reinstate more 'natural' hydrological regimes and increase the volume of water available for local and *en route* wetlands. Specifically, SEFRP Augmentation will allow for the maintenance and adaptive management of water levels in Lake Hawdon North and the maintenance of contemporary salinity and water levels of the Robe Lakes.

Lake Hawdon North, the largest potentially affected wetland, is a 2500 ha seasonally inundated lake dominated by native vegetation that provides important habitat for native fish and waterbirds including migratory waders (internationally significant numbers of the Double-banded plover have been observed (Christie and Jessop, 2007)). In order to maintain environmental benefits to Lake Hawdon North, whilst providing yield to the Coorong, a Drain L regulating structure is proposed at the western (down-stream) end of Lake Hawdon North. This structure, subject to final design, would regulate the inundation of Lake Hawdon North using runoff generated from the Drain L catchment below the SEFRP Augmentation diversion points. Previously, flows from Avenue Flat K Drain and Drain K (included within SEFRP Augmentation) would have contributed to Drain L flows. The regulator could be used to facilitate improved management of Lake Hawdon North, including more frequent and longer inundation (subject to stakeholder consultation) (Taylor et al. 2014). Modelling indicated that sufficient runoff will be generated within Drain L downstream of the SEFRP Augmentation diversion to maintain the high quality estuarine character of the Robe Lakes and an open channel mouth at Robe (Taylor et al. 2014).

An added ecological benefit of the changes to the Drain L catchment and Lake Hawdon is an overall reduction in the quantity of fresh water released to the ocean at Robe. Studies of the marine environment in the vicinity of similar drainage discharge points in the South East have shown degradation of sea-grass beds (Seddon et al. 2003; Wear et al. 2006). The same may be occurring in Guichen Bay at the mouth of Drain L, although no specific studies have been conducted at the site.

5.3 Information Requirement 4.4.2 - Potential Adverse Ecological Effects

The major potential adverse ecological effects of SEFRP Augmentation, including clearance of native vegetation, soil and water quality impact to *en route* wetlands and Coorong are covered in the original *SEFRP Phase 2 Business Case* (2013, s6.6, 6.7) and the *SEFRP EPBC Referral, Section 3*. Any additional risk posed by SEFRP Augmentation and the potential for Augmentation to exacerbate existing SEFRP risks are currently being investigated by the CIP.

Potential exacerbation of water quality impacts on the CSL

The introduction of further water from the South East into the CSL could enhance potential risks identified in previous SEFRP documents, including the contribution of nutrients and reduction of CSL salinity (a risk if salinities are reduced below target levels (Mosley et al. 2017, Paton et al. 2015)).

Since the potential adverse ecological effects were catalogued for the original SEFRP supply measure, a detailed water quality risk assessment has been undertaken (Wilson et al. 2016). This study found that the water quality risks to the Coorong ecosystem posed by increased inflows from the South East drainage network are low and manageable. Water quality monitoring data in the Coorong has shown no adverse impacts due to Salt Creek inflows (Mosley et al. 2017). The nutrient concentration of Salt Creek flows is considerably lower than the standing concentration in the CSL, and this is not anticipated to change under either the SEFRP or the SEFRP Augmentation. The data suggests that any additional CSL water quality risks posed by SEFRP Augmentation are minimal and that, in fact, there may be water quality benefits. Notwithstanding, potential adverse impacts from particular flow events or conditions have the additional operational safeguard of water being diverted, as currently occurs, out to sea rather than to the Coorong, or diverted to *en route* wetlands rather than the CSL.

A major component of the current concern surrounding changes in salinity and nutrient levels in the CSL as a result of increased flows from the South East is the lack of understanding of the potential impacts on filamentous algae growth. While the impacts of filamentous green algae have been studied and targets for its management have been set (Wallace et al. 2014; DEWNR 2015), understanding of the relative contribution to its growth from nutrient inputs from water from the South East versus the existing nutrient pool within the Coorong and nutrient inputs from the River Murray is poorly understood. It is possible that substantially reducing CSL salinity will favour filamentous algae growth (Mosley et al. 2017). Further detailed investigations are currently being conducted to understand the drivers behind algal proliferation through the CIP and the CLLMM Optimising *Ruppia* Habitat project. Under SEFRP Augmentation, as with the original SEFRP supply measure, operational control of the timing and quantities of water release to the CSL will provide primary control for water quality and managing filamentous algae growth. The SEFRP Augmentation poses no increased risk of 'over-freshening' the CSL, because if the additional flows are not required they could be diverted to sea via either Drain L or the Blackford Drain, or stored in/delivered to *en route* wetlands.

Connectivity of South East Drain catchments fish habitat

The exotic fish species *Gambusia holbrooki* is present within the Blackford Drain catchment, but not within the Drain L catchment. Consequently, linking the Blackford with the Avenue Flat K Drain, Drain K and Wilmot drains within the Drain L catchment poses a risk to numerous native fish and frog species. South Australia's most significant population of the Australian Mudfish (*Neochanna cleaveri*) would be at risk, along with the nationally listed (vulnerable) Dwarf Galaxias (*Galaxiella pusilla*) and Southern Bellfrog (*Litoria raniformis*). The exclusion of *Gambusia* from those catchments using an exclusion structure on the Blackford Drain is being investigated through the CIP.

In contrast to the need to limit fish migration from the north of the project, there is equally an environmental risk that Lake Hawdon North regulation may prevent the up-stream migration of native fish such as Congolli, Yelloweye Mullet, Australian Salmon and *Galaxias* (Taylor et al. 2014). To mitigate this risk, the Lake Hawdon North Regulator design includes provision for a 'fishway' structure.

5.4 Information Requirement 4.5.1 - Current hydrology and proposed changes to the hydrology

SEFRP Hydrology

This section should be read in the context of the South East hydrology as outlined in the *SEFRP Phase 2 Business Case* and updated in section 5 of the *SEFRP SDL Adjustment Supply Measure Phase 2 Business Case*. The updated hydrology for the area provided in the *SEFRP SDL Adjustment Supply Measure Phase 2 Business Case* used daily time-step rainfall-runoff modelling to represent runoff from the Upper South East drainage system on the MDBA benchmark 1891-2009 period. Salinity was interpolated from a regression relationship developed from flow/salinity data at Salt Creek (Gauge A2390568).

The modelled contribution from the Existing Drainage Network acceptably replicated gauged flows at Salt Creek, noting that there had been construction of drains in the Upper South East over the past two decades, which makes comparison to consistent conditions difficult. Consequently, the model was used to estimate yield to the Coorong from the SEFRP, which would link the Blackford Catchment to the Taratap Drain through 12km of new drain and approximately 81km of drain upgrades.

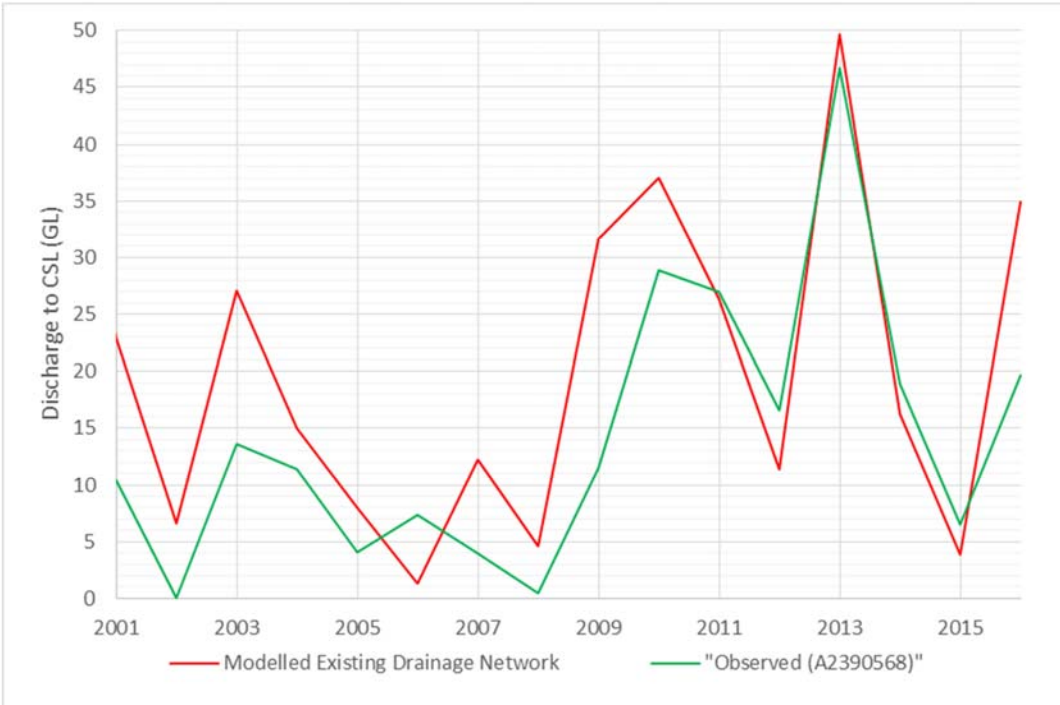
SEFRP Augmentation Hydrological Changes

Updated hydrological modelling of the SEFRP Augmentation, including the EDN and SEFRP [redacted] has re-evaluated prior modelling (AWE 2012, Taylor et al. 2014) to refine the potential yield to the CSL. Based on existing channel capacities and pending upgrades within the EDN and SEFRP, a maximum total diversion of 300ML/day to the Blackford catchment from SEFRP Augmentation was assumed.

The updated yield modelling incorporates an eWater Source model from Taylor et al (2014) for the Drain K and Wilmot Drain catchments (main catchments for SEFRP Augmentation) and a WaterCress model originally developed by Wood and Way (2011) for the Blackford Drain catchment. Transmission losses were incorporated within yield modelling using an MS Excel-based water balance model originally developed by Montazeri et al (2011) and subsequently modified by AWE (2012, 2015). For all models, timeframes were updated to include data from 1889-2016 (compared to 1891-2009).

The resulting modelled annual yields to the Coorong (catchment yield minus transmission loss) were compared with the recorded volumes at Salt Creek, where recording began in 2001 (See figure 2 below). The modelled volumes are greater than observed volumes from 2001-2009. This result is expected, as the model includes all current drains, a number of which were constructed between 2003-2012. From 2011 onwards the observed and modelled results are very similar and prior to 2009 there is a strong correlation between observed and modelled inputs to the CSL [redacted]

Figure 2: Modelled and observed flow to the Coorong at Salt Creek. It should be noted that prior to 2011 the model includes as yet unconstructed drains, and as such is expected to over-estimate observed discharge [redacted]



Stage 1 hydrological modelling [redacted] provides a number of construction and yield scenarios for SEFRP Augmentation. Those scenarios are represented in figure 3 below. A maximum 300ML/day diversion from Avenue Flat/Drain K and a 150ML/day diversion from the Wilmot Drain was selected as an optimum scenario in terms of yield efficiency compared to drain upgrades required. The resulting yields to the Coorong South Lagoon, compared with the Existing Drainage Network and SEFRP are presented below in table 4, full results from all scenarios are included in Attachment 2.

Figure 3 - Time series of annual yield to Blackford Drain at 300 ML/d peak diversion from Drain K, showing different peak contributions from Wilmot Drain [redacted]

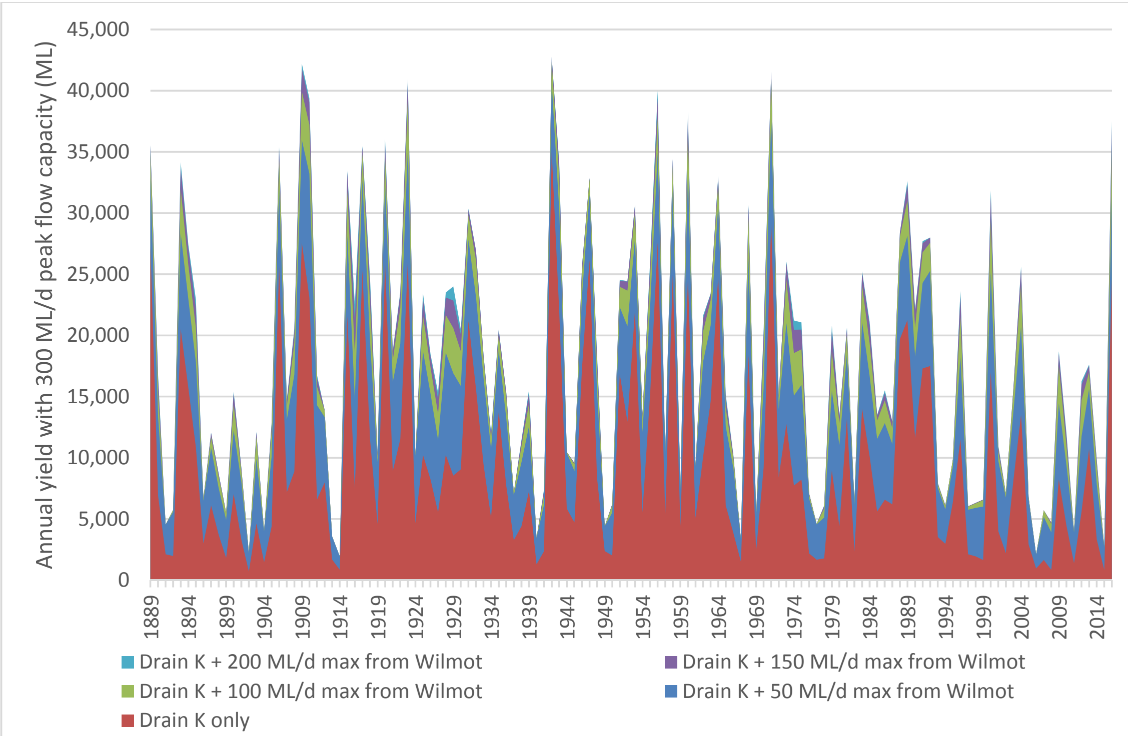


Table 4 – Adapted from [redacted] **Summary of average annual yields (1889-2016) to the Coorong South Lagoon under 3 scenarios (EDN, SEFRP, SEFRP Augmentation)**

Scenario	Maximum diversion from Blackford (ML/d)	Maximum diversion from Avenue Flat K Drain/Drain K (ML/d)	Maximum contribution from Wilmot (ML/d)	Release to CSL (ML/yr)	Increase in release to CSL above EDN (ML/yr)
SEFRPA	600	300	150	70,879	+41,494
SEFRP	600	0	0	55,301	+25,916
EDN	0	0	0	29,385	-

Based on a refined and extended (1989-2016) hydrological model, SEFRP Augmentation can provide approximately 2.5-42.5 GL of water per year to the Coorong South Lagoon, in addition to contribution from the Existing Drainage Network and SEFRP. A median yield of 15.6 GL per year is expected.

5.5 Information Requirement 4.6 – Operating Regime

The SEFRP Augmentation operating strategy will be determined in consultation with the local community and take into account any information generated through additional ecological investigations. Ideally, funding of SERFP Augmentation would include support for the development of a Decision Support Framework that takes into account barrage flows, downstream and *en route* wetland requirements and predicted Coorong salinity conditions. For the purposes of the SDL adjustment mechanism and enabling the Murray-Darling Basin Authority to represent the SEFRP Augmentation in the SDL adjustment benchmark model run, a number of operating assumptions have been developed based on the current understanding/assumptions of how the SEFRP Augmentation may be operated. These are provided below, noting that these assumptions may not be included in the final operating regime of the SEFRP Augmentation to be developed as part of project implementation.

There are a number of proposed structures as part of SEFRP Augmentation that will be operated depending on the water requirements of the CSL and local wetlands. These may divert flow from SEFRP Augmentation into the SEFRP Blackford Drain system, from which point the operating infrastructure and decisions remain essentially unchanged. From North to South, these regulators are:

1. the regulator at the junction of [redacted] and the proposed extension of the Blackford Drain (includes anti-fish passage);

2. the regulator at the junction of the Wilmot Drain and the proposed extension of the Avenue Flat Drain;

3. the regulator at the western end of Lake Hawdon North (includes fish migration passage).

Avenue Flat/Drain K and Wilmot Drain Regulators:

While a detailed Operating Procedure will be developed as part of the implementation of the SEFRP Augmentation, assumptions regarding diversion rules are required for the purposes of modelling and assessing the proposal. As such, it has been assumed that flow from the Avenue Flat/Drain K and Wilmot drains will be diverted, when needed to improve environmental benefits and when water is available, up to the capacity of the proposed drains of 300 and 150ML/d respectively. Any diversion would take into account the environmental watering requirements of the downstream wetlands, Lake Hawdon North and the Robe Lakes (generally met by Drain L local catchment yield).

Lake Hawdon Regulator:

Currently water from the Drain L catchment (including Avenue Flat/Drain K) flows through Lake Hawdon North within the Drain L channel, which bisects the lake. Currently during high flows in Drain L (over 3.7mAHD) there is some inundation of the lake from the Drain, with extensive inundation occurring less frequently and for shorter durations (Taylor et al. 2014). Low and moderate flows provide little water to the lake and flow downstream within the channel, through the Robe Lakes out to sea. This project proposes to install a regulating structure immediately downstream of Lake Hawdon North, similar in function to other major regulators within the system. The structure's design would facilitate maintenance of lake levels in Lake Hawdon North or through flow of up to 3000 ML/day depending on operational and environmental needs.

Operational safeguards to manage adverse impacts:

As with the existing SEFRP, there are a number of substantial operational safeguards allowing any SEFRP Augmentation flows that would be harmful to the Coorong to be diverted. 'Excess' water can be stored in and/or used for environmental benefits to *en route* SEFRP wetlands at Taratap, Tilley Swamp and Morella. Additionally, water from SEFRP Augmentation can be diverted through Drain L into Lake Hawdon North, where the proposed regulating structure would then determine flows to the Robe Lakes. In the event that any/all of these storages are full or their inundation is inappropriate, water can be released to the ocean at the existing Drain L and Blackford Drain outlets. The engineering design and operation of the SEFRP Augmentation infrastructure will ensure management expectations of the existing South Eastern Drainage Network are maintained. This includes flood mitigation in winter and the maintenance of groundwater in spring and summer using groundwater regulators.

5.6 Information Requirement 4.8 - Technical feasibility and fitness for purpose

Detailed determinations regarding technical feasibility and fitness for purpose (e.g. cost-benefit analysis, detailed budget, operational monitoring and record keeping arrangements and governance and funding structure details) will be presented in a full SEFRP Augmentation Business Case.

Alignment options investigation

Multiple SEFRP Augmentation alignment options were originally investigated as part of the SEFRP feasibility study in 2010-2012. During that process two options were discounted due to geographical and hydrological considerations: the western-most Biscuit Flat alignment was not considered feasible as it was too far west to align with the Northern Floodway within the existing SEFRP. The eastern-most alignment, Western Avenue, was discounted due to poor hydraulics, significant impacts on local drainage and water quality issues.

Cost estimates were developed for the Reedy Creek alignment and Blackford Extension. The latter alignment was preferred based on community input, lower transmission losses and comparatively minimal native vegetation clearance during drain construction.

A review of alignment options for the CIP concluded that connecting to the existing SEFRP (Blackford) alignment was the preferred means of implementing Augmentation. The Blackford alignment maximizes yield to the Coorong, minimizes cost through use of existing infrastructure and is considered most likely to gain community and landholder support.

Technical feasibility

The engineering pre-feasibility design and costings for SEFRP Augmentation construction are available in Attachment 2. The design and costings are based on the hydrological modelling (Attachment 1) of SEFRP Augmentation yield reaching a maximum of 500ML/day to the Blackford at the Drain K regulator; yield was considered optimal at 300ML/day from the Avenue Flat K Drain/Drain K + 150ML/day from the Wilmot Drain. In order to facilitate these yields, construction of new drain sections linking the Blackford Drain with the Avenue Flat K Drain/Drain K and Wilmot Drain is required. Sections of the Avenue Flat drain will be upgraded to ensure sufficient capacity.

Based on the hydrological modelling yields and the associated design and construction costings and subject to further ecological investigations and local wetland environmental watering requirements, the SEFRP Augmentation could provide a median of 15.6 GL/year to the CSL.

5.7 Information Requirement 4.9 - Complementary actions and interdependencies

SEFRP Augmentation relies on the completion of the current SEFRP project to deliver water to the CSL.

In terms of ecological benefits to the Coorong, there are interdependencies between SEFRP Augmentation and any potential regulating structure within the Coorong South Lagoon (investigation ongoing through the Coorong Investigations Project).

The SEFRP Augmentation potentially provides an SDL adjustment for the CSL, which sits in SDL resource unit SS10 (SA Non-Prescribed Areas). Any subsequent effects on the Lower Lakes or Murray Mouth would extend into resource unit SS11 (SA Murray) and could be better characterized as risks and impacts rather than an SDL adjustment.

5.8 Information Requirement 4.10.1 - Costs, benefits and funding arrangement for new unfunded projects

The existing SEFRP is fully costed and funded through the *Coorong, Lower Lakes and Murray Mouth Recovery Project Schedule SA-07* to the South Australian and Commonwealth Water Management Partnership Agreement; construction is underway.

Pre-feasibility design and costing (Attachment 2) of SEFRP Augmentation estimates the construction costs to be [redacted].

A total project costing, based on a comparative cost breakdown of SEFRP, estimates a total SERFP Augmentation cost of up to [redacted] (Table 5 below).

SEFRP Augmentation could be funded through SDL Supply Measure Funding or State Priority Project (SPP) underspends, subject to further Commonwealth negotiation and the SEFRP Augmentation Business Case process.

By 30 June 2017, if determined feasible through the Coorong Investigations Project, a SEFRP Augmentation Implementation Business Case suitable for Australian Government funding consideration will be developed.

It is anticipated that the SEFRP Augmentation Business Case can undergo Commonwealth Due Diligence Assessment by December 2017.

Subject to Commonwealth funding, a number of pre-implementation activities could be progressed during the period July to December 2017, in anticipation of a favorable Due Diligence outcome. These include Planning and Design, Community Engagement, Impact Assessment, Modelling and Surveys, Legal – as well as elements of Detailed Design, Cultural Heritage Clearances and Environmental Management

Table 5 – Indicative SEFRP Augmentation Budget

SEFRP Augmentation Activity	Indicative Budget	Budget Details/Comments
Planning, Design and Community Engagement	[redacted]	Indicative percentage based on comparison with SEFRP Funding Agreement, reduced to reflect partial funding of these tasks by the Coorong Investigations Project
Impact Assessment	[redacted]	Indicative percentage based on comparison with SEFRP SDL Phase 2 Business Case
Modelling and Surveys	[redacted]	Indicative percentage based on comparison with SEFRP Funding Agreement, reduced to reflect partial funding of these tasks by the Coorong Investigations Project
Legal	[redacted]	Indicative percentage based on comparison with SEFRP Funding Agreement
Land Acquisition	[redacted]	Indicative percentage based on comparison with SEFRP Funding Agreement
Cultural Heritage Clearances	[redacted]	Indicative percentage based on comparison with SEFRP Funding Agreement
Environmental Management	[redacted]	Indicative percentage based on comparison with SEFRP Funding Agreement
Land Access	[redacted]	Indicative percentage based on comparison with SEFRP Funding Agreement
Construction (including contingency)	[redacted]	Tonkin Consulting 2017 (Attachment 2)
Project Management	[redacted]	Indicative percentage [redacted] of overall project cost based on comparison with SEFRP SDL Phase 2 Business Case
OVERALL TOTAL:	[redacted]	Phase 1 + Phase 2 project delivery, subject to detailed revision during Business Case Development

6. List of Attachments

[redacted] [redacted]

[redacted] [redacted]

Attachment 3 Mosley et al. (2017) Assessment and modelling of the effects of the 2013-2016 Morella Basin releases on Coorong water quality. Report to the Department of Environment, Water and Natural Resources (DEWNR). University of Adelaide, South Australia.

Attachment 4 Wilson et al. (2016) South East Flows Restoration Project: Water quality risk assessment for the Coorong. DEWNR Technical report 2016/01, Government of South Australia, through Department of Environment, Water and Natural Resources, Adelaide.

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