

Bilya Maadjit Murray River Action Plan

2022

Prepared for
Peel-Harvey Catchment Council

By Urbaqua

November 2022

urbaqua
land and water solutions



PHCC

Working
Together

Peel-Harvey Catchment Council

We acknowledge the Bindjareb Noongar people as Traditional Custodians of this land and pay our respects to all Elders past and present.

Disclaimer and Limitation

This document is published in accordance with and subject to an agreement between Urbaqua and the Client, Peel-Harvey Catchment Council and it is designed to be used by others as a guide. It has been prepared using the standard of skill and care ordinarily exercised by environmental professionals in the preparation of such documents.

This report is a qualitative assessment only, based on the scope of services defined by the Client, budgetary and time constraints imposed by the Client, the information supplied by the Client (and its agents), and the method consistent with the preceding. Urbaqua has not attempted to verify the accuracy or completeness of the information supplied.

Any person or organisation that relies upon or uses the document for purposes or reasons other than those agreed by Urbaqua and the Client without first obtaining the prior written consent of Urbaqua, does so entirely at their own risk and Urbaqua, denies all liability in tort, contract or otherwise for any loss, damage or injury of any kind whatsoever (whether in negligence or otherwise) that may be suffered as a consequence of relying on this Document for any purpose other than that agreed with the Client.

Copying of this report or parts of this report is not permitted without the authorisation of the Client or Urbaqua.

Acknowledgements

Urbaqua and Peel-Harvey Catchment Council would like to acknowledge the following people for their significant contribution to this project:

1. Alcoa Foundation (funding partner);
2. Department of Water and Environmental Regulation;
3. The Shire of Murray.



Department of
**Water and Environmental
Regulation**

EXECUTIVE SUMMARY

The Murray River is one of the three main rivers that discharge into the Peel-Harvey Estuary, along with the Serpentine River and Harvey River. As with most rivers in the south-west of Western Australia, the Murray River catchment has been subject to significant disturbances since European settlement in the 1830s from agriculture, urban expansion, and dam construction. Along with these past and current pressures, the Murray River also faces threats from the impacts of projected decline in rainfall and sea-level rise.

The River Action Plan (RAP) has been prepared to provide a basis for rehabilitation works, and a summary of baseline and ongoing condition assessments to reference future works against. The document was prepared in partnership between the Peel-Harvey Catchment Council and Urbaqua, with funding provided by the Alcoa Foundation. The RAP addresses approximately 53.1km of river from the Peel-Harvey Estuary to the rise to the Darling Scarp, divided into six (6) reaches in the Lower Murray and nine (9) in the Middle Murray, so 15 reaches in total. These have been referred to as the Lower Murray Reaches 1 - 6 (or LM1 – LM6) and the Middle Murray Reaches 1 - 9 (or MM1 – MM9) to ensure consistency of naming with previous versions of the RAPs (refer to Section 1.1).

The RAP was prepared based on field inspections of the reaches and desktop analysis of aerial imagery, and previous investigations. Each reach was assessed in accordance with the **Department of Water and Environmental Regulation's** (DWER) *River Restoration Manual* (WRC, 1999), specifically the Pen-Scott method that grades foreshore between grades A (pristine) and D (ditch). Scoring of the foreshore condition allowed for determination of priority areas for rehabilitation.

Much of the river demonstrated the impacts of land use pressures. There is considerable erosion and bank instability throughout the Murray primarily due to livestock access and boat wave action (from increased recreational use from urbanisation). Riparian vegetation, particularly the understorey, is diminished/ non-existent and/or dominated by weeds.

The assessment also identified areas along the river with some areas of good quality remnant vegetation, and a diversity of stream habitats particularly in the Middle Murray.

A summary of the recommendations that have been provided as part of this RAP are provided in Table 1. Further information on the issues, evidence and recommended actions are provided later in this RAP.

Table 1: Murray River Actions and Recommendations Summary

Priority	Location	Action
1. Improve ecological health of the Murray River and surrounds		
Short term	Reaches LM1, LM3, LM4, MM7	Install erosion or bank stabilisation measures (hard or soft engineering structures). Consider artificial bank options that provide opportunities for habitat (mimic natural surfaces that mussels etc. can inhabit)
Short term	Reaches LM1	Consider replacement of ineffective erosion protection structures
Short term	Reaches LM1, LM5, LM6, MM2, MM8	Provide controls or fencing to prevent livestock access/ boat access/ pedestrian access
Short term	Reach LM1, LM4, LM5, LM6, MM1, MM2, MM4, MM5, MM9	At high value areas, undertake weed removal to assist regeneration of native vegetation

Priority	Location	Action
Short term	Reach LM1, LM4, LM5, LM6, MM1, MM2, MM4, MM5, MM9	At high value areas, undertake revegetation programs to assist regeneration of native vegetation through seedlings, seed mats etc. If possible, avoid the use of plastic tree guards to help reduce the amount of plastic that could potentially enter the river
Short term	Reaches LM4, LM5, MM5	Remove bulk litter and informal recreational facilities
Short term	Reaches MM1, MM5	Control aquatic weeds and consider thinning of other invasive aquatic species such as giant reeds
Short term	Reaches LM4, MM8	Stabilise banks to protect healthy trees from bank collapse where exposed roots occur
Long term	Reaches MM1, MM5, MM6, MM8	Investigate sources of nutrients within the tributaries and catchment, include water quality sampling for total nitrogen and total phosphorus
Long term	Reaches MM1, MM6, MM8	Retrofit WSUD in any local catchment with low water quality discharge
Long term	Reach LM2	Consider introducing pedestrian footpaths to help control access and minimise disturbance to foreshore vegetation
Long term	Reach MM1	Investigate installing a fish ladder at Pinjarra weir to allow for fish (and other fauna) migration
2. Increase community environmental and cultural knowledge, awareness, and capacity		
Short term	Reach LM3, MM1	Educational programs targeting use of fertilisers in private gardens near waterways
Short term	Reach LM1, LM2, LM3, LM5	Educational programs and engagement with residents about boat usage/ speed, no wash zones etc.
Short term	Reaches LM1, LM2, LM6	Consider signage or education around the impact of boating and speeding on wildlife
Short term	Reach LM2, LM4, LM6, MM1	Advice and resources to define/control access points to the river
Short term	Reach LM3	Educational programs and engagement with residents about unauthorised infrastructure like jetties
Short term	Reach MM1	Establish education sites with signage of the river values and restoration efforts (including actions for the community)
Short term	Reach LM5, MM3, MM4	Education on the management of large woody debris to protect habitats and mitigate erosion potential. Focus on effective ways of removing debris if required, while still maintaining diverse habitats within the river
Short term	Reach MM3, MM4, MM5, MM6, MM7, MM9	Educational programs and engagement with residents about feral animal management

Priority	Location	Action
Short term	All reaches	<p>Provide resources and/or preparation of guidelines aimed at residents and landholders abutting and interacting with the river. Options include;</p> <ul style="list-style-type: none"> Identifying what boating and recreational activities can occur on or along the river including maps of slow speed areas or 'no-wash zones' Boating activities including speed and wake consideration and impact on wildlife Fertiliser management and nutrient loadings Weeding and appropriate ways to remove weeds Fencing for livestock to alleviate erosion and pugging Revegetation including appropriate species selection and bank profile location Erosion control measures or effective bank stabilisation options – also refer landholders to existing relevant guidelines including the <i>Foreshore Stabilisation Guidelines</i> (Shire of Murray, 2019) and <i>Best Management Practices for Foreshore Stabilisation: Brushwall</i> (DBCA, 2020) Management of large woody debris while maintaining diverse habitats Simplifying where to find the information required for planning approval for jetties, pagodas etc. <p>Direct landowners and residents to existing guidance on;</p> <ul style="list-style-type: none"> Feral animal management including guidance on baiting (SoM and DPIRD websites) Planning approval requirements for jetties, pagodas etc (SoM website) Livestock management (SoM website)
Long term	All reaches	Any new guidelines could be distributed to residents as part of a community workshop program to make them aware of the guidance available
3. Increase vegetation connectivity to improve aquatic, riparian, and terrestrial habitats		
Short term	Reach LM3	Protect high quality riparian vegetation in or adjacent to reserves
Short term	Reaches MM4, MM5, MM6, MM7	Use of best practise management for weed herbicide application near waterways
Long term	Reaches MM4, MM5, MM6, MM7	Work to replace invasive grasses/weeds with native ground cover and shrubs
Long term	Reaches MM2, MM3	Improve riparian vegetation in areas of bare ground and ground cover
4. Enhance relationships with the Bindjareb Noongar community including the provision of skills and training for future employment opportunities		
Short term	All reaches	Ensure due diligence is followed in implementing consultation, engagement, and on-ground works under the Aboriginal Heritage Act
Short term	All reaches	Identify and build opportunities for training and employment linked to working on country
Short term	All reaches	Work with contractors to identify opportunities for Bindjareb Noongar procurement and training when implementing on-ground works
Long term	All reaches	Identify and implement related skills-based training opportunities for the local Bindjareb Noongar community linked to working on country
5. Increase stakeholder networks and connections		
Short term	Reach LM1, LM2, LM5	Work with the DoT to enforce 5 knot speed limit to reduce boat wake

Priority	Location	Action
Short term	Reaches LM1, LM2, LM5, LM6	Work with DoT to possibly provide mobile markers deployed in the navigation channel that read boat speed, using mobile buoys with a speed sign moved around to key locations to help alert skippers to the speed limits, DoT officers stationed at different locations with speed radar once a week
Long term	Reaches LM1, LM2, LM5, LM6, MM1	Consideration should be given to the use of specially designed boats, which have large ballast or have a hull shape or fittings that are designed to create a large wave behind the boat. Consider results from the "Vessel wake study" occurring from the mouth of the Murray to South Yunderup. Also consider application of the "Wave wake predictor"
Long term	Reaches LM1 or LM2	Work with DoT to consider a permanent speed-reading device at a key location on the Murray
6. Increase knowledge and capacity of private landholders, groups, and organisations to deliver projects		
Short term	Reach LM1, LM4, LM5, LM6, MM1, MM2, MM4, MM5, MM9	Provide resources to landholders to identify and eradicate weeds
Short term	Reach MM3, MM4, MM5, MM6, MM7, MM9	Encourage landholders to control feral animals
Short term	Reaches LM1, LM3, LM4, MM7	Provide resources to landholders to identify erosion risks and implement erosion controls
Long term	All Reaches	Encourage land holders to reduce nutrient inputs within the catchment
Long term	Reach LM1, LM4, LM5, LM6, MM1, MM2, MM4, MM5, MM9	Encourage land holders to plant local natives within the riparian zone. Maintain and upgrade damaged fencing. Install new fencing where there is non-existent fencing to protect riparian zones
7. Mitigate impacts of climate change		
Short term	Reach LM4, LM5, LM6	Continue monitoring salinity up into LM Reach 4 and beyond so the extent and duration of saltwater ingress in the Murray can be compared in future RAPs. This could provide information on the potential impact of sea level rise/ climate change, or changes in land use in the catchment. Impacts of saltwater ingress include; changes in fauna communities (emergence of marine fish and crabs further up the river), changes in aquatic vegetation and ecosystems, impact on fringing tree species, and potential impact on groundwater supplies
Short term	Reach LM1	Investigate die-off of trees and implement recommendations
Long term	Reaches LM4	Implement investigation into effectiveness of erosion control measures in different conditions
Long term	Reaches LM1, LM2	Prepare a 'Wash and wave action: riverbank erosion management plan' (improved management of boating wash, and climate change impacts on riverbank erosion)

CONTENTS

1	Introduction.....	1
1.1	Previous Murray RAPs	1
1.2	Strategic Planning Context	1
1.3	Project Aims	2
2	The Murray River	4
2.1	River System and Catchment	4
2.2	Climate and Flows.....	7
2.3	Cultural Heritage	7
2.4	European Heritage.....	8
2.5	Community.....	9
2.6	Previous Key issues.....	9
3	Preparation	11
3.1	Existing studies.....	11
3.2	Consultation.....	11
3.3	Assessment	13
3.4	River Foreshore Condition Assessment	18
4	Reach Assessments	20
4.1	Lower Murray Reach 1	24
4.2	Lower Murray Reach 2	38
4.3	Lower Murray Reach 3	48
4.4	Lower Murray Reach 4	57
4.5	Lower Murray Reach 5	68
4.6	Lower Murray Reach 6	78
4.7	Middle Murray Reach 1	88
4.8	Middle Murray Reach 2	98
4.9	Middle Murray Reach 3	108
4.10	Middle Murray Reach 4	117
4.11	Middle Murray Reach 5	126
4.12	Middle Murray Reach 6	135
4.13	Middle Murray Reach 7	144
4.14	Middle Murray Reach 8	154
4.15	Middle Murray Reach 9	163
5	Comparison to Previous Studies.....	169
6	Recommendations.....	171
7	References	177
	Appendix 1: Data Analysis Methodology	179
	Floodway and Bank Vegetation	180
	Verge Vegetation.....	181
	Stream Cover	182
	Bank Stability and Erosion.....	182
	Aquatic Habitat	183
	Appendix 2: Reach Scoring Summary.....	185

Appendix 3: Water Quality Summary (information provided by PHCC and DWER)	186
---	-----

Figures

Figure 1: Murray River Catchment	6
Figure 2: Lower Murray River Action Plan reaches	14
Figure 3: Middle Murray River Action Plan reaches	15
Figure 4: Pen-Scott Foreshore Condition Assessment (Pen & Scott, 1995)	18
Figure 5: Reach Scoring Example	20
Figure 6: Lower Murray Reach 1 - Location Map	21
Figure 7: Lower Murray Reach 1 - Elevation Map.....	22
Figure 8: Lower Murray Reach 1 – Land Use Map (Peel Region Scheme).....	23
Figure 9: Lower Murray Reach 1 – 2014 Condition Map.....	28
Figure 10: Lower Murray Reach 1a – Current Condition Map	29
Figure 11: Lower Murray Reach 1b – Current Condition Map	30
Figure 12: Lower Murray Reach 1a – Management Actions since 2014.....	31
Figure 13: Lower Murray Reach 1b – Management Actions since 2014.....	32
Figure 14: Lower Murray Reach 2 - Location Map	35
Figure 15: Lower Murray Reach 2 - Elevation Map.....	36
Figure 16: Lower Murray Reach 2 – Land Use Map (Peel Region Scheme).....	37
Figure 17: Lower Murray Reach 2 – 2014 Condition Map.....	41
Figure 18: Lower Murray Reach 2 – Current Condition Map.....	42
Figure 19: Lower Murray Reach 3 - Location Map	45
Figure 20: Lower Murray Reach 3 - Elevation Map.....	46
Figure 21: Lower Murray Reach 3 - Land Use Map (Peel Region Scheme)	47
Figure 22: Lower Murray Reach 3 – 2014 Condition Map.....	51
Figure 23: Lower Murray Reach 3 – Current Condition Map.....	52
Figure 24: Lower Murray Reach 4 - Location Map	54
Figure 25: Lower Murray Reach 4 - Elevation Map.....	55
Figure 26: Lower Murray Reach 4 - Land Use Map (Peel Region Scheme)	56
Figure 27: Lower Murray Reach 4 – 2014 Condition Map.....	60
Figure 28: Lower Murray Reach 4 – Current Condition Map.....	61
Figure 29: Lower Murray Reach 4 – Management Actions since 2014	62
Figure 30: Lower Murray Reach 5 - Location Map	65
Figure 31: Lower Murray Reach 5 - Elevation Map.....	66
Figure 32: Lower Murray Reach 5 - Land Use Map (Peel Region Scheme)	67
Figure 33: Lower Murray Reach 5 – 2014 Condition Map.....	71
Figure 34: Lower Murray Reach 5 – Current Condition Map.....	72
Figure 35: Lower Murray Reach 6 - Location Map	75
Figure 36: Lower Murray Reach 6 - Elevation Map.....	76
Figure 37: Lower Murray Reach 6 - Land Use Map (Peel Region Scheme)	77
Figure 38: Lower Murray Reach 6 – 2014 Condition Map.....	81
Figure 39: Lower Murray Reach 6 – Current Condition Map.....	82
Figure 40: Lower Murray Reach 6 – Management Actions since 2014	83
Figure 41: Middle Murray Reach 1 - Location Map.....	85
Figure 42: Middle Murray Reach 1 - Elevation Map.....	86
Figure 43: Middle Murray Reach 1 - Land Use Map (Peel Region Scheme).....	87
Figure 44: Middle Murray Reach 1 – 2015 Condition Map	91
Figure 45: Middle Murray Reach 1 – Current Condition Map	92
Figure 46: Middle Murray Reach 1 – Management Actions since 2015.....	93
Figure 47: Middle Murray Reach 2 - Location Map.....	95
Figure 48: Middle Murray Reach 2 - Elevation Map.....	96

Figure 49: Middle Murray Reach 2 - Land Use Map (Peel Region Scheme)	97
Figure 50: Middle Murray Reach 2 – 2015 Condition Map	101
Figure 51: Middle Murray Reach 2 – Current Condition Map	102
Figure 52: Middle Murray Reach 2 – Management Actions since 2015	103
Figure 53: Middle Murray Reach 3 - Location Map	105
Figure 54: Middle Murray Reach 3 - Elevation Map	106
Figure 55: Middle Murray Reach 3 - Land Use Map (Peel Region Scheme)	107
Figure 56: Middle Murray Reach 3 – 2015 Condition Map	111
Figure 57: Middle Murray Reach 3 – Current Condition Map	112
Figure 58: Middle Murray Reach 4 - Location Map	114
Figure 59: Middle Murray Reach 4 - Elevation Map	115
Figure 60: Middle Murray Reach 4 - Land Use Map (Peel Region Scheme)	116
Figure 61: Middle Murray Reach 4 – 2015 Condition Map	120
Figure 62: Middle Murray Reach 4 – Current Condition Map	121
Figure 63: Middle Murray Reach 5 - Location Map	123
Figure 64: Middle Murray Reach 5 - Elevation Map	124
Figure 65: Middle Murray Reach 5 - Land Use Map (Peel Region Scheme)	125
Figure 66: Middle Murray Reach 5 – 2015 Condition Map	129
Figure 67: Middle Murray Reach 5 – Current Condition Map	130
Figure 68: Middle Murray Reach 6 - Location Map	132
Figure 69: Middle Murray Reach 6 - Elevation Map	133
Figure 70: Middle Murray Reach 6 - Land Use Map (Peel Region Scheme)	134
Figure 71: Middle Murray Reach 6 – 2015 Condition Map	138
Figure 72: Middle Murray Reach 6 – Current Condition Map	139
Figure 73: Middle Murray Reach 7 - Location Map	141
Figure 74: Middle Murray Reach 7 - Elevation Map	142
Figure 75: Middle Murray Reach 7 – Land Use Map (Peel Region Scheme)	143
Figure 76: Middle Murray Reach 7 – 2015 Condition Map	147
Figure 77: Middle Murray Reach 7 – Current Condition Map	148
Figure 78: Middle Murray Reach 7 – Management Actions since 2015	149
Figure 79: Middle Murray Reach 8 - Location Map	151
Figure 80: Middle Murray Reach 8 - Elevation Map	152
Figure 81: Middle Murray Reach 8 – Land Use Map (Peel Region Scheme)	153
Figure 82: Middle Murray Reach 8 – 2015 Condition Map	157
Figure 83: Middle Murray Reach 8 – Current Condition Map	158
Figure 84: Middle Murray Reach 9 - Location Map	160
Figure 85: Middle Murray Reach 9 - Elevation Map	161
Figure 86: Middle Murray Reach 9 – Land Use Map (Peel Region Scheme)	162
Figure 87: Middle Murray Reach 9 – 2015 Condition Map	166
Figure 88: Middle Murray Reach 9 – Current Condition Map	167
Figure 89: Lower Murray DO (%)	187
Figure 90: Lower Murray Electrical Conductivity (mS/cm)	188
Figure 91: Middle Murray DO (%)	189
Figure 92: Middle Murray Reach 1 DO (%)	190
Figure 93: Middle Murray Reach 2 DO (%)	190
Figure 94: Middle Murray Reach 3 DO (%)	190
Figure 95: Middle Murray Reach 4 DO (%)	190
Figure 96: Middle Murray Reach 5 DO (%)	190
Figure 97: Middle Murray Reach 6 DO (%)	190
Figure 98: Middle Murray Reach 7 DO (%)	190
Figure 99: Middle Murray Reach 8 DO (%)	190
Figure 100: Middle Murray Reach 9 DO (%)	190
Figure 101: Middle Murray Salinity (mg/l)	190

Figure 102: Middle Murray Reach 1 Salinity (mg/l)	190
Figure 103: Middle Murray Reach 2 Salinity (mg/l)	190
Figure 104: Middle Murray Reach 3 Salinity (mg/l)	190
Figure 105: Middle Murray Reach 4 Salinity (mg/l)	190
Figure 106: Middle Murray Reach 5 Salinity (mg/l)	190
Figure 107: Middle Murray Reach 6 Salinity (mg/l)	190
Figure 108: Middle Murray Reach 7 Salinity (mg/l)	190
Figure 109: Middle Murray Reach 8 Salinity (mg/l)	190
Figure 110: Middle Murray Reach 9 Salinity (mg/l)	190

Tables

Table 1: Murray River Actions and Recommendations Summary	i
Table 2: Reach definitions	16
Table 3: Reach Assessment Data Format	20
Table 4: Lower Murray Reach 1 Description and Conditions	25
Table 5: Lower Murray Reach 1 Management Actions and Recommendations	33
Table 6: Lower Murray Reach 2 Description and Conditions	39
Table 7: Lower Murray Reach 2 Management Actions and Recommendations	43
Table 8: Lower Murray Reach 3 Description and Conditions	49
Table 9: Lower Murray Reach 3 Management Actions and Recommendations	53
Table 10: Lower Murray Reach 4 Description and Conditions	58
Table 11: Lower Murray Reach 4 Management Actions and Recommendations	63
Table 12: Lower Murray Reach 5 Description and Conditions	69
Table 13: Lower Murray Reach 5 Management Actions and Recommendations	73
Table 14: Lower Murray Reach 6 Description and Conditions	79
Table 15: Lower Murray Reach 6 Management Actions and Recommendations	84
Table 16: Middle Murray Reach 1 Description and Conditions	89
Table 17: Middle Murray Reach 1 Management Actions and Recommendations	94
Table 18: Middle Murray Reach 2 Description and Conditions	99
Table 19: Middle Murray Reach 2 Management Actions and Recommendations	104
Table 20: Middle Murray Reach 3 Description and Conditions	109
Table 21: Middle Murray Reach 3 Management Actions and Recommendations	113
Table 22: Middle Murray Reach 4 Description and Conditions	118
Table 23: Middle Murray Reach 4 Management Actions and Recommendations	122
Table 24: Middle Murray Reach 5 Description and Conditions	127
Table 25: Middle Murray Reach 5 Management Actions and Recommendations	131
Table 26: Middle Murray Reach 6 Description and Conditions	136
Table 27: Middle Murray Reach 6 Management Actions and Recommendations	140
Table 28: Middle Murray Reach 7 Description and Conditions	145
Table 29: Middle Murray Reach 7 Management Actions and Recommendations	150
Table 30: Middle Murray Reach 8 Description and Conditions	155
Table 31: Middle Murray Reach 8 Management Actions and Recommendations	159
Table 32: Middle Murray Reach 9 Description and Conditions	164
Table 33: Middle Murray Reach 9 Management Actions and Recommendations	168
Table 34: Summary of Comparison to Previous RAP Ratings and Location Priority	170
Table 35: Priority Actions and Recommendations	172
Table 36: Stream Health Scoring (WRC, 1999)	179
Table 37: Foreshore Category Scoring	180
Table 38: Floodway and Bank Vegetation Indicators	180
Table 39: Floodway and Bank Vegetation Scoring	181
Table 40: Verge Vegetation Indicators	181

Table 41: Verge Vegetation Scoring 181

Table 42: Stream Cover Indicators..... 182

Table 43: Stream Cover Scoring 182

Table 44: Bank Stability and Erosion Indicators..... 182

Table 45: Bank Stability and Erosion Scoring..... 183

Table 46: Aquatic Habitat Indicators..... 183

Table 47: Aquatic Habitat Scoring..... 184

1 INTRODUCTION

This project is delivered by the Peel-Harvey Catchment Council as part of the 'Healing Bilya - Restoring the Murray and Serpentine Rivers' project funded by the Alcoa Foundation's 'Three Rivers One Estuary' Initiative.

The Murray River Action Plan (RAP) 2022 has been prepared to assess the current state of the river and guide future restoration actions. Conservation and restoration of the river is paramount to protecting the environmental, economic, social, and heritage values of the river and the Peel-Harvey Estuary.

The Murray River is located approximately 72 km south of Perth and is the largest river in the Peel-Harvey Catchment encompassing an area of approximately 8,300 km². It is also one of few major rivers near Perth that is not dammed for public water supply. Beginning 170 km inland, the Hotham and Williams Rivers carry their brackish waters to their confluence, where they become the Murray River, before flowing into the Ramsar listed Peel-Harvey Estuary. The Peel-Harvey Estuary is one of the most diverse estuarine environments in South-West WA.

1.1 Previous Murray RAPs

In 2002 the Department of Environment (now Department of Water and Environmental Regulation), in conjunction with Local and State Government Agencies undertook a study into the development of an 'Economic Development and Recreation Management Plan for the Peel Waterways'. Recommendation 6.2 of that plan was to 'prepare and implement a detailed rehabilitation scheme for the Murray River' (Everall Consulting Biologist, 2002).

In 2003 the 'Lower Murray River Action Plan' was produced by the Department of Environment, through the 'Ribbons of Blue' project. This Plan covered the 'Lower Murray' sections of the river only. Following the development of the 2003 Plan, several restoration and rehabilitation works were carried out along the Lower Murray River.

In 2008, the PHCC developed the 'Middle Murray River Action Plan' as an extension of the existing 'Lower Murray River Action Plan' 2003.

In 2014 and 2015, both Plans were reviewed and updated through PHCC's 'Rivers 2 Ramsar' project that was funded by the Australian Government (the Lower Murray in 2014 and the Middle Murray in 2015).

In 2022, through the current 'Healing Bilya - Restoring the Murray and Serpentine Rivers' project funded through the Alcoa Foundations Three Rivers One Estuary Initiative, these Plans are being updated to reflect the current condition of the river. This plan address both the Lower and Middle Murray in one document.

1.2 Strategic Planning Context

In 2020, the Department of Water and Environmental Regulation (DWER) developed the 'Bindjareb Djiiba (Peel-Harvey Estuary) Protection Plan, a whole of government approach to protecting the Peel-Harvey Estuary and its' internationally recognised values. Additionally, 'Bindjareb Gabi Wonga – Bindjareb Water Story' identifies the Aboriginal creation beliefs, values and management goals, and guides actions for improved and collaborative management of

the Djilba (estuary). What is being achieved in the Murray River contributes to the broader actions that are helping to improve the ecological health of the Peel-Harvey Estuary.

1.3 Project Aims

The need to protect and conserve the Murray River is of paramount importance, as it is part of the wider ecosystem. Principal aims of the Murray RAP are to achieve the protection of the Murray River ecosystem and enhance the long-term ecological condition of the river.

The Murray RAP is not a statutory Plan and does not represent government policy or regulation, nor does it have legal status. It seeks to;

- Provide a condition report and a point of reference, against which, any future works which are implemented can be compared to.
- Review the management and rehabilitation progress since the RAPs were first initiated in 2003.
- Provide a direction for future management to protect and rehabilitate the Murray River.
- The Murray RAP should be considered with other technical plans and/or condition reports such as the Bindjareb Djilba (Peel-Harvey) Protection Plan, Interim Water Quality Index scoring and the Shire of Murray DRAFT Coastal Hazard Risk Management and Adaptation Plan (CHRMAP).

The Murray RAP is not a static Plan and should continue to be reassessed at regular intervals, as it has since 2003, to re-evaluate and update any changes in the condition. Associated objectives of the RAP are that it should be used as the foundation for further works and funding applications, and for the Plan to act as an initial source of technical advice.

This updated RAP will inform and prioritise on-ground actions and will become a vital source of information for government departments and non-government organisations when planning works along the river into the future. The document outlines the findings of field inspections and desktop data review and presents recommendations for roles, responsibilities, and timeframes to implement the RAP.

The Murray RAP has been prepared consistent with the PHCC's vision for the catchment:

The Peel-Harvey catchment is once again a flourishing network of interconnected, productive landscapes, with diverse, healthy and resilient ecosystems, globally and locally recognised, acknowledged and embraced for its environmental significance. It is wisely managed by a community that values it – people working together for a healthy environment.

The PHCC's Strategic Directions 2019-2026 (PHCC, 2019) provides the goals that guide the preparation of the RAP, namely;

- Influence key decision-makers for better governance;
- Facilitate collaborative adaptive management;
- Deliver quality environmental outcomes; and,
- Engage and enable individuals and communities.

Specifically, the Murray RAP is a key component of the Alcoa Foundation's 'Three Rivers, One Estuary' initiative in partnership with the Peel-Harvey Catchment Council. The project will be achieved through a collaborative approach to improve the health, biodiversity, and ecosystem

health through engagement with private landholders and the Bindjareb Noongar community, focusing on the riparian zones of the Murray River.

2 THE MURRAY RIVER

2.1 River System and Catchment

The Murray River is located approximately 72 kilometres south of Perth and is the largest River in the Peel-Harvey Catchment encompassing an area of approximately 8,300km². It is a brackish waterway and has an estimated mean annual flow of 360 gigalitres (DoW, 2010). Its' headwaters begin 170km inland on the Yilgarn Plateau as the Hotham and Williams Rivers, merging west of Boddington to become the Murray River.

The North and South Dandalup Rivers are dammed in the Darling Range for surface water storage, significantly altering their natural flows. These rivers merge on the Coastal Plain and flow into the Murray River. These tributaries are deeply incised on the coastal plain due to the removal of fringing vegetation and are significant sources of nutrients to the Murray River (Pen, 1999).

The Murray River provides 63% of surface inflow into the Peel-Harvey Estuary (PHCC, 2011), the largest estuarine wetland in Western Australia. The Peel-Harvey Estuary forms a significant portion of the RAMSAR listed Peel-Yalgorup Wetland System. Several Environmental Protection Policy (EPP) and Conservation Category wetlands adjacent to the Murray River system.

This action plan concentrates on the 'Coastal Plain' portion of the Murray River, extending from the Delta Islands in the Peel Inlet to the Darling Scarp Rise, approximately 53.1 km upstream from the Delta Islands.

2.1.1 Usage

The river had been used historically for irrigation of crops and orchards with the development of irrigation channels and pumps. Most of the irrigation has ceased due to the decline in water quality, with salt from upper catchments impacting the irrigated lands. The river is still used, in places, for livestock watering, particularly in the upper reaches. In the lower reaches, boating and recreational activities are a common use within the river.

2.1.2 Catchment and Land Uses

The land within the Murray catchment is shown in Figure 1. It consists of three sub catchments;

- The Dandalup river system
- The Kwinana Peel coastal system
- The Murray River and tributaries system

Land use within the Murray River Catchment is varied. Much of the Lower Murray areas are urbanised and include North and South Yunderup, Ravenswood and Pinjarra townsites. The Middle Murray areas are predominantly large-scale rural properties. Some areas are divided into semi-rural lifestyle blocks. There are also industrial and horticultural operations in the Middle Murray which are connected to the Murray through runoff into drains, tributaries and creeks feeding into the Murray.

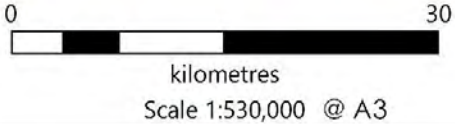
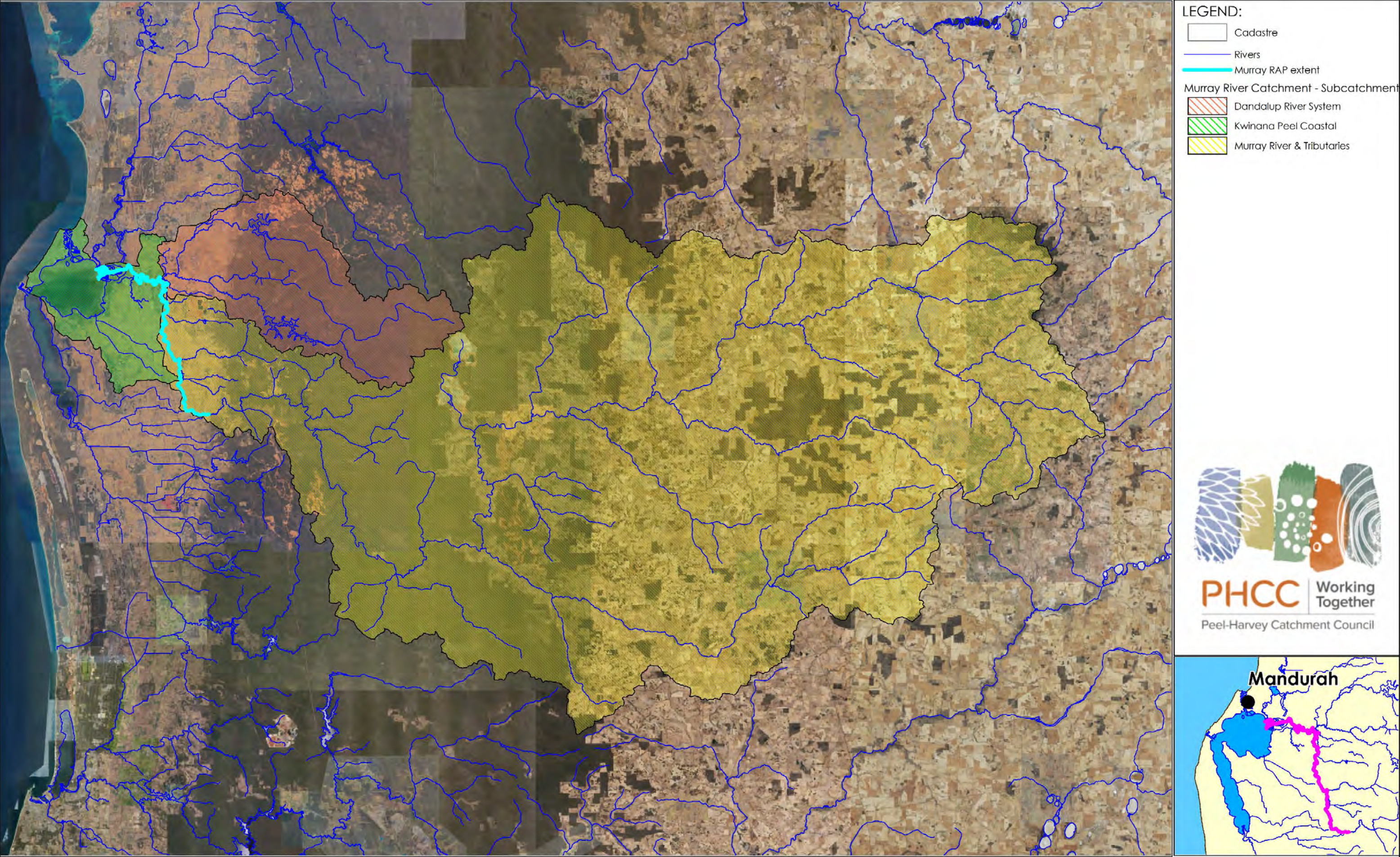
Unfortunately, the Murray River has become degraded over-time due to the clearing of land for agriculture and urbanisation, as well as the boating activity in the lower sections of the river.

Reserves and private land along the river reaches are all within the 1% AEP floodplain (floodway or flood fringe) as identified in the Water and Rivers commission flood study 1983, mapped in the

'Peel Region Scheme - *Floodplain Management Policy*' (WAPC, 2002) and the WA flood mapping (DWER, 2020).

The *Rivers 2 Ramsar – Connecting Corridors for Landscape Resilience* (A PHCC lead project funded by the Australian Government) included work on this section of the Murray (as well as the Serpentine and Harvey Rivers). The project was undertaken from 2013 to 2017 and aimed to protect cultural and ecological values by improving the ecosystem function across priority areas in the Harvey, Serpentine & Murray Rivers.

Key actions included restoration and protection of riverbanks and riparian corridors through weed control, access and erosion control, habitat protection for aquatic, riparian and terrestrial species and a review of the River Action Plans (this report).



2.2 Climate and Flows

The climate for the Murray River assessment area is typical of the south-western region of Western Australia and is characterised by the Koppen Climate Classification as Dry Subtropical featuring mild winters and hot to very hot summers. The dominant rainfall mechanisms are frontal systems caused by cold fronts associated with low pressure systems that extend across southern Australian between May and October. During the summer months, thunderstorms and ex-tropical cyclones can bring intense rainfall and flooding of low-lying areas, however most flows enter the estuary during a 4-to-6-month period over winter (EPA, 2008).

The region is subject to hot dry summers and mild wet winters. Approximately 80% of annual precipitation falls between April and October, with an annual rainfall on the coastal plain averaging at approximately 800mm and increasing to 1,300mm over the Darling Scarp. There has, however, been a significant decline in winter rainfall, a result of weakened and less frequent frontal systems. At the Pinjarra South meteorological station (009976), the average annual rainfall over the last 20 years has been 685mm/ annum.

Around half the annual inflow to the estuary is received in July and August, with two thirds received from June to October (PHCC, 2014). Most streams receive minimal flow between December and April with the majority of this being derived from groundwater (WRC, 2000 and Bussemaker, 2003). Although summer rainfall is generally scant, occasional thunderstorms and decaying tropical cyclones can produce heavy falls and subsequent river flows. These summer flows account for many of the floods seen in the Murray River over the past 100 years. The winter fronts produce approximately 80% of the annual rainfall resulting in more than 63% of the catchment flow entering the estuary between June and October (PHCC, 2011).

2.3 Cultural Heritage

Aboriginal people have inhabited the landscape of the southwest of Western Australia for approximately 50,000 years. During this time, traditional folklore and spiritual beliefs have developed around the natural features of the landscape giving importance to the connection with country. Waterways and wetlands form an integral part of the aboriginal heritage and culture, with the Waugal, a powerful serpent-like being forming and inhabiting all freshwater bodies (Dortch and Cuthbert, 2005). Disturbance of water sources amounts to disturbance of the Waugal, particularly at certain times of the year, hence the importance of timing for restoration projects within these areas.

"Beauty is in the eye of the beholder, if it's beautiful for one person, then it should be beautiful for future generations, so look after it don't destroy it. You look after the land and the land will look after you" - Franklyn Nannup – Bindjareb Noongar Traditional Owner

"Each day we walk in the steps of our ancestors and our ancestors have been here for 50,000 years. There is a commitment to look after our waterways, we all have that responsibility" - George Walley – Bindjareb Noongar Traditional Owner

The earliest known inhabitants of the Peel Region were Aborigines of the Pindjarup (Bindjareb) dialect group of the Nyoongah (Noongar) people (O'Connor et al., 1989). At the time of the first European settlement in the Peel area in 1830, this group of Aborigines was thought to have numbered around 100. They lived in three main groups near the Murray River and along the coastal plain. This region was a meeting and commodities bartering place for the Aborigines who inhabited the south-west corner of WA. The Murray River provided sources of food, water and shelter/camping grounds as well as forming an important part of the spiritual heritage and so is

significant to the Aboriginal people from both a 'domestic' and 'spiritual' viewpoint (O'Connor et al., 1989).

Within the study area lies the site of the "Pinjarra Massacre Memorial Site" where, in October 1834, between thirty to forty Noongars were killed (Bradby, 1997). This site holds significant importance to the local Bindjareb Noongar community, as well as nationally, being a national site of significance. A plaque to commemorate the event has been established at the site.

The Murray River is a site of Aboriginal significance and is registered as Site 3537, a mythological site in the Department of Planning, Lands and Heritage. There are also a number of additional Aboriginal Heritage Sites that have been identified within the project area and are identified in this document. The Aboriginal Heritage Act 2021 (ACH Act) provides a framework for the recognition, protection, conservation, and preservation of Aboriginal cultural heritage while recognising the fundamental importance of Aboriginal cultural heritage to Aboriginal people. The ACH Act protects all Aboriginal Sites in Western Australia, regardless of whether they are registered or not.

Before undertaking any work on country, officers, contractors, and community members should engage with the delegated local Bindjareb Noongar Elders, Traditional Owners, Knowledge Holders, and/or Representatives to determine cultural values of site/s, co-develop scope for on-ground actions and determine if on-ground actions are likely to have an impact on cultural value of site. If required, an Aboriginal Cultural Heritage Management Plan should be developed in accordance with the ACH Act prior to any works proceeding.

The PHCC documents, the Noongar Participation Plan 2021, DWER's 'Bindjareb Gabi Wonga, the Bindjareb Water Story' and 'Bring Together Walk Together' should also be considered and followed.

In addition to the above, the following should be considered for works undertaken within all reaches within the Murray River;

- Maximise opportunities through implementation of the plan to increase aboriginal training, employment and business opportunities, including direct procurement of local businesses and organisations.

2.4 European Heritage

European settlement commenced in the Peel region in late 1829 under the program known as the Peel Settlement Scheme. Shortly after the establishment of the Swan River Colony, Thomas Peel was granted 250,000 acres extending from Cockburn Sound to the Murray River and inland to the Darling Scarp. Under the Peel Settlement Scheme, farming of the land commenced in 1835, displacing Bindjareb Noongar camping and foraging areas, clearing land, and introducing livestock (Bradby, 1997).

The Murray River was seen as a major asset to the early settlers for the fine sedimentary soils that their livestock grazed on, the abundant fresh water and as a freight route. Descendants of some of the families that settled the area are still residing in the region.

Several sites such as the Coopers Mill North Yunderup, Edenvale Homestead, and Blythewood Homestead have significant European cultural value. Coopers Mill has a Statement of Significant by the State Heritage Office and is thought to be the first wind powered flour mill constructed in the district during the colonial era, and the only one remaining today.

2.4.1 Change in Land Use

The biggest impact on the Murray River occurred during the 1900's, with much of the riparian vegetation being removed or degraded through agricultural practices. Most of the wetlands were drained to some extent, logs (and thereby ecological habitat) were removed from the rivers, and sediments from erosion filled in many of the deep pools that remained (Bradby, 1997).

2.5 Community

The Murray River is a key recreational and tourism resource for the Shire of Murray and the Peel Region. The lower portion of the river is focussed on an urban lifestyle including recreational boating, swimming, fishing and use of public open space, while the upper reaches within the river are focussed on rural and agricultural uses.

Involvement of the local community in the rehabilitation and management of these sites is imperative to achieve a successful outcome for the river and its' values.

2.6 Previous Key issues

Previous investigations have identified the following key issues (these do not include current or future issues, please refer to later sections):

- Land development and land use changes –
 - Opening of the Dawesville Channel has changed the tidal regime escalating existing erosion issues relating to livestock and recreational access to the River.
 - The tidal effect of the Peel Inlet results in stratification, particularly in the lower reaches. The Lower Murray River is stratified for most of the year (apart from the winter rainfall season when the river has strong flows of fresh to brackish water throughout its profile).
 - The passenger rail service, Kwinana Freeway extension, Peel-Harvey deviation and growth in population has seen increased subdivision and land use changes along the Murray River and its tributaries placing added pressure on the environment.
 - Urban and rural development, livestock access, removal of riparian vegetation and woody debris have contributed to nutrient enrichment of waterways, foreshore erosion, loss of biodiversity, increased water flow and sedimentation along the Murray River.
- Agricultural/ urban drainage - Agriculture, road and urban drainage systems contribute high nutrient loads to the Murray River resulting in summer phytoplankton blooms and health warnings placed along sections of the River.
- Recreation - Increased recreational demand by day-trippers and permanent residents impacts the water quality and bank erosion. Intensified boat activity is resulting in erosion, undercutting and slumping of the bed and upper-river banks through increased wave action.
- Riparian management -
 - Loss of riparian vegetation - Fringing vegetation has little or no natural regeneration. Mature trees have stabilised banks in the past however many

have or are starting to fall into the channel leaving banks exposed resulting in increased erosion.

- o Livestock access - A considerable amount of the Middle Murray River is fenced due to agricultural practices as fences are generally used to restrict access to livestock at certain times of the year, but still allow access during winter months.
- o Weed invasion - Throughout most of the reaches, weed encroachment into the foreshore area was high, with several invasive species encroaching, including cottonbush, watsonia, and blackberry. Other significant weeds present included apple of sodom, wild figs, wild olives and bridal creeper. Nearer to the Pinjarra Weir and township, there are many woody weeds and garden escapees including morning glory.
- o Feral animal invasion – feral animals and their animal burrows have been noted in various reaches, predating on the native species. Particularly more in the Middle Murray reaches where Agriculture is more prominent (i.e., not Urban).
- o Wetland protection - There are several EPP and Conservation Category wetlands adjacent to or within the Murray River foreshore. As wetlands have the potential to be impacted by a wide range of hydrological factors, there is a responsibility to an overall integrates management approach for managing water quantity and quality levels so environmental, cultural and other wetland values are less impacted.

3 PREPARATION

Preparation of the Murray River Action Plan included a review of existing studies and available data sets supported by field assessments to ground truth desktop findings. The key data sets and methodology are outlined below.

3.1 Existing studies

The Murray River Action Plan has been prepared having consideration of several existing studies as outlined below. Key considerations included existing land use, landform, and vegetation.

- Water quality improvement plan for the rivers and estuary of the Peel-Harvey system – phosphorus management (EPA, 2008);
- Peel-Harvey Catchment Nutrient Reports 2015 and 2017 update (DWER, 2017b, c, d, e);
- Murray River Action Plan 2003;
- Middle Murray River Action Plan 2008;
- Lower Murray River Action Plan 2014;
- Middle Murray River Action Plan 2015;
- Shire of Murray **DRAFT** CHRMAP 2022; and
- Shire of Murray Level 2 Flora and Vegetation Survey Murray River Delta Reserve 2018.

3.2 Consultation

A variety of stakeholder and community consultation meetings were held to gain insights into how the river is currently used and valued, whether any on-ground works are planned and to explore cultural connections to the river.

The RAP was prepared by PHCC and Urbaqua staff with contributions sought from:

- The Department of Water and Environmental Regulation (DWER);
- The Shire of Murray (SoM);
- The Department of Transport (DoT);
- The Department of Primary Industries and Regional Development (DPIRD);
- The Department of Biodiversity, Conservation and Attractions (DBCA);
- Local Bindjareb Noongar elders and representatives;
- Mandurah Environment and Heritage Group; and
- Local community members and groups including 'Friends of Rivers, Peel'.

The involvement of the local community in the development of this Plan was critical to its success. Landholder interviews were carried out in the previous reviews, providing an invaluable insight into the history of the river and its use over the past century.

Access to properties to conduct Foreshore Assessments were also critical to the level of detail provided within the document. Most of the landholders within the study area were contacted and interviewed where possible, and most of the river was accessed by foot, car or boat to make note of foreshore conditions and interesting features.



Plate 1: Community Consultation Photos - Community Engagement Set-up at 'Planting in the Park', Willow Gardens Foreshore Reserve, South Yunderup Event, June 2022. Community workshop 'Restoring Waterways from Scarp to Sea'

3.3 Assessment

The RAP has been prepared to address the aims (Section 1.2) through a combination of field inspections and desktop reviews of the existing datasets. The RAP provides a summary of the river condition to determine priority sites for future restoration actions. The 2003 and 2008 Murray RAPs acts as a baseline condition, and this 2022 RAP acts to reassess the river and to review the performance of restoration works undertaken after 2003/2008 and 2014/2015 reviews, and to identify any new issues that require intervention.

The field assessment was completed for approximately 53.1 km of river from the Murray delta islands to the Darling Scarp Rise. The river was divided into fifteen (15) reaches aligned to significant features on the river including confluences with regional drains, pools, and wetlands. The reaches are shown in Figure 2 (6 reaches in the Lower Murray) and Figure 3 (9 reaches in the Middle Murray) outlined in Table 2.

The field assessment was undertaken consistent with the Department of Water and Environmental Regulation's *River Restoration Manual* (WRC, 1999). PHCC completed the field assessments between in July 2021 – May 2022 prior to winter rainfall. The methodology is based on the standardised Pen-Scott method (Pen & Scott, 1995, WRC, 1999) that results in sub-categories for foreshore condition of grades A (pristine) to D (ditch), as shown in Figure 4. Further detail on the assessment methodology, adaptation of the Pen-Scott methodology and rating system is provided in Appendix 1. **The detail is noted within each 'reach' of the river which is defined as a section of the river channel. Within each main reach there are smaller sections or 'sub-reaches'.** Each reach is anywhere between 1 – 5.8 km in length and each sub-reach is typically between 200 – 500 m long. The methodology was developed to be repeatable and allow for future assessment by non-technical volunteers.

The investigations recognised and identified patterns in certain conditions measures, these are;

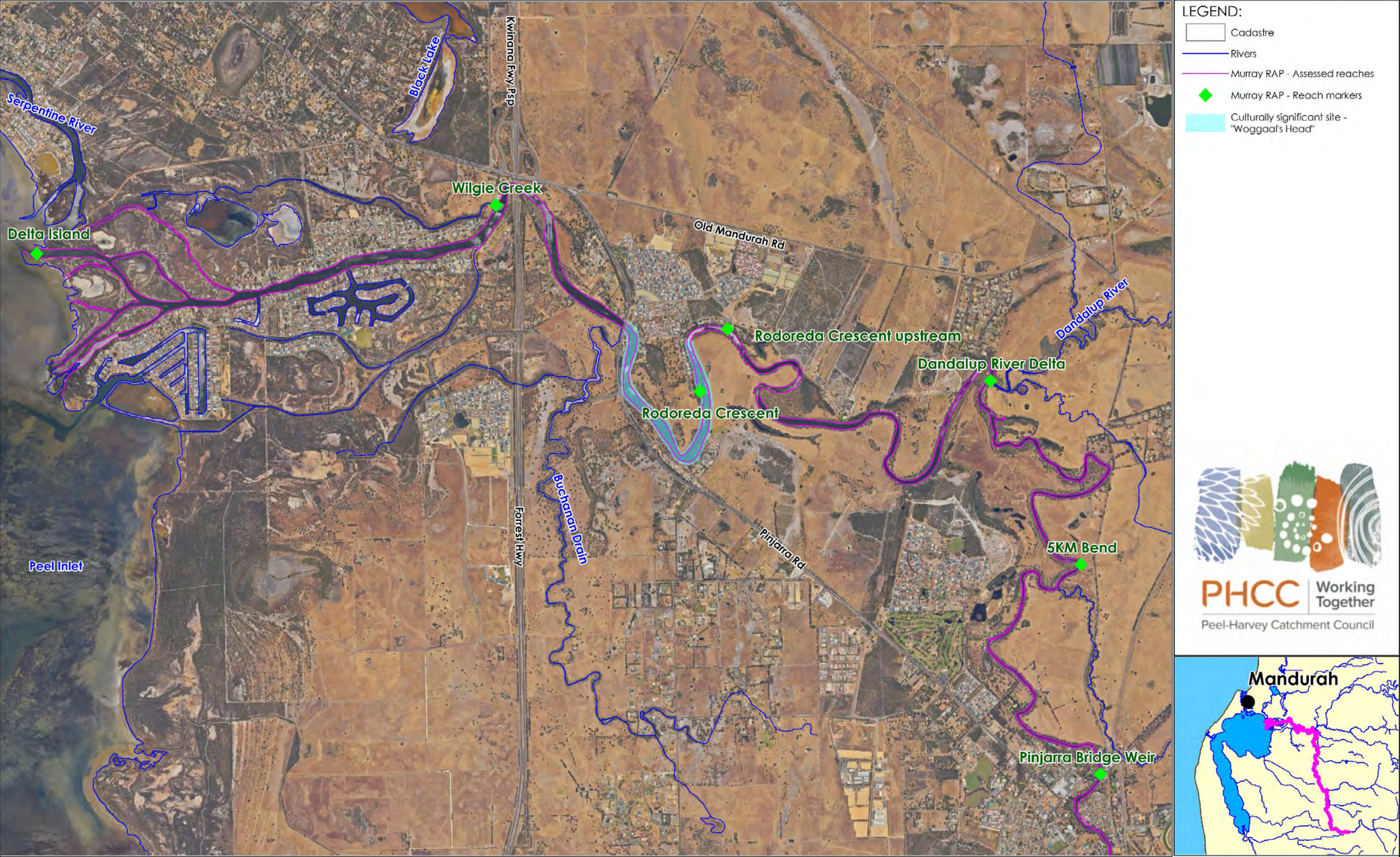
- Vegetation condition;
- Stream cover;
- Geomorphology (Bank stability and erosion);
- Habitat diversity.

Field investigations were supported by desktop assessment of data sets including water quality data, photography, aerial imagery, regional soil mapping, and other desktop investigations. In addition to the condition measures assessed as part of the investigations (above), other aspects were noted and are included in the 'Description and Conditions' tables for each reach. These are;

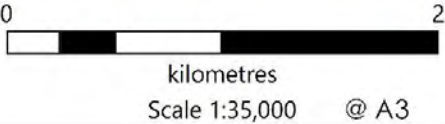
- Land use;
- Fencing and infrastructure;
- Channel form and soils;
- Weeds;
- Other issues;
- Water quality;
- Community and cultural values.

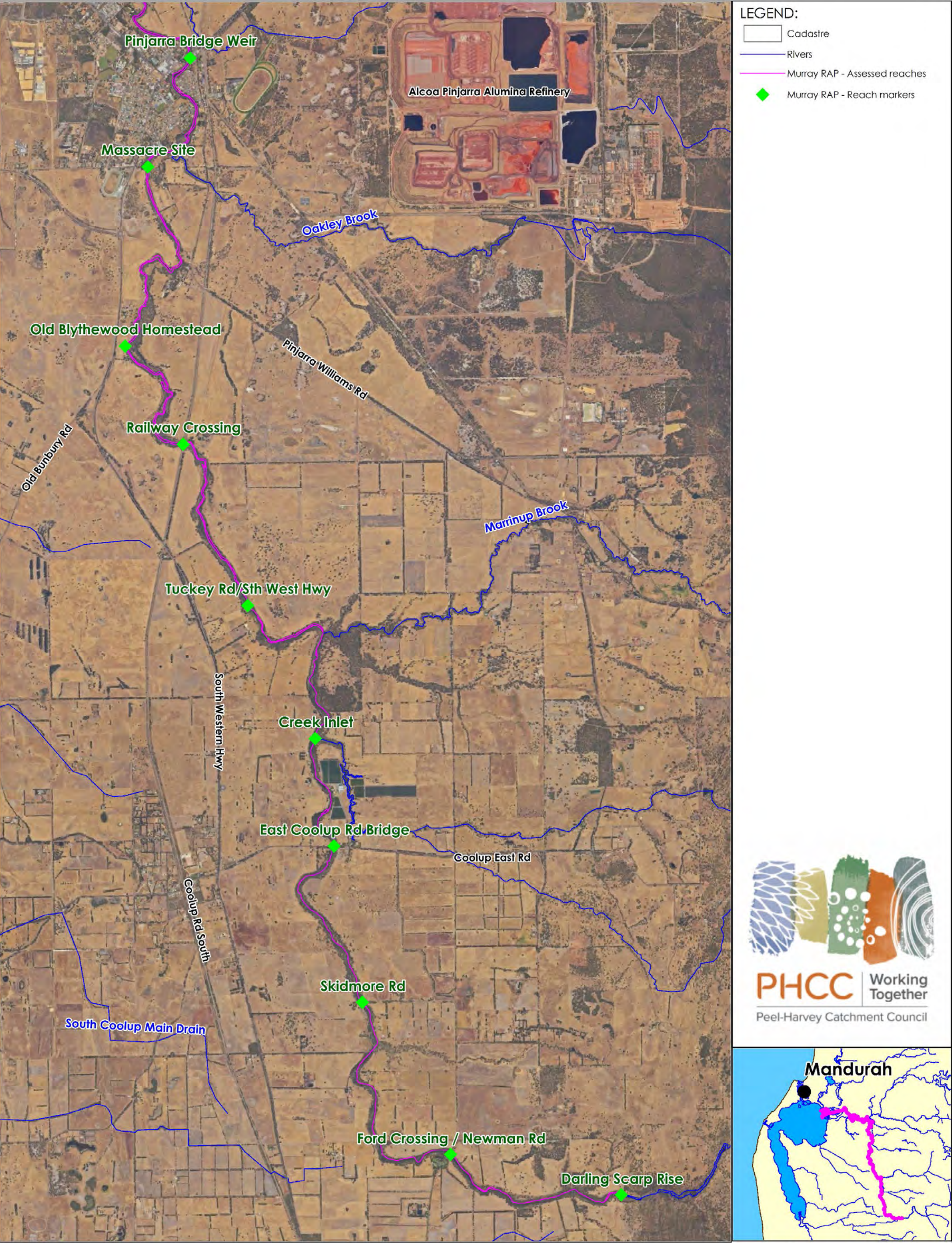
Portions of the river were difficult to access due to waterlogging of surrounding floodplains (particularly the delta islands), and in some cases access was restricted by land ownership so assessment in these areas was solely desktop based or through observations from boats.

Peel Harvey Catchment Council - Lower and Middle Murray River Action Plan
Figure 2 - Lower Murray Reaches



* ©2022. While Urbaqua has taken care to ensure the accuracy of this product, Urbaqua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbaqua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.





* ©2022. While Urbaqua has taken care to ensure the accuracy of this product, Urbaqua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbaqua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.

Table 2: Reach definitions

Reach		Start	Coordinates	Finish	Coordinates	Length	Page Ref
Lower Murray	1	Delta Island	E383737 N6394815	Wilgie Creek	E388451 N6395145	5.2 km	24
	2	Wilgie Creek	E388451 N6395145	Rodoreda Crescent	E390644 N6393402	4.8 km	38
	3	Rodoreda Crescent	E390644 N6393402	Rodoreda Crescent Upstream	E390877 N6394021	1.0 km	48
	4	Rodoreda Crescent Upstream	E390877 N6394021	Dandalup River Delta	E393594 N6393516	5.8 km	57
	5	Dandalup River Delta	E393594 N6393516	5 km bend	E394514 N6391617	4.4 km	68
	6	5 km bend	E394514 N6391617	Pinjarra Bridge Weir	E394709 N6389477	4.0 km	78
Middle Murray	1	Pinjarra Bridge Weir	E394709 N6389477	Pinjarra Massacre Memorial Site	E394102.7 N6387825.0	2.5 km	88
	2	Pinjarra Massacre Memorial Site	E394102.7 N6387825.0	Old Blythewood Homestead	E393758.2 N6385115.4	3.9 km	98
	3	Old Blythewood Homestead	E393758.2 N6385115.4	Railway Crossing	E394630.8 N6383622.9	2.7 km	108
	4	Railway Crossing	E394630.8 N6383622.9	Tuckey Rd/ South West Hwy	E395595.2 N6381211.8	3.1 km	117
	5	Tuckey Rd/ South West Hwy	E395595.2 N6381211.8	Creek Inlet	E396559.7 N6379076.2	3.5 km	126
	6	Creek Inlet	E396559.7 N6379076.2	East Coolup Rd Bridge	E396973.0 N6377514.8	2.0 km	135
	7	East Coolup Rd Bridge	E396973.0	Skidmore Rd	E397363.4	3.0 km	144

Reach	Start	Coordinates	Finish	Coordinates	Length	Page Ref
		N6377514.8		N6375195.5		
8	Skidmore Rd	E397363.4 N6375195.5	Ford Crossing/ Newman Rd	E398672.2 N6372899.3	4.0 km	154
9	Ford Crossing/ Newman Rd	E398672.2 N6372899.3	Darling Scarp Rise	E401244.1 N6372279.3	3.2 km	163

3.4 River Foreshore Condition Assessment

The Pen-Scott method of riparian zone foreshore assessment was used to evaluate the condition of the Murray River foreshore. The Pen-Scott method is a standardised rating technique that allows the user to classify foreshore areas along a gradient from pristine (A grade) through to highly degraded (D grade). The four grades were further divided into sub-categories per grade, i.e. A1, B2, C3. A description of these grades follows and they are represented pictorially Figure 4 (Pen & Scott, 1995).

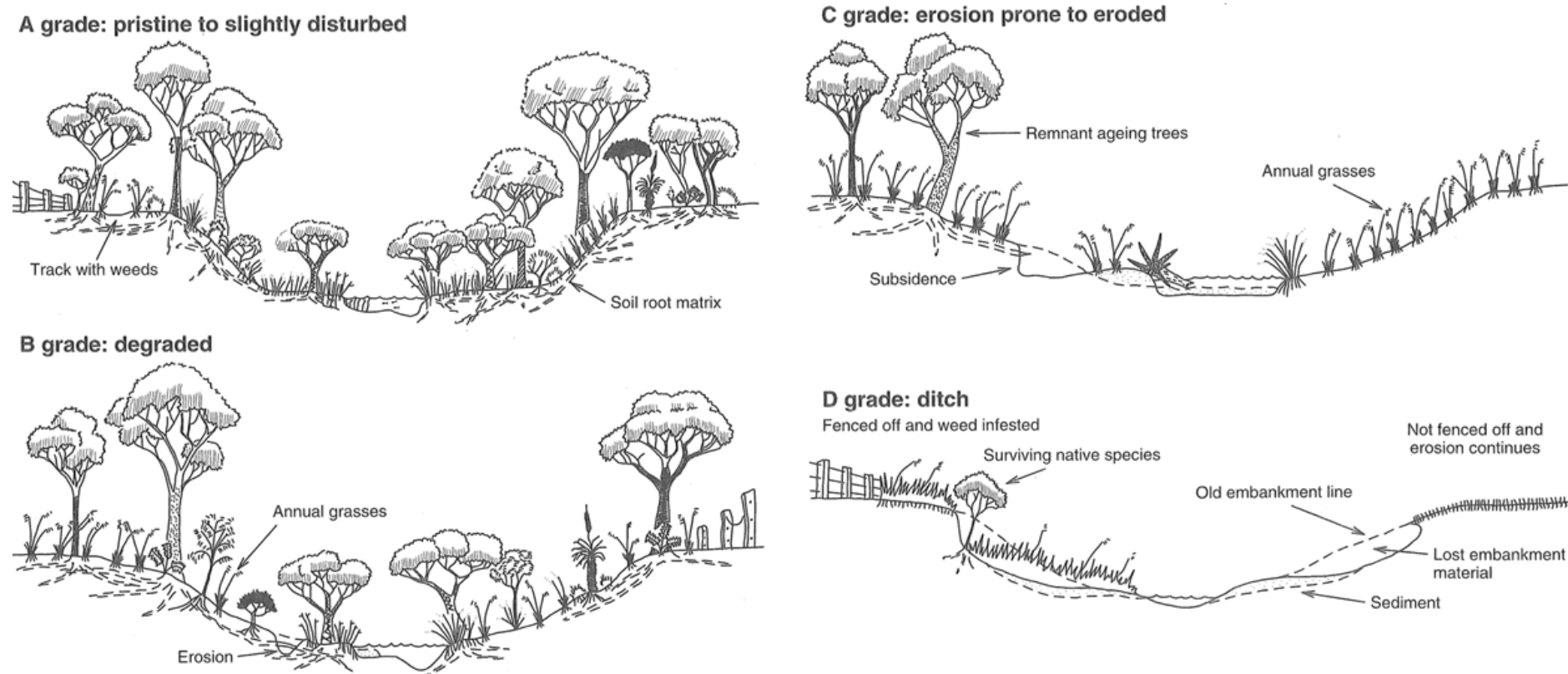


Figure 4: Pen-Scott Foreshore Condition Assessment (Pen & Scott, 1995)

<p>A Grade Foreshore</p> <p>A1: Pristine The river embankments and floodway are entirely vegetated with native species, and there is no evidence of human presence or livestock damage.</p> <p>A2: Near pristine Native vegetation dominates. Some introduced weeds may be present in the understorey, but not to the extent that they displace native species. Otherwise, there is no evidence of human impact. A river valley in this condition is as good as will be found today.</p> <p>A3: Slightly disturbed  Native vegetation dominates, but there are some areas of human disturbance where soil may be exposed, and weeds are relatively dense (such as along tracks). The native vegetation would quickly recolonise the disturbed areas if human activity declined.</p>	<p>C Grade Foreshore</p> <p>C1: Erosion prone  Trees remain, and possibly some large shrubs or tree grasses, but the understorey consists entirely of weeds, mainly annual grasses. The trees are generally resilient or long-lived species but there is little or no evidence of regeneration. The shallow-rooted weedy understorey provides no support to the soil, and only a small increase in physical disturbance will expose the soil and make the river embankments and floodway vulnerable to erosion.</p> <p>C2: Soil exposed  Older trees remain, but the ground is virtually bare. Annual grasses and other weeds have been removed by livestock trampling or grazing, or through overuse by humans. Low-level soil erosion has begun, by the action of either wind or water.</p> <p>C3: Eroded  Soil is washed away from between tree roots, trees are being undermined and unsupported embankments are subsiding into the river valley.</p>
<p>B Grade Foreshore</p> <p>B1: Degraded - weed infested  Weeds have become a significant component of the understorey vegetation. Although native species are dominant, a few have been replaced by weeds.</p> <p>B2: Degraded - heavily weed infested  In the understorey, weeds are about as abundant as native species. The regeneration of some tree and large shrub species may have declined.</p> <p>B3: Degraded - weed dominated  Weeds dominate the understorey, but many native species remain. Some trees and large shrub species may have declined or disappeared altogether.</p>	<p>D Grade Foreshore</p> <p>D1: Ditch - eroding There is not enough fringing vegetation to control erosion. Some trees and shrubs remain and act to retard erosion in certain spots but are doomed to be undermined eventually.</p> <p>D2: Ditch - freely eroding No significant fringing vegetation remains, and erosion is completely out of control. Undermined and subsided embankments are common, and large sediment plumes are visible along the river channel.</p> <p>D3: Drain - weed dominated The highly eroded river valley has been fenced off, preventing control of weeds by livestock. Perennial (long-lived) weeds have become established. The river has become a simple drain, similar or identical to a typical major urban drain.</p>

4 REACH ASSESSMENTS

Results of the site inspections are provided in this section, along with management recommendations to improve identified issues. The data and information are provided for each reach (Lower Murray 1 to 6 and Middle Murray 1 to 9) in the format outlined in Table 3.

Table 3: Reach Assessment Data Format

Item	Format	Title	Notes
1	Figure	Reach Location Map	Reach, tributaries, and surrounding features
2	Figure	Reach Elevation Map	River and floodplain digital elevation model based on DWER LIDAR data
3	Figure	Land Use Map	Peel Region Scheme mapping to give context to each reach regarding surrounding land uses
4	Table	Reach Description and Conditions	Summary of the characteristics of each reach and description of assessment scores
5	Figure	Reach Condition Assessment – 2014 or 2015	Condition mapping from past assessment for comparative purposes
6	Figure	Reach Condition Assessment - Current	Assessment scores for each sub-reach with points of interest including infrastructure, weeds, and significant erosion
7	Figure	Management Actions since 2014/15	If management actions have been employed in the reach since 2014/15, then these have been identified (NB. Not applicable to all reaches)
8	Table	Reach Management Actions and Recommendations	Recommendations to improve the reach based on condition assessment and notable features

The detailed scoring for each sub-reach and bank is provided in Appendix 2 based on the methodology outlined in Appendix 1. Further mapping water quality (salinity and dissolved oxygen) are provided in Appendix 3. Reference to these maps is made selectively through the reach assessments.

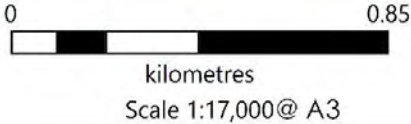
		Left Bank						
		Floodway and Bank Veg	Verge Vegetation	Stream Cover	Bank Stability and Erosion	Habitat Diversity	Total Score	Rating
Reach	Subreach							
2	1	2.5	2.5	2.50	2	1	10.50	C2
2	2	1.5	2	1.86	7	2	14.36	C1
2	3	2.5	1	2.29	7	1.5	14.29	C1
2	4	3.5	3	3.00	6	2	17.50	B2-B3
2	5	3	6	2.00	4	2	17.00	B3
2	6	2.5	3	4.00	7	2.5	19.00	B2-B3
2	7	2	3	3.00	7	2	17.00	B3
2	8	1.5	4.5	2.00	6	1.5	15.50	B3-C1
2	9	2.5	2	2.57	3.5	2	12.57	C1-C2
2	10	2.5	3	3.00	6	1.5	16.00	B3-C1
2	11	2	3	2.43	6	2.5	15.93	B3-C1
2	12	2.5	4	2.71	5	2	16.21	B3
2	13	3	4	2.00	7	1.5	17.50	B2-B3

Figure 5: Reach Scoring Example

Peel Harvey Catchment Council - Lower and Middle Murray River Action Plan
Figure 6 - Lower Murray Reach 1: Delta Islands to Wilgie Creek - Location Map.



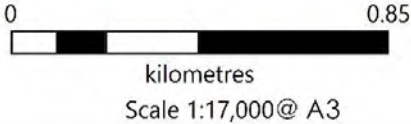
* @2022. While Urbaqua has taken care to ensure the accuracy of this product, Urbaqua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbaqua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.



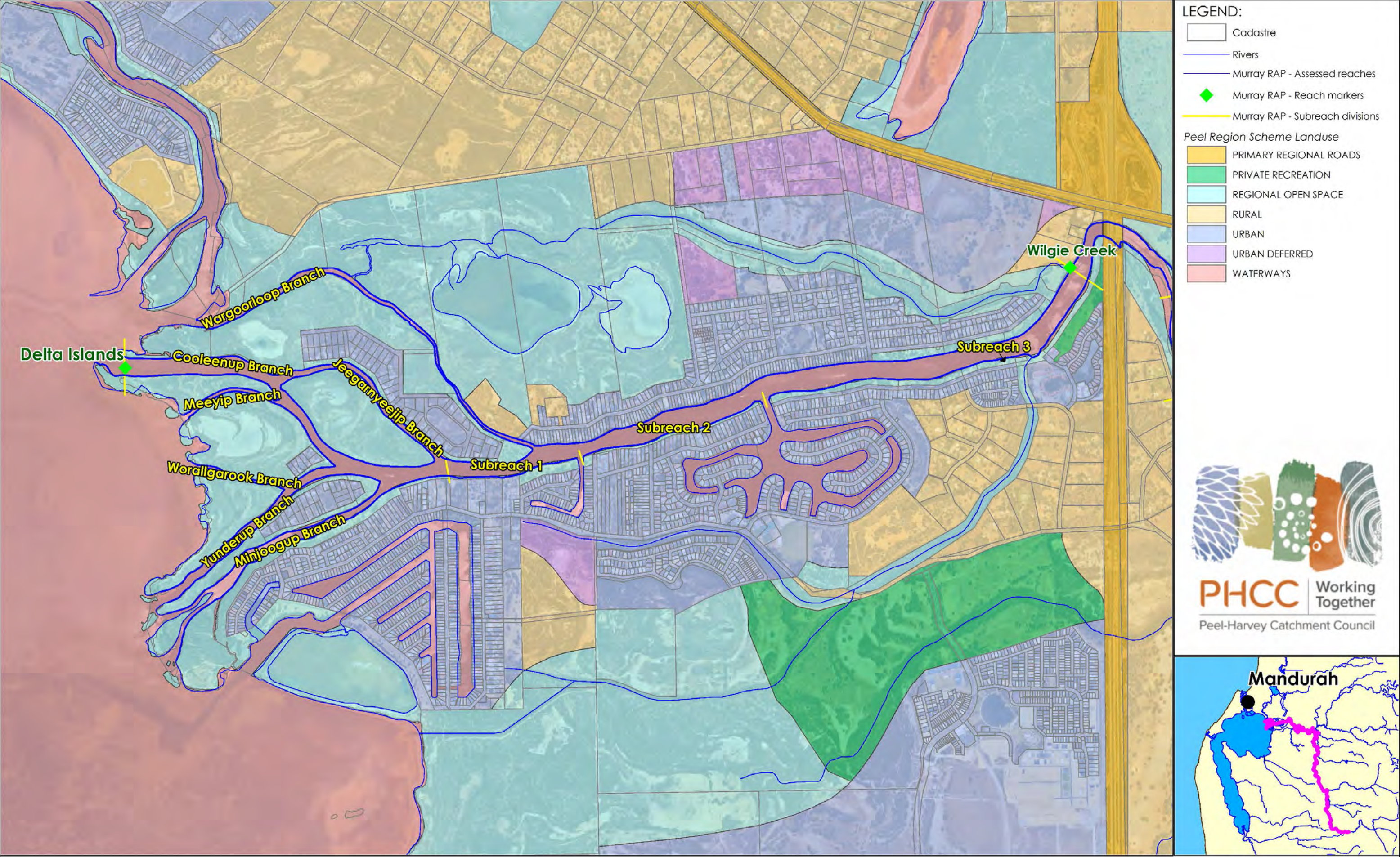
Peel Harvey Catchment Council - Lower and Middle Murray River Action Plan
Figure 7 - Lower Murray Reach 1: Delta Islands to Wilgie Creek - Elevation Map.



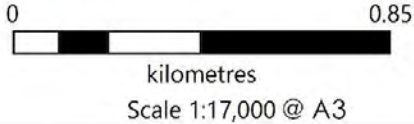
* ©2022. While Urbaqua has taken care to ensure the accuracy of this product, Urbaqua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbaqua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.



Peel Harvey Catchment Council - Lower and Middle Murray River Action Plan
Figure 8 - Lower Murray Reach 1: Delta Islands - Landuse Map (Peel Region Scheme).



* @2022. While Urbagua has taken care to ensure the accuracy of this product, Urbagua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbagua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.



4.1 Lower Murray Reach 1

This reach is approximately 5.2 km long and begins at the Delta Islands (Figure 6). It comprises several braided channels entering the Peel Inlet and ends at Wilgie Creek where rural grazing land commences. Vesting of much of this area is with the Shire of Murray. Urban development dominates both sides of the river and foreshores. Due to access issues during the 2022 survey, observations were mainly derived from boat. Observational evidence was recorded, such as reviewing previous rehabilitation programs, which included revegetation and bank stabilisation (after the 2014 RAP). A desktop investigation was also undertaken which reviewed additional data from the Shire of Murray DRAFT CHRMAP investigation and a 2018 Level 2 Flora Survey of the Delta Islands (NAH, 2018).



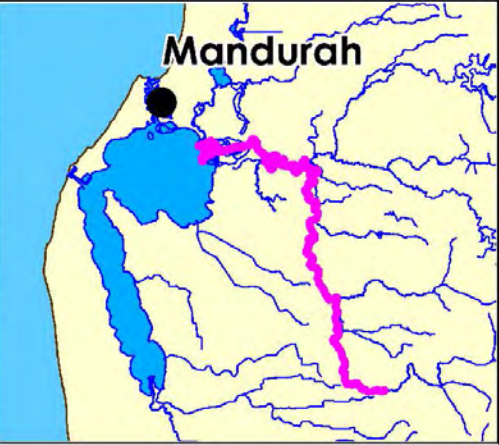
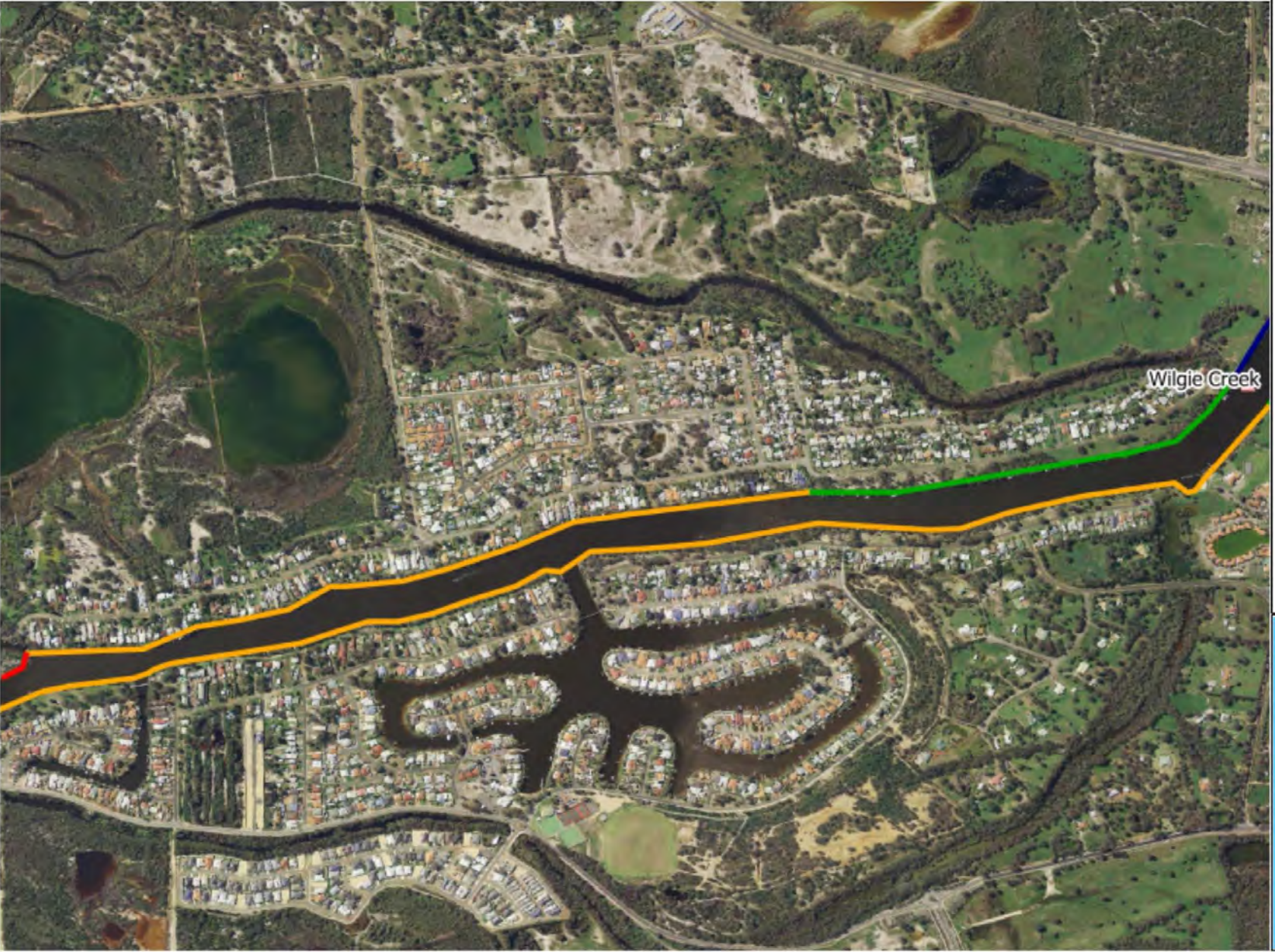
Plate 2: Lower Murray Reach 1 Photos

Table 4: Lower Murray Reach 1 Description and Conditions

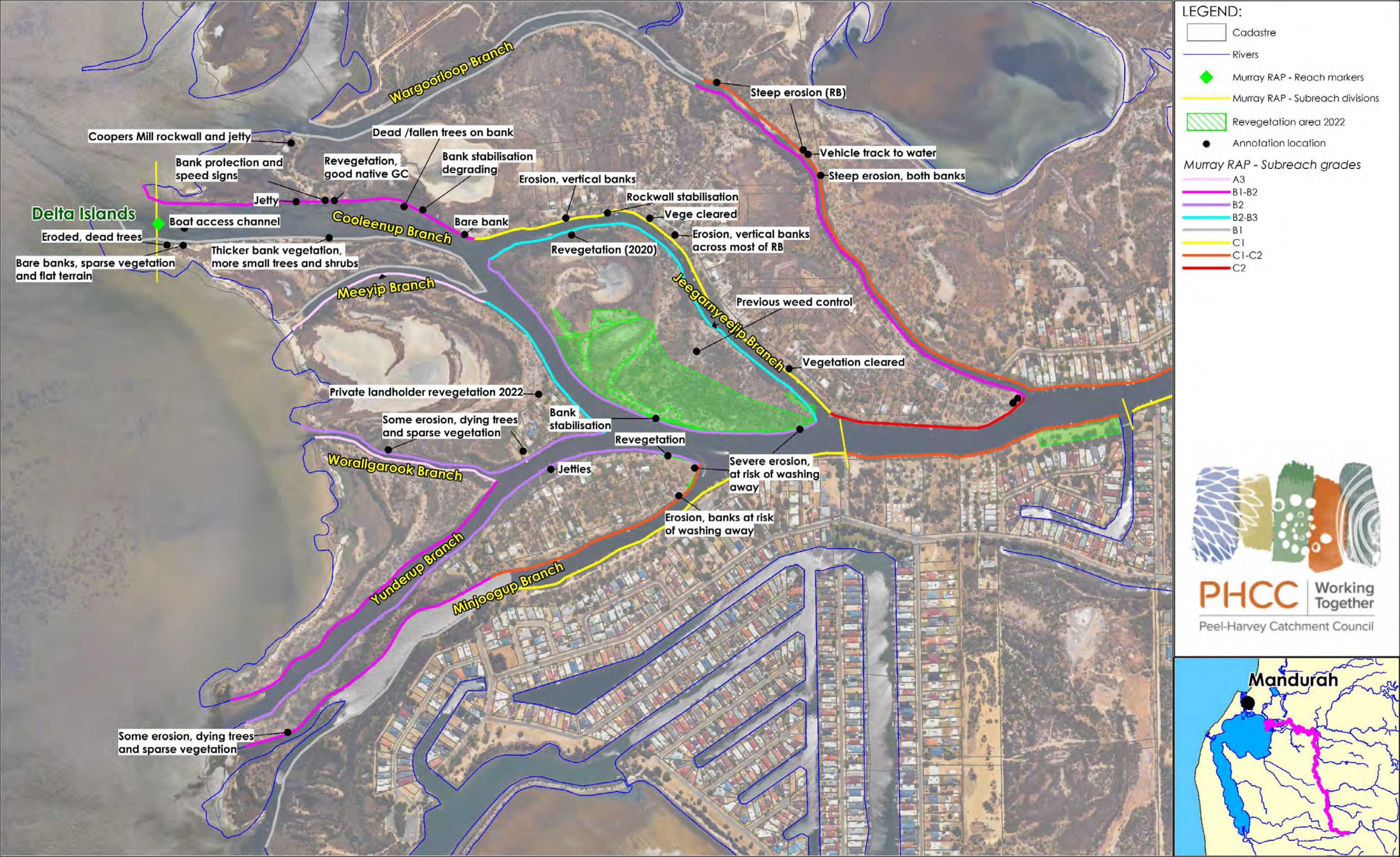
Feature	Comments
Land Use	<p>Since the 2014 RAP, the land use surrounding Reach 1 has remained unchanged.</p> <p>Some urban development exists on the Islands. Surrounding land uses include canal developments, caravan parks, a shop, and a fuelling station. There are privately owned blocks with riparian rights adjacent to the river. Most of the Delta Islands are Crown Reserves (Figure 8). Some reserves exist between urban blocks and the river on the left bank. Most reserves abutting the foreshore are vested with the Shire of Murray.</p>
Fencing and Infrastructure	No fencing was noted
Channel Form and Soils	<p>Reach 1a comprises several braided channels entering the Peel Inlet which form the Delta Islands. The land is low lying. Stage 1b is a straight defined channel with a canal estate coming off it (Figure 7).</p> <p>Reach 1a consists of three soil types. The delta islands are Vasse V1 (saline tidal flats of foetid muds and humic clays with shell and limestone fragments) and Vasse V2 (samphire covered sand and mud flats marginally higher than V1, frequently inundated). Cooleenup and Jeegarnyeejip Islands include Vasse V3 (sandflats marginally higher than V2, deep alkaline alluvial sands and clayey sands, frequently inundated).</p> <p>Vasse V3 and V6a are predominant on the left bank. Toward the end of the reach soils change to B2 on right bank and P10 on the left bank. All soils along this reach have a high to moderate phosphorous export risk. There is risk of Acid Sulfate Soils is high.</p>
Vegetation Cover and Stream Health	<p>The vegetation condition in general in the Delta Islands varied from Completely Degraded to Excellent (NAH, 2018).</p> <p>The vegetation type at the lower end of the reach adjacent to the Inlet is predominately Samphire Heath (predominantly categorised as Excellent (NAH, 2018)) and Casuarina Woodland (predominantly categorised as Good to Very Good (NAH, 2018)). Parts of the Samphire Heath complex is Completely Degraded along the Inlet edge (NAH, 2018) however there is evidence of Samphire regeneration in the inner areas under tidal influence. The demise of Melaleuca, Eucalypts and Casuarina along delta tidal flats has been influenced by increased tides. Tree deaths have been noted as part of this investigation (Figure 10).</p> <p>The upper islands are predominantly Mixed Woodland and some Kunzea Tall Shrubland. Jeegarnyeejip Island has had revegetation and weed control undertaken since the last RAP (Figure 12) as part of the previous action plan. The 2018 Level 2 Flora survey (NAH, 2018) noted that the vegetation condition on this island was predominately Good to Excellent, with some sparse Degraded patches (NAH, 2018). A population of <i>Stylidium longitubum</i> (a conservation significant flora species) were identified on Cooleenup Island in the 'Good' Mixed Woodland.</p> <p>East of the Delta Islands the overstorey is predominantly Paperbark (<i>Melaleuca spp</i>) and Casuarina. The understorey is very sparse with isolated clumps of sedges and rushes. Some sedges and rushes line the river foreshore, however, there has been a loss of fringing vegetation along all urban areas and foreshore reserves in the upper extent of the reach.</p> <p>The 2018 Flora and Vegetation survey identified 87 native species within the Delta Reserve which was more than the number identified in NatureMap just prior to the 2018 survey (DBCA, 2017) which identified just 35 native species. (NB. NatureMap is no longer available).</p> <p>Since the 2014 RAP, extensive revegetation has been undertaken on the southern side of Jeegarnyeejip Island with <i>Juncus kraussii</i> and <i>Samolus repens</i> planted along the banks (Figure 12). Revegetation has also occurred on riparian portions of Wilgie Creek including seeding</p>

Feature	Comments
	and seedlings (Figure 13).
Weeds	<p>The 2018 Flora and Vegetation survey identified 37 weed species within the Delta Reserve which was more than the number identified in NatureMap just prior to the 2018 survey (DBCA, 2017) which identified just 11 weed species. (NB. NatureMap is no longer available).</p> <p>Weed species identified included; bridal creeper, black flag, cape bluebell, hottentot fig, bulbil watsonia, and one-leaf cape tulip (NAH, 2018). Three of the weeds identified are C3 declared pests under the <i>Biosecurity and Agriculture Management Act 2007</i> (WA), Bridal Creeper (<i>Asparagus asparagoides</i>) on Cooleenup Island, One-leaf Cape Tulip (<i>Moraea flaccida</i>) on Jeegarnyeejip Island and Arum Lily (<i>Zantedeschia aethiopica</i>) on Ballee Island (NAH, 2018). Bridal creeper is also a weed of national significance (WoNS) (Department of Environment, 2012). Exotic garden weeds were also present (mostly situated near/on housing).</p> <p>Since the 2014 RAP, extensive weed management has been undertaken on the whole of Jeegarnyeejip Island with foliar spray of love/ veldt grass and watsonia (Figure 12). Some further weed control has also occurred adjacent to Wilgie Creek (Figure 13).</p>
Erosion	<p>The Delta Islands are low lying and susceptible to inundation and erosion. Banks have historically had extensive rock and log walling, however, increased tidal activity from the Dawesville Channel has caused clay banks to slump and some older areas of walling are degrading. Increasing human activity has resulted in the loss of sedges, rushes and upper storey vegetation in places and an increase in foreshore erosion. Historically baffle boards have been used in places in the Delta Islands, however generally they have failed to stop erosion or add to the stability of the sub reach.</p> <p>Deposition is evident between Cooleenup and Jeegarnyeejip Islands, and erosion is evident a long a lot of the south bank of Cooleenup Island where vertical banks, bare and degraded banks, and fallen over trees are evident, demonstrating impacts of erosion (Figure 10).</p> <p>Since the 2014 RAP, baffle board repair has occurred on the southern side of Jeegarnyeejip Island and seeded geofabric with jute matting has been installed as a soft measure of erosion control (Figure 12). On Cooleenup Island, a variety of different erosion control measures have been implemented towards the southern end using geofabric, jute matting, rocks, sandbags, and battering.</p> <p>In the upper extent of the reach (sub reaches 2-3), vertical edges and severe erosion are noted in places opposite the South Yunderup caravan park and Wilgie Creek (Figure 11).</p>
Habitat Condition	<p>The Delta Islands provide a variety of foreshore habitats for terrestrial animals including roosting sites. Instream habitat is varied as the braided channel provides a variety of widths and depths, as does the tidal influence. There is a significant amount of instream woody debris and dead trees. The upper reaches are mostly straight and there is some instream woody debris along the water-edge providing roosting sites, but rock and log walls have replaced much of the natural embankment (Plate 2).</p>
Other Issues	<p>Unauthorised access by small boats is resulting in the destruction of fringing vegetation and erosion. Illegal activity was evident at certain points along the reach, such as illegal clearing of vegetation and new jetty construction.</p> <p>Baffle boards have been installed along this reach in the past, and although at first, they mitigated the erosion issues, over time they became degraded and now provide little protection or improvement to bank stabilisation.</p>
Water quality	<p>The dissolved oxygen content of Reach 1 was high (89.7%), likely due to proximity to the estuary and wave action (Figure 89).</p> <p>The electrical conductivity in the Lower Murray Reach 1 was approximately 57mS/cm (Figure 90). This EC is indicative of saline water (seawater is approximately 50mS/cm). High salt levels can lead to loss of vegetation with plant species that are intolerant to salt.</p>
Community	<p>It was considered that boat usage, and hence boat wash, was increasing, and therefore causing more issues within this reach within regards</p>

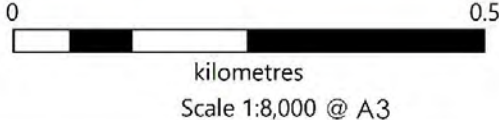
Feature	Comments
and Cultural Values	<p>to erosion and bank stability, but also risk to marine life.</p> <p>Local Bindjareb Noongar Elders and Representatives will provide knowledge and advice on each site, its' cultural significance, and values. Please refer to Section 2.3 of this document to ensure all processes and procedures are followed.</p> <p>Landholders within this reach are passionate about the health of the waterway. Residents highly value the river not only for its beauty but for its ecosystem services it provides. The community expresses concern with increased boat usage along this reach and the effects it is having on the riverbanks particularly around the Delta Islands. The community are dedicated and motivated to protect the rivers natural assets and are strong advocates in raising awareness about the health of the waterway. This reach is also accustomed to a variety of recreational activities such as canoeing, kayaking, fishing, swimming, walking, and boating.</p>



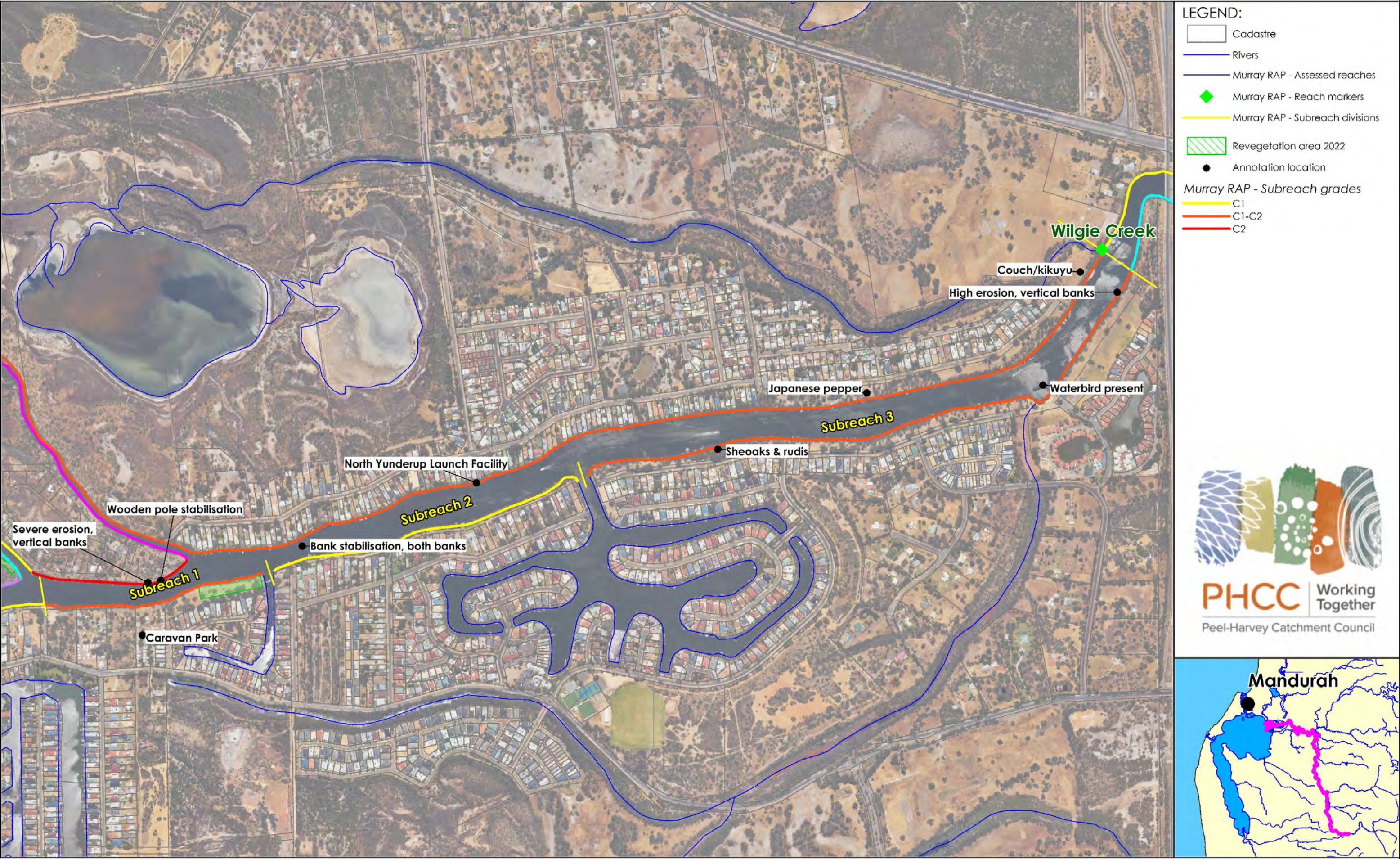
Peel Harvey Catchment Council - Lower and Middle Murray River Action Plan
Figure 10 - Lower Murray Reach 1a: Delta Islands. Current Condition Map.



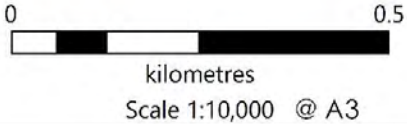
* @2022. While Urbaqua has taken care to ensure the accuracy of this product, Urbaqua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbaqua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.

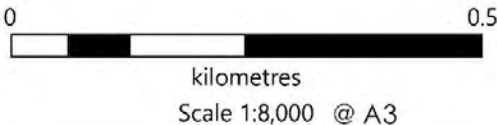
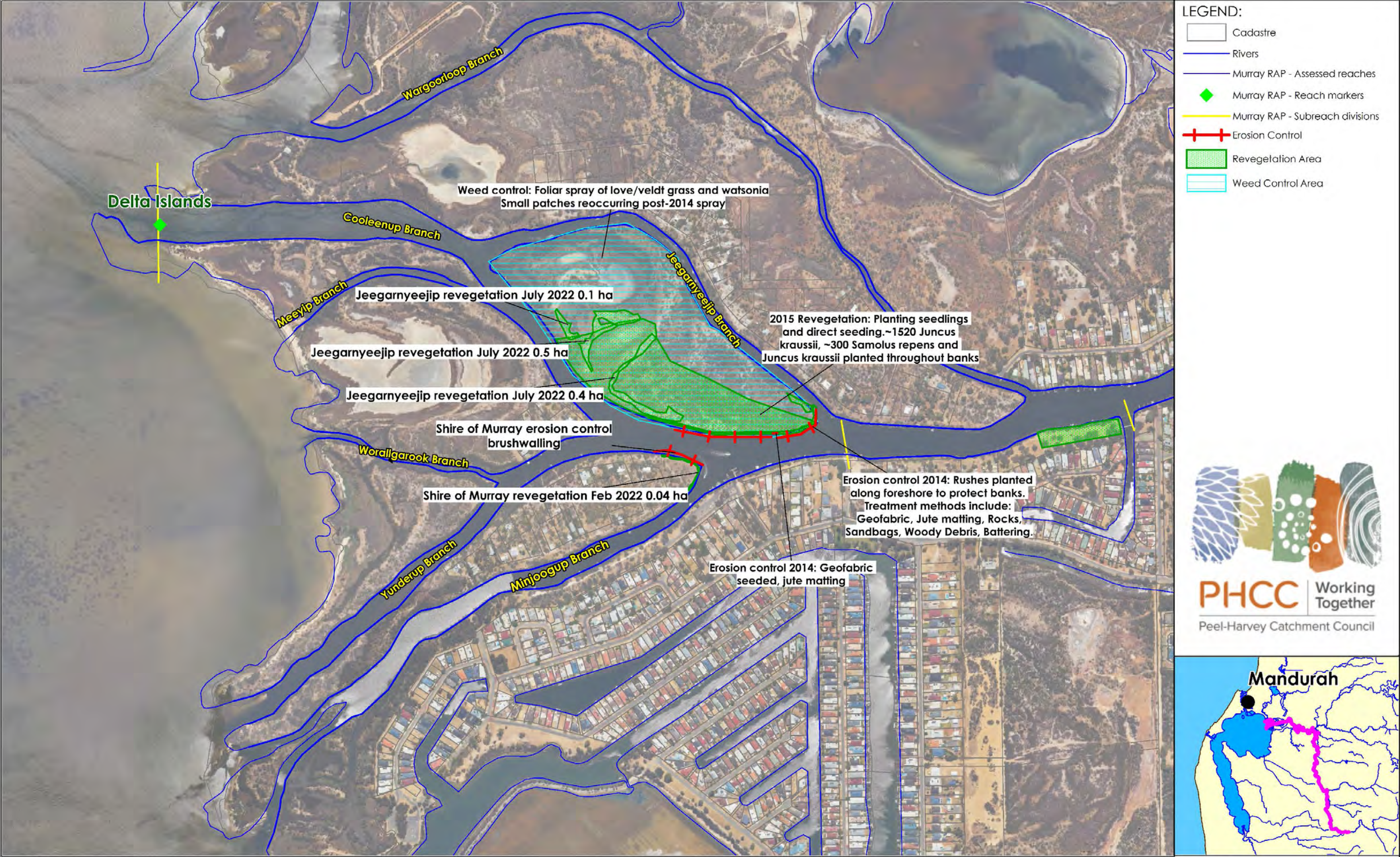


Peel Harvey Catchment Council - Lower and Middle Murray River Action Plan
Figure 11 - Lower Murray Reach 1b: Delta Islands to Wilgie Creek - Current Condition Map.

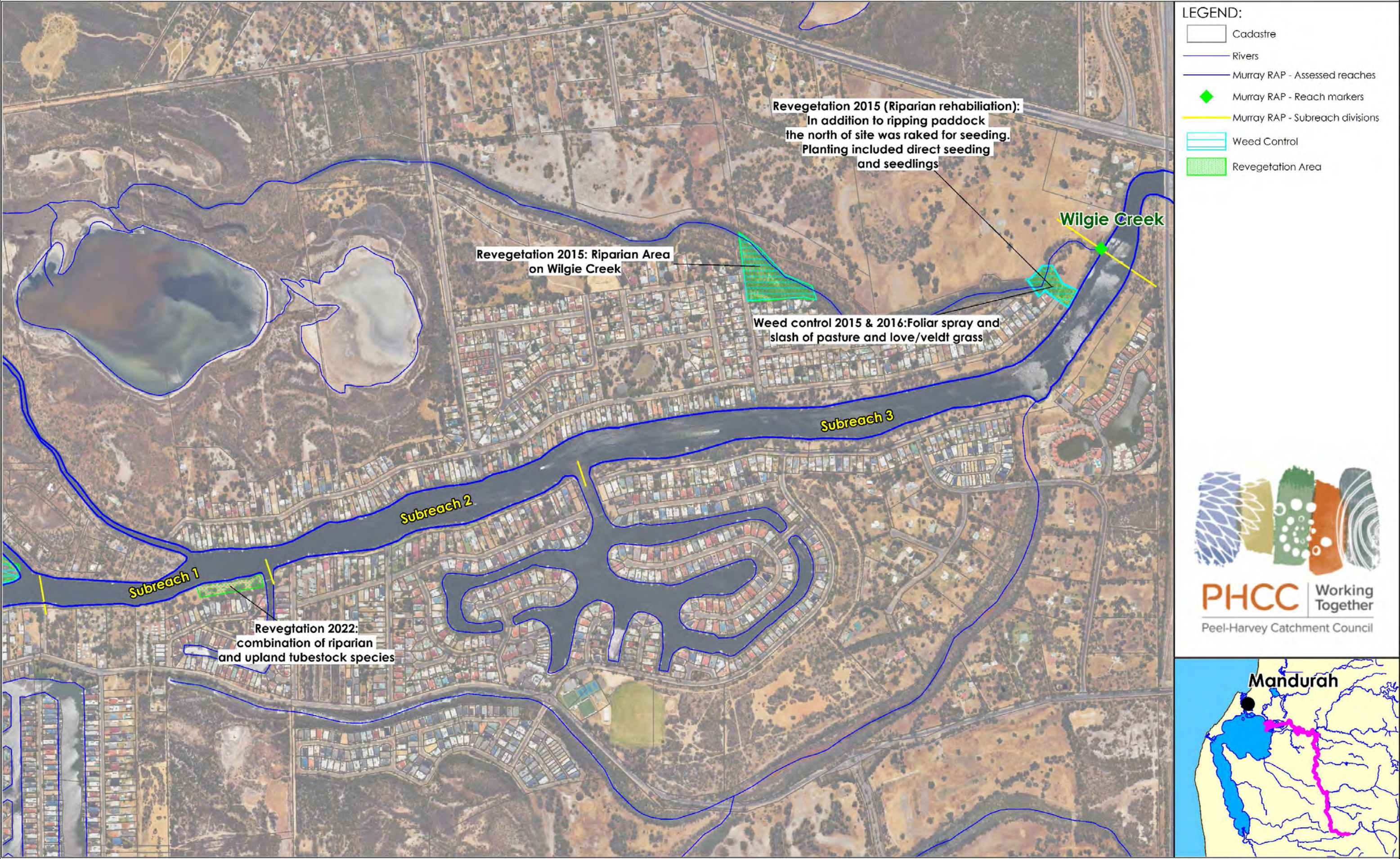


* ©2022. While Urbagua has taken care to ensure the accuracy of this product, Urbagua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbagua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.





Peel Harvey Catchment Council - Lower and Middle Murray River Action Plan
Figure 13 - Lower Murray Reach 1b: Delta Islands to Wilgie Creek - Actions since 2014.



* ©2022. While Urbagua has taken care to ensure the accuracy of this product, Urbagua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbagua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.

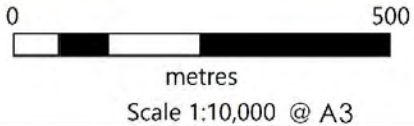


Table 5: Lower Murray Reach 1 Management Actions and Recommendations

Issues

- The Shire of Murray **DRAFT** CHRMAP identifies that sub-reach 2 was at risk of erosion, and that there was a threat to adjacent land within this reach and its' assets. Climate change and rising sea levels will exacerbate these issues.
- Increased tidal activity and wave action from increased boat usage is exacerbating bank stability issues.
- South Yunderup was noted as being particularly susceptible to erosion and inundation (Shire of Murray **DRAFT** CHRMAP).
- Uncontrolled activities such as; clearing, vehicular access, installation of landings, small boats access/ landings etc.

Prioritised management actions recommended

Boats:

- Work with Department of Transport to enforce 5 knot limit.
- Possible options include; using mobile markers deployed in the navigation channel that read boat speed, using mobile buoys with a speed sign moved around to key locations to help alert skippers to the speed limits, DoT officers stationed at different locations with speed radar once a week.
- Educational programs targeting boat wash e.g., 'no wash zones'.

Erosion and bank stabilisation:

- Continue to work with the landholders to improve conditions of riverbanks through recommended bank stabilisation techniques.
- Provide advice to the landholders on methods to identify erosion risk to allow for early intervention.
- The Shire of Murray **DRAFT** CHRMAP identified that possible remediation measures in this reach could include a range of mitigations from annual reporting, to managed retreat, to protection through nature-based solutions or hard engineering walls.

Revegetation and weeds:

- A future rehabilitation site has been identified with sub-reach 1 (Figure 11).
- Implement revegetation programs, as recommended in the *Lower Murray River Foreshore Stabilisation Guidelines* (Shire of Murray, 2019), including the recommended selection species for locations **within the bank profile for "Zone 1 and Zone 2"**.
- Investigate die-off of trees and implement recommendations.

Planning:

- Work with relevant stakeholders to identify unapproved installation of structures such as jetties. Enforce actions.
- Provide resources and/or guidelines to landholders directly abutting the river. Guidelines that would be useful for land uses and issues relevant to activities within this reach include;
- Boating activities including speed awareness and wake consideration and impact on wildlife
- Weeding and appropriate ways to remove weeds.
- Revegetation techniques including appropriate species selection and bank profile location.
- Erosion control measures or effective bank stabilisation options – also refer landholders to existing relevant guidelines including the Foreshore Stabilisation Guidelines (Shire of Murray, 2019) and Best Management Practices for Foreshore Stabilisation: Brushwall (DBCA, 2020).
- Simplifying where to find the information required for planning approval for jetties, pagodas etc.

Long term management actions recommended

Boats:

- Consider a permanent speed-reading device at a key location on the Murray.
- Consideration should be given to the use of specially designed boats, which have large ballast or have a hull shape or fittings that are designed to create a large wave behind the boat. Consider **results from the "Vessel wake study" occurring from the mouth of the Murray to South Yunderup. Also**

consider application of the "Wave wake predictor".

- Consider 'no wash zones' to mitigate the impacts of boat wash on riverbanks and/or install equipment to raise awareness of reducing boat speed.

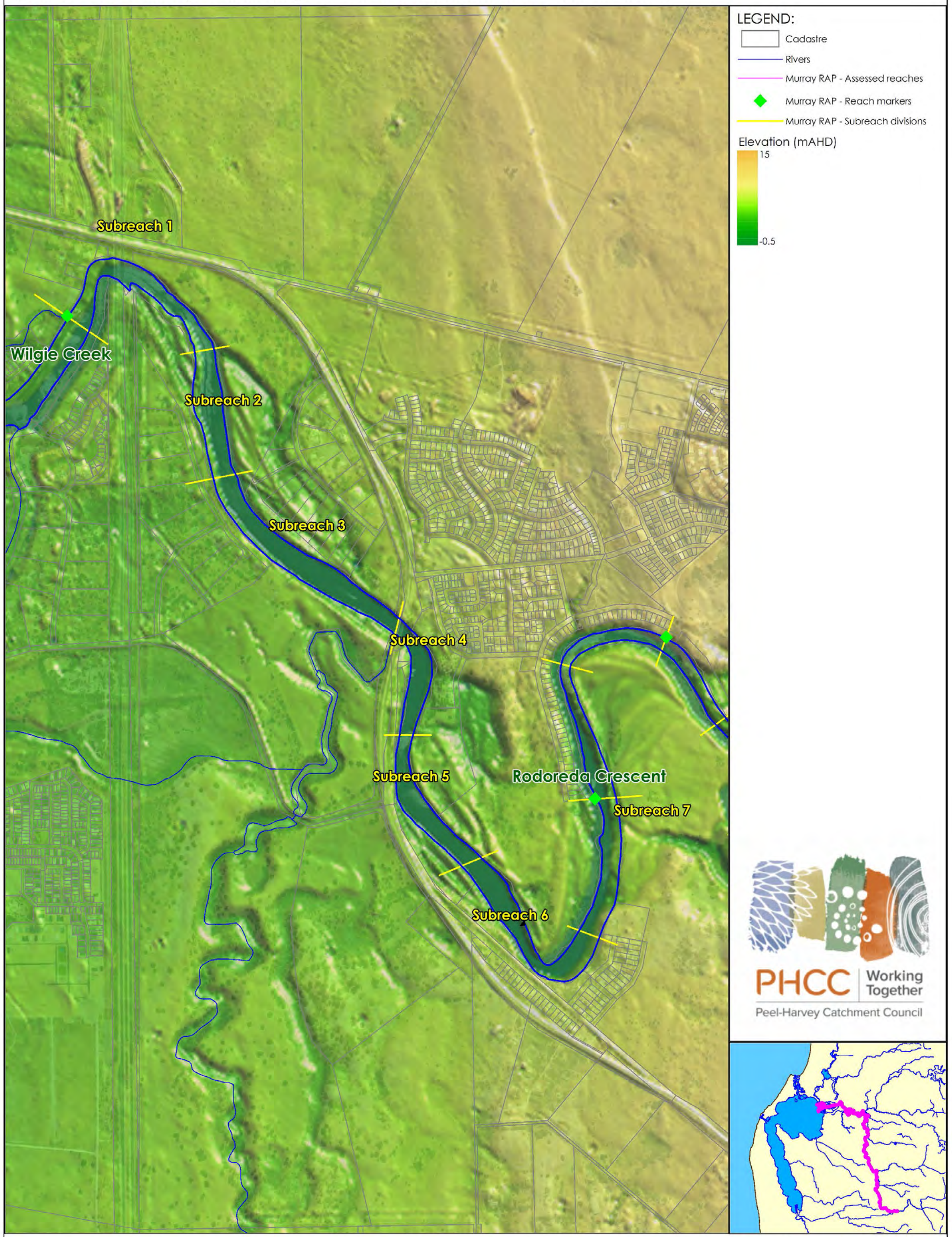
Erosion and bank stabilisation:

- Prepare a Murray River erosion management plan for Improved management of boating wash and riverbank erosion. Use results from the "Vessel wake study" occurring from the mouth of the Murray to South Yunderup. Also consider the impacts of climate change and sea level rise on bank stability in low reaches.
- Given baffle boards have not been seen to be particularly effective at reducing erosion, consider whether further repair of baffle boards is a worthwhile endeavour. Focus efforts on other bank stabilisation control measures as considered in the *Lower Murray River Foreshore Stabilisation Guidelines* (Shire of Murray, 2019).
- Based on investigation, consider bank protection to prevent erosion on the Islands situated on the main channel of the river (combination of soft and hard engineering)

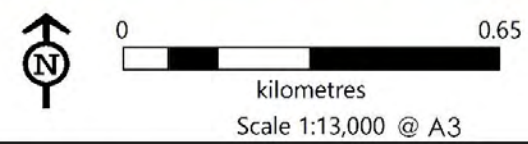
Weeds:

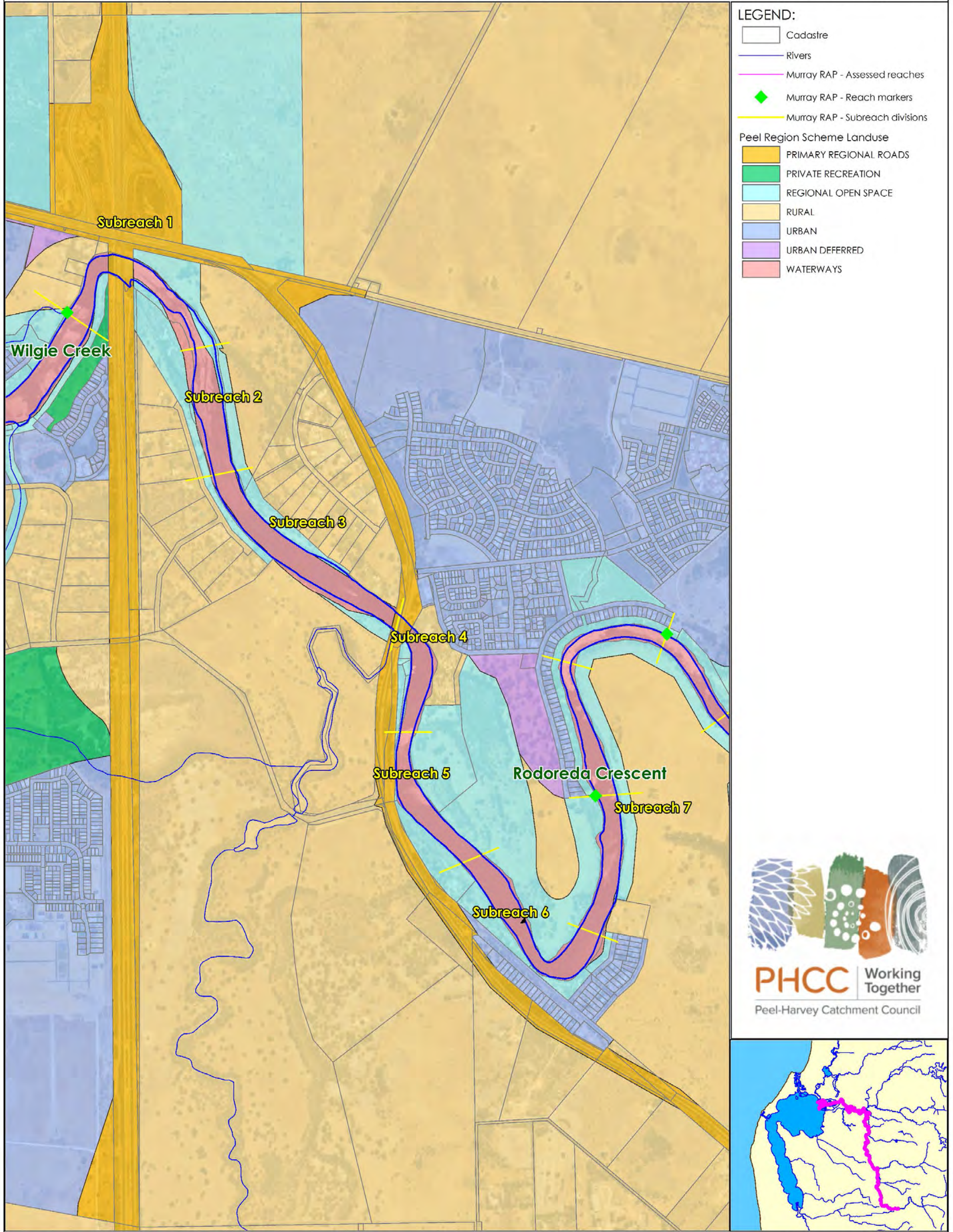
- Weed species identified on the Delta Islands (the Urban portion of Cooleenup Island) require the landowner/land manager to control the population to limit damage – Further consultation and liaison with landowners required.
-





* ©2022. While Urbaqua has taken care to ensure the accuracy of this product, Urbaqua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbaqua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.





4.2 Lower Murray Reach 2

This reach is approximately 4.8 km long and includes some private rural land (Figure 14). Private land abuts the river for a portion of this reach however directly adjacent to the foreshore is zoned Regional Open Space (Figure 16). C Class Reserve adjoins the Ravenswood Caravan Park on the right bank (Reserve 26526) and along the initial section of the left bank (Reserve 34502). Both reserves are zoned public recreation but remain unvested. The lower extent of the reach is impacted by farming.



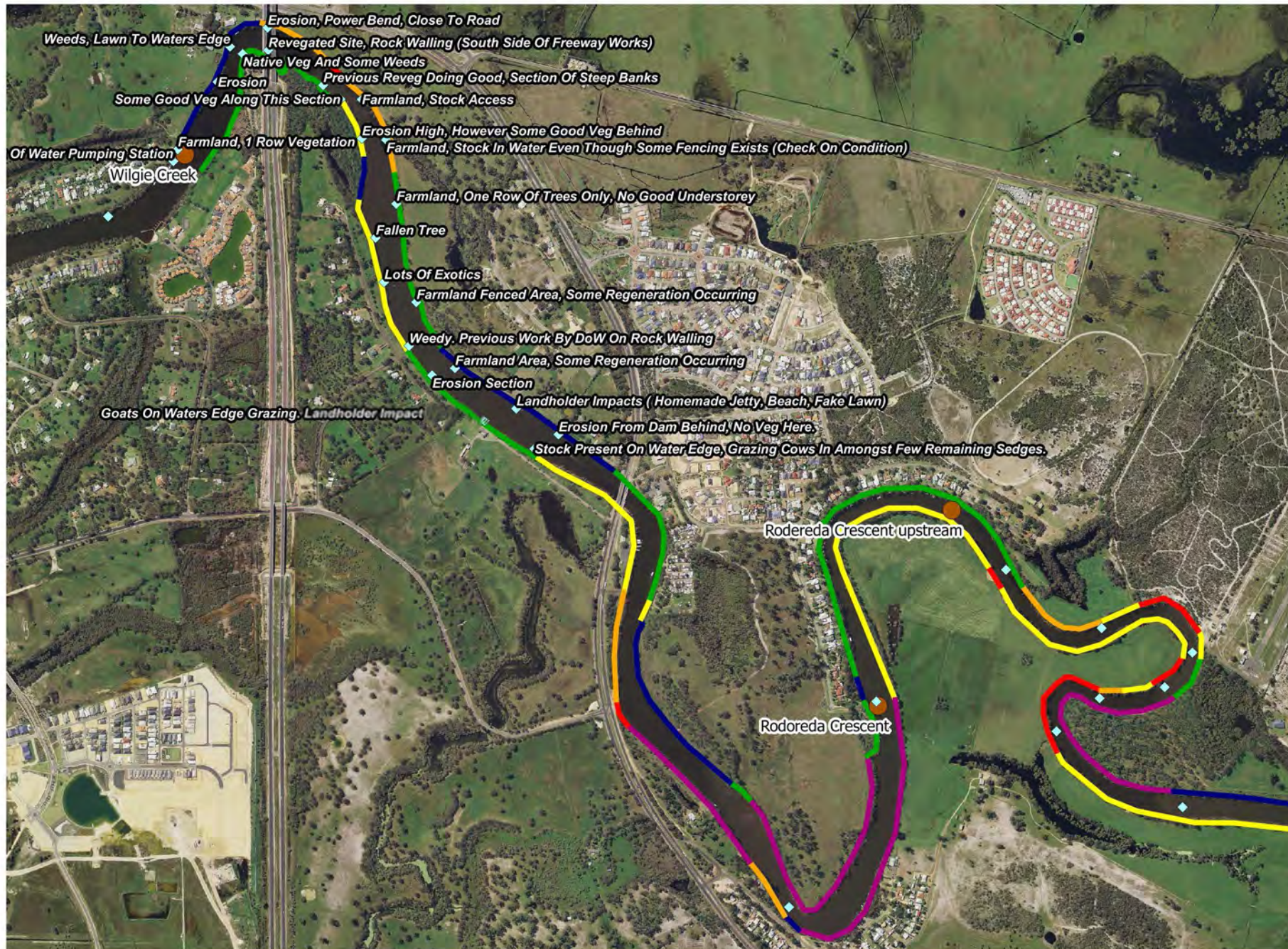
Plate 3: Lower Murray Reach 2 Photos

Table 6: Lower Murray Reach 2 Description and Conditions

Feature	Comments
Land Use	<p>Much of the riparian zone along this reach is within regional open space (ROS). However, set back from the river is mostly rural landholdings. There is one small area of Urban at the river bend within this reach, and a larger area of ROS with some remnant forest.</p> <p>The rural land is mostly livestock grazing land. Crown Reserve 34502 is zoned public recreation and remains unvested. Ravenswood Hotel and Caravan Park are located on lot 65 north east of Ravenswood Bridge (Figure 16).</p>
Fencing and Infrastructure	<p>Some foreshore fencing exists in both urban and rural areas. Livestock has access to large sections of the river.</p> <p>The upper reaches noted many jetties along the banks and a boat ramp, and boat mooring points at the Ravenswood Hotel, identifying common boat usage.</p>
Channel Form and Soils	<p>This reach is winding with a defined channel. A tributary joins the river in Reach 4 (Figure 15). There was no observed sediment deposition or plumes. There are no pools present within this reach.</p> <p>The left bank is predominantly Pinjarra P2 soils (identified as flat to very gently undulating plain with deep alkaline mottled yellow duplex soils which generally consist of shallow pale sand to sandy loam over clay), with a small area of Bassendean B2 (identified as flat to very gently undulating sandplain with well to moderately well drained deep bleached grey sands with a pale-yellow B horizon or a weak iron-organic hardpan 1-2 m.)</p> <p>The right bank is predominantly Pinjarra P10 (identified as gently undulating to flat terraces adjacent to major rivers, but below the general level of the plain, with deep well drained uniform brownish sands or loams subject to periodic flooding), with a small area of Bassendean B2 (identified as flat to very gently undulating sandplain with well to moderately well drained deep bleached grey sands with a pale-yellow B horizon or a weak iron-organic hardpan 1-2 m.)</p>
Vegetation Cover and Stream Health	<p>Paper barks and flooded gums (<i>Eucalyptus rudis</i>) are dominant in low wet areas, with <i>Juncus kraussii</i> moderately present or sparse throughout the reach.</p> <p>In the lower sub reaches there are tall trees directly adjacent to the foreshore, however back from the foreshore edge the landscape is often dominated by grassed areas (couch, kikuyu and watsonia) for agricultural grazing. Sub reach 2 has some good condition, native riparian vegetation and Sub Reach 5 has some areas of remnant vegetation and forest set back from the river (in ROS).</p> <p>There is a moderate amount of healthy native woody vegetation regrowth within the streamside zone throughout many of the sub-reaches. Some filamentous algae were noted on substrates within some of the middle reaches.</p>
Weeds	<p>Pasture grasses (couch, kikuyu), watsonia, and lovegrass are dominant in grazing areas where livestock access the river. Bridal creeper, giant reeds, oleandra and pure onion weed were also observed in spots.</p> <p>Watsonia and bracken Fern dominate the understorey east of Ravenswood Caravan Park.</p>
Erosion	<p>Points of undercutting and moderate bank erosion occur along several sections of both banks. Livestock access and tracks were evident in places. Although there are fences along some extents, livestock were still observed outside the fencing (Figure 18)</p> <p>The upper reaches show high to moderate levels of erosion caused by livestock, human access, runoff, and stormwater inflow (e.g., Buchanan's drain), cleared vegetation and boat wakes/ wave action.</p> <p>Rock walling has been undertaken along a short section to control undercutting on the left bank. Banks are stabilised by log walling at</p>

Feature	Comments
	Ravenswood Hotel, which many boats use as mooring points.
Habitat Condition	Large meanders and bends occur in this reach. The depth of the channel is up to 20 meters at the bends. Fallen trees provide roosting sites for terrestrial animals. There is a moderate amount of woody debris, occurring in 2-3 different sizes.
Other Issues	Crown reserves 26526 and 34502 are zoned for 'public recreation' but are unvested. Reserve 26526 appears to be currently used for grazing and adjoins Lot 63. The 2014 survey revealed these sections as potential revegetation sites.
Water Quality	The dissolved oxygen content of Reach 2 was relatively high (72.4%), likely due to the wave action from boat usage (Figure 89). The electrical conductivity in the Lower Murray Reach 2 was approximately 51.8mS/cm (Figure 90). This EC is lightly lower than Reach 1 which is expected given it is further from the Estuary, however it is still indicative of saline water (seawater is approximately 50mS/cm).
Community and Cultural Values	'Other Heritage Place 8962 – Yunderup Aboriginal Site – Fish Trap' and part of 'Registered Aboriginal Site 3677 – Waugal Cave – Mythological Site', and culturally significant site – "Woggaal's Head" are located within this reach. Local Bindjareb Noongar Elders and Representatives will provide knowledge and advice on each site, its' cultural significance, and values. Please refer to Section 2.3 of this document to ensure all processes and procedures are followed. This reach is also accustomed to many different recreational activities such as canoeing, kayaking, swimming, fishing and walking. Supply issues for dog poo bags noted as an issue. Like Reach 1, boat usage and hence boat wash was increasing, and therefore causing more issues within this reach within regards to erosion and bank stability, but also risk to marine life. Landholders within this reach have utilised the some of the land for farming and highly value the river not only for its beauty but for its ecosystem services it provides. With the Ravenswood Hotel positioned on the river, the broader community have the opportunity to experience what this unique waterway has to offer. Boat users capitalise on this opportunity and park at the vessel mooring provided to enjoy lunch or dinner in such an idyllic setting.

Peel Harvey Catchment Council - Lower and Middle Murray River Action Plan
Figure 17 - Lower Murray Reach 2: Wilgie Creek to Rodoreda Crescent - 2014 Condition Map



Lower Murray River Action Plan
Review 2014
Foreshore Condition Assessment



Legend

- Murray River Reaches
- Grade
- B2-B3
- B3-C1
- C1
- C1-C2
- C2
- C2-C3
- C3



0 100 200 300 400 m



GDA 94 UTM 50
Aerial Photo: Metro South Sep.2013
Prepared by J Garvey
Date: 29/07/2014

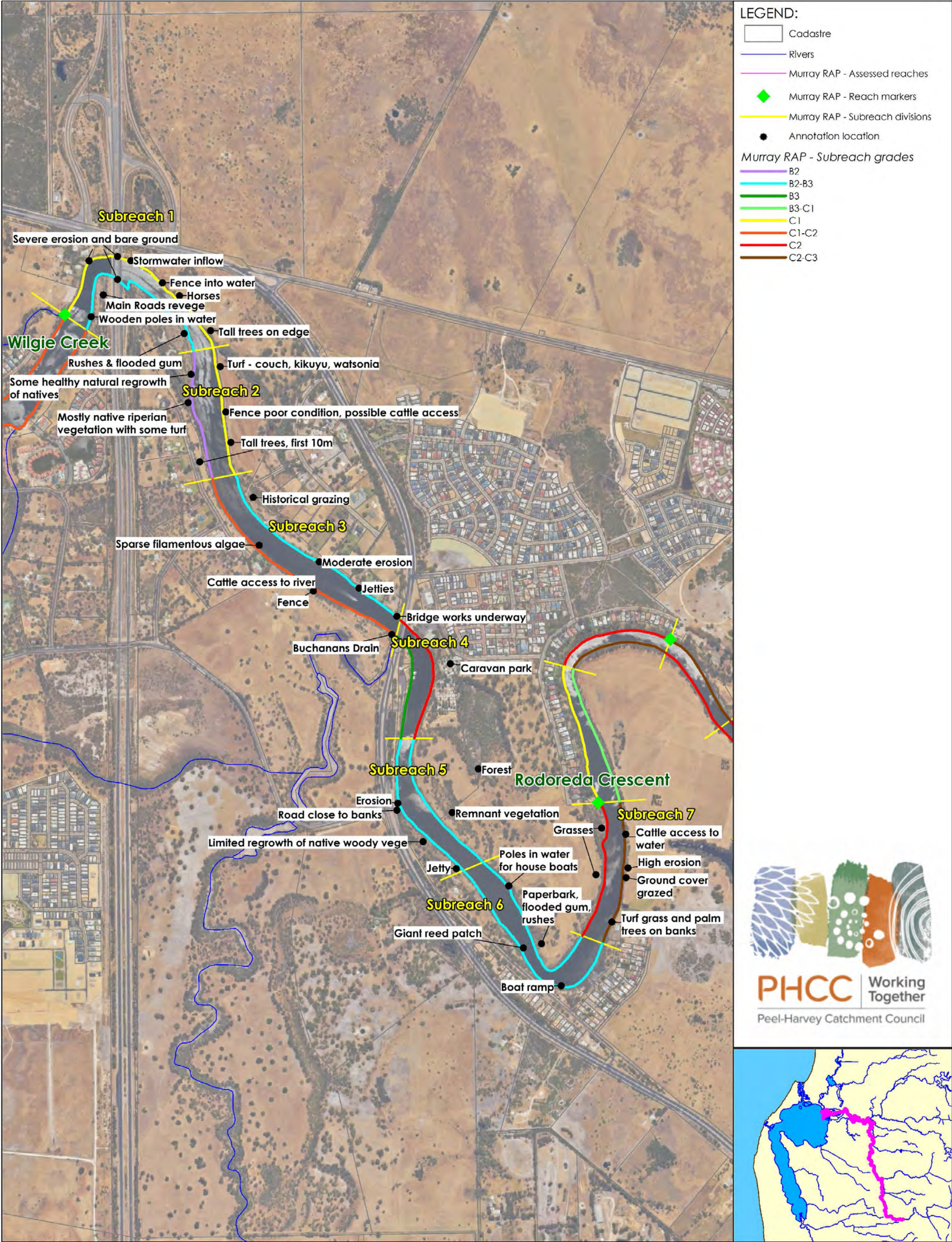
Peel-Harvey Catchment Council
Rivers 2 Ramsar
Connecting River Corridors
for Landscape Resilience



Australian Government

This project is supported by the
Peel-Harvey Catchment Council,
through funding from the
Australian Government

Peel Harvey Catchment Council - Lower and Middle Murray River Action Plan
Figure 18 - Lower Murray Reach 2: Wilgie Creek to Rodoreda Crescent - Current Condition Map.



* ©2022. While Urbaqua has taken care to ensure the accuracy of this product, Urbaqua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbaqua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.

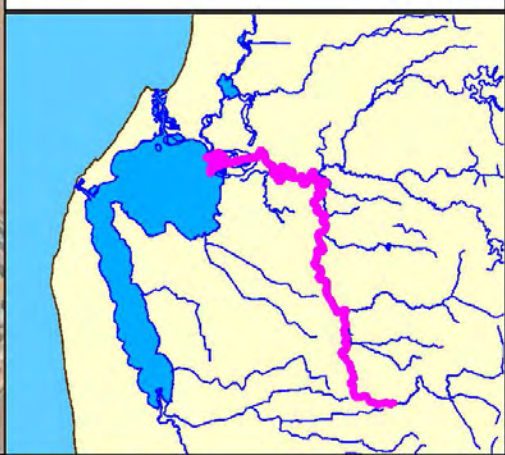


Table 7: Lower Murray Reach 2 Management Actions and Recommendations

Issues

- Single tree line along a lot of this reach; once this disappears there will be no riparian vegetation which will have devastating impacts on native terrestrial and aquatic fauna, water quality and bank stability.
- Livestock access and subsequent bank erosion.
- Weeds.
- Drains contributing to nutrient and sediment loadings.
- Higher recreational use and boating use due to increased urbanisation.

Prioritised management actions recommended

Boats:

- Consider signage or education around the impact of boating and speeding on wildlife.
- Work with Department of Transport to enforce 5 knot limit. Consider results from the "Vessel wake study" occurring from the mouth of the Murray to South Yunderup.
- Possible options include; using mobile markers deployed in the navigation channel that read boat speed, using mobile buoys with a speed sign moved around to key locations to help alert skippers to the speed limits, DoT officers stationed at different locations with speed radar once a week.
- Educational programs targeting boat wash e.g., 'no wash zones'.

Revegetation and weeding:

- Consider planting further significant tree species behind the single tree line to strengthen the riparian zone.
- Implement revegetation programs, as recommended in the *Lower Murray River Foreshore Stabilisation Guidelines* (Shire of Murray, 2019), including the recommended selection species for locations within the bank profile for "Zone 1 and Zone 2".
- Removal of the giant reed patch.

Planning/ Engagement:

- Introduce dog 'poo bag' supply and erect signage along the foreshore to reduce pollution and nutrient loading from uncollected faeces.
- Provide resources and/or guidelines to landholders directly abutting the river. Guidelines that would be useful for land uses and issues relevant to activities within this reach include:
- Boating activities including speed awareness and wake consideration and impact on wildlife
- Identifying what boating and recreational activities can occur on or along the river including maps of slow speed areas or 'no-wash zones'.
- Weeding and appropriate ways to remove weeds.
- Revegetation techniques including appropriate species selection and bank profile location.
- Erosion control measures or effective bank stabilisation options – also refer landholders to existing relevant guidelines including the *Foreshore Stabilisation Guidelines* (Shire of Murray, 2019) and *Best Management Practices for Foreshore Stabilisation: Brushwall* (DBCA, 2020).

Long term management actions recommended

Boats:

- Consider a permanent speed-reading device at a key location on the Murray.
- Consider 'no wash zones' to mitigate the impacts of boat wash on riverbanks and/or install equipment to raise awareness of reducing boat speed.

Erosion and bank stabilisation:

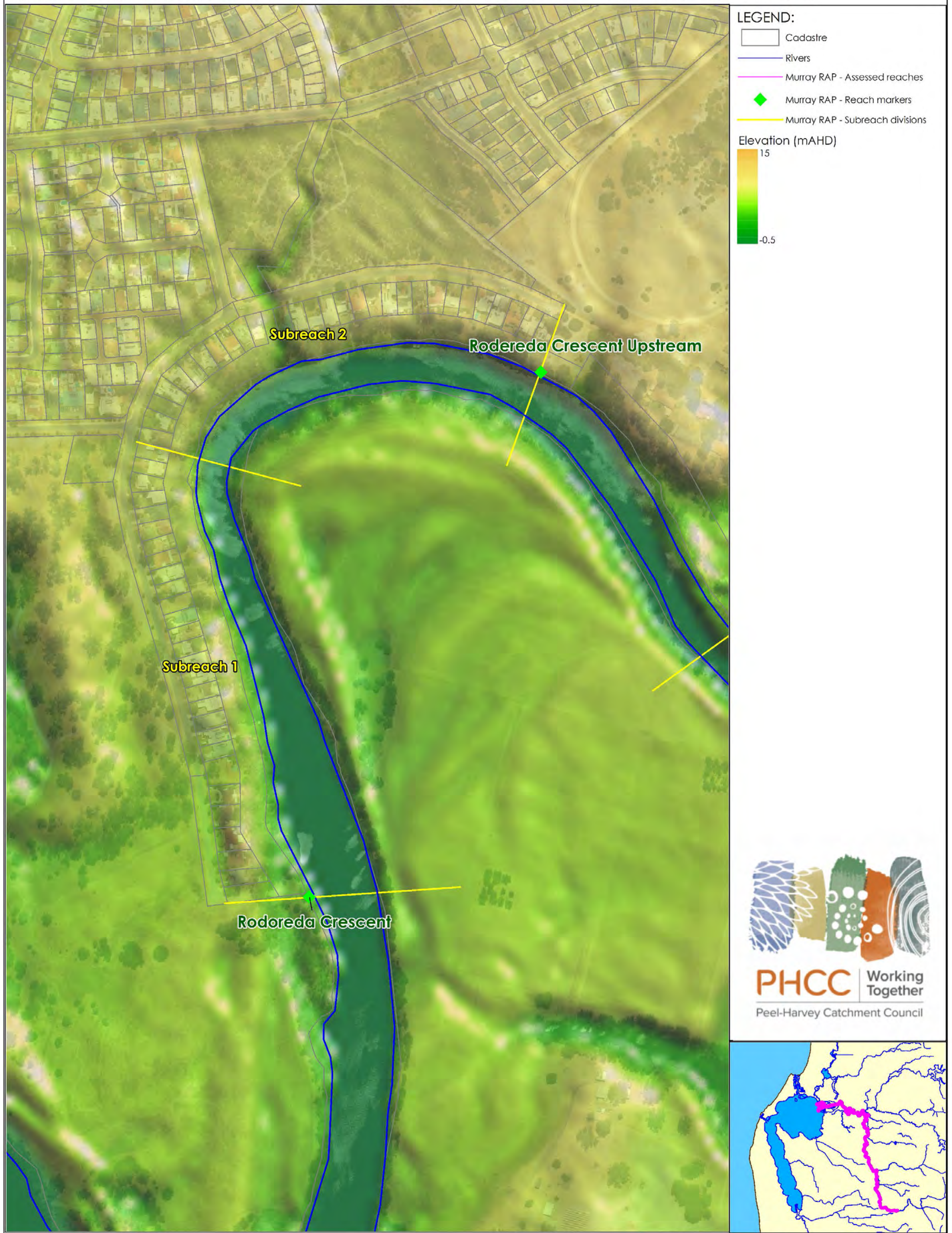
- Prepare a Murray River Erosion Management Plan for Improved management of boating wash and riverbank erosion. Use results from the “Vessel wake study” occurring from the mouth of the Murray to South Yunderup.
- Provide walking paths to direct human traffic and reduce uncontrolled access and damage to fringing vegetation in foreshores.

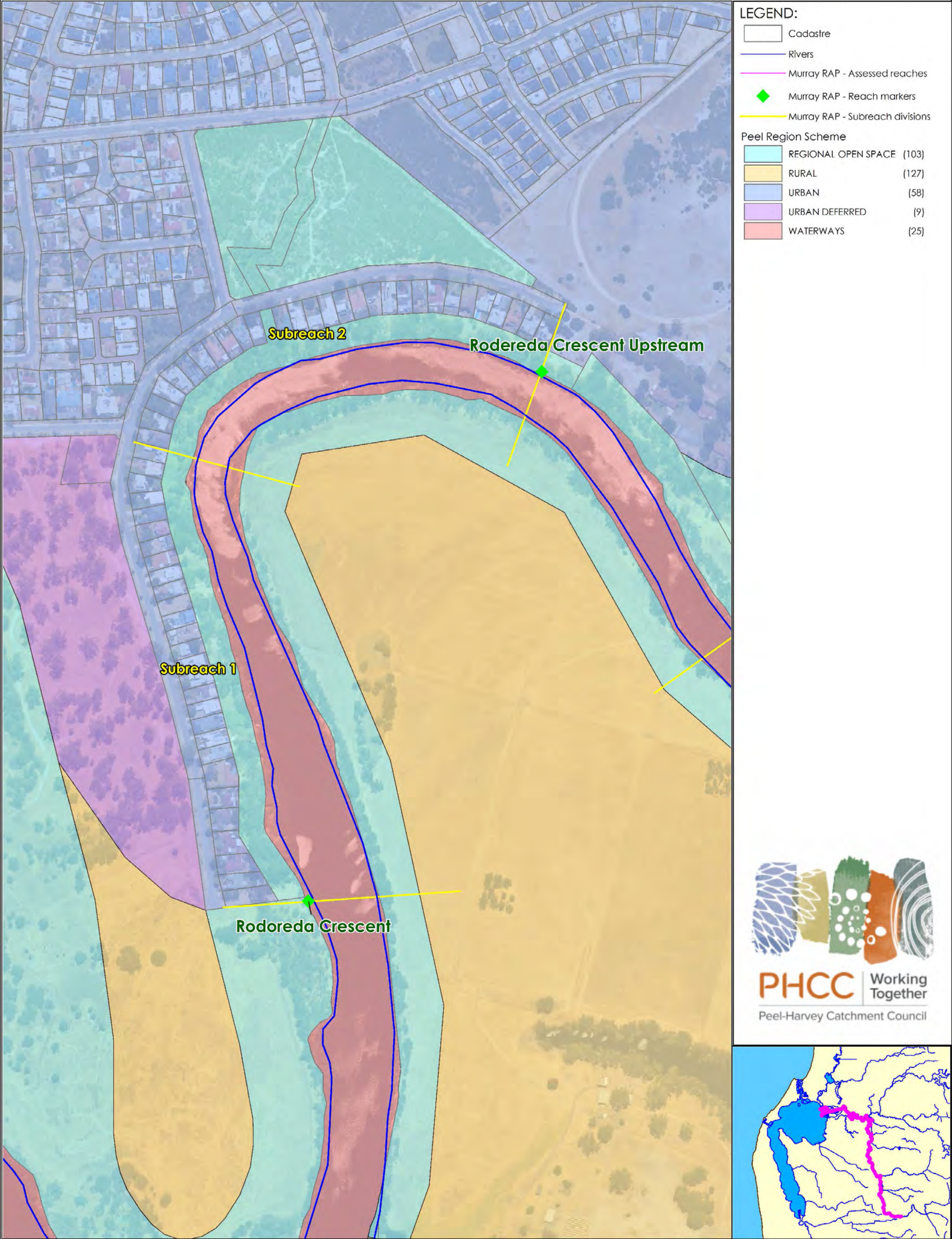
Access:

- Consider introducing pedestrian footpaths to help control access and minimise disturbance to foreshore vegetation and define reserve riparian management areas from grassed recreation areas.
-



* ©2022. While Urbaqua has taken care to ensure the accuracy of this product, Urbaqua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbaqua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
 Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.





* ©2022. While Urbaqua has taken care to ensure the accuracy of this product, Urbaqua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbaqua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.

4.3 Lower Murray Reach 3

Reach 3 is a short reach, only 1 km long (Figure 19). It has been focussed on as it has unique issues related to urban development along the right bank.



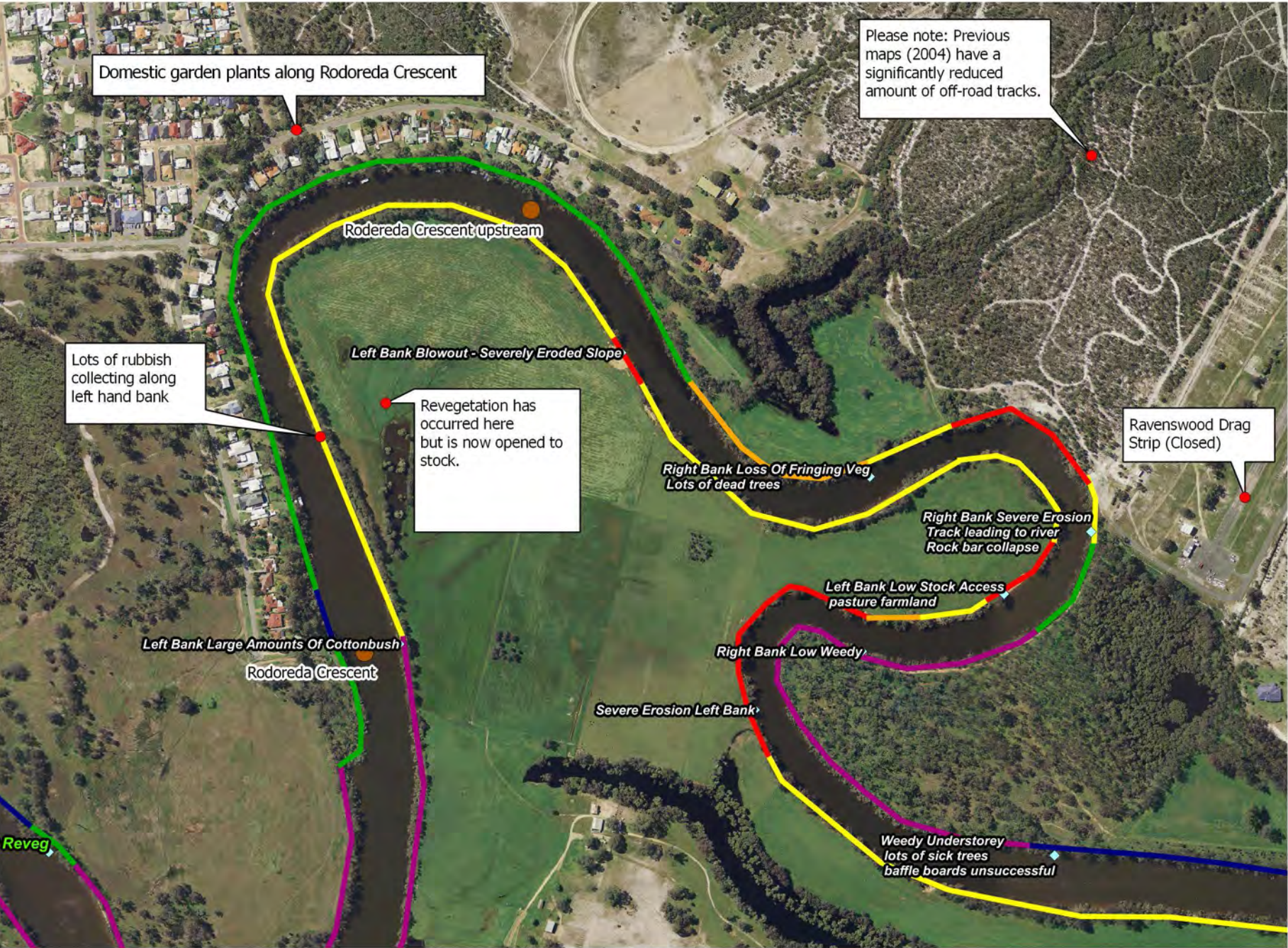
Plate 4: Lower Murray Reach 3 Photos

Table 8: Lower Murray Reach 3 Description and Conditions

Feature	Comments
Land Use	The riparian edge immediately abutting the river edge is zoned regional open space. Urban development adjoins the right bank reserve, which is vested to the Department of Water and Environmental Regulation. The left bank is privately owned rural (grazing) land (Figure 21).
Fencing and Infrastructure	Fencing limited. Private residential jetties are present along the right bank
Channel Form and Soils	The channel consists of a bend in the river. It is a defined channel and has one tributary entering on the right bank (Figure 20). The left bank is Pinjarra P10 soils (identified as gently undulating to flat terraces adjacent to major rivers, but below the general level of the plain, with deep well drained uniform brownish sands or loams subject to periodic flooding). The right bank is Bassendean B2 (identified as flat to very gently undulating sandplain with well to moderately well drained, deep, bleached grey sands with a pale-yellow B horizon or a weak iron-organic hardpan at 1-2 m). There are no sediment depositions noted.
Vegetation Cover and Stream Health	Only one row of native vegetation (mostly flooded gum and melaleucas) protects a large section of the left bank. The understorey on this bank consists of a small amount of native ground cover as it is dominated by remnant ageing trees and there is very little to no natural regeneration. Beyond the fringing vegetation grasses and weeds dominate the landscape, impacted by livestock grazing. The right bank shows a relatively high proportion of turfed areas and exotic trees within the residential gardens, but with some native ground cover and shrubs.
Weeds	Introduced garden plants, including yuccas, palm trees, bridal creeper, olive trees and jack pepper are dominant along the right bank. Oleandra was also observed in this reach. Annual pasture grasses dominate the left bank behind the fringing vegetation.
Erosion	Erosion is evident along most of the lengths of this reach. The left bank shows a high level of bank instability, while the right bank shows a moderate level of instability. Livestock have river access along the left bank. Livestock access has resulted in some hard panning with bare ground extending down to the river. Undercutting is occurring along sections where there is no fringing vegetation. Rock wall protection is frequent along the right bank adjacent to the residential area. Logs and planks are also strapped to the bank in some locations (Figure 23).
Habitat Condition	There are no channels, pools, or riffles within this reach. There is some sparse woody debris, all about the same size (5-9cm diameter). There are leaves and detritus throughout and in sub reach 2 some algae was observed in the water column but not on substrate.
Other Issues	The fence line from pre 2014 rehabilitation has been removed allowing livestock access to the new trees and foreshore. There are numerous private residential jetties allowing human access and boating activities. House boats and other vessels were moored up at jetties.
Water Quality	The dissolved oxygen content of Reach 3 was relatively high (67.5%), likely due to the wave action from boat usage (Figure 89). The electrical conductivity in the Lower Murray Reach 3 was approximately 47.7mS/cm (Figure 90). This EC is lightly lower than Reach 1 and 2 which is expected given it is further from the Estuary, however it is still indicative of saline water (seawater is approximately 50mS/cm).

Feature	Comments
Community and Cultural Values	<p>'Other Heritage Place 3678 – Adam Road Camp – Camp, Water Source' and part of 'Registered Aboriginal Site 3677 – Waugal Cave – Mythological Site', and culturally significant site – "Woggaal's Head" are located within this reach. Local Bindjareb Noongar Elders and Representatives will provide knowledge and advice on each site, its' cultural significance, and values. Please refer to Section 2.3 of this document to ensure all processes and procedures are followed.</p> <p>Landholders within this reach have utilised the left bank for farming and highly value the river not only for its beauty but for its ecosystem services it provides. Recreational activities such as boating, canoeing, kayaking and fishing occur in this reach.</p>

Peel Harvey Catchment Council - Lower and Middle Murray River Action Plan
Figure 22 - Lower Murray Reach 3: Rodoreda Crescent to Rodoreda Crescent Upstream - 2014 Condition Map



Lower Murray River Action Plan
Review 2014
Foreshore Condition Assessment



Legend

- Murray River Reaches Grade
- B2-B3
 - B3-C1
 - C1
 - C1-C2
 - C2
 - C2-C3
 - C3



0 50 100 150 200 m

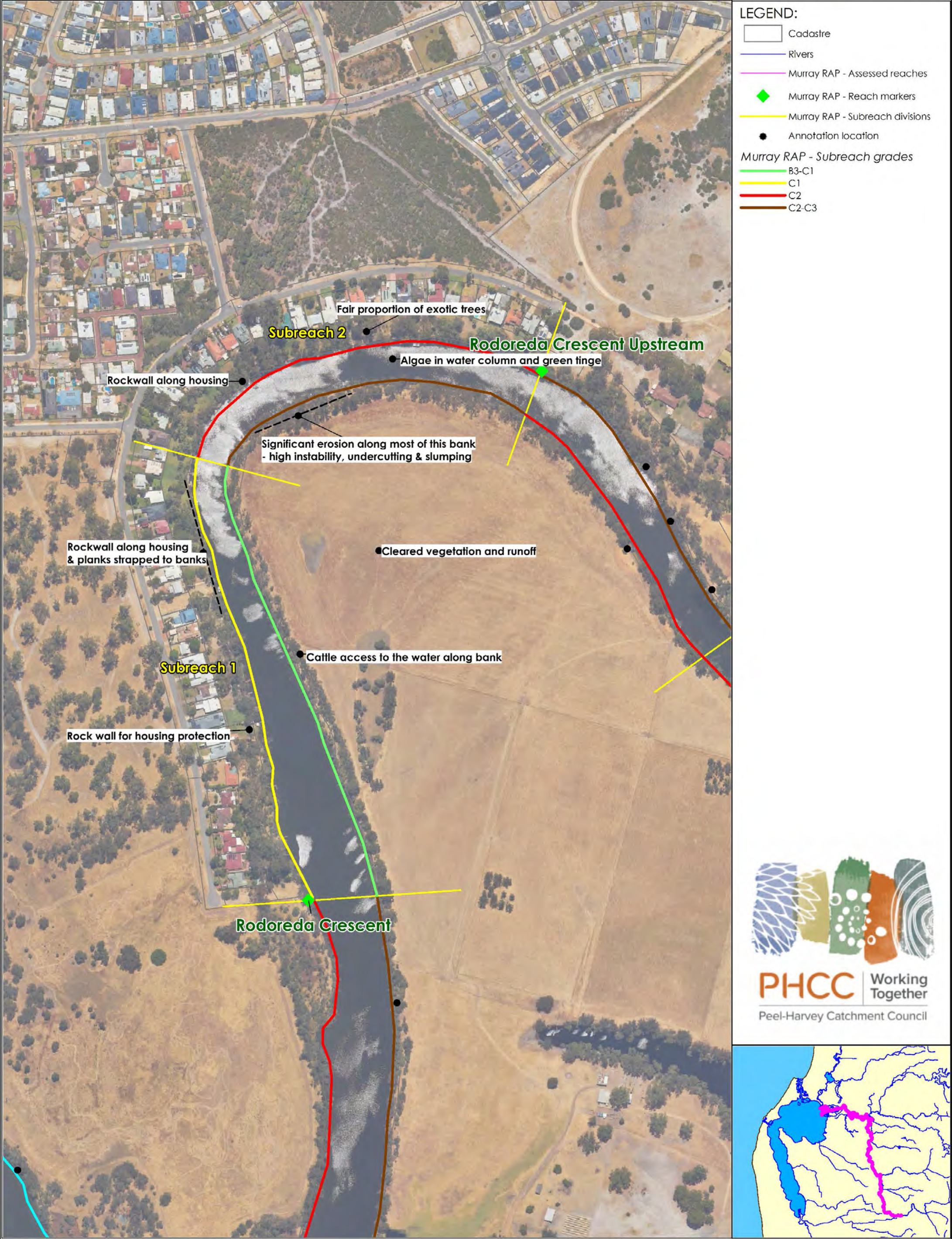
GDA 94 UTM 50
Aerial Photo: Metro South Sep.2013
Prepared by J Garvey
Date: 29/07/2014

Peel-Harvey Catchment Council
Rivers 2 Ramsar
Connecting River Corridors
for Landscape Resilience



Australian Government

This project is supported by the Peel-Harvey Catchment Council, through funding from the Australian Government



*©2022. While Urbaqua has taken care to ensure the accuracy of this product, Urbaqua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbaqua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.

Table 9: Lower Murray Reach 3 Management Actions and Recommendations

Issues

- Residential areas directly adjacent to river resulting in domestic (fertilised) gardens up to the rivers' edge.
- Erosion issues and uncontrolled mitigation actions.
- Unauthorised jetties or other infrastructure.
- Fringing vegetation has little regenerative vegetation and only one tree row thick. Once this disappears there will be no riparian vegetation which will have devastating impacts on native terrestrial and aquatic fauna, water quality and bank stability.

Prioritised management actions recommended

Boats:

- Work with Department of Transport to enforce 5 knot limit.
- Possible options include; using mobile markers deployed in the navigation channel that read boat speed, using mobile buoys with a speed sign moved around to key locations to help alert skippers to the speed limits, DoT officers stationed at different locations with speed radar once a week.

Education:

- Educational programs targeting use of fertilisers near waterways.
- Educational programs and engagement with residents about boat usage/ speed and unauthorised infrastructure like jetties.

Planning/ Engagement:

- Continue to work with the landholders to improve fencing and limit stock access to the river.
- Provide resources to landholders to eradicate weed species and planting of native vegetation to improve bank stability and biodiversity
- Provide resources and/or guidelines to landholders directly abutting the river. Guidelines that would be useful for land uses and issues relevant to activities within this reach include;
 - Fertiliser management and nutrient loadings
 - Identifying what boating and recreational activities can occur on or along the river including maps of slow speed areas or 'no-wash zones'.
 - Weeding and appropriate ways to remove weeds.
 - Erosion control measures or effective bank stabilisation options – also refer landholders to existing relevant guidelines including the *Foreshore Stabilisation Guidelines* (Shire of Murray, 2019) and *Best Management Practices for Foreshore Stabilisation: Brushwall* (DBCA, 2020). Planning approval requirements for jetties, pagodas etc.
- Direct landowners and residents to existing guidance on;
 - Planning approval requirements for jetties, pagodas etc (SoM website).

Long term management actions recommended

Consultation:

- Any new guidelines should be distributed to residents as part of a community workshop program to make them aware of the guidance available.

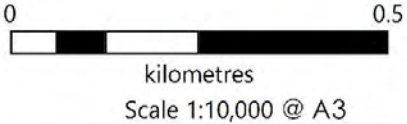
Revegetation:

- Consider planting further significant tree species behind the single tree line to strengthen the riparian zone.

Peel Harvey Catchment Council - Lower and Middle Murray River Action Plan
Figure 24 - Lower Murray Reach 4: Rodoreda Crescent to Dandalup River Confluence - Location Map



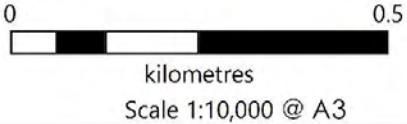
* ©2022. While Urbagua has taken care to ensure the accuracy of this product, Urbagua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbagua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.

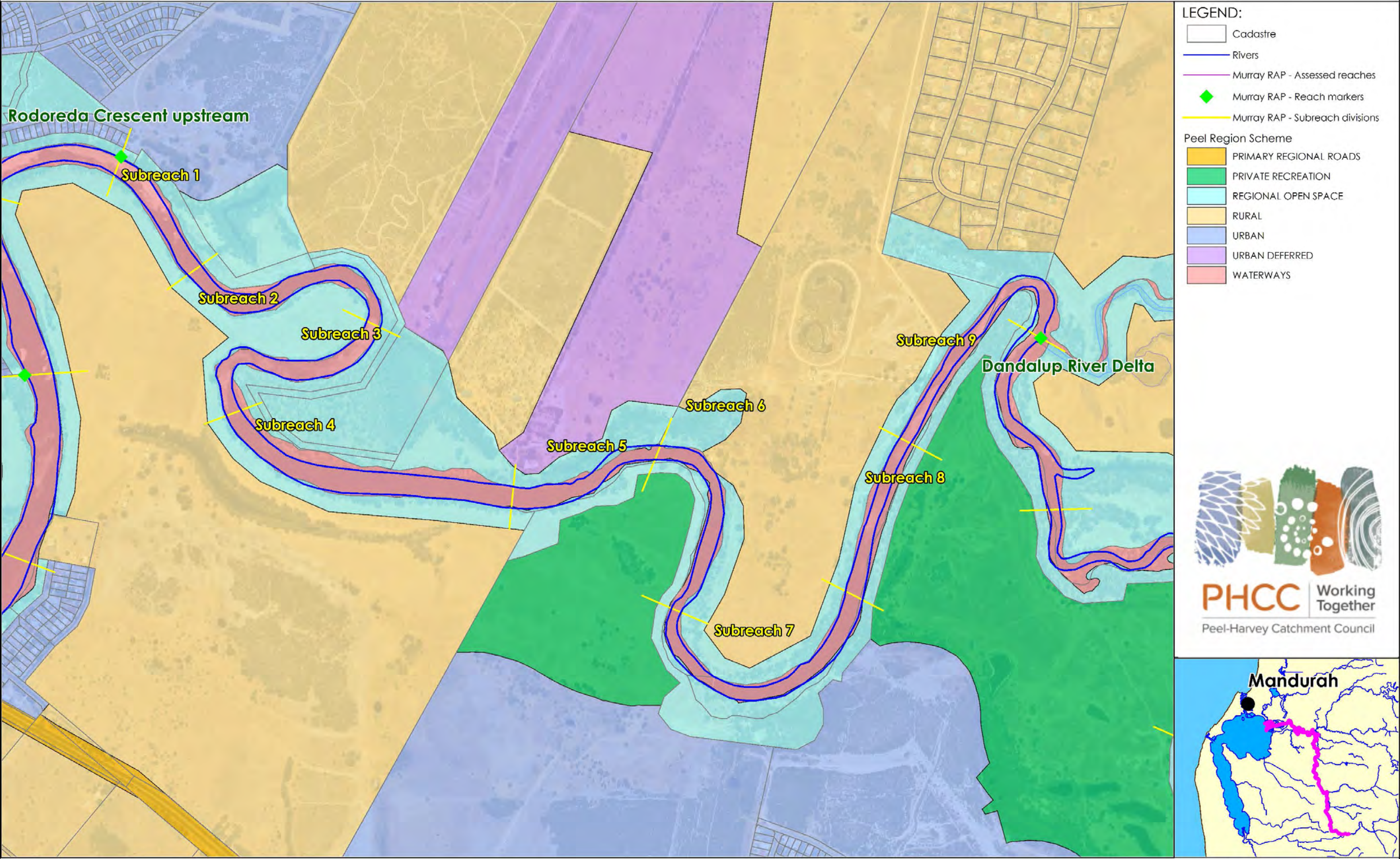


Peel Harvey Catchment Council - Lower and Middle Murray River Action Plan
Figure 25 - Lower Murray Reach 4: Rodoreda Crescent to Dandalup River Confluence - Elevation Map

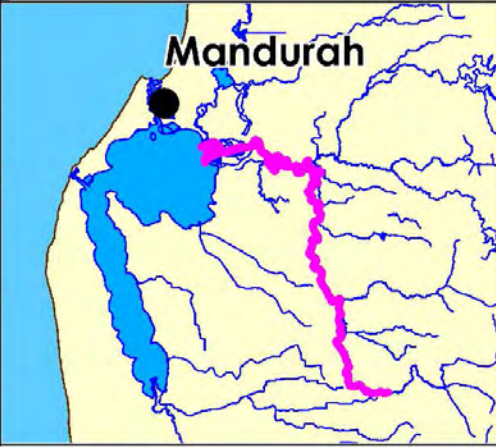
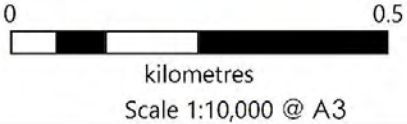


* ©2022. While Urbagua has taken care to ensure the accuracy of this product, Urbagua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbagua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.





* ©2022. While Urbagua has taken care to ensure the accuracy of this product, Urbagua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbagua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.



4.4 Lower Murray Reach 4

This reach is approximately 5.8 km long and includes Crown Land vested with the Shire of Murray (Figure 24). The remaining land is in private ownership.



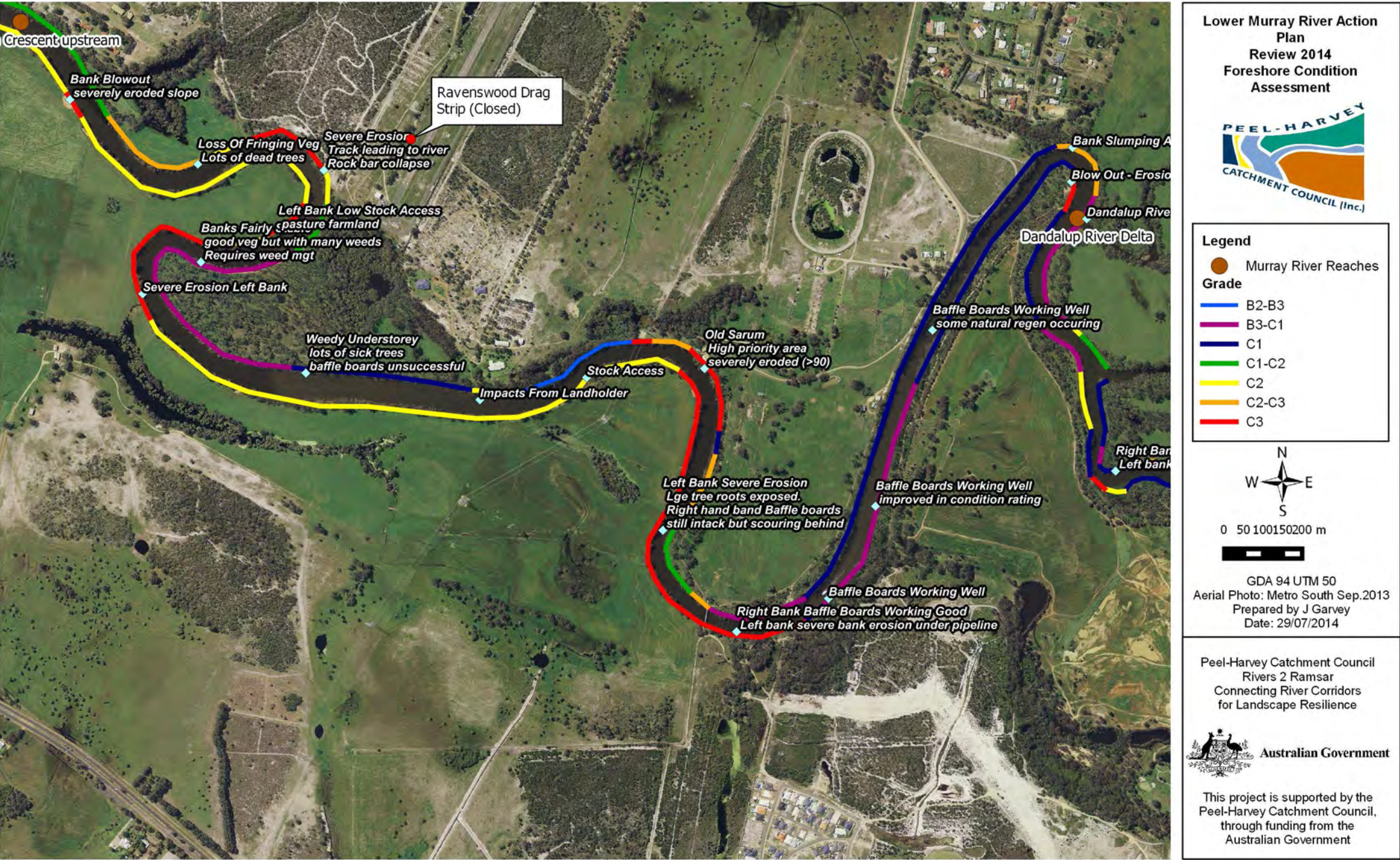
Plate 5: Lower Murray Reach 4 Photos

Table 10: Lower Murray Reach 4 Description and Conditions

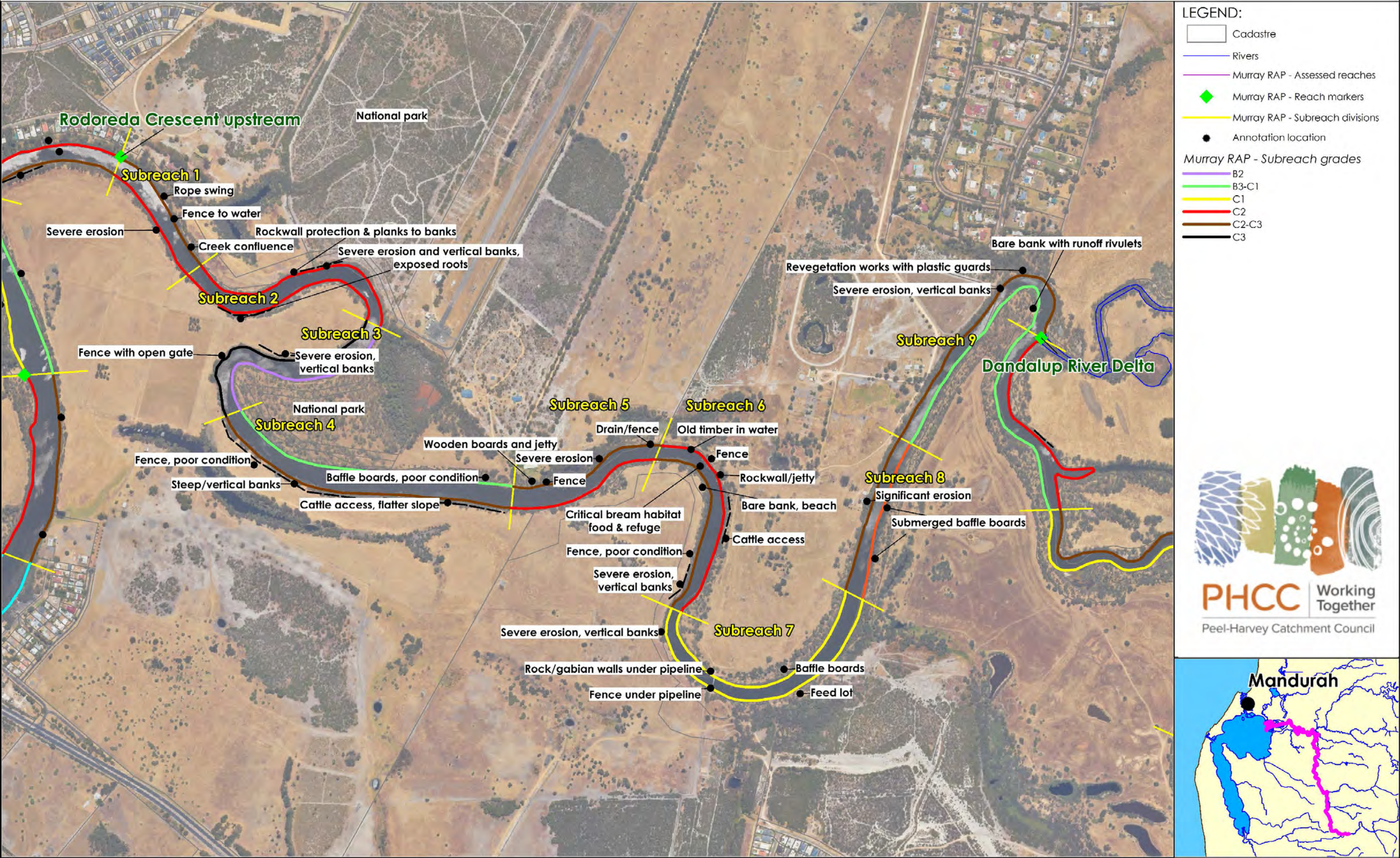
Feature	Comments
Land Use	<p>The foreshore reserve along this length is within regional open space. Sections of the right bank in front of lot 22, 52 and 41 and a section of the left bank abutting lot 331 are vested with the Shire of Murray.</p> <p>Land adjoining the foreshore reserves and the river is predominantly grazed rural land. A (DLI) C class reserve 45616 (George Brook reserve) abuts an urban deferred subdivision and is managed by the Shire of Murray.</p> <p>The southern bank of the upper reaches are zoned either Urban or Private Recreation (Figure 26).</p>
Fencing and Infrastructure	<p>There is some sporadic fencing in places along the reach, however often in poor condition and in isolated positions (Figure 28).</p> <p>Gabion walls have been installed beneath the pipeline in sub reach 7 to stabilise the banks (Plate 5).</p>
Channel Form and Soils	<p>The main channel is well defined however is surrounded by lower lying areas and wetland/ swamp areas. The main channel width is approximately 60m across (Figure 25).</p> <p>Both the left and right banks are predominantly Pinjarra P10 soils (gently undulating to flat terraces adjacent to major rivers, but below the general level of the plain, with deep well drained uniform brownish sands or loams subject to periodic flooding).</p> <p>There are some large sections of Pinjarra P6a on the left bank (identified as very gently undulating alluvial terraces and low rises contiguous with the plain, with deep moderately well to well drained soils associated with major current river systems and larger streams. Acidic red and yellow duplex soils), and some small pockets of Pinjarra P7 (identified as seasonally inundated swamps and depressions with very poorly drained variable acidic mottled yellow and grey sandy duplex and effective duplex soils.).</p> <p>There is a small area of Bassendean B4 on the right bank in sub reach 9 (identified as a broad poorly drained sandplain with deep grey siliceous sands or bleached sands, underlain at depths generally greater than 1.5 m by clay or less frequently a strong iron-organic hardpan).</p>
Vegetation Cover and Stream Health	<p>The groundcover layer and shrub layers had reduced coverage in a lot of the reach. Where ground cover was noted, it was mostly weedy grasses. Paperbarks (<i>Melaleuca raphiophylla</i>), flooded gums (<i>Eucalyptus rudis</i>) were observed the full length of the reach with some rushes as well. The river's edge (foreshore) had mature trees along a lot of the extent of the reach.</p> <p>Beyond the riparian foreshore, livestock grazing has degraded a lot of the vegetation in the rural areas. Most grazed areas retain one or two rows of upper storey species only. If present, vegetation beyond the foreshore is mostly weeds/ grasses/ crops. Some remnant vegetation was noted, and mostly on the right bank.</p>
Weeds	<p>Exotic weeds such as bridal creeper, fleabane, oleandra, oxalis, watsonia, kikuyu, couch grass, dock, veldt grass, olive trees, palm trees, and agave are scattered along both banks of the river.</p> <p>The level of infestation in 2014 was noted as low but with the potential to increase rapidly. Currently it was noted that exotic ground cover (grasses etc) in particular, was starting to increase in proportion to the overall groundcover, more specifically in the upper sub reaches.</p>
Erosion	<p>Severe erosion with vertical banks and exposed tree roots were observed at several places along the reaches, particularly sub reaches 1 – 6 and 9. Almost the entire of the left bank in the lower reaches is affected by some erosion (moderate to severe), this decreases to approximately half of the left bank in the upper reaches. Erosion impacts the right bank to a lesser extent, except for sub reach 8 which experiences severe erosion. Slumping with rivulets caused by runoff is prevalent on the left bank opposite the Dandalup River confluence and associated wet areas (Plate 5).</p>

Feature	Comments
	Baffle boards have been used in various locations to varying degrees of success. Rock walls and planks strapped to banks have been used in some locations (Figure 28).
Habitat Condition	<p>There is generally sparse to moderate abundance of woody debris, quite small in size and without a large variation in sizing. There are leaves and detritus present but little biological substrate cover. There is little abundance of roots or vegetation draped in the water. <i>Juncus kraussii</i> observed in the water edge at various places.</p> <p>This reach has well some well vegetated fringing reserves abutting the river, acting as a corridor for terrestrial animals.</p>
Other Issues	<p>In the 2014 RAP it was noted that within Private Lot 52 there was some sever degradation due to vehicular impact since 2003, observed from aerial photos (Figure 27). Since the 2014 aerials, it appears that further degradation has occurred due to vehicles. Further investigation warranted.</p> <p>Some weed control (hand weeding of watsonia) has been undertaken since the 2014 RAP within sub reach 9 (the ROS) (Figure 29).</p>
Community and Cultural Values	<p>'Registered Aboriginal Site 3680 – Waugal Swamp – Mythological Site' is located within this reach. Local Bindjareb Noongar Elders and Representatives will provide knowledge and advice on each site, its' cultural significance, and values. Please refer to Section 2.3 of this document to ensure all processes and procedures are followed.</p> <p>Landholders within this reach have utilised majority of the reach for farming and highly value the river not only for its' beauty but for the ecosystem services it provides. Recreational activities mainly comprising of boating, canoeing, kayaking, and fishing occur throughout this reach. The community highly value George Brook Reserve (managed by the Shire of Murray) situated in sub-reach 9. This is a place that allows residents to admire the river, have a picnic and take a walk through the reserve.</p>

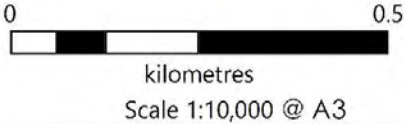
Peel Harvey Catchment Council - Lower and Middle Murray River Action Plan
Figure 27 - Lower Murray Reach 4: Rodoreda Crescent Upstream to Dandalup River Confluence - 2014 Condition Map



Peel Harvey Catchment Council - Lower and Middle Murray River Action Plan
Figure 28 - Lower Murray Reach 4: Rodoreda Crescent to Dandalup River Confluence - Current Condition Map.



* ©2022. While Urbaqua has taken care to ensure the accuracy of this product, Urbaqua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbaqua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.





* ©2022. While Urbagua has taken care to ensure the accuracy of this product, Urbagua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbagua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.

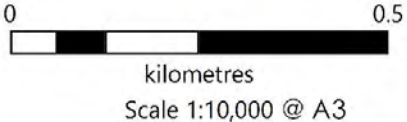


Table 11: Lower Murray Reach 4 Management Actions and Recommendations

Issues

- Severe vertical banks
- Fringing vegetation only one row thick and consists of mature trees and little regenerative vegetative.

Prioritised management actions recommended

Erosion and bank stability

- Replace ineffective erosion control structures (e.g., baffle boards, pine revetment) with soft (matting, logs, and woody debris) or hard (rock-pitching) engineering bank protection.
- Provide residents with advice and resources to define/control access points to the river.
- Remove tree swing to discourage recreational use of this reach.

Water quality:

- Bulk litter and informal recreation facilities (fire pits, tree swings) along these reaches should be removed to ensure no leaching of chemicals (e.g., petrochemicals) into the river and discourage use.
- Continue monitoring salinity up into LM Reach 4 and beyond so the extent and duration of saltwater ingress in the Murray can be compared in future RAPs to be better understood. This could provide information on the potential impact of sea level rise/ climate change, or changes in land use in the catchment. Impacts of saltwater ingress include; changes in fauna communities (emergence of marine fish and crabs further up the river), changes in aquatic vegetation and ecosystems, impact on fringing tree species, and potential impact on groundwater supplies.

Revegetation:

- Assist regeneration of native vegetation through seedlings, seed matts etc. Consider advice from the South Dandalup River Action Plan (PHCC, 2008).
- Continue to undertake revegetation and weed control programs particularly within George Brook Reserve.

Planning/ Engagement:

- Continue to work with the landholders to improve fencing and limit stock access to the river
- Provide resources and/or preparation of guidelines aimed at residents and landholders directly abutting the river. Guidelines that would be useful for land uses and issues relevant to activities within this reach include;
 - Identifying what boating and recreational activities can occur on or along the river including maps of slow speed areas or 'no-wash zones'.
 - Fencing for livestock to alleviate erosion and pugging
 - Boating activities including speed and wake consideration and impact on wildlife
 - Weeding and appropriate ways to remove weeds. Consider weeding advice from the South Dandalup River Action Plan (PHCC, 2008).
 - Revegetation including appropriate species selection and bank profile location.
 - Erosion control measures or walls – refer to the Foreshore Stabilisation Guidelines (Shire of Murray, 2019) particularly for stabilisation options.
 - BMP guidelines for more specialised and specific erosion and stabilisation techniques e.g., Best Management Practice for Foreshore Stabilisation: Brushwall (DBCA, 2020).
- Direct landowners and residents to existing guidance on;
 - Livestock management (SoM website).

Long term management actions recommended

Erosion and bank stabilisation:

- Baffle boards have been installed at various places along this reach, along both banks. There has been success at some of the sites, and not at others. It appears that the positions in the river and waterflow have some influence on the success or failure of this kind of bank stabilisation. Further investigation into when and where baffle boards and/or other mechanisms should be used is recommended. This could be aimed at helping landowners pick the most appropriate mechanism to combat erosion.

Protection and revegetation:

- Preserve all patches of remnant vegetation and wetlands abutting the river, specifically on the right bank and the 'dolphin shaped' wetland on the left bank.
 - Work with landholders to create good quality habitat corridors for wildlife between patches of fragmented bushland.
 - Work with landholders to restore areas of cleared land through revegetation programs.
-

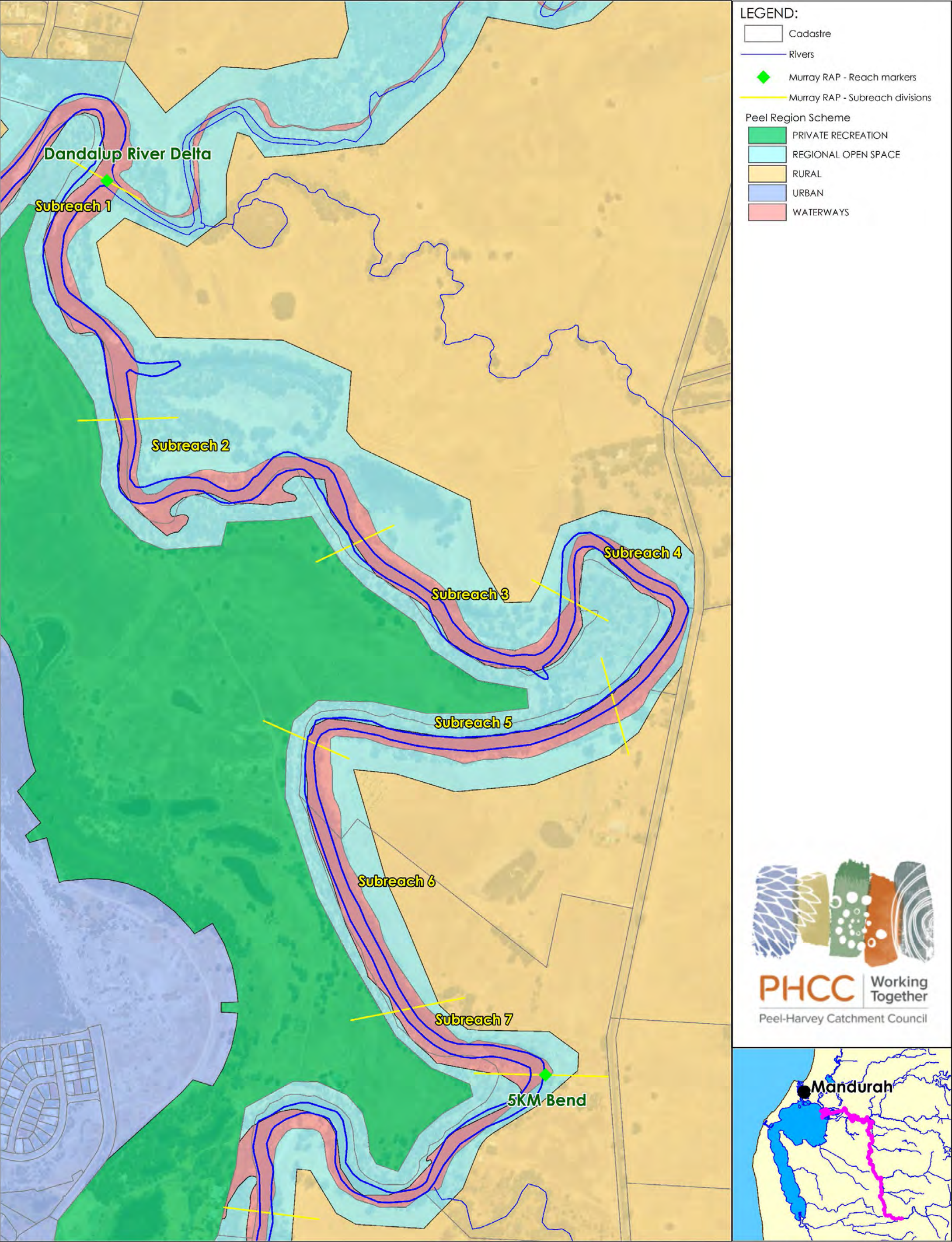


* ©2022. While Urbaqua has taken care to ensure the accuracy of this product, Urbaqua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbaqua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.

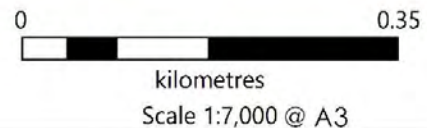


* ©2022. While Urbaqua has taken care to ensure the accuracy of this product, Urbaqua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbaqua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.

Peel Harvey Catchment Council - Lower and Middle Murray River Action Plan
Figure 32 - Lower Murray Reach 5: Dandalup River Delta to 5 Km Bend - Landuse Map (PRS)



* ©2022. While Urbaqua has taken care to ensure the accuracy of this product, Urbaqua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbaqua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.



4.5 Lower Murray Reach 5

This reach is approximately 4.4 km long and includes a backwater, and numerous meanders and bends (Figure 30). There are low lying areas on both banks.



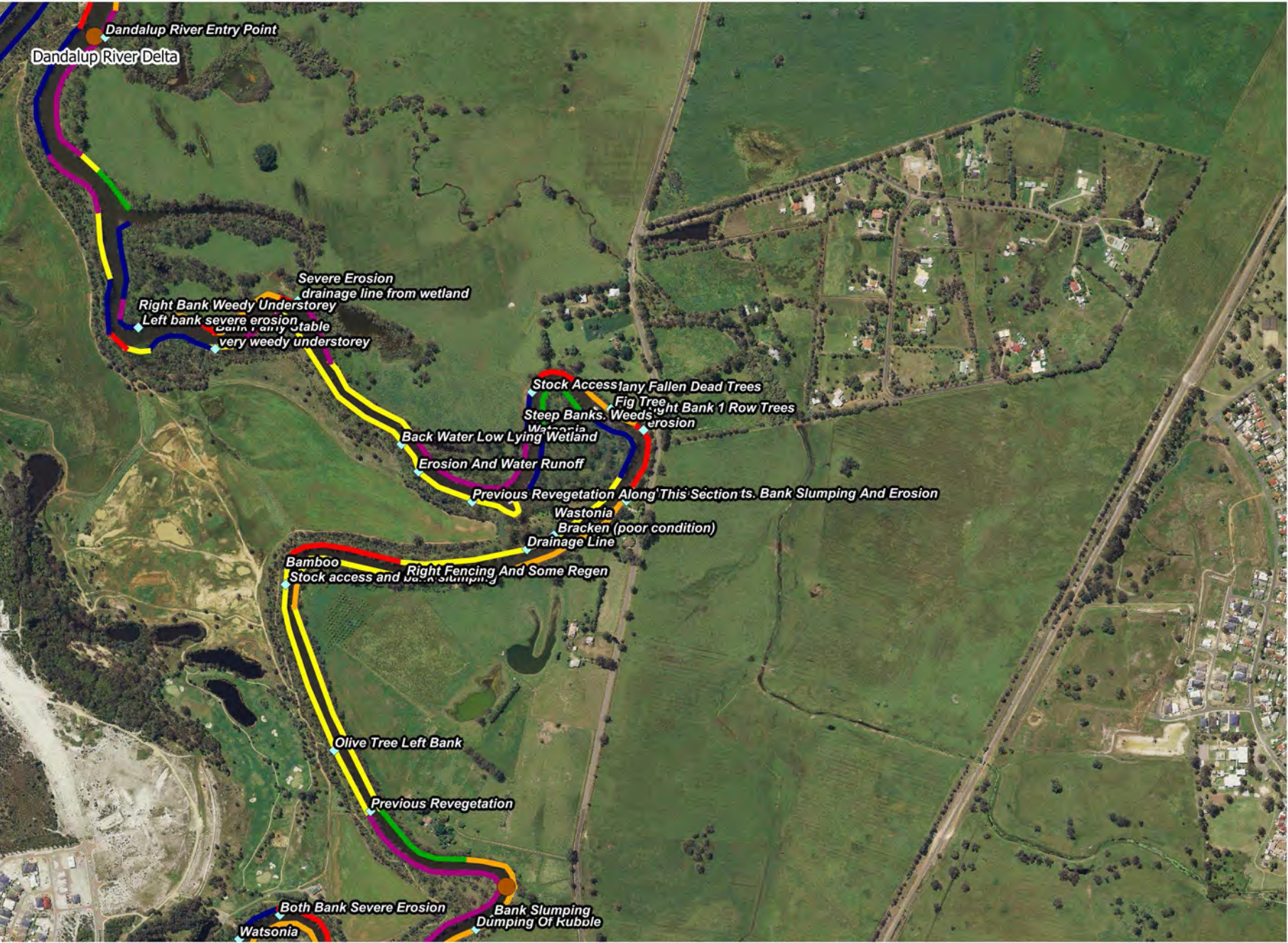
Plate 6: Lower Murray Reach 5 Photos

Table 12: Lower Murray Reach 5 Description and Conditions

Feature	Comments
Land Use	<p>The right bank is privately owned rural land used for livestock grazing. A small citrus orchard exists on the right bank.</p> <p>The left bank is Private Recreation and is vested with the Shire of Murray as part of the Ravenswood Sanctuary Development (now called 'Murray River Country Estate').</p>
Fencing and Infrastructure	<p>Limited fencing on the right bank, except for some average fencing in sub reach 7.</p> <p>There is no fencing along the left bank, except for a perpendicular fence in sub reach 5. The 2014 RAP noted that fencing was present along most of the left bank extent.</p> <p>No other infrastructure of note was identified.</p>
Channel Form and Soils	<p>This reach includes a backwater, and numerous meanders and bends. There is uniform flow and is approximately 40-50m in width. There are low lying areas on both banks (Figure 31). Riverbed to top of bank varies from 2-3m on each bank.</p> <p>The left and right banks are predominantly Pinjarra P10 (identified as gently undulating to flat terraces adjacent to major rivers, but below the general level of the plain, with deep well drained uniform brownish sands or loams subject to periodic flooding) and P6a (identified as very gently undulating alluvial terraces and low rises contiguous with the plain, with deep moderately well to well drained soils associated with major current river systems and larger streams. Acidic red and yellow duplex soils). The right bank has two small sections of Pinjarra P3 (identified as flat to very gently undulating plain with deep, imperfect to poorly drained acidic gradational yellow or grey-brown earths and mottled yellow duplex soils, with loam to clay loam surface horizons).</p>
Vegetation Cover and Stream Health	<p>Livestock grazing has degraded this area. The groundcover layer and shrub layers have reduced coverage in a lot of the reach. Where ground cover was noted, it was mostly weedy grasses with some native bracken fern. Paperbarks (<i>Melaleuca raphiophylla</i>), flooded gums (<i>Eucalyptus rudis</i>) were observed the full length of the reach. The river's edge (foreshore) had mature trees along a lot of the extent of the reach within the exception of the fully bare banks due to livestock access.</p> <p>There was limited to moderate regrowth of native woody vegetation noted in the foreshore riparian zone.</p> <p>Beyond the riparian foreshore, livestock grazing has degraded a lot of the vegetation in the rural areas (right bank). Most grazed areas retain one or two rows of upper storey species only. If present, vegetation beyond the foreshore is mostly weeds/ grasses/ crops. The left bank was also mostly cleared beyond the foreshore, and if present, in the form of weeds/ grasses/ crops.</p>
Weeds	<p>Oxalis, couch grass, kikuyu, watsonia were noted along the entire reach. In addition, in the upper reaches there were also bridal creeper, olive trees, fig trees, veldt grass, flame tree and giant reeds in places.</p>
Erosion	<p>Both the right and left bank is undercut for a lot of the reach and affected by slumping in places.</p> <p>Extensive livestock access has resulted in a loss of vegetation and isolated area of bank damage on the right bank (livestock were predominantly cattle, but horses and sheep were also present in places).</p> <p>No erosion or stabilisation works have been undertaken within this reach.</p>
Habitat	<p>There is mostly a moderate amount of woody debris with pieces of similar size. There is detritus and leaves but little to no biological substrate cover. The water colour was light green throughout this reach and a small amount of algae was noted in the water column at the time of the site visit.</p>

Feature	Comments
	A backwater exists to the south of the Dandalup River confluence, and a connected wetland occurs in this reach (Figure 34). These areas provide important off stream spawning areas for native fish and a refuge to aquatic and terrestrial organisms in summer. An island exists in the middle of the reach and has the potential to be an important refuge for terrestrial animals.
Other Issues	The left bank, associated with the Country Estate, was successfully revegetated with an improvement in condition between the 2003 and 2014 RAPs.
Community and Cultural Values	<p>'Registered Aboriginal Site 3681 – Waugal – Ceremonial, Mythological Site' is located within this reach. Local Bindjareb Noongar Elders and Representatives will provide knowledge and advice on each site, its' cultural significance, and values. Please refer to Section 2.3 of this document to ensure all processes and procedures are followed.</p> <p>Landholders within this reach have utilised majority of the reach for farming and highly value the river not only for its' beauty but for the ecosystem services it provides. Recreational activities mainly comprising of boating, canoeing, kayaking and fishing occur throughout this reach.</p>

Peel Harvey Catchment Council - Lower and Middle Murray River Action Plan
Figure 33 - Lower Murray Reach 5: Dandalup River Delta to 5 km Bend - 2014 Condition Map



Lower Murray River Action Plan
Review 2014
Foreshore Condition Assessment



Legend

- Murray River Reaches Grade
- B2-B3
 - B3-C1
 - C1
 - C1-C2
 - C2
 - C2-C3
 - C3



0 50 100 150 200 m



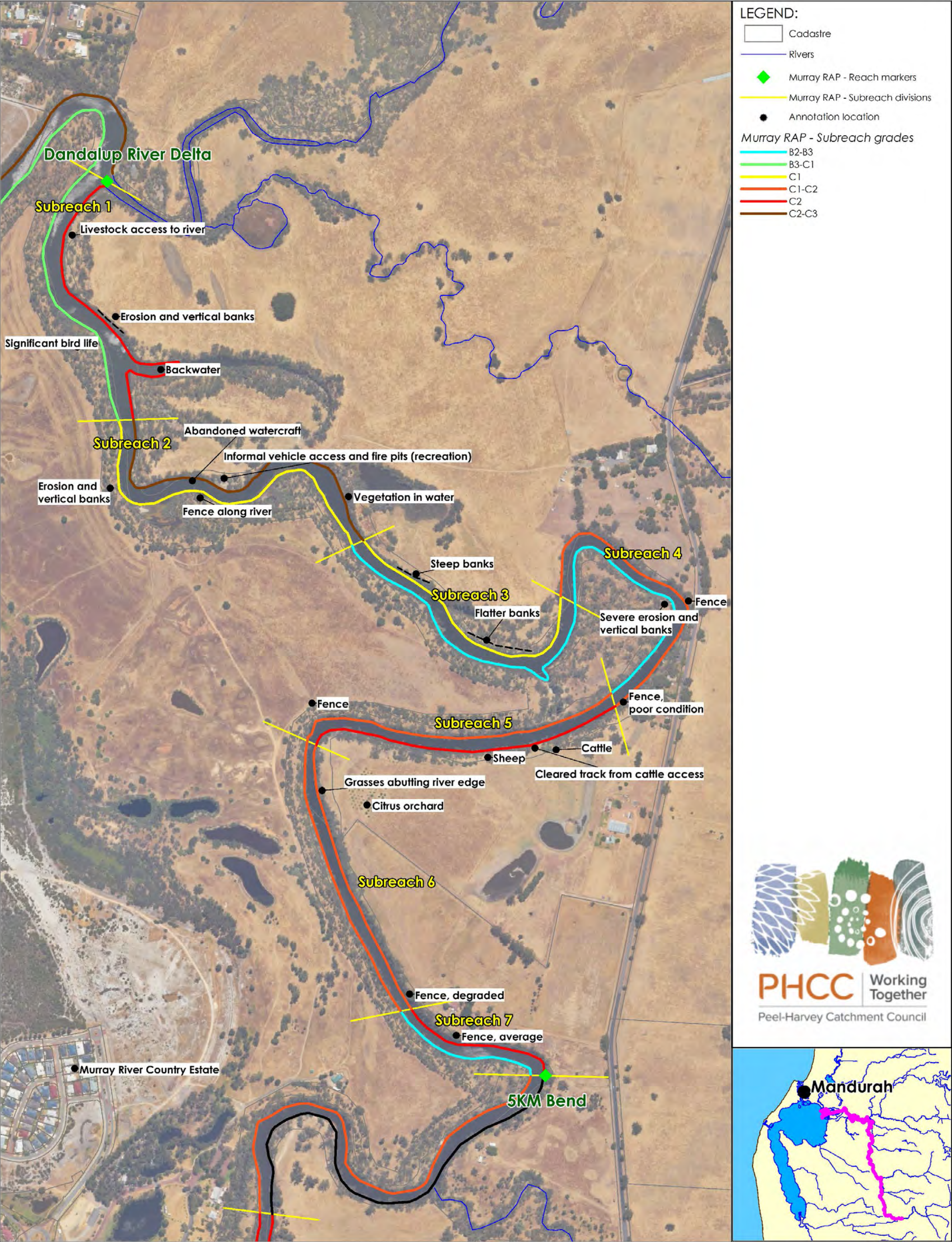
GDA 94 UTM 50
Aerial Photo: Metro South Sep.2013
Prepared by J Garvey
Date: 29/07/2014

Peel-Harvey Catchment Council
Rivers 2 Ramsar
Connecting River Corridors
for Landscape Resilience



Australian Government

This project is supported by the
Peel-Harvey Catchment Council,
through funding from the
Australian Government



* ©2022. While Urbaqua has taken care to ensure the accuracy of this product, Urbaqua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbaqua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.

Table 13: Lower Murray Reach 5 Management Actions and Recommendations

Issues

- Steep vertical edged banks with slumping
- Large woody debris is an integral and natural part of river systems, fulfilling an important role in river ecology. In the past, removal of large woody debris from the water has occurred in instances where they may be diverting water flow onto the bank and subsequently causing erosion in vulnerable areas. Preferred management practice has shifted to leaving the greatest amount of large woody debris possible in situ, to provide habitat for aquatic flora and fauna.
- Loss of fringing vegetation due to livestock access.
- Weed encroachment.

Prioritised management actions recommended

Livestock access:

- Manage livestock access to the river through fencing and controlled livestock access sites or offsite water options.

Revegetation and weeding:

- Preserve all patches of remnant vegetation and wetlands abutting the river, particularly the area of remnant vegetation within sub-reach 4 (left bank).
- Protection and rehabilitation of native riparian vegetation (further information can be found in the South Dandalup River Action Plan (PHCC, 2008)) through these mechanisms:
 - Direct seeding
 - Planting of seedlings
 - Pre-seeded matting
 - Transplanting
- Work with landholders with regards to appropriate weed management – different species have different weeding techniques. See Planning below.
- Work with landowners to fence off and revegetate drains and tributaries discharging into the river which will also improve water quality runoff.

Water quality:

- Bulk litter and informal recreation facilities (fire pits, tree swings) along these reaches should be removed to ensure no leaching of petrochemicals into the river and discourage use.

Land care:

- Education on the management of large woody debris to protect habitats and mitigate erosion potential. Focus on effective ways of removing debris if required.

Planning/ Engagement:

- Provide resources and/or preparation of guidelines aimed at residents and landholders directly abutting the river. Guidelines that would be useful for land uses and issues relevant to activities within this reach include;
 - Fertiliser management and nutrient loadings
 - Fencing for livestock to alleviate erosion and pugging
 - Weeding and appropriate ways to remove weeds depending on the weed type (further information can be found in the South Dandalup River Action Plan (PHCC, 2008)).

- Revegetation including appropriate species selection and bank profile location.
- Erosion control measures or effective bank stabilisation options – also refer landholders to existing relevant guidelines including the *Foreshore Stabilisation Guidelines* (Shire of Murray, 2019) and *Best Management Practices for Foreshore Stabilisation: Brushwall* (DBCA, 2020).

Long term management actions recommended

Protection and Revegetation:

- Work with landholders to create good quality habitat corridors for wildlife between patches of cleared land and the wetlands/ Dandalup River.
- Preserve all patches of remnant vegetation and wetlands abutting the river, particularly the area of remnant vegetation within sub-reach 4 (left bank).
- Work with landholders to create good quality habitat corridors for wildlife between patches of cleared land and wetlands/Dandalup River.

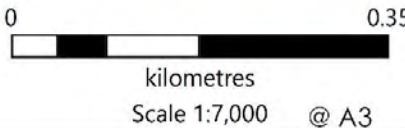
Boats:

- Work with Department of Transport to enforce a 5-knot speed limit in this reach;
 - Introduce additional boat signage to create awareness of impacts to foreshore
 - Consider mobile speed device placement.
-

Peel Harvey Catchment Council - Lower and Middle Murray River Action Plan
Figure 35 - Lower Murray Reach 6: 5km Bend to Pinjarra Bridge Weir - Location Map



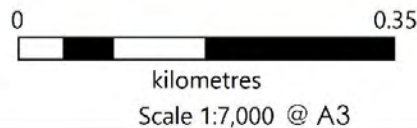
*©2022. While Urbaqua has taken care to ensure the accuracy of this product, Urbaqua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbaqua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.



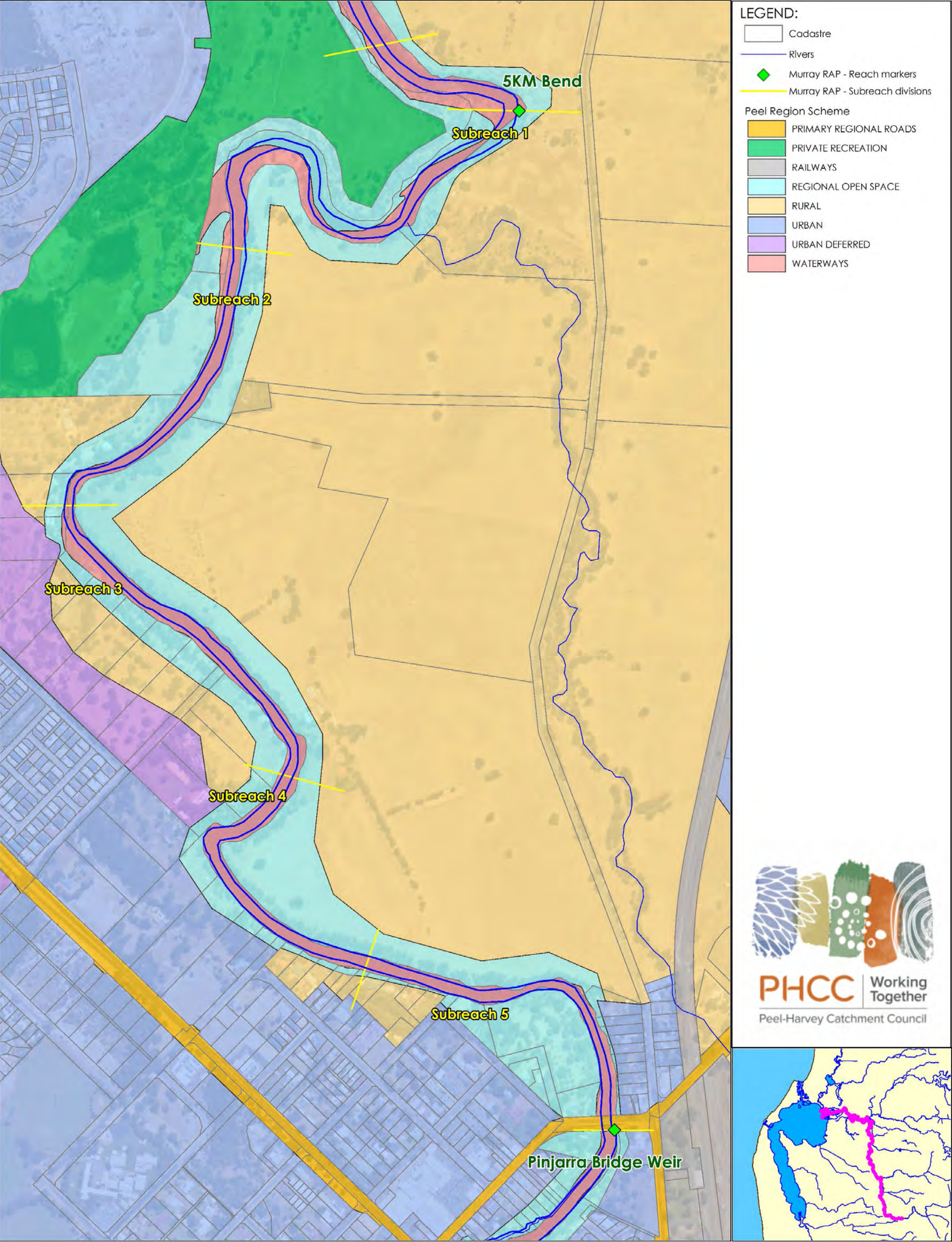
Peel Harvey Catchment Council - Lower and Middle Murray River Action Plan
Figure 36 - Lower Murray Reach 6: 5km Bend to Pinjarra Bridge Weir - Elevation Map



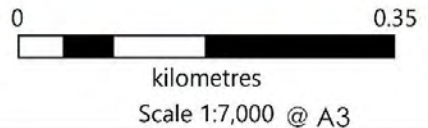
* ©2022. While Urbaqua has taken care to ensure the accuracy of this product, Urbaqua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbaqua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.



Peel Harvey Catchment Council - Lower and Middle Murray River Action Plan
Figure 37 - Lower Murray Reach 6: 5km Bend to Pinjarra Bridge Weir - Landuse Map (PRS)



* ©2022. While Urbagua has taken care to ensure the accuracy of this product, Urbagua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbagua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.



Scale 1:7,000 @ A3

4.6 Lower Murray Reach 6

This reach is approximately 4 km long (Figure 35). Both banks of the river are privately owned and most landowners still have and are executing their riparian rights. Both banks are predominantly Rural with some Urban on the left bank.



Plate 7: Lower Murray Reach 6 Photos

Table 14: Lower Murray Reach 6 Description and Conditions

Feature	Comments
Land Use	Rural grazing land dominates the right bank, with urban blocks located close to the Pinjarra Bridge. There is evidence of livestock access to the river along this reach. The left bank consists of Private recreation (vested with the Shire of Murray), Urban, Urban Deferred and some smaller rural blocks (Figure 37)
Fencing and Infrastructure	There is little to no fencing on either side of the river. There are some isolated examples of isolated fences in places, often in poor condition. No other significant infrastructure.
Channel Form and Soils	<p>This reach includes numerous meanders and bends. There is mostly uniform flow and is approximately 35 - 45m in width along the reach. There are some low-lying areas on both banks (Figure 36). The channel depth varies from 1.5 to 3m on each bank.</p> <p>The left and right banks are dominated by P10 soils (identified by gently undulating to flat terraces adjacent to major rivers, but below the general level of the plain, with deep well drained uniform brownish sands or loams subject to periodic flooding) with some sections of P6a (very gently undulating alluvial terraces and low rises contiguous with the plain, with deep moderately well to well drained soils associated with major current river systems and larger streams. Acidic red and yellow duplex soils).</p> <p>On the right bank near the Pinjarra Townsite there are some small areas of P6a and P1a (identified as flat to very gently undulating plain with deep acidic mottled yellow duplex (or effective duplex) soils. Shallow pale sand to sandy loam over clay; imperfect to poorly drained and generally not susceptible to salinity).</p> <p>On the left bank there is some Bassendean B2 (flat to very gently undulating sandplain with well to moderately well drained deep bleached grey sands with a pale-yellow B horizon or a weak iron-organic hardpan 1-2 m).</p>
Vegetation Cover and Stream Health	<p>This reach is highly degraded with a patchy overstorey of swamp paperbark (<i>Melaleuca raphiophylla</i>) and flooded gum (<i>Eucalyptus rudis</i>). There is very little to no understorey present (ground cover or shrubs) and very little natural regeneration. Weeds (grasses etc) dominate the understorey.</p> <p>The loss of understorey was due to livestock access mostly, but in the upper reaches fire/ flood also played a factor.</p>
Weeds	<p>There is an infestation of weeds along this reach, probably due to the proximity of urban development. The number of different weed species was high.</p> <p>Weeds included: palm trees, couch grass, oxalis, kikuyu, veldt grass, watsonia, cottonbush, arum lily, heather, olive trees, love grass, giant reed, dipogan, succulents, and bridal creeper.</p>
Erosion	<p>Livestock access has resulted in severe erosion and bank slumping, on the right bank in particular. Undercutting was apparent on both banks. The lower reaches of the right bank experience a high level of bank instability along most of the length of sub-reaches 1 and 2. The rest of the reach shows moderate instability and a moderate proportion of the length affected by erosion).</p> <p>The right bank showed minor damage from livestock including vegetation damage, bank damage and isolated areas of pugging.</p> <p>There is little bank stabilisation along the length of reach. There are two isolated spot of log walls and wooden bank stabilisation in the middle of the reach (Figure 39)</p>

Feature	Comments
Habitat Condition	There is a sparse amount of woody debris along the reach, and what is present, is small and of a similar size. There is detritus and leaves but no biological substrate cover. There is a small proportion of aquatic reeds. The water colour was light green throughout this reach and a small amount of algae was noted in the water column at the time of the site visit.
Other Issues	Weed control has been undertaken in near Pinjarra townsite since 2014. This consisted of hand weeding watsonia (Figure 40).
Community and Cultural Values	<p>Local Bindjareb Noongar Elders and Representatives will provide knowledge and advice on each site, its' cultural significance, and values. Please refer to Section 2.3 of this document to ensure all processes and procedures are followed.</p> <p>Landholders within this reach have utilised majority of the reach for farming and highly value the river not only for its' beauty but for the ecosystem services it provides. Recreational activities mainly comprising of boating, canoeing, kayaking, fishing, swimming, and walking occur throughout this reach.</p>

Peel Harvey Catchment Council - Lower and Middle Murray River Action Plan
Figure 38 - Lower Murray Reach 6: 5 km Bend to Pinjarra Bridge Weir - 2014 Condition Map



Lower Murray River Action
Plan
Review 2014
Foreshore Condition
Assessment



Legend

- Murray River Reaches
Grade
- B2-B3
 - B3-C1
 - C1
 - C1-C2
 - C2
 - C2-C3
 - C3



0 50 100 150 200 m



GDA 94 UTM 50
Aerial Photo: Metro South Sep.2013
Prepared by J Garvey
Date: 29/07/2014

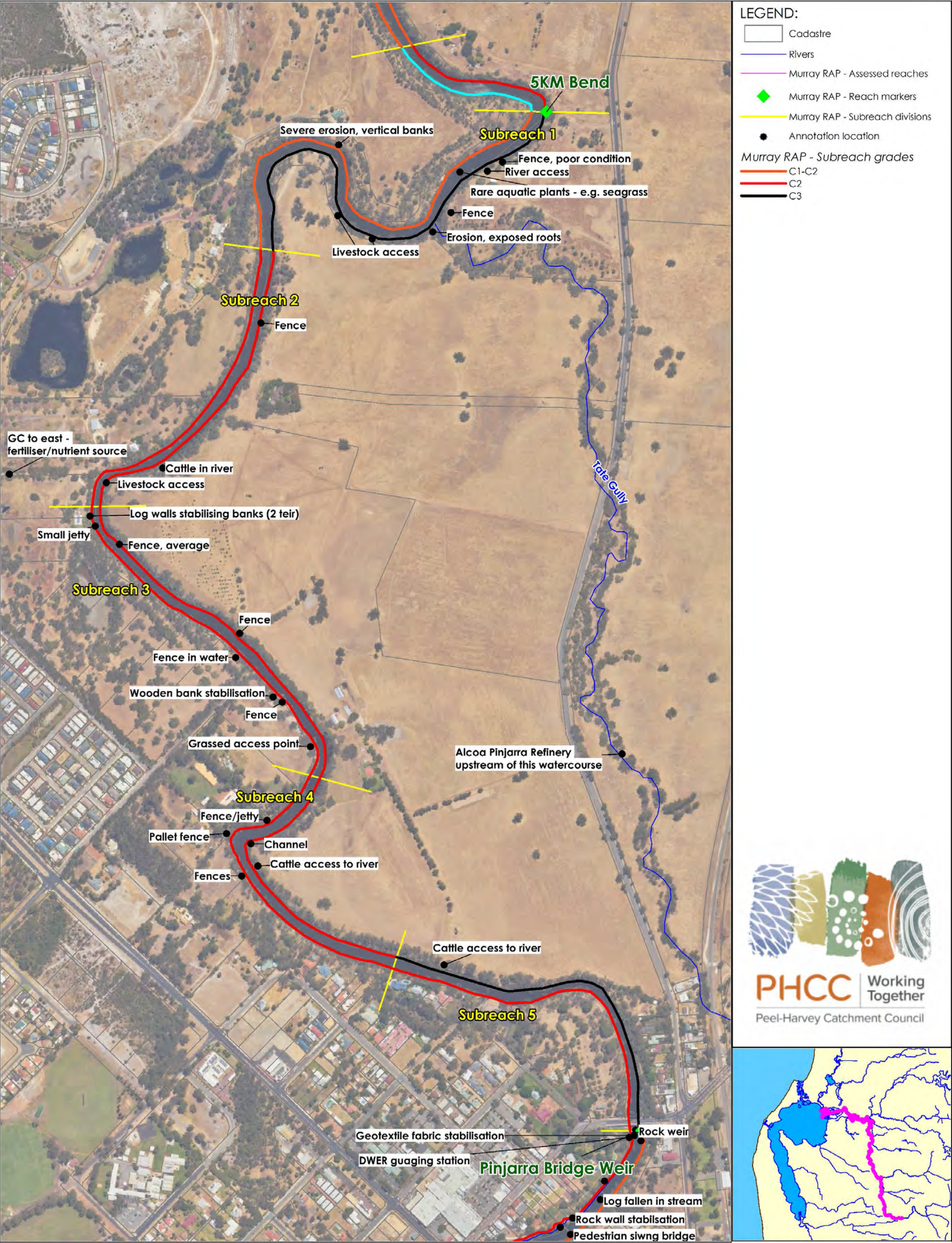
Peel-Harvey Catchment Council
Rivers 2 Ramsar
Connecting River Corridors
for Landscape Resilience



Australian Government

This project is supported by the
Peel-Harvey Catchment Council,
through funding from the
Australian Government

Peel Harvey Catchment Council - Lower and Middle Murray River Action Plan
Figure 39 - Lower Murray Reach 6: 5km Bend to Pinjarra Bridge Weir - Current Condition Map



*©2022. While Urbaqua has taken care to ensure the accuracy of this product, Urbaqua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbaqua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.

Peel Harvey Catchment Council - Lower and Middle Murray River Action Plan
Figure 40 - Lower Murray Reach 6: 5km Bend to Pinjarra Bridge Weir - Actions Since 2014



* ©2022. While Urbaqua has taken care to ensure the accuracy of this product, Urbaqua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbaqua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.

Table 15: Lower Murray Reach 6 Management Actions and Recommendations

Issues

- Erosion issues and bank stability issues from livestock access.
- Boat usage associated with proximity to the townsite, subsequent wave action impacts on bank stability.
- Weeds dominate the understorey due to livestock impacts.

Prioritised management actions recommended

Boats:

- Possible options include; using mobile markers deployed in the navigation channel that read boat speed, using mobile buoys with a speed sign moved around to key locations to help alert skippers to the speed limits, DoT officers stationed at different locations with speed radar once a week.
- Educational programs targeting boat wash e.g., 'no wash zones'.

Revegetation and weeding:

- Some weeding has been done in 2014 however further weed control and education of residents would be beneficial.
- Assist regeneration of native vegetation through planting and/or direct seeding at identified sites.

Planning/ Engagement:

- Provide resources and/or preparation of guidelines aimed at residents and landholders directly abutting the river. Guidelines that would be useful for land uses and issues relevant to activities within this reach include;
 - Fencing for livestock to alleviate erosion and pugging.
 - Weeding and appropriate ways to remove weeds.
 - Revegetation including appropriate species selection and bank profile location.
 - Erosion control measures and bank stabilisation options – refer to the Foreshore Stabilisation Guidelines (Shire of Murray, 2019) and BMP guidelines for more specialised and specific erosion and stabilisation techniques e.g., Best Management Practice for Foreshore Stabilisation: Brushwall (DBCA, 2020).
 - Simplifying where to find the information required for planning approval for jetties, pagodas etc.
 - Erosion control measures or effective bank stabilisation options – also refer landholders to existing relevant guidelines including the *Foreshore Stabilisation Guidelines* (Shire of Murray, 2019) and *Best Management Practices for Foreshore Stabilisation: Brushwall* (DBCA, 2020).
 - Boating activities including speed and wake consideration and impact on wildlife.
- Direct landowners and residents to existing guidance on;
 - Planning approval requirements for jetties, pagodas etc (SoM website)

Long term management actions recommended

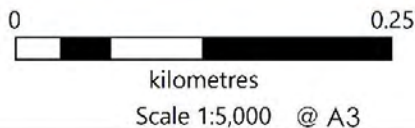
Consultation:

- Provide residents with advice and resources to define/control access points to the river.
- Work with landholders to create good quality habitat corridors between the Murray River and waterway to the east known as Tate Gully.

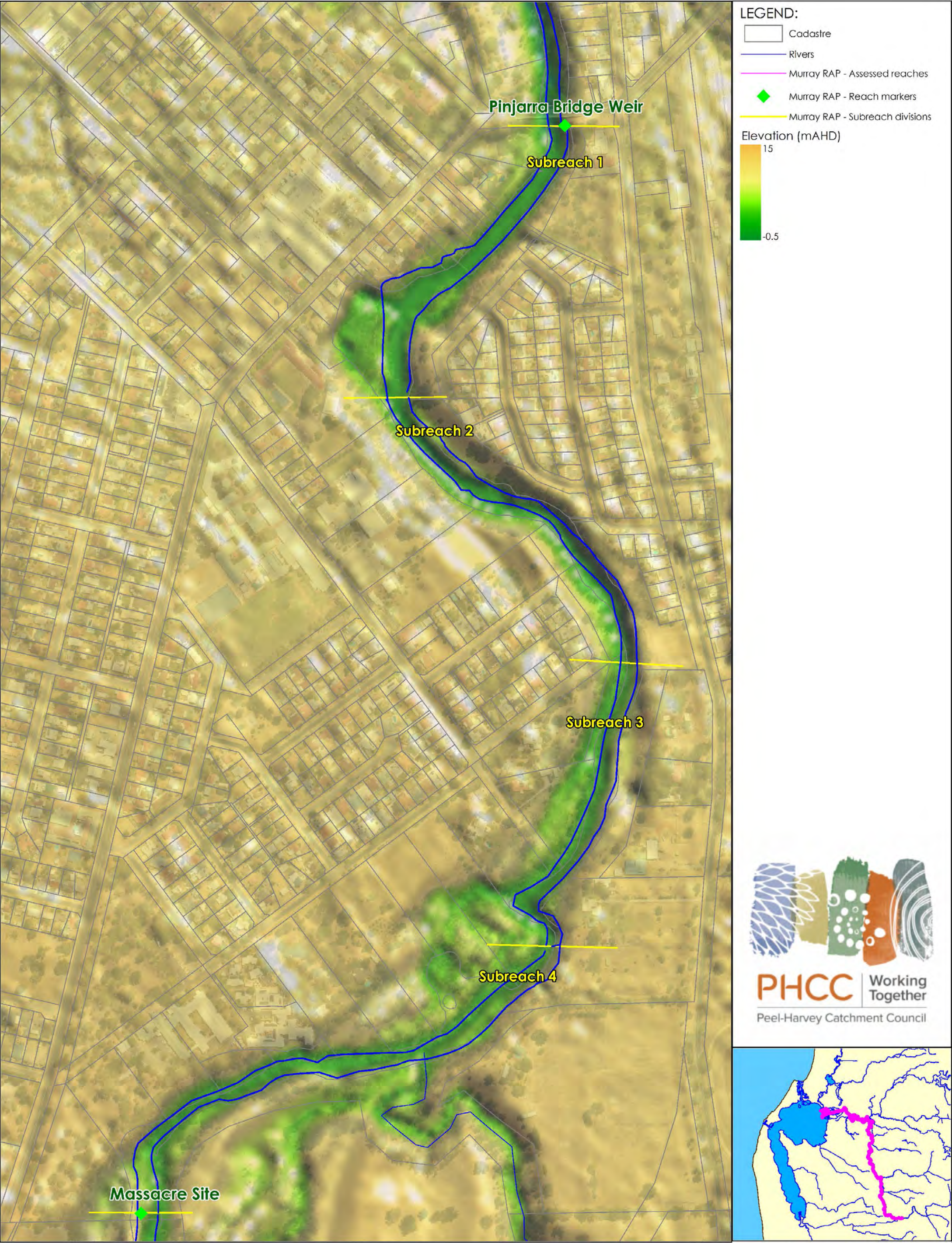
Peel Harvey Catchment Council - Lower and Middle Murray River Action Plan
Figure 41 - Middle Murray Reach 1: Pinjarra Bridge Weir to Massacre Site - Location map



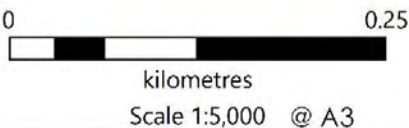
* ©2022. While Urbaqua has taken care to ensure the accuracy of this product, Urbaqua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbaqua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.



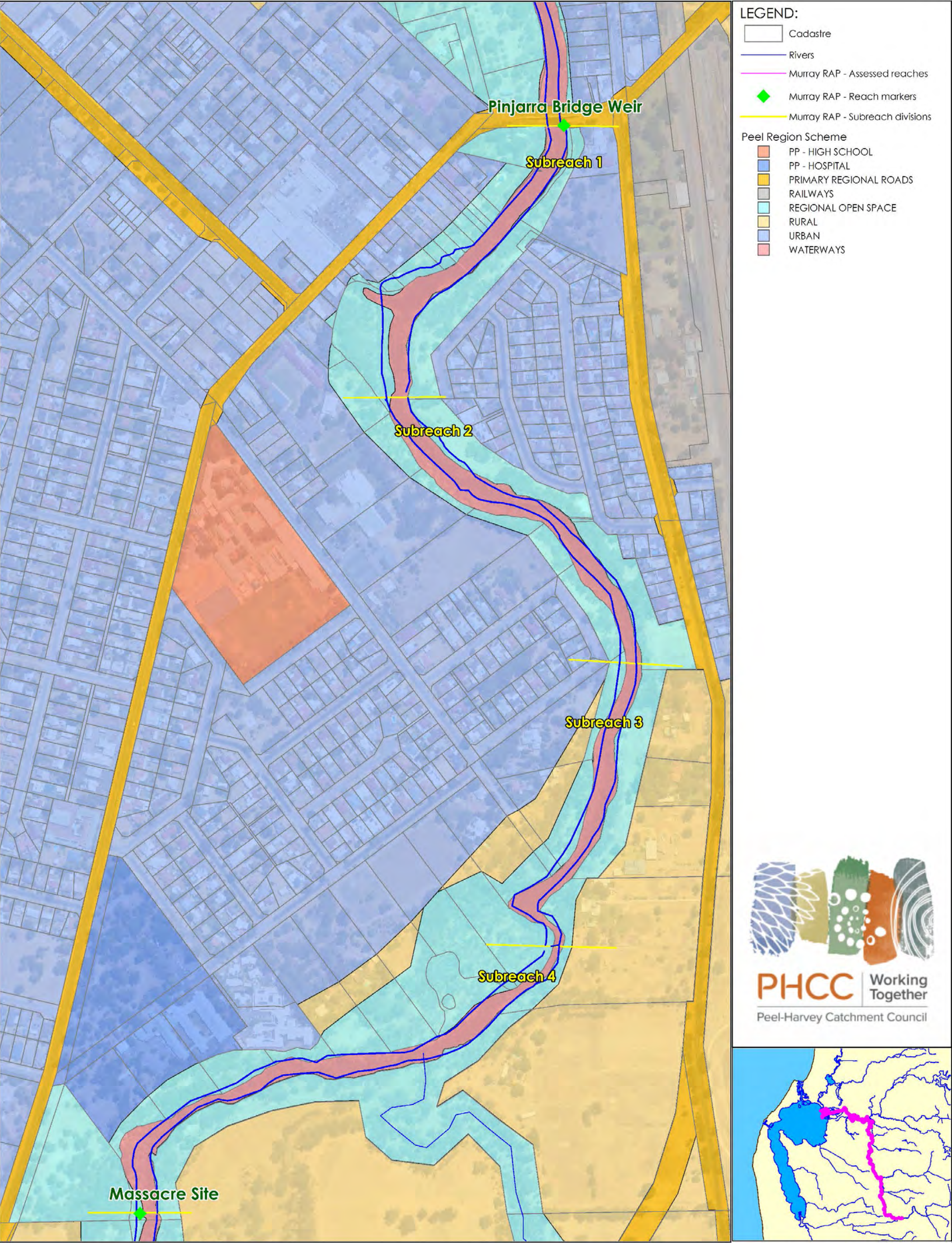
Peel Harvey Catchment Council - Lower and Middle Murray River Action Plan
Figure 42 - Middle Murray Reach 1: Pinjarra Bridge Weir to Massacre Site - Elevation Map



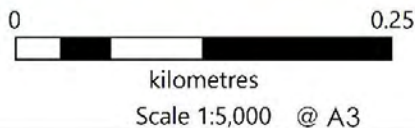
*©2022. While Urbagua has taken care to ensure the accuracy of this product, Urbagua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbagua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.



Peel Harvey Catchment Council - Lower and Middle Murray River Action Plan
Figure 43 - Middle Murray Reach 1: Pinjarra Bridge Weir to Massacre Site - Landuse Map (PRS)



* ©2022. While Urbaqua has taken care to ensure the accuracy of this product, Urbaqua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbaqua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.



Scale 1:5,000 @ A3



4.7 Middle Murray Reach 1

Reach 1 is 2.5km long and covers the area from the Pinjarra Weir near the South Western Highway bridge upstream to where the Battle of Pinjarra Massacre Memorial site ('Massacre Site') (Figure 41). This reach is primarily associated with urban land use, however there are several small semi-rural holdings within the area.



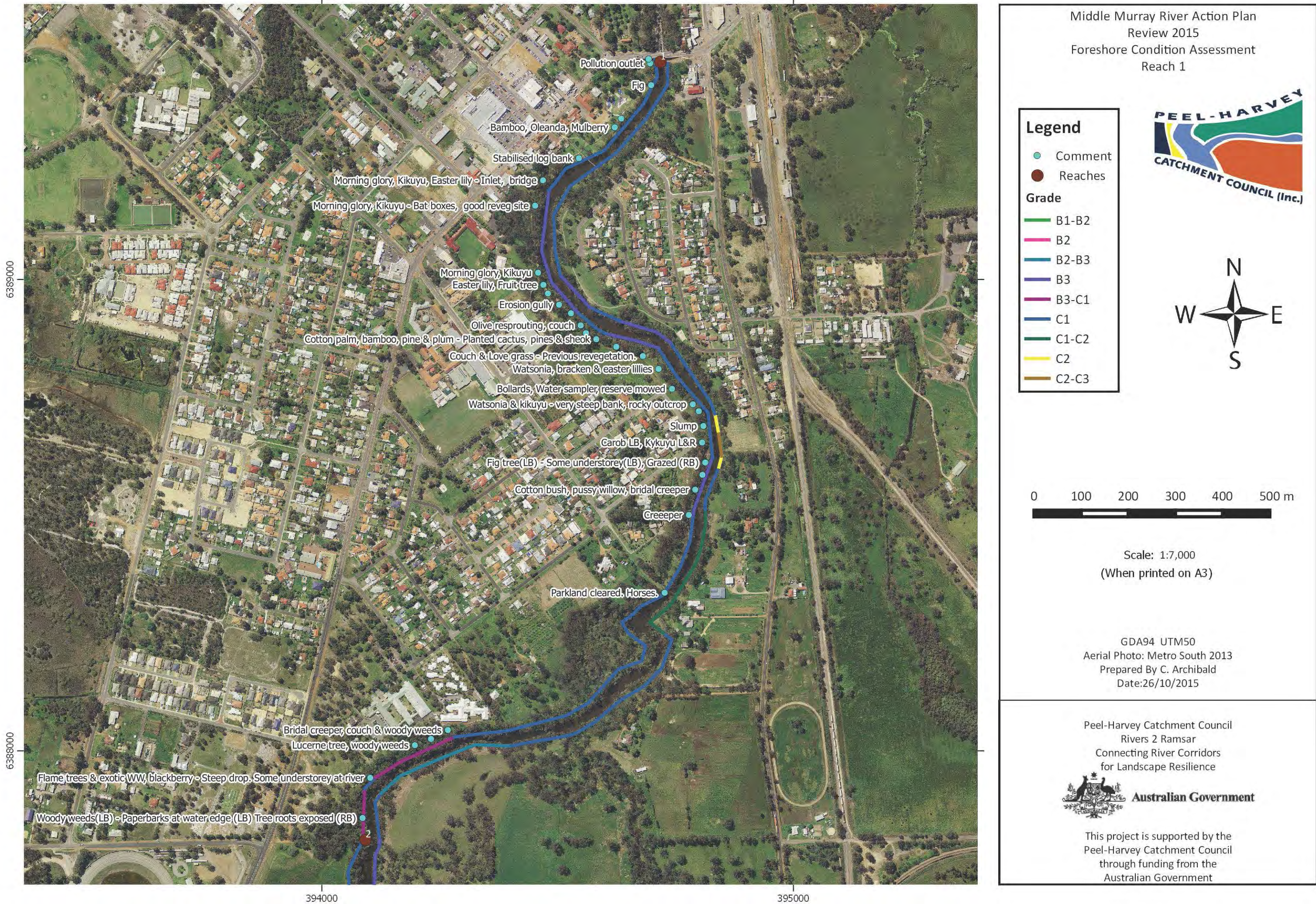
Plate 8: Middle Murray Reach 1 Photos

Table 16: Middle Murray Reach 1 Description and Conditions

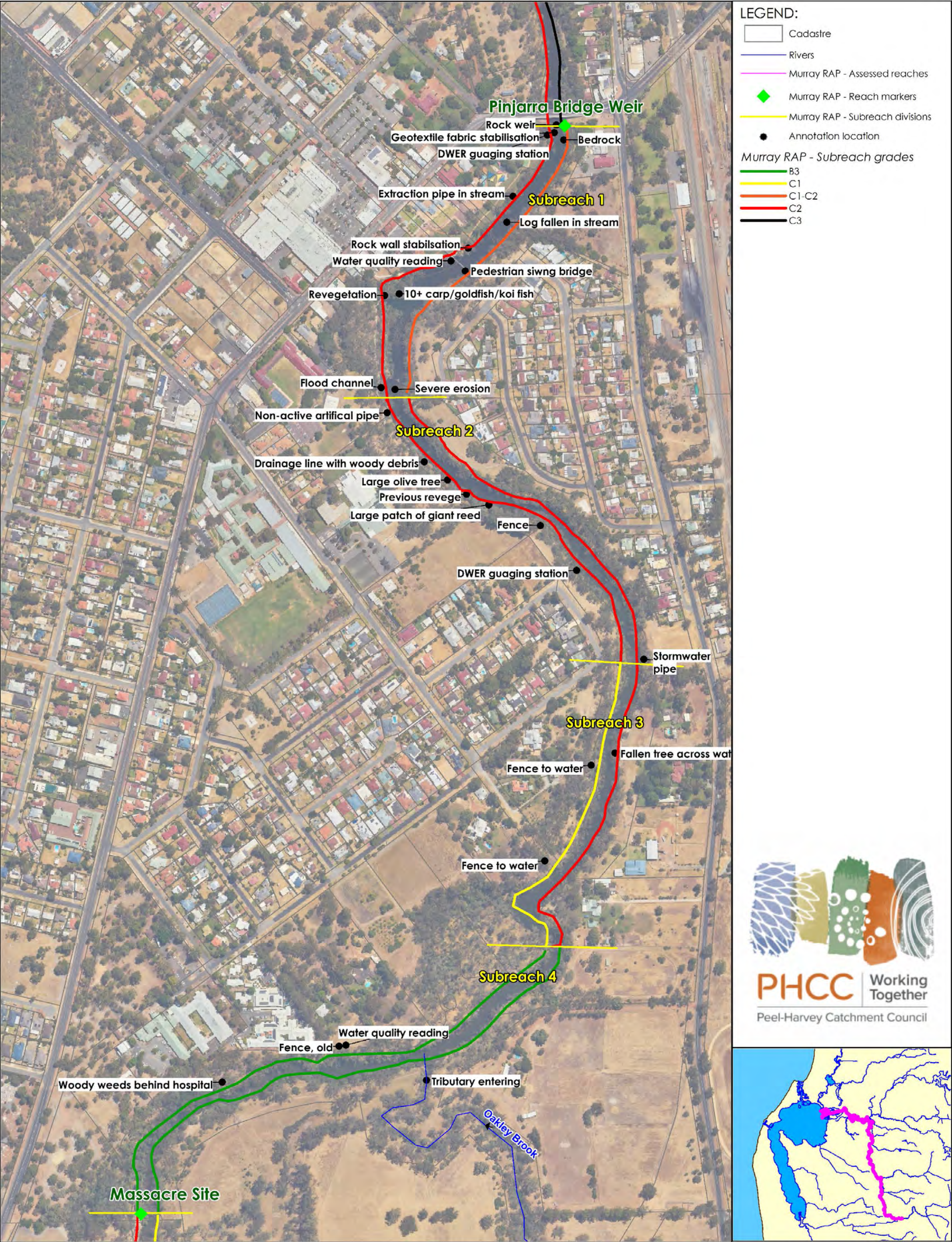
Feature	Comments
Land Use	<p>Most of the reach is surrounded by urban land due to the Pinjarra townsite. The upper reaches are some smaller rural lots, and shire reserves (ROS) (Figure 43).</p> <p>Most of the foreshore areas in private ownership, some of which are grazed to the river edge.</p>
Fencing and Infrastructure	<p>Most of the reach does not have fencing as urban dwellings and reserves dominate the lots surrounding the river. Some poorly maintained, perpendicular fencing is present within the smaller rural lots on the left bank in this reach. Fencing is a lower priority in this reach as very few livestock exist.</p> <p>Other infrastructure of note within this reach includes; Pinjarra weir and the swing bridge</p>
Channel Form and Soils	<p>This reach is a gentle meander with one tributary entering the river in sub reach 4 (Figure 42). There is low flow observed (below 0.1m/s) and the river width is approximately 60 – 100m along the extent of the reach. The bank full channel depth is 10-15m. There is a pool after the weir and some obvious sand bar deposition and bedrock in sub reach 1 (Figure 45).</p> <p>The right bank is predominantly Pinjarra P6a (very gently undulating alluvial terraces and low rises contiguous with the plain, with deep moderately well to well drained soils associated with major current river systems and larger streams. Acidic red and yellow duplex soils), with a small amount of Pinjarra P9 (Shallowly incised stream channels of minor creeks with deep acidic mottled yellow duplex soils).</p> <p>The left bank is predominantly Bassendean B2 (flat to very gently undulating sandplain with well to moderately well drained deep bleached grey sands with a pale-yellow B horizon or a weak iron-organic hardpan 1-2 m) with some Bassendean B4 (broad poorly drained sandplain with deep grey siliceous sands or bleached sands, underlain at depths generally greater than 1.5 m by clay or less frequently a strong iron-organic hardpan).</p>
Vegetation Cover and Stream Health	<p>This reach has no, to very little, ground cover, with little shrub layer. The dominant riparian species are swamp paperbark (<i>Melaleuca raphiophylla</i>), flooded gum (<i>Eucalyptus rudis</i>) and tea tree. There is some natural regeneration as well as planted regeneration of native woody vegetation. Weeds (grasses etc) dominate the understorey.</p> <p>The loss of understorey was due to human impact, fire/ flood and in some cases, natural bedrock.</p> <p>There is less dominance of native trees as a proportion of the riparian foreshore compared to other reaches. Foreshore vegetation also includes a fair proportion of shrubs (both native and weed species).</p>
Weeds	<p>Weeds are dominant in this reach due to the urban nature around Pinjarra townsite. A greater number of various species were noted within this reach. Weeds encountered included; stink weed, fig, love grass, giant reed, Japanese pepper, morning glory, dock, jacaranda, prickly pear, cotton palm, plane trees, pine trees, date palms, Mexican tea, bougainvillea, Ficus, blackberry, nightshade, olive trees, bracken, and Brazilian pepper.</p>
Erosion	<p>Livestock is not dominant along this reach of the river (no livestock noted). The edges are predominantly stepped. The severity of erosion is low-moderate along the length of this reach and the length of banks affected are lower. Factors affecting erosion are human access and cleared vegetation and runoff.</p>

Feature	Comments
	<p>Since 2015 RAP, some areas of concern like Cantwell Park near the swing bridge, have had erosion remediation work. Beneath the swing bridge was previously stabilised with log banks whereas this has been replaced with rock wall stabilisation.</p> <p>Other erosion management measures in this reach include; bank matting, logs strapped to bank and revegetation (mostly around the townsite).</p>
Habitat Condition	There is a sparse to moderate amount of woody debris along the reach, and what is present, is larger and in various sizes. There were several dead trees noted across the river. There are leaves, a fairly high proportion biological substrate cover and algae present.
Other Issues	<p>Walk trails exist on both sides of the river which increases access and awareness of work occurring in the area, making it a focus for community-based activities such as planting days.</p> <p>Several Shire vested reserves sit within the reach, some of which have had riparian restoration activities such as weed control and revegetation (Figure 46). Activities include, had weeding of watsonia, spray of lupins and pasture species in revegetation sites, riparian revegetation following weeding, revegetation of sedges planted into weed matting, and spraying woody weeds.</p> <p>In the southern part of the reach, opposite the Pinjarra Massacre Memorial Site, the local landowner has been involved in revegetation activities over a number of years.</p>
Water Quality	<p>The salinity within this reach is slightly brackish and consistent at ~2,100 mg/l (Figure 102). This is dramatically less than the salinity noted in the Lower Murray Reaches 1-3.</p> <p>The DO within this reach is moderate and consistent at ~mid 70% (Figure 92).</p>
Community and Cultural Values	<p>'Registered Aboriginal Site 3786 – Pinjarra Massacre – Camp, Massacre, Meeting Place' is located within this reach. This is an extremely important cultural site both locally and nationally. Local Bindjareb Noongar Elders and Representatives will provide knowledge and advice on each site, its' cultural significance, and values. Please refer to Section 2.3 of this document to ensure all processes and procedures are followed.</p> <p>Recreational activities include fishing where there is access to the river, walking, canoeing, kayaking, and picnicking etc.</p>

Peel Harvey Catchment Council - Lower and Middle Murray River Action Plan
Figure 44 - Middle Murray Reach 1: Pinjarra Bridge Weir to Massacre Site - 2015 Condition Map



Peel Harvey Catchment Council - Lower and Middle Murray River Action Plan
Figure 45 - Middle Murray Reach 1: Pinjarra Bridge Weir to Massacre Site - Current Condition Map.



*©2022. While Urbaqua has taken care to ensure the accuracy of this product, Urbaqua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbaqua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.



* ©2022. While Urbaqua has taken care to ensure the accuracy of this product, Urbaqua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbaqua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.

Table 17: Middle Murray Reach 1 Management Actions and Recommendations

Issues

- Obstruction within the river caused Pinjarra weir inhibits the provision of a passageway for fish and other aquatic species. It restricts a seamless migration and therefore possibly their survival.
- Weed infestation due to urban impact.
- Litter due to urban impact.
- Stormwater inflows potentially impacting water quality.

Prioritised management actions recommended

Weed management:

- Continue weed management actions to control weed infestation from urbanisation.
- Removal of the giant reed patch observed within this reach.

Engagement and awareness:

- Increase community awareness of actions being taken.
- Establish education signage at carparks to outline restoration works already undertaken and measures the community can undertake to improve water quality and weeds within the wider catchment.
- Implement actions to reduce the amount of litter ending up in the river i.e., educational programs targeting clean waterways/ raising awareness at community events.
- Management of weeds from reserves and private land should be a long-term aim of the rehabilitation of the Murray River.

Water quality:

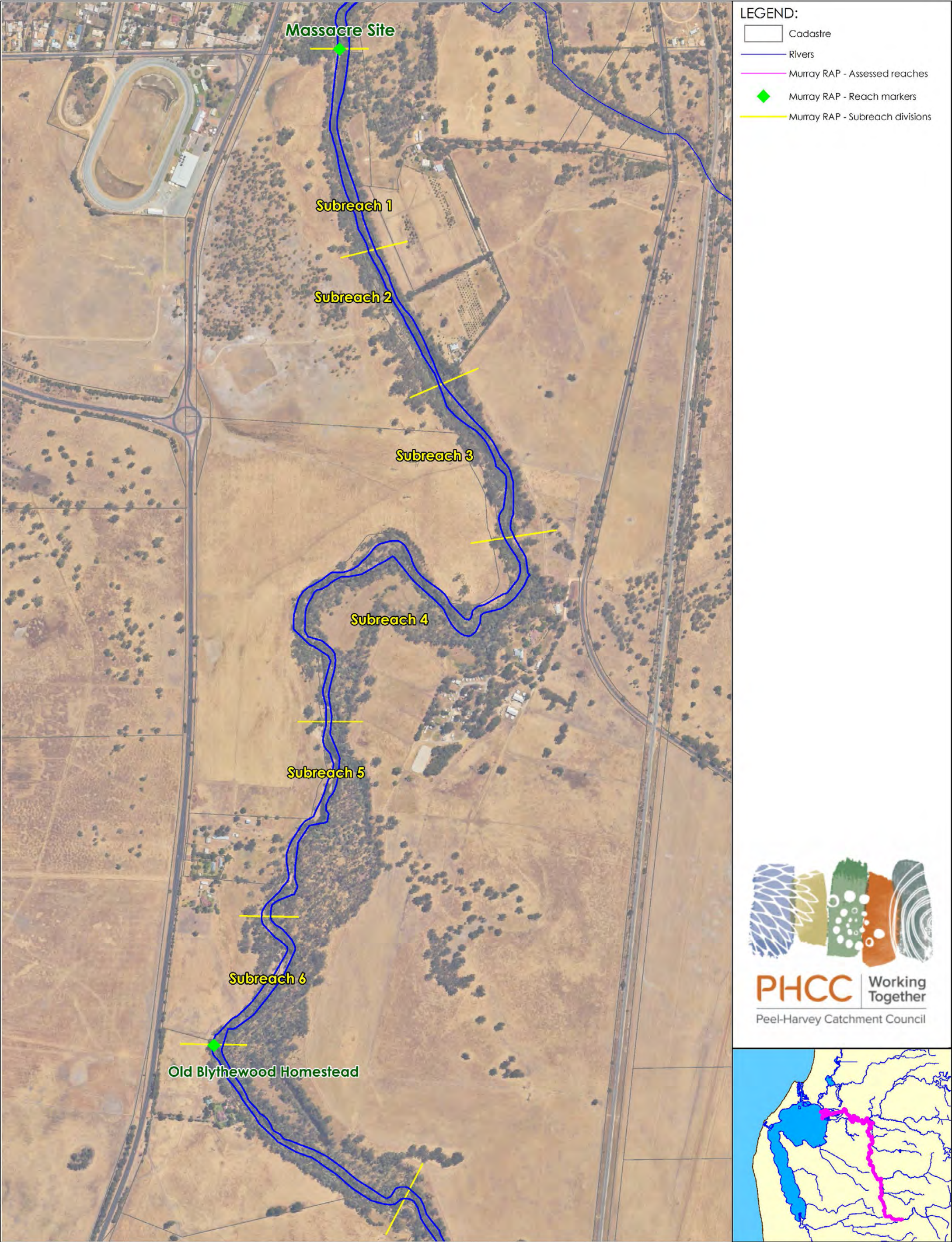
- Consider water quality treatment of inflow stormwater through revegetation of drains.
- Consider including total nitrogen and total phosphorus testing of water quality sampling to assess eutrophication potential.

Long term management actions recommended

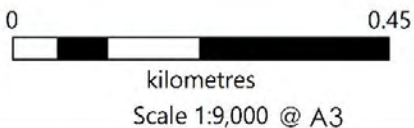
Infrastructure:

- Investigation into installing a fish ladder at Pinjarra weir. Fish ladders not only benefit fish, but marron and turtle migration as well.
- Most fish ladders are a channel constructed around an obstruction in a river (Pinjarra weir) which enables fish (and others) to pass around the barriers by swimming and leaping up a series of relatively low steps (hence the term ladder) into the waters on the other side. The velocity of water falling over the steps must be great enough to attract the fish to the ladder, but it cannot be so great that it washes fish back downstream or exhausts them to the point of inability to continue their journey upriver.
- Consideration given to the most appropriate type of fish ladder, possibly a 'pool and orifice fish ladder' where the overflowing weir is provided with a submerged orifice within its body so the fish can travel to upstream by just passing through each orifice rather than jumping over the weir crest, or a 'vertical slot fish ladder' where the weirs are replaced by walls with vertical slots so that the fish can pass through these slots from pool to pool and to the upstream easily. Vertical slot fish ladders allow the fish to swim at their preferred depth. New designs have also been developed that should be explored as well.

Peel Harvey Catchment Council - Lower and Middle Murray River Action Plan
Figure 47 - Middle Murray Reach 2: Massacre Site to Old Blythewood Homestead - Location Map



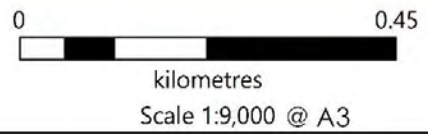
* ©2022. While Urbaqua has taken care to ensure the accuracy of this product, Urbaqua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbaqua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.



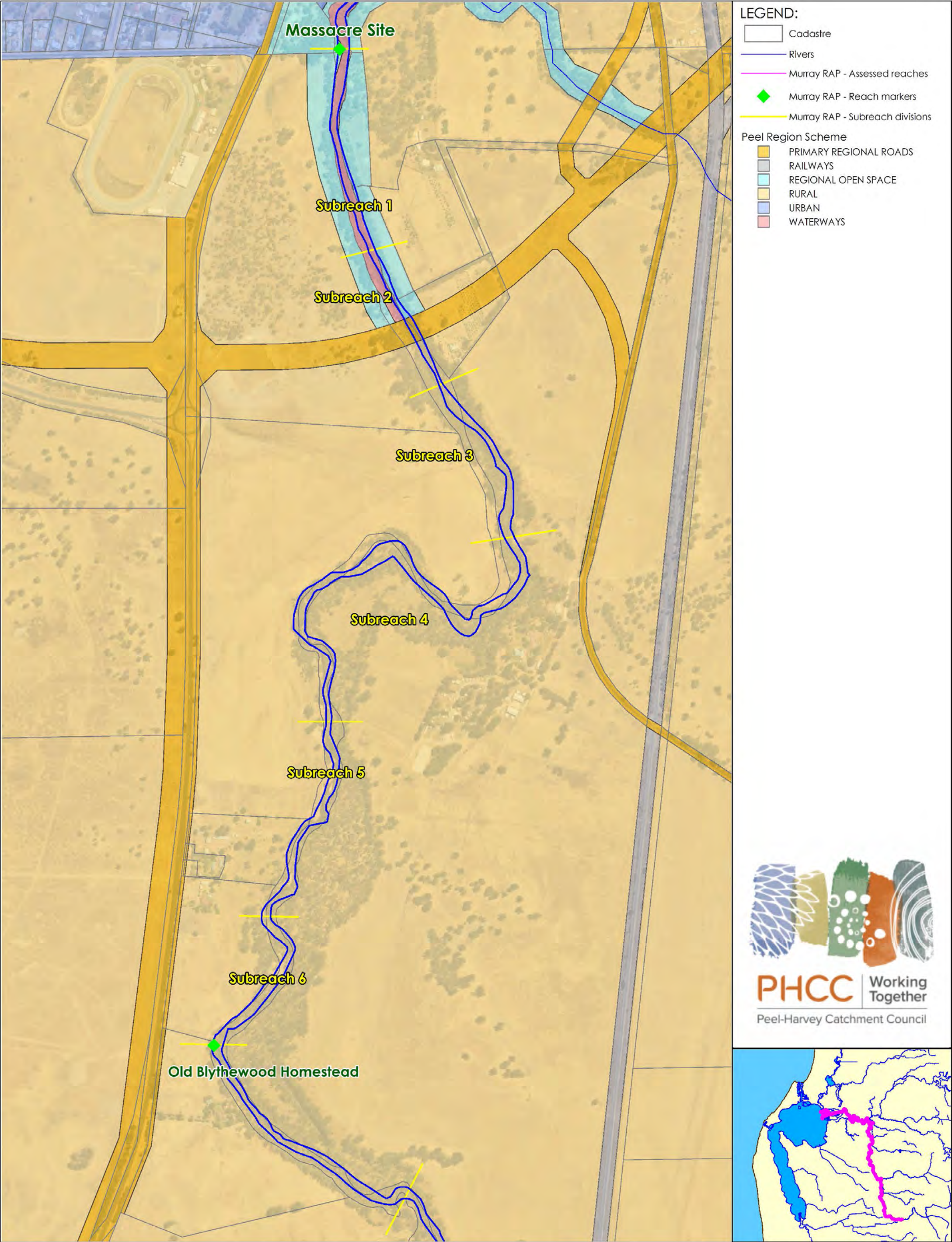
Peel Harvey Catchment Council - Lower and Middle Murray River Action Plan
Figure 48 - Middle Murray Reach 2: Massacre Site to Old Blythewood Homestead - Elevation Map



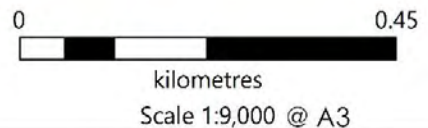
* @2022. While Urbaqua has taken care to ensure the accuracy of this product, Urbaqua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbaqua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.



Peel Harvey Catchment Council - Lower and Middle Murray River Action Plan
Figure 49 - Middle Murray Reach 2: Massacre Site to Old Blythewood Homestead - Landuse Map (PRS)



* ©2022. While Urbaqua has taken care to ensure the accuracy of this product, Urbaqua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbaqua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.



4.8 Middle Murray Reach 2

This reach is 3.9km long and extends from the edge of the Pinjarra Townsite and is primarily associated with rural land use (Figure 47). It is a relatively well-defined channel in the lower sub reaches with some braiding in the upper sub reaches.



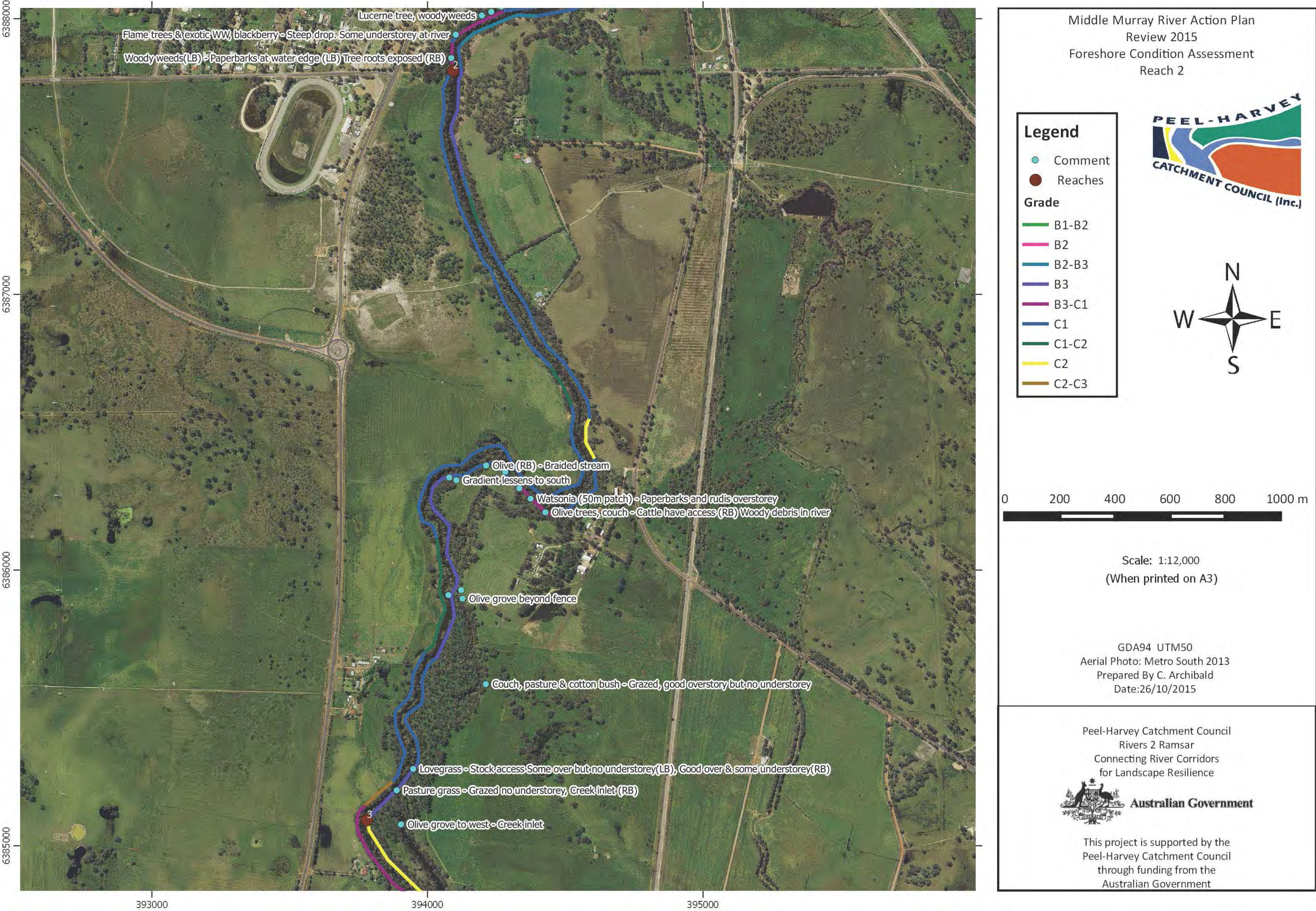
Plate 9: Middle Murray Reach 2 Photos

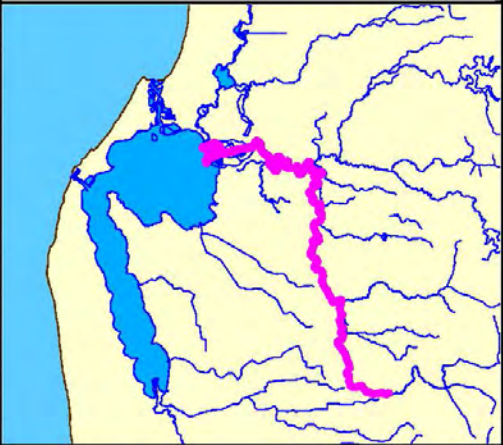
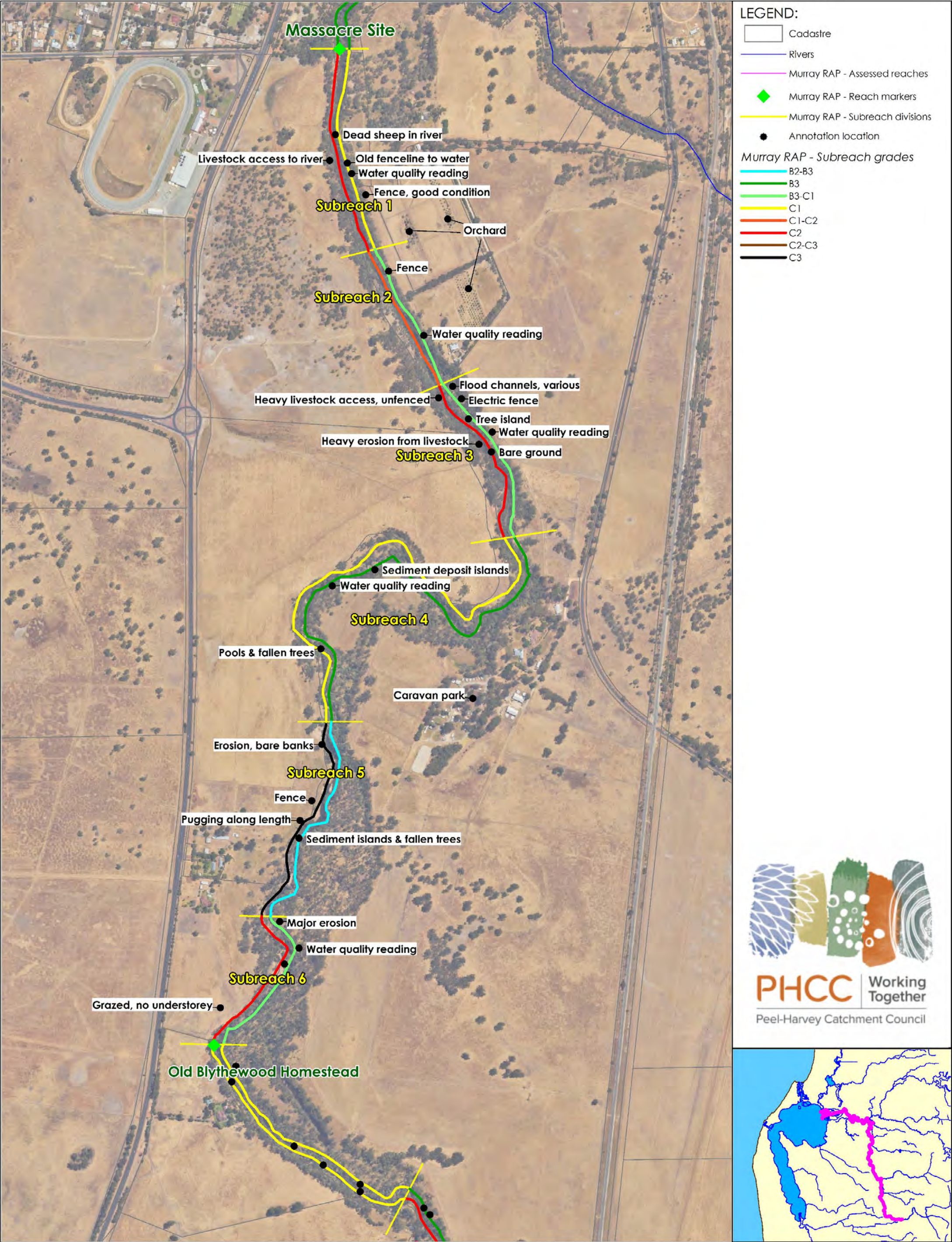
Table 18: Middle Murray Reach 2 Description and Conditions

Feature	Comments
Land Use	This reach is entirely Rural. Regional open space encompasses the foreshore as far as sub reach 2 but beyond that the foreshore area is in private ownership. There are some orchards and a caravan park within this reach (Figure 49).
Fencing and Infrastructure	The right bank has a good-conditioned fence along the length of this reach. Most of the fencing is used to keep the livestock away from the river during summer months when the water levels are low. During winter and spring, when the water levels are higher, livestock are allowed access to the river for grazing. The left bank had varying degrees of fencing along the length.
Channel Form and Soils	It is a relatively well-defined channel in the lower reaches with some braiding in the upper sub reaches (Figure 48). There is low flow observed (below 0.1m/s). Riverbed to top of bank varies from 1.0 – 3.0m on each bank. There are pools and some sediment island/ deposition along the length (Figure 51). The bank full channel width is approximately wide at 80 – 200m along the extent of the reach, with a bank full depth of 20m-25m. The soils are predominantly Pinjarra P6a (Very gently undulating alluvial terraces and low rises contiguous with the plain, with deep moderately well to well drained soils associated with major current river systems and larger streams. Acidic red and yellow duplex soils) on both banks, with some smaller areas of Pinjarra 1a (Flat to very gently undulating plain with deep acidic mottled yellow duplex (or ineffective duplex) soils. Shallow pale sand to sandy loam over clay; imperfect to poorly drained and generally not susceptible to salinity), and Pinjarra P3 (Flat to very gently undulating plain with deep, imperfect to poorly drained acidic gradational yellow or grey-brown earths and mottled yellow duplex soils, with loam to clay loam surface horizon).
Vegetation Cover and Stream Health	This reach has no to very little ground cover. There native shrubs and trees are present in the riparian zone, particularly in the upper reaches. The dominant riparian species are swamp paperbark (<i>Melaleuca raphiophylla</i>), flooded gum (<i>Eucalyptus rudis</i>) and tea tree (<i>Melaleuca alternifolia</i>), with some rushes in places. The riparian zone is wide in this reach (40 - 150m). There is a moderate amount of natural regeneration of native woody vegetation. The loss of understorey was mostly due to fire/ flood, and in some cases, human impact.
Weeds	There is less proportion of weeds within this reach. Weeds observed included; bracken fern, brazilian pepper, ficus, dock, blackberry nightshade, rye grass, olive tree, Mexican tea, African love grass, wild oats, and fig trees.
Erosion	Erosion was not overly significant in this reach. There were no erosion protection measures within this reach. Most was low to moderate severity except for one area on the left bank which had high severity. Erosion damage was considered a result of livestock access, human impact, cleared vegetation and runoff. Most livestock damage was to the bank stability and vegetation grazing. Sub reach 5 showed some lengths of pugging.
Habitat condition	Significant amount of fallen trees and islands within this reach provide multiple habitats for aquatics, as well as crossing points for terrestrial animals. There is a moderate to dense amount of woody debris along the reach, and what is present, is larger and in various sizes. There are leaves and algae observed, and a high proportion biological substrate cover. There was no to little aquatic plant coverage.
Other Issues	This reach is also dominated by few landholders and as such any management actions will need to involve those land managers as a primary

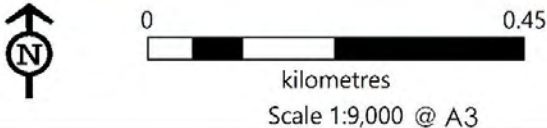
Feature	Comments
	<p>action (Figure 49).</p> <p>Weed control and revegetation works have been undertaken in sub reach 1 (Figure 52)</p>
Water Quality	<p>The salinity within this reach is slightly brackish and consistent at ~2,000 mg/l (Figure 103).</p> <p>The DO within this reach is varied, between low 60% and mid 80%. The higher DO was in the middle of the reach around areas of pool and fallen trees (Figure 93).</p>
Community and Cultural Values	<p>'Registered Aboriginal Site 3786 – Pinjarra Massacre – Camp, Massacre, Meeting Place' is located within this reach. This is an extremely important cultural site both locally and nationally. Local Bindjareb Noongar Elders and Representatives will provide knowledge and advice on each site, its' cultural significance, and values. Please refer to Section 2.3 of this document to ensure all processes and procedures are followed.</p> <p>This land has been farmed for years where the river has been utilised as watering points for livestock. The landholders highly value the river and its' beauty as well as the ecosystem services it provides. The community within this reach are passionate about controlling weeds, mainly cottonbush, to improve the ecosystem health of the river.</p>

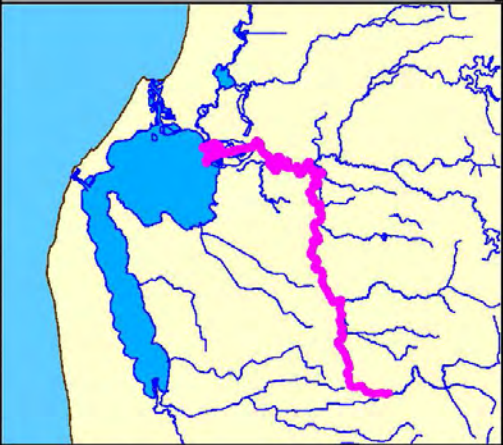
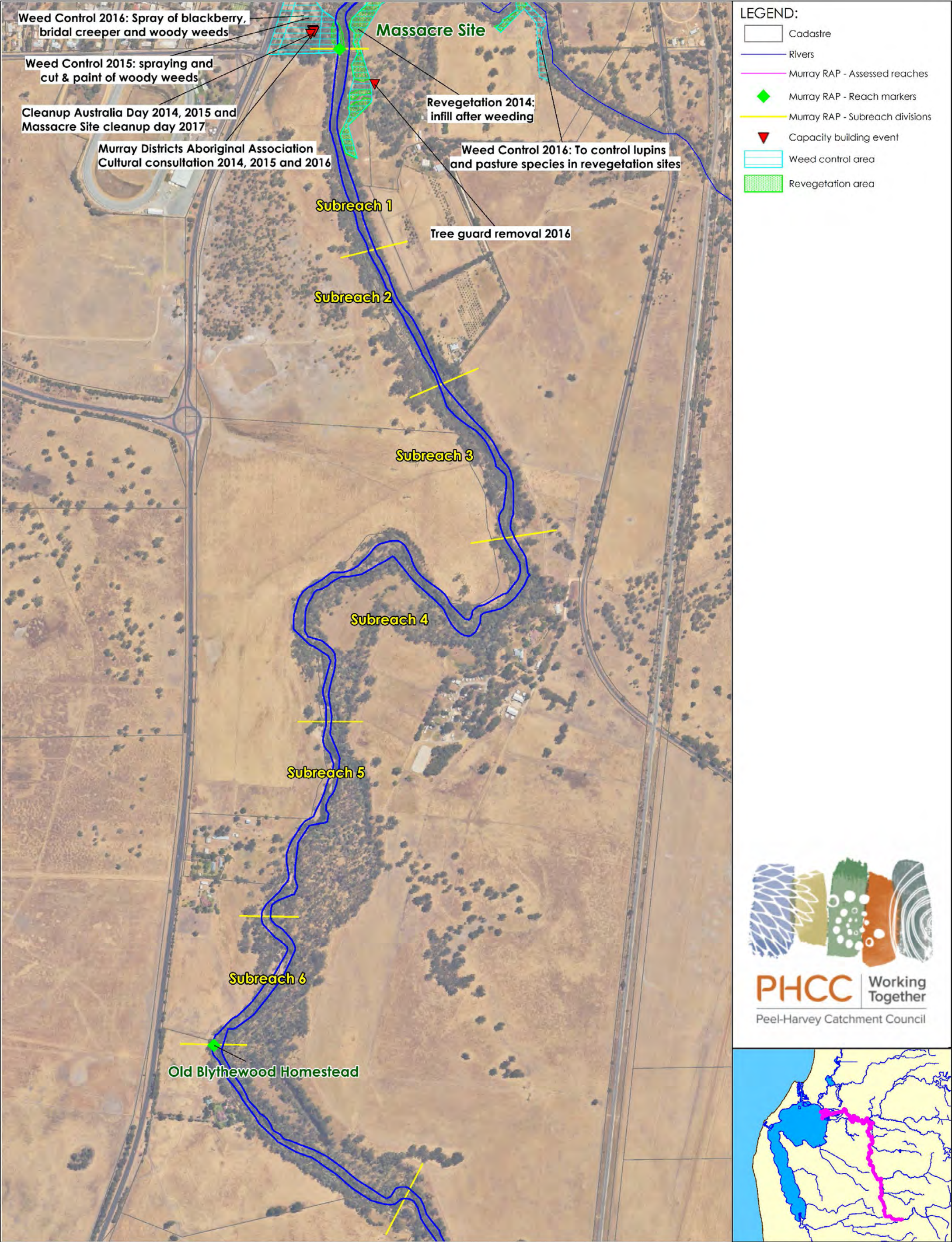
Peel Harvey Catchment Council - Lower and Middle Murray River Action Plan
Figure 50 - Middle Murray Reach 2: Massacre Site to Old Blythewood Homestead - 2015 Condition Map



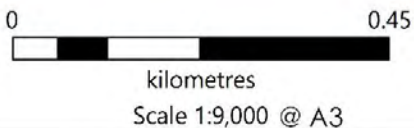


* ©2022. While Urbaqua has taken care to ensure the accuracy of this product, Urbaqua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbaqua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.





* ©2022. While Urbaqua has taken care to ensure the accuracy of this product, Urbaqua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbaqua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.



Scale 1:9,000 @ A3



Table 19: Middle Murray Reach 2 Management Actions and Recommendations

Issues

- Orchards adjacent to the river.
- Livestock access with little fencing along this length.
- Invasive weeds.
- Sediment deposits.

Prioritised management actions recommended

Livestock access:

- Engage with landowners to improve or provide additional fencing to manage livestock access.
- Provide incentives for landholders to fence off the river to livestock and rehabilitate the riparian zone through weed control, revegetation, and some erosion control.

Planning:

- Provide resources and/or preparation of guidelines aimed at residents and landholders directly abutting the river. Guidelines that would be useful for land uses and issues relevant to activities within this reach include;
 - Fertiliser management and nutrient loadings
 - Fencing for livestock to alleviate erosion and pugging
 - Weeding and appropriate ways to remove weeds.
 - Revegetation including appropriate species selection and bank profile location.
 - Erosion control measures or effective bank stabilisation options – also refer landholders to existing relevant guidelines including the Foreshore Stabilisation Guidelines (Shire of Murray, 2019) and Best Management Practices for Foreshore Stabilisation: Brushwall (DBCA, 2020).
 - Management of large woody debris while maintaining diverse habitats
- Direct landowners and residents to existing guidance on;
 - Livestock management (SoM website).

Long term management actions recommended

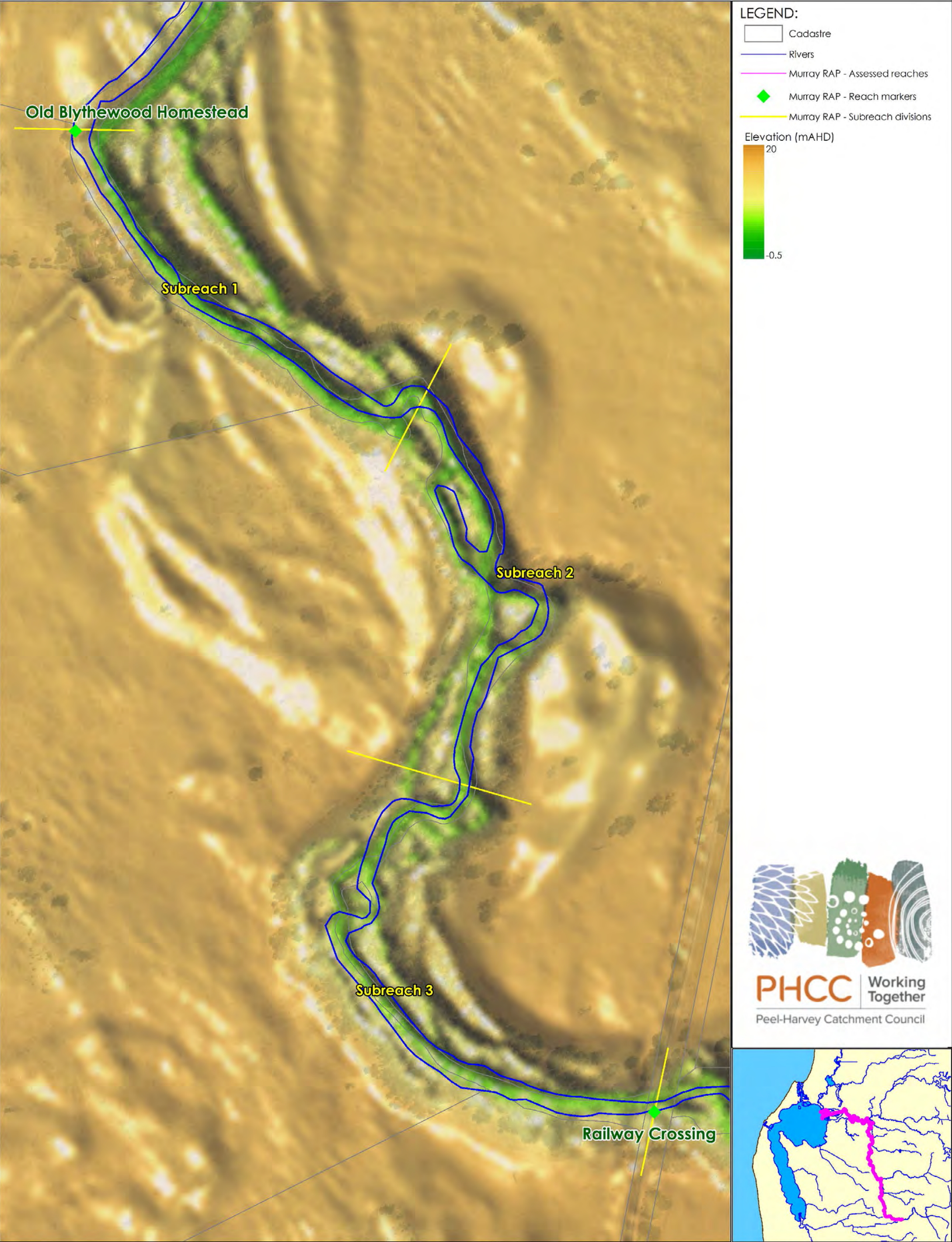
Revegetation:

- Work with landowner to encourage revegetation of understorey of riparian zone, particularly on the western side of the river within this reach. This would be best done after the establishment of fencing to ensure livestock do not destroy revegetation efforts.
- Improve riparian vegetation in areas of bare ground to create good quality habitat corridors.

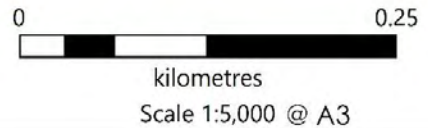


*©2022. While Urbaqua has taken care to ensure the accuracy of this product, Urbaqua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbaqua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.

Peel Harvey Catchment Council - Lower and Middle Murray River Action Plan
Figure 54 - Middle Murray Reach 3: Old Blythwood Homestead to Railway Crossing - Elevation Map.



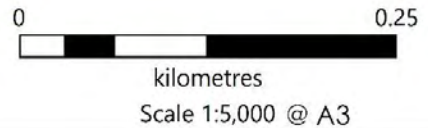
*©2022. While Urbaqua has taken care to ensure the accuracy of this product, Urbaqua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbaqua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.



Scale 1:5,000 @ A3



* ©2022. While Urbaqua has taken care to ensure the accuracy of this product, Urbaqua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbaqua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.



4.9 Middle Murray Reach 3

Reach 3 is 2.7km long and covers the area from Old Blythewood Estate to the Railway crossing of the Murray River (Figure 53). This reach is primarily associated with rural land use and incorporates only three landholders and as such any management actions will need to involve those land managers as a primary action.



Plate 10: Middle Murray Reach 3 Photos

Table 20: Middle Murray Reach 3 Description and Conditions



Feature	Comments
Land Use	This reach is entirely Rural (Figure 55).
Fencing and Infrastructure	The entire reach is fenced along the river (Figure 57). The fence along the right bank is in good condition for the whole reach. The fence on the left bank is in average condition (some damage or holes).
Channel Form and Soils	<p>The channel is a meandering, relatively well-defined channel within this reach. There are several anabranches which reconnect with the river downstream forming river islands (Figure 54).</p> <p>There is variable to low flow observed (below 0.1m/s). Riverbed to top of bank varies from 1.5 – 3.0m on each bank with some shallower areas and riffles. There are pools and some sediment island/ deposition along the length. Channel width (bank full) is wide, at 80 – 200m along the extent of the reach, with a bank full depth of 20-30m due to the surrounding topography.</p> <p>The soils on both the left and right bank are predominantly Pinjarra P6a (Very gently undulating alluvial terraces and low rises contiguous with the plain, with deep moderately well to well drained soils associated with major current river systems and larger streams. Acidic red and yellow duplex soils), with some smaller areas of Pinjarra 1a (Flat to very gently undulating plain with deep acidic mottled yellow duplex (or ineffective duplex) soils. Shallow pale sand to sandy loam over clay; imperfect to poorly drained and generally not susceptible to salinity).</p>
Vegetation Cover and Stream Health	<p>This reach has no, to very little, ground cover. There native shrubs and trees are present in the riparian zone, particularly in the upper reaches. The dominant riparian species are swamp paperbark (<i>Melaleuca raphiophylla</i>), flooded gum (<i>Eucalyptus rudis</i>) and tea tree, with some rushes in places. The riparian zone is wide in this reach (60 - 100m). There is a moderate amount of natural regeneration of native woody vegetation.</p> <p>The loss of understorey was mostly due to fire/ flood and human impact.</p>
Weeds	There is a small proportion of weeds within this reach. Weeds observed included; African love grass, dock, thistle, blackberry nightshade, cottonbush, olive species, apple of Sodom, wild oats, Mexican tea, turf grass. There is a high density of weeds near the railway.
Erosion	The erosion within this reach is quite variable. The left bank ranges from low/moderate to high severity across a small proportion of the length (<20%). The right banks ranges from minor erosion with excellent structural integrity (sub reach 1) to high severity (sub reach 3). The proportion of the reaches impacted are low. Much of the reach is subject to erosive pressures because of livestock access, feral animal, human access and cleared vegetation and runoff. No erosion control measures have been implemented.
Habitat Condition	<p>Significant amount of fallen trees and islands within this reach provide multiple habitats for aquatics, as well as crossing points for terrestrial animals. There were a variety of channels, runs, pool and riffles observed in this reach. Riffles are useful habitat as they provide food source on a conveyor belt that brings food to the animals, and shelter from predators. Many species of invertebrates reproduce or grow to maturity in riffles.</p> <p>There is a moderate to dense amount of woody debris along the reach, and what is present, is larger and in various sizes. There are leaves and algae observed, and a moderate proportion biological substrate cover. There was some submerged and floating aquatic plant coverage.</p>
Other Issues	None
Water Quality	The salinity within this reach is slightly brackish and consistent at ~2,100 mg/l (Figure 104).

Feature	Comments
	The DO within this reach is moderate and consistent at ~high 60% to mid 70% (Figure 94).
Community and Cultural Values	<p>Local Bindjareb Noongar Elders and Representatives will provide knowledge and advice on each site, its' cultural significance, and values. Please refer to Section 2.3 of this document to ensure all processes and procedures are followed.</p> <p>Landholders in this reach have used the land for agricultural purposes for many years. They highly value the waterway and have undertaken restoration works such as weed control, revegetation and fencing previously to help improve the ecological condition of the river.</p>

Peel Harvey Catchment Council - Lower and Middle Murray River Action Plan
Figure 56 - Middle Murray Reach 3: Old Blythewood Homestead to Railway Crossing - 2015 Condition Map



Middle Murray River Action Plan
Review 2015
Foreshore Condition Assessment
Reach 3



Legend

- Comment
- Reaches

Grade


- B1-B2
- B2
- B2-B3
- B3
- B3-C1
- C1
- C1-C2
- C2
- C2-C3

0 100 200 300 400 500 m

Scale: 1:7,000
(When printed on A3)

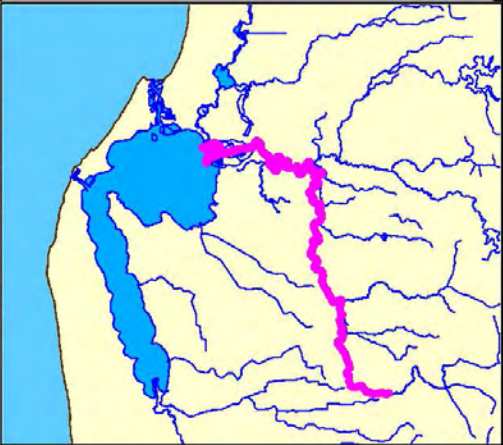
GDA94 UTM50
Aerial Photo: Metro South 2013
Prepared By C. Archibald
Date:26/10/2015

Peel-Harvey Catchment Council
Rivers 2 Ramsar
Connecting River Corridors
for Landscape Resilience



Australian Government

This project is supported by the
Peel-Harvey Catchment Council
through funding from the
Australian Government



*©2022. While Urbaqua has taken care to ensure the accuracy of this product, Urbaqua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbaqua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.

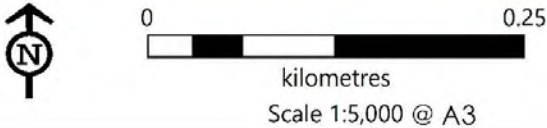


Table 21: Middle Murray Reach 3 Management Actions and Recommendations

Issues

- Weed infestation (lovegrass in particular).
- Dense debris across the river which although can provide good habitat, can also cause obstruction issues and erosion impacts if not managed appropriately.
- Sediment build-up within the river.

Prioritised management actions recommended

Revegetation:

- Continue to work with landholders to restore biodiversity to the river through weed control and revegetation programs, particularly in areas of bare ground.

Community engagement:

- Provide landowners with advice on the management of large woody debris to still maintain the habitat it provides.
- Provide landholders with advice and resources to control feral animals, particularly rabbits and foxes.

Planning/ Engagement:

- Provide resources and/or preparation of guidelines aimed at residents and landholders abutting and interacting with the river. Options include;
 - Management of large woody debris while maintaining diverse habitats
- Direct landowners and residents to existing guidance on;
 - Feral animal management including guidance on baiting (SoM and DPIRD websites)

Long term management actions recommended

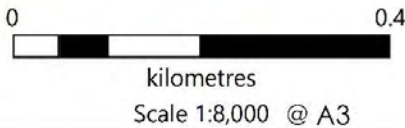
Community engagement:

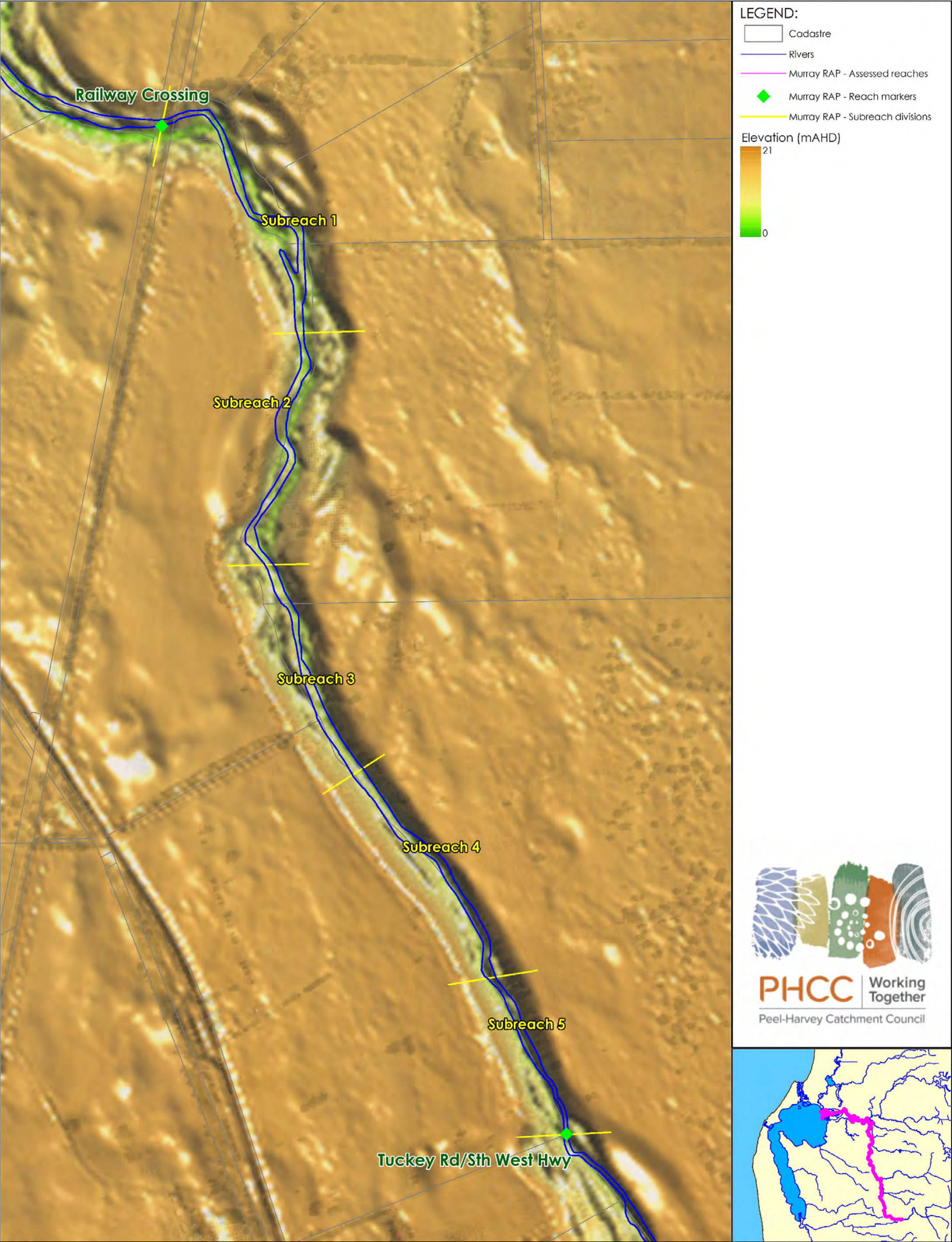
- Provide landholders with advice on erosion control and assist with resources to ameliorate sites to reduce sediment build up in the river.
 - With investigation, work with landholders to consider improving habitat for fish where applicable.
-

Peel Harvey Catchment Council - Lower and Middle Murray River Action Plan
Figure 58 - Middle Murray Reach 4: Railway Crossing to Tuckey Rd/Sth West Hwy - Location Map



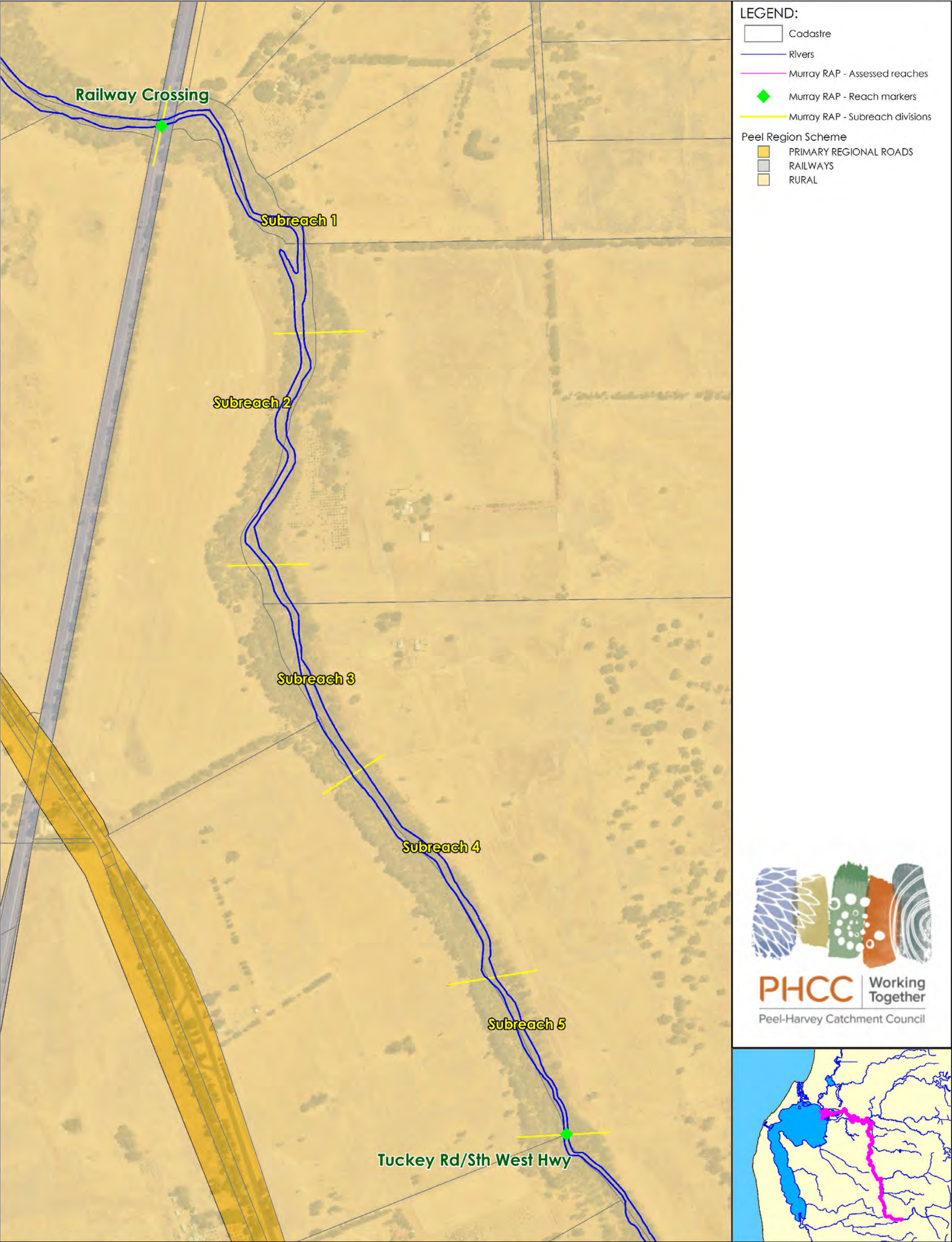
*©2022. While Urbaqua has taken care to ensure the accuracy of this product, Urbaqua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbaqua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.



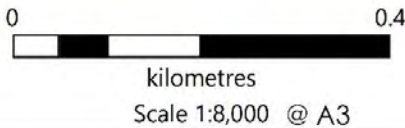


* ©2022. While Urbaqua has taken care to ensure the accuracy of this product, Urbaqua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbaqua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.

Peel Harvey Catchment Council - Lower and Middle Murray River Action Plan
Figure 60 - Middle Murray Reach 4: Railway Crossing to Tuckey Rd/Sth West Hwy - Landuse Map (PRS)



* ©2022. While Urbaqua has taken care to ensure the accuracy of this product, Urbaqua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbaqua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.



4.10 Middle Murray Reach 4

Reach 4 is 3.1km long and covers the area from the Railway crossing upstream to South-West Hwy (Figure 58). This reach is primarily associated with rural land use.



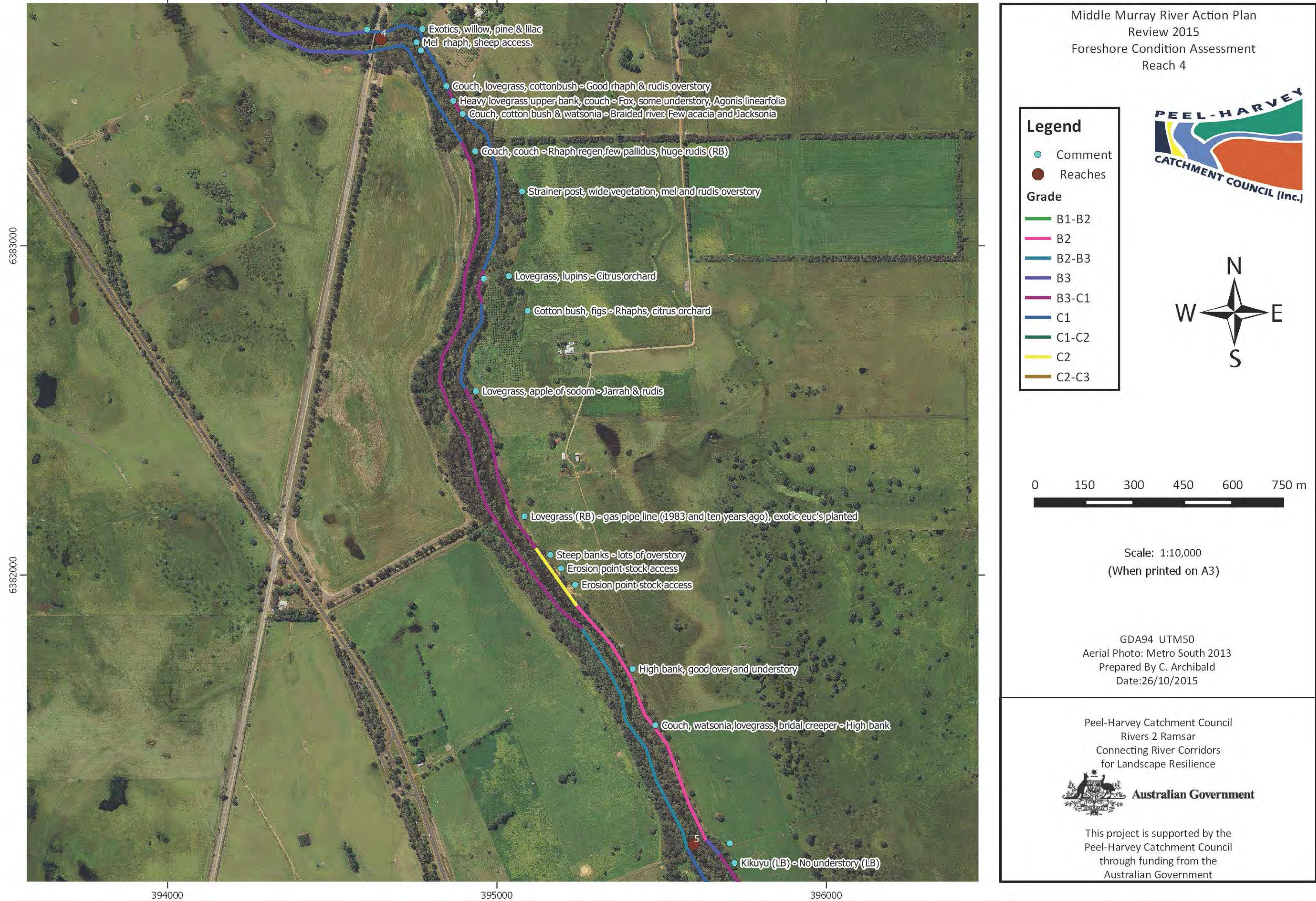
Plate 11: Middle Murray Reach 4 Photos

Table 22: Middle Murray Reach 4 Description and Conditions

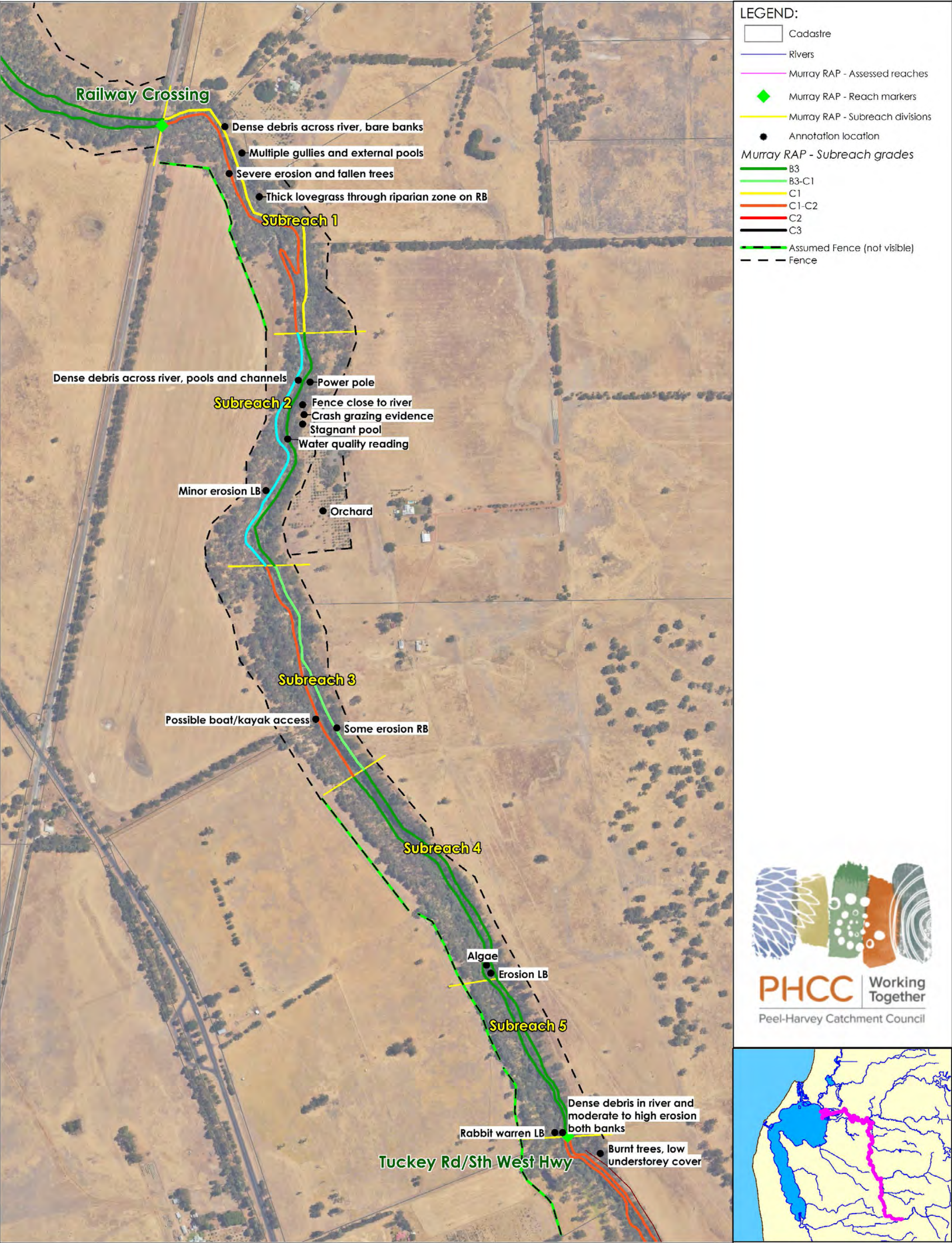
Feature	Comments
Land Use	The land surrounding this reach is all Rural and is used for livestock grazing (Figure 60)
Fencing and Infrastructure	The whole reach is fenced and in good condition, except for a small section in sub reach 5 which is in average condition on the left bank. Most of the fencing is used to keep the livestock away from the river permanently (Figure 62).
Channel Form and Soils	<p>The channel is a relatively straight, well-defined channel within this reach (Figure 59).</p> <p>There is variable to low flow observed (below 0.1m/s). Riverbed to top of bank varies from 0.05 in riffles to 3.0m. The water depth is highly variable in this reach. There are pools present and high levels of sedimentation are obvious between pools. The total channel width is wide at 50 – 150m across for the extent of the reach. The channel depth (bank full depth) varies between 20 to 30m deep.</p> <p>The soils on both the left and right bank are predominantly Pinjarra P6a (Very gently undulating alluvial terraces and low rises contiguous with the plain, with deep moderately well to well drained soils associated with major current river systems and larger streams. Acidic red and yellow duplex soils), with some smaller areas of Pinjarra 1a set back from the foreshore (Flat to very gently undulating plain with deep acidic mottled yellow duplex (or ineffective duplex) soils. Shallow pale sand to sandy loam over clay; imperfect to poorly drained and generally not susceptible to salinity).</p>
Vegetation Cover and Stream Health	The riparian zone is reduced in the native ground cover, shrubs, and trees. The dominant riparian species are swamp paperbark (<i>Melaleuca raphiophylla</i>), flooded gum (<i>Eucalyptus rudis</i>) and tea tree. The riparian zone is wide in this reach (30 - 70m). There is a moderate amount of natural regeneration of native woody vegetation (both shrubs and trees). The loss of understorey was mostly due to fire/ flood and human impact.
Weeds	There is a small proportion of shrub and tree exotics, but a fairly high proportion of weed ground cover. Weeds observed included; African love grass, blackberry nightshade, cottonbush, dock, thistle, Mexican tea, ficus, wild oats, orchard trees, watsonia, grasses.
Erosion	The erosion severity was very uniform across this reach. The entire reach on the left and right banks had low/ moderate severity of erosion and a low proportion of the length affected (<20%). There was no livestock access for most of this reach except for some isolated occurrences of bank damage, but for the most part, erosion within this reach is not a major issue. No erosion control measures had been implemented.
Habitat Condition	<p>Significant amount of fallen trees and islands within this reach provide multiple habitats for aquatics, as well as crossing points for terrestrial animals. There were a variety of channels, runs, pool and riffles observed in this reach. Riffles are useful habitat as they provide food source on a conveyor belt that brings food to the animals, and shelter from predators. Many species of invertebrates reproduce or grow to maturity in riffles.</p> <p>There is a moderate to dense amount of woody debris along the reach, and what is present, is larger and in various sizes. There are leaves and algae observed, and a moderate proportion biological substrate cover. There was a moderate amount of submerged aquatic plant coverage.</p>
Other Issues	There was some evidence of fox dens and rabbit warrens (Figure 62).
Water Quality	<p>The salinity within this reach is slightly brackish and consistent at ~2,100 mg/l (Figure 105).</p> <p>The DO within this reach is varied (from mid 50% to mid 90%)(Figure 95).</p>

Feature	Comments
Community and Cultural Values	<p>Local Bindjareb Noongar Elders and Representatives will provide knowledge and advice on each site, its' cultural significance, and values. Please refer to Section 2.3 of this document to ensure all processes and procedures are followed.</p> <p>Landholders in this reach have used the land for agricultural purposes for many years. They highly value the waterway and have undertaken restoration works such as weed control, revegetation and fencing previously to help improve the ecological condition of the river.</p>

Peel Harvey Catchment Council - Lower and Middle Murray River Action Plan
Figure 61 - Middle Murray Reach 4: Railway Crossing to Tuckey Rd/Sth West Hwy - 2015 Condition Map



Peel Harvey Catchment Council - Lower and Middle Murray River Action Plan
Figure 62 - Middle Murray Reach 4: Railway Crossing to Tuckey Rd/Sth West Hwy - Current Condition Map.



* ©2022. While Urbaqua has taken care to ensure the accuracy of this product, Urbaqua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbaqua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.

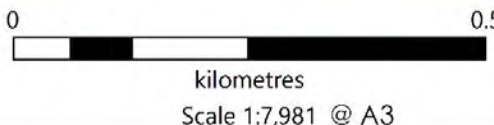


Table 23: Middle Murray Reach 4 Management Actions and Recommendations

Issues

- Biosecurity issues - feral animals were noted along this reach (foxes and rabbits).
- Infestation of weeds.
- Potential for excess nutrient export in run-off.

Prioritised management actions recommended

Planning/ Engagement:

- Preparation of guidelines aimed at local landholders. Guidelines that would be useful for land uses and issues relevant to activities within this reach include;
 - Fencing for livestock to alleviate erosion and pugging
 - Weeding and appropriate ways to remove weeds.
 - Revegetation including appropriate species selection and bank profile location.
 - Erosion control measures or effective bank stabilisation options – also refer landholders to existing relevant guidelines including the *Foreshore Stabilisation Guidelines* (Shire of Murray, 2019) and *Best Management Practices for Foreshore Stabilisation: Brushwall* (DBCA, 2020).
 - Management of large woody debris
- Direct landowners and residents to existing guidance on;
 - Feral animal management including guidance on baiting (SoM and DPIRD websites)
 - Livestock management (SoM website).

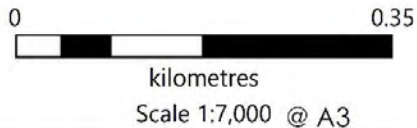
Long term management actions recommended

Weed management:

- Reduce encroachment of Love Grass into the river from drainage reserve by establishing a buffer with low infestation extending at least 50m back from the river and ideally completely remove Love Grass infestation through weed control and revegetation.

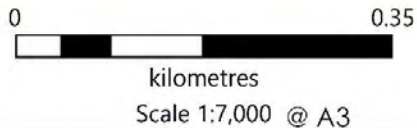


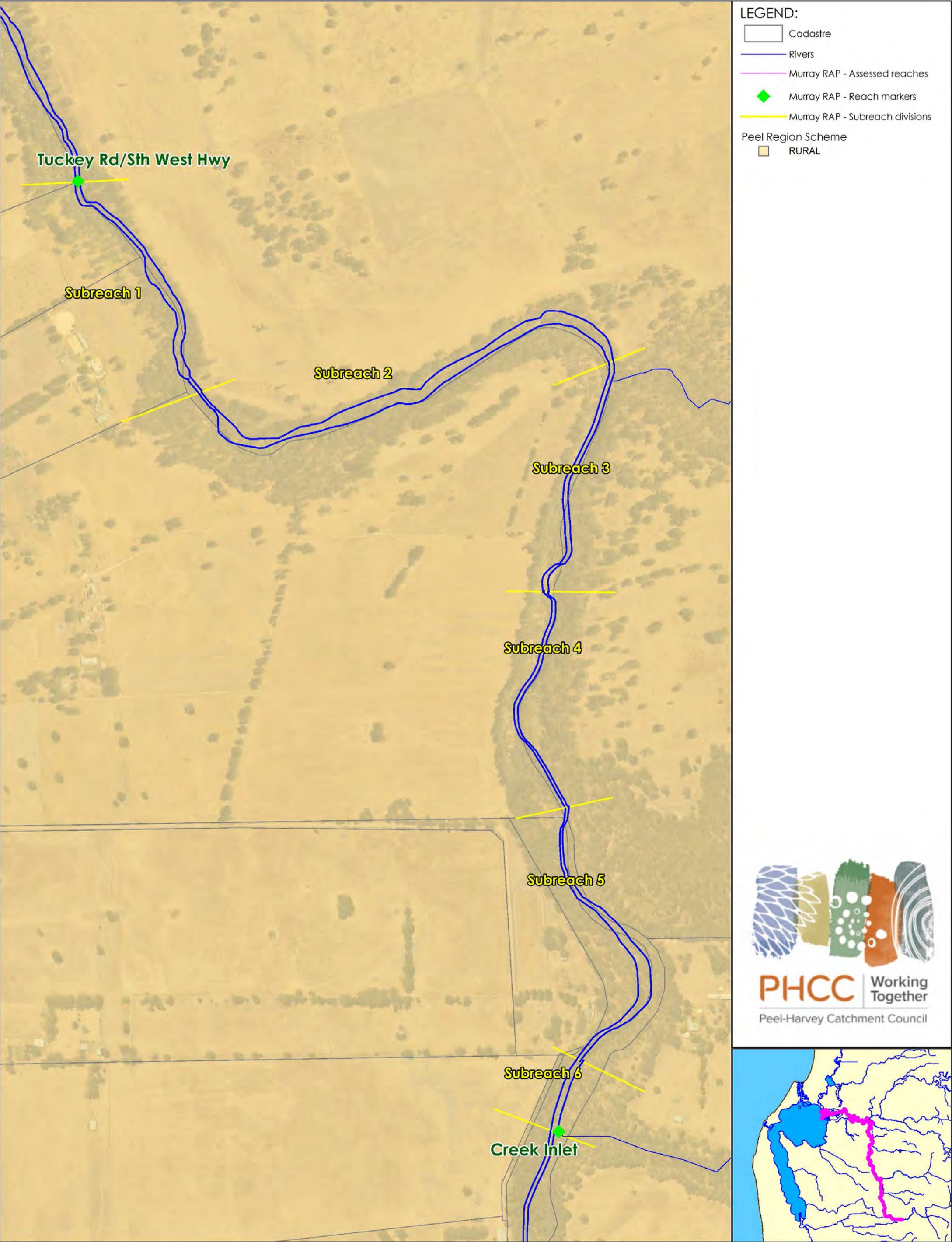
* ©2022. While Urbaqua has taken care to ensure the accuracy of this product, Urbaqua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbaqua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.



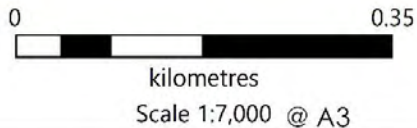


* @2022. While Urbaqua has taken care to ensure the accuracy of this product, Urbaqua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbaqua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.





* ©2022. While Urbaqua has taken care to ensure the accuracy of this product, Urbaqua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbaqua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.



4.11 Middle Murray Reach 5

Reach 5 is 3.5km long and covers the area to the Creek inlet (Figure 63). This reach is associated with rural land use.



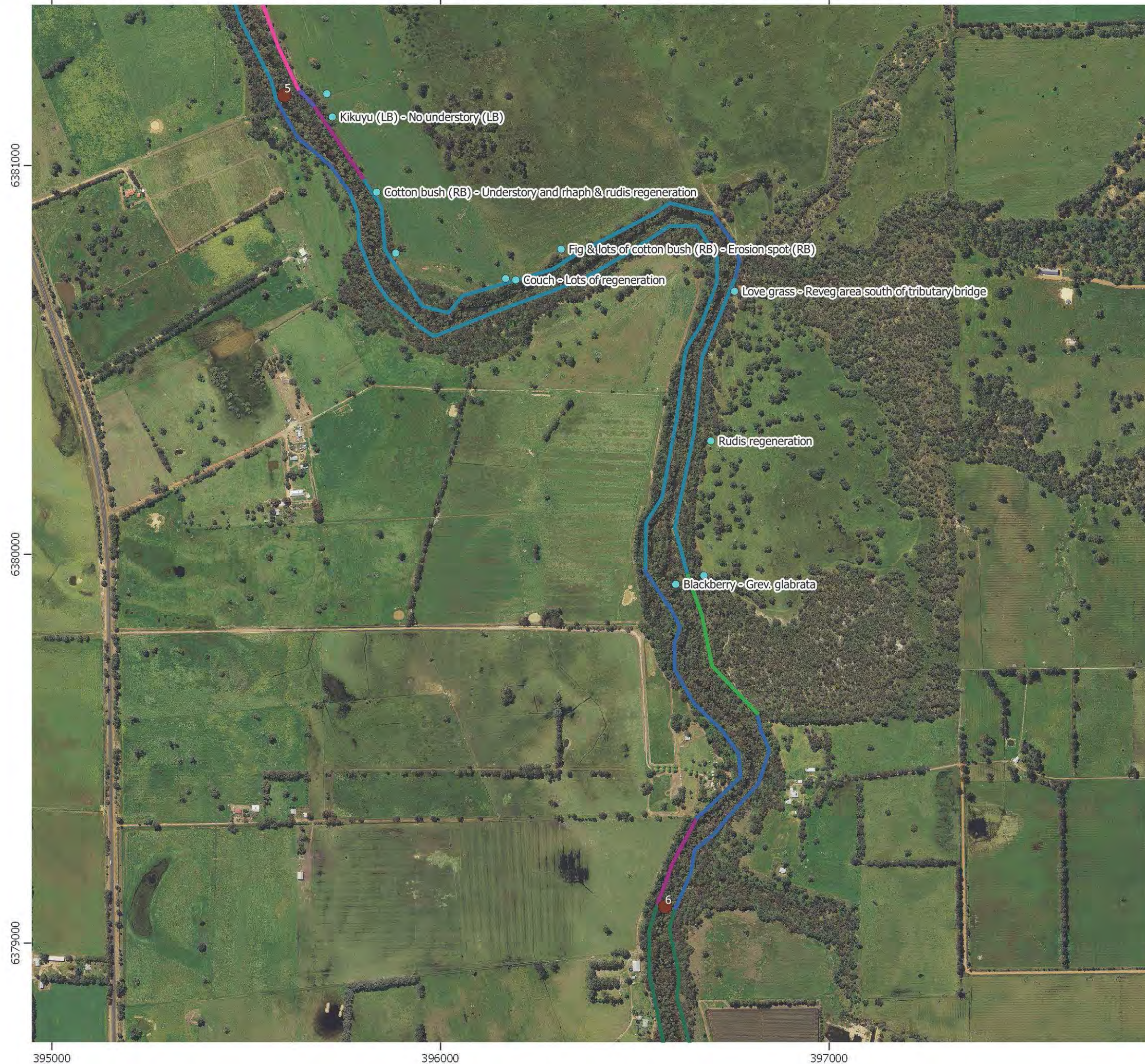
Plate 12: Middle Murray Reach 5 Photos

Table 24: Middle Murray Reach 5 Description and Conditions

Feature	Comments
Land Use	This reach is surrounded by Rural landholdings (Figure 65).
Fencing and Infrastructure	Most of the river is fenced in the reach, and in average to good condition. Some parts of the reach could not be accessed/ seen so the presence of a fence could not be confirmed.
Channel Form and Soils	<p>The channel is a relatively straight, defined channel within this reach. The Creek Inlet joins the river in the upper reach (Figure 64).</p> <p>There is variable to uniform flow across this reach. The water depth is variable in this reach, the riverbed to top of bank varies from 0.05 in riffles to 3.0m. The channel is wide (80m to 180m) and deep (ranging from 20m – 30m).</p> <p>The soils on both the left and right bank are predominantly Pinjarra P6a (Very gently undulating alluvial terraces and low rises contiguous with the plain, with deep moderately well to well drained soils associated with major current river systems and larger streams. Acidic red and yellow duplex soils), and Pinjarra 1a and 1b (Flat to very gently undulating plain with deep acidic mottled yellow duplex (or ineffective duplex) soils. Shallow pale sand to sandy loam over clay; imperfect to poorly drained and generally not susceptible to salinity). There are some Pinjarra P9 associated with shallowly incised stream channels of minor creeks (with deep acidic mottled yellow duplex soils.)</p>
Vegetation Cover and Stream Health	<p>The riparian zone is reduced in the native ground cover and shrubs. The dominant riparian species are swamp paperbark (<i>Melaleuca raphiophylla</i>), flooded gum (<i>Eucalyptus rudis</i>) and tea tree, with some areas of rushes. The riparian zone is wide in this reach (40 - 80m). There is a moderate amount of natural regeneration of native woody vegetation (both shrubs and trees). The loss of understorey was mostly due to fire/ flood and human impact. Many large trees and shrubs remain within the floodway and the understorey is still intact in areas where the fences have been in place for considerable time, even if weeds are dominant.</p> <p>There is an established river health assessment site at the Marrinup Brook/ Murray River confluence that is subject to ongoing monitoring to determine the condition of the river using fish and crayfish as indicators of river health.</p>
Weeds	<p>Weeds made up a large portion of the ground cover in this reach.</p> <p>Weeds observed included; cottonbush, wild oats, African love grass, watsonia, lupins, Mexican tea, grasses, dock, blow fly grass, ficus. Most were consistently observed along the whole reach.</p>
Erosion	The erosion severity was very uniform across this reach. The entire reach on the left and right banks had low/ moderate severity of erosion and a low proportion of the length affected (<20%). There was no livestock access noted in this reach and so, for the most part, erosion within this reach is not a major issue. No erosion control measures had been implemented.
Habitat Condition	<p>There were a variety of channels, runs, pool and riffles observed in this reach.</p> <p>There is a moderate amount of woody debris along the reach and is larger and in various sizes. There are leaves observed, and a moderate proportion biological substrate cover. There was a moderate amount of submerged aquatic plant coverage, and emergent vegetation in the upper reach (Plate 12).</p>
Other Issues	A large revegetation project at Marrinup Brook saw the condition rating improve greatly between to 2008 RAP and 2015 RAP.
Water Quality	The salinity within this reach is slightly brackish and a little more varied, from ~1,800 to 2,100mg/l. The lower salinity ready is near a tributary point so may indicate an influx of fresher water from this (Figure 106).

Feature	Comments
	The DO within this reach is varied (from mid 60% to 110%). The high DO was observed in the upper sub reaches and may be due to the mixing caused by tributaries entering the upper end of the reach (Figure 96).
Community and Cultural Values	<p>Local Bindjareb Noongar Elders and Representatives will provide knowledge and advice on each site, its' cultural significance, and values. Please refer to Section 2.3 of this document to ensure all processes and procedures are followed.</p> <p>The landholders have an extremely high regard for the river in this reach and value its' beauty and the ecosystem service it provides. They have conducted riparian restoration works for many years such as fencing to manage livestock access to the river, weed control and revegetation to improve the overall health of the waterway.</p>

Peel Harvey Catchment Council - Lower and Middle Murray River Action Plan
 Figure 66 - Middle Murray Reach 5: Tuckey Rd/Sth West Hwy to Creek Inlet - 2015 Condition Map



Middle Murray River Action Plan
 Review 2015
 Foreshore Condition Assessment
 Reach 5



Legend

- Comment
- Reaches

Grade

- B1-B2
- B2
- B2-B3
- B3
- B3-C1
- C1
- C1-C2
- C2
- C2-C3



Scale: 1:10,000
 (When printed on A3)

GDA94 UTM50
 Aerial Photo: Metro South 2013
 Prepared By C. Archibald
 Date: 26/10/2015

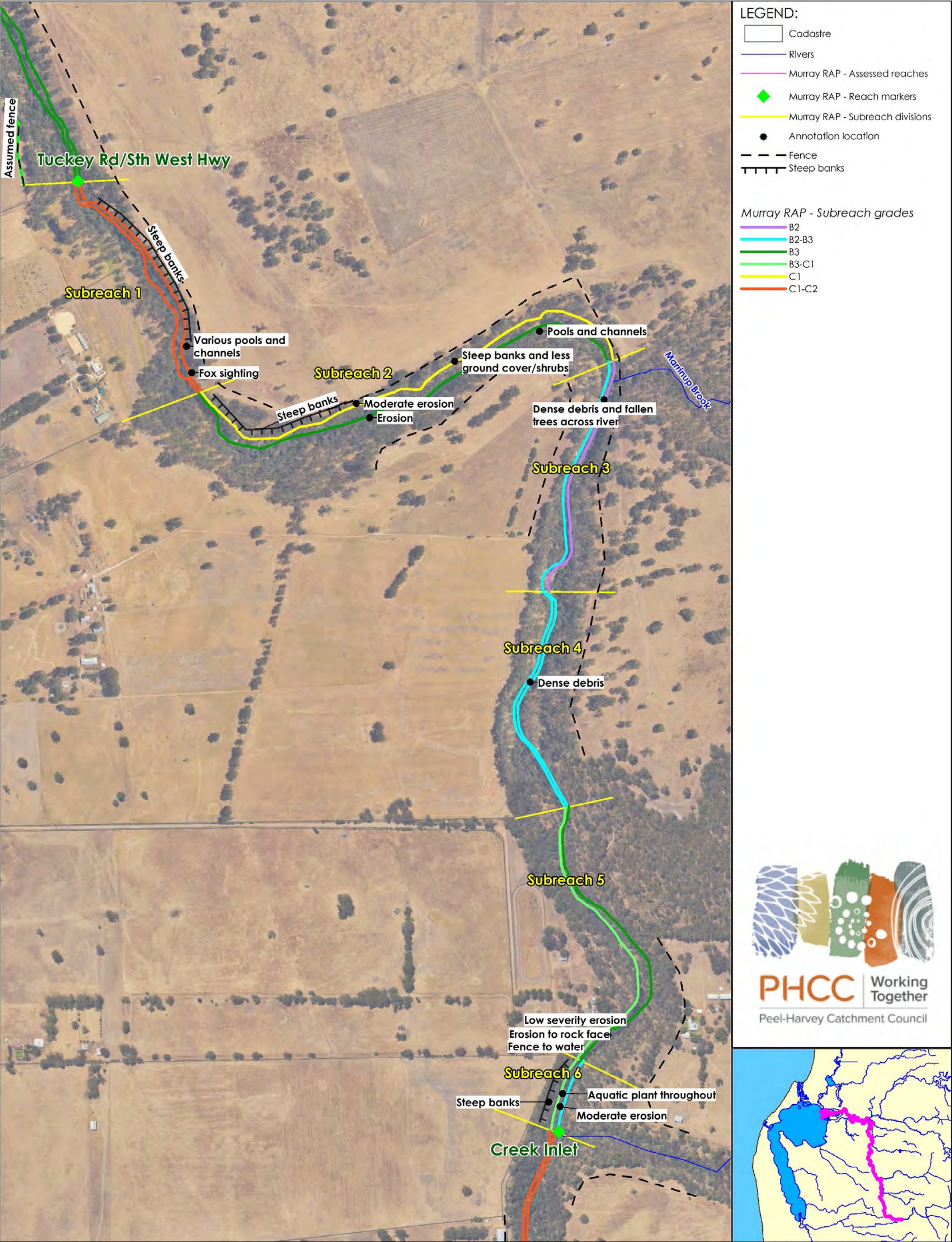
Peel-Harvey Catchment Council
 Rivers 2 Ramsar
 Connecting River Corridors
 for Landscape Resilience



Australian Government

This project is supported by the
 Peel-Harvey Catchment Council
 through funding from the
 Australian Government

Peel Harvey Catchment Council - Lower and Middle Murray River Action Plan
Figure 67 - Middle Murray Reach 5: Tuckey Rd/Sth West Hwy to Creek Inlet - Current Condition Map



*©2022. While Urbaqua has taken care to ensure the accuracy of this product, Urbaqua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbaqua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.

Table 25: Middle Murray Reach 5 Management Actions and Recommendations

Issues

- Feral animals (foxes) noted in this reach.
- Weeds were abundant in this reach (particularly cottonbush).
- Algae and dense aquatic plants were also noted in places.
- Some large, dense debris items noted in stream
- Very steep, large banks noted.
- Litter/ rubbish noted.

Prioritised management actions recommended

Planning/ Engagement:

- Work with landholders to prepare and implement a specific 'Cottonbush Management Plan' (refer to Reach 9, Table 33).
- Provide resources and advice to landholders on how to effectively remove aquatic vegetation without resulting in a nutrient bloom. Consider thinning aquatic weeds.
- Provide resources and/or preparation of guidelines aimed at residents and landholders abutting and interacting with the river. Options include;
 - Weeding and appropriate ways to remove weeds
 - Erosion control measures or effective bank stabilisation options – also refer landholders to existing relevant guidelines including the *Foreshore Stabilisation Guidelines* (Shire of Murray, 2019) and *Best Management Practices for Foreshore Stabilisation: Brushwall* (DBCA, 2020).
 - Management of large woody debris while maintaining diverse habitats
- Direct landowners and residents to existing guidance on;
 - Feral animal management including guidance on baiting (SoM and DPIRD websites)

Water Quality

- Consider including total nitrogen and total phosphorus testing of water quality sampling to assess eutrophication potential.

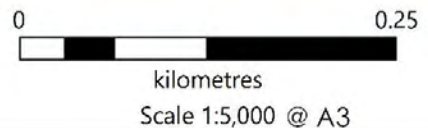
Long term management actions recommended

Community engagement:

- Provide resources and advice to landholders on how to effectively control and manage fallen trees and woody debris.
- Provide landholders with advice and resources to control feral animals, particularly rabbits and foxes.



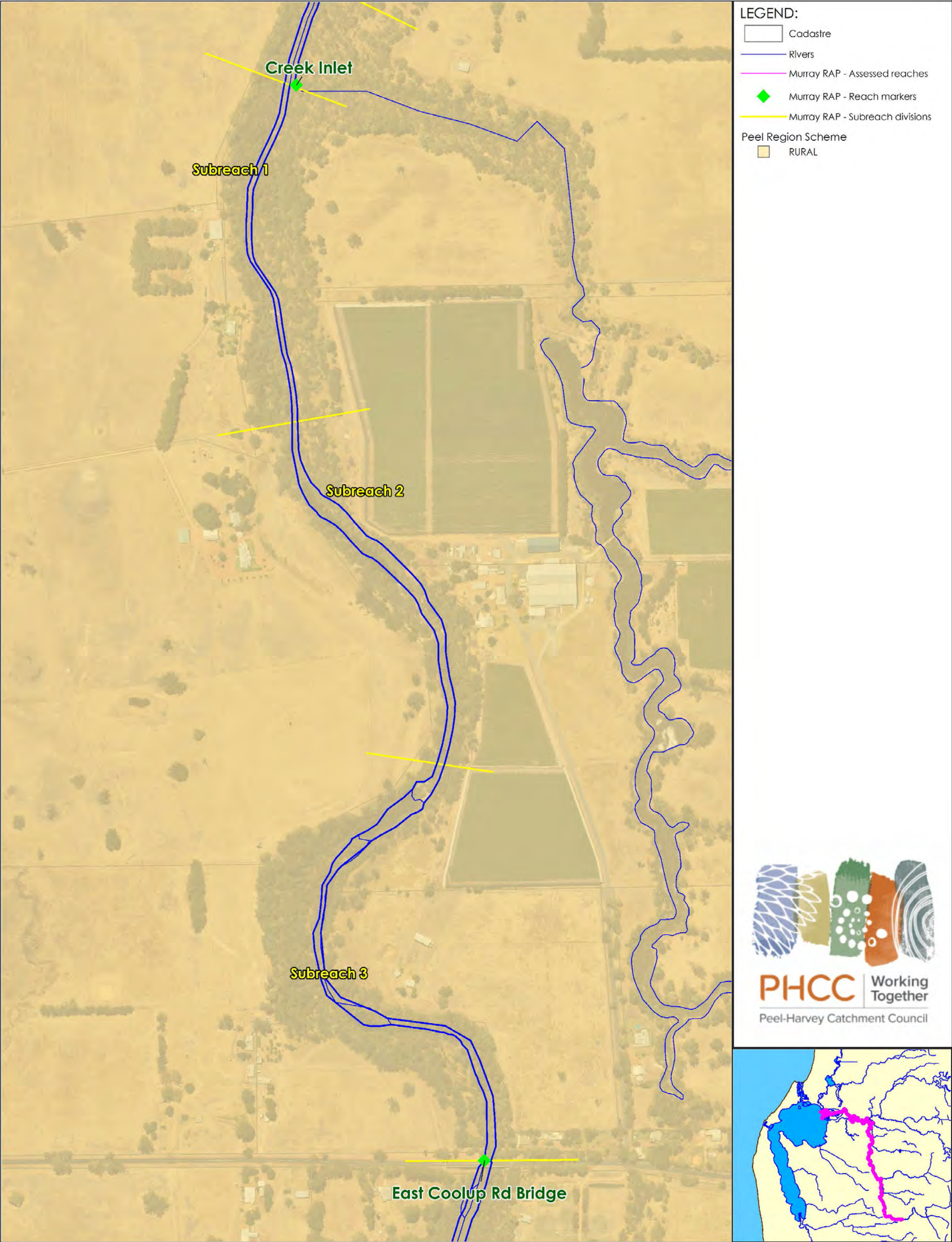
* ©2022. While Urbaqua has taken care to ensure the accuracy of this product, Urbaqua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbaqua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.



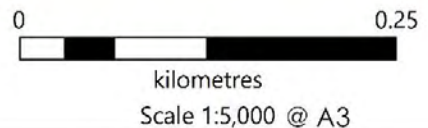


* ©2022. While Urbagua has taken care to ensure the accuracy of this product, Urbagua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbagua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.

Peel Harvey Catchment Council - Lower and Middle Murray River Action Plan
Figure 70 - Middle Murray Reach 6: Creek Inlet to East Coolup Rd Bridge - Landuse Map (PRS)



* ©2022. While Urbaqua has taken care to ensure the accuracy of this product, Urbaqua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbaqua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.



4.12 Middle Murray Reach 6

Reach 6 is 2.0km long and covers the area from the Creek Inlet upstream to the East Coolup Rd bridge (Figure 68). This reach is associated with rural land use.



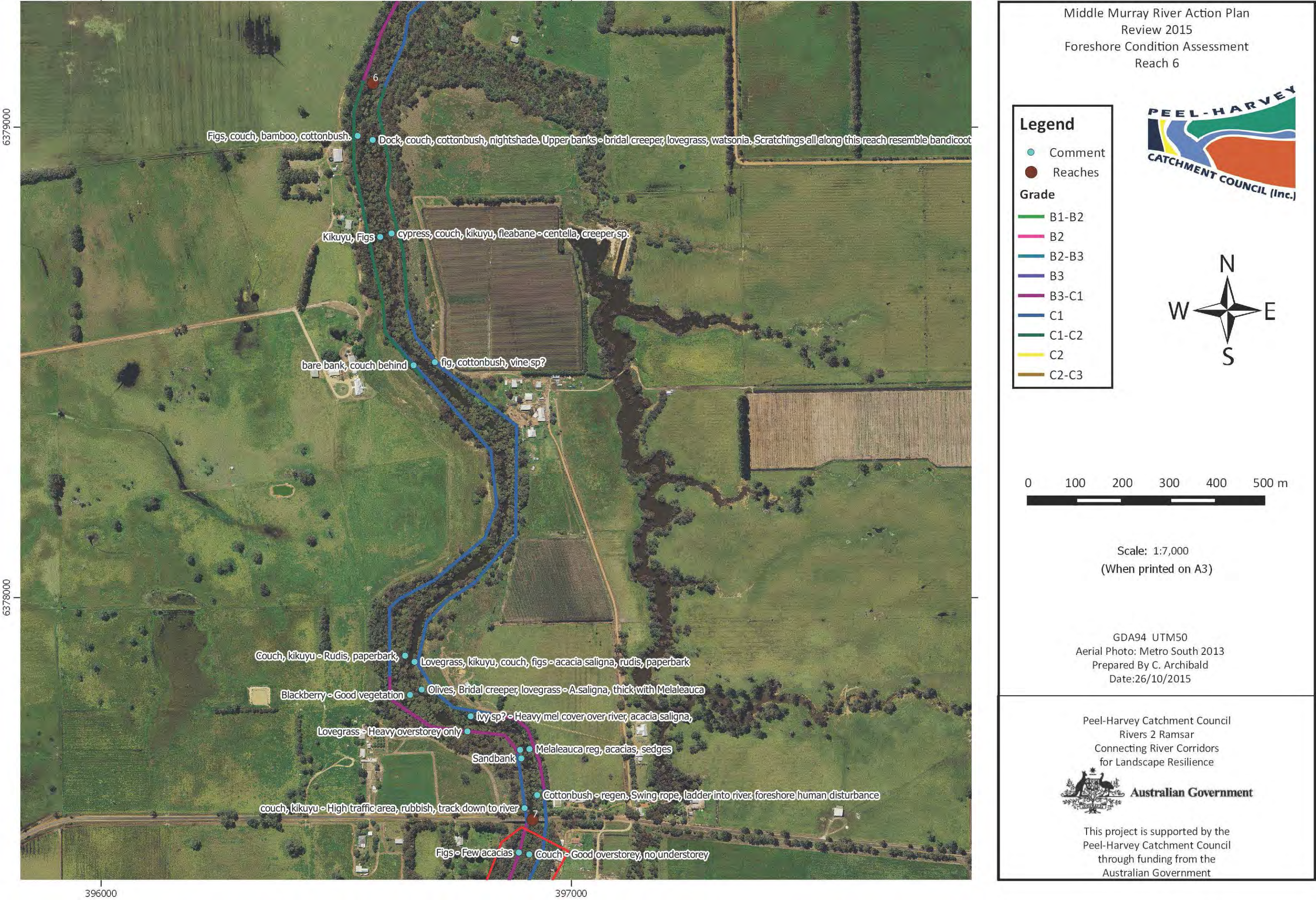
Plate 13: Middle Murray Reach 6 Photos

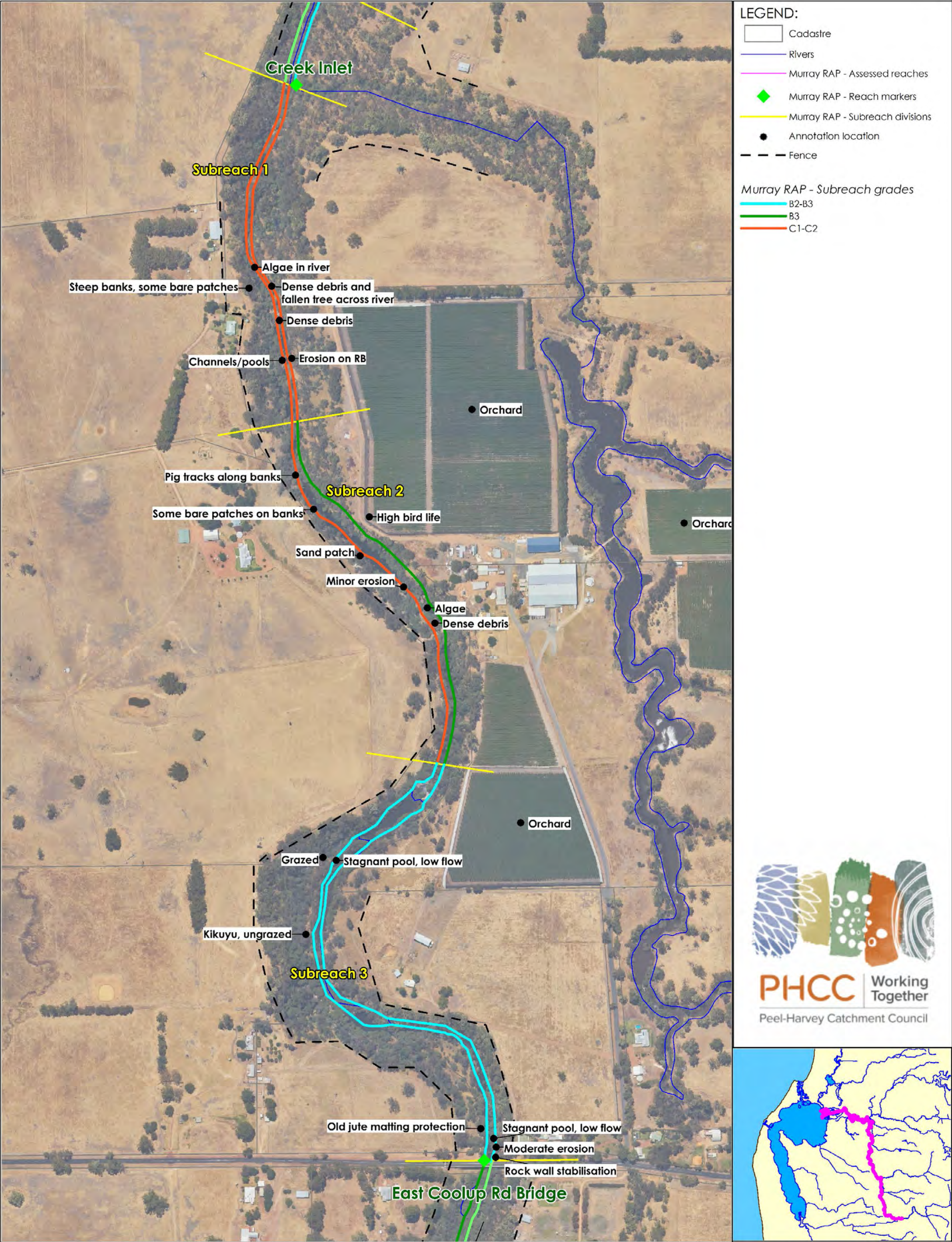
Table 26: Middle Murray Reach 6 Description and Conditions

Feature	Comments
Land Use	This reach is entirely Rural landholdings (Figure 70). There are several large, commercial orchards along this reach.
Fencing and Infrastructure	Almost the entire left bank has good conditioned, fencing along it. The right bank has some fencing in the upper sub reach. Fencing does not appear to be used adjacent to the orchards on the right bank. East Coolup Bridge is at the upper extent of this reach.
Channel Form and Soils	The channel meanders a little, with a defined channel within this reach. The Creek Inlet joins the river in the lower reach (Figure 69). There is variable flow through this reach. The water depth is variable in this reach, the riverbed to top of bank varies from 0.05 in riffles to 3.0m. The channel is wide (100m to 130m) and deep (ranging from 30m – 40m). The soils on both the left and right bank are predominantly Pinjarra P6a (Very gently undulating alluvial terraces and low rises contiguous with the plain, with deep moderately well to well drained soils associated with major current river systems and larger streams. Acidic red and yellow duplex soils), and Pinjarra 1a and 1b (Flat to very gently undulating plain with deep acidic mottled yellow duplex (or ineffective duplex) soils. Shallow pale sand to sandy loam over clay; imperfect to poorly drained and generally not susceptible to salinity). There are some Pinjarra P9 associated with shallowly incised stream channels of minor creeks (with deep acidic mottled yellow duplex soils.)
Vegetation Cover and Stream Health	The riparian zone is reduced in the native ground cover and shrubs. The dominant riparian species are swamp paperbark (<i>Melaleuca raphiophylla</i>), flooded gum (<i>Eucalyptus rudis</i>). The riparian zone is wide in this reach (40 - 60m). There is a moderate to abundant amount of natural regeneration of native woody vegetation (particularly paperbarks). The loss of understorey was mostly due to livestock, and human impact, impact from kangaroos was also noted. Livestock access (sheep) is prevalent in sections of the reach and this is evident from grazing of the understorey.
Weeds	Weed species found along the reach include; fig, blackberry, cottonbush, Mexican tea, thistle, love grass, dock, couch, nightshade. Most were found the entire length of the reach. Watsonia was not found however, which is a marked difference to the 2015 RAP when watsonia dominated.
Erosion	Livestock access occurs along the length of this reach. Most of the impact was due to grazing of groundcover and there was only very slight disturbance was caused movement (<1 track per site). The erosion severity was very uniform across this reach. The entire reach on the left and right banks had low/ moderate severity of erosion. The left bank had a low proportion of the length affected (<20%), whereas the right bank was slightly more affected proportionately. There was no livestock access noted in this reach and so, for the most part, erosion within this reach is not a major issue. No erosion control measures had been implemented.
Habitat Condition	There were a variety of channels, runs, pool and riffles observed in this reach. There is a moderate to dense amount of woody debris along the reach and is larger and in various sizes. There are leaves and algae observed (Plate 13), and a moderate proportion biological substrate cover. There was a significant amount of submerged aquatic plant coverage.
Other Issues	Evidence of foxes and rabbits were noted within this reach (Figure 72).

Feature	Comments
Water Quality	<p>The salinity within this reach is fresh to very slightly brackish and varied from ~500 to 1,500 mg/l (Figure 107).</p> <p>The DO within this reach is varied (from 14% to mid 60%). This reading is low and likely indicative of stagnant water (Figure 97).</p>
Community and Cultural Values	<p>Local Bindjareb Noongar Elders and Representatives will provide knowledge and advice on each site, its' cultural significance, and values. Please refer to Section 2.3 of this document to ensure all processes and procedures are followed.</p> <p>The landholders have an extremely high regard for the river in this reach and value its' beauty and the ecosystem services it provides. They have conducted riparian restoration works for many years such as fencing to manage livestock access to the river, weed control and revegetation to improve the overall health of the waterway.</p>

Peel Harvey Catchment Council - Lower and Middle Murray River Action Plan
Figure 71 - Middle Murray Reach 6: Creek Inlet to East Coolup Rd Bridge - 2015 Condition Map





* ©2022. While Urbaqua has taken care to ensure the accuracy of this product, Urbaqua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbaqua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.

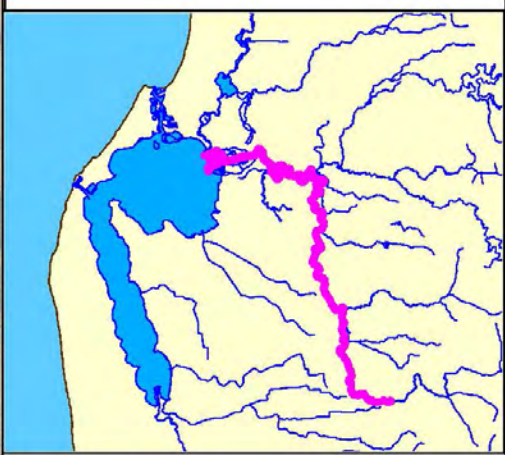
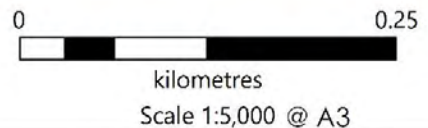


Table 27: Middle Murray Reach 6 Management Actions and Recommendations

Issues

- Some access of livestock to riverbank.
- Feral animals – pigs.
- Weed infestation – cottonbush.
- Dense orchards near the river.
- Algae within the river.

Prioritised management actions recommended

Community engagement:

- Work with landholders to prepare and implement a specific 'Cottonbush Management Plan' (refer to Reach 9, Table 33).
- Work with landholders to install and maintain fencing in a good condition.
- Provide landholders with advice and resources to control feral animals, particularly pigs and possibly rabbits and foxes.
- Engage with the local orchards regarding fertiliser use, runoff management and possibly working together to implement water quality control measures such as vegetated swales before runoff enters the river.

Planning:

- Provide resources and/or preparation of guidelines aimed at residents and landholders abutting and interacting with the river. Options include:
 - Fertiliser management and nutrient loadings.
 - Water quality treatment options for high nutrient runoff.
 - Weeding and appropriate ways to remove weeds.

Habitat creation:

- Consider creating habitat linkages and possible in-stream habitats for fish (pools).

Water Quality

- Consider including total nitrogen and total phosphorus testing of water quality sampling to assess eutrophication potential.

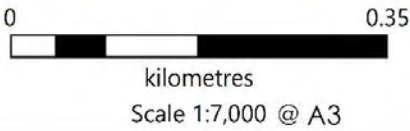
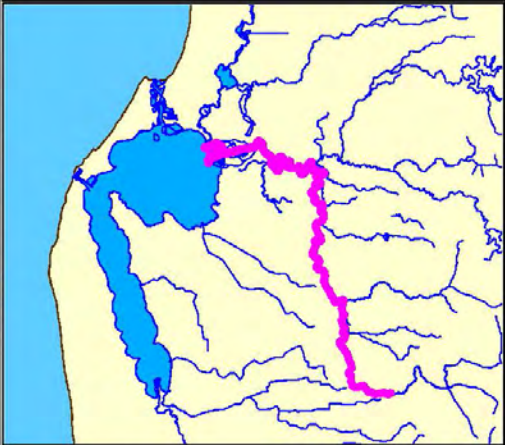
Long term management actions recommended

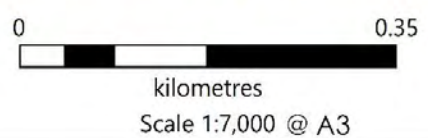
Community engagement:

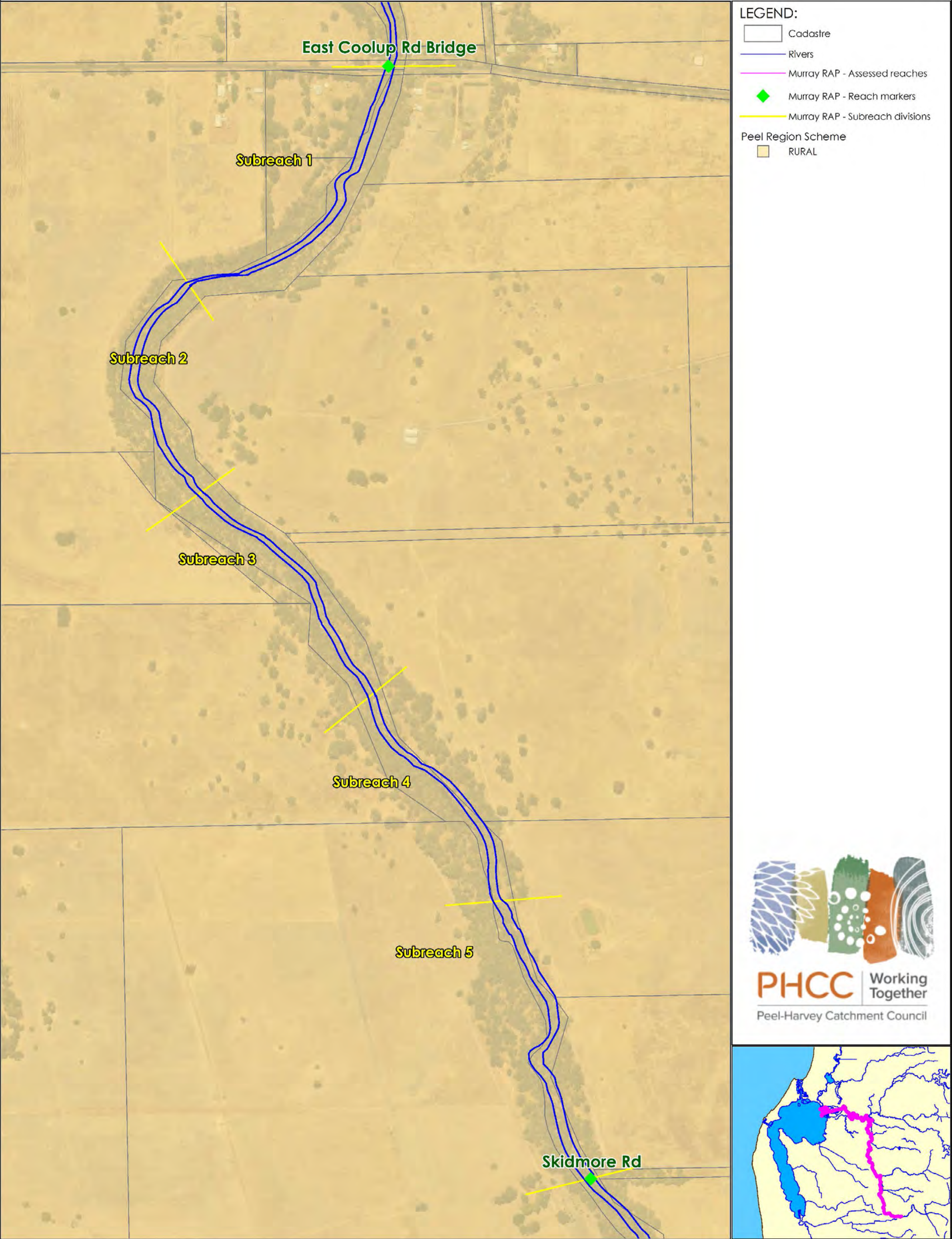
- Work with landholders to improve land use practices and reduce nutrient inputs in the catchment.
-



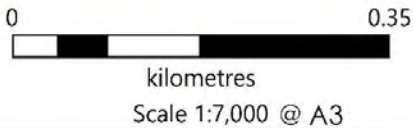
- LEGEND:
- Cadastral
 - Rivers
 - Murray RAP - Assessed reaches
 - Murray RAP - Reach markers
 - Murray RAP - Subreach divisions







* ©2022. While Urbaqua has taken care to ensure the accuracy of this product, Urbaqua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbaqua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.



4.13 Middle Murray Reach 7

Reach 7 is 3.0 km long and covers the area from the East Coolup Rd bridge upstream to Skidmore Rd (Figure 73). This reach is associated with rural land use.



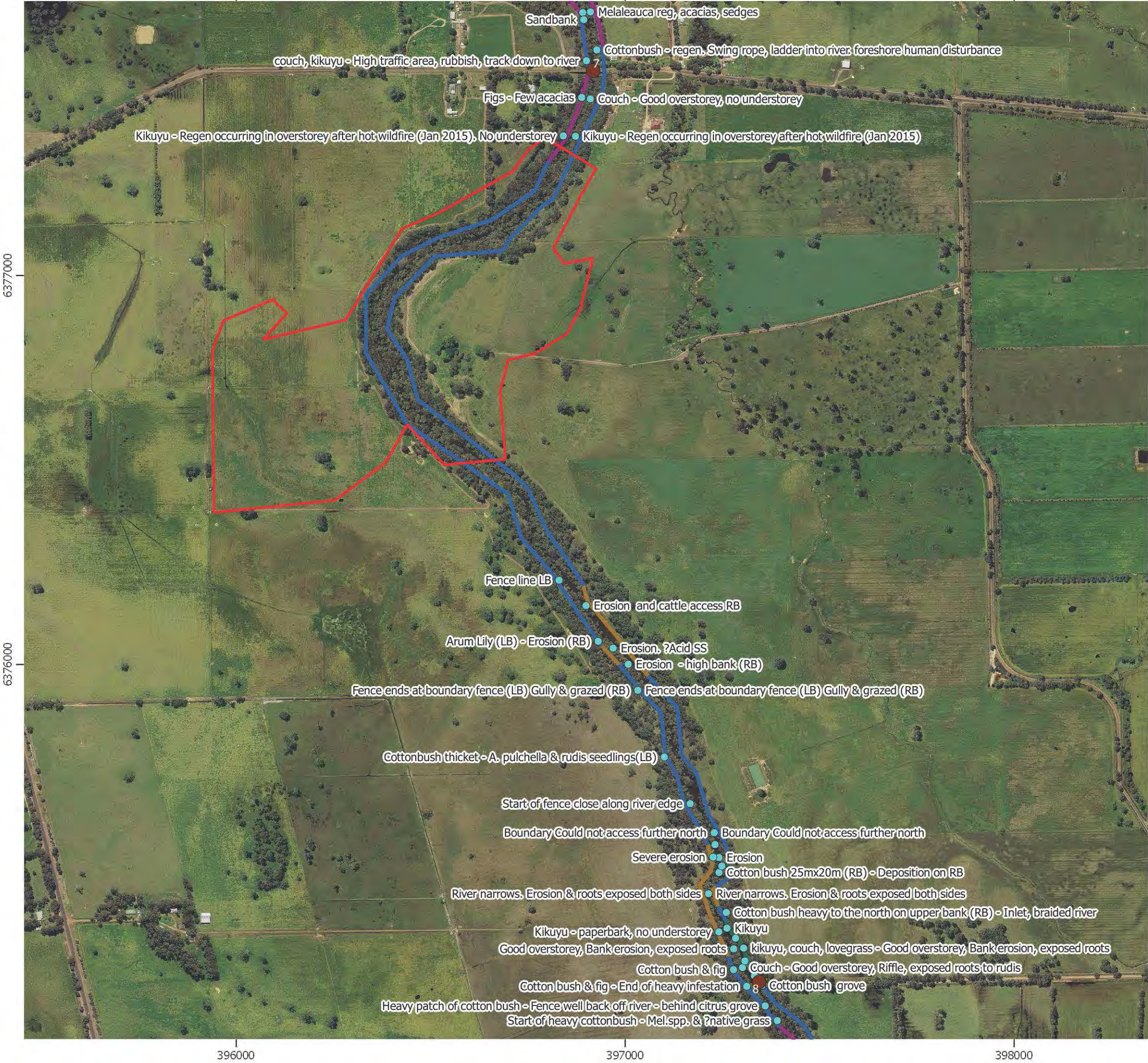
Plate 14: Middle Murray Reach 7 Photos

Table 28: Middle Murray Reach 7 Description and Conditions

Feature	Comments
Land Use	This reach is entirely Rural landholdings (Figure 75).
Fencing and Infrastructure	Fencing is present along most of the reach, the condition of the fencing varies from poor to good. Some sections fencing is absent entirely. East Coolup Bridge is at the lower extent of this reach.
Channel Form and Soils	<p>The channel within this reach is relatively straight with one bend It is a defined channel. The Creek Inlet joins the river in the lower reach (Figure 69). There is mostly variable flow through this reach. The water depth is fairly consistent within this reach, being approximately 1m deep on the left bank and over 3m on the right bank. The bank full channel width is varied (40m to 150m) and deep (ranging from 30m – 40m).</p> <p>The soils on both the left and right bank are Pinjarra P6a (Very gently undulating alluvial terraces and low rises contiguous with the plain, with deep moderately well to well drained soils associated with major current river systems and larger streams. Acidic red and yellow duplex soils).</p>
Vegetation Cover and Stream Health	<p>Much of the riparian area is dominated by weeds. The riparian zone has little, to no, native ground cover due to the presence of weeds. The dominant riparian tree species are swamp paperbark (<i>Melaleuca raphiophylla</i>) and flooded gum (<i>Eucalyptus rudis</i>). Other native species noted included; <i>Grevillea manglesii</i>, <i>Styphandra glauca</i>, <i>Acacia saligna</i>, <i>Acacia pulchella</i>, <i>Corymbia calophylla</i> (Marri), <i>Eucalyptus marginata</i> (Jarrah), and <i>Xanthorrhoea pressii</i>.</p> <p>The riparian zone is wide in this reach (50 - 60m). There is a moderate amount of natural regeneration of healthy native woody vegetation (both shrubs and trees).</p>
Weeds	There are vast swathes of couch and kikuyu grasses within this reach. Sour grass and love grass is also present along the whole length, preventing recruitment of native seedlings. Other weed species include; veld grass, pale pigeon grass, olive trees, cottonbush, oxalis, Mexican tea, Guildford grass, arum lily, paspalum, polichos pea, watsonia, fig, blue lupin, blackberry, cape lilac, bridal creeper, giant reed, edible fig and orange trees.
Erosion	There is a little evidence of livestock present in this reach but generally erosion and bank stability is not considered a major issue in this reach. There was low/moderate severity of erosion along most of this reach with the left bank showing excellent structural integrity in sub reach 5. Some erosion is occurring at the end of Skidmore Rd from drainage water.
Habitat Condition	<p>There were a variety of channels, runs, pool and riffles observed in this reach, with more variety at the upper end of the reach.</p> <p>There is a dense amount of woody debris along the whole reach, an a very wide variety of sizes. There are detritus and leaves, and a dense proportion biological substrate cover. The proportion of submerged aquatic plant coverage was unknown due to depth of water.</p> <p>Feral animals (rabbits and foxes) were sighted along this reach.</p>
Other Issues	<p>Weed encroachment was previously occurring from the East Coolup Road reserve (2015 RAP). Access to the river from the East Coolup Rd, was previously a concern for residents from a perceived fire risk, particularly with large stands of Love Grass. Fencing was installed in 2016 in sub reach 1 to prevent livestock access. Revegetation and weeding occurred on the other side of the new fencing, where woody weeds were removed and guards and matts were used for seedlings (Figure 78).</p> <p>A wildfire in 2015 swept through parts of this reach (sub reach 2 and parts of sub reach 1) (Figure 76). At the time of the 2015 review many native trees and shrubs were showing new growth, however grounds were still relatively bare. In this investigation, the regrowth was so dense</p>

Feature	Comments
	that access and survey to sub reach 2 was not possible. Evidence of more recent bushfire was also present along parts of the right bank.
Water Quality	The salinity within this reach is very slightly brackish at ~ 1,500 mg/l (Figure 108). The DO within this reach is relatively high at 78.1% (Figure 98).
Community and Cultural Values	Local Bindjareb Noongar Elders and Representatives will provide knowledge and advice on each site, its' cultural significance, and values. Please refer to Section 2.3 of this document to ensure all processes and procedures are followed.

Peel Harvey Catchment Council - Lower and Middle Murray River Action Plan
Figure 76 - Middle Murray Reach 7: East Coolup Rd Bridge to Skidmore Rd - 2015 Condition Map



Middle Murray River Action Plan
Review 2015
Foreshore Condition Assessment
Reach 7

Legend

- Comment
- Reaches

Grade

- B1-B2
- B2
- B2-B3
- B3
- B3-C1
- C1
- C1-C2
- C2
- C2-C3
- Burnt Jan 2015

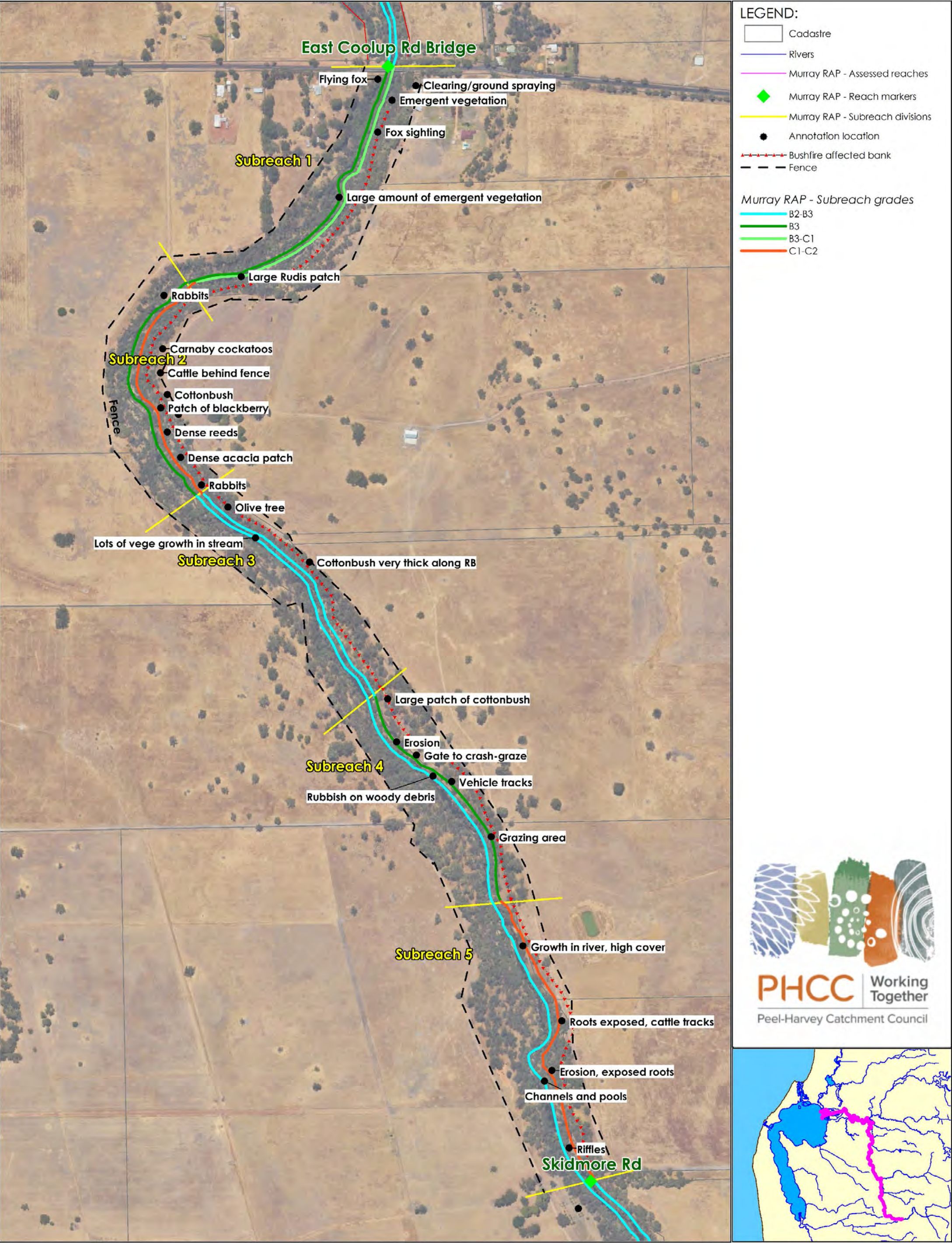
Scale: 1:10,000
(When printed on A3)

GDA94 UTM50
Aerial Photo: Metro South 2013
Prepared By C. Archibald
Date:24/11/2015

Peel-Harvey Catchment Council
Rivers 2 Ramsar
Connecting River Corridors
for Landscape Resilience

Australian Government

This project is supported by the
Peel-Harvey Catchment Council
through funding from the
Australian Government



*©2022. While Urbaqua has taken care to ensure the accuracy of this product, Urbaqua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbaqua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.



* ©2022. While Urbaqua has taken care to ensure the accuracy of this product, Urbaqua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbaqua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.

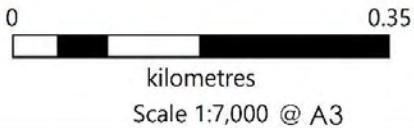


Table 29: Middle Murray Reach 7 Management Actions and Recommendations

Issues

- Biosecurity - Feral animals noted in several places (rabbits and foxes).
- Vast swathes of couch and kikuyu grasses within this reach. Sour grass and love grass is also present along the whole length, preventing recruitment of native seedlings

Prioritised management actions recommended

Community engagement:

- Provide resources to landholders to eradicate invasive grasses from the channel in conjunction with planting of native ground cover and shrubs to improve riparian vegetation.
- Provide landholders with advice and resources to control feral animals, particularly rabbits and foxes. Direct landowners and residents to existing guidance on;
 - Feral animal management including guidance on baiting (SoM and DPIRD websites)
 - Water quality treatment options for high nutrient runoff.

Long term management actions recommended

Erosion management:

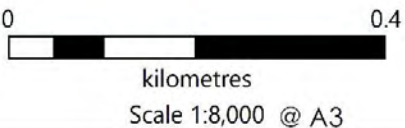
- Discuss erosion control measures for Skidmore Rd Drain entering river reserve with SoM and DWER.
-



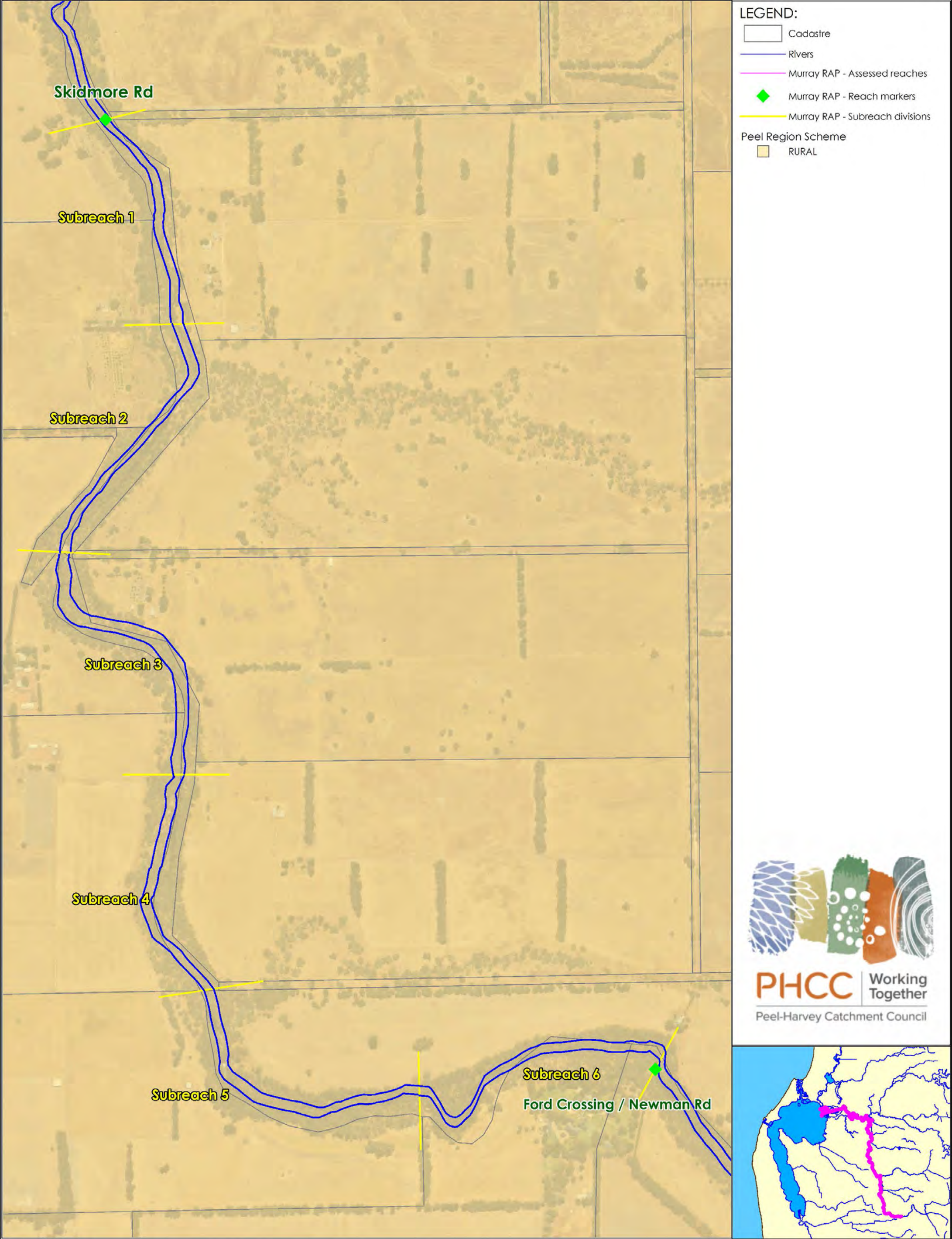
* ©2022. While Urbaqua has taken care to ensure the accuracy of this product, Urbaqua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbaqua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.



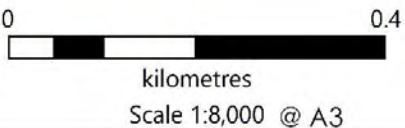
* ©2022. While Urbaqua has taken care to ensure the accuracy of this product, Urbaqua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbaqua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.



Scale 1:8,000 @ A3



* ©2022. While Urbaqua has taken care to ensure the accuracy of this product, Urbaqua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbaqua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.



4.14 Middle Murray Reach 8

Reach 8 is 4.0 km in length and covers the area from Skidmore Rd upstream to the Ford Crossing at the end of Newman Rd (Figure 79). This reach is associated with rural land use.



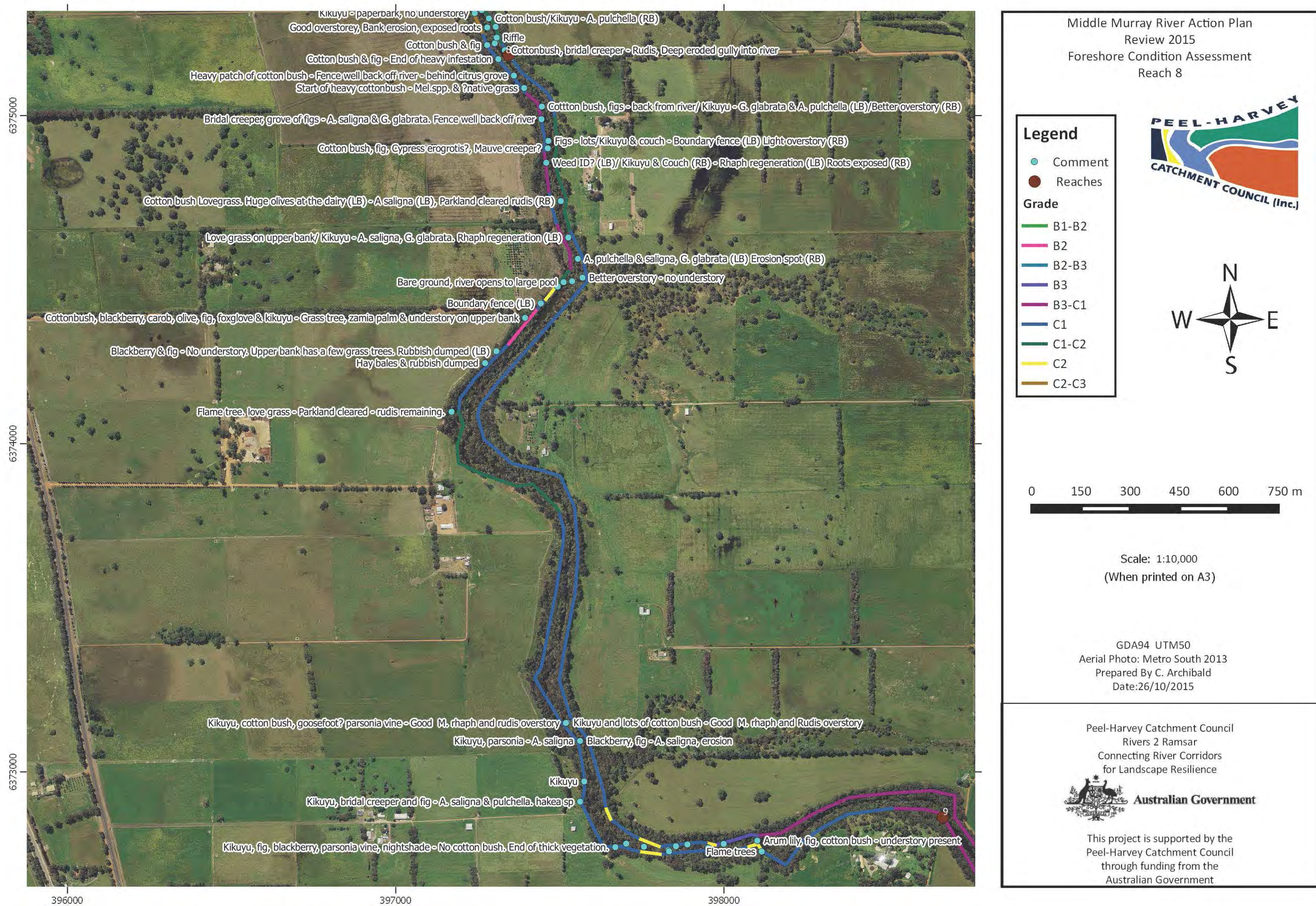
Plate 15: Middle Murray Reach 8 Photos

Table 30: Middle Murray Reach 8 Description and Conditions

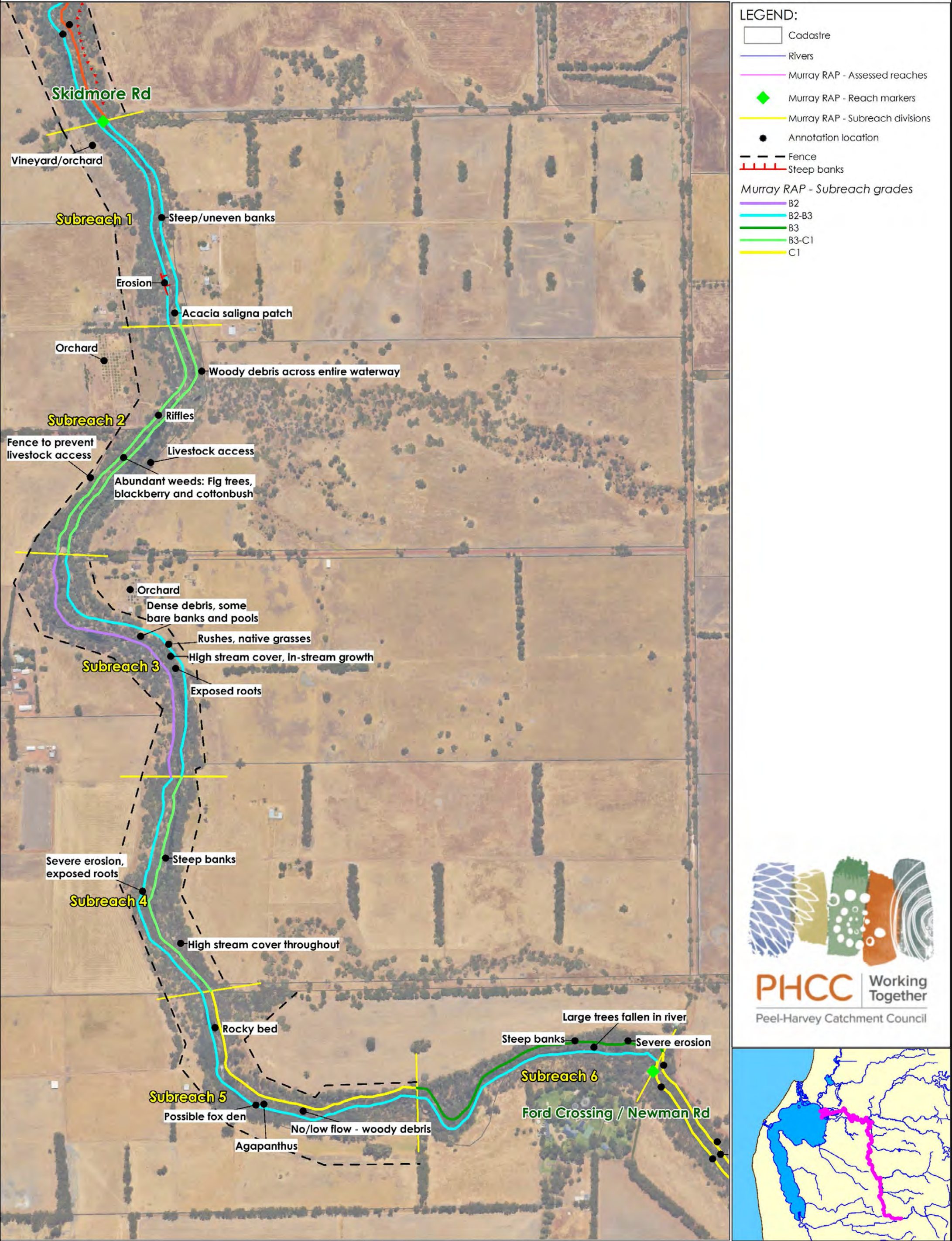
Feature	Comments
Land Use	The surrounding land use is Rural (Figure 81). There are some small vineyards and orchards within this reach.
Fencing and Infrastructure	The left bank has fencing down most of the length. Fencing on the right bank is sporadic but present in places. The fences were in good condition.
Channel Form and Soils	<p>The channel meanders within this reach and has a right bend towards to scarp. It is a relatively well-defined channel. There are two tributary which join the river in sub reach 2 and 4 (Figure 80). There is mostly variable flow through this reach. The water depth is variable within this reach, ranging from shallow in the riffles to deep water (>3m). The bank full channel width is varied (80m to 200m) and deep (ranging from 30m – 50m).</p> <p>The soils on both the left and right bank are Pinjarra P6a (Very gently undulating alluvial terraces and low rises contiguous with the plain, with deep moderately well to well drained soils associated with major current river systems and larger streams. Acidic red and yellow duplex soils) with a small amount of Pinjarra P9 (Shallowly incised stream channels of minor creeks and rivers with deep acidic mottled yellow duplex soils).</p>
Vegetation Cover and Stream Health	<p>The riparian zone has a varied amount of native groundcover (from no to some) native ground cover. This is inversely proportional to the weed groundcover proportion. Sub reach 3 had native groundcover. The dominant riparian tree species are swamp paperbark (<i>Melaleuca rhaphiophylla</i>), tea tree and flooded gum (<i>Eucalyptus rudis</i>). The riparian zone is wide in this reach (40 - 70m).</p> <p>Native grevillea was sighted (possibly a P2). There was a fairly moderate amount of organic litter observed in the riparian zone.</p> <p>A moderate amount of healthy, natural regeneration of native woody vegetation occurred within this reach.</p>
Weeds	<p>Weeds dominated the understorey and ground cover within this reach, particularly cottonbush.</p> <p>Weeds observed included; love grass, dock, nut grass, Mexican tea, nightshade, fleabane, figs, blackberry, wild oat, cottonbush, olive trees, blow fly grass. These species were mostly observed throughout the whole length of the reach.</p>
Erosion	<p>Erosion problems occur in the areas where livestock have access to the river in the lower reaches. Generally, the whole reach had low/moderate severity of erosion. There was evidence of exposed tree roots in some places. Livestock issues included bank damage, loss of vegetation and tracks.</p> <p>The upper end of the reach (sub reach 6) had greater erosion severity, moderate to high, particularly on the right bank. Although no livestock were noted in this section. Factors that were affecting bank stability in this area included runoff, flows, and a culvert crossing.</p>
Habitat Condition	<p>There were a variety of channels, runs, pool and riffles observed in this reach.</p> <p>There is a moderate to dense amount of woody debris along the upper end of the reach, however the low end showed more sparse coverage. There are algae, detritus and leaves present but low proportion biological substrate cover. The proportion of submerged aquatic plant coverage was variable.</p>
Other Issues	The 2015 review has revealed that cottonbush, has become more widespread in lower reaches, requiring urgent action. This reach had seen quite a significant decrease to its condition since the 2008 study. Although the understory still has weeds present, the ratings have improved for this reach since 2015.
Water Quality	The salinity within this reach is slightly brackish at ~ 1,700 mg/l and fairly consistent through the reach (Figure 109).

Feature	Comments
	The DO within this reach is slightly varied, from mid 50% to low 70% (Figure 99).
Community and Cultural Values	<p>Local Bindjareb Noongar Elders and Representatives will provide knowledge and advice on each site, its' cultural significance, and values. Please refer to Section 2.3 of this document to ensure all processes and procedures are followed.</p> <p>Landholders in this reach highly value the river, not only for its' beauty but for the ecosystem services it provides. They have conducted restoration works such as weed control, fencing and revegetation and are passionate about continuing these restoration works to protect and conserve the Murray River into the future.</p>

Peel Harvey Catchment Council - Lower and Middle Murray River Action Plan
Figure 82 - Middle Murray Reach 8: Skidmore Rd to Ford Crossing/Newman Rd - 2015 Condition Map



Peel Harvey Catchment Council - Lower and Middle Murray River Action Plan
Figure 83 - Middle Murray Reach 8: Skidmore Rd to Ford Crossing / Newman Rd - Current Condition Map



*©2022. While Urbaqua has taken care to ensure the accuracy of this product, Urbaqua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbaqua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.



Table 31: Middle Murray Reach 8 Management Actions and Recommendations

Issues

- Weeds – cottonbush.
- Erosion in spots with exposed root zones.
- Feral animals.
- Some smaller local orchards and a vineyard adjacent to river which has potential for nutrient export from fertilisers.
- Large wooden debris.

Prioritised management actions recommended

Community engagement:

- Work with landholders to prepare and implement a specific 'Cottonbush Management Plan' (refer to Reach 9, Table 33).
- Provide landholders with advice on erosion control and assist with resources to ameliorate sites.
- Direct landowners and residents to existing guidance on feral animal management including guidance on baiting (SoM and DPIRD websites).

Water Quality

- Consider including total nitrogen and total phosphorus testing of water quality sampling to assess eutrophication potential.

Long term management actions recommended

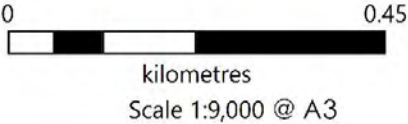
Community engagement:

- Provide incentives for landholders to fence off the river to livestock in areas where fencing has deteriorated, and rehabilitate the riparian zone through weed control, revegetation and some erosion control.
-

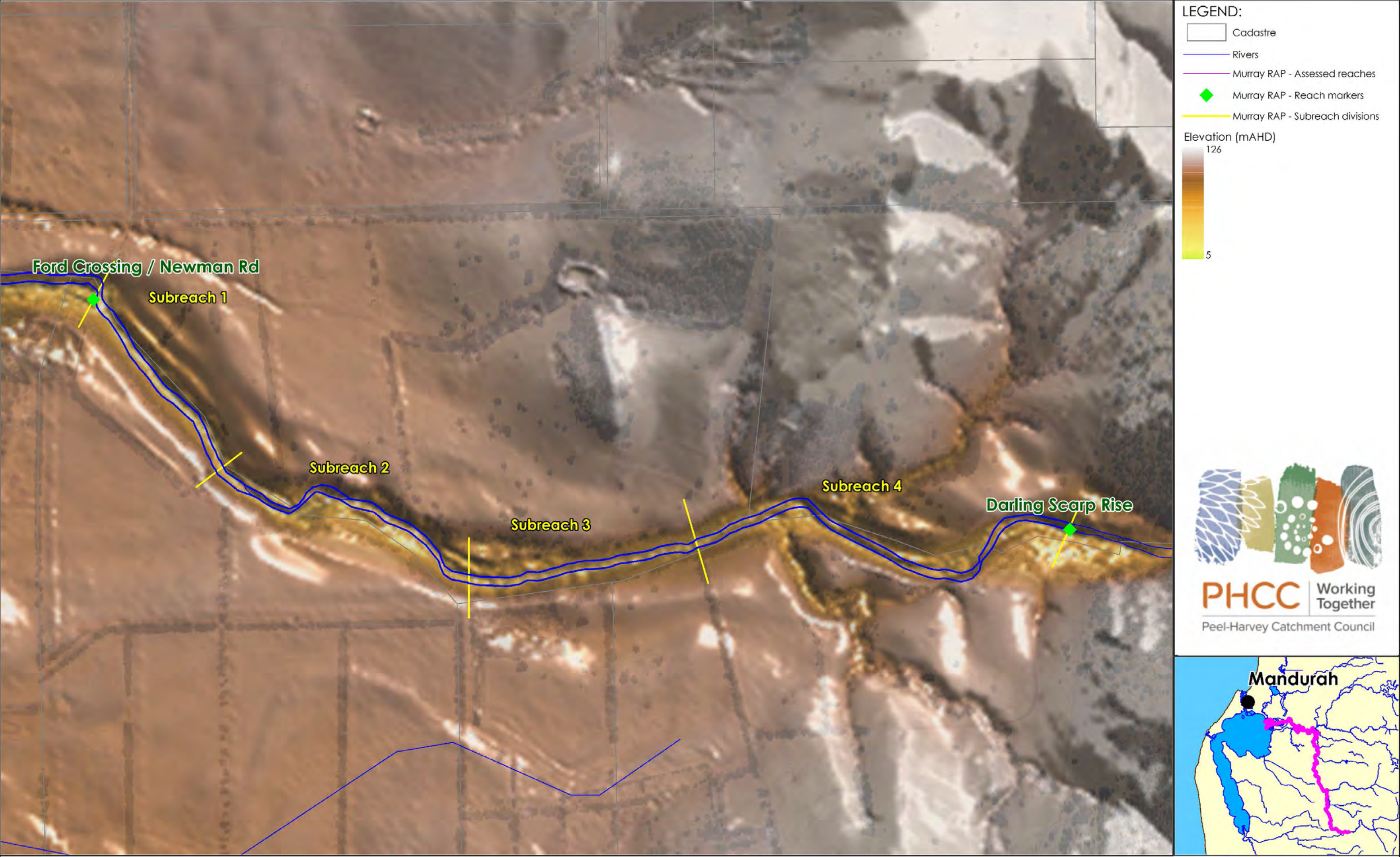
Peel Harvey Catchment Council - Lower and Middle Murray River Action Plan
Figure 84 - Middle Murray Reach 9: Ford Crossing / Newman Rd to Darling Scarp Rise - Location Map



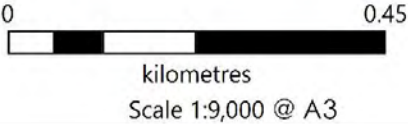
* ©2022. While Urbaqua has taken care to ensure the accuracy of this product, Urbaqua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbaqua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.



Peel Harvey Catchment Council - Lower and Middle Murray River Action Plan
Figure 85 - Middle Murray Reach 9: Ford Crossing / Newman Rd to Darling Scarp Rise - Elevation Map



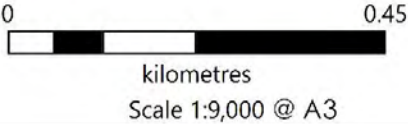
* @2022. While Urbagua has taken care to ensure the accuracy of this product, Urbagua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbagua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.



Peel Harvey Catchment Council - Lower and Middle Murray River Action Plan
Figure 86 - Middle Murray Reach 9: Ford Crossing / Newman Rd to Darling Scarp Rise - Landuse Map (PRS)



* @2022. While Urbaqua has taken care to ensure the accuracy of this product, Urbaqua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbaqua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.



4.15 Middle Murray Reach 9

Reach 9 (Figure 84) is 3.2 km long and covers the area from the Ford Crossing at the end of Newman Rd to the bridge crossing near the rise of the Darling Scarp. This reach is associated with rural land use.



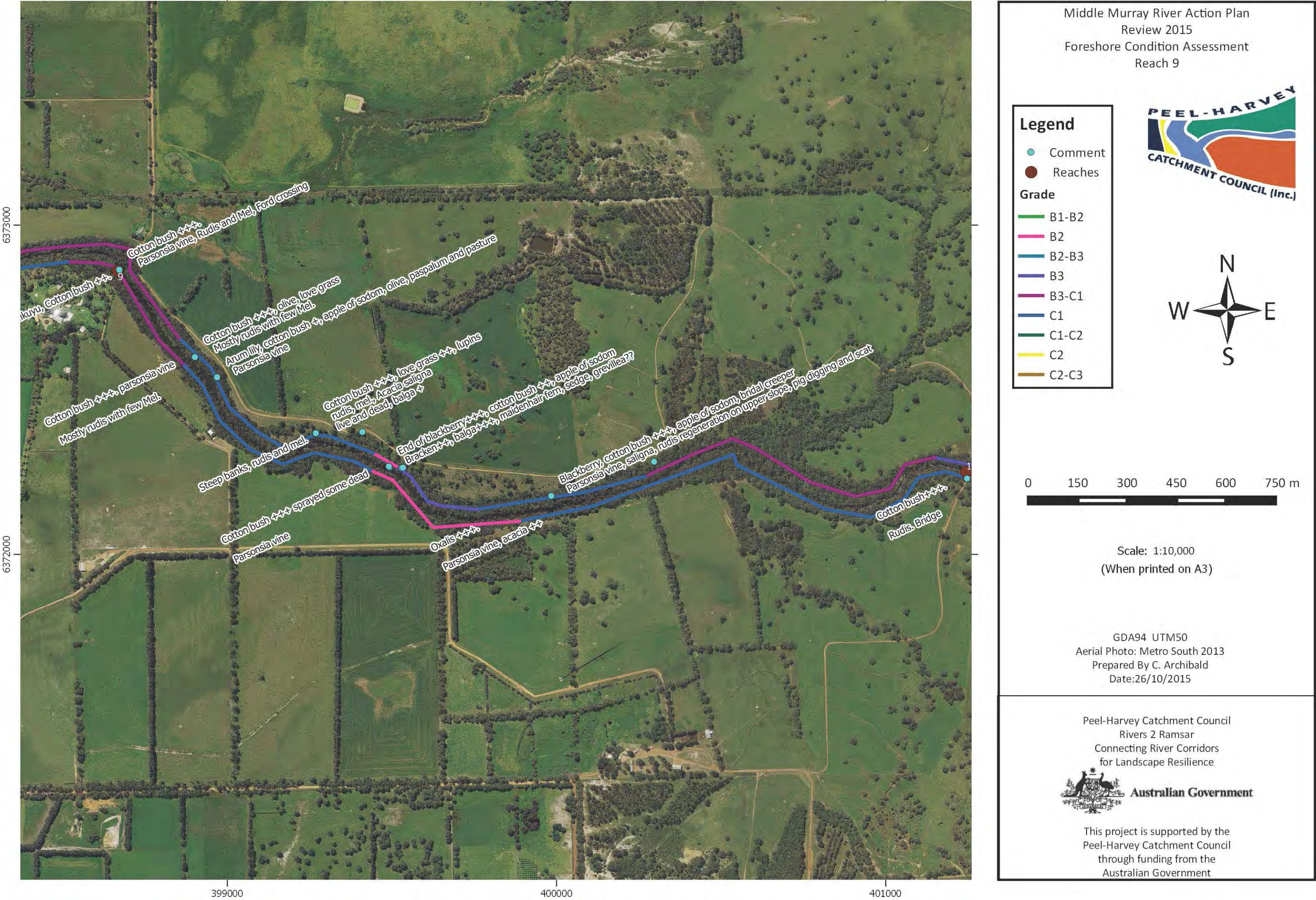
Plate 16: Middle Murray Reach 9 Photos

Table 32: Middle Murray Reach 9 Description and Conditions

Feature	Comments
Land Use	The land surrounding this reach is Rural (Figure 86)
Fencing and Infrastructure	The entire left and right banks have been fenced along the river with livestock excluded from the river permanently. The fences are in good condition. There is a culvert crossing at the lower end of this reach (Ford crossing).
Channel Form and Soils	The channel within this reach is relatively straight. There are other tributaries joining the river at the start of the Darling Scarp rise (Figure 85). There is mostly variable flow through this reach. The water depth is fairly consistent and deep (1.5m upwards). The bank full channel width becomes narrower in this reach (12m to 45m) and deep (ranging from 30m – 40m). The soils on both the left and right bank are Pinjarra P6a (Very gently undulating alluvial terraces and low rises contiguous with the plain, with deep moderately well to well drained soils associated with major current river systems and larger streams. Acidic red and yellow duplex soils), with a small section of Pinjarra P1d (flat to very gently undulating plain with deep acidic mottled yellow duplex (or effective duplex) soils. Shallow pale sand to sandy loam over clay; imperfect to poorly drained and moderately susceptible to salinity)
Vegetation Cover and Stream Health	The riparian zone is had a varied amount of native groundcover (from no to some) native ground cover. This is inversely proportional to the weed groundcover proportion. Sub reach 1 had native groundcover. The dominant riparian tree species are swamp paperbark (<i>Melaleuca rhaphiophylla</i>), and flooded gum (<i>Eucalyptus rudis</i>). The riparian zone is wide in this reach (25 - 60m). A moderate amount of healthy, natural regeneration of native woody vegetation occurred within this reach.
Weeds	Grasses dominated a lot of the weeds present. Sub reach 2 was dominated by blackberry and cottonbush. Weeds species noted along this reach include; love grass, kikuyu, doc, oxalis, couch grass, castor oil, arum lily, creeper plant, paspalum, nightshade, thistle, flatweed, nut grass, bridal creeper, sour grass, fig tree cottonbush.
Erosion	There was low/moderate severity of erosion within this reach, which impacted less than 20% of the length. There was no livestock noted within this reach and any erosion is considered to be caused by human access and water flows. Erosion was not considered a significant issue in this reach.
Habitat Condition	This reach only mostly of a channel. There was a moderate amount of woody debris in smaller sizes. There were leaves present. The proportion of submerged aquatic plant coverage was negligible.
Other Issues	None
Water Quality	The dissolved oxygen within sub reach 4 is high (99%) due to the aeration in the riffles and rocky bed forms (Figure 100). The salinity is slightly brackish (1,700-2,000mg/l) and increases in salinity towards the upper sub reaches (Figure 110).
Community and Cultural Values	Local Bindjareb Noongar Elders and Representatives will provide knowledge and advice on each site, its' cultural significance, and values. Please refer to Section 2.3 of this document to ensure all processes and procedures are followed. This stretch of river has resided with one owner for its' entirety since settlement, and they have been a strong advocate for protecting the riverbanks from livestock. The river has been fenced for many years. The landholders are passionate in continuing restoration actions to help

Feature	Comments
	protect the Murray River and are actively managing cottonbush that inhabits the banks of the river to prevent it from spreading further downstream.

Peel Harvey Catchment Council - Lower and Middle Murray River Action Plan
Figure 87 - Middle Murray Reach 9: Ford Crossing/Newman Rd to Darling Scarp Rise - 2015 Condition Map



Peel Harvey Catchment Council - Lower and Middle Murray River Action Plan
Figure 88 - Middle Murray Reach 9: Ford Crossing / Newman Rd to Darling Scarp Rise. Current Condition Map.



* @2022. While Urbaqua has taken care to ensure the accuracy of this product, Urbaqua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbaqua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.

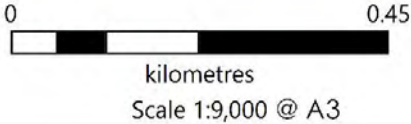


Table 33: Middle Murray Reach 9 Management Actions and Recommendations

Issues

- Invasive weeds are an issue, particularly cottonbush and blackberry.
- Feral animals – pigs.

Prioritised management actions recommended

Weed management:

- This landholder has developed a 'Cottonbush Management Plan' that has been in action since 2019. Continue to work with this landholder to implement this plan and look for opportunities to restore areas where weeds have been removed and replace with native vegetation.
- Work with landholder to try to implement the 'Cottonbush Management Plan' to further reaches (MM Reaches 5, 6, 8)
- Work with the landowner to eradicate one large patch of blackberry.

Long term management actions recommended

Community engagement:

- Provide a workshop to landowners on different options for feral animal control including fencing, trapping, baiting, shooting. Provide advice on other options that might be more effective dependant on the animal.
 - Provide advice to landholders on how new technologies (e.g., drones) can be useful in effectively managing weeds in landscapes that are difficult to access.
-

5 COMPARISON TO PREVIOUS STUDIES

The latest 2022 review and update of the Middle-Murray RAP looks at the present condition and the changes that have occurred since the original 2008 and the 2014/2015 studies. Some key findings are:

- This 2022 review and update has provided the opportunity to observe previous restoration and rehabilitation works undertaken as part of and since the original studies.
- Previous methods used in on ground projects can be examined and reviewed to see what has been successful and what has not, providing a good understanding and basis for future activities.
- Improvement was noted in the 2014/2015 study following implementation of the 2008 RAP recommendations. For example, joint projects with private landholders on the Oakley and Marrinup Brooks, which included restricting livestock access to the river through fencing and revegetating those areas with native species, has seen the foreshore rating increase to much better conditions.
- In early 2015 the area within Reach 7 of the Middle Murray was subjected to an out-of-control bushfire, destroying much of the vegetation. The regrowth in the bushfire patch has since growth back substantially and is now dense.
- Since the 2014/2015 study, recommendations implemented within the Delta Islands reach of the Lower Murray have resulted in a decline in weed growth on some of the islands. Jeegarnyeejip Island has had weed control measures (spraying of veldt grass and watsonia) and revegetation works undertaken (~1800 new seedlings planted throughout the banks). This has improved native vegetation growth and reduced weed growth (particularly watsonia) on the island.
- Extensive erosion control measures were also implemented on the southern foreshore of Jeegarnyeejip Island, with bank stabilization methods installed across approximately 80% of the banks. The erosion control measures included planting of rushes along the foreshore, with jute matting and geofabric installed and seeded, and rock and baffle board installation and repairs.
- Revegetation works close to the East Coolup Road Bridge (Middle Murray Reach 7) has also shown foreshore rating improvement along Sub-reach 1 since the 2014/2015 study.

In Table 34 below, a comparison of the overall ratings between the different assessments has been undertaken. This looks at each reaches' current rating and whether there has been a decline or improvement since previous years. 'Priority' has been identified based on the overall 2022 rating, and whether there has been a decline or little improvement.

Table 34: Summary of Comparison to Previous RAP Ratings and Location Priority

Murray River Section		2022 Rating - Summary	2014/2015 Rating - Summary	2008 Rating - Summary	Change to ratings over time	Management actions undertaken since 2014/15	Preliminary priority (on 2022 ratings only)	Priority based on decline and mngt to date	Overall Priority
Lower Murray	Reach 1 *No scoring for Deltas this reach in 2014/15	A 8%, B 54%, C 38%	C 100% (doesn't include Delta Islands)	n/a	Improvement	Yes			
	Reach 2	B 57%, C 43%	B 10%, C 90%	n/a	Improvement	No			
	Reach 3	B 25%, C 75%	C 100%	n/a	Improvement	No	Priority		
	Reach 4	B 17%, C 83%	B 14%, C 86%	n/a	Stable	Yes	Priority	Priority	2nd
	Reach 5	B 29%, C 71%	B 16%, C 84%	n/a	Improvement	No	Priority		
	Reach 6	C 100%	B 4%, C 96%	n/a	Decline	Yes	Priority	Priority	1st
Middle Murray	Reach 1	B 25%, C 75%	B 27%, C 73%	B 42%, C 58%	Stable	Yes	Priority	Priority	3rd
	Reach 2	B 38%, C 62%	B 22%, C 78%	B 12%, C 82%, D 6%	Continued improvement	Yes	Priority		
	Reach 3	B 66%, C 34%	B 66%, C 34%	C 100%	Stable	No	Priority	Priority	4th
	Reach 4	B 70%, C 30%	B 48%, C 52%	B 38%, C 62%	Continued improvement	No			
	Reach 5	B 75%, C 25%	B 70%, C 30%	B 52%, C 48%	Recently stable	No		Priority	
	Reach 6	B 50%, C 50%	B 14%, C 86%	B 14%, C 86%	Recent improvement	No			
	Reach 7	B 80%, C 20%	B 3%, C 97%	B 38%, C 62%	Recent improvement	Yes			
	Reach 8	B 92%, C 2%	B 12%, C 88%	B 48%, C 42%	Recent improvement	No			
	Reach 9	B 38%, C 562%	B 41%, C 59%	B 100%	Recently stable	No	Priority	Priority	5th

KEY

Continued = The change observed is a trend from 2008 to 2014/15 to 2022

Recent = The change is only observed between 2014/15 and 2022

6 RECOMMENDATIONS

A summary of the recommended actions is provided in Table 1 and Table 35 below. It is envisioned that these actions are adapted based on findings from further investigations, identification of other issues and threats, or following remediation work. Funding is required for recommended actions to be successfully undertaken.

Abbreviations for the various agencies in Table 35 are provided below:

- BNCommunity: Bindjareb Noongar Community
- DBCA: Department of Biodiversity, Conservation and Attractions
- DFES: Department of Fire and Emergency Services
- DMIRS: Department of Mines, Industry Regulation and Safety
- DoC: Department of Communities
- DoT: Department of Transport
- DPIRD: Department of Primary Industries and Regional Development
- DPLH: Department of Planning, Lands and Heritage
- LACHS: Local Aboriginal Cultural Heritage Services
- DWER: Department of Water and Environmental Regulation
- SoM: Shire of Murray
- Private: Private Landholders
- PHCC: Peel-Harvey Catchment Council
- WC: Water Corporation

Table 35: Priority Actions and Recommendations

Item	Priority	Location	Action	Key Stakeholders
1	Short term	All reaches	<p>Provide resources and/or preparation of guidelines aimed at residents and landholders abutting and interacting with the river. Options include;</p> <p>Identifying what boating and recreational activities can occur on or along the river including maps of slow speed areas or 'no-wash zones'.</p> <ul style="list-style-type: none"> • Boating activities including speed and wake consideration and impact on wildlife • Fertiliser management and nutrient loadings • Weeding and appropriate ways to remove weeds • Fencing for livestock to alleviate erosion and pugging • Revegetation including appropriate species selection and bank profile location. • Erosion control measures or effective bank stabilisation options – also refer landholders to existing relevant guidelines including the <i>Foreshore Stabilisation Guidelines</i> (Shire of Murray, 2019) and <i>Best Management Practices for Foreshore Stabilisation: Brushwall</i> (DBCA, 2020). • Management of large woody debris while maintaining diverse habitats • Simplifying where to find the information required for planning approval for jetties, pagodas etc. <p>Direct landowners and residents to existing guidance on;</p> <ul style="list-style-type: none"> • Feral animal management including guidance on baiting (SoM and DPIRD websites) • Planning approval requirements for jetties, pagodas etc (SoM website) • Livestock management (SoM website). 	SoM (Manager) DWER DoT DBCA DPLH DPIRD Private
2	Short term	All reaches	<p>Any new guidelines could be distributed to landowners/ residents as part of a community workshop program to make them aware of the guidance available. Also make them aware of existing guidance and have experts available to provide further advice of problems.</p>	SoM (Manager) DWER DoT DBCA DPLH DPIRD Private
3	Short term	Reach LM1, LM4, LM5, LM6, MM1, MM2, MM4, MM5, MM9	<p>Undertake weed removal at high value areas as trials for wider restoration works.</p>	SoM PHCC Private DPLH LACHS

Item	Priority	Location	Action	Key Stakeholders
4	Short term	Reach LM1, LM4, LM5, LM6, MM1, MM2, MM4, MM5, MM9	At high value areas, undertake revegetation programs to assist regeneration of native vegetation through seedlings, seed matts etc. If possible, avoid the use of plastic tree guards to help reduce the amount of plastic that could potentially enter the river.	SoM PHCC Private DPLH LACHS
5	Short term	Reaches MM5, MM6, MM8 and MM9	Work with landholders to prepare and implement a specific 'Cottonbush Management Plan'	SoM Private LACHS
6	Short term	All reaches	Work with the Local Aboriginal Cultural Heritage Services, Bindjareb Elders, Knowledge holders and Community members in the planning and delivery of all on-ground works	SoM BNCommunity LACHS
7	Short term	Reach LM4, LM5, LM6	Continue monitoring salinity up into LM Reach 4 and beyond so the extent and duration of saltwater ingress in the Murray can be compared in future RAPs. This could provide information on the potential impact of sea level rise/ climate change, or changes in land use in the catchment. Impacts of saltwater ingress include: changes in fauna communities (emergence of marine fish and crabs further up the river), changes in aquatic vegetation and ecosystems, impact on fringing tree species, and potential impact on groundwater supplies.	DWER PHCC
8	Short term	Reaches LM1, LM3, LM4, MM7	Implement localised bank protection and stabilisation where there is potential for bank erosion and collapse of healthy trees. Consider succession tree planting on banks with only one row of trees fringing the river.	SoM LACHS
9	Short term	Reaches LM1, LM2, LM6	Investigate effective erosion controls for different conditions. Consider replacing ineffective erosion control structures (e.g., baffle boards, pine revetment) with soft (matting, logs, and woody debris) or hard (rock-pitching) engineering bank protection. Consider artificial bank options that provide opportunities for habitat (mimic natural surfaces that mussels etc. can inhabit).	SoM LACHS
10	Short term	Reaches LM1, LM2, LM5, LM6	Work with DoT to enforce 5 knot speed limit to prevent boat wake - possibly provide mobile markers deployed in the navigation channel that read boat speed, using mobile buoys with a speed sign moved around to key locations to help alert skippers to the speed limits, DoT officers stationed at different locations with speed radar once a week.	DoT SoM LACHS
11	Short term	Reaches LM1, LM2, LM6	Consider signage or education around the impact of boating and speeding on wildlife.	DoT SoM LACHS
12	Long term	Reaches LM1, LM2, LM6	Prepare a 'Wash and wave action: riverbank erosion management plan' (improved management of boating wash, and climate change impacts on riverbank erosion)	SoM DWER

Item	Priority	Location	Action	Key Stakeholders
				DBCA DPLH LACHS
13	Long term	Reaches LM1, LM5, LM6, MM2, MM8	Consider providing incentives to landowners to provide fencing to deter livestock access to the foreshore and thereby protect riparian vegetation.	Private SoM DPLH LACHS
14	Long term	Reaches MM4, MM5, MM6, MM7	Work with landowners to replace invasive grasses with planting of native ground cover and shrubs to improve riparian vegetation.	Private SoM PHCC LACHS
15	Long term	Reaches MM2, MM3	Improve riparian vegetation in areas of bare ground and ground cover.	SoM Private LACHS
16	Short term	Reaches MM4, MM5, MM6, MM7	Use of best practice management for weed herbicide application near waterways.	SoM Private LACHS
17	Long term	Reach LM6/MM1	Investigate installing a fish ladder at Pinjarra weir to allow fish migration.	SoM DWER DPLH DBCA LACHS
18	Long term	Reaches LM1, LM2, LM5, LM6, MM1	Consideration should be given to the use of specially designed boats, which have large ballast or have a hull shape or fittings that are designed to create a large wave behind the boat. Consider results from the "Vessel wake study" occurring from the mouth of the Murray to South Yunderup. Also consider application of the "Wave wake predictor".	SoM DoT DWER LACHS
20	Short term	Reach LM1, LM4, LM5, LM6, MM1, MM2, MM4, MM5, MM9	Provide resources to the landholders to identify and eradicate weed species based on the weed present.	SoM LACHS

Item	Priority	Location	Action	Key Stakeholders
21	Long term	Reaches LM5, LM6	Work with landholders to create good quality habitat corridors.	SoM Private LACHS
22	Short term	Reaches MM1, MM5, MM6, MM8	Include total nitrogen and total phosphorus testing of water quality sampling in key reaches to assess eutrophication potential	DWER DBCA SoM
23	Long term	Reaches MM1, MM5, MM6, MM8	Investigations into possible high nutrient runoff contributions from surrounding land use (e.g., Orchards, farming).	SoM Private DWER LACHS
24	Long term	Reaches MM1, MM6, MM8	Review local drainage catchments to identify high-risk pollution sources and consider retrofitting drainage systems to ensure water quality treatment prior to discharge into the Murray River.	SoM DWER LACHS
25	Short term	Reaches MM1, MM5	Control aquatic weeds and consider thinning of invasive aquatic species such giant reed.	SoM DWER LACHS
26	Long term	Reaches LM1 or LM2	Work with DoT to consider a permanent speed-reading device at a key location on the Murray.	DoT SoM
27	Short term	Reaches LM1, LM3, LM4, MM7	Provide advice to the landholder on methods to identify erosion risk to allow for early intervention.	SoM LACHS
28	Long term	Reach LM2	Consider installing pedestrian footpaths to help control access and minimise disturbance to foreshore vegetation.	SoM LACHS
29	Short term	Reach LM3	Protect high-quality vegetation in adjacent reserves and landholdings.	SoM Private LACHS DBCA
30	Long term	All reaches	Identify and implement related skills-based training opportunities for the local Bindjareb Noongar Community linked to working on country to increase procurement opportunities.	SoM BNCommunity LACHS

Item	Priority	Location	Action	Key Stakeholders
31	Long term	Reach LM1, LM4, LM5, LM6, MM1, MM2, MM4, MM5, MM9	Encourage landholders to plant local natives within the riparian zone.	SoM Private LACHS
32	Short term	Reach MM3, MM4, MM5, MM6, MM7, MM9	Landholders should be encouraged to control feral animals, particularly pigs to protect banks and riparian vegetation, and foxes and rabbits.	SoM LACHS
33	Short term	Reach LM5, MM3, MM4	Work with landowners to remove woody debris when causing flow/erosion issues, but while still maintaining habitat diversity.	Private SoM LACHS
34	Long term	All Reaches	Encourage land holders to reduce nutrient inputs within the catchment.	SoM LACHS
35	Short term	Reaches LM4, LM5, MM5	Bulk litter and informal recreation facilities (fire pits, tree swings) along these reaches should be removed to ensure no there is no leaching of chemicals (e.g., Petrochemicals) into the river and discourage use/ entry to the river.	SoM Private LACHS
36	Short term	Reach LM1	Investigate die-off of trees and implement recommendations.	SoM LACHS

7 REFERENCES

Beatty SJ & Morgan DL (2008) Fishway assessment for the Pinjarra Weir. Report to the Peel-Harvey Catchment Council. Centre for Fish and Fisheries Research, Murdoch University, Western Australia.

Bradby, K (1997) *Peel-Harvey: the decline and rescue of an ecosystem*, Mandurah, WA.

Bussemaker, P., Kelsey, P., Zammit, C., (2004) Nutrient Status and Trend in the Waterways of the Peel-Harvey Catchment (unpublished internal report), Department of Environment.

Centre for Sustainable Aquatic Ecosystems (2020) *Centre for Sustainable Aquatic Ecosystems (unpublished)*, Murdoch University.

CSIRO (2006) (online). Weedy blackberry and raspberry species in Western Australia and strategies for their management. Unpublished report submitted to the Department of Agriculture, Fisheries and Forestry.

Department of Agriculture Western Australia (2003) AGMAPS Land Profiler CD ROM

Department of Biodiversity, Conservation and Attractions (DBCA) (2017) *NatureMap*, viewed October 2017 <http://naturemap.dpaw.wa.gov.au/default.aspx>.

Department of Biodiversity, Conservation and Attractions (DBCA) (2020). Best Management practices for Foreshore Stabilisation: Brushwall. Syrnix, Seashore Engineering and Tranen.

Department of Environment & Department of Agriculture Western Australia (2003) *Preliminary agency statement of natural resource management priorities in Western Australia*. Department of Environment. East Perth, Western Australia.

Department of the Environment and Energy (2012) *Commonwealth Listing Advice on Claypans of the Swan Coastal Plain*.
<http://www.environment.gov.au/biodiversity/threatened/communities/pubs/121-listing-advice.pdf>.

Department of Water and Environmental Regulation (DWER) (2020) [Western Australia floodplain mapping \(arcgis.com\)](#)

Department of Water (2010) *Murray drainage and water management plan*. Department of Water, Perth, Western Australia.

Department of Water (DoW) (2015) *Selection of future climate projections for Western Australia*, Perth, WA.

Environmental Protection Authority (EPA) (2008) *Water quality improvement plan for the rivers and estuary of the Peel-Harvey system – phosphorus management*, Perth, WA.

Overall Consulting Biologist (2002) *Economic Development and Recreation Management Plan for the Peel Waterways*. Prepared for the Water and Rivers Commission.

Hams, A.B. (2008) Middle Murray River Action Plan, Peel-Harvey Catchment Council, Mandurah, Western Australia.

Hanran-Smith, G. (2003) Margaret River Action Plan. Prepared for the Cape to Cape Catchment Group.

Lukatelich, R.J. McComb A.J. (1983) *Water Monitoring Program in the Murray River*. Report No. 3

Natural Area Holdings (NAH) (2018) Level 2 Flora and Vegetation Survey Murray River Delta Reserve. Prepared for the Shire of Murray.

O'Connor, R. Quartermiane, G. Bodney, C. (1989) Report on an Investigation into Aboriginal Significance of Wetlands and Rivers in the Perth- Bunbury Region. Western Australian Water Resources Council.

Peel Development Commission (1999) *Peel Geographic Perspective*. Peel Development Commission, Western Australia.

Peel-Harvey Catchment Council (2008) South Dandalup River Action Plan.

Peel-Harvey Catchment Council (2011) Catchment, condition and priorities, Peel-Harvey Catchment 2011, a report by Ironbark Environmental to the Peel-Harvey Catchment Council and Regional Development Australia (Peel), Mandurah, Western Australia.

Peel-Harvey Catchment Council (2014) Peel-Harvey Catchment Council, Our Catchment, Climate. Retrieved from <http://www.peel-harvey.org>.

Pen, L.J. (1995) Stream Foreshore Assessment in Farming Areas. Blackwood Catchment Coordinating Group, Western Australia.

Pen, L.J. (1999) Managing Our Rivers: A Guide to the Nature and Management of Streams of South Western Australia, Water and Rivers Commission, Perth, Western Australia.

Riparian Research (2002) River and Riparian Lands Management Newsletter Edition 22. Land and Water Australia.

Shire of Murray (2019). Lower Murray River. Foreshore Stabilisation Guidelines. Syrnix Environmental.

Waterways Commission (1992) *Peel Inlet Management Programme*. Report No. 27 Water and Rivers Commission and Avon River Management Authority (1999) *Avon River Management Programme*, Water and Rivers Commission, Water Resource Management Series, No WRM 11.

Waters and Rivers Commission (WRC) (1999) *River restoration manual: planning and management – foreshore condition assessment in farming areas of south-west Western Australia*, Perth, WA.

Water and Rivers Commission (2001) *Water Quality of the Murray River January 1995 – December 1999*. Draft Report. Water and Rivers Commission.

Water and Rivers Commission (2002) *A Community Guideline to Surface Water Quality Investigations*. Draft Report Project for Water and Rivers Commission.

Water and Rivers Commission (2002) *River Recovery Plan, Section 13 – Beverley Townsite to Edwards Crossing*. Water and Rivers Commission River Recover Plan Report No RRP 4.

Western Australian Planning Commission (2002) *Peel Region Scheme: Floodplain management policy*. The Commission. Perth, Western Australia.

White, K. & Comer, S. (1999) *Capel River Action Plan*. A Report prepared for the Geographe Catchment Council – GeoCatch and the Capel Land Conservation District Committee.

APPENDIX 1: DATA ANALYSIS METHODOLOGY

The methodology for collating and assessing the data is adapted from *River Restoration – Foreshore condition assessment in farming areas of south-west Western Australia* (WRC, 1999). For consistency with previously prepared RAPs, the detailed foreshore criteria was prepared considering grades between A (pristine) and D (drain). The detailed assessment allows for 3 sub-categories and therefore 12 categories overall. Assigning a category is generally a subjective exercise, matching observation with descriptions for each category.

In order to provide a more objective, repeatable approach, key parameters are assessed and scored based on the data breakdown provided below. Table 36 (WRC, 1999) provides a scoring system to calculate overall stream health and has been adapted to score foreshore conditions. For the Murray RAP, each bank within each sub-reach has been assessed with this scoring system, noting that habitat diversity refers to conditions within the channel, and therefore is the same for both banks.

Table 36: Stream Health Scoring (WRC, 1999)

	Floodway and bank vegetation	Verge vegetation	Stream Cover	Bank Stability and Erosion	Habitat Diversity
Excellent	<ul style="list-style-type: none"> - Healthy undisturbed native vegetation - No Weeds <p>(15 points)</p>	<ul style="list-style-type: none"> - Healthy undisturbed native vegetation - Verges more than 20m wide <p>(8 points)</p>	<ul style="list-style-type: none"> - Abundant cover: shade, overhanging vegetation - Snags, leaf litter, rocks and/or aquatic vegetation in stream <p>(8 points)</p>	<ul style="list-style-type: none"> - No erosion or subsidence or sediment deposits - Dense vegetation cover on banks and verge - No disturbance <p>(8 points)</p>	<ul style="list-style-type: none"> - Three or more habitat types - Some permanent water <p>(6 points)</p>
Good	<ul style="list-style-type: none"> - Mainly healthy undisturbed native vegetation - Some weeds - No recent disturbances <p>(12 points)</p>	<ul style="list-style-type: none"> - Mainly healthy undisturbed native vegetation - Verges less than 20m wide <p>(6 points)</p>	<ul style="list-style-type: none"> - Abundant shade and overhanging vegetation - Some cover in the stream <p>(6 points)</p>	<ul style="list-style-type: none"> - No significant erosion, subsidence or sediment deposits in floodway or on lower banks - May be some soil exposure and vegetation thinning on upper bank and verge <p>(6 points)</p>	<ul style="list-style-type: none"> - Two habitat types - Some permanent water <p>(4 points)</p>
Moderate	<ul style="list-style-type: none"> - Good vegetation cover but a mixture of native and exotic species - Localised clearing - Little recent disturbance <p>(6 points)</p>	<ul style="list-style-type: none"> - Good vegetation cover but a mixture of native and exotic species - Verges 20m wide or more <p>(4 points)</p>	<ul style="list-style-type: none"> - Some permanent shade and overhanging vegetation - Some instream cover <p>(4 points)</p>	<ul style="list-style-type: none"> - Good vegetation cover - Only localised erosion, bank collapse and sediment heaps - Verges may have sparse vegetation cover <p>(4 points)</p>	<ul style="list-style-type: none"> - Mainly one habitat type with permanent water, or a range of habitats with no permanent water <p>(2 points)</p>
Poor	<ul style="list-style-type: none"> - Mainly exotic ground cover - Obvious site disturbance <p>(3 points)</p>	<ul style="list-style-type: none"> - Narrow verges only (<20m wide) - Mainly exotic vegetation <p>(2 points)</p>	<ul style="list-style-type: none"> - Channel mainly clear - Little permanent shade or instream cover <p>(2 points)</p>	<ul style="list-style-type: none"> - Extensive active erosion and sediment heaps - Bare banks and verges common - Banks may be collapsing <p>(2 points)</p>	<ul style="list-style-type: none"> - Mainly one habitat type with no permanent water <p>(1 point)</p>
Very Poor	<ul style="list-style-type: none"> - Mostly bare ground or exotic ground cover (i.e. pasture gardens or weeds but no trees) <p>(0 points)</p>	<ul style="list-style-type: none"> - Mostly bare ground or exotic ground cover (i.e. pasture gardens or weeds but no trees) <p>(0 points)</p>	<ul style="list-style-type: none"> - Virtually no shade or instream cover <p>(0 points)</p>	<ul style="list-style-type: none"> - Almost continuous erosion - Over 50% of banks collapsing - Sediment heaps line or fill much of the floodway - Little or no vegetation cover <p>(0 points)</p>	<ul style="list-style-type: none"> - Stream channelized - No pools, riffles or meanders - The stream forms a continuous channel <p>(0 points)</p>

Scores from each bank were determined from an analysis of key parameters, described further below. The scores from this analysis were then equated to the foreshore condition, based on the scoring system outlined in Table 37. Assignment of a rating is based on the total score for all the categories. Where total score falls between two ratings, additional categories are applied. For example, a score of 28 would be assigned B1-B2. Manual adjustments to the final condition category were then applied based on a review of field photography, water quality data and other data sets.

Table 37: Foreshore Category Scoring

	Score					Rating
	Floodway and Bank Veg	Verge Vegetation	Stream Cover	Bank Stability and Erosion	Habitat Diversity	
A1	15	8	8	8	6	45
A2	12	8	8	8	6	42
A3	12	6	8	6	4	36
B1	12	4	6	6	4	32
B1-B2	-	-	-	-	-	28
B2	6	4	4	6	4	24
B2-B3	-	-	-	-	-	20.5
B3	3	2	4	6	2	17
B3-C1	-	-	-	-	-	16
C1	3	4	2	4	2	15
C1-C2	-	-	-	-	-	13
C2	3	2	2	2	2	11
C2-C3	-	-	-	-	-	9
C3	3	0	0	2	2	7
D1	3	2	0	0	0	5
D2	3	0	0	0	0	3
D3	0	0	0	0	0	0

Floodway and Bank Vegetation

Floodway and bank vegetation represents the largest category (by score). The key indicators (used to determine scores) and other considerations (for adjustment) are provided in Table 38.

Table 38: Floodway and Bank Vegetation Indicators

Key indicators	Other considerations
Streamside Zone Vegetation: Bare Ground	Riparian Layer: Ground Layer (rushes/sedges)
Streamside Zone Vegetation: Turf Grass	Riparian Layer: Shrub Layer
Streamside Zone Vegetation: Ground Cover	Riparian Layer: Tree Layer
Streamside Zone Vegetation: Shrubs	Width of Riparian Zone
Streamside Zone Vegetation: Trees <10 m	Dominant Riparian Species
Streamside Zone Vegetation: Trees >10 m	Riparian Zone Absent or Reduced Factors
Streamside Zone Vegetation: Turf Grass % Exotic	Streamside Zone Vegetation: Trees <10 m % Exotic
Streamside Zone Vegetation: Ground Cover % Exotic	Streamside Zone Vegetation: Trees >10 m % Exotic
Streamside Zone Vegetation: Shrubs % Exotic	

The scoring for the floodway and bank vegetation is outlined in Table 39.

Table 39: Floodway and Bank Vegetation Scoring

Rating	Score	Description	Indicator Assessment
Excellent	15 points	- Healthy undisturbed native vegetation - No Weeds	- No bare ground - No weeds - Shrub or Tree Cover >50%
Good	12 points	- Mainly healthy undisturbed native vegetation - Some weeds - No recent disturbances	- No bare ground - Weeds <10% - Shrub or Tree Cover >50%
Moderate	6 points	- Good vegetation cover but a mixture of native and exotic species - Localised clearing - Little recent disturbance	- Bare ground <10% - Weeds 10%-49% - Shrub and Tree Cover 10-49%
Poor	3 points	- Mainly exotic ground cover - Obvious site disturbance	- Bare ground 10-49% - Exotic Ground Cover 10%-49% - Turf Grass 10-49%
Very Poor	0 points	- Mostly bare ground or exotic ground cover (i.e., pasture gardens or weeds but no trees)	- Bare ground >50% - Exotic Ground Cover >50% - Turf Grass >50%

Verge Vegetation

Verge vegetation is the surrounding vegetation from the river. The condition of the verge vegetation influences the stability of the banks, livestock access and general encroachment in the riparian environment. The key indicators (used to determine scores) and other considerations (for adjustment) are provided in Table 40.

Table 40: Verge Vegetation Indicators

Key Indicators	Other considerations
Beyond the Streamside Zone: Dominant Feature 10-49m	Beyond the Streamside Zone: Dominant Feature >100m
Beyond the Streamside Zone: Dominant Feature 50-99m	

The scoring for the floodway and bank vegetation is outlined in Table 41. The average between the 10-49m and 50-99m scores were used for the foreshore.

Table 41: Verge Vegetation Scoring

Rating	Score	Description	Indicator Assessment
Excellent	8 points	- Healthy undisturbed native vegetation - Verges more than 20m wide	Forest
Good	6 points	- Mainly healthy undisturbed native vegetation - Verges less than 20m wide	Remnant Vegetation
Moderate	4 points	- Good vegetation cover but a mixture of native and exotic species - Verges 20m wide or more	Plantation
Poor	2 points	- Narrow verges only (<20m wide) - Mainly exotic vegetation	Weeds/Grasses/Crops
Very Poor	0 points	- Mostly bare ground or exotic ground cover (i.e., pasture gardens or weeds but no trees)	Minimal vegetation

Stream Cover

Stream cover provides a measure of the vegetation within and overhanging the stream. The key indicators are outlined in Table 42, along with the other factors that are considered in the assessment.

Table 42: Stream Cover Indicators

Key indicators	Other considerations
Stream Cover overhanging banks %	Bank vegetation draped in water
Tree overhanging %	Tree overhang
Aquatic plants & macro cover %	Stream width
Emergent proportion %	Shrub overhanging %
Submerged proportion %	
Woody debris	

The scoring for the stream cover is outlined in Table 43. Unlike other categories, the key indicators are generally independent of each other and therefore a weighted approach is undertaken. Each indicator is scored separately then weighted to provide a final stream cover score.

Table 43: Stream Cover Scoring

Rating	Score	Stream Cover Overhanging banks %	Tree Overhanging %	Aquatic plants & macro cover %	Emergent proportion %	Submerged proportion %	Woody debris
Weighting		100%	50%	50%	50%	25%	75%
Excellent	8 pts	50-100%	>80%	>50%	>70%	<20%	Dense
Good	6 pts	-	>60%	>30%	>50%	<40%	Moderate
Moderate	4 pts	10-49%	>50%	>20%	>40%	<60%	Sparse
Poor	2 pts	1-9%	>25%	>10%	>25%	<80%	None
Very Poor	0 pts	0%	0%	0%	0%	<100%	-

Bank Stability and Erosion

Whilst erosion is a natural process for river systems, accelerated or wide-spread erosion is indicative on an unstable system. The key indicators (used to determine scores) and other considerations (for adjustment) are provided in Table 44.

Table 44: Bank Stability and Erosion Indicators

Key indicators	Other considerations
Erosion %	Bank Shape
Erosion Severity	Bank Slope
	Bank Depth

The scoring for the bank stability and erosion is outlined in Table 45 and is a combination of erosion extent and the severity of erosion. Bank dimensions are considered also as steep banks with extensive or severe erosion require intervention more than gentle banks with the same score.

Table 45: Bank Stability and Erosion Scoring

Rating	Score	Description	Indicator Assessment
Excellent	8 points	<ul style="list-style-type: none"> - No erosion or subsidence or sediment deposits - Dense vegetation cover on banks and verge - No disturbance 	- 0-4% erosion & minor rating
Good	6 points	<ul style="list-style-type: none"> - No significant erosion, subsidence or sediment deposits in floodway or on lower banks - May be some soil exposure and vegetation thinning on upper bank and verge 	<ul style="list-style-type: none"> - 0-4% erosion & low-moderate rating; or - 5-19% erosion & minor rating
Moderate	4 points	<ul style="list-style-type: none"> - Good vegetation cover - Only localised erosion, bank collapse and sediment heaps - Verges may have sparse vegetation cover 	<ul style="list-style-type: none"> - 0-4% erosion & high to severe rating; or - 5-19% erosion & low-moderate rating
Poor	2 points	<ul style="list-style-type: none"> - Extensive active erosion and sediment heaps - Bare banks and verges common - Banks may be collapsing 	<ul style="list-style-type: none"> - 5-19% erosion & high to severe rating; or - 20-49% erosion & minor or low-moderate rating
Very Poor	0 points	<ul style="list-style-type: none"> - Almost continuous erosion - Over 50% of banks collapsing - Sediment heaps line or fill much of the floodway - Little or no vegetation cover 	<ul style="list-style-type: none"> - 20-49% erosion & high to severe rating; or - >50% erosion with any rating

Aquatic Habitat

Aquatic habitat is determined from assessment of the channel itself rather than each bank. Therefore, the aquatic habitat score is applied to both the left and right banks for any sub-reach. The key indicators (used to determine scores) and other considerations (for adjustment) are provided in Table 46.

Table 46: Aquatic Habitat Indicators

Key indicators	Other considerations
Habitat % Channel	Water Odours
Habitat % Pool	Water Oils
Habitat % Riffle	Turbidity
Habitat % Reach	Tannin Staining
	Algae in Water Column
	Algae on Substrate
	Sediment Plume
	Sediment Oils
	Sediment Odours

The scoring for the aquatic habitat is outlined in Table 47. Diversity in habitat is required for an excellent rating.

Table 47: Aquatic Habitat Scoring

Rating	Score	Description	Indicator Assessment
Excellent	6 points	- Three or more habitat types - Some permanent water	- Pool habitat >20% and Riffle habitat >20%
Good	4 points	- Two habitat types - Some permanent water	- Pool habitat >20% or Riffle habitat >20%
Moderate	2 points	- Mainly one habitat type with permanent water, or a range of habitats with no permanent water	- Pool habitat >10% or Riffle habitat >10%
Poor	1 point	- Mainly one habitat type with no permanent water	- Pool habitat >5% or Riffle habitat >5%
Very Poor	0 points	- Stream channelized - No pools, riffles, or meanders - The stream forms a continuous channel	- No Pool or Riffle habitat

APPENDIX 2: REACH SCORING SUMMARY

LOWER MURRAY

ReachSub-reach		Left Bank						
		Floodway and Bank Veg	Verge Vegetation	Stream Cover	Bank Stability and Erosion	Habitat Diversity	Total Score	Rating
1	Wargoorloop Branch	11	6	4.00	6	4	31.00	B1
1	Wargoorloop Branch2	11	6	3.86	6	1	27.86	B1-B2
1	Cooleenup Branch	11	6	4.00	4	4	29.00	B1
1	Cooleenup Branch 2	3	3	3.29	6	2	17.29	B2-B3
1	Jeegarnyeejip Branch	6	3	3.29	4	2	18.29	B2-B3
1	Meeyip Branch	11	8	4.50	6	5	34.50	A3
1	Worallgarook Branch	11	8	4.50	6	5	34.50	A3
1	Yunderup Branch	6	5	4.00	6	2	23.00	B2
1	Minjoorgup Branch	11	4	4.00	6	4	29.00	B1
1	Minjoogup Branch2	3	1	2.57	6	1	13.57	C1
1	1	3	1	2.57	4	1	11.57	C1-C2
1	2	5	1	2.57	4	1	13.57	C1
1	3	3	2	2.86	4	1	12.86	C1-C2
2	1	3	4	5.14	2	4	18.14	B2-B3
2	2	6	4	5.71	6	0	21.71	B2
2	3	3	0	5.29	4	0	12.29	C1-C2
2	4	3	2	5.71	6	0	16.71	B3
2	5	5	3	5.71	0	4	17.71	B2-B3
2	6	6	3	6.14	3	0	18.14	B2-B3
2	7	3	0	4.71	0	1	8.71	C2-C3
3	1	5	2	4.57	2	2	15.57	B3-C1
3	2	3	1	4.57	0	0	8.57	C2-C3
4	1	3	1	3.71	3	0	10.71	C2
4	2	3	1	5.29	0	1	10.29	C2
4	3	1	0	4.43	0	1	6.43	C3
4	4	3	0	5.86	0	0	8.86	C2-C3
4	5	3	1	4.71	1	0	9.71	C2
4	6	2	0	5.14	0	0	7.14	C2-C3
4	7	3	4	5.43	0	1	13.43	C1
4	8	3	2	4.14	2	0	11.14	C1-C2
4	9	0	4	5.14	4	2	15.14	B3-C1
5	1	3	4	4.29	4	0	15.29	B3-C1
5	2	3	4	5.43	1	1	14.43	C1
5	3	4	5	5.57	4	1	19.57	B2-B3
5	4	3	4	5.00	2	4	18.00	B2-B3
5	5	3	2	5.29	0	2	12.29	C1-C2
5	6	3	4	5.29	0	0	12.29	C1-C2
5	7	3	4	4.57	4	2	17.57	B2-B3
6	1	3	4	5.00	0	0	12.00	C1-C2
6	2	3	1	4.86	2	0	10.86	C2
6	3	3	2	4.86	1	0	10.86	C2
6	4	2	1	5.00	2	0	10.00	C2
6	5	3	1	5.00	2	0	11.00	C2

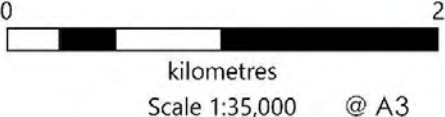
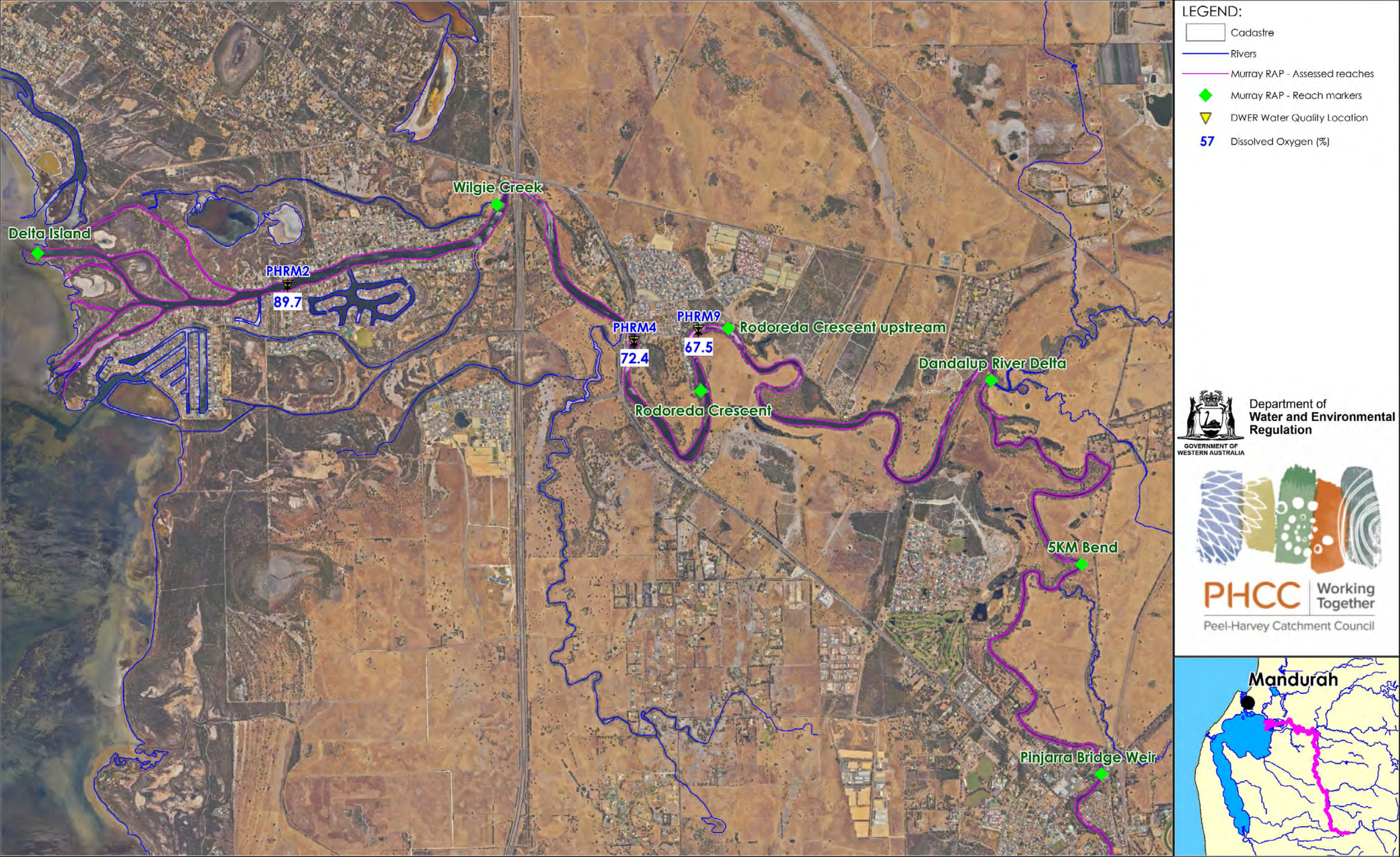
Right Bank						
Floodway and Bank Veg	Verge Vegetation	Stream Cover	Bank Stability and Erosion	Habitat Diversity	Total Score	Rating
9	6	3.86	6	4	28.86	B1
3	6	3.00	0	1	13.00	C1-C2
9	6	3.29	4	4	26.29	B1-B2
9	6	3.86	2	2	22.86	B2
5	1	2.71	4	2	14.71	C1
9	6	3.86	6	5	29.86	B1
6	6	3.00	4	5	24.00	B2
9	6	3.86	6	2	26.86	B1-B2
9	3	3.86	6	4	25.86	B1-B2
3	2	2.00	4	1	12.00	C1-C2
3	2	2.00	3	1	11.00	C2
3	2	2.00	4	1	12.00	C1-C2
3	2	2.29	4	1	12.29	C1-C2
3	1	5.14	0	4	13.14	C1
3	2	5.71	4	0	14.71	C1
4	1	6.14	6	0	17.14	B2-B3
3	2	5.57	0	0	10.57	C2
5	2	5.71	2	4	18.71	B2-B3
6	4	6.14	4	0	20.14	B2-B3
4	2	2.00	2	1	11.00	C2
3	1	3.71	4	2	13.71	C1
3	1	4.00	2	0	10.00	C2
2	1	3.71	2	0	8.71	C2-C3
3	1	5.29	0	1	10.29	C2
6	6	5.57	2	1	20.57	B2
3	5	5.86	2	0	15.86	B3-C1
0	3	4.71	0	0	7.71	C2-C3
3	1.5	5.14	0	0	9.64	C2
3	1	5.43	4	1	14.43	C1
2	2	4.14	0	0	8.14	C2-C3
0	0	5.14	0	2	7.14	C2-C3
3	1	5.14	0	0	9.14	C2
2	1	4.86	0	1	8.86	C2-C3
4	4	5.57	0	1	14.57	C1
3	1	5.00	0	4	13.00	C1-C2
0	1	5.29	1	2	9.29	C2
3	1	5.29	2	0	11.29	C1-C2
3	1	4.57	0	2	10.57	C2
0	1	5.00	0	0	6.00	C3
3	1	4.86	1	0	9.86	C2
2	1	4.86	2	0	9.86	C2
3	1	4.57	1	0	9.57	C2
1	0	4.57	1	0	6.57	C3

MIDDLE MURRAY

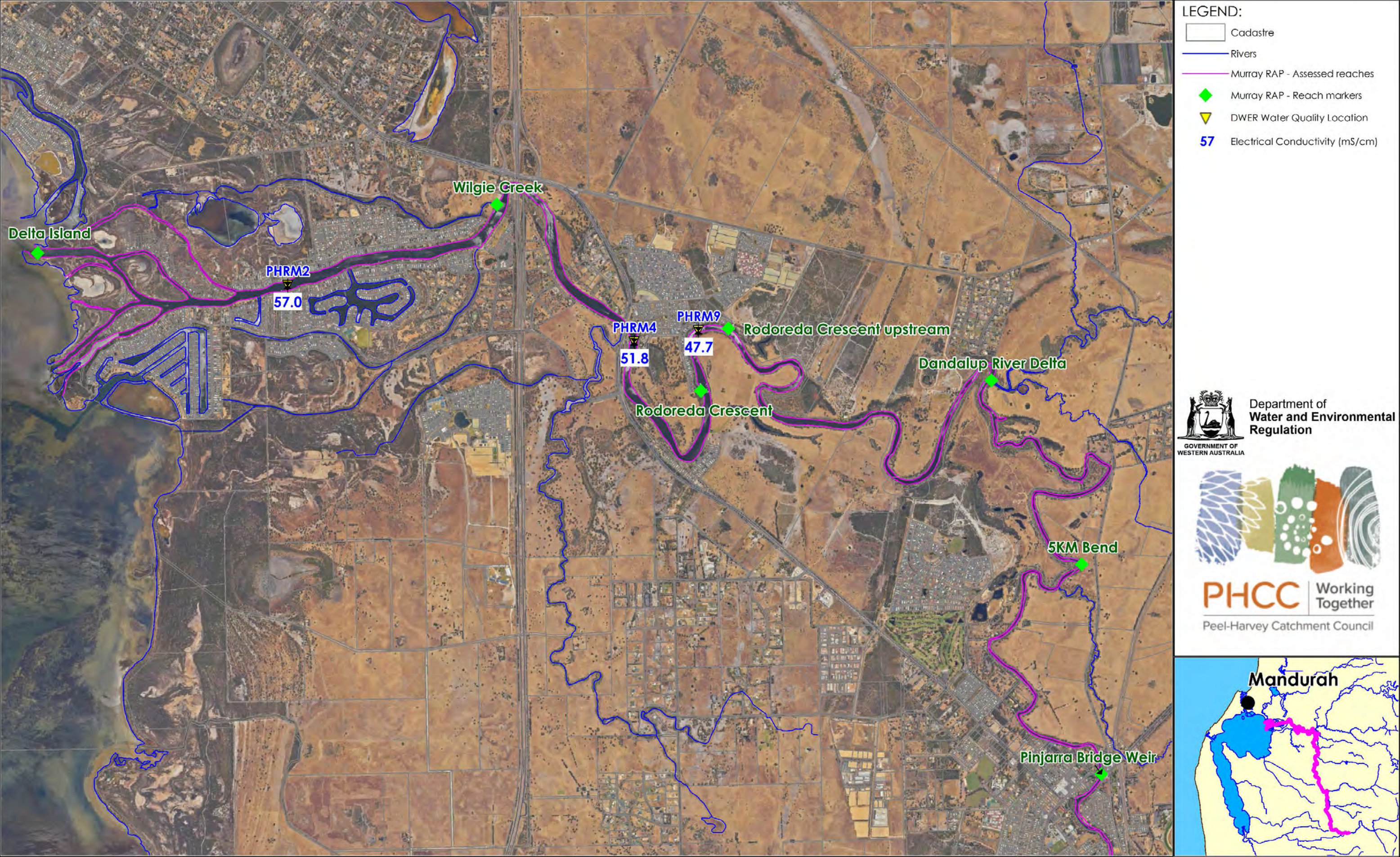
		Left Bank						
Reach	Sub-reach	Floodway and Bank Veg	Verge Vegetation	Stream Cover	Bank Stability and Erosion	Habitat Diversity	Total Score	Rating
1	1	3	3	2.00	2	1	11.00	C2
1	2	2	3	3.00	3	0	11.00	C2
1	3	3	3	3.00	4	1	14.00	C1
1	4	3	4	5.00	4	1	17.00	B3
2	1	3	4	2.43	1	0	10.43	C2
2	2	0	3	3.14	4	2	12.14	C1-C2
2	3	0	3	2.43	2	2	9.43	C2
2	4	3	3	2.43	4	2	14.43	C1
2	5	0	1	3.14	0	2	6.14	C3
2	6	0	3	2.71	2	2	9.71	C2
3	1	3	2	5.00	6	1	17.00	B3
3	2	4	2	3.00	4	2	15.00	C1
3	3	3	3	4.00	6	1	17.00	B3
4	1	3	1	3.43	4	1	12.43	C1-C2
4	2	6	1	3.71	6	2	18.71	B2-B3
4	3	3	1	3.29	3	1	11.29	C1-C2
4	4	6	1	3.86	6	0	16.86	B3
4	5	6	1	4.14	4	1	16.14	B3
5	1	3	1	4.00	4	0	12.00	C1-C2
5	2	3	3	5.00	4	2	17.00	B3
5	3	3	3	4.57	6	1	17.57	B2-B3
5	4	6	3	3.86	6	0	18.86	B2-B3
5	5	3	4	4.14	4	0	15.14	B3-C1
5	6	3	4	4.43	4	0	15.43	B3-C1
6	1	3	3	4.86	2	0	12.86	C1-C2
6	2	0	0	3.57	4	4	11.57	C1-C2
6	3	3	1	5.57	6	2	17.57	B2-B3
7	1	6	1	3.86	4	2	16.86	B3
7	2	6	1	3.86	6	0	16.86	B3
7	3	3	3	5.43	6	0	17.43	B2-B3
7	4	3	1	5.14	6	4	19.14	B2-B3
7	5	3	1	4.86	6	4	18.86	B2-B3
8	1	6	4	5.43	2	2	19.43	B2-B3
8	2	3	4	4.00	4	1	16.00	B3-C1
8	3	6	4	5.43	4	4	23.43	B2
8	4	3	4	6.00	6	1	20.00	B2-B3
8	5	3	4	4.29	6	1	18.29	B2-B3
8	6	6	4	6.00	2	1	19.00	B2-B3
9	1	3	1	4.14	4	1	13.14	C1
9	2	3	1	3.57	6	1	14.57	C1
9	3	3	2	4.14	6	2	17.14	B2-B3
9	4	3	1	2.86	6	4	16.86	B3

Right Bank						
Floodway and Bank Veg	Verge Vegetation	Stream Cover	Bank Stability and Erosion	Habitat Diversity	Total Score	Rating
3	3	2.00	4	1	13.00	C1-C2
3	1	3.00	3	0	10.00	C2
3	1	3.00	2	1	10.00	C2
3	4	4.29	4	1	16.29	B3
3	4	2.43	4	0	13.43	C1
2	3	3.71	4	2	14.71	C1
3	3	3.43	4	2	15.43	B3-C1
3	3	3.43	4	2	15.43	B3-C1
3	6	3.14	2	2	16.14	B3
3	6	2.71	4	2	17.71	B2-B3
3	3	3.00	6	1	16.00	B3-C1
3	4	6.00	6	2	21.00	B2
3	3	4.00	6	1	17.00	B3
3	3	3.43	3	1	13.43	C1
3	4	3.71	4	2	16.71	B3
6	1	3.29	4	1	15.29	B3-C1
6	1	3.86	6	0	16.86	B3
6	1	4.57	4	1	16.57	B3
3	1	4.29	3	0	11.29	C1-C2
3	1	5.00	3	2	14.00	C1
6	4	4.57	6	1	21.57	B2
6	4	3.29	6	0	19.29	B2-B3
0	6	4.43	6	0	16.43	B3
6	6	4.43	4	0	20.43	B2-B3
2	4	4.86	2	0	12.86	C1-C2
3	4	3.57	2	4	16.57	B3
3	2	5.57	6	2	18.57	B2-B3
0	1	6.14	6	2	15.14	B3-C1
0	1	4.14	6	0	11.14	C1-C2
3	3	5.71	6	0	17.71	B2-B3
3	1	4.86	4	4	16.86	B3
0	1	3.43	4	4	12.43	C1-C2
3	3	5.43	4	2	17.43	B2-B3
3	4	4.00	4	1	16.00	B3-C1
3	3	5.43	4	4	19.43	B2-B3
0	3	6.00	6	1	16.00	B3-C1
0	4	4.29	4	1	13.29	C1
6	4	6.00	0	1	17.00	B3
3	1	4.14	4	1	13.14	C1
3	1	3.86	2	1	10.86	C2
0	2	3.86	6	2	13.86	C1
3	1	3.29	6	4	17.29	B2-B3

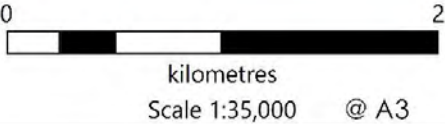
APPENDIX 3: WATER QUALITY SUMMARY (INFORMATION PROVIDED BY PHCC AND DWER)

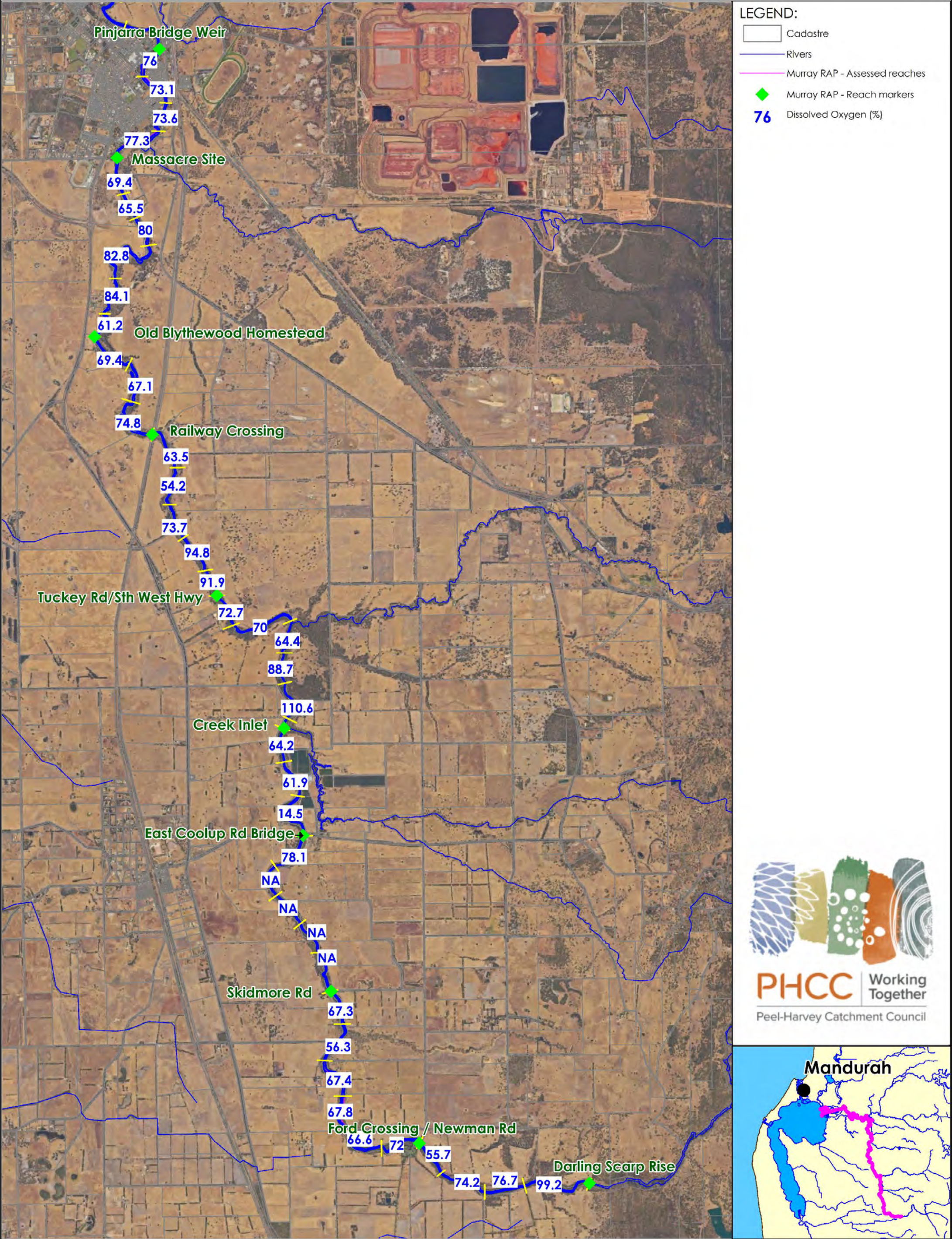


Peel Harvey Catchment Council - Lower and Middle Murray River Action Plan
Figure 90 - Lower Murray Reaches - Electrical Conductivity (mS/cm).

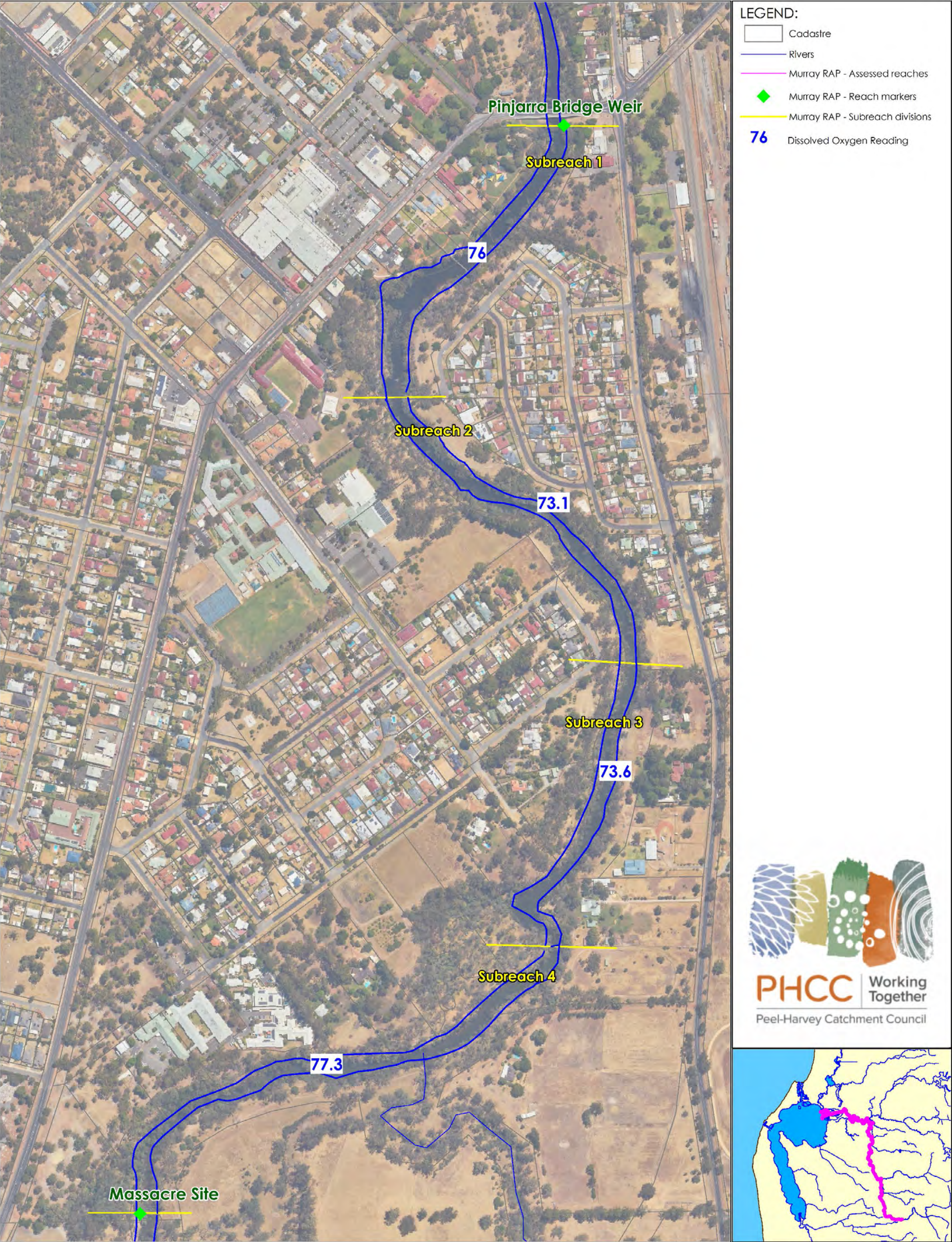


* ©2022. While Urbagua has taken care to ensure the accuracy of this product, Urbagua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbagua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.

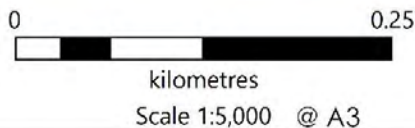




* ©2022. While Urbaqua has taken care to ensure the accuracy of this product, Urbaqua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbaqua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.

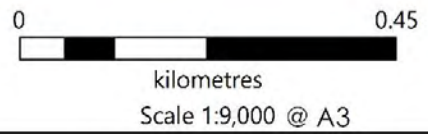


* ©2022. While Urbaqua has taken care to ensure the accuracy of this product, Urbaqua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbaqua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.





* ©2022. While Urbaqua has taken care to ensure the accuracy of this product, Urbaqua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbaqua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.





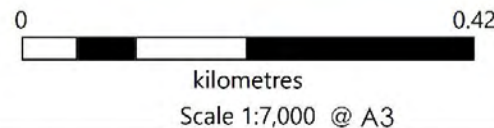


*©2022. While Urbaqua has taken care to ensure the accuracy of this product, Urbaqua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbaqua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.

Peel Harvey Catchment Council - Lower and Middle Murray River Action Plan
Figure 96 - Middle Murray Reach 5: Tuckey Rd/Sth West Hwy to Creek Inlet - Dissolved Oxygen (%)

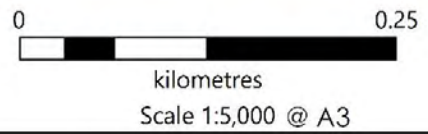


*©2022. While Urbaqua has taken care to ensure the accuracy of this product, Urbaqua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbaqua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.





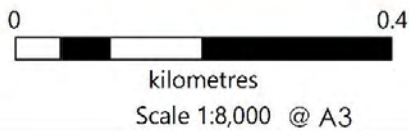
* ©2022. While Urbaqua has taken care to ensure the accuracy of this product, Urbaqua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbaqua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.

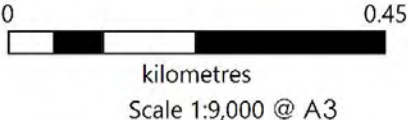


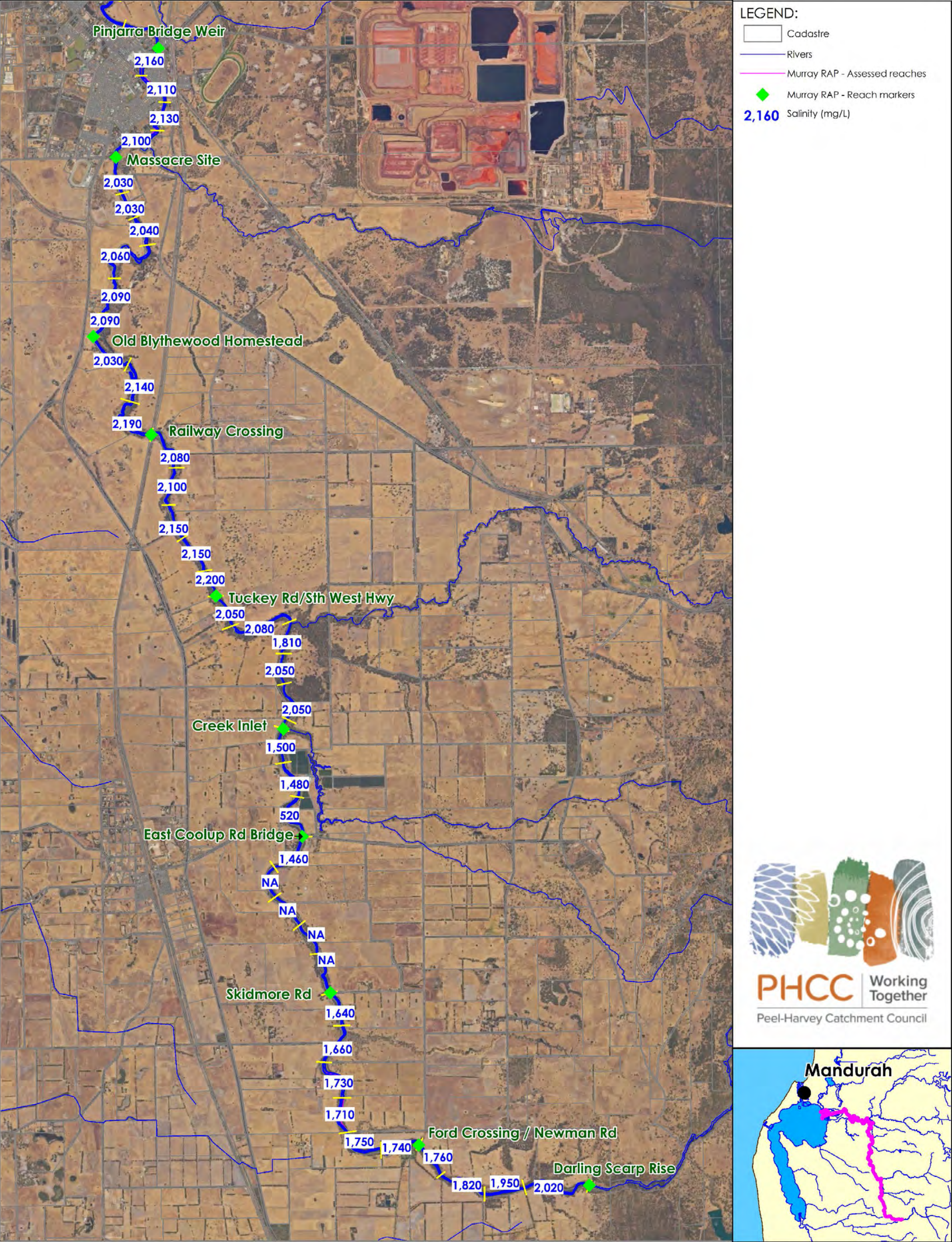




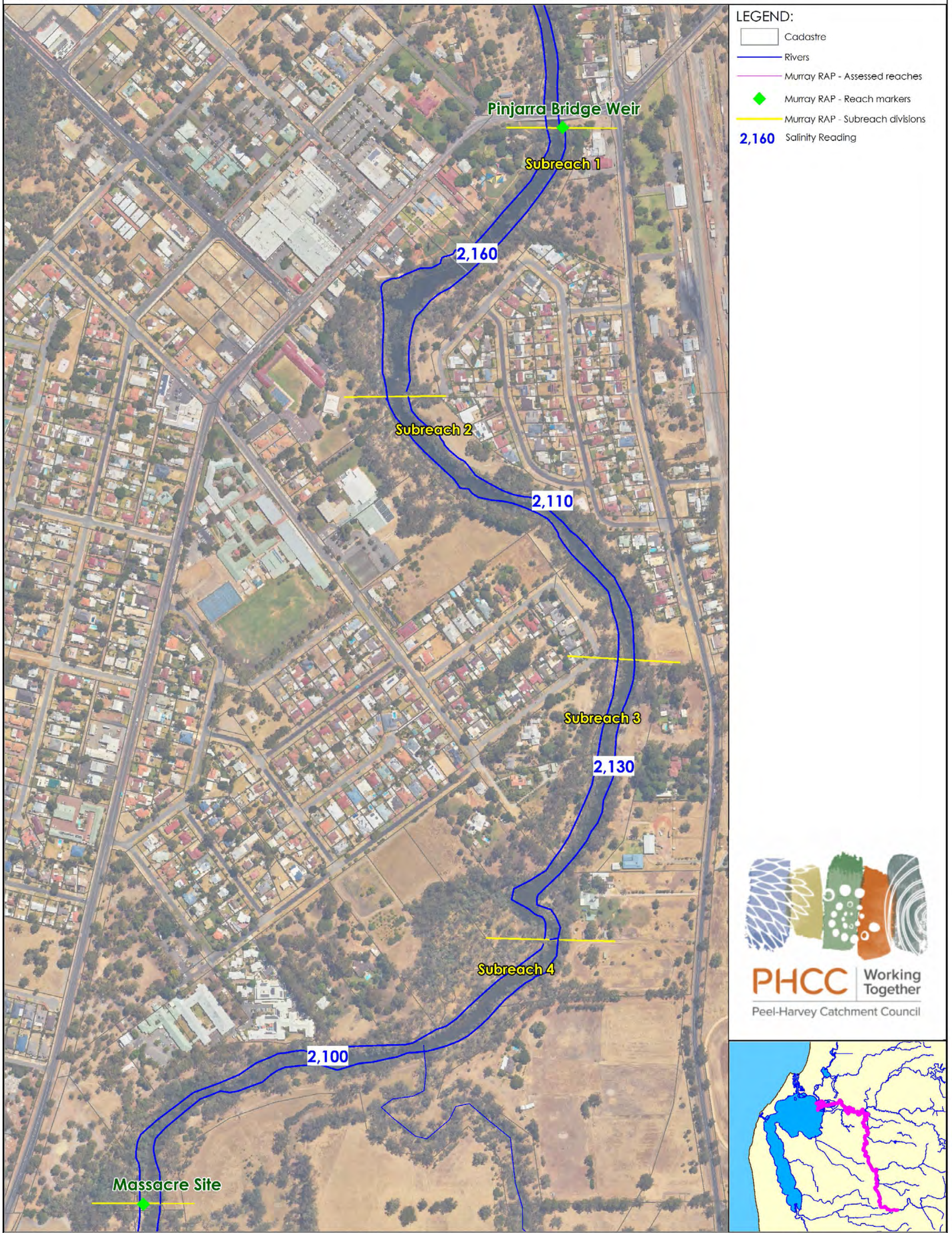
* ©2022. While Urbaqua has taken care to ensure the accuracy of this product, Urbaqua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbaqua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.







* ©2022. While Urbaqua has taken care to ensure the accuracy of this product, Urbaqua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbaqua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.





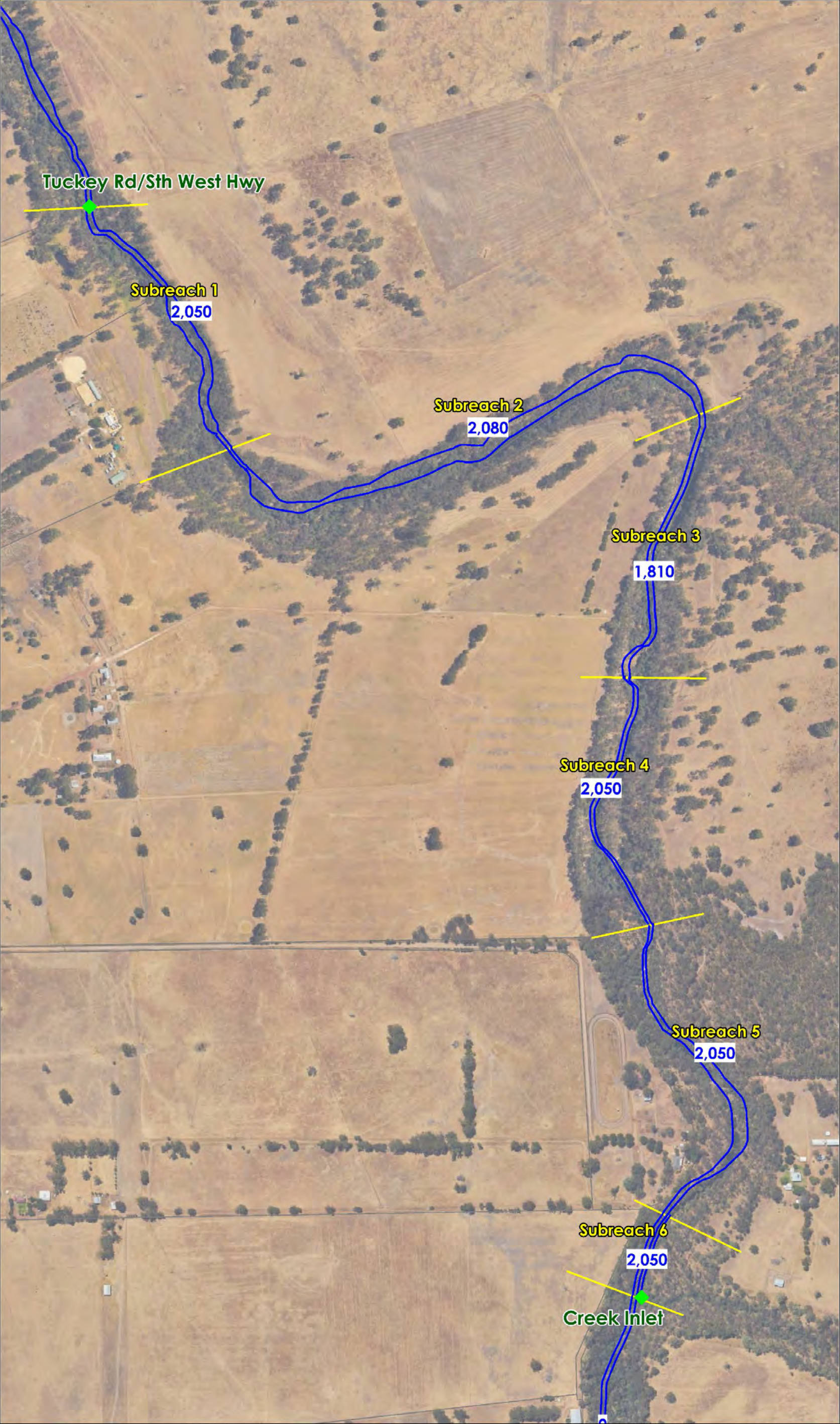
* ©2022. While Urbaqua has taken care to ensure the accuracy of this product, Urbaqua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbaqua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.



* ©2022. While Urbaqua has taken care to ensure the accuracy of this product, Urbaqua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbaqua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.



*©2022. While Urbaqua has taken care to ensure the accuracy of this product, Urbaqua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbaqua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.

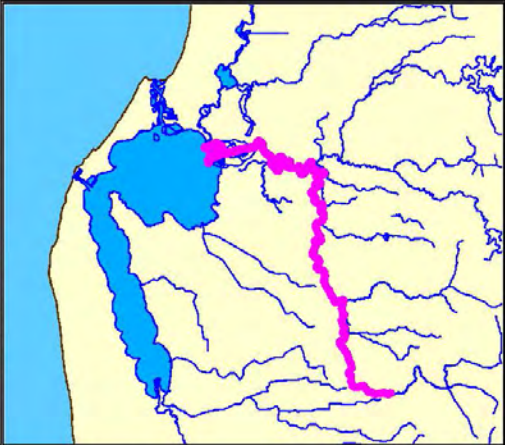


LEGEND:

- Cadastre
- Rivers
- Murray RAP - Assessed reaches
- Murray RAP - Reach markers
- Murray RAP - Subreach divisions

2,160 Salinity (mg/L)

PHCC Working Together
Peel-Harvey Catchment Council



* ©2022. While Urbaqua has taken care to ensure the accuracy of this product, Urbaqua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbaqua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.

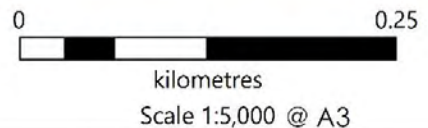
0 0.35
kilometres
Scale 1:7,000 @ A3

urbaqua
land and water solutions

Peel Harvey Catchment Council - Lower and Middle Murray River Action Plan
Figure 107 - Middle Murray Reach 6: Creek Inlet to East Coolup Rd Bridge Salinity (mg/L)



*©2022. While Urbaqua has taken care to ensure the accuracy of this product, Urbaqua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbaqua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.

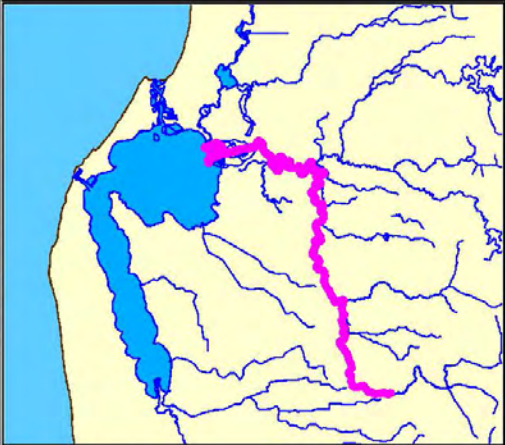




LEGEND:

- Cadastral
- Rivers
- Murray RAP - Assessed reaches
- Murray RAP - Reach markers
- Murray RAP - Subreach divisions
- 2,160 Salinity (mg/L)

PHCC Working Together
Peel-Harvey Catchment Council



* ©2022. While Urbaqua has taken care to ensure the accuracy of this product, Urbaqua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbaqua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.

0 0.35
kilometres
Scale 1:7,000 @ A3

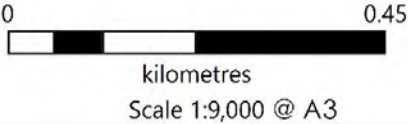
urbaqua
land and water solutions



* ©2022. While Urbaqua has taken care to ensure the accuracy of this product, Urbaqua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbaqua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.



* ©2022. While Urbaqua has taken care to ensure the accuracy of this product, Urbaqua and client make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Urbaqua and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: Landgate, PHCC Created by: HB Projection: MGA: zone 50.





Client: Peel-Harvey Catchment Council

Report	Version	Prepared by	Reviewed by	Submitted to Client	
				Copies	Date
Preliminary draft	V1	RMu, REp	REp	Electronic	8 July 2022
Draft for PHCC	V2	REp	REp	Electronic	12 Aug 22
Final	V3	REp	REp	Electronic	30 Aug 22
Final	V4	REp	REp	Electronic	15 Nov 22

Urbaqua
land & water solutions
Suite 4/226 Carr Place
p: 08 9328 4663 | f: 08 6316 1431
e: info@urbaqua.org.au
www.urbaqua.org.au