WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS

Report

Cummins Wanilla Basin – Preliminary Drainage Management Plan

Eyre Peninsula Landscape Board, Department for Environment and Water

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EXECUTIVE SUMMARY

Purpose

The purpose of this report is to provide sound planning on a wide range of improvements and management needs with the focus on investigation of options for reducing the problem of waterlogging and dryland salinity in the Cummins Wanilla Basin catchment area. This work will be used by Eyre Peninsula Landscape Board (EPLB) to provide advice and recommendations on the strategic management of the drainage network for the future. It will also be used to help allocate $250k funding potentially available to deliver on-ground remedial works, with like-for-like contribution from stakeholders anticipated. A Recommended Practice document has also been prepared in parallel to this drainage management plan, to provide further information on the causes of waterlogging and dryland salinity to landowners, and to inform on best practice for remedial works. This document aims to provide some guidance on best practice, whilst acknowledging the importance of local knowledge.

This work is important for guiding future management of the drainage network in a strategic way. It is also important to improve water quality leaving the catchment, and to help prevent siltation in Kellidie Bay which will ultimately impact a range of commercial and recreational activities, such as recreational and commercial fishing, including the oyster industry in Coffin Bay.

Drivers for the Study

The Catchment Management Plan was completed in June 2002 and was the result of a 3 year study aimed at coordinating and implementing on ground works to address the immediate issues of dryland salinity and waterlogging. A review and evaluation of the Cummins Wanilla Basin Project was undertaken in 2009 by Rural Solutions SA. This included appraisal of the incentive-based on-ground works (OGW), monitoring activities and strategic initiatives undertaken to address the issue of dryland salinity. Since 2009, no further review has been taken of OGW.

Economic analysis of the CWB Drainage Management System in 2018 identified the need for investment in and implementation of a drainage management plan for the CWB drainage channel system and associated drainage scheme infrastructure. Landowners invest in rehabilitating drainage affected land and improving production from that land.

The CWB drainage channel system has been developed privately and with government assistance. They require ongoing upkeep in order to maintain hydraulic function and intended flow efficiencies. The economic analysis report documents that significant flows have occurred throughout this catchment over the last few winters (not quantified), resulting in the silting up/blocking of drains and an increase in waterlogged and salinity impacted areas. At the same time previously available state and federal government financial assistance for system maintenance has been lost and maintenance relies on uncoordinated individual landholder action.

Objectives

In order to make recommendations for a drainage management plan to resolve these issues, the key objectives were to:

- Provide recommendations on key future management actions for the catchment
- Understand the drainage channels and other infrastructure in the CWB area
- Understand the waterlogging mechanisms in the Basin so that these can be addressed holistically
- Recommend prioritised drainage management works to mitigate waterlogging and salinity
- Prepare a Recommended Practices document which will include a set of engineering guidelines and specifications for common types of infrastructure upgrade

Approach

Initial data gathering included a desktop review of previous studies relating to the Cummins Wanilla Basin, review of best practice and advice from other states, review of groundwater and surface water, and comparison of this information with stakeholder requirements. Stakeholder requirements were assessed following two meetings, a site visit to speak to landowners, and an online GIS based survey. The response to this survey was less than anticipated, with an insufficient number of individuals responding. A second attempt at survey was undertaken, but did not produce a significant number of responses from additional landowners. As a result, the survey information was inadequate to enable quantitative assessment of the catchment, and a list of proposed specific on-ground works could not be completed. The GIS element allowed mapping of reported issues, which have been compared with surface water modelling and groundwater maps.

Results gained have been compiled in a GIS based map, which will allow EPLB to demonstrate a strategic plan with key works prioritised. It is intended that this will improve the prospects for future Federal government funding applications to assist with drainage works in the CWB.

A recommendation has been made for on-ground works targeting the following areas:

- Upgrading and clearing drainage channels
- Watercourse crossings
- Replacement of drainage pipes beneath roads

Although this approach was not sufficient to allow quantitative planning of works, the consistency in the reporting of observed problems allowed their overall nature to be understood. This has been used to take a strategic approach to future planning of remedial works. A number of works have been identified following a landowner survey, and these works should be investigated further to ensure they meet the criteria to be recommended for implementation.

Main Recommendations

The original aim of this Drainage Management Plan was to identify and prioritise on-ground works that would be funded under an identified $250k. As the level of engagement did not allow specific works to be identified, a draft application form and a prioritisation process were developed to allow the funding to be accessed following applications by landowners and other stakeholders. This approach will allow a more appropriate catchment-level consideration to be followed.

Recommendations for works have been made following discussion and observation of the problems reported in the catchment, and how remedial works can help to resolve the problems. These solutions also align with the strategic outcomes in the 2017 Strategic Plan for the Eyre Peninsula Natural Resources Management Region (now the Eyre Peninsula Landscape Board).

The main recommendations following this reporting are:

- Undertake catchment level planning for works to reduce salinity and waterlogging
- Encourage landowners to undertake property level management planning, with advice and support from EPLB as appropriate
- Consider further recommendations for future work including monitoring
- To seek applications from landowners for on-ground works that can be funded on a like-for-like basis, which will mainly be a property level planning
- All works applications to be assessed and prioritised to ensure they meet strategic aims, but this would be most effective following catchment level analysis and planning

Recommendations for Future Work

It is recommended that resolution of the following issues should be prioritised as part of a longer term strategy approach:

- Improving drainage to reduce waterlogging and erosion
- Increasing planting of high water-use crops or native vegetation – this will help reduce waterlogging and also prevent erosion of bare patches of land
- Ensure any works consider the impacts of water quality and sedimentation downstream in the catchment
- Further investigation and monitoring – consider how a further survey and/ or data gathering exercise could be carried out to ensure more thorough engagement by landowners and other stakeholders
- Opportunities for catchment-level studies and design
- Periodic review of on-ground works undertaken (both partially funded by the available grant, and also fully privately funded) and comparison with improvements to waterlogging, salinity and water quality.

Recommended Practice Sheets

The Recommended Practices have been written so that best practice works are encouraged at both property and catchment level. To resolve the issues identified in the catchment, a number of short-term solutions for improvement were identified:

- Promotion of the Recommended Practices document
- Encouragement of applications for funding by landowners and other stakeholders
- Prioritisation of applications received
- Construction works to progress

GLOSSARY AND ABBREVIATIONS

Term	Definition	Abbreviation
Acid Sulphate Soils	Acid sulphate soils are natural sediments that contain iron sulphides. However, if the soils are drained, excavated or exposed to air by a lowering of the water table, the sulphides react with oxygen to form sulfuric acid.	ASS
Annual Exceedance Probability	The probability that a given rainfall total accumulated over a given duration will be exceeded in any one year.	AEP
Australian Height Datum	The datum that sets mean sea level as zero elevation.	AHD
Average Recurrence Interval	The average or expected value of the periods between exceedances of a given rainfall total accumulated over a given duration.	ARI
Catchment	Area of a landscape from which a surface watercourse or groundwater system derives its water. Catchments are generally separated by 'no flow' divides associated with high topography.	
Cummins Wanilla Basin	Catchment area discussed in this document.	CWB
Department for Environment and Water	SA Government Department responsible for ensuring that South Australia's natural resources are managed productively and sustainably, while improving the condition and resilience of the state's natural environment.	DEW
Digital Elevation Model	A bare-earth elevation model of the earth's surface, with features such as vegetation, bridges and roads filtered out.	DEM
Digital Terrain Model	A DTM is a mathematical representation of the ground surface. A DTM augments a DEM by including linear features of the bare-earth terrain.	DTM
Discharge area	Area in the landscape where the net movement of groundwater is out of the catchment. Waterlogging and salting are most likely to occur in this area, as expressions of groundwater discharging at the soil surface by seepage or evaporation.	
DCLEP	District Council of the Lower Eyre Peninsula	
Dryland	Not under irrigation.	
Eyre Peninsula Landscape Board	The catchment management authority for Cummins Wanilla Basin	EPLB
Flood	Relatively high stream flow which overtops the natural or artificial banks in any part of a stream, river, estuary, lake or dam, and/or overland runoff before entering a watercourse and/or coastal inundation resulting from super elevated sea levels and/or waves overtopping coastline defences.	-
Flood Frequency Analysis	A technique to predict flow values corresponding to specific return periods or probabilities along a watercourse or flow path.	FFA
Groundwater	Water occurring below the surface of the landscape, at greater pressure than atmospheric, occupying cavities and spaces in regolith and bedrock. The upper surface of the groundwater is the water table.	

Term	Definition	Abbreviation
Groundwater discharge	Removal of water from the saturated zone. Water exits the groundwater by surface seepage, subsurface outflow, base flow in streams, evaporation, and evapotranspiration.	
Groundwater Infiltration	Groundwater that infiltrates pipeline and manhole defects located below the ground surface. Groundwater infiltration is separate and distinguished from inflow resulting from storm events. Infiltration is a steady 24-hour flow that usually varies during the year in relation to the groundwater levels above the sewers.	GWI
Groundwater recharge	Water entering the groundwater from the saturated zone immediately above the water table.	
Hydrology	The study of water movement in various states through the terrestrial and atmospheric environments, including underground water, surface water and rainfall, embracing the concept of a hydrologic cycle. This study involves aspects of soils, geology, oceanography, and meteorology, emphasising the processes and quantities of water flow above the terrestrial surface.	
Hydrogeology	Hydrogeology is the study of groundwater – it is sometimes referred to as geohydrology or groundwater hydrology. Hydrogeology deals with how water gets into the ground (recharge), how it flows in the subsurface (through aquifers) and how groundwater interacts with the surrounding soil and rock (the geology).	
Landform feature	Identifiable part or feature of the land surface that has characteristic form and properties identifiable in the field. In relation to salinity, a natural landform or artificial landscape feature that controls water movement in such a way that portions of the landscape, called potential discharge areas, are at risk of salting if groundwater recharge exceeds groundwater outflow.	
Lower Eyre Agricultural Development Association	A farmer-driven organisation that is meeting the research, development and extension needs of the local farming community through working with key research and development organisations, natural resource management bodies and local industry.	LEADA
On-Ground Works		OGW
Potential Acid Sulphate Soils	ASS which have not been oxidised by exposure to air	PASS
Primary Industries and Resources South Australia	An agency of the South Australian Government whose focus is the economic development of the state of South Australia. Its key areas of work include primary industry (in South Australia, mainly farming), and biosecurity.	PIRSA
Regional Flood Frequency Estimation	Methods used to estimate design floods in ungauged and poorly gauged catchments. It is a data-based empirical procedure which attempts to compensate for the lack of temporal data at a given location by spatial data.	RFFE

Term	Definition	Abbreviation
Riparian zone	Areas of land that adjoin, influence or are influenced by a body of water. Typical examples are riverbanks, floodplains, lake foreshores and wetland fringes.	
Runoff	The amount of rainfall that actually ends up as stream or pipe flow, also known as rainfall excess.	-
Saline soil	A soil containing sufficient concentrations of soluble salts within the soil profile to result in reduced plant productivity or plant death. Climate, soil type, depth to salinity in the soil and plant species influence the effect on plant productivity.	
Saline water	A water containing sufficient concentrations of soluble salts to limit plant productivity under certain environmental and management conditions or to otherwise limit the potential uses of the water	
Salinisation	The process of salts accumulating in soils or waters (also called salting).	
Salinity	The presence of soluble salts in or on soils or in waters. High levels of soluble salts may result in reduced plant productivity or plant death and may limit its suitability for various purposes.	
Salt scald	An area, bare of vegetation, where erosion of the surface soil has exposed a saline or sodic subsoil. See also scald. .	
Scald	Area where erosion of surface soil has exposed subsoils that remain bare of vegetation. Scalds can be saline or non-saline, sodic or non-sodic.	
Sodicity	The presence of a high proportion of sodium ions relative to other cations in a water or soil (in exchangeable and/or soluble form).	
Stakeholders	Entities potentially affected by the proposed activities.	
Transmission area	Area in a catchment where the net movement of water in the groundwater is lateral (approximately parallel to the soil surface) rather than vertical.	
Water table	Upper surface of a zone of saturation in an unconfined aquifer, which will be at atmospheric pressure. Below the water table, the aquifer material is permanently saturated; above the water table, the rock or soil is unsaturated. The ‘depth’ of the water table is measured relative to the soil surface as standing water level (SWL).	
Salinity Management Plan		SMP
SMS	Surface Water Modelling Software distributed by Aquaveo which can be used as an interface for TUFLOW, allowing the user to view results and also to create a TUFLOW model within the SMS interface.	SMS
Stakeholders	Entities potentially affected by the proposed activities	Stakeholders

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1 INTRODUCTION

1.1 Purpose of the Report

The purpose of this report is to investigate options for reducing the problem of waterlogging and dryland salinity in the Cummins Wanilla Basin catchment area, and to develop a new drainage management plan. This report will be used by EPLB to help allocate $250k funding potentially available to deliver on-ground remedial works, with like-for-like contribution from stakeholders anticipated. A Recommended Practices document has also been prepared in parallel, to provide further information on the causes of waterlogging and dryland salinity to landowners, and to inform on best practice for remedial works. This document aims to provide some guidance on best practice, whilst acknowledging the importance of local knowledge.

This will also allow EPLB to demonstrate a strategic planning approach, with key works prioritised. It is intended that this will improve the prospects for future Federal government funding applications, and other grants that may be available to assist with drainage works in the CWB.

This report was commissioned by EPLB, with funding contributions from Eyre Peninsula Landscape Board, District Council of Lower Eyre Peninsula and Lower Eyre Agricultural Development Association (LEADA).

1.2 Objectives & Outputs

The main project objective is improved management of drainage in the Cummins Wanilla Basin. This has been done by identifying the main causes of salinity and waterlogging and making recommendations to identify and prioritise works.

Dryland salinity and waterlogging are significant economic threats to the agricultural enterprises of the CWB, and through these impacts there is an ecological threat upon the integrity of the remaining endemic fauna and flora. In order to make recommendations for a drainage management plan to resolve these issues, the key objectives were to:

- Understand the drainage channels and other infrastructure in the CWB area, and how this contributes to water quality further down the catchment at Lake Wangary and Kellidie Bay.
- Understand the waterlogging mechanisms in the Basin so that these can be addressed holistically
- Understand how land is managed in the CWB, and what changes can be made for improvements
- Recommend prioritised drainage management works to mitigate waterlogging and salinity
- Prepare a drainage management plan
- Prepare a Recommended Practices document which will include a set of engineering guidelines and specifications for common types of infrastructure upgrade

1.3 Data Gathering

Data was gathered from the following sources:

- Desktop review of documentation from stakeholders, and also industry best practice and research
- A surface water model of the catchment was prepared
- Study of groundwater resources
- Online survey information from landowners, which aimed to map these on GIS
- Discussion with landowners, EPLB and other key stakeholders

1.4 Development of Brief

The original brief was intended to result in a prioritised list of specific property-level solutions which would be effective in resolving some of the waterlogging and dryland salinity issues. An online GIS survey was developed to capture as much data as possible about the location and nature of the problems encountered. Due to the limited input from stakeholder groups, the focus needed to be adjusted slightly. Stakeholder consultation has concentrated on speaking to a smaller number of landowners and stakeholders to determine the typical issues landowners face, and recommended solutions at property level. A previous survey had more landowner responses, and the comments, which could not be related to points on a map, were reviewed to ensure that typical problems were addressed.

In order to develop a more sustainable long-term catchment approach, a prioritisation process was developed to enable EPLB to liaise directly with landowners through Expressions of Interest for funding for works, and a draft works application form is included in Appendix C. This will also assist a longer-term strategic approach which can be taken for catchment planning, further investigations and additional works.

1.5 Approach to Drainage Management Plan

Following review of all of the information available, this was used to determine both catchment targeted recommendations and potential property-level solutions, by considering how the available information can be best used:

- Overlay information including surface water, salinity, geology etc
- Ground “truthing” with what landowners have said (limited)
- Some of the typical issues that need to be resolved
- How to prioritise EOI funding applications
- Strategy for future e.g. further studies
- Recommendations for further studies or work
- Using recommendations to prepare a Standard Operating Procedure to assist landowners in identifying best practice works to help remediate waterlogging ad dryland salinity.

1.6 Implementation of this Plan

The principles and strategies contained within this plan should be implemented as part of a longer-term strategy to improve waterlogging and dryland salinity in the Cummins Wanilla Basin. The key principles are to manage properties in order to reduce dryland salinity and decrease waterlogging, and to favour a strategic management approach. Following consultation, recommendations were made for short and longer-term solutions for improvement. These are detailed in Section 9.3.

2 BACKGROUND

2.1 Cummins Wanilla Basin

The Cummins Wanilla Basin (CWB) is an agricultural region on the Lower Eyre Peninsula of South Australia, and comprises an area of approximately 850km^2, mainly used for cropping and grazing. Falling productivity is an issue, along with water quality in the catchment. There is an extensive aquaculture industry including oyster farming within the bay area of Coffin Bay, which is the major coastal discharge zone of the CWB.

Native vegetation currently covers only 6% or 50km^2 of the Basin, having been extensively cleared since the 1950s.

2.2 Stakeholders

The following stakeholders were consulted as part of this study to ensure the development of the plan is inclusive of relevant historical knowledge, previous works, and proposed management works:

- Eyre Peninsula Landscape Board staff
- Cummins Wanilla Basin Streamcare Group representatives
- Landowners

As part of the project development, stakeholders were provided with an opportunity to comment on the criteria and content of both the proposed Drainage Management Plan and the Recommended Practices document. The stakeholder group was largely engaged and supportive of the proposed Drainage Management Plan.

2.3 Fishing and Aquaculture

Coffin Bay is the premier oyster growing region for South Australia, and the area includes other fisheries such as Rock Lobster, Shark, Leather Jacket, Whiting, Cockles, Garfish and Sand Crabs. Coffin Bay is situated 42 km from Port Lincoln on the Eyre Peninsula.

The water is monitored by a Quality Assurance Testing Program to maintain its pristine natural state. The commercial success of the area relies largely on its reputation for high quality seafood. Coffin Bay is the major coastal discharge zone of the CWB.

Glengyle Creek is the man watercourse in the CWB catchment, discharging into Lake Wangary. Minniribbee Creek is the discharge from Lake Wangary into Kellidie Bay which occurs seasonally every July/ August, spilling to Coffin Bay.

Seven estuaries within the EPLB region have been included in the Directory of Important Wetlands in Australia, including Coffin Bay.

2.4 Relevant Legislation

The Minister for Environment and Water (the Minister) administers the Landscape South Australia Act 2019 (LSA Act), the principal legislation for natural resources management. The Eyre Peninsula Landscape Board Region is one of eight regional landscape boards established in South Australia under the LSA Act. There is also a new metropolitan Green Adelaide Board.

The Eyre Peninsula Landscape Board (the Board) under the Minister's delegation is the Region's peak body for natural resources management. The Board operates under the functions of the LSA Act, and the summarised role of the Board includes duties to:

- undertake an active role in management of natural resources within their region;

- prepare, maintain and implement a regional LSA Plan;
- raise awareness and support educational initiatives for integrated and sustainable management;
- provide advice to the assessment of proposal referred to the Board;
- promote the objectives of the LSA Act in relation to Development Plans.

While implementation of the regional LSA Plan is the responsibility of the Board, the implementation of the Board's programs that are specified in the Business Plan are the responsibility of the Department of Environment and Water (DEW). A service level agreement is in place to administer this arrangement.

Roles and responsibilities for governance were summarised in the Strategic Plan for the Eyre Peninsula Natural Resources Management Region (2017) and a copy of these role descriptions is included in Appendix D.

Some of the key pieces of legislation are outlined below, and other national legislation, plans and strategies are listed in Appendix H.

2.4.1 Landscape South Australia Act 2019

This is an Act to promote sustainable and integrated management of the State's landscapes, to make provision for the protection of the State's natural resources, to repeal the Natural Resources Management Act 2004 and to make consequential amendments to other Acts, and for other purposes.

From 1 July 2020, the Landscape South Australia Act 2019 replaced the Natural Resources Management Act 2004, as the key framework for managing the state's land, water, pest plants and animals, and biodiversity across the state. Eight new regional Landscape South Australia boards will administer the new Act.

The Eyre Peninsula Landscape Board is the relevant authority for the management and protection of land under the Act. Under the Act, any works affecting a body of water will need a Water Affecting Activity Permit, and a Landowner may apply for a permit for any local/ on-farm works which do not satisfy the criteria, but must be able to demonstrate to the relevant authorities why such works should be permitted.

2.4.2 Water Affecting Activity Policy

The Water Affecting Activity Policy sets out the principles for managing water infrastructure and water-take. The policy is applicable to the Eyre Peninsula Landscape Board Region, and has been developed under the provisions of the Landscape South Australia Act 2019.

The Act defines Water Affecting Activities as activities that may impact the condition of a water resource, water dependent ecosystems or water users. Generally existing drainage channel clearance and maintenance would not require a permit.

Common examples of water affecting activities requiring a permit include: constructing a dam, constructing a road crossing over a watercourse, draining water into a watercourse or lake, or drilling a well. A permit and compliance framework is in place to manage potential impacts associated with these activities. A series of sheets have been included in the Recommended Practices that have been developed alongside this Plan. Appendix E contains a flowchart showing the assessment process for Water Affecting Activities Permits.

The Water Affecting Activity Policy sets out the matters that the Eyre Peninsula Landscape Board and the Minister will consider when granting or refusing a water affecting activity permit.

It is anticipated that the Water Affecting Activity processes and guidelines will be updated following the Landscape South Australia Act becoming effective on 1 July 2020.

2.4.3 Aboriginal Heritage

The Aboriginal Heritage Act 1988 protects Aboriginal heritage in South Australia. It recognises the strong relationships Aboriginal people have with the land, which may go back many thousands of years. The Act provides automatic protection for all places and objects in the state that are important to Aboriginal people because of connections with their culture. These places and objects are referred to as Aboriginal sites, and are frequently associated with wetlands and waterways. As such, these environmental assets will continue to be particularly important to Aboriginal people.

Under the Act it is an offence for anyone to excavate, damage, destroy, conceal or in any way alter an Aboriginal site without the Minister's permission. An authorisation can only be made after a consultation process with the relevant traditional owners, and may be subject to stringent conditions.

2.5 Funding

Historically, there was significant state funding available for CWB drainage management. In around 2012, the typical weather trend was getting wetter, which resulted in observed increases in vegetation build-up, and farmers wanting to carry out ad hoc desilting works on their land. This coincided with Federal and State funding becoming less available.

An economic analysis carried out (summarised in Section 4.9) demonstrated a need for investment in a strategic approach, rather than continuing with a reactive individual approach. The EPLB, the District Council of Lower Eyre Peninsula and The Lower Eyre Agricultural Development Association (LEADA) have contributed to this study to develop a strategic approach to basin management.

Funding is currently available for delivery of a strategic approach to infrastructure works, which will enable access to $250k funding. This will be spent on delivery of on-ground works on a "like-for-like" basis, with landowners and other groups and stakeholders contributing 50% of the cost of any works. This funding can be accessed by submitting an application, and further details of this are included in Section 10.

3 STAKEHOLDER CONSULTATION

3.1 Initial Consultation

An initial meeting was held with key stakeholders on 26 November 2019 to ensure the problem was fully understood, and also to clearly define and explain the scope of the work with the Project Steering Group prior to stakeholder engagement.

3.2 Online GIS Survey

A web-based online map was developed, and sent to around 100 of the 250 landowners in the catchment on a web browser. This was accessible via personal computer or portable device, to facilitate rapid assessment of existing drainage channels and other infrastructure. Landowners were asked to:

- Identify the location of existing assets using a 'drop-pin' approach
- Comment on asset quality and effectiveness
- Provide existing channel dimensions where available
- Comment on observations during wet and dry weather conditions
- Provide photos.

The aim of this survey was to provide additional information on the current relative capacity and condition of assets, which would help to inform the development of scalable, catchment-wide management advice.

A copy of the survey is included in Appendix A and the results of the survey are included in Appendix B. This information was used to "ground truth" the information gained by looking at surface water and hydrogeological information.

Feedback was less than anticipated with a small number of responses, apparently from only two landowners, which was lower than a previous attempt to engage landowners in 2018 (which received 23 landowners' responses covering 37 properties). Comments from the 2018 survey were also reviewed as part of this plan, and the complete set of comments are included in Appendix G, and summarised in Section 5.9. Comments from both landowner surveys have been reviewed, to ensure the Recommended Practices include relevant information for landowners.

A second survey was undertaken, and the number of responses and the level of detail was still inadequate to recommend a list of prioritised on ground works, but the works identified from the survey are consistent with the strategic aims set out in this report.

3.3 Stakeholder Meeting

A second site visit and stakeholder meeting was held on 13 March 2020. An in-depth discussion with landowners and representatives from EPLB provided invaluable information on the problems encountered in the region, as well as some of the successful on-ground works discussed.

A summary of what was discussed is included in Section 4, and this influenced the direction of this report as it allowed an in-depth look at what the immediate challenges in land management are. It also allowed this Drainage Management Plan to focus on ways to understand and resolve these issues.

A copy of the District Council of Lower Eyre Peninsula's drainage assets database was discussed, although it has not been possible to obtain a copy of this database.

4 OBSERVATIONS IN THE CUMMINS WANILLA BASIN

4.1 General Problems

4.1.1 Dry Land Salinity

Dryland salinity occurs in the CWB, and is typically caused when a saline water table rises and evaporation leaves salts at or near the soil surface. This is exacerbated by widespread clearing of native vegetation and replacement with crops, which changes that hydrological balance. Works likely to increase the risk of dryland salinity have been observed as part of this study.

4.1.2 Waterlogging

It is understood that the waterlogging in the Basin is mainly caused by wet weather surface water, and also groundwater in some areas. Since the 1950s, landowners have developed their own drainage networks and creek modifications, and the management of these is variable. Development of a drainage management plan for CWB is now needed to replace the individual management approach, and to ensure that the works consider whole-of-catchment effects.

A high proportion of the landowners are engaged and knowledgeable, and there are also a number of new owners who are enthusiastic and needing support for effective drainage management.

4.1.3 Stream Channel Erosion

Glengyle Creek is the main watercourse and the 2002 Catchment Management Plan identified the sediment deposited as a result of upstream channel erosion to be a significant factor in both the extent of salinisation and water logging. The erosion was attributed to an unstable surface water discharge system, mainly due to landscape manipulation from vegetation management and channelisation.

4.1.4 Vegetation Management

The Eyre Peninsula generally, and Cummins Wanilla Basin specifically, are of high botanical and conservation significance. In particular river red gum, scarlet bottlebrush and dryland tea tree along creek lines, and broad leaf box north of Edillilie. Much of the original native vegetation has been cleared since the 1950s for agricultural purposes, and this has contributed significantly to dryland salinity and waterlogging.

4.2 Initial Observations

Some initial observations were made following a preliminary meeting with stakeholders on 26 November 2019:

- Anecdotally, deeper drainage seems to have worked the most effectively to reduce the problem of waterlogging;
- ASS was verbally reported as being a potential issue in the catchment, but no significant evidence has been observed in the form of acidification of drainage water pH level. Further investigation of drains and drainage waters would need to be undertaken to determine risks;
- Groundwater expression is observed to fluctuate with wetter periods, indicating local recharge;
- Landcare planted grasses and trees which were observed to have reduced salinity “for a bit”;
- Council cleared Couch grass from ditches but this worsened erosion (and consequent downstream sedimentation);
- Sodic clay is present, which typically indicates higher salinity;

- Salinity problems were emergent after wet years in the 1970s, which could be due to expressing groundwater. This could also be longer-term effects from having cleared deep-rooted and native vegetation in the 1950s; and
- Following previous remedial works salinity was observed to fall initially, and then rise again. It is thought that this could be attributable to different farming practices.

These observations provided additional evidence that there is a problem with waterlogging which contributed to dryland salinity. Due to local recharge being observed as an indication of groundwater expression, a property-level response to on-ground works is likely to have a beneficial effect. Any proposed works should also consider the effect on neighbouring properties, and catchment-level effects on watercourses.

4.3 Stakeholder Site Visit

During a site visit on 13 March 2020, a number of observations were made. The Recommended Practices include best practice design of observed good practice, and also issues needing improvement.

4.3.1 General Observations

Following discussion, a number of general observations were made about the catchment:

- Typically pockets of waterlogged ground are encountered in lower-lying areas, and most farmers try to keep stock out of these areas. Most of the low-lying areas are under water for most of the winter
- Where the Merintha Creek crosses the Tod Highway, was all salt scald in the 80s. The ground was improved greatly by keeping stock off the land and keeping water moving
- Merintha Creek is generally well maintained and operational, and the first 100mm of rain in the season does not create problems. However, any more rain than this and the ground becomes waterlogged
- Sodic clay is generally at shallow depths in the valley
- Some landowners have used windmills to pump water to higher ground, and this has had beneficial effects on waterlogging at property-level
- Maintenance and clearing of drains has an observable good effect on waterlogging. Where “clearing” has significantly changed the line, level or cross section of the original watercourse, an increase in erosion and deposition has resulted
- When maintaining roads, the grader drivers need to get out and clean pipes carrying drainage under the road – if the pipes extended longer beyond the embankments to begin with, this would not need to happen, and there would be fewer pipes blocked in this way
- The general appetite is for ford crossings where a crossing is needed
- Native vegetation was generally cleared after the Second World War and this is now reduced quality crop-growing ground, also not helped by bushfire damage
- Ripping along contour lines helps to keep water on the higher ground
- 1 – 1.5 tonne per hectare improvement in crop yield by delving with clay
- Keeping on top of simple maintenance issues are critical as the land is so flat
- Salt water couch grass is a problem in creeks causing excessive blockages with siltation and vegetation
- A high volume of surface water is observed to run off higher ground

4.3.2 Good Practice Observed

During the site visits a number of good practice works were observed, and some of these are show below:

Trenches well designed and constructed:

Shallow battered edges to allow safer access for maintenance and reduce erosion

Managed weed growth

Stock fencing – prevents erosion in fenced off areas

Culverts adequately sized, free flowing, and adequately protected from erosion

Placement of rock good size and placement, having previously been too small

4.3.3 Observations for Improvements

Areas where consideration of Best Practice could improve problems observed

	Observation	Remedial works recommended
	Some "clearing" is 3m deepening of channel, which has contributed to: ■ Erosion ■ Acid Sulphate Soils not observed, but iron bacteria gel forming in areas, which is an indicator of acidic conditions ■ Ponding of water at property boundary	Design watercourse profile to ensure velocity is kept within reasonable limits, and that it can connect to the receiving watercourse
	Infrastructure not designed for the purpose	Proper sizing and design of culverts and other structures required, to prevent risk of blockages

	Observation	Remedial works recommended
	Material from drainage channel excavation deposited too close to channel Increased risk of washing into channel during high flow events Can prevent effective drainage of adjacent land	Place material further from channel
	Levees constructed as part of channel construction may be too high to prevent adequate drainage, as water cannot flow from adjacent land	Ensure surface water from adjacent land can drain into an appropriately designed drainage channel

	Observation	Remedial works recommended
	Road crossing – inadequate culvert Drainage culvert beneath the road is set too high, but soil build-up from adjacent farmland management means adjacent land is waterlogged before it overtops the windrow, and reaches culvert. This can occur along fence lines and interrupts shallow drainage on flat land	Larger pipes would block less frequently Pipes should be set lower so that the soffit is at lower water level in drainage trenches Edges of farmed land to ensure that surface water can flow to the drainage channels – a basic land survey would show where there were issues with continuity of connection between the land and drainage channels
	Road crossing – inadequate culvert Culverts nearing end of life collapsing Spoil build-up from adjacent road grading can block drainage culverts	Adequate design required (size, depth, material), and requires an ongoing programme of clearance and maintenance

	Observation	Remedial works recommended
	Salt scald and patchy vegetation	Improving drainage will help reduce salinity. Planting native vegetation or higher-use crops will help reduce erosion of land through wind, and will also help lower groundwater
	Heavily vegetated drainage channel blocking culvert flow – non-native reeds, which are difficult to keep clear	Appropriate programme of clearance Replanting with appropriate species could help prevent return of invasive vegetation, but this is a more long-term option

	Observation	Remedial works recommended
 	Water flows over the top of inadequately sized and maintained culverts and roads in high water events Road being eroded Increased siltation downstream	Appropriate design and sizing - culverts need unblocking and sizing checked Pipes are very old, have reached end of lifespan and have collapsed. Need to replace infrastructure that has reached end of lifespan

	Observation	Remedial works recommended
 	Effect of straightened creek - increasing velocities has also increased erosion. Creek was originally knee deep, and has eroded in the last 10-15 years so that the bed is significantly lower than the culvert under the road.	Avoid significantly changing channel alignment where possible Design of channel works to consider appropriate velocities

	Observation	Remedial works recommended
	Salt water couch very persistent, and hard to maintain an effective maintenance treatment of channel clearing and planting of puccinellia	Appropriate weed clearing and maintenance
	Inappropriate vegetation growth impedes flows, further reducing the problem of siltation	

4.4 Stakeholder Workshop

A stakeholder workshop was held on 10 September 2020, and a discussion was held about the draft version of this report, and its purpose. Amendments were made to the report to ensure that a strategic approach requiring catchment management is clearly defined.

5 LITERATURE AND DATA REVIEW

A review of available data and literature relating to the Cummins Wanilla Basin was reviewed to determine the progression of the problem of salinity and waterlogging, as well as previous remedial works and their effectiveness.

Where recommendations were made for remedial works or suggested improvements, this information was used to ensure best practice works and recommendations have been incorporated into this plan and the Recommended Practices where appropriate. The consistent message is that significantly changing drainage channels increases problems with erosion, sedimentation and water quality, salinity has increased since native vegetation was cleared in the 1950s, and waterlogging and salinity need to be managed. It is also widely reported that using best practice for farm management and drainage has a beneficial effect on waterlogging and salinity.

5.1 A Field Assessment of the Status of Streambank and Streambed Erosion in the Edillilie District

This is a report of a survey of the major creeks and drainage lines in the Edillilie district, undertaken in 1988, which focused on the sections of cropping and grazing land between the Tod Highway and the east and the Tod Pipeline easement to the west.

It found that mechanical interference by straightening, narrowing, deepening and cultivation of drainage lines, and the removal of vegetation caused detrimental changes to both streamflow and groundwater flow. These were consequences of increased velocity and reduced bank protection, resulting in significant erosion.

5.2 Assessment of Salinity Management Options for Wanilla

This study was completed in 2000, and assessed the hydrological factors influencing salinity in the Wanilla catchment. The recommendations were that salt management strategies needed to be reviewed, and that further work was needed to understand the discrepancies between catchment-scale groundwater modelling and farm-scale modelling of groundwater recharge values.

5.3 Cummins Wanilla Basin Catchment Management Plan

The Catchment Management Plan was completed in June 2002 and was the result of a 3 year study aimed at coordinating and implementing on-ground works to address the immediate issues of dryland salinity and waterlogging. Stream channel erosion was another issue identified for urgent resolution, as this impacts infrastructure asset life in addition to dryland salinity and waterlogging.

The following issues were identified as being the main problems for which on-ground works were required:

- Dryland salinity
- Waterlogging
- Stream channel erosion
- Vegetation management
- Education and awareness

The report also contains some very good explanations of the causes of waterlogging and dryland salinity.

5.4 Review and Evaluation of the Cummins Wanilla Basin Project

This Catchment Audit was a review and evaluation of the Cummins Wanilla Basin Project was undertaken in 2009 by Rural Solutions SA of the incentive-based on-ground works (OGW), monitoring activities and strategic initiatives undertaken to address the issue of dryland salinity. The EPLB summarised and mapped OGW funded through the Cummins Wanilla Basin Group, to determine the works' alignment with the recommended actions contained in the original Salinity Management Plan (SMP) produced in 2001 and a Catchment Management Plan (CMP) produced in 2002. Other works were done as a result of the CMP but were not assessed as part of this study.

Over 2000 ha of OGW were established, with a focus on ongoing stream care and creek rehabilitation which aimed to decrease erosion and sediment loads from the uplands. The other aim was to clean out silted drainage lines on the lowland floodplains and capture sediment in grade-control structures. In addition, lucerne and saltbush plantings contributed to localised control of waterlogging and salinity. A total of 48 landowners in the CWB were involved in the OGW program.

TABLE 5-1 SUMMARY OF 2009 OGW

OGW Category	OGW Description	Quantity
Water management	Erosion control structures	22 structures
Biodiversity	Creek line rehabilitation	10.4 km
	Fencing remnant vegetation	17.3 km
	Remnant vegetation protected	63 ha
	Fencing revegetation	1.8 km
	Revegetation	35 ha
	Revegetation – tubestock	8,043 tubestock
	Revegetation - direct seeding	327.4 km
Sustainable agriculture	Lucerne establishment	356.6 ha
	Saltbush	16 ha
	Fencing	36.3 km

5.4.1 Review of OGW

Almost all of the OGW were found to contribute positively to salinity management, whilst simultaneously addressing erosion, water logging, stream management, biodiversity and sustainable agriculture. Direct groundwater measurements showed a general trend in lowering over two decades due to reducing rainfall trends.

The major problems in the Cummins Wanilla Basin (CWB) have been waterlogging and salinity. Saline swamps have been a feature of the downstream end of the catchment. Since 1996, less runoff and fewer incidences of flash flooding were observed in the CWB due to changing climatic patterns. Any big rain events that have occurred in recent years seem to have occurred in narrow strips.

Electromagnetic groundwater testing allowed the differences in groundwater salinity to be mapped, showing the difference between 1992 and 2005. Depth to groundwater was also measured through piezometers installed in the early 1990s but these did not allow sufficient data to look at improvements that had been made with the OGW. OGW has included getting the water moving on the flats to help the low-lying country to dry out. Silt traps, grade-control structures and rock structures had been installed. A major bushfire in 2005 wiped out a lot of tree planting and fencing. The fencing was redone and the vegetation has largely regenerated.

Lucerne has been planted in dune/ swale country, but there were difficulties with getting it established due to non-wetting sands. It was recommended that more work needs to be done on the use of presswheel technology (for good crop establishment in dry soil conditions). Once established, farmers reported getting good value from the grazing of lucerne.

It was reported that resolution of the creek issues was successful, and although lucerne was pushed hard as an issue, there were fewer funding opportunities for this. Landcare groups have changed focus in recent years with more emphasis now being on improved farming and production systems. There is an on-going imperative for integrated natural resource management, particularly:

- Fencing of remnant vegetation/fencing and revegetation of saline drainage lines and riparian zones
- Increasing the perennial vegetation component of the farming enterprise
- Enhancing surface drainage and controlling sedimentation derived from upstream erosion

5.4.2 Water Quality

Water Quality Sampling Data of the streams entering Lake Wangary was included in the Audit, which showed that between 1997 and 2007, the following was observed:

- No significant change to pesticides, heavy metals or nutrients in the water
- Although faecal coliforms entering the lake increased, this was significantly improved for water leaving the lake
- Salinity showed an increase

The audit observed that dryland salinity had decreased due to declining rainfall.

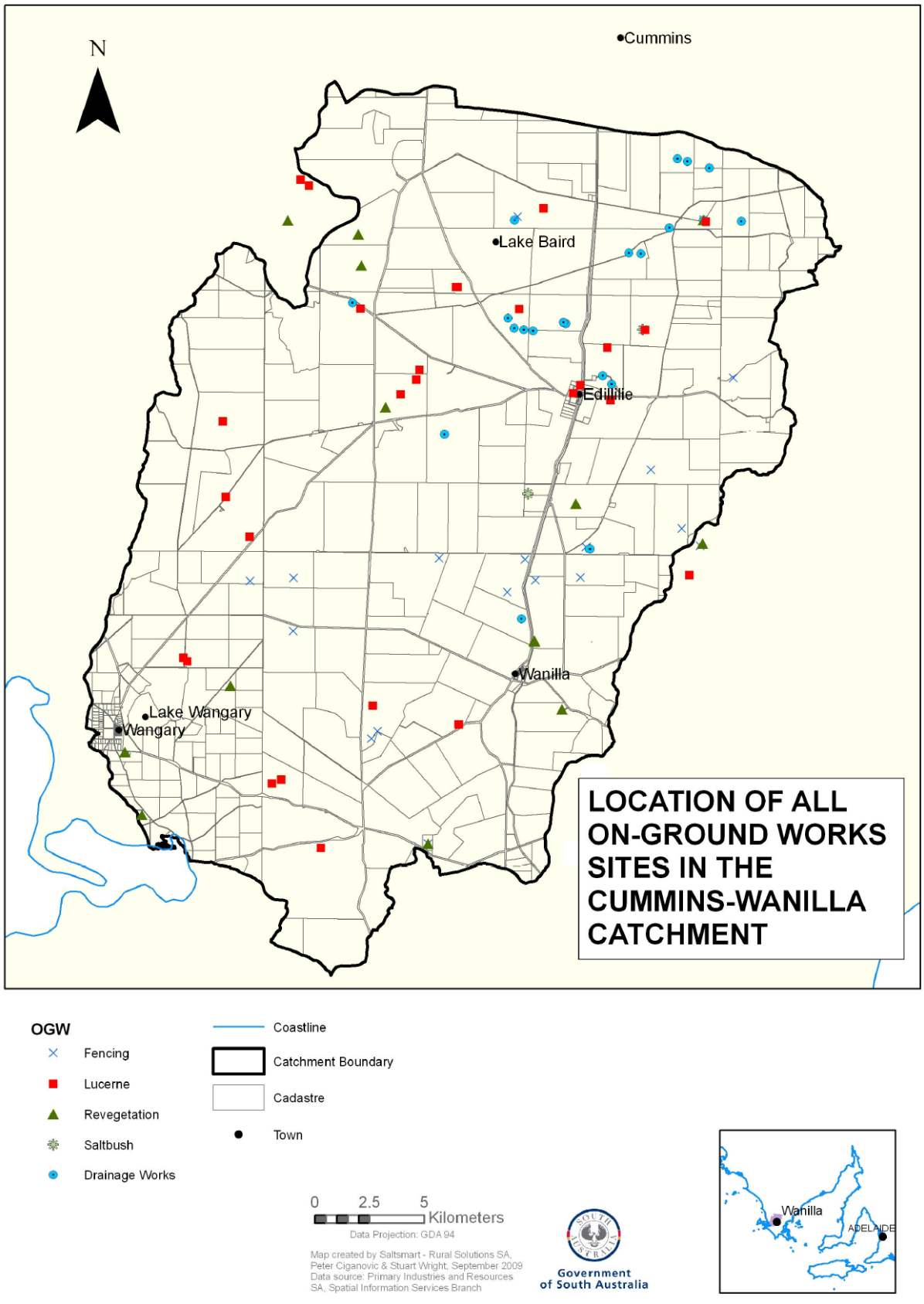

FIGURE 5-1 LOCATION OF ON-GROUND WORKS

5.5 Strategic Plan for the Eyre Peninsula Natural Resources Management Region

This 2017 strategic plan aimed to progress the objects of the Natural Resources Management Act (now repealed by the Landscape South Australia Act 2019) including supporting ecological sustainable development of the Region, which covers 51,000 km2. The Plan identifies riparian aquatic ecosystems as being poor to fair and declining. Table 5-2 below gives the present state, condition and trends of Natural Resources as listed in the Strategic Plan.

Goals were listed as:

- Sustainable management and use of land, sea and water
- Healthy and resilient land, sea and water ecosystems
- Active participation in natural resource management

TABLE 5-2 PRESENT STATE, CONDITION AND TRENDS OF NATURAL RESOURCES

Natural Resource	State	Condition*	Trend	Data confidence*	Data source
Groundwater – prescribed wells areas	Dynamic groundwater levels and salinity that fluctuate with periods of low and high rainfall.	Good	Stable#	Very good	Groundwater status reports by the DEWNR
Riparian aquatic ecosystems	Highly modified ecosystem with elevated levels of nutrients, salinity and turbidity.	Poor to Fair	Declining	Very good	Aquatic ecosystem condition reports by the Environmental Protection Authority
Soil cover – erosion risk	Soil cover improving due to improved farming practices of no-till and stubble retention.	Good	Improving	Excellent	Erosion Protection Field surveys by DEWNR
Soil acidity	Soil acidification is increasing due to high fertilizer use, low lime application and continuous cropping.	Poor	Declining	Fair	Lime sales analysis by DEWNR
Native vegetation condition	Native vegetation has been degraded from past clearance and development, grazing and pests.	Fair	Unknown	Good	Biodiversity Condition Monitoring by the Nature Conservation Society of SA and DEWNR
Threatened native species and ecological communities	Native species and ecological communities are impacted by fragmented habitat, pests, altered hydrology, inappropriate fire regimes, development and recreational impacts.	Poor	Declining	Excellent	Biological Databases of South Australia by DEWNR; and the listed threatened species and ecological communities by the Department of Environment
Marine ecosystems – seagrass	Seagrass communities near populated areas degraded by stormwater, treated sewage, agricultural runoff, aquaculture and industrial discharge.	Good	Unknown	Good	Aquatic ecosystem condition reports by the Environmental Protection Authority
Marine ecosystems – mangrove and samphire	Mangroves and salt marsh have been degraded by land clearance, coastal development, tidal and drainage barriers, water quality and recreational impacts.	Good	Unknown	Fair	Analysis of Coastal Protection Board's Geographic Information System data by DEWNR
Fish stocks	Modified marine food webs from commercial and recreational fishers.	Fair	Stable	Excellent	Fish stock reports by Primary Industries and Regions South Australia

The CWB is within the Southern Eyre subregion, and the key challenges and opportunities listed include agricultural viability and declining biodiversity. Identified land management risks include:

- High risk of soil acidification
- Medium risk of dryland salinity and waterlogging
- Medium risk of soil structure decline

- High risk of wind erosion
- Medium risk of water repellent soils

Appendix B of the Plan gives catchment design values applicable under Act.

5.6 Water Quality in the Wanilla and Wangary catchments

In 2017-18, monitoring of salinity and nutrient levels was undertaken in the Wangary and Wanilla Catchment, which showed a seasonal effect. Salinity levels were modest but found to be increasing. It was found that Lake Wangary acts as a “modifier” reducing inflowing salinity levels of EC 20-30k to around EC 15k at the outflow. It was reported that 300 - 500ppm salinity flows into Coffin Bay but the watercourse only flows in winter. When there is sufficient rainfall, Lake Wangary tends to only spill in July/ August into Coffin Bay.

5.7 Economic Analysis of the CWB Drainage Management System

This report was completed in August 2018 and reviewed previous on-ground works in terms of their effectiveness. EconSearch undertook an economic analysis, using the results of a landholder survey with the aim to provide the necessary economic information for grant applications.

The CWB drainage channel system has been developed both privately and with government assistance. The OGW require ongoing upkeep to maintain hydraulic function and intended flow efficiencies. Significant flows occurred throughout this catchment over the few winters (not quantified) preceding the report, resulting in the silting up/ blocking of drains and an increase in waterlogged and salinity impacted areas. At the same time, previously available state and federal government financial assistance for system maintenance was lost and maintenance often relied on uncoordinated individual landholder action.

Twenty-three landowners responded to a survey, 20 of whom reported on-farm areas affected by drainage-related problems. The 23 respondents operated 37 properties in the CWB, totalling 32,145 ha. A map was not included of where the current problems are, but the comments from landowners have been included in Appendix G. The comments are consistent with the typical problems encountered, but also demonstrate that where works have not been given permission, the reasons for this may not have been fully understood. None of the comments are relatable to individual properties or areas, which does not allow this information to be effectively applied.

The total economic impact of the reduction in farm production due to drainage-related problems was estimated to be between $3.4m and $4.1m in Gross Regional Product (GRP) depending on the season. This impact represented between 1.6 and 1.9 per cent of regional GRP ($210.8 m in 2016/17). A need was identified for a drainage management plan, and clearly demonstrated a requirement for ongoing funding of OGW. It was also estimated that if the costs of developing and maintaining a drainage management plan are less than $16.4m then implementing such a plan would be a worthwhile option to the community.

It can be seen from the survey that issues of waterlogging and soil/groundwater salinity have been a long-term issue, although apparently more of an issue in the last 20 years.

5.8 Briefing to Board on Cummins Wanilla Drainage Plan

This briefing dated 25 June 2019 to the Eyre Peninsula Landscape Board was prepared to provide an update on the Cummins Wanilla Streamcare Group’s recent efforts to source funding in order to resolve environmental and drainage management issues within the catchment, and to gain ‘in principle’ support from the Board for the development of the drainage plan.

In August 2017, a paper was presented to the Board to seek funding to undertake a landholder survey to gather data on the economic impact of the current functioning of the drainage system on local agriculture and to determine the potential loss of production.

It was identified that funding would be beneficial if used for high priority rehabilitation/ upgrades of the drainage scheme infrastructure, which would be coordinated through an expression of interest process with landowners (including local government), with a minimum of 50% matching funding.

As an important step in the development and implementation of the management plan, the group also identified the need to educate landowners about how the system functions, hydrological flows, permit application requirements and best practice drainage maintenance etc.

6 EXISTING BASIN ENVIRONMENT

6.1 Catchment

The catchment is bounded by the Marble Range to the west, the Koppio Hills in the east and Kellidie Bay in the south. The northern boundary is the drainage divide between Oleo Creek and Curtawilla Creek. It is almost entirely within the District Council of Lower Eyre Peninsula (DCLEP), with a small area in the northeast within the District Council of Tumby Bay boundary. There is also an extensive aquaculture industry within the bay areas of Coffin Bay, which is the major coastal discharge zone of the CWB.

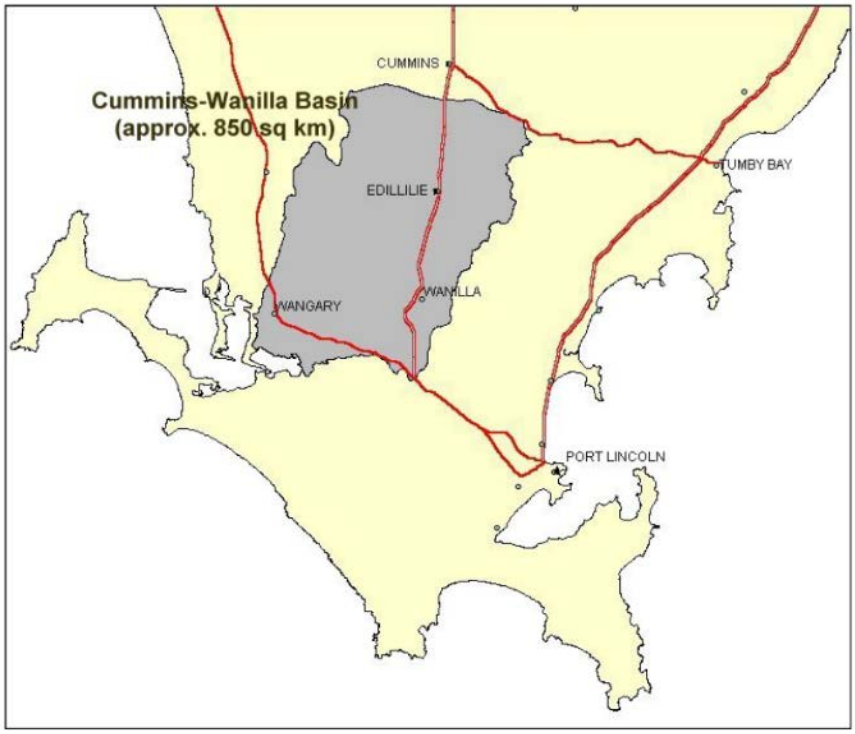

FIGURE 6-1 LOCATION OF THE CUMMINS WANILLA BASIN

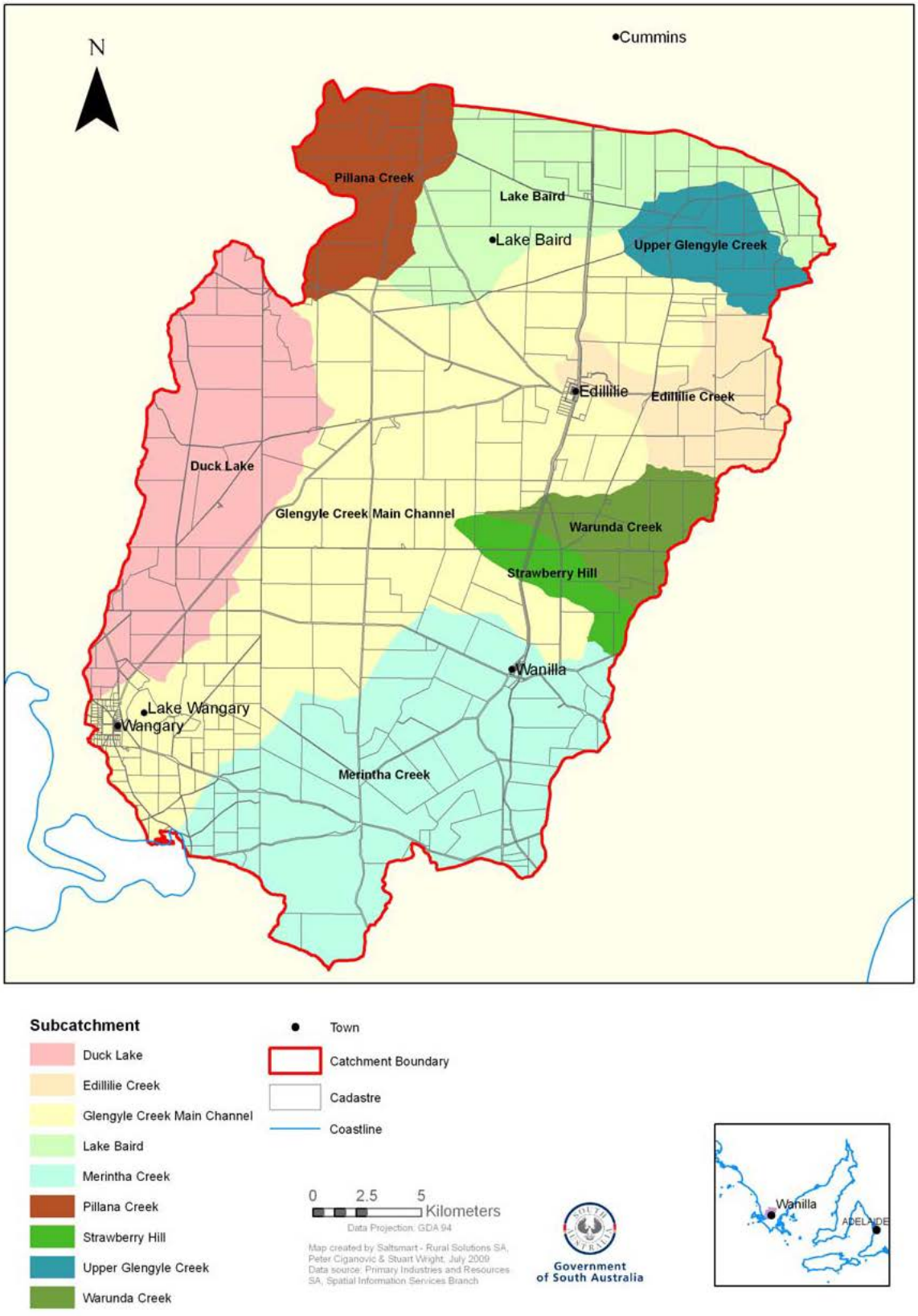

FIGURE 6-2 THE NINE CATCHMENTS THAT MAKE UP THE CWB

6.2 Climate

Future weather patterns are difficult to predict, as is their likely impact on salinity and related issues. The effects of climate change on salinity are anticipated to be:

- More large episodic rainfall events/floods (salinity increases)
- Sea level rise (salinity increases)
- More frequent & more intense bushfires (salinity increases)
- Increased soil evaporation (salinity increases)
- Temperature increase (salinity increases)
- Less annual rainfall (salinity increases)
- Less winter and spring rainfall (salinity decreases)
- Increased vegetation transpiration (salinity decreases)
- Less frequent frosts (salinity decreases)
- Less summer and autumn rainfall (salinity decreases)

6.3 Oyster Industry

Coffin Bay is the premier oyster growing region for South Australia, and the water is monitored by a Quality Assurance Testing Program to maintain its pristine natural state. The commercial success of the area relies largely on its reputation for high quality seafood. Coffin Bay is the major coastal discharge zone of the CWB.

Although the Review and Evaluation of the CWB audit observed that dryland salinity appeared to have decreased due to declining rainfall, the observations following preparation of this Drainage Management Plan indicate that it is increasing again. The audit also observed that faecal coliforms reduced, and that salinity in the surface water had increased.

A programme of further monitoring should be undertaken to assess water quality since 2009.

6.4 Surface Water

The drainage system comprises an extensive network of earthen formed channels and drains. Remediating issues and maintaining the drainage system is currently a major challenge and forms a major priority for future management needs.

The major drainage line draining the Cummins Wanilla Basin is the Glengyle Creek, which is fed by a network of tributaries and trunk and lateral drains that have been built to alleviate the waterlogging problems in the catchment. The Glengyle Creek flows south westerly to Lake Wangary and in times of high peak flows, Lake Wangary overtops and discharges to the sea via the Minniribbie Creek which has incised a channel through the existing limestone formation. Surface drainage in the Glengyle Creek main channel is governed by the low gradients of the relatively flat valley floor. The relatively low capacity of the main channel has historically been prone to siltation problems due to sediment loadings contributed from stream erosion in its tributaries upstream. Any deepening of the main channel has been constrained by the natural gradient of the land and by the heights at which existing road culverts have been built.

6.5 Geology

The Cummins Wanilla Basin is located within the southern Gawler Craton which is the oldest and largest geological province in South Australia, preserving a complex tectonic history spanning from around 3200 million years ago to 1450 million years ago. Basement rocks consist of the Sleaford Complex in the west of

the basin near Marble Range and the Hutchinson Group sediments which form the Koppio Hills in the east of the basin. The Sleaford Complex is characterised by metasediments, granites and gneisses while the Hutchison Group is characterised by quartzite, dolomite, iron formation, schist and amphibolite. Areas of basement outcrop occur on both the western and eastern flanks of the basin and in some small, isolated areas within the basin (Figure 6-3). Weathering of basement sediments is reported to occur at depths of up to 50 m (Martin, Sereda & Clarke 1998).

Basement rocks are overlain by Tertiary Wanilla and Uley Formations. Tertiary Wanilla sediments are characterised by fine grained to gravelly fluvial sand interbedded with variable thicknesses of carbonaceous clay while the Uley Formation is characterised by sandstone, clayey to orange-brown well sorted and rounded quartz, minor lateritic and non-lateritic gravel.

The Tertiary sediments are in turn unconformably overlain by the Quaternary Wiabuna Formation, Bridgewater Formation and other undifferentiated Pleistocene sediments. The Wiabuna Formation and Bridgewater Formations are largely constrained to the southern extent of the basin. The remainder of the basin is largely covered in an undifferentiated Pleistocene sedimentary sequence consisting of gravel, clay, silt and sand with soft carbonate, overlying nodular/tabular calcrete. The major drainage channels within the basin consist of present-day Holocene alluvium.

Quaternary sequences are generally up to 10 m in thickness, except towards the south-eastern coastline where they are often up to 30 m thick. Tertiary sequences are commonly less than 10 m in thickness (Berens et al., 2011). There are relatively few lithological logs available for the wells completed in the Cummins Wanilla Basin. Drillers logs are more readily available, however, in most cases the quality of records does not allow for discernment of the different formations.

TABLE 6-1 SUMMARY OF GEOLOGICAL FORMATIONS WITHIN THE STUDY AREA

Age	Formation	Description
Quaternary	Bridgewater Formation	Calcareous sands, broken shell fragments and limestone, often with calcrete at the surface, karstic
	Wiabuna Formation	Silt to fine-grained sand, orange-brown, calcareous, conglomeratic in part. Aeolian
	Undifferentiated Quaternary Sediments	Pleistocene gravel, clay, silt and sand with soft carbonate, overlying nodular/tabular calcrete
Tertiary	Wanilla Formation	Fine-grained to gravelly fluvial sand interbedded with variable thicknesses of carbonaceous clay
	Uley Formation	Sandstone, clayey to orange-brown quartz, well sorted and rounded, minor lateritic and non-lateritic gravel
Pre Cambrian	Hutchison Group	A basal massive to flaggy quartzite sequence (Warrow Quartzite, Lhw), overlain by carbonates, iron formation, amphibolite and pelitic to semi-pelitic schist. Includes Cook Gap Schist
	Sleaford Complex	Metasediments, granites and gneisses. Includes the Dutton Suite

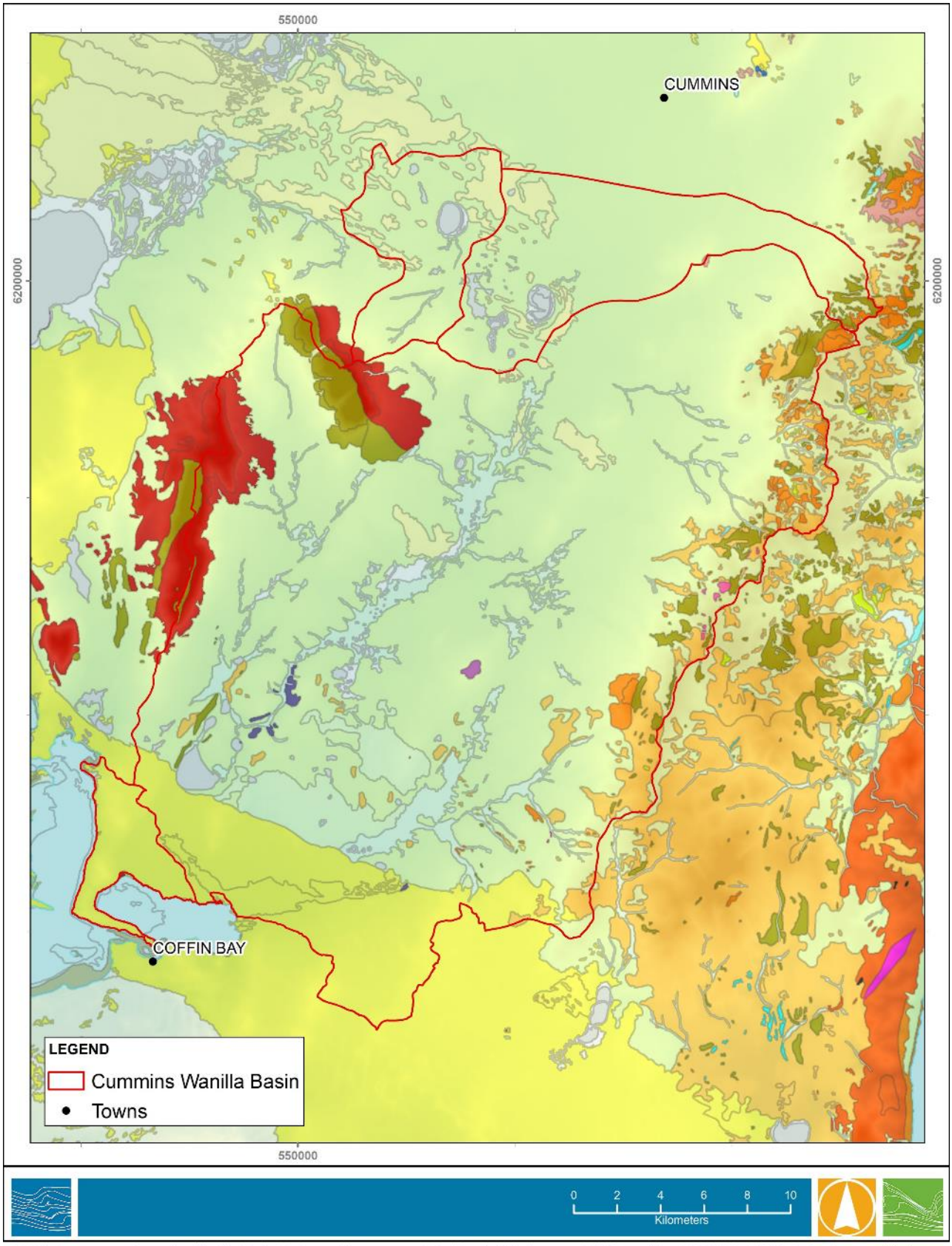

FIGURE 6-3 SURFACE GEOLOGY

6.6 Groundwater

6.6.1 Hydrostratigraphy

The Bridgewater Formation which is present in the southern extent of the basin is the most productive aquifer in the area. This formation contains low salinity groundwater which supports many townships on the Eyre Peninsula. Elsewhere, Quaternary sediments consist of undifferentiated Pleistocene sediments which are reported to have hydraulic properties of unconfined or semi-confined aquifer systems (Berens et al., 2011).

Tertiary sands are distributed throughout the Eyre Peninsula and contain aquifers that are either semi-confined or confined and are generally overlain by Quaternary sediments and aquifers (Berens et al., 2011). The sandier intervals form the aquifer, where present clays and silts slow and restrict the flow of groundwater in the basin.

Basement lithologies include gneisses, volcanics and granites of the Gawler Craton and these rocks form a regionally extensive fractured rock aquifer, however, the understanding of this aquifer is limited and it is reported to be irregular in occurrence, salinity and yield (Berens et al., 2011).

The most extensively studied area within the basin occurs within Popes sub-catchment, 3 km southeast of the township of Wanilla. Within this catchment, hydraulic conductivities for the Tertiary sediments were reported to range from 0.0015 m/d to 1.42 m/d while basement hydraulic conductivities ranged from 0.0012 m/d to 1.42 m/d. The reported ranges suggest that the aquifers are highly variable with hydraulic conductivities typical of silts and fine sands. There is limited information and data regarding the hydraulic properties of the aquifers elsewhere in the basin, however, it is considered that these parameter ranges are representative of conditions throughout the basin.

There is insufficient data to determine if the basement and overlying Tertiary and Quaternary sediments act as a connected groundwater resource or whether they act independently of each other.

6.6.2 Groundwater Recharge and Discharge

Much of the original deep-rooted perennial native vegetation in the Cummins Wanilla Basin has been extensively cleared since the 1950s for agricultural purposes (CWBMP, 2002). Clearance of this vegetation and replacement with shallow-rooted annual pastures has increased the rate of groundwater recharge over much of the basin. Studies in Popes sub-catchment found that recharge can vary significantly on both a regional scale and on a paddock scale (Richardson, 1994). CSIRO (2002) reported recharge rates in Popes sub-catchment of 1 mm/year under native deep rooted vegetation and 20-50 mm/year for cleared agricultural areas. Areas of higher recharge are often characterised by fresher groundwater (CSIRO, 2002).

Groundwater flows from the topographically higher areas around the margins of the basin towards the major drainage lines in the centre of the basin. Discharge from the basin occurs to the southwest towards Wangary and as baseflow to watercourses. Saline discharge is concentrated along drainage lines, local low-lying areas and break of slope areas (CSIRO, 2000). The low hydraulic conductivity of the aquifers in the basin prevents discharge of the higher recharge volumes, resulting in rising groundwater levels throughout much of the basin.

Although the issues associated with rising water tables such as dryland salinity and waterlogging have been exacerbated by higher recharge rates, it is reported that some areas within the Wanilla catchment may have been groundwater seepage areas prior to widespread clearing of native vegetation in the early 1950s (CSIRO, 2000).

6.6.3 Groundwater Salinity

Groundwater salinity is highly variable, ranging from less than 1,000 mg/L up to 30,000 mg/L. Lower salinities are generally found in the south of the basin where the Bridgewater Formation outcrops and receives direct

rainfall recharge. Higher groundwater salinities are generally found towards the centre of the basin and in areas where the water table is shallow, and salinity has increased as a result of evapotranspiration.

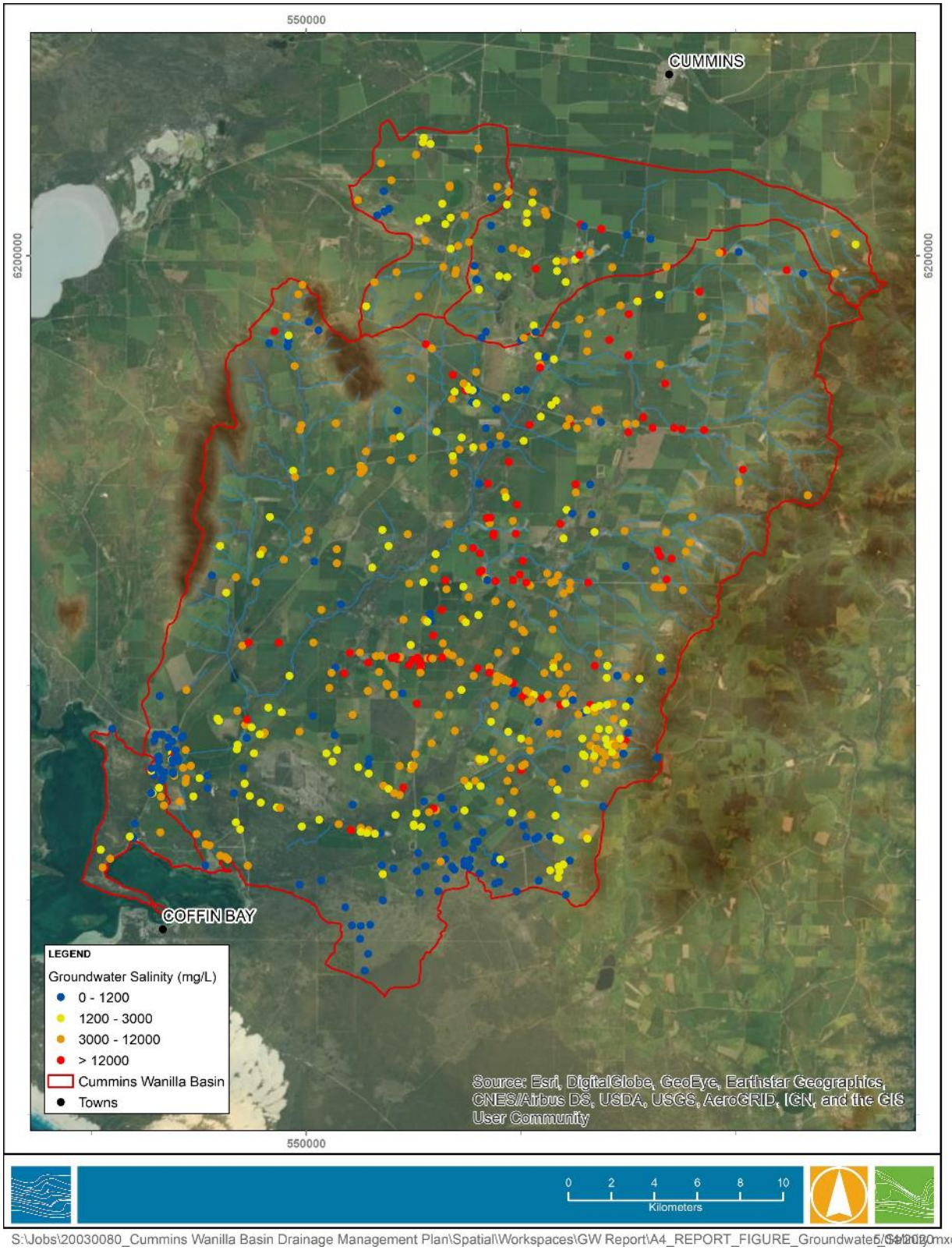

FIGURE 6-4 GROUNDWATER SALINITY ALL AQUIFERS

7 HYDROLOGICAL ANALYSIS

The quality of data available for the catchment was assessed, including gauge data, available GIS layers, digital elevation information and existing asset records. The most appropriate method of undertaking hydrological and hydraulic assessment was determined.

7.1 Overview

Glengyle Creek is the main watercourse in the catchment, and drains approximately 532 km2, discharging into Lake Wangary. Minniribbee Creek is the discharge from Lake Wangary into Kellidie Bay which occurs seasonally every July/ August, spilling to Coffin Bay.

7.2 Catchment Boundary:

As shown in Figure 7-1, the black line represents the Cummins Wanilla Basin catchment boundary and the water courses are shown as blue. From the 50m contour map, it can be seen that the Cummins Wanilla Basin catchment is quite flat. The inflow from the regional area mainly comes from ridges on the west and east side of the catchment.

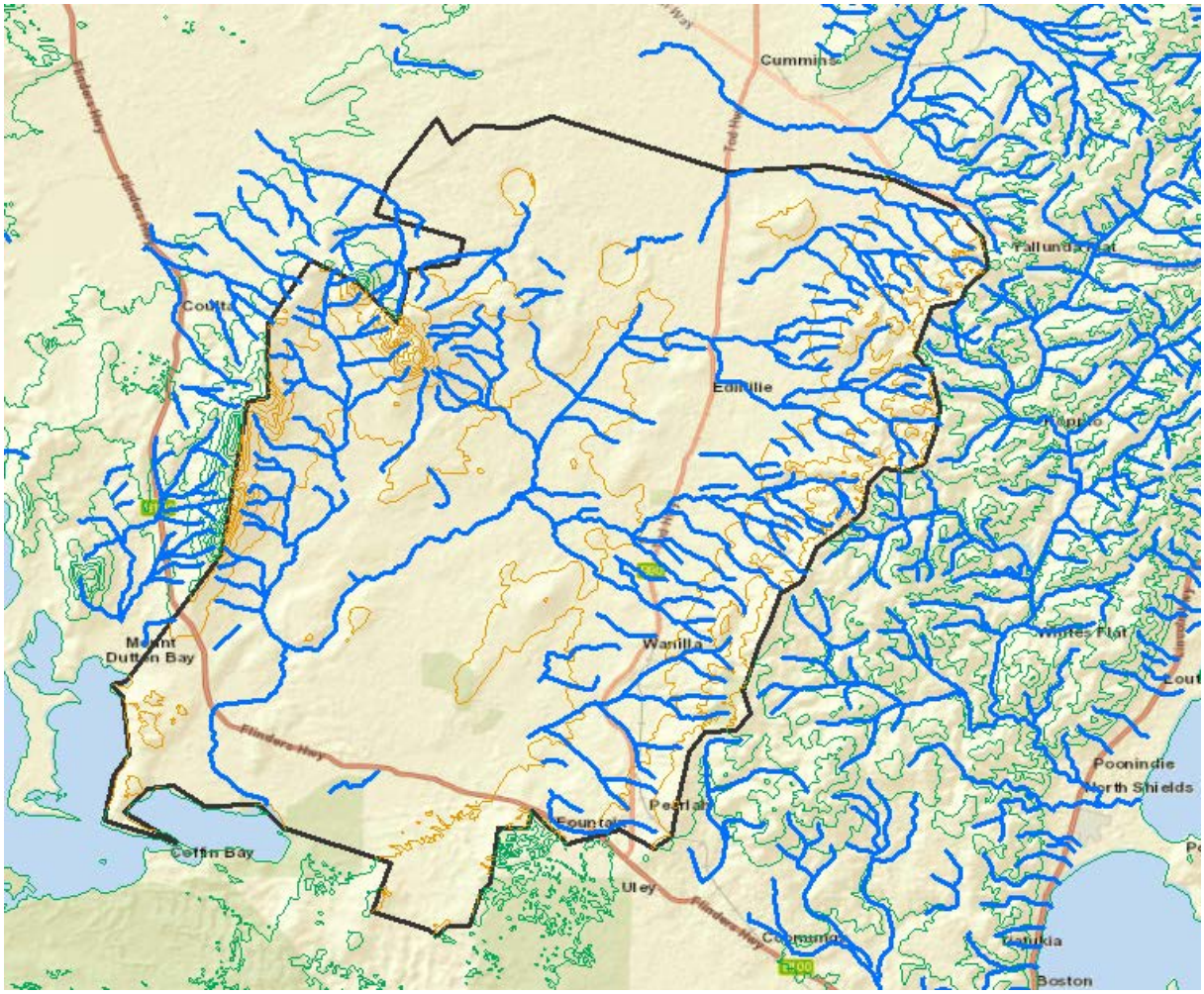

FIGURE 7-1 CWB CATCHMENT BOUNDARY

7.3 Methodology

For a better understanding of the drainage principle within the research area, there are a few methods/models that can be used, which are listed in Table 7-1.

TABLE 7-1 ALTERNATIVE MODELLING METHODS

Modelling Methods		Detailed DEM	Survey of pits, pipes, culverts, bridges, creeks, basins	Rainfall gauge data	Flow gauge data	Soil type	Survey of the Cross sections of the creeks
TUFLOW	A 1D/2D finite difference numerical model used to simulate hydrodynamic behaviour in floodplain environments.	Y	Y	Y, for calculating the inflow boundary condition	Y, for calculating the inflow boundary condition	N	Y, if modelling the creek as 1D element
DRAINS	A 1D stormwater drainage system design and analysis program	Y, for catchment delineation	Y	Y	N	Y	Y, for overflow route define
HecRas	A 1D or 1D/2D program that models the hydraulics of water flow through rivers and other channels	N	Y	N	Y	N	Y
Arc Map	Flow accumulation	Y	N	N	N	N	N

7.4 Arc Map

Arc map was used to generate the flow accumulation line, and 1 second LiDAR data (approximate 25m x 30m grid), was used to generate the flow accumulation line. Using the classical single flow direction method, the flow accumulation was determined, as shown in Figure 7-2, where the black colour is the DEM, and the blue line is the flow accumulation line. This did not produce usable information.

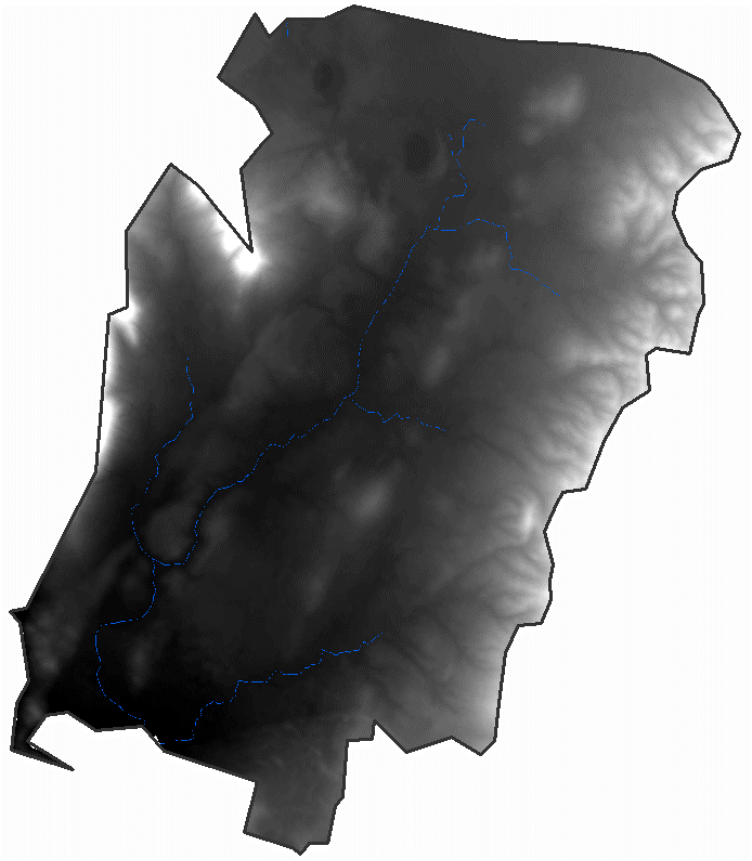

FIGURE 7-2 FLOW ACCUMULATION LINE FROM ARC MAP

7.5 TUFLOW Model

A 1D/2D TUFLOW model was then created using SMS. The model was run within the TUFLOW software package to simulate direct rainfall within the study area and generate the drainage/flood inundation maps.

1 Second LiDAR data was used for the TUFLOW model DEM input. The extent of the 2D model is he catchment boundary identified in Figure 7-1. The model schematisation process included determining the model grid size. A range of sizes were tested from 5m to 15m, and 15m grid size was determined to provide a good balance between model run times and flexibility, whilst also providing enough detail to represent the drainage networks in the research area in a 2D modelling environment. A random (synthetic) direct rainfall was used as the input boundary condition to rain evenly across the whole catchment area.

The TUFLOW modelling results, i.e. the maximum flood depth mapping can be found in Figure 7-3. This figure shows the depth of flood water, which is not necessarily an indication of waterlogging.

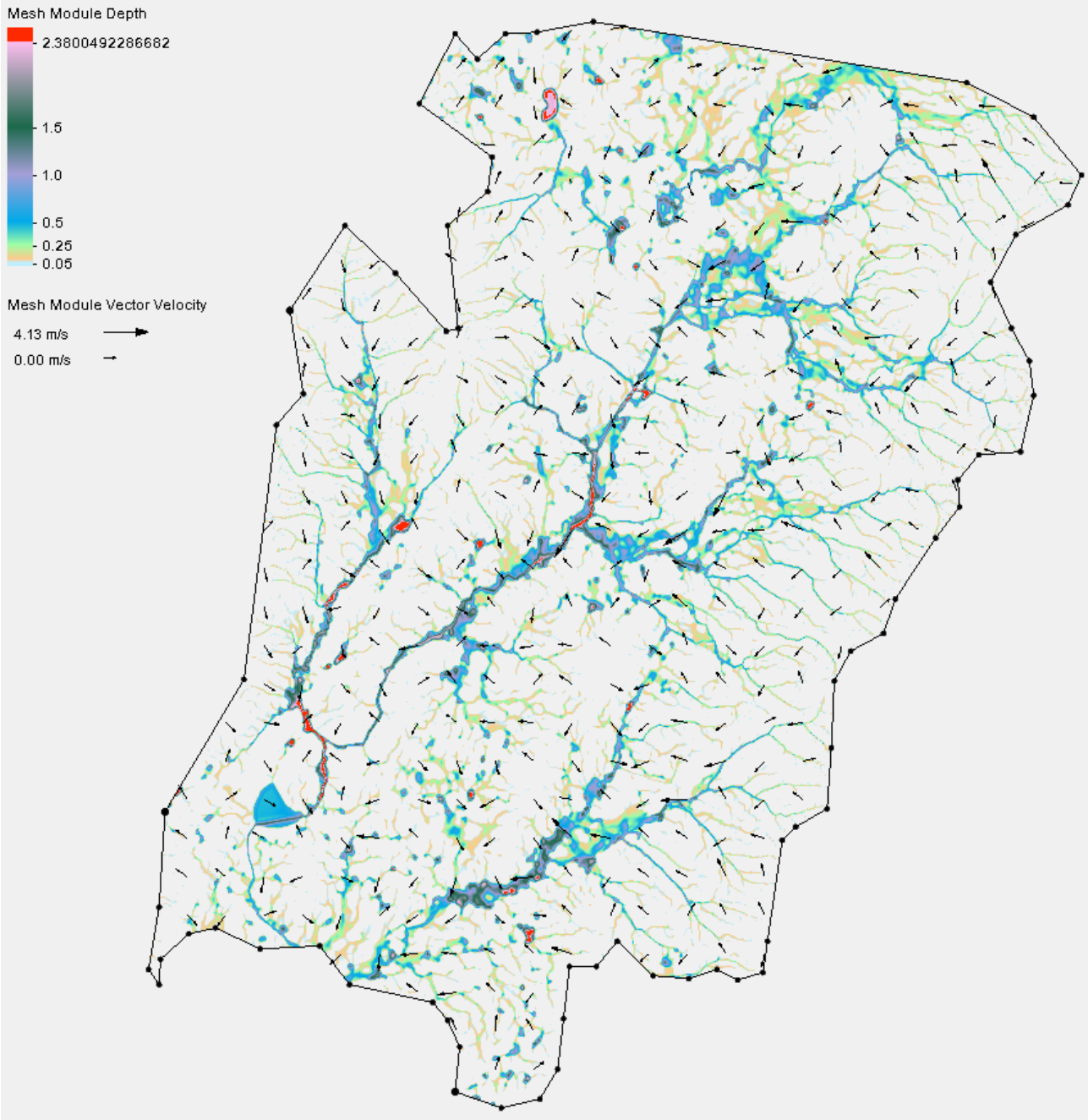

FIGURE 7-3 MAXIMUM FLOOD DEPTH MAP OF CUMMINS WANILLA BASIN CATCHMENT

8 HYDROGEOLOGICAL ANALYSIS

8.1 Overview

The Cummins Wanilla Basin is one of several focus areas within South Australia where groundwater levels have been routinely monitored for several decades to track the impacts of dryland salinity. Groundwater monitoring locations are illustrated in Figure 8-2. The highest density of groundwater wells and monitoring occurs in Popes sub-catchment within the Wanilla Basin, 3 km southwest of the township of Wanilla. Currently, the Cummins Wanilla network comprises around 50 groundwater level monitoring wells with levels monitored at six-monthly intervals. The aquifers that are currently being monitored consist of the fractured rock aquifer, Tertiary Sediments, Quaternary Sediments and various combinations of these (i.e. some wells are screened over multiple formations).

All current and historical groundwater level data within the Cummins Wanilla Basin has been downloaded via the South Australia online groundwater portal WaterConnect. For each well with multiple groundwater level records, a hydrograph has been produced to assess the changes in level that have occurred with time. Some wells contain only a few records while others which have been routinely monitored contain up to 150 records over a 30 year period.

There is a strong correlation between groundwater level trends and rainfall in the Cummins Wanilla Basin, with intense rainfall events typically associated with high levels of recharge and rising groundwater levels. To evaluate this trend, rainfall data has been obtained from four rainfall stations across the basin. These stations include Cummins, Koppio, Coulta and Woolga. Data was sourced from the SILO patch point dataset which provides a continuous record of daily data by interpolation from the nearest rainfall station for periods where records are unavailable.

The data has been presented using the Cumulative Deviation from Mean Monthly Rainfall (CDMR) approach which calculates the cumulative difference between actual monthly rainfall and average monthly rainfall from the first to the last rainfall reading over the study period. A rising trend represents periods of above average rainfall, with a falling curve representing periods receiving below average rainfall.

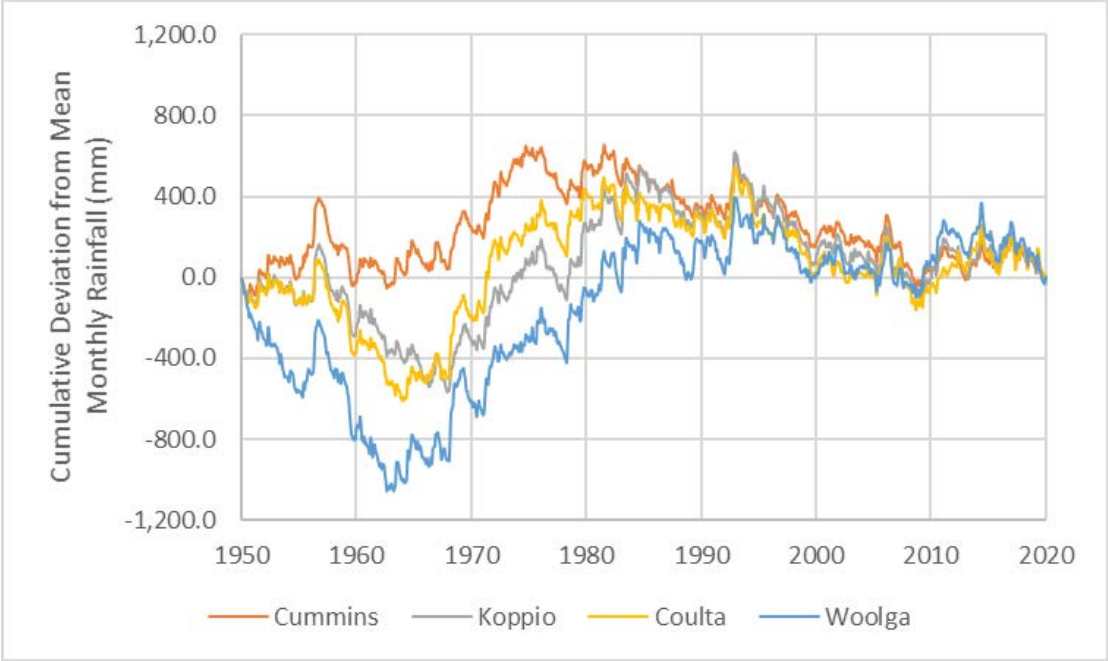

FIGURE 8-1 CUMULATIVE DEVIATION FROM MEAN MONTHLY RAINFALL FOR SELECTED RAINFALL STATIONS

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FIGURE 8-2 GROUNDWATER MONITORING LOCATIONS

8.2 Groundwater Trends

The majority of groundwater monitoring has occurred since 1990 with only a handful of wells monitored prior to this time. Throughout the majority of the basin, groundwater trends are positively linked to rainfall with periods of above average rainfall resulting in rising groundwater levels, and periods of below average rainfall resulting in falling groundwater levels. Selected hydrographs which illustrate this trend are shown in Figure 8-3.

The following observations can be made:

- Wetter than average years from 2009 to 2011 and intense spring rainfall in 2015 led to rising groundwater levels throughout the basin.
- Groundwater levels peaked in the early 1990s, and again in 2012 and 2015.
- Below average rainfall during the millennium drought from 2001 to 2009 led to falling groundwater levels throughout much of the basin.
- Since 2015, rainfall has been below average and groundwater levels have in turn decreased.
- For the majority of wells, groundwater levels are currently between historic highs and lows.
- Groundwater levels in some wells can vary by up to 3.5 m as result of rainfall variability. For example, well 602802021 (Figure 8-3) has recorded levels as low as 4 m below ground level and as high as 0.5 m below ground level.

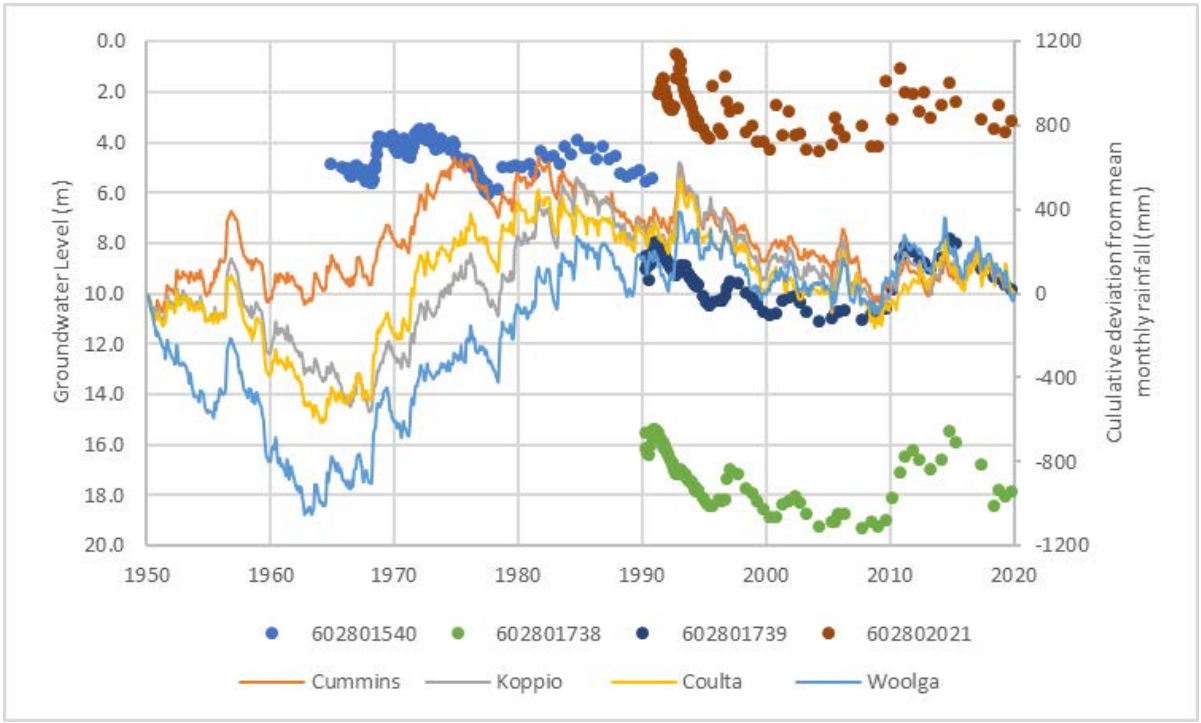

FIGURE 8-3 SELECTED HYDROGRAPHS ILLUSTRATING RELATIONSHIP BETWEEN RAINFALL AND GROUNDWATER LEVELS IN THE CUMMINS WANILLA BASIN

In many areas of the basin groundwater levels are at or near surface. These areas are likely to be experiencing increasing soil salinity, waterlogging or a combination of the two. Selected hydrographs from wells where groundwater levels are close to the surface are illustrated in Figure 8-4. In these areas there is less groundwater variability, and the decreasing groundwater levels which are due to below average rainfall are not as evident as in some other areas.

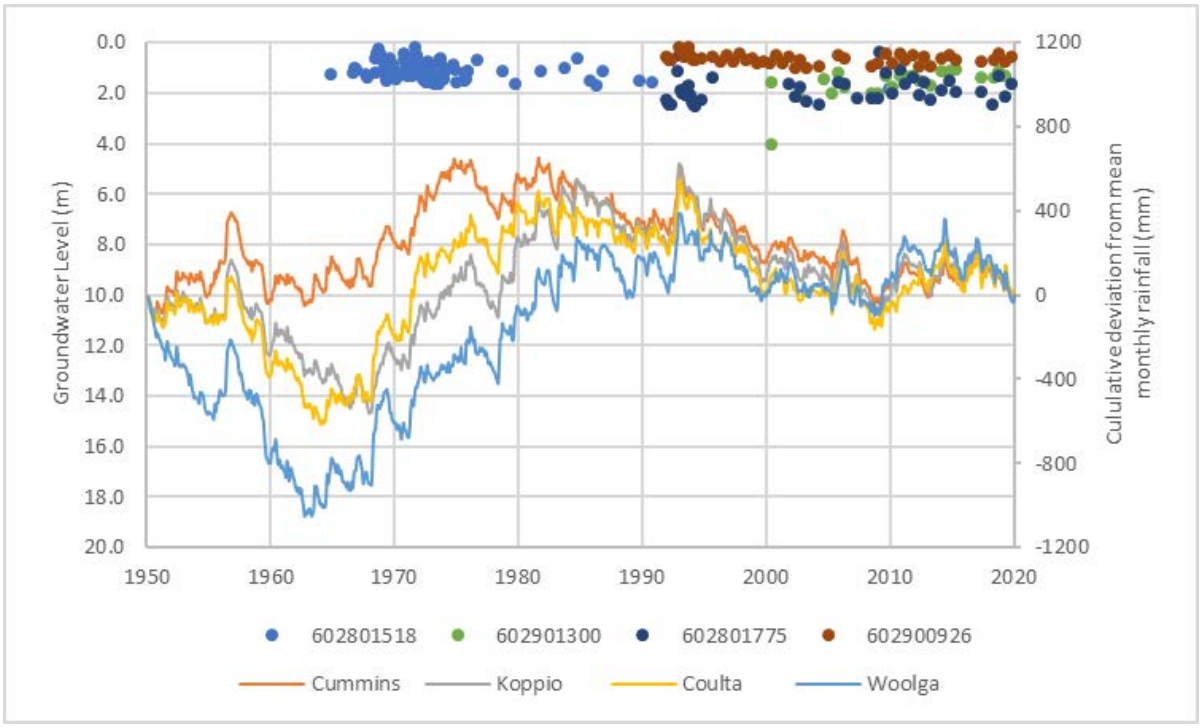

FIGURE 8-4 SELECTED HYDROGRAPHS ILLUSTRATING AREAS PRONE TO SALINISATION WHERE GROUNDWATER LEVELS ARE WITHIN 2 M OF GROUND LEVEL

8.3 Problem Areas

When a saline water table rises to within 2 m of the ground surface, there is a higher risk of salt concentration at the surface by evapotranspiration. Areas with shallow water tables are also prone to waterlogging. The areas of concern are generally located near drainage lines, in local low-lying areas and at the break of slope between elevated and low lying areas. Groundwater levels in these discharge zones are driven by process occurring elsewhere in the catchment, such as recharge over deep sands or outcropping fractured rock aquifers at the margins of the basin.

Groundwater level data from spring 2019 is presented in Figure 8-1. Spring data has been selected as this represents the post-winter recharge high. The data shows that there are several areas where groundwater levels are within 2 m of the ground surface. These areas occur both within the central low-lying areas in the middle and south of the basin as well as towards the topographically higher areas at the margins of the basin (for example near Wanilla).

The areas with groundwater levels within 2 m will change with time as groundwater levels rise and fall in response to rainfall-induced recharge. A return to above average rainfall conditions will see an increase in the number of wells with groundwater levels within 2 m as well as an increase in the total impacted area.

The highest density of groundwater level monitoring occurs in the Wanilla sub-catchment. It is clear from this data that significant groundwater level variations can occur over short distances, with some areas showing differences of 15 m over just 500 m. Outside of the Wanilla sub-catchment, groundwater monitoring wells are, on average between 3 and 5 km apart, making it difficult to accurately predict levels in between these points. In these areas, reliance on on-ground observations such as visual signs of salinity scalding, waterlogging or poor crop productivity can be used to identify impacted or problem areas.

Identification of impacted areas should rely on a combination of groundwater level data as well as on-ground observations at the farm scale.

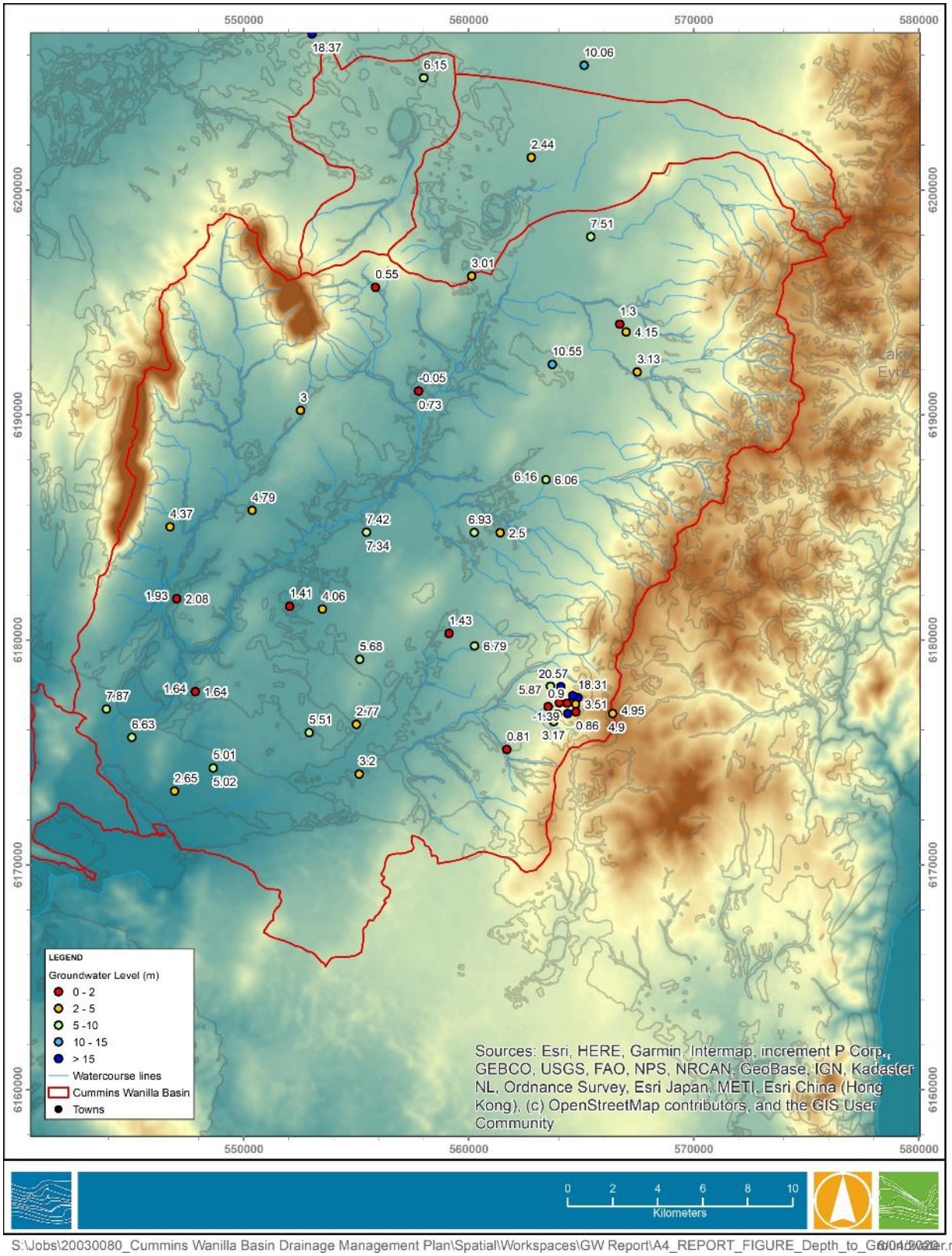

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FIGURE 8-5 DEPTH TO GROUNDWATER IN THE CUMMINS WANILLA BASIN

8.4 Future Trends

Climate change is likely to result in below average rainfall throughout the Cummins Wanilla Basin. This may act to keep groundwater levels marginally lower, however increases will still occur as a result of high intensity rainfall events and periods of above average rainfall. There are currently no tools available to predict groundwater levels in the Cummins Wanilla Basin under different climate scenarios.

Continuing monitoring would allow differentiation of the effectiveness of any management actions when compared against rainfall variability. There are a number of opportunities for this, which are dependent on funding:

- The Department for Environment and Water monitor a network of groundwater wells throughout the Cummins Wanilla Basin (Figure 8-2). Continued monitoring of these wells will enable catchment-wide trends to be captured and will inform the effectiveness of any management actions. The wells are currently monitored twice every year, and this data could be used to determine trends.
- Citizen science programs could be considered to provide additional monitoring capacity and to target specific areas where management intervention is planned. Similar programs have been used in other areas of South Australia (e.g. Mount Compass) to capture additional data and to increase community awareness regarding local issues.

A simple numerical groundwater flow model was used to assess several options for agricultural management of dryland salinity at Wanilla (Richardson, 1994). The management options where chosen as potentially being able to rectify the hydraulic imbalance produced by clearing of native deep-rooted vegetation. The study found that treatments (management options) need to be implemented at the right scale with treatments over small areas having limited impact. The most effective management strategies were predicted to be at the catchment scale thus affecting the entire local groundwater system (Richardson, 1994).

8.5 Groundwater Management

Landscapes are not uniformly affected, which makes it difficult to plan remedial actions. A range of options are required to deal with site-specific issues.

Options to restore the recharge/discharge imbalance are presented below.

Options to reduce recharge include:

- Establishment of deep-rooted vegetation or deep-rooted perennial pasture (or alternate high water-use plants) such as lucerne in groundwater recharge areas.
- Protect existing vegetated areas.
- Improve drainage throughout the catchment to prevent pooling of water and subsequent recharge.
- Promote clay spreading on sand hills (CWBMP, 2002).
- Deep sands and fractured rock aquifer are the prime recharge areas within the basin and accordingly require priority attention (CWDNP, 2002). Richardson (1994) reported that by accurately mapping the spatial variability in recharge, more efficient management strategies can be used by targeting higher water-use options to areas of highest recharge.

Option to increase discharge include:

- Deep drains. A review by GHD (2017) into the effectiveness of groundwater drains found that:
  - Single deep drains are unlikely to effectively lower and control groundwater.
  - Parallel deep drains may be effective in some instances.

- Soil and crop response to deep drainage has not yet been quantified.
- Drainage discharge water quality is variable and can be acidic.
- Drainage discharges can have downstream impacts, but those impacts can be managed.
- Farmers support deep drainage and rely on other farmers for advice.
- Appropriate governance arrangements must be in place before drain construction.

It was also found that landowners do not appear to access technical advice available from government agencies, which they claim is considered too broad, not specific to individual farms and not providing clear guidance on actions. They say they want face-to-face information about their particular situation.

8.6 Groundwater pumping.

Richardson (1995) reported that short term benefits could be gained by pumping groundwater from high transmissivity zones using groundwater wells. Using this method, groundwater levels are lowered over a small area leading to less evaporative discharge and reduced salinity accumulation in the root zone. This solution will only be effective in limited situations where aquifer conditions are favourable, and any benefits will be localised (i.e. tens to hundreds of metres).

Relief wells and syphons can also be used where leaky artesian aquifer conditions are present. In these cases, groundwater is 'free-flowing' from the well by the artesian pressure of the aquifer. There are several sites in the Cummins Wanilla Basin where groundwater levels are reported to be up to 2.0 m above ground level (e.g. 602802034). These sites would require further on-ground assessment and testing to assess whether this solution is suitable for the site conditions.

Key unknowns to be addressed prior to implementation of these strategies include:

- Detailed mapping of recharge areas and soil type at the basin scale.
- Assessment of aquifer conditions at the basin scale.
- Mapping and identification of all impacted areas.

The following considerations should be addressed prior to implementing any of the engineering solutions presented above:

- Detailed planning and design.
- Strategies for managing discharge of groundwater and assessment of impacts on downstream users.
- Schedule and cost implications for management of infrastructure.
- Requirement for Water Affecting Activity Permits.
- Framework for monitoring, evaluation and reporting

9 STRATEGIC APPROACH TO REMEDIATION WORKS

Managing salinity requires persistence, as the effect of works can take a long time to improve, and effects of poor management can take decades to have a detrimental effect. There are no quick solutions, and fundamental change may be required in land use and management practices. The effects may not be seen on the land that the works are carried out on.

A strategic approach is essential to manage waterlogging and dryland salinity in the Cummins Wanilla Basin, working in partnership at catchment level where possible. Some of the issues identified will need government stakeholder support, however private landowners and communities have the largest role in managing land and water quality. A strategic approach would allow the most effective use of funding to achieve the highest benefits. A catchment approach would ensure that any works done would have wider benefits than just property-level benefits. It would also facilitate works being done at a property level, which would be needed to effectively address problems further downstream of the catchment.

This Plan identifies an approach that will allow the farming community to share and adopt best practice, and to allow proposed on-ground works to be carried out in a prioritised way. The recommended best practice works are all works that will help with short term-improvements to waterlogging and salinity, but are limited by the funding currently available, which does not provide for a strategic catchment level approach.

The main recommendations following this reporting are:

- To seek applications from landowners for on-ground works that can be funded on a like-for-like basis, which will mainly be a property level planning
- All works applications to be assessed and prioritised to ensure they meet strategic aims
- Encourage landowners to undertake property level management planning, with advice and support from EPLB as appropriate
- Consider further recommendations for future work including monitoring
- Undertake catchment level planning for works to reduce salinity and waterlogging

Beyond this short-term opportunity, the Plan makes recommendations to ensure longer-term strategic planning, monitoring and review. This will help to inform future funding applications for work and increase the opportunities for larger scale catchment-level works.

The key strategic elements should be:

- Working in partnerships that involve all stakeholders
- Adopting appropriate tools to manage salinity and waterlogging
- Retaining native vegetation
- Encouraging research and development to improve salinity management
- Developing continuous monitoring and evaluation of on-ground works, and their effectiveness

The main recommendations following this reporting are:

- To seek applications from landowners for on-ground works that can be funded on a like-for-like
- All works to be assessed and prioritised

9.1 Issues Identified

The following issues were identified as being critical to resolve waterlogging and dryland salinity:

- Appropriate drainage

- Channel erosion
- Vegetation management
- Good land management practices
  - High-level infrastructure upgrades required
  - Classify infrastructure works in Primary, Secondary and Tertiary levels

9.2 Prioritised Works

Works have been prioritised in this report to align with funding available, however the real priority should be around longer term catchment priorities. A more strategic catchment-wide approach for planning and monitoring would ensure the most effective solutions to improve waterlogging and salinity.

The prioritisation of works could be considered in terms of asset type, management area, land quality, or proximity to hotpots of concern. A number of on-ground works were identified as part of the landholder survey, which would align with the strategic objectives set out in this report. These works are tabled in more detail in Appendix B and should be investigated further to see if they meet the criteria to be recommended for implementation. These works include:

- Increasing culvert capacity
- Drain clearing and/ or deepening
- Re-siting of culverts
- Improve channel crossings
- Vegetation maintenance

As the on-ground works recommended above are based on landholders responses, these must be investigated further to ensure they are the most appropriate works to prioritise. Further recommended works are likely to emerge once like for like funding is offered. All on-ground works emerging from the survey should be reviewed along with applications for funding received as part of the next stage. Overall priority is recommended for works which contribute to a strategic catchment approach, and the works identified as part of the survey appear to meet these criteria.

9.3 Remediation

Limiting the extent of waterlogging within a catchment by planting any vegetation that will survive and use water, through appropriate and effective drainage, and managing surface runoff to limit flooding. By converting waterlogged ground back to more natural ground runoff will be delayed after rainfall events. This could be achieved by planting saltbush for example, in a previously waterlogged area. It is important that any drainage options do not contribute to increased flood risk elsewhere. There needs to be a combined approach to control and reduce waterlogged areas of existing natural and artificial drainage systems. Any new drainage should, therefore, follow best practice for design and construction. The Recommended Practices document aims to explain the causes of waterlogging and dryland salinity, and the processes and procedures that can reduce and control these.

Dryland salinity and waterlogging can be effectively managed through both engineered options and changes in farming and land management practices. The effectiveness of this increases if a whole of catchment approach is taken:

- Effective surface water drainage
- Groundwater recharge reduction and management

- Promotion of land use that remediates dryland salinity
- Adequate infrastructure
- Vegetation management

9.4 GIS Mapping

A GIS mapping database has been developed as part of this report, which includes information on:

- Base survey data
- Digital Elevation information
- Asset information from District Council of Lower Eyre Peninsula (although this dates from 2013)
- Survey results from the landholder survey undertaken in January 2020
- Surface water modelling

9.5 Tools to Manage Salinity

There is a range of tools available to manage salinity. Each landowner will need to consider a range of these tools to suit their specific needs and meet their objectives. In addition, a catchment approach is likely to have a better chance of success. The tools described are economically beneficial to the landowner in the longer-term. There are costs involved in establishing these, and there is also a fund available for these works, which will be allocated following an application process, assessment and prioritisation. Following consultation, recommendations were made for short and longer-term solutions for improvement, which include:

9.5.1 Short-term solutions for improvement:

- Promotion of the Recommended Practices document developed in parallel with this DMP
- Availability of funding to be utilised by landowners and other stakeholders
- Prioritisation of applications received, to determine works that can be funded using the $250k grant available
- Construction works to progress

9.5.2 Longer term strategy and monitoring

- Seek opportunities for future funding
- Further investigation and monitoring to further identify the nature and cause of salinity and waterlogging, and to review the effectiveness of on-ground works
- Opportunities for catchment level studies and design – a more strategic planning approach will allow identification of larger schemes, which can be used to demonstrate further applications by EPLB and other bodies for funding.
- Deep sands and fractured rock aquifer are the prime recharge areas within the basin and accordingly require priority attention. By accurately mapping the spatial variability in recharge, more efficient management strategies can be used by targeting higher water-use options to areas of highest recharge.
- A programme of further monitoring should be undertaken to assess water quality in Coffin Bay

9.6 Main Practices to Manage Waterlogging and Salinity

The following best practice areas have been developed in more detail in the Recommended Practices, which will have the most effective impact at property level, on reducing the problems in the CWB.

9.6.1 Land Management

Current farming practices may need significant change so that they use more water or help to use saline ground or surface water in a productive way. Modifying existing farming systems will not be as effective as developing new farming systems that include a considerable area of deep-rooted perennial species. Some changes to agricultural practices include:

- Promote clay spreading on sand hills
- Perennial species that use more water will be profitable, and will help to reduce salinity through lowering groundwater
- Protect existing vegetated areas
- Annual crops with longer growing seasons and increased rooting depths
- Reduction of erosion through over-grazing, or by excluding stock from areas by fencing
- Development of more salt-tolerant crops

9.6.2 Surface Water Drainage

Improve drainage throughout the catchment to prevent pooling of water and subsequent recharge. Some ways of doing this include:

- Erosion management
- Removal of instream blockages and sedimentation
- Improved hydraulic effectiveness of channel through appropriate design and construction, which will reduce erosion and siltation, help to control vegetation growth, and appropriately improve removal of surface and ground water
- Management of vegetation in watercourses
- Mapping of discharge zones within the Cummins Wanilla Basin to plan adequate and effective drainage
- Dams and watering holes to be offline
- Investigating cost of pumping shallow ground water
- Consider appropriately designed deep drains

9.6.3 Infrastructure Management

- Stock fencing to prevent erosion of drainage embankments, and allow vegetation regrowth/ rehabilitation
- Road and track construction to be planned to avoid impeding surface water flows
- Effective design of culverts (e.g. location, capacity and level)
- Ensure culvert functionality maintained through trash screens etc.

9.6.4 Vegetation Management

Deep rooted perennials have a high water-use potential and are a primary tool to manage waterlogging and salinity. Their extended growing season and deep root systems allow better use of rainfall, which will help with rising groundwater. Appropriate vegetation management and strategic revegetation could help to reduce waterlogging and dryland salinity by:

- Reducing groundwater recharge with high water-use plants e.g. lucerne or saltbush, or woody plants
- Perennial pasturing, particularly deep rooted lucerne

- Reducing salinity through increasing groundwater discharge
- Increasing vegetation cover would reduce the risk of erosion and minimise salt accumulation through evaporation
- Promoting change in farm management and practice
- Promoting clay spreading on sand hills

Appropriate planting should be recommended in areas where growth would be most effective. For example, the CWB Audit report of OGW in 2009 includes maps of where lucerne planting would be most effective, generally around the margins of the basin, and a copy of this map has been included in Appendix F.

9.7 Recommended Practices

A Recommended Practices document and information sheets were prepared in parallel with this DMP, providing engineering guidelines and non-site-specific design specifications for the different types of works or infrastructure upgrades, to ensure that these can be constructed to standard. This document aims to reflect the problems and remedial works identified following preparation of this Plan, and includes matters such as;

- Explanations of mechanisms for waterlogging and salinity
- Drain maintenance, including walls and levees
- Vehicle crossings and culverts
- Grade control structures
- Bank and erosion control
- Drainage form/cross-section/falls for all grades/classes of drainage channels.
- Water Affecting Activity permits for works (e.g. clearing drains)
- Siltation
- Good practice for drainage channels

The aim of the document was to achieve an appropriate level of education, not just to regard the recommended on-ground works to be a “set and forget” solution.

9.8 Further Recommendations

Prioritisation of works should be undertaken, and this would be most effective following catchment level analysis and planning. The following recommended works will all improve waterlogging and salinity in the Cummins Wanilla Basin, but greater benefits will be achieved through taking a strategic catchment level approach. Although this is the ideal approach, it is limited by current funding, and relies on landowner engagement and their appetite for like for like funding.

9.8.1 Land Management

It is recommended that landholders develop farm/ water management plans for their individual properties. Previously, the Board ran a project to assist farmers develop these, and the reinstatement of advice for future planning could encourage every farm with drainage infrastructure to develop a farm specific management plan. This would help future larger scale funding applications, and would also ensure that benefits were more likely to be achieved at catchment level.

9.8.2 Monitoring and Evaluation

Ongoing monitoring and evaluation should be carried out at property, catchment, region and state level, and will provide information to landowners, the community and EPLB on:

- Development of and progress towards agreed goals for drainage, agricultural systems, infrastructure
- Changes in land use management
- Development of management plans by landowners, community groups and government agencies
- Development of management systems, informed by correlation between monitored groundwater levels, surface water, improved productivity
- Success of new and ongoing works, and their effectiveness in reducing dryland salinity and waterlogging
- A programme of further monitoring should be undertaken to assess water quality in Coffin Bay, as this has not been done since 2009.

9.8.3 Further Survey and Investigation

Further survey and investigation should be considered, including:

- The identification of areas impacted by groundwater will need to rely on a combination of groundwater level data and on-ground observations such as salt scalds, water logging or reduced crop productivity to identify areas which may require management
- Further survey of major watercourses
- Asset survey of both private and council owned infrastructure – e.g. flap valves, flow regulators, new drainage channels, culverts
- Better catchment-level survey
- Trial demonstration sites
- Mapping recharge areas to target a programme of vegetation
- More monitoring wells to determine areas of salinity, as well as the effects of some of the property level on-ground works as a result of this funded work
- Monitoring of water quality to ensure no decrease in water quality that may affect the aquaculture industries in Coffin Bay

9.8.4 Asset Management

To develop the District Council of Lower Eyre Peninsula's asset database for drainage assets would allow targeted approach to clearing and maintenance, and would allow early repair of structures, helping to avoid costly replacement following asset failure. It would also assist strategic spending to be prioritised.

9.8.5 Further Consultation

Further investigation and monitoring and/or a data gathering exercise could be carried out to ensure more thorough engagement by landowners and other stakeholders. Different ways to ensure high levels of engagement could include an initial marketing campaign, or a review of on ground works funded as part of this work.

Although the GIS survey was not as successful as anticipated, being able to map the comments was useful for allowing comparison with other information. Stakeholder meetings with maps on a table could be considered, and a projector could be setup with an online map to allow greater detail of visibility for a particular area of interest.

To help ensure good interaction with the community, District Council of Lower Eyre Peninsula could publicise it on their website, do a press release, and forward the information specifically to any concerned parties like 'Friends of' groups, Landcare groups, etc.

It could be a good opportunity to post on LinkedIn or other social media like Twitter etc. which can showcase the work undertaken in a good light.

9.8.6 Further Mapping

Further additions could be added as layers to the GIS mapping developed as part of this project. Some beneficial information could be:

- More recent aerial photography of areas of concern
- On ground works and when they were constructed/ implemented
- Improvements to areas of concern e.g. salt scald which would allow the progression to be monitored and compared with other data
- Monitoring data e.g. groundwater
- Newer Lower Eyre Peninsula Council asset information
- Priority areas for targeted outcomes such as economic gain or environmental improvements

9.8.7 MERI Approach

A MERI approach is a Monitoring, Evaluation, Reporting and Improvement Framework. The SA Government recently funded a program of projects under the National Landcare Program, which addressed problems such as:

- loss of vegetation;
- soil degradation;
- the introduction of pest weeds and animals;
- changes in water quality and flows;
- changes in fire regimes.

The Eyre Peninsula Landscape Board prepared a MERI framework document in 2009 to outline the context, process and tools needed for successful MERI at all levels. The document defined MERI and provided a snapshot of where the region was currently with monitoring and baseline data.

This scheme could be built upon, for example following funded on-ground works. This could entail farmers providing samples for testing and monitoring of groundwater and surface water quality

10 FUNDING FOR WORK

A grant has been allocated to support public landowners in identifying and assessing their land for works that will improve waterlogging and salinity problems. Expressions of Interest will be sought from landowners, and it is recommended that these be assessed under a competitive grant process.

An effective response to salinity and waterlogging management at a catchment scale requires sound information, clear objectives, targets and priorities that are owned and supported by all stakeholders. Four key aspects were considered when setting a method for prioritising applications for on-ground works:

- Sustaining land and water resources, reducing further deterioration in salinity and waterlogging, and where possible, restoring land and water quality
- Conserving natural diversity, protecting remaining natural areas, and restoring a representative range of natural environments on a regional scale through improved land management and farming
- Reducing economic and financial losses to the individual, the community and the state, in terms of agricultural production, water quality downstream in the catchment (with particular attention to the oyster industry in Coffin Bay), water resources, environmental values and infrastructure
- Reduction of impacts on landowners across the catchment

The funding approach taken is not considered to be the most effective strategic approach, but recommended works will have a measurable effect on waterlogging and salinity. A property level approach may not bring the best benefits, as the benefits may not be relevant to the property where any works are carried out. It is likely that regional or catchment level infrastructure will demonstrate the most effective benefits for this reason.

Monitoring the effectiveness of any works carried out as a result of this funding is an opportunity to help inform any future strategic catchment level approach.

10.1 Aim

To reduce the severity of waterlogging and dryland salinity. A part-funded approach will allow landowners to manage their own properties in accordance with their traditional practices as well as recognised good farming practice. A number of on-ground works has already been identified as part of the survey which align with the recommended strategic aims for catchment level planning to reduce waterlogging and salinity. Funding applications will allow all on-ground works to be assessed and prioritised.

10.2 How Funding will be Allocated

Funding is available to support landowners and community groups to undertake works with the aim of managing and reducing the problem of dryland salinity and waterlogging. This funding is available for landowners who identify works and are prepared to match the funding. To help landowners and community groups have a better understanding of what causes these problems, and the best practice approach to manage them, a Recommended Practices document has been developed alongside this Drainage Management Plan. This will help with identifying and prioritising the remedial works that will be most effective.

Although there are benefits to carrying out asset and land management works, key barriers include engaging in procurement processes and funding the work. Private landowners often have limited resources to identify, assess, and progress the development of work required on their land.

Funded works should seek to maximise efficiency, and the number of sites available through the programme. Landowners should be encouraged to bring forward batches of several sites, where possible.

10.3 Landholder Requirements

While the programme provides a support service to bring these sites forward more efficiently; the landowner maintains responsibility for their own sites.

- The landholder will have to decide on the work required;
- The landholder will apply for any permits and approvals required, being mindful of best practice;
- The landowner must have the resources and skills to complete the work and contribute 50% of the costs.

10.4 Prioritisation of Works

Priority should be given to catchment-level planning, or that which considers a number of properties, and which aim to achieve the following actions:

TABLE 10-1 PRIORITISED WORKS

To manage recharge	To manage discharge	To ensure a partnership approach
■ Changing land use practices ■ Protecting, improving and adding to native vegetation ■ Revegetation with commercial deep-rooted perennials, especially tree crops ■ Revegetation with native species ■ Catchment planning and management, including surface water management	■ Protecting, improving and adding to native vegetation ■ Revegetation with commercial deep-rooted perennials, especially tree crops ■ Productive use of saline land ■ Subsurface water management ■ Catchment planning and management	■ Catchment planning and management ■ Priority catchments to protect productive land, biodiversity and water quality ■ Community capacity building (locally based professional support, training)

10.5 Assessment of Applications for Funding

The grant has been allocated to support public landowners in identifying and assessing their land for works which will improve waterlogging and salinity problems. Expressions of Interest will be sought from landowners, and it is recommended that these be assessed under a competitive grant process. The following criteria could be used to assess and prioritise projects until funding is spent:

- **Improvements in Waterlogging or Salinity** – this includes the likelihood of success of the work in resolving waterlogging and salinity problems, and whether the work will benefit land at property or catchment level. It should also include an estimation of the anticipated increase in productivity.
- **Long-term Outcomes** – Whether the works are on-ground works, or targeted investigations and surveys, and preference is recommended for projects that focus on achieving long-term outcomes, which may include connecting vegetation between a fragmented landscape or fencing an area from stock.
- **Cost** – the cost of the work identified. There is limited funding available, and landowners could also be given preference depending on when they apply for funding for the work
- **In-kind Contribution** – a preference should be given where in-kind or cash contributions are proposed. An in-kind contribution is where the applicant gives their own time in physical labour and/or invests their own funds into the project.

- **Management Plans** – where applicants have an existing or proposed land management plan developed for their property or activities, which shows how any proposed works have been evaluated to reduce salinity and waterlogging. It should be demonstrated how the work will be maintained in the future.
- **Collaboration** – collaborative projects with neighbours or community group members is favourable. Similar works may need to occur over property boundaries or within local communities, and collaborative works are more likely to have catchment-level benefits.
- **Sustainability** – Whether the recommended work is sustainable and accepted good practice and includes planting of areas of native vegetation. Consideration should be given to any anticipated effects on neighbouring properties or the catchment generally. Priority will be given to projects that demonstrate a potential to maintain and improve the quality of these assets in an area of conservation significance.

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WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS

APPENDIX A
ONLINE GIS SURVEY

The following survey was posted online and accessed by a QR code sent to landowners via letter. EPLB also offered to capture relevant information at their offices, or via a printed set of questions.

Dryland salinity and waterlogging are significant economic threats to farming businesses within the Cummins Wanilla Basin (CWB). This is why the Cummins Wanilla Basin Streamcare Group (CWBSG) in collaboration with the Eyre Peninsula Landscape Board (EPLB), is investigating options for reducing waterlogging and salinity as part of a new Drainage Management Plan (the plan) currently under development. Following the development of the plan, the CWBSG will use the plans recommendations to allocate funding to deliver on-ground remedial works with like-for-like contribution from stakeholders.

Your input into the plan is critical to ensure we get the best end product. As such we need help from as many landowners as possible to gather information for the Drainage Management Plan in order to:

- Identify existing drainage channels and other infrastructure
- Identify areas of waterlogging and salinity-impacted areas and its potential causes
- Identify successful examples of previous remediation works that can be replicated
- Prioritise drainage management works to reduce waterlogging and salinity
- Prepare a set of guidelines and specifications for common types of infrastructure upgrades (e.g. channels, stock crossings)

You can help us by completing this survey about a drainage asset or issue you are aware of, and then marking its location on the below map. You can leave any question blank if you don't have a response, but you must mark the location on the map to submit an entry.

To mark the location on the map you can start by typing your address in the search bar, or use the + button to zoom-in on the map. Please zoom-in first to mark the asset location as accurately as possible. If the asset is a linear feature (e.g. a channel), just pick a location anywhere along the channel.

The location of the asset you submit will be able to be viewed by others, and you will see the location of other submissions when completing the survey, however please be assured that your name and contact details, should you wish to share them with us (optional), will remain anonymous and won't be visible to others.

If you know of a second drainage asset/issue that you want to tell us about, please submit this entry first, and then start the survey again for the second asset/issue.

Please note, it is important to show emerging trends (better or worse), not just a current state of what is happening now. This will help us to understand more about how the catchment is behaving and changing, and it will help to understand what is working as well as what is not. Both are equally important.

1. What is the asset type?
    - Channel
    - Culvert
    - Drain
    - Dam
    - Flow Control Structure
    - Storage Basin
    - Watercourse

- Other (please state)

2. Please describe the “other” asset type?
3. Asset Dimensions (e.g. channel is 2m wide, 1m deep, and approximately 2km long)
4. Your general observations on this asset's quality and effectiveness
5. Your general observations on this asset's performance during wet and/ or dry weather conditions
6. Indicate the main type of problem you have observed for this asset. If there are multiple problems, please select 'Other' and explain further below. Leave this question blank if there are no problems
   - Erosion
   - Salinity
   - Sedimentation
   - Waterlogging
   - Other
7. Observed problems (only if 'Other')
8. Observed problems (date) if possible, indicate the year and season or month that you observed the problem, and whether this is a problem that has got better or worse over time, or since a certain date/ event
9. Your main maintenance activities. What is your main maintenance/ repair activity for this asset? If there are multiple activities, please select 'Other' and explain further below.
   - Embankment Repair (low points or holes
   - Erosion Control
   - Siltation
   - Stock Damage
   - Other
10. Maintenance activities (Only if 'Other')
11. Maintenance issues. Describe any maintenance problems or limitations you have relating to this asset
12. Other information. Provide any other relevant information or comment relating to this asset
13. Improvement recommendations. List any major improvements you would like to be considered for this asset
14. Contact Details (optional)
15. Any photos or other relevant documents you have relating to this asset will be useful in helping us to look at solutions to the problem

APPENDIX B
ONLINE SURVEY RESULTS

The above map shows the locations relating to comments from landowners who participated in the January and August 2020 surveys, and their comments are included in the table below. This information is included in an interactive online map, which can be investigated to show each point in relation to surface features including surface water etc.

OBJECT ID	Asset Type	Asset Quality	Maintenance Activities	Improvement Recommendations	Contact Details	X and y coordinates
6	Culvert Pipe approx. 500mm	Highly inadequate for normal winter rainfall. Floods back into my paddock with some water remaining all winter and other times takes way too long to drain. Remaining water causes bare patches and salt	Culvert needed serious upscaling in two positions Totally inadequate size average flow ever year creates back up. Two positions on Warunda Road where this happens	Triple capacity of culverts so I can drain saline areas on my farm	0429332415	135.64128, -34.464671
7	Watercourse	water running through our property and into Lake Wangary		The problem seems to be shifting from the Wanilla Basin area to the stream and Lake Wangary itself.	JTB and Co. Trevor McMahon 0414459142	135.511198, -34.54234
8	Drain 800m x 1m x 300mm. simple grader blade drain. by-passes dam.	works well when maintained and ground saturated. Moves water away.	re-done with grader blade on tractor (3 point link Needs to be done again and possibly with level		0438850240	135.677132, -34.50008
9	Drain excavated 200m x 1m deep x 1.4m. from end of small drain to creek	ok but needs cleaning out. works well when cleaned out and runs water into creek.	none since excavation 15y ago. no excavator to do the job	clean out	0438850240	135.674414, -34.497639
10	Drain -grader blade 300m x 1m x 300mm deep. drains NW into swamp	needs cleaning. works 'ok' when clean. dams nearby gone salty. water table risen.	Siltation - might need a level to check alignment	deeper drainage??		135.655229, -34.496275
12	Drain grader blade drain - 200m long x 1m x 300mm	Average condition, over grown not easily seen on aerial map. works good when clean Flow control structure overgrown and silted up.	cleaned out by hand on high spots know and then need a good clean and maybe deepen 150mm		0438850240	135.654617, -34.495116

OBJECT ID	Asset Type	Asset Quality	Maintenance Activities	Improvement Recommendations	Contact Details	X and y coordinates
13	Drain grader blade 400m x 1m x 300mm deep.	average condition. runs ok when clean. but need to be deepened. compaction from stock	needs to be cleaned and deepened. check levels and alignment.	deepen and check levels	0438850240	135.677276, -34.505602
14	Drain 4M Wide and 1M Deep for 6kms	salt water flow restricted. isn't flow consistently through drain. February 2000 till now Culvert - sedimentation	De-siltation - limited due to Financial	De-silting the drain		135.691706, -34.338256
15	Watercourse 2m wide x 1m deep and roughly 3kms long	reasonable drainage but couch continues to be a problem	stock crossings	sections of creek need couch cleaned out again. We saw an improvement after the last time it was cleaned out.	susie13@bigpond.com	135.673082, -34.453786
16	Drain w drain profile. 2m wide. 0.5 deep 600m long. runs north east to south west	been good and drains water well. Does silt up near main road (west). works well when clean. bit of silt at west towards road. silt and growth in drain flow control structure	needs minor clean out	look at improving side drainage near south west end. some small side drains may still be evident.	0438935140	135.666711, -34.542084
17	1 drain dividing into 2. w drain profile. 2m wide. 0.5m deep. 600m long.	works well when clean.		clean out needed	0438935140	135.661537, -34.554297
18	Drain 800m. 2m wide. 0.5 deep. w drain profile	good drainage when clean		needs a clean out and tune up.	0438935140	135.668087, -34.544963
19	Drain w drain profile. 2m wide. 0.5 deep. 800m long	aging. good when clean		needs clean out and tune up	0438935140	135.669644, -34.546514

OBJECT ID	Asset Type	Asset Quality	Maintenance Activities	Improvement Recommendations	Contact Details	X and y coordinates
20	Watercourse - run from railway line, from 2 points through to the road, joining to make one	few blockages restricting flow in control structure. dead trees / siltation. western end (last 100m) silts up		remove silt from western end and possibly look at cleaning out other blockages throughout.	0438935140	135.661741, -34.548469
21	Watercourse - section about 300m	few overgrown areas restricting flow. weeds. veg. and dead timber (following fire)		possibly look at cleaning out some of the blockages	0438935140	135.66827, -34.560689
22	Drain	Builds up with silt quite quickly, banks of drain are acting as a plug and not allowing water into drain. salt is spreading from these sites. Areas at dam that have been planted down to trees are now dying. Since Aug-15	3	Eliminate drain banks - allow excess water to drain into main drain.	0427888414	135.67528, -34.483669
23	Agriculture land 700m long / 1.5m wide / 800deep	Removing salt water from adjacent land. Water running into drain Over last 10years	Redoing and deepening creek line. Also needs underground piping to remove excess water	Piping into salt area	Mickan2@bigpond.com. //. 0427885072	135.782058, -34.357386
24	Drain 1pass Grader blade drain	Below average. Wet conditions water is slow to get away and clear the area. Water becomes stagnant and floods the area surrounding the drains. Salinity increased Jun-14	Need to Correct levels to drain water away	Correct levels in a drain that is large enough in correct lay of the land to drain water sufficiently	ctpuckridge@gmail.com	135.538026, -34.417421

OBJECT ID	Asset Type	Asset Quality	Maintenance Activities	Improvement Recommendations	Contact Details	X and y coordinates
25	Drain Depth 4M, Width is 4M, Length is 5km	Very Effective, wet during survey Waterlogging from 2000 to 2020	Cleaning out existing drain, issues due to cost/ finance		gumpark29@gmail.com	135.6728371, -34.3383093
26	The drain-watercourse is app 5m wide, 2m deep and 1220m long (on property only)	The drain-watercourse is effective but previous remedial works need upgrading following washing out of the drain bed and additional strategic rock input required	Embankment repair & strategic rock input required. Previous drain-watercourse rock input is washing away	Additional rock input. Low lying areas immediately adjacent require a submerged culvert to channel water into Edillilie Creek	0458441104, nicholasjohnson84@gmail.com	135.6768475 - 34.384171
27	Drain 2m wide, 0.5m deep & 3,500m long	Saturated along the western drain due to drain bank		The V drain must be upgraded to a W as the western V is inhibiting water egress	0458441104, nicholasjohnson84@gmail.com	135.6821353 - 34.38127263
28	Soak - 130m long, 50m wide & ~0.5m deep	The asset is productivity limited.		Submerged channelled culvert required for effective water egress	0458441104, nicholasjohnson84@gmail.com	135.6698614 - 34.37947487
29	Drain 4m wide x 3.5km long x variable depth	average - can blow out levee bank wall sections during flood flows	on council road reserve and private land - part drain part aqueduct			135.6893986 - 34.36498559
30	Flow control structure - council road reserve	ok		old and needs to be looked at for any required maintenance works		135.7040971 - 34.36061937

OBJECT ID	Asset Type	Asset Quality	Maintenance Activities	Improvement Recommendations	Contact Details	X and y coordinates
31	Culvert 1 pipe 450ID	being replaced		needs about 300 tonnes of sediment removed on upstream side of road in council road reserve		135.6922042 - 34.47704489
32	Drain 1.5m wide, .5m deep, 370m long	Placed in wrong position , does not work. Was installed to remove water from water logged area, no water flows in drain still gets water logged below drain	Did have a drain in different position but drain flow was too steep and caused erosion issue and was filled in	Drain needs to be relocated	0427854117	135.5241209 - 34.47872118
33	Watercourse 4.5m wide, 2m deep, 650m long	Drains water but flow is too fast. Water flows during winter months and some permanent water pools all year – observed since 1990's		More flow barriers and some silt removed from main creek	0427854117	135.5209881 - 34.47755374
34	Watercourse - Creek is 1-3m wide and 1-2m deep	Crossing pipes worn out. During wet weather makes it hard to cross		Replace crossing pipes and fill with rubble to enable crossing	0488130077	135.7371402 - 34.41536055
35	Watercourse Crossing - Creek 2m wide 1m deep	Crossing pipes worn out. During wet weather makes it hard to cross		Replace crossing pipes and fill with rubble to enable crossing	0488130076	135.7424509 - 34.41369214
36	Watercourse Crossing - Creek is 2m wide 1m deep	Crossing is “stuffed” - pipes washed out. During wet weather makes it hard to cross		Replace crossing pipes and fill with rubble to enable crossing	0488130076	135.7421103 - 34.41336354

OBJECT ID	Asset Type	Asset Quality	Maintenance Activities	Improvement Recommendations	Contact Details	X and y coordinates
37	Grader drains 1m wide 0.5m deep	They work well Work great in wet conditions to run water to watercourses		Need cleaning out Clean out with a grader	0488130076	135.7557601 - 34.43784761
38	Dam 30m x 30m x 10m	Dam Works well but Leaks	Don't have machinery to fix	Needs to be cleaned out and gravel seam pushed out and covered with clay	0488130076	135.7333636 - 34.43571952
39	Water crossing 5m wide	Floods when wet. Just keeps eroding and water logging	Don't have machinery to fix	Pipes and rubble to make crossing	0488130076	135.7575303 - 34.43670173
40	Track that water runs over 6m wide	Ok Eroded when wet	Don't have machinery to fix	Needs machinery and rubble to fix. Pipes under the track to allow water to flow under	0488130076	135.7497573, -34.436330082
41	Dam 30x30x10	Ok but leaks	Don't have machinery to fix	Dig out to remove gravel seam and cover with clay	0488130076	135.7497787 - 34.43732113
42	Drain 2m Wide x 1-2m High x 4km long	average build-up of silt and juncus acutus	ongoing cleaning	Remove embankments on the side and full clean out of drain	0427888414 westfieldajlk@outlook.com	135.6752396, -34.4837636042

OBJECT ID	Asset Type	Asset Quality	Maintenance Activities	Improvement Recommendations	Contact Details	X and y coordinates
43	Drain 1.5m wide x 2km long	Fair build us of silt		Remove embankments on the sides as these are acting like a plug and holding up water reaching the drain	0427888414 westfieldajlk@outlook.com	135.6701595 - 34.48585068
44	Flow control structure DC of Lower Eyre Peninsula drain pipe under the road width of Warunda Road	Poor - water lays in paddock as drain is set to high - water unable to drain away - road acts as a barrier Salinity problems for 24 years	unable to do as belongs to council	lower the drain so water can be released from property	0427888414 westfieldajlk@outlook.com	135.6803304 - 34.47760821
45	Channel 2 meters wide by 1 meter deep	MediumBetter in wetter conditions Poor water movement under ground	Stock damage 2010	Side drains required	0427764267	135.6803328 - 34.35013418
46	Water course several kms long A prickly bulrush is growing and spreading on these areas. Salinity has been an issue for 20-30 years	Watercourses are saline. Too salty for stock. Sown to Puccinelia and tall wheat grass 20-30 years ago. Allows some summer grazing	Dealing with the prickly bulrush that is growing and spreading. We have been burning it in winter if conditions allow	The pin is just one location the rest are reflected on maps attached. You are welcome to come and have a look, anytime. We can't see ourselves, what could be improved upon	Phil McCracken 0427 764 272	135.7697985 - 34.41667187

APPENDIX C
EXAMPLE WORKS APPLICATION FORM

APPLY FOR FUNDING FOR WATERLOGGING OR SALINITY MANAGEMENT WORKS FOR LANDOWNERS

What projects will we fund?

We may fund landowners to carry out works that will benefit waterlogging and dryland salinity. Funding must be for capital expenditure to undertake on-ground works.

Priority will be given to catchment-level planning, or that which considers a number of properties, and which aim to achieve the following actions:

To manage recharge	To manage discharge	To ensure a partnership approach
■ Changing land use practices ■ Protecting, improving and adding to native vegetation ■ Revegetation with commercial deep-rooted perennials, especially tree crops ■ Revegetation with native species ■ Catchment planning and management, including surface water management	■ Protecting, improving and adding to native vegetation ■ Revegetation with commercial deep-rooted perennials, especially tree crops ■ Productive use of saline land ■ Subsurface water management ■ Catchment planning and management	■ Catchment planning and management ■ Priority catchments to protect productive land, biodiversity and water quality ■ Community capacity building (locally-based professional support, training)

Prioritisation

We will prioritise sites that require the lowest unlocking costs per unit in order to ensure value for money and allow funding to stretch further. The following criteria will be used to assess and prioritise projects until funding is spent:

- **Improvements in Waterlogging or Salinity** – this includes the likelihood of success of the work in resolving waterlogging and salinity problems, and whether the work will benefit land at a property or catchment level. It should also include an estimation of the anticipated increase in productivity.
- **Classification of works** – and whether these are Primary, Secondary or Tertiary works.
- **Long-term Outcomes** – Whether the works are on-ground works, or targeted investigations and surveys. Preference is recommended for projects that focus on achieving long-term outcomes, which may include connecting vegetation between a fragmented landscape or fencing an area from stock.
- **Cost** – the cost of the work identified. There is limited funding available, and landowners could also be given preference depending on when they apply for funding for the work
- **In-kind Contribution** – a preference should be given where in-kind or cash contributions are proposed. An in-kind contribution is where the applicant gives their own time in physical labour and/or invests their own funds into the project.
- **Management Plans** – where applicants have an existing or proposed land management plan developed for their property or activities, which shows how any proposed works have been evaluated to reduce salinity and waterlogging. It should be demonstrated how the work will be maintained in the future.

- **Collaboration** – collaborative projects with neighbours or community group members is favourable. Similar works may need to occur over property boundaries or within local communities, and collaborative works are more likely to have catchment-level benefits.
- **Sustainability** – Whether the recommended work is sustainable and accepted good practice and includes planting of areas of native vegetation. Consideration should be given to any anticipated effects on neighbouring properties or the catchment generally. Priority will be given to projects that demonstrate a potential to maintain and improve the quality of these assets in an area of conservation significance.
- We will prioritise landowners with a credible approach to delivering these works
- We will prioritise landowners who can deliver against significant milestones in the first year and draw down funding within the life of the programme

HOW TO APPLY

Property Information

Address or lot number of the property where works are to be carried out	
Contact details for the owner (name, mailing address, email and phone)	
Property area (hectares) and current land use	
List any access roads, power easements, and agreements with surrounding properties	

Describe the actions and their appropriateness for each site

Describe the nature of the proposed work to be funded, demonstrating the nature and extent of work required to achieve benefits for each site. Consider the appropriateness of the actions and the level of funding required.

How will the project be managed?

Do you have the capacity, resources and skills to deliver the works? Describe the arrangements for any additional resources you plan to bring in. Please give details of whether you propose to undertake the work yourself or use a contractor.

Prioritisation Criteria

Improvements in Waterlogging or Salinity – How will this work help to resolve waterlogging and salinity problems and will the work benefit land at a property or catchment level? Where applicable, please also include an estimation of the anticipated increase in productivity.

Long-term Outcomes – Are the works on-ground works, and is there a focus on achieving long-term outcomes, which may include connecting vegetation between a fragmented landscape or fencing an area from stock?

Management Plans – Do you have an existing or proposed land management plan developed for your property or activities, which shows how any proposed works have been evaluated to reduce salinity and waterlogging? The plan should demonstrate how the work will be maintained in the future.

Collaboration – Collaborative projects with neighbours or community group members is favourable. Do the works occur over property boundaries or within local communities, what collaborative works are proposed, and do they have catchment level benefits?

Sustainability – Is the work sustainable and accepted good practice? Does it include planting of areas of native vegetation? Consideration should be given to any anticipated effects on neighbouring properties or the catchment generally. Priority will be given to projects that demonstrate a potential to maintain and improve the quality of these assets in an area of conservation significance.

Total project cost (including any secured match funding)

Please provide a breakdown of the anticipated cost of the work, and what is your proposed contribution (monetary, in-kind, or labour costs)?

Please outline clear and achievable milestones for preparation, construction etc., and the funding associated to them

Milestone/description of activity	When will the activity take place?	Budget forecast

DECLARATION

The declaration form must be completed by the landowner or his authorised agent. Expressions of interest without this will not be considered.

By submitting this application form, you agree to the following:

We will use this form and the other information you may have provided for the following purposes:

- To decide whether to award you with support.
- To hold in our database for as long as is necessary for statistical purposes.
- If we offer you funding or support, we will publish information relating to the activity we have funded.

I hereby declare that the information supplied on this form are true and to the best of my knowledge.

Name:

Position:

Date:

APPENDIX D
ROLES AND RESPONSIBILITIES FOR GOVERNANCE

Table 21 - Roles and responsibilities

Organisation or Body	Role and Responsibilities (legislation)
Native Vegetation Council under the *Native Vegetation Act 1991*	• Provide advice and make decisions about the protection, removal and re-establishment of native vegetation • Fund research and conservation projects that promote the responsible and ongoing management of native vegetation • Provide advice on development applications that proposes to impact native vegetation (*Development Act 1993*) • Assess applications to clear native vegetation and determine the required significant environmental benefit payment • Administer the Native Vegetation Fund including the collection and spending of money for significant environmental benefit offsets
Coast Protection Board	• Develop and fund coast protection infrastructure (*Coastal Protection Act 1972*) • Assess and provide advice on development applications (*Development Act 1993*)
Parks and Wilderness Council	• Provide advice to the Minster for any matter relating to the *National Parks and Wildlife Act 1978*, *Marine Parks Act* or the *Wilderness Protection Act 1992* • Provide advice to the Minster about management of reserves and conservation of wildlife including funding arrangements, policy development, education and community participation
Stormwater Management Authority under the *Local Government* (Stormwater Management) *Amendment Act 2007*	• Develop and maintain stormwater management planning guidelines • Authority for approving stormwater management plans
SA Water	• Provide water to households, farms and businesses connected to the reticulated water supply infrastructure • Operate and maintain reticulated water supply and sewage infrastructure
Primary Industries and Regions SA (PIRSA)	• PIRSA's Biosecurity SA division manages the risks to South Australia posed by animal and plant diseases, food borne illness, and misuse of rural chemicals • NRM Biosecurity within PIRSA in conjunction with NRM Boards, oversees programs to destroy or contain pest plant and animals, and programs to prevent new pests coming into the region • Issue permits and exemptions for activities that would otherwise contravene fisheries management rules (*Fisheries Management Act 2007*) • Issue commercial fishing licenses and other commercial permits (*Fisheries Management Act 2007*) • Oversee Fisheries Management Plan and fish stock status reports (*Fisheries Management Act 2007*) • Support aquaculture through managing licensing of aquaculture activities and monitoring (*Aquaculture Act 2001*)
Department for Planning, Transport and Infrastructure	• Develop and implement coastal land use planning policy (*Development Act 1993*) • Issue aquatic activities licenses (*Harbors and Navigation Act 1993*)

APPENDIX E
ASSESSMENT PROCESS FOR WATER AFFECTING ACTIVITIES PERMITS

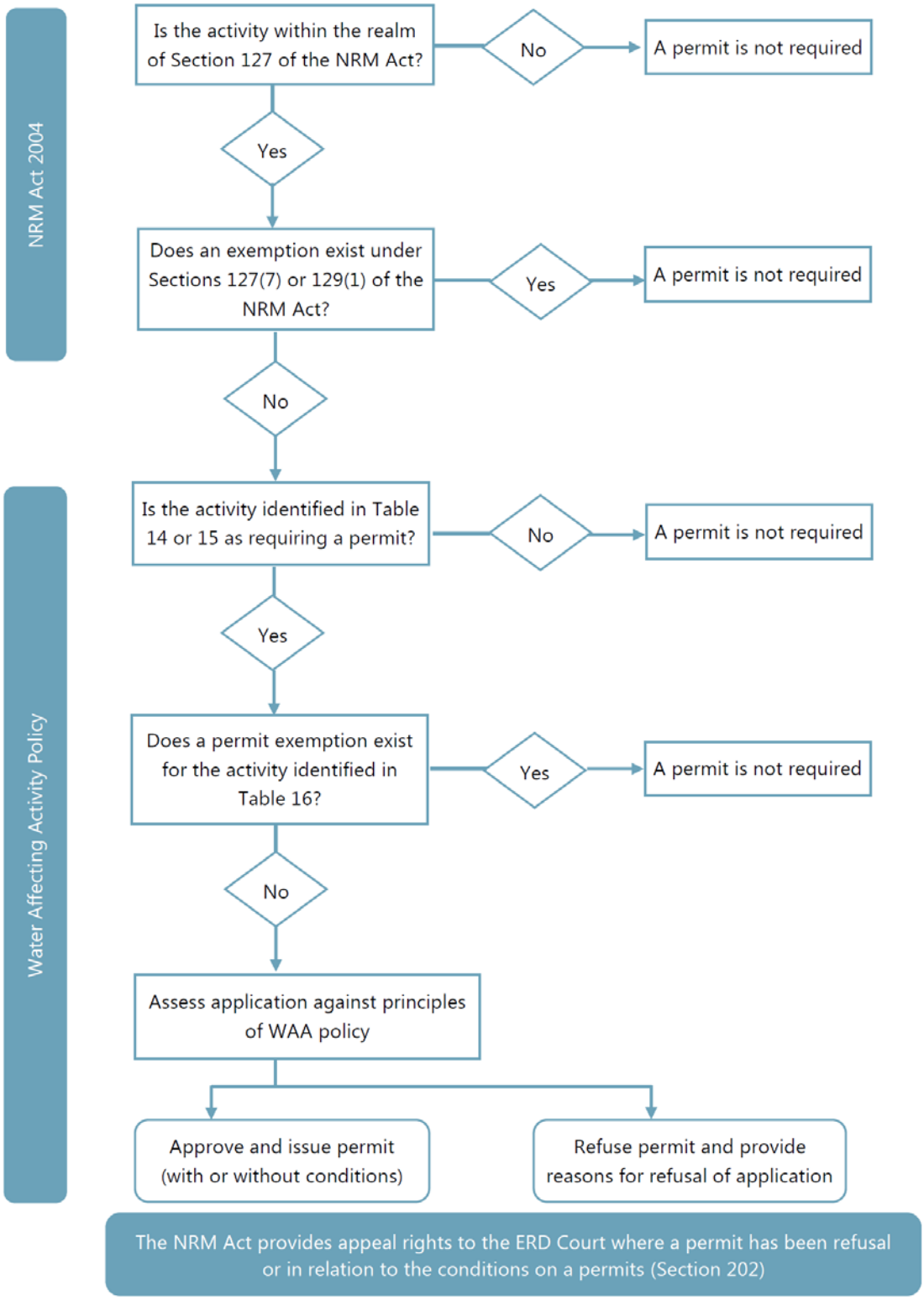
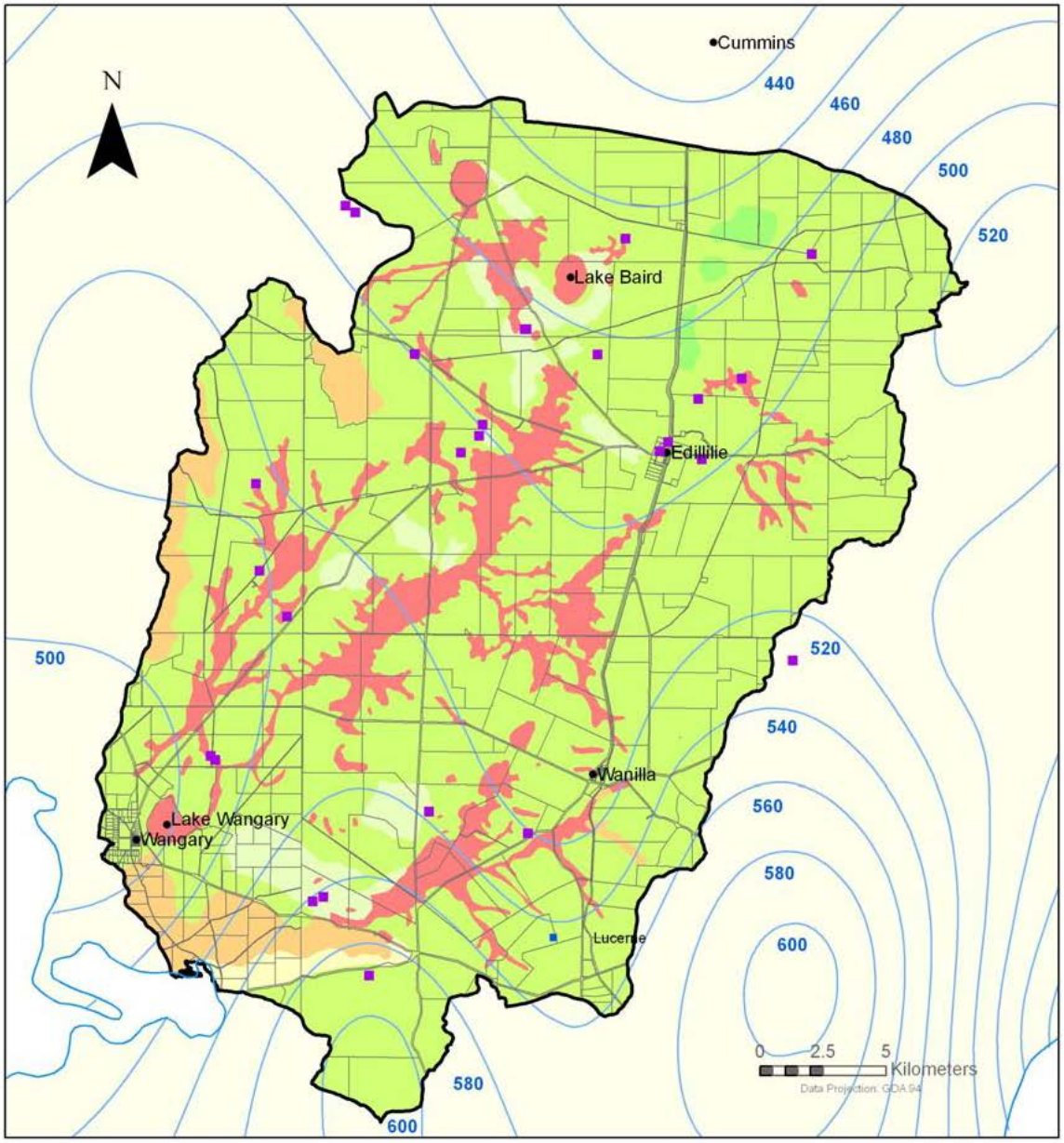


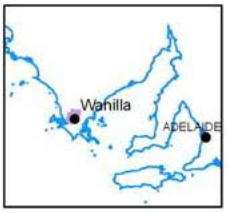
Figure 26 – Assessment process for Water Affecting Activities Permits

APPENDIX F
LUCERNE SUITABILITY MAP



Proportion of land with moderate to high potential	Most common potential class
More than 60%	*Moderately high to high potential*
More than 60%	*Moderate potential*
30 - 60%	*Low to high potential (mixed)*
10 - 30%	*Moderately low to low potential (mixed)*
Less than 1%	*Moderately low potential*
Less than 1%	*Low potential*

Catchment Boundary
Cadastre
Coastline
Town
Lucerne
Rainfall Isohyet (mm)



Map created by Saltsmart - Rural Solutions SA, Peter Ciganovic & Stuart Wright, July 2009
Data source: Primary Industries and Resources SA, Spatial Information Services Branch

Government of South Australia

APPENDIX G
COMMENTS FROM ECONOMIC ANALYSIS OF THE CWB DRAINAGE MANAGEMENT SYSTEM

Requesting Financial Support from Government

- I wish I could get some financial and physical assistance to achieve what I know is restoring the land to productive, beautiful country. It is heartbreaking to see the beautiful country being reduced to scalded salt areas. This shouldn't happen. But my life isn't long enough and I have to be careful that I don't blow my budget trying to achieve this. Thank you.
- Government to give 150% - 200% tax deduction on any proven dollars [spent on] salt and drainage related issues to encourage all farmers to spend some of their own money [where they] have salt problems. If left unattended it will ruin some farms forever.

Please Do Something to Change Situation

- Property been in family for 118 years and we hope to leave it in better shape for the next generation. Better drainage would be a huge help.
- What water (rain) falls on this farm stays on farm.
- Investigate 'moles' (sp) for drainage. Investigate water use plants (forage, perennials, trees) Go to person, organisation for advice.
- Maybe adding 'clay' to improve soil might help. Don't know!
- We are also in the oyster industry. Impact of water quality, quantity, and rate running into the bays and sea need also to be considered.
- Someone who has experience and takes costs versus value of improvements into account who can advise would be very valuable to me, i.e. certain cropping areas to lucerne or drains would work in this area but not in that one. If he or she has done this with their own money they tend to have a good grasp on the costs versus profit margin.

Issues with Survey

- Many of the questions were difficult to answer as we farm outside the area affected and serviced by the drainage schemes implemented by CWB Streamcare Group.

Lack of Support from Authorities

- Requested permission to dig drains to get saline water off land - inspector came and refused permit to dig drain - this was ridiculous – madness.
- When concerns were raised at a water security meeting here at the Cummins Bowling Club, these concerns were dismissed as laughable. They didn't want to know. Saline water = saline land.
- Council is effectively causing salt to get worse on this country because it takes 3-4 days and weeks in wet years to completely drain. We need cooperation with council! I have numerous drainage works that I would commence immediately but they are pointless because drainage across roads is totally inadequate. When council renewed this >10years ago what they put in was poorer than what was originally there. It floods my country as a result of it!

No Problem

- There has been drainage in place for the past 30 years, on the wettest, and salt affected areas on my property.
- We only own an 80 Ha limestone block along Minniribbie creek, south of Lake Wangary. No permanent water means it is only used for light grazing from time to time. No salinity issues.

Complementary Measures

- The world is continually evolving and unfortunately the salinity problems of the CWB will continue to worsen. I actually don't think there is a lot that can be done to stop this problem. The problem starts in the Koppio hills and I suppose the clearing of land has caused this problem. Historically the land was covered with large deep rooted trees that not only used up moisture but slowed runoff. Perhaps the development of salt resistant pastures e.g. – messin[a] are the way of the future. Perennial pastures that grow in the summer would be preferable.

APPENDIX H
OTHER LEGISLATION, PLANS AND STRATEGIES

Australia's Biodiversity Conservation Strategy (2010 – 2030)

A guiding framework for biodiversity conservation. Three priorities for action are engaging all Australians in biodiversity conservation, building ecosystem resilience in a changing climate, and achieving measurable results.

Australian Pest Animal Strategy 2017 - 2027

Seeks to address the undesirable impacts caused by exotic vertebrate animals (mammals, birds, reptiles, amphibians and fish) that have become pests in Australia, and to prevent the establishment of new exotic vertebrate pests.

Australian Weeds Strategy 2017 - 2027

A framework to establish consistent guidance for all parties involved in weed management and identifies priorities for weed management across the nation. Aims to minimise the impact of weeds on Australia's environmental, economic and social assets.

Caring for our Country 2013-2018

EPLB investment initiative seeking to achieve a healthy, better protected, well managed and resilient environment that provides essential ecosystem services in a changing climate.

Environment Protection and Biodiversity Conservation Act 1999

Relates to the protection of the environment and conservation of nationally significant biodiversity. Species that contribute to Eyre Peninsula's landscapes, seascapes and ecosystems may be protected under this Act.

National Bushfire Management Policy 2014

Focuses on the management of fire in forests and rangelands, primarily on public lands. Places priority on the protection of life and identifies the need for consideration of the community benefits of ecosystem services.

National Recovery Plan for Mallee fowl (2007)

Strategies to secure existing populations across the species' range and achieve de-listing of Mallee fowl under the EPBC Act within 20 years through managing populations, planning, research and monitoring, community involvement and project coordination.

National Water Initiative

The NWI is a shared commitment by governments to increase the efficiency of Australia's water use, leading to greater certainty for investment and productivity, for rural and urban communities and for the environment. The NWI built upon the 1994 COAG Water Reform Framework.

Australia's blueprint for water reform, the principal water policy agreement of the Council of Australian Governments. Commitments under the NWI relating to the Regional Landscape Plan themes of water resources and groundwater resources include to prepare water plans with provision for the environment and deal with over-allocated or stressed water systems.

National Water Quality Management Strategy

A joint national approach to improving water quality in Australian and New Zealand waterways that aims to protect the nations' water resources by improving water quality while supporting the businesses, industry, environment and communities that depend on water for their continued development.

Plan National Wildlife Corridors

An Australian Government initiative to support landscape connectivity that link up areas of habitat, while supporting multiple land uses such as; conservation, farming and forestry. Guides and support individuals, private land managers, community groups, policy makers, planners and natural resource managers to develop and manage corridor initiatives.

State Legislation, Plans and Strategies

Aquaculture Act 2001 and Aquaculture Zone Policies (Various)

The *Aquaculture Act 2001* regulates the development and operation of marine and inland aquaculture activities in South Australia. To assist this regulation, the Act enables the creation of policies and zones to manage specific areas and activities. There are nine aquaculture zones within the EPLB region, these include: Lower Eyre Peninsula, Coffin Bay, Tumby Bay, Port Neill, Arno Bay, Fitzgerald Bay, Smoky Bay, Streaky Bay and Cape D'Estrees

Development Act 1993 and Development Regulations 2008

The *Development Act 1993* guides planning and development across the State by regulating development through the creation of Development Plans that facilitate sustainable development and the protection of the environment. Under the Regulations applications for certain forms of development must be referred to the Minister or delegate responsible for the administration of the *Natural Resources Management Act 2004 (repealed by the Landscape South Australia Act 2019).*

Fisheries Management Act 2007 and Fisheries Management Plans (various)

The Fisheries Management Act 2007 regulates classes of commercial and recreational fishing activities. Management Plans describe the biological, economic and social characteristics of the fishery, identify its actual or potential impacts on its associated ecosystem/s, identify any ecological factors that could have an impact on the performance of the fishery, and identify management objectives, research priorities and risks. There are Management Plans for abalone, prawns, rock lobster, marine scale fish and blue crab.

Local Government Act 1999

The *Local Government Act 1999* provides South Australian Local Governments with power to raise revenue through rates. This revenue is to provide and maintain infrastructure and services Under Schedule 1A, Local Governments may prepare a stormwater management plan. Landscape Boards must consider any stormwater management plan prepared within their region and advise the Stormwater Management Authority if the plan contains appropriate provisions.

Marine Parks Act 2007 and Marine Park Management Plans (various)

The *Marine Parks Act 2007* enables the ability to protect and conserve marine areas by establishing Marine Parks and associated zones. There are ten Marine Parks within the EPLB Region. These include: Far West Coast, Nuyts Archipelago, West Coast Bays, Investigator, Thorny Passage, Neptune Islands Group, Gambier Islands Group, Sir Joseph Banks Group, Franklin Harbor and Upper Spencer Gulf Marine Parks. Each Marine Park has a specific management plan.

Marine Parks Act 2007 and Marine Park Management Plans (various)

This Act sets out the roles and responsibilities for natural resources management in South Australia. It provides the framework for the Minister, the Landscape Boards, and Regional Natural Resources Management Plans (to be replaced by Landscape Plans).

National Parks and Wildlife Act 1972

Provides for the establishment and management of reserves and the conservation of wildlife within National Parks, Conservation Parks, and Recreation Parks. The Act provides arranges for the Minister to enter into an arrangement with Native Title Holders to co-manage public land.

Climate Change Adaptation Framework for South Australia (August 2012)

A basis for the state's response to climate change through regional partnerships and the development of Adaptation Plans. The Eyre Peninsula Regional Climate Change Adaptation Plan and Natural Resources Management Plan work together to build regional capacity to protect and enhance natural resources in a changing climate.

Conserving Nature (2012 – 2020)

A strategy for creating the state's terrestrial and inland aquatic protected area system. It guides and assists decision-making by the State Government, non-government organisations and others, about where to establish new protected landscapes, seascapes and ecosystems (or add to existing protected areas) so they achieve the best conservation and community outcomes.

Living Coast Strategy for South Australia

The State Government's environmental policy directions for sustainable management of South Australia's coastal, estuarine and marine environments. Focuses on promoting environmental stewardship, and also supports development of industries operating within sustainable frameworks.

NatureLinks

A practical approach to conserving the State's native flora and fauna by managing and restoring large areas of habitat within broad 'biodiversity corridors', enabling native species to adapt and survive to environmental change.

No Species Loss: A Nature Conservation Strategy for South Australia (2007 – 2017)

Strategy to protect the state's native species from extinction through: conservation of biodiversity; community ownership and stewardship for biodiversity; ecological knowledge that can influence decision making; adjustment to the impacts of climate change; and active and integrated natural resources management partnerships.

Pest Management Strategy

State-wide strategy to protect the environment and public safety from the adverse impacts of pest plants and animals that threaten landscapes, seascapes, ecosystems, and agricultural production. Made up of strategies, a management plan, community engagement and operational procedures.

The Planning Strategy for South Australia – Eyre and Western Region Plan

Sets out the State Government's vision for land use and future development. Contains principles and policies relating to environment and sustainability, economic development, and population, settlements and culture. The Plan also seeks to promote the capability of the region's people and industries to adapt to changing climatic, economic and social conditions.

South Australia's Climate Change Strategy 2015-2050 – Towards a low carbon economy

Outlines the government's aspirations for the future and provides a framework for renewed effort and action. Towards achieving South Australia's emissions reduction target and building resilience to the climatic changes.

South Australia's Strategic Plan

A long term vision for South Australia. Targets in the SASP relating to the environment, community and economy link to various themes in the Regional Plan such as ecosystems, agricultural production and sustainable land management

State Natural Resources Management Plan

Sets a long term vision and goals, with priorities identified for a five year period 2019-2020. The Plan contains policy for the overarching management of South Australia's natural resources. It provides a framework for all natural resources management initiatives, including regional Plans and agency activities.

Water for Good

A plan to ensure there will always be enough water in South Australia in the context of population growth and reduced rainfall. Actions include Regional Water Plans and desalinated seawater to supplement Eyre Peninsula's water resources.

Regional and Local Plans and Strategies

Adjoining Regional Plans

Regional NRM Plans (to be replaced by Landscape Plans) for the:

- Alinytjara Wilurara Region
- South Australian Arid Lands Region
- Northern and Yorke Region

These Regional Plans describe each region's goals and long term and intermediate targets with associated strategies and actions to achieve these. The Eyre Peninsula Regional Landscape Plan must be consistent with the strategic regional plans of neighbouring regions.

Biodiversity Plan for Eyre Peninsula (2002)

A strategic approach to the conservation and management of biodiversity within the Eyre Region. This Plan guides the conservation, management and rehabilitation of ecosystems and landscapes.

Development Plans (various)

Regulates development in the region. Contain policies for Local Government Areas relating to Natural Resources, Water, Stormwater, Coastal Areas, Hazards, Heritage, Open Space and Recreation and primary Production. Development plans exist for each of the 11 Councils within the EPLB Region; City of Whyalla, City of Port Lincoln, District Council of Lower Eyre Peninsula, District Council of Tumby Bay, District Council of Ceduna, District Council of Streaky Bay, District Council of Elliston, Wudinna District Council, District Council of Cleve, District Council of Kimba and District Council of Franklin Harbour.

East Meets West NatureLink Plan (2006)

Established to assist the species and ecosystems within central and northern Eyre Peninsula and the Far West of South Australia to survive, evolve and adapt to environmental change. It will achieve this by connecting habitats, through a comprehensive system of core protected areas that are buffered and linked by lands which have complementary land management objectives.

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