REPORT

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PIKE IMPLEMENTATION PLAN

AN INTEGRATED PLAN TO ENSURE THE LONG TERM ECOLOGICAL AND ECONOMIC SUSTAINABILITY OF THE PIKE RIVER REGION

DEPARTMENT FOR WATER

Government of South Australia
Department for Water

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ACKNOWLEDGMENTS

The preparation of this Pike Implementation Plan has been supported and assisted by many people and organisations including the South Australian Murray-Darling Basin Natural Resources Management Board (SA MDB NRMB), the Department for Environment and Natural Resources (DENR) and Primary Industries and Resources SA (PIRSA) and community representatives from the Pike River Land Management Group.

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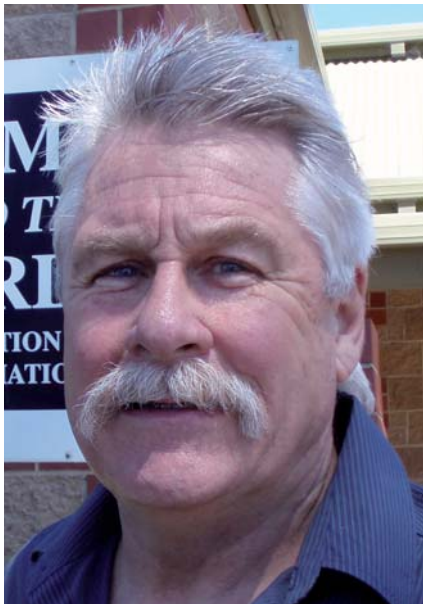
FOREWORD



The development of the Pike Implementation Plan represents a significant step in improving the health of the Pike Floodplain adjacent to Lock 5 in the South Australian Riverland. The community identified the need for urgent action on the Pike River with the release of the Pike Land and Water Management Plan in 2006. At that time water quality and the declining health of the floodplain were two major concerns for the local community.

On this basis, the Pike Implementation Plan Reference Committee was established to identify a way to protect the significant environmental assets on the Pike floodplain and to protect the quality of the water for both environmental and consumptive users. The reference committee includes representatives from the local community, the Department for Water (DFW), Department of Environment and Natural Resources (DENR), the South Australian Murray-Darling Basin Natural Resources Management Board (SA MDB NRMB) and SA Water.

This Plan outlines the preferred options to be implemented on the Pike Floodplain which include hydrological management and fish passage, sustainable diversion limits and flexible extraction, removal of grazing on the floodplain and control of pest plant and animal species, and salt interception. A provisional budget is also provided for these options.

I encourage you to read through this document and others produced as part of the Pike Project, such as Pike River Reflections, From Dreamtime to 2009 and Recovering the Pike Information Booklet. I also encourage you to support the implementation of this project which will not only benefit the environment and the local community but also future generations of the Riverland who will need a healthy River Murray to prosper.

Bruce Hewett
Chairman, Pike River Land Management Group
Pike River Land Management Group

EXECUTIVE SUMMARY

This document presents an implementation plan for the Pike floodplain which is an anabranch system located adjacent to Lock 5 on the River Murray in South Australia (Figure 1).

The Pike region is unique, being a South Australian River Murray priority floodplain with significant ecological value but also with high social and economic value. This includes supporting an extensive irrigation industry.

The vision for the Pike floodplain is: "To achieve a healthy mosaic of floodplain communities which is representative of the communities which would be expected under 'natural' conditions and which ensure that indigenous plant and animal species and communities survive and flourish throughout the site."

From this vision, the following overall objectives have been identified:

- To improve the condition of existing vegetation;
- To improve key aquatic riparian and terrestrial habitats required by native flora and fauna, including waterbirds, fish, reptiles, mammals and frogs;
- To achieve a sustainable balance between the needs of the various users of the floodplain; and
- To recognise and, where possible, respond to the needs of the existing productive users of the floodplain.

The Pike floodplain contains eight main ecological assets (including watercourses, wetlands, shrublands and dunes). The greatest threat to the floodplain environment is the lack of appropriate environmental flows which affects all the ecological assets on the floodplain. Other significant threats include poor surface water management; rising groundwater levels caused by past irrigation practices and artificially high surface water levels maintained in the RM channel and anabranch creeks; barriers to flow and fish passage; floodplain grazing; and pest plants and animals.

This implementation plan clearly demonstrates the requirement to modify and develop new infrastructure on the floodplain in order to re-introduce a more variable hydraulic regime, which more closely resembles the "natural" regime for which floodplain biota are adapted.

Such management actions will reduce floodplain decline including preventing the predicted death of 90% of the floodplain trees. It will also facilitate fish passage and help restore regional biodiversity including habitat value, species abundance and breeding opportunities for fauna and flora. It will also potentially improve soil condition and water quality of groundwater and surface water systems.

The proposal entails construction of a new network of environmental flow regulating structures at Col Col and Tanyaca Creek. To achieve the required hydrological regime, smaller ancillary structures on bypass flow routes will also be required.

In addition, some complementary surface water management actions are considered in the implementation plan including pumping, channel forming, gravity watering and weir pool raising. Such options are recommended to bring benefits to floodplain areas outside the impact of the regulating structures. Pumping onto high value wetland sites can be effective at a local scale (less than 5% of the floodplain).

The plan also considers the requirements for sustainable water for irrigation as well as long term salt interception, removal of grazing on the floodplain and control of pest plants and animals. This includes recommending the development of sustainable diversion limits for irrigation, and ensuring current irrigation pumps are modified to cope with the new floodplain watering regime. It also considers initiatives to ensure long term management of on-farm irrigation including reducing likelihood of off-site impacts.

The plan encompasses the Pike Salt Interception Scheme (SIS), intercepting saline groundwater on the highland area (although it is acknowledged that such investment has already been sought and is currently in the process of being considered by the Murray-Darling Basin Authority).

This implementation plan requires investment of approximately $46 million to restore environment flows, to secure sustainable water for irrigators and to remove floodplain grazing. The costs associated with the intervention actions outlined

in this plan are comparable with other floodplain rehabilitation projects of a similar scale with the Murray-Darling Basin. The project time-frames are dependent on construction times and the requirement to gain approvals and funding. The minimum time frame for completion is forecast to be 2015.

This implementation plan also clearly identifies project risks including the potential for cyanobacterial blooms, salinity, and invasion by weeds, interrupted fish passage and increases in common carp. Importantly, it has been identified that the majority of project risks can be mitigated by using an adaptive management approach and careful management under variable flow conditions.

The operating regime and watering requirements have also been scoped within the plan including the required approvals.

In addition, to maximise the intended benefit of the project and minimise risks the plan recommends some additional investigations prior to the major works being undertaken. This includes hydraulic, groundwater and vegetation modelling to understand flow behaviour and salinity impacts. It also involves confirming the design and operating range of the new and modified infrastructure (regulators, ancillary banks, fishways and irrigation infrastructure).

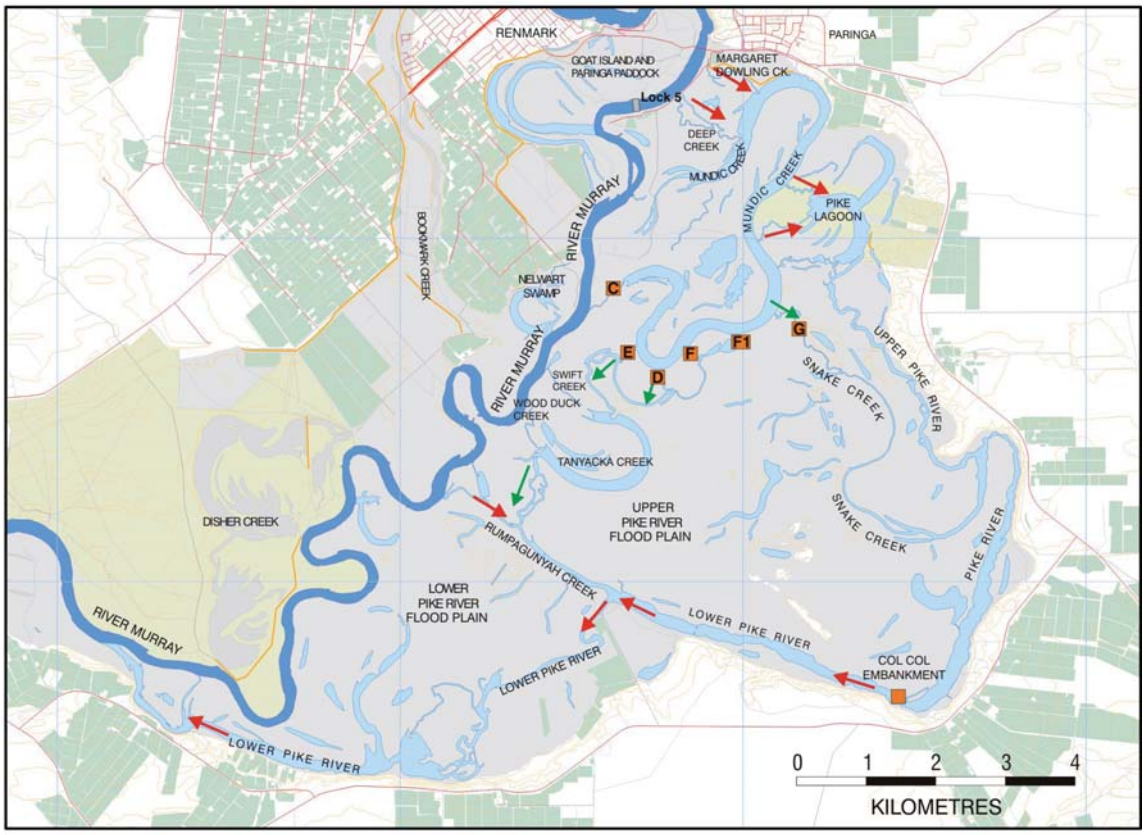
The proposal has received significant community backing and support including from the Pike Implementation Plan (PIP) Reference Committee and associated sub-committees. It has also received support from community, scientific, agency and indigenous groups.

INTRODUCTION

LOCATION

Pike Floodplain is located within the anabranch system between Lyrup and Paringa on the River Murray in South Australia (Figure 1). The total area of the Pike Floodplain is nearly 7071 hectares. The majority is leased Crown Land however the region contains the Pike River Conservation Park and land owned by the National Trust.

Figure 1: Location and main features of Pike floodplain



SIGNIFICANCE

The Pike Floodplain region has been identified as one of only three priority floodplain regions for rehabilitation within the River Murray of South Australia (the other two sites are Chowilla and Katarapko). It has also been identified as a High Conservation Value Aquatic Ecosystem on a national level due to its unique ecological and hydraulic character. The region has four species of national significance, the Southern Bell Frog, Murray Cod, Malleefowl, and the Regent Parrot. It also contains an additional 18 species with State conservation significance

The region has significant potential for broad-scale floodplain inundation as there is a three metre hydraulic gradient between the upper and lower pools created by Lock and Weir 5.

The Pike Floodplain is also a key priority site for floodplain rehabilitation and protection as per the South Australian Murray-Darling Basin (SA MDB) Natural Resource Management Plan.

VISION

The vision for the Pike Floodplain is:
"To achieve a healthy mosaic of floodplain communities which is representative of the communities which would be expected under 'natural' conditions and which ensure that indigenous plant and animal species and communities survive and flourish throughout the site."

OBJECTIVES

The objectives of this initiative are:

- To improve the condition of existing vegetation;
- To improve key aquatic riparian and terrestrial habitats required by native flora and fauna, including waterbirds, fish, reptiles, mammals and frogs;
- To achieve a sustainable balance between the needs of the various users of the floodplain; and
- To recognise and, where possible, respond to the needs of the existing productive users of the floodplain and anabranch complex.

ASSETS

The following assets have been identified for the Pike Floodplain:

- Flowing watercourses;
- Permanent wetlands;
- Temporary wetlands;
- Red Gum woodlands (*Eucalyptus camaldulensis*);
- Lignum shrublands (*Muehlenbeckia florulenta*);
- Chenopod Shrublands / Grasslands;
- Black Box woodlands (*Eucalyptus largiflorens*); and
- Dunes.

The assets each represent ecological communities under different hydrological regimes and comprise all terrestrial and aquatic habitats on the floodplain (refer to the Pike Floodplain Management Plan for more information).

URGENCY OF ACTION

Declining Health of the Pike Floodplain

The viability (or condition) of the Pike floodplain assets were assessed by rating individual ecological attributes of each asset (Ecological Associates and AWE 2008). Table 1 summarises the individual assets and overall viability (condition). The overall biodiversity health rating of the Pike Floodplain is 'fair'. The health rating is a combined assessment of vegetation condition, size and level of connectivity to other vegetation.

Table 1: Summary of individual asset viability (condition)

Assets		Landscape Context		Condition		Size		Viability (Condition) Rank
		Grade	Weight	Grade	Weight	Grade	Weight	
1	Flowing Watercourses	Fair	1	Fair	1	Poor	1	Fair
	Permanent Wetland (static)	Fair	1	Poor	1	-	1	Fair
2	Temporary Wetlands	Poor	1	Poor	1	-	1	Poor
4	Red Gum Woodlands	Fair	1	Fair	1	Fair	1	Fair
5	Lignum Shrublands	Poor	1	Poor	1	Fair	1	Poor
6	Chenopod Shrublands	Fair	1	Poor	1	-	1	Fair
7	Black Box Woodlands	Fair	1	Fair	1	Fair	1	Fair
8	Dune System	Fair	1	Poor	1	-	1	Fair
Biodiversity Health Rank								Fair

A key causative factor in declining health is stress due to lack of flooding over the past 16 years creating low soil moisture and saline groundwater in the root zone. As described in the floodplain management plan, each of these ecosystems requires a specific water regime and currently these minimum requirements are not being met (CSIRO 2005).

For example, to maintain River Red Gum forest (1,257ha) and Black Box woodland (1,540) a flood is required every 2-3 years for red-gum and 4-8 years for Black Box; with the duration of inundation ideally exceeding 3 months.

Under natural conditions, a flood event of 80,000 ML/day occurred on average every 2-3 years and would provide water to the majority of the River Red Gum communities on the Pike floodplain. An event of this magnitude has not been experienced since 1993.

This lack of flooding, in conjunction with ongoing salt accumulation in the floodplain soils due to elevated groundwater levels has resulted in widespread decline in the health of trees throughout the Pike floodplain (Ecological Associates 2008). More generally, floodplain condition has declined due to rising salinity and lack of flows, with impacts on vegetation health, reduced breeding and recruitment of flora and fauna, loss of habitat and food sources.

Reduced flows in combination with floodplain salinisation has also led to increases in surface water salinity over a ten year period potentially threatening future irrigation supplies and extraction of water for domestic use on the floodplain.

Re-instating a more natural flooding regime is urgently required to prevent further decline and promote widespread recovery and recruitment of flood dependant species. The health of the floodplain and its capacity to recover is also impacted by direct floodplain grazing and pests which has damaged native vegetation condition and which impacts on vegetation recruitment.

Stakeholder Support

This Pike Implementation Plan has been endorsed by the Department for Water (DFW), Department for Environment and Natural Resources (DENR); the PIP Reference Committee; Pike Floodplain Steering Committee; Pike Sustainable Water Steering Committee, Renmark to the Border LAP (RBLAP); Pike-Mundic Irrigators Association, the South Australian Murray-Darling Basin Natural Resources Management Board (SA MDB NRMB) and the Pike River Land Management Group (PRLMG). These committees are made up of government, stakeholder and community representation.

This Pike Implementation Plan also draws significant information from the Pike Floodplain Management Plan which was developed in 2008 by Ecological Associates and AWE.

All aforementioned plans are consistent with the direction of the Pike River Land and Water Management plan, which addresses the long term sustainability and environmental issues of the region.

A co-operative approach to the integrated management of the Pike Floodplain has been documented through a Memorandum of Understanding (2007) between the community and the government which was resigned in September 2009 for a further three years.

Plate 1: Signing of the first Memorandum of Understanding for the Pike Implementation Program in 2007. From L-R: Bruce Hewett, chair of the Pike River Land and Water Management Group; David Wotton, Presiding Member of the SA MDB NRM Board; Karelene Maywald, Honourable Member for Chaffey and Minister for the River Murray; Stuart Martin, Chair of the Renmark to the Border Local Action Planning Committee. Back: Chris Alderton, LWMP Renmark to the Border Local Action Planning Association

ECOLOGICAL VALUES

The Pike floodplain has a range of significant ecological , cultural heritage and conservation values.

The floodplain region contains a diverse range of aquatic and floodplain habitats and correspondingly diverse flora and fauna. The system provides the unique potential to preserve a diverse complex of inter-related habitats at one location including flowing habitats.

The area's diverse range of habitats support 17 plant species with conservation significance under the SA National Parks and Wildlife Act. In terms of fauna, the region has four species of national significance, the Southern Bell Frog, Murray Cod, Malleefowl, and the Regent Parrot. It also contains an additional 18 species with State Conservation significance.

The Pike floodplain has been identified as a priority floodplain for environmental flows. The identification of priority floodplains within the South Australian section of the Murray-Darling Basin was defined by the principles for prioritisation of assets from the SA Environmental Flows for the River Murray Strategy (2005). The identification of priority sites will be used by DFW to inform the South Australian River Murray Watering Plan annually.

Plate 2: Freshwater Catfish

Plate 3: Golden Perch

CULTURAL HERITAGE VALUES

Indigenous

Aboriginal occupation by the Tartangan People along the River Murray system dates back more than 30,000 years (Nicholls 2009). Remains of the workings of the Tartangan people are found in the cliffs bordering the Pike floodplain, with artifacts dated between 8,000 and 30,000 years.

Prior to European settlement, the Erawirung Aboriginal tribe populated the area from above Paringa down to Loxton. They had a keen understanding of plants and animals and incorporated the physical features of the land into their rich mythology (DENR 1994).

A number of sites of Aboriginal significance have been identified throughout the Pike area. The Pike region was utilized for mining stone tools and there is evidence of old campsites in the region with extensive midden heaps.

There is much documented evidence of how the aboriginal tribes utilised the abundant natural resources of the Pike region (SA MDB NRMB 2008).

Plate 4: One of many culturally significant Canoe Trees present on the Pike floodplain

European

European settlement occurred on the Pike floodplain by 1851 with cattle grazing on the Paringa run which also carried up to 24,000 sheep and had extensive frontage to the Pike River.

Irrigation development began in 1887 at Renmark and was the first irrigation development in South Australia. The majority of highland irrigation development occurred in the 1960s. The main crops grown are wine grapes, citrus, almonds and stone fruit. Most crops are irrigated either by drip or under canopy systems.

Today irrigation settlements extend on the south bank of the anabranch system from the Gurra Gurra Lakes complex in the south to Paringa in the north. The majority of the irrigated agriculture closely follows the highland cliffs. Irrigation on the floodplain has been removed due to the impacts of soil salinisation.

The long history of European and indigenous settlement gives it considerable heritage value as reflected in the Pike River Reflections- From Dreamtime to 2009 history publication (Nicholls, 2009).

Economic Value

The horticultural value of the area is highlighted by figures which show that the district produced 29% of the Riverland's stone fruit, 16% of its nuts and almost 10% of its citrus in the 2003/04 season. The annual average Gross Value of Production (GVP) for the Pike Irrigation area is approximately $18m.

The economic viability of horticulture is dependent on taking water directly from the Pike River with a current allocation of 22.5 GL for predominantly irrigation (99% volume) but also domestic and stock. There are also 5 approved "Prior Commitment" allocations in the Pike irrigation area with a total volume of 14.8GL. The water allocations have significant market value.

MAJOR THREATS

The critical threats to each asset were ranked by determining the stresses on each asset and the source of each stress (Ecological Associates and AWE, 2008). Table 2 summarises the threat rating for each asset and identifies the ranking for each threat.

A very high threat (e.g. lack of environmental flows) therefore is a very large contributor to a stress (e.g. altered hydrological regime) that is largely irreversible and severely affects the ecological system (e.g. temporary wetlands) across most of its range or scope.

Table 2: Summary of threat ratings for each asset

Threats Across Targets		Flowing (Habitat for Flow Dependent Species) Watercourses (Habitat for Flow Dependent species)	Permanent Wetland (static)	Temporary Wetlands (floodplain depressions)	Red Gum Woodlands	Lignum Shrublands	Chenopod Shrublands/ Grasslands (temporarily inundated)	Black Box Woodlands	Dunes	Overall Threat Rank
Project-specific Threats		1	2	3	4	5	6	7	8	
1	Lack of environmental flows (over extraction, river regulation)	Med	High	Very High	Very High	Very High	Low	Very High	Med	Very High
2	Impounding Structures (ponded water for irrigation - groundwater / salinity impacts, restricts connectivity	High	Med	Very High	High	High	High	High	-	Very High
3	Irrigation drainage (groundwater elevates resulting in saline soils)	Med	High	Very High	High	High	High	High	-	Very High
4	Regional land clearance (groundwater rise resulting in saline soils)	Med	High	Very High	High	High	High	High	-	Very High
5	Grazing	Low	Med	Med	Med	Med	High	Med	High	High
6	Pest animals (grazing - pigs, goats, rabbits)	-	-	-	-	Med	High	Low	Low	Low
7	Lack of fish passages	Med	Low	-	-	-	Low	-	-	Low
8	Pest fish species (Carp, Gambusia)	Med	Low	-	-	-	-	-	-	Low
9	Weeds	-	-	Low	Low	-	-	Low	Low	Low
10	Recreational Use (tracks, camping, firewood collection)	-	Low	-	Low	-	-	Low	-	Low
11	Over abundant kangaroos	-	-	-	-	-	-	Low	-	Low
Threat Status for Targets & project		High	High	Very High	Very High	Very High	High	Very High	Med	Very High

From this analysis, the lack of environmental flows is the highest ranking threat to the ecological health of the Pike floodplain affecting four out of the eight environmental assets. Ecological assets such as wetlands, River Red Gum, Lignum and Black Box communities had the highest threat status of 'very high'. These ecosystems make up a significant proportion of the floodplain.

Other threats include floodplain grazing, floodplain salinisation, sedimentation of watercourses and lack of fish passage. Without significant intervention there will be further decline in floodplain health, habitats and biota.

Lack of environmental flows

Under natural conditions (pre-regulation) flow was highly variable and frequently reached levels which would inundate the floodplain (Table 3). On average, most of the Pike floodplain including Black Box woodlands, would be inundated one year in four.

River regulation and diversions have severely reduced the frequency and duration of floodplain inundation.

Regulation through the construction of locks and weirs and upstream storages has significantly reduced the frequency and duration of flood events. In particular, small to medium sized floods have been reduced dramatically on most of the catchments' floodplains. Regulation has also reduced natural wetting and drying cycles needed to rejuvenate the ecological condition.

In addition, environmental flows within the Pike anabranch complex as well as on the floodplain have been further reduced by the construction of levee banks and blockages in permanently flowing waterways and other temporary flow paths. Consequently, this has reduced the connectivity between the river, anabranch complex and the floodplain.

Reduced environmental flows have led to significant ecological impacts including:

- Loss of long lived terrestrial vegetation and transition to arid or drought tolerant understorey species;
- Loss of ephemeral habitats through no natural summer drying, leading to a loss of in-stream habitat diversity, and a reduced range of bank habitats;
- Loss of flow dependent native fauna eg. Freshwater mussels (*Alathyria jacksoni*), Murray crayfish (*Euastacus armatus*) and River snails (*Notopala hanleyi*);
- Reduced exchange of organic material, carbon, nutrients and sediment between the floodplain and the river;
- Degradation of natural low flow channel shape;
- Thermal stratification, favouring cyanobacteria;
- Reduced diversity and biomass of invertebrates in annually flooded areas; and
- Reduced diversity of waterbirds and terrestrial native fauna.

Plate 5: Mixed Blackbox and Redgum Woodland located near Mundic Lagoon

Table 3: Flooding extent, frequency, and duration under natural and current conditions at Pike (Ecological Associates and AWE, 2008)

River Murray Flow to SA (ML/day)	Return Period (number of times peak flow occurs in 100 years)		Duration (number of months flow is exceeded)	
	Natural	Current	Natural	Current
5000	100	100	11.8	11.9
10,000	100	94	10.1	4.6
20,000	99	63	7.8	4.6
30,000	96	51	6.4	3.9
40,000	91	40	4.9	3.3
50,000	79	30	3.9	2.7
60,000	59	21	3.9	2.5
70,000	49	15	3.6	2.9
80,000	45	12	3.25	2..6
90,000	37	11	3.1	2.1
100,000	32	9	2.9	2.0
120,000	23	5	2.2	2.8
150,000	12	4	2.2	1.5

Elevation of Floodplain Groundwater Levels

The River Murray floodplain, including Pike is typically a natural discharge point for saline groundwater. Groundwater levels and salinity have increased on the floodplain due to river regulation (locks and weirs) and discharge of saline groundwater from highland irrigation areas to the floodplain.

Elevated saline groundwater levels (up to 2-3m higher than normal) and reduced soil moisture due to low flooding has led to increased soil salinisation. The combination of a semi-arid climate with surface clay soils of low permeability means that, generally, there is little leaching of salt between floods.

Significant areas of the floodplain are currently affected by soil salinisation and the degree of salinisation is expected to increase. Salinisation of floodplain soils is a major factor in the decline of the health of floodplain trees and in many areas it has caused extensive vegetation death. Vegetation dieback is due to a combination of lack of environmental flows and the impacts of soil salinisation.

Regular inundation events are important because they recharge the soil and groundwater, and flush salt that has accumulated through the dry period from the tree root zones. Flushing of salt from the floodplain soils now occurs less frequently as a consequence of reduced flooding.

Requirements to achieve objectives

Engineering intervention is required to compensate for the reduced flows and provide the required floodplain inundation and reduction of salt accumulation through flushing of the floodplain soils. Works will be required at a number of sites to enhance the wetland/floodplain hydrology during either low flows or a natural flood event.

Removal of grazing and controlling pests on the floodplain is also essential to facilitate recovery of the Pike. This will in combination with the altered hydraulic regime promote prolific regeneration of floodplain species. It is considered that active revegetation will therefore not be required.

Maintaining sufficient flows through the system also means ensuring sustainable water extraction within the Pike system. This requires setting a sustainable limit of water diversions for irrigator and domestic use.

Details of preferred management actions required to achieve the Pike Floodplain objectives are presented in the next chapter.

HYDROLOGICAL MANAGEMENT AND FISH PASSAGE OPTIONS

There are a number of potential hydrological management options for the Pike Floodplain. Options include removal and/or modification of present structures and barriers, as well as the construction of new infrastructure. Investigations have been undertaken to assess the range of management options in order to determine how to best to achieve management objectives. The potential options have been assessed for technical feasibility based on cost, salinity impact, contribution to environmental objectives and water use.

Do nothing

This management option involves taking no further intervention on the Pike floodplain. As shown in the current condition assessment, many of the environmental assets on the floodplain are in poor condition. In addition, a significant number of assets are at very high risk of further degradation. It is likely, that under the current regime, vegetation on the Pike floodplain will experience irreversible decline and transition to a more salt tolerant community with a loss of significant ecological value.

The key processes which will continue to degrade the ecosystems are:

- The intensification and spread of soil salinisation, particularly in low-lying floodplain areas north of Mundic Creek and along the Upper and Lower Pike River;
- Floodplain inundation insufficient for the survival of floodplain Black Box, Lignum and River Red Gum and insufficient to maintain the primary productivity on which floodplain biota depend;
- Insufficient soil moisture to maintain tree health except along the flushed zone of the River Murray and the zone immediately adjacent to permanent watercourses; and
- Depletion of native vegetation and inability to recruit due to grazing, salinisation and lack of flows.

Wetland Management Options

A number of options involve direct management of wetlands within the Pike floodplain to help rehabilitate their values.

Gravity Watering Wetland Sites

This option involves engineering works to connect low lying wetland areas to allow watering by gravity feed. Engineering works required include new blocking banks, regulator structures and construction of drainage channels. The option can only be applied at a small number of sites and therefore does not offer a comprehensive solution.

Re-introduce Wetting and Drying on Individual Wetlands

A number of wetlands (7) on the Pike floodplain can be individually regulated to re-introduce seasonal wetting and drying cycles. Water levels can be raised by pumping or capturing water during high river levels. Water levels can be lowered by releasing water or through losses to evaporation and seepage.

This option is seen to be a long term management action but complementary to larger scale water manipulations in order to achieve the environmental objectives.

Potential sites for manipulation include: Woodcutters Wetland, Lower Snake Creek Wetland, Letton's Homestead Wetland, Letton's Flat Wetland, Swift Creek Wetland; and Rumpagunyah Flood Runner.

Figure 2: Map of Wetland Sites for Water Manipulation

Seasonally raise water levels in Tanyaca Creek

A number of options involve seasonally manipulating water levels in order to increase capacity to inundate and dry areas

The option involves seasonally raising water levels in the Tanyaca Creek by 0.5m and lowering them by 1.0m, by regulating flow from the River Murray into the Tanyaca Creek.

Raising water levels would include modification to inflows (Mundic Creek), installing regulated levees to control inflows (Wood Duck Creek and Swift Creek) and outflows (Rampangunyah Creek). This will improve the environmental flows.

Manipulating water levels in this system will not impact on irrigators' capacity to extract water from the Pike system. This option is seen as a long term management option but complementary to large scale water manipulations to achieve environmental objectives.

Seasonally raise and lower water levels in the upper Pike-Mundic

Water levels can also be so raised by 0.5m and lowered by 1.0m in the Pike- Mundic system. This would improve the environmental flows to a small area of floodplain woodland communities assisting in their recovery on wetland fringes which are currently permanently inundated.

As with Tanyaca is the option seen as a long term management option but complementary to large scale water manipulations to achieve environmental objectives.

Lock and Weir Pool Manipulation

The Pike floodplain and anabranch system straddles Lock 4 and Lock 5 and provides opportunities for weir pool manipulation to increase flows and in-stream water levels.

Weir pool raising at Lock 5

This option involves raising the Lock and Weir No. 5 upper pool level 500mm from its normal level of 16.30m AHD to a maximum level of 16.80m AHD. This will increase flows through the Pike anabranch and increase the area of floodplain currently inundated.

This is a proposed long term management option but seen as complementary to large scale water manipulations to achieve the environmental objectives.

Weir pool raising at Lock 4

Weir pool raising at Lock 4 up to 14.34m AHD (an increase of up to 1.15m) would increases flows and raise water levels in the lower Pike. This is a proposed long term management option but is seen as complementary to large scale water manipulations to achieve the environmental objectives.

Enhancing Fish Passage

This option involves incorporating fish passage into the design of new regulating structures. Currently, upstream fish passage is completely blocked by all regulating structures (Banks A, A1, B, C, D, E, F, F1, G, H and Coombs Bridge) with the exception of Col Col embankment (where crude fish passage is currently provided). In addition, Lock 5 road crossings are not easily traversed by migrating fish.

This includes identifying the sites where fish passage is most important. This is a proposed long term management option but is seen as complementary to large scale water manipulations to achieve the environmental objectives.

Irrigation Infrastructure

This option involves artificially watering trees through pumping. It aims to address the watering requirements of Black Box trees which are typically found in elevated sections of the floodplain. Significant flows of 80,000 ML/day (flow to SA) are required to naturally flood these areas.

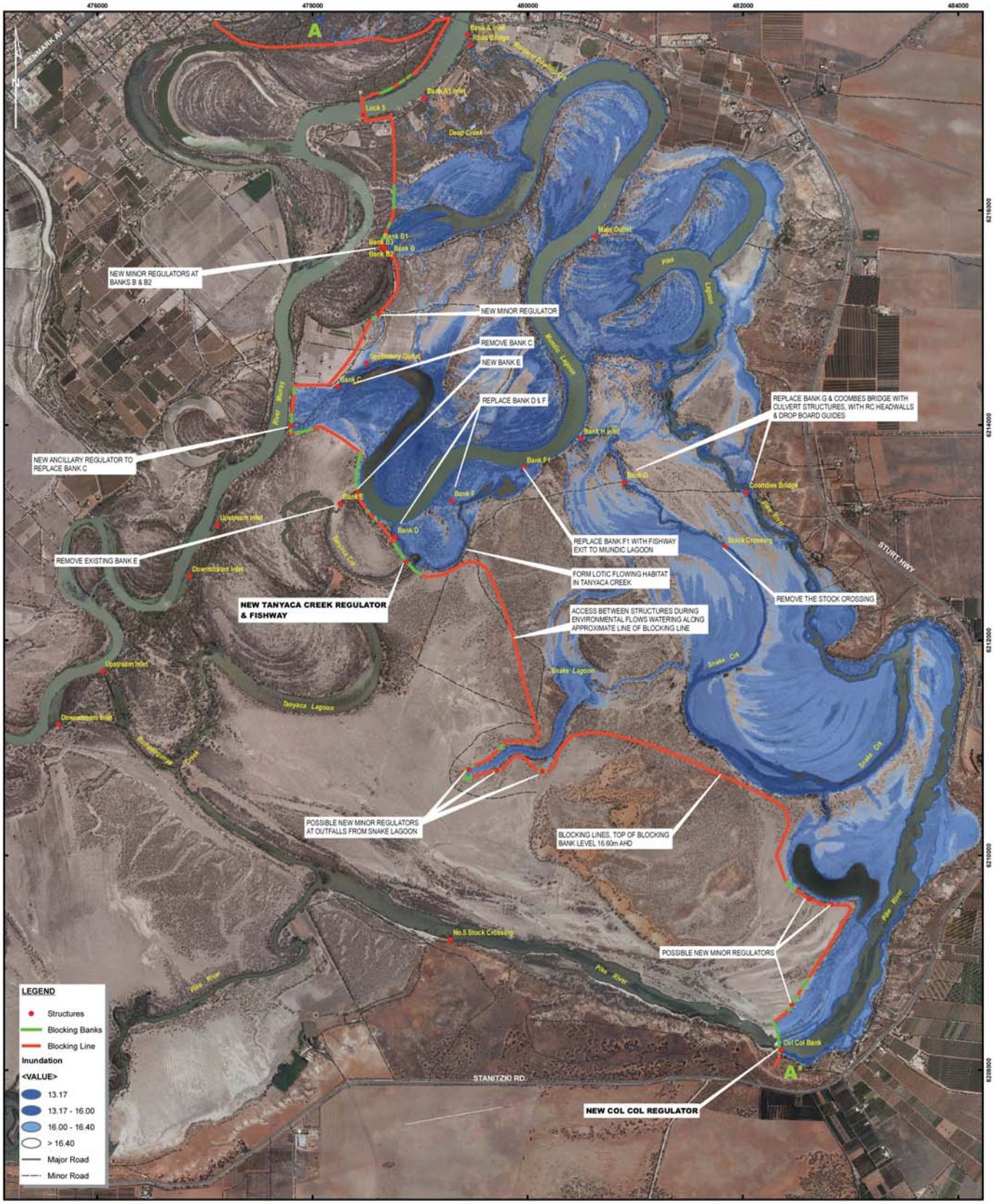
This option is not considered to be a long-term management option as it has a high cost ($1.6m establishment cost, for 70ha) (URS 2006). It also does not provide for the range of ecological benefits associated with floodplain inundation such as increased connectivity between river and floodplain habitats, freshening of groundwater, improved soil condition and enhanced regional biodiversity.

Large Scale Water Manipulation through Installation and Operation of Environmental Regulating Infrastructure

This option has the potential to create large scale water manipulation on the Pike Floodplain through the introduction of new environmental regulating infrastructure which would be designed to vary water levels upstream of Col Col and Tanyaca Creek up to a maximum elevation of 16.4m AHD (varying water levels over 2.05 metres: 14.35m AHD – 16.4m AHD) (Figure 3). Such intervention would result in significant floodplain inundation (~1500ha) (Hollis, 2009a).

Plate 6: Ephemeral Wetland fed from Rumpagunyah Creek

Figure 3: Potential inundation extent generated by operating the proposed Pike regulators up to a maximum height of 16.40m AHD



This option involves the construction of a new network of environmental regulating structures at Col Col and on Tanyaca Creek and associated fishways, ancillary by-pass regulators, blocking banks and other works.

The regulators could potentially operate under flows ranging from entitlement conditions up to 50,000 ML/day (QSA), although flows of at least 10,000 ML/day downstream of Lock 5 would be optimal to maximise potential ecological benefit.

This is the preferred proposed long-term management action for achieving the environmental objectives and is discussed in detail in the following chapter.

Improving Flows through the Pike Floodplain System.

There are some opportunities to increase the degree of flowing water habitat that is required by native fish species and other aquatic biota.

Increasing flow from Mundic Creek to Lock 4 via Creeks

This option involves increasing flows in the channel between the Mundic and Tanyaca Creeks by modifying the structures which control outflows from the Mundic Creek. To achieve maximum hydraulic benefits, flows from the River Murray into the Mundic would need to be increased and the flow out of the Mundic controlled.

This is a proposed long term management option but is seen as complementary to large scale water manipulations to achieve the environmental objectives.

Increasing Flows in the Lower Pike Floodplain

This option involves increasing the frequency of flushing flows in the Lower Pike River by lowering the sill of the channel near the River Murray. This will reduce the accumulation of salt in the “dead-end” sections of the Lower Pike River and improve water and hence salt transfer from the lower Pike to the River Murray.

This is a proposed long term management option but is seen as complementary to large scale water manipulations to achieve the environmental objectives.

Summary

A summary is provided in Table 4 for addressing the requirement to maintain environmental flows, e.g. inundation events and a variable in-stream hydraulic regime.

As illustrated in Table 4, the construction of environmental regulators in Tanyaca Creek and Col Col combined with some ancillary works has the greatest potential for improving floodplain health and contributing to environmental objectives.

The other management actions are seen as complementary but do have the scope to increase the area of floodplain that can potentially be improved.

Table 4: Summary of potential surface water management options for the Pike anabranch and floodplain complex

Management Option	Potential for increased tree benefits	Potential for increased understorey vegetation	Potential for increased bird benefits	Potential for increased fish benefits	Potential for increased frog benefits	Potential for increased water quality benefits	Nutrient transfer from the floodplain to the River	Area influenced	Capacity to achieve ecological objectives
Do Nothing									Low
Weir Pool raising at Lock 5	✓	✓	✓	✓	✓	✓	✓	<5% of the floodplain	Low
Permanent pumping infrastructure	✓	✓	✓	✓	✓			<5% of the floodplain	Low
Gravity watering wetland sites	✓	✓	✓	✓	✓	✓	✓	<5% of the floodplain	Low
Irrigation infrastructure	✓✓							<5% of the floodplain	Low
Environmental regulating structures at Col Col & on Tanyaca Creek up to 16.4m AHD	✓✓✓	✓✓✓	✓✓✓	✓✓	✓✓✓	✓✓✓	✓✓✓	>30% of the floodplain	High
Seasonally raise and lower water levels in Tanyaca Creek	✓		✓	✓	✓	✓	✓	<5% of the floodplain	Low
Raise and Lower Lock 4								<5% of the floodplain	Low
Upgrade structures to provide fish passage				✓✓					Low
Regulate individual Wetlands	✓	✓	✓	✓	✓	✓	✓		Low
Improve flow paths				✓		✓		<5% of the floodplain	Low
Alternative elevations and locations for downstream regulating structures	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	<30%	Moderate

WATER EXTRACTION MANAGEMENT OPTIONS

Do nothing

The key risk to ongoing water extraction under a "do-nothing" scenario is increasing salinity levels and loss of adequate flows and water levels throughout the Pike anabranch complex. This would have unacceptable consequences to the local community and economy. Modelling shows that salinity levels have the potential to increase if flows are significantly reduced by high levels of water extraction particularly in the summer months (AWE 2009)

Flows have also reduced significantly when compared to historical levels. Reductions in flows are due largely to the current hydraulic regime and existing barriers which are accelerating the rate of siltation and invasive vegetation growth (particularly *Typha sp* and *Phragmites australis*).

Setting Sustainable Diversion Limits.

The option has been endorsed by the community and government as an acceptable solution to maintain the security of existing extractors and ensure any future water allocation does not compromise environmental objectives. It is proposed as a long term action and described in detail in future sections.

Achieving Irrigation Efficiency and a District Code of Practice for Irrigation

In addition to establishing a sustainable diversion limit on irrigation, there is a requirement to ensure irrigators are efficient and are minimising the levels of deep drainage and impacts on the groundwater table. This is through developing an appropriate code of practice including assessing levels of irrigation efficiency. This can be implemented through conditions of site use approval and rules regarding transfer of entitlements. Ensuring best practice is important for long term management of the Pike Floodplain and maximising productivity from the region.

Flexible Water Extraction

This option involves modifying and/or moving pumps that extract water from the Pike system. This will ensure that water supply can be maintained to irrigation properties whilst the floodplain can be hydrologically managed to increase environmental benefits. This option has been endorsed by the Sustainable Water Management committee and is recommended as a long term complementary option.

Reducing Siltation Levels throughout the Pike anabranch system

This option is seen only as a short term strategy until longer term surface water management actions as previously described are implemented.

FLOODPLAIN MANAGEMENT OPTIONS

Do nothing - Retain current grazing regime

Currently, there are significant areas of the floodplain which are grazed by livestock (cattle, sheep and goats). This damages vegetation, compacts soils and reduces the capacity of vegetation to regenerate and be viable in the long term. As shown by the risk assessment, grazing is considered a high overall risk to the ecological integrity of the floodplain, impacting significantly on seven out of the eight assets. Also, a range of pest plants and animals are currently threatening the floodplain and without immediate action they have the potential to spread and impact on the ecological communities within the region.

Removal of Grazing on the Floodplain

This option involves permanently removing livestock grazing from the Pike floodplain on all land tenures. This is considered an integral action to ensuring rehabilitation of the region in the long term and has been endorsed by government agencies and also the general community as a recommended long term management action. The continuation of livestock grazing on the Pike floodplain has the potential to jeopardise investment required for rehabilitation activities.

Terrestrial Weed and Pest Control

This option involves controlling weeds on the floodplain and aquatic areas. In particular a number of terrestrial weeds are invading from nearby residential areas and have the potential to spread further into the Pike region.

This includes weeds such as Date palms, Athel Pine, Desert Ash, Olives, Bridal Creeper, Californian Burr, Ceder trees and Prickly Pear. There are also a number of aquatic weeds that have spread throughout the anabranch system which have the potential for high ecological impacts including Willows. These weeds are mainly affecting the littoral zones, creek lines and ponded areas of the floodplain.

There is also a threat posed by feral animals on the floodplain including rabbits, hares, and foxes. Foxes are widespread right across the floodplain predating on frogs, turtles, ground dwelling birds and nests containing eggs. Rabbits and hares are prevalent particularly on the high banks and cliffs around Pike. They damage vegetation on the higher ground, eating vegetation and digging up sites of Aboriginal cultural significance.

Sustainable Recreation

The Pike floodplain supports a number of recreational uses including fishing, camping and boating. A recreation management plan is recommended to identify options to better manage the impacts of these activities and access within the floodplain. It is likely the development of a plan would occur once other high priority issues have been addressed. Sustainable recreation on the floodplain needs to protect sensitive areas and restrict or manage the times and locations at which some activities take place.

GROUNDWATER MANAGEMENT OPTIONS

Do Nothing

The Pike Floodplain region is currently inputting the highest level of salt into the River Murray of anywhere in South Australia. Estimated salt levels entering the River Murray are 78 tonnes per day. Saline groundwater intrusions caused by the historical impacts of highland irrigation is the main cause.

Salt Interception Scheme- Highland Areas

The recommended option by the state government, community and irrigators is to develop a Salt Interception Scheme (SIS) of groundwater wells intercepting saline groundwater along the edge of the highland adjoining the Pike River floodplain. This option is a proposed long-term management action and is discussed in the following chapters.

Salt Interception Scheme- Extend to Floodplain

It is recognised that flow management options may not be sufficient to achieve all objectives and targets for the Pike floodplain. Some areas are beyond the extent of influence for surface water management options, or are more likely to respond to groundwater management. Therefore, as part of the options assessment process groundwater management should also be thoroughly investigated and assessed.

Artificially high saline groundwater levels and increased rate of salt accumulation in the floodplain soils are contributing to the ecological decline of the Pike floodplain. It is therefore considered necessary for the long-term management needs of the Pike floodplain to investigate the role and application of groundwater management in dealing with the ecological needs of the floodplain. Groundwater management may provide significant floodplain benefit to areas beyond the influence of surface water management and may provide additional floodplain protection during times when proposed new surface water infrastructure will not be in operation. However this option requires further investigation to determine its viability.

Plate 7: Overlooking the Pike floodplain from the surrounding highland

HYDROLOGICAL MANAGEMENT AND FISH PASSAGE

The preferred long term management option is the large scale water manipulation through the installation of environmental regulating structures.

This will ensure the maintenance of current ecological systems and also facilitate significant rehabilitation. It will also increase resilience to the impact of future droughts and climate change.

In conjunction with the preferred long term management option there are also some complementary management options which will help ameliorate areas of the floodplain not covered by large scale water manipulation. These are detailed in the Complementary Measures Section.

As discussed, the construction of the new environmental regulators will achieve the most significant ecological benefit. Operation of the proposed structures at Tanyaca Creek and Col Col to 16.40m AHD at low flows (10,000ML/day flow to SA) will inundate approximately 25% (1,466ha) of the Pike floodplain (Watertech 2009). The total area inundated is similar in size to a natural event (65,000ML/day) but is primarily focused on the Upper Pike.

Modelling has been undertaken to define the extent of inundation with environmental regulators in place (Table 5). These areas are considered to be conservative because the area of influence is typically greater than the area inundated due to recharging of soils and the groundwater system beyond the water-line. This has been evidenced in recent watering initiatives in the Murray-Darling Basin.

Table 5: Modelled inundation coverage for elevations with and without environmental regulators on the Pike floodplain

Flow to SA	Area inundated (ha)	Extra area inundated (ha)	% of floodplain inundated	Area of Red Gum inundated (ha)	Area of Black Box inundated (ha)	Natural flow required to inundate equivalent area (ML/day)
10,000 ML/ day (without environmental regulators)	814	0	11.5%	0	0	<30,000
10,000 ML/ day (with environmental regulator operated at 15.8m AHD)	1616	802	23%	148	98	65,000
10,000 ML/ day (with environmental regulator operated at 16.4m AHD	1817	1003	28.5%	244	370	70,000

Proposed Works

In accordance with concept designs developed (URS 2009), the proposal includes the following works:

- New minor regulators at Banks B and B2, the road from Bank B to Bank C and outlets from Snake Creek;
- New minor regulators placed strategically at key locations along the embankments to provide additional outlets during an E-flows event;
- Remove existing Banks C, D, E, F & G and Coombs Bridge and replace with new ancillary regulators (the latter to provide vehicle passage);
- Major new regulator required with fishway at Tanyaca Creek and Col Col;
- Replace Bank F1 with fishway exit from Mundic Lagoon;
- Replace Deep Creek and Margaret Dowling Creek inlet structures (fishways provided for both structures);
- 2.7km of embankment constructed to a crest height of 16.6m AHD (200mm above the proposed maximum elevation of regulating structures (16.4m AHD));

A staged approach is recommended with the following four stages:

a) Replace inlet structures and continue investigations to confirm floodplain options ($4.1m)
b) Improve hydraulic connectivity and provide fish passage ($6.7m)
c) Replace Bank B complex and Bank C complex to improve hydraulics during natural floods ($4.7m) 2012-13
d) Install environmental regulators to create managed floodplain inundations whenever required irrespective of natural flow conditions ($28.9m) 2013-14.

Plate 8: Col Col Regulator, one of the numerous structures in the Pike anabranch complex identified for replacement

Costs

As outlined the estimated cost for the works and required investigations are approximately $46 million for installing regulating structures and ensuring fish passage.

Ecological Benefits

The proposed environmental regulators will inundate approximately 244ha of River Red Gums and 370ha of Black Box at low flows, significantly improving the condition of existing trees as well as creating an environment which will be suitable to establish and sustain new emergent trees. No other proposed management intervention throughout the Murray-Darling Basin has the capacity to influence such a large area of Black Box.

Operation of the environmental regulators will improve vegetation condition on the Pike floodplain through the introduction of a flooding regime that will improve soil water availability, freshen the saline groundwater and reverse the accumulation of salt in the floodplain soils.

Modelling completed to date indicates that the operation of the environmental regulators at low flows (i.e. 10,000ML/day) will inundate a high number of ephemeral creeks and wetlands, providing an improved water regime for significant areas of River Red Gum forest, Black Box woodlands and Coobah woodlands on the Pike floodplain.

Non-tree vegetation will also benefit, with operation of the proposed environmental regulators capable of delivering an improved water regime to the lignum shrublands, the grassland/sedge land areas, and the herb land areas.

The prediction of a significant improvement in vegetation condition is supported by research on the lower Murray floodplains which showed that floodplain inundation results (in most cases) in significant increases in the abundance of native flood dependent herbs and grasses (Nicol and Weedon 2007).

In addition, introducing higher levels of flow variability through such infrastructure, including the installation of fish passage structures will advantage the larger and migratory fish species as well as improve some fish populations (Lloyd 2008). This includes allowing some significant recruitment events to occur and habitat for floodplain fish specialists to be created.

Potential ecological risks

There are a number of ecological risks associated with altering the water regime including potential for cyanobacterial blooms, black-water events, weed invasion, reduced lotic or flowing habitats, and increased carp populations.

Significant work has already occurred to understand how to mitigate these risks and maximise ecological benefits. Although this has occurred at Chowilla it is directly transferable to the Pike system as the system behaves in a similar manner.

The risk assessment undertaken indicates that most risks can be removed or reduced by avoiding operating regulators at maximum capacity under low flow conditions and/or reducing the frequency of such events.

Other strategies to address risks include retaining and where possible increasing fast flowing habitat; ensuring variability in flow and water levels; facilitating fish passage through design of structures and monitoring after operation of the regulator for the presence of any weed expansions or new infestations of pest plants.

Salinity Impacts

In-stream Salinity Levels

Introducing managed floodplain inundation through the periodic operation of the Pike regulators will result in a transitory post flood salt load in the River Murray. The quantification of the salt load and resultant salinity impact for such an event is required and necessitates surface water and groundwater modelling.

Elevated Saline Groundwater Levels on Pike

The issue of elevated groundwater levels and potential increased floodplain salinisation resulting from the operation of the regulator also requires further investigation.

Potential Operating Regime and Water Use

In order to maximise ecological benefit and minimise the potential for adverse effects, the operation of the regulators will be undertaken in an adaptive management framework. This includes a robust monitoring program which monitors floodplain condition but also assesses impacts and benefits of the flood regime to soils, groundwater, receiving Murray waters and other important biota (Brookes et. al 2007).

Additional work remains to be done in developing an operating regime for the Pike environmental regulators. The Pike environmental regulators can potentially be operated over a wide range of heights and flow conditions (up to 50,000ML/day). Flows above 10,000ML/day are optimal for maximising ecological benefits.

In the case of lower flows, a number of options can be employed to manage risks including

- Inundating less floodplain but maintaining minimum flow velocity;
- Inundating more floodplain, but potentially reducing flow velocity.
- Potentially delaying the operation of the regulator until higher inflows are available if this does not compromise ecological requirements;
- Potentially reducing the duration of operation to minimise water quality risks.

Water Requirements

Determining the water requirements under the new operating regime involves calculating both water losses (seepage and evaporation) and delivery volume (volume required to increase River Murray flow to a level suitable for operation of the regulator). Utilising the Pike hydrodynamic model, water losses can be calculated based on factors such as inflows, outflows, area of floodplain inundation, rate of seepage and evaporation throughout the operating regime.

Modelling shows that approximately 12.4GL of water will be consumed by the environment under the proposed 120 days operating regime (Water Technology 2009).

Additional modelling is required to further quantify the required volumes under a range of scenarios. Water losses can be potentially reduced by reducing the height of the environmental regulators or reducing the duration of flooding.

It is highly likely Pike will be able to 'piggy-back' on water provided to SA for other high priority landscapes such as the Lower Lakes, Coorong and Murray Mouth and Chowilla and Katarapko thereby reducing the need to fully account for the entire required volume to be delivered.

Complementary Measures

To maximise the operation of the proposed environmental regulators at Tanyaca and Col Col a raising of Lock 5 to top of piers (16.80m AHD) is preferred. In addition, upgraded regulators at Margaret Dowling Creek and Deep Creek will be utilised to facilitate delivery of water into the anabranch whilst downstream structures will be utilised to control the rate of water level rise and fall. Pulse flows can potentially be delivered during Spring to generate native fish movement and spawning behaviour in addition to providing benefits to fringing vegetation.

There is opportunity in the future to increase the scope of influence of the environmental regulators through complementary surface water management options. The following have been endorsed as options but further investigations are required to confirm the feasibility, design and cost of such options:

- Wetland Management- Gravity watering and re-introduction of wetting and drying;
- Seasonally raising water levels and lock and weir pool manipulations;

It is noted however that such options will not have the large scale impact of the proposed environmental regulators.

SUSTAINABLE DIVERSION LIMIT FOR IRRIGATION

Evidence indicates that setting sustainable diversion limits (SDL) is required to ensure any further water allocation from the Pike River system will not compromise the water quality and quantity available to current diverters or result in adverse ecological impacts in key locations of the floodplain.

A number of scenarios have been modelled to examine the impact of increasing extractions above current levels. The impact of increased extraction varies depending on location, level of extraction, River Murray flows and long term factors such as the implementation of the salt interception scheme.

The MDBA is also developing some overall models for SDL's using a basin wide approach which may influence the setting of SDL's within the Pike Floodplain. However, there is still anticipated to be scope for inputting specific information about the Pike through the River Murray Prescribed Watercourse Water Allocation Planning Process.

A proposed action involves input into the development of a SDL through the River Murray Water Allocation Plan (WAP) including the setting of trigger levels for adaptively managing the system and fine tuning the SDL requirements.

Proposed Works

Setting of Sustainable Diversion Limits on the Upper, Mid and Lower Pike River. Sustainable diversion limits enforced through the new River Murray WAP. Developing appropriate trigger levels for monitoring real-time impacts of water extraction.

Modelling of Sustainable Diversion Limits $10,000.

Develop trigger points and associated Surface Water Monitoring System and analyse monitoring information.

Ecological Benefits

Sustainable diversion limits will be set in order to ensure that water flows and levels do not decrease to a point where there is likely to be further ecological impact.

Potential Ecological Risks

Inadequate modelling and monitoring leads to an unsustainable diversion limit

Salinity Risks

The implementation of a Sustainable Diversion Limit will reduce the potential for future salinity impact within the Pike River as a result of water extraction.

Plate 9: Tanyaca Creek

FLEXIBLE WATER EXTRACTION FOR IRRIGATION

Integral to improving the overall management of the floodplain is to have the flexibility to alter water levels either up or down depending on the ecological requirements to re-instate a more natural hydraulic regime.

There is a requirement to ensure that current water extraction within the area can continue despite changes to water levels through examining options for modifying or relocating pumps within the floodplain and also potentially introducing regulating infrastructure such as “re-lift” weirs.

Proposed Works

Modelling of the impact of water level changes on the Pike Floodplain and associated costing.

Some initial modelling work has been undertaken but there is a requirement to complete the modelling work to determine the required changes to pumps needed to cope with changing water levels (lowering and raising).

Pump Modification and/or relocation.

Significant costs will be incurred to allow the more flexible extraction of water supplies. A pump survey report (Rural Solutions) has found that maintaining water supplies will involve modifications to 92 pumps, including 34 domestic and 58 irrigation pumps under the lowering scenarios currently proposed. The level of modification varies from relocation of pumps, for example for domestic supplies on the Pike Lagoon, to minor and major modifications of existing pump structures. The number of modifications is affected by the degree of raising or lowering of water levels.

Re-lift Weir at Pike Lagoon Outlet

The construction of a re-lift weir at the outlet of Pike lagoon would enable water levels in Mundic and Pike lagoon to be lowered, whilst maintaining current water levels on the downstream side of the weir where a number of irrigators extract water. This option requires further investigation and will focus primarily on the reach from Coombs Bridge to Col Col embankment.

Costs

The modelling is expected to cost approximately $80,000 to complete requirements for flexible extraction and undertake detail design of any modifications.

The estimated costs of relocating and modifying pumps is $2 million however this will be refined once modelling and concept designs are completed.

Modelling work to investigate the possibility of a Re-lift Weir is likely to cost $30,000.

Ecological Benefits

Flexible water extraction will permit greater variation in water levels within the Pike anabranch particularly in the Upper Pike.

Potential Ecological Risks

Further work needs to be carried out on the ecological implications of the re-lift weir particularly in regard to fish passage.

Salinity Risks

Further work needs to be carried out on the ecological implications of the re-lift weir particularly in regard to salinity impacts.

Reducing Siltation throughout the anabranch network

To guarantee the short term viability of water supplies, it may be necessary to undertake some managed channel maintenance or desilting works to ensure that water flows are not restricted by invasive vegetation choking and silting up waterways. Desilting is not considered to be a preferred long term management action as other actions are proposed to remove barriers to flow and improve the hydraulic regime throughout the anabranch network in time. It is believed these initiatives will reduce the level of siltation and prevent the need to undertake long term desilting works.

Proposed Works

Short term “channel maintenance”, willow removal and removal of weeds in key locations of the floodplain.

Cost

The cost of short term desilting works in designated locations is likely to cost $50,000.

REMOVAL OF GRAZING ON THE FLOODPLAIN

Integral to rehabilitating the Pike floodplain is the permanent removal of livestock grazing. This will improve the capacity of the ecosystem to respond to proposed management actions.

Proposed Works

Removal of all grazing on the Pike floodplain is proposed. Annual licenses for grazing on Crown Land have not been renewed as a first step toward achieving this option.

Costs

Negotiations are ongoing to facilitate the permanent removal of livestock grazing on the Pike floodplain.

Ecological Benefits

Removal of grazing will reduce soil disturbance and destruction of native vegetation resulting in increased biodiversity. It will also promote regeneration and recovery of native vegetation and complement the large scale water manipulation activities proposed.

Potential Ecological Risks

The floodplain will have to be monitored for weed growth which can be particularly prevalent to areas where livestock have recently been removed.

Salinity Risks

There is unlikely to be any salinity risk associated with this option.

Potential Operating Regime And Water Use

Not Relevant.

PEST PLANT AND ANIMAL CONTROL ON THE FLOODPLAIN

Retaining and/or enhancing the values of the floodplain will include controlling pest plants and animals that are currently established or have the potential to establish, particularly post flood.

Proposed Works

Terrestrial and aquatic weed control and terrestrial animal control.

Costs

The initial cost of weed control would require $80,000 with an ongoing annual maintenance program for weeds which would require a budget of $10,000 to $15,000. Fox control would require $2,000 per year and would involve surrounding land-owners fox baiting at coordinated times during the year. Approximately $150,000 would be required initially for rabbit control with $10,000 to $15,000 required annually thereafter.

Ecological Benefits

The ecological benefits of removing pest plants and animals will be high as such species have the potential to invade high value areas particularly along the creek-lines and the littoral zones. Rabbits and foxes also have a high impact on ecosystems, particularly in reducing breeding capacity of plants, amphibians and ground dwelling birds as well as reducing available habitat.

Potential Ecological Risks

Aquatic weed and animal control must be conducted in a way as to minimise harm to non-target species. This includes in the consideration of appropriate chemicals, bait deployment and physical activities such as warren ripping.

Salinity Risks

This option is unlikely to have any associated salinity risks.

Potential Operating Regime And Water Use

Not Relevant.

DEVELOPING A SUSTAINABLE RECREATION PLAN

Recreation is important to the local community but recreational impacts can be significant especially when unmanaged.

Proposed Works

Development of a Pike River highland and floodplain sustainable recreation plan.

Costs

A recreation plan would require $50,000 to develop with another $100,000 for implementation of initial works such as walking & vehicle tracks, upgrade of boat ramps and signage.

Ecological Benefits

Recreation, particularly unmanaged vehicle access and camping can have significant negative impacts on both flora and fauna in localised areas. Such activities result in degradation of groundcovers, illegal harvesting or collection of plant species, introduction of pest plant species and general litter management issues. Motorbike access can also result in noise pollution and degradation of vegetation. Signage can educate the public to understand the value of the ecological aspects of the floodplain and times when and where recreational activities are not-suitable or must be reduced. However the development of a recreation plan is unlikely to generate any ecological benefits in its own right, these can only be achieved through implementation.

Potential Ecological risks

There will be no ecological risks associated with developing the plan itself. These will be considered during the development of the plan and again prior to implementation.

Salinity Risks

There will be no salinity risks associated with developing the plan itself. These will be considered during the development of the plan and again prior to implementation.

Potential Operating Regime And Water Use

Not relevant

Plate 10: Aquatic vegetation thriving in a section of the upper Pike

SALT INTERCEPTION & GROUNDWATER MANAGEMENT

Ground Water Interception Scheme- Highlands

Reducing the intrusion of saline groundwater into the Pike surface water system and ultimately the river requires an engineering solution which effectively intercepts the highly saline groundwater in the irrigated highlands. This will maximise the interception of saline groundwater flowing towards the Pike River, the floodplain and the River Murray. The Pike SIS is expected to have the following benefits:

- A salinity benefit, at Morgan, of 35.4 EC or 167.6 tonnes per day;
- Delivery of the most cost effective scheme to date within the entire Murray-Darling Basin (benefit to cost ratio 2.31);
- The EC credits available under the scheme will contribute to each jurisdiction's credit balance (if funded through the MDBA).

Proposed Works

- Establishment of 59 groundwater interception wells between Paringa and Lyrup, all on the edge of the highland;
- 25 kms of trunk main pipeline and 13 kms of spur main with sizes ranging from 450mm down to 63mm diameter, all running along the highland; and
- Transfer of intercepted saline groundwater to Noora Basin at a rate of 93 L/sec averaged over the next 30 years.

Cost

The estimated total capital costs are $25,321 million with annual operation and maintenance costs estimated at $847,000 per year. An additional $403,000 will be required every seventh year for pump replacement.

The MDBA is responsible for providing costs for the impact of development prior to 1988 which is estimated to be 92% of salinity impact with an estimated cost of $23m. The South Australian Government is responsible for the remaining $2m.

The Pike SIS has been technically endorsed by the MDBA's Natural Resource Management Committee; they have approved $500,000 of funding in 2009-10 to progress to detailed design.

The Scheme has not yet been adopted as a shared works by the Murray-Darling Basin Authority. The MDBA cannot adopt the project until a decision is made regarding phase 2 of the Basin Salinity Management Strategy which has recommended that the EC target be extended by 40EC since the original target of 61EC has been reached through the construction of the Murtho SIS.

South Australia is looking into options to use its component of funds to progress detailed design and construction further in the interim.

Ecological Benefits

In the long term the SIS will reduce the saline groundwater inflows from the highland area to the floodplain. This process should over the long term reduce the salt build up on the floodplain and salt inflows into the River Murray, creating a beneficial environment for salt sensitive species.

Potential Ecological Risks

There are no ecological risks to the Pike floodplain; however salt interception disposal basins such as Noora are negatively affected by the introduction of greater amounts of saline water.

Salinity risks

There are no salinity risks on the floodplain as a result of the introduction of an SIS, however as previously noted impacts will occur at the site of disposal.

Potential Operating Regime And Water Use

The operation of the salt interception scheme is likely to depend on the rate of draw-down in the groundwater tables. The water use of salt interception schemes is likely to be taken into in the forthcoming Basin Plan developed by the Murray-Darling Basin Authority.

Floodplain Groundwater Management

It is recognised that flow management options may not be sufficient to achieve all objectives and targets for the Pike floodplain. Some areas are beyond the extent of influence for surface water management options, or are more likely to

respond to groundwater management. Therefore, as part of the options assessment process groundwater management should also be thoroughly investigated and assessed.

Artificially high saline groundwater levels and increased rate of salt accumulation in the floodplain soils are contributing to the ecological decline of the Pike floodplain. It is therefore considered necessary for the long-term management needs of the Pike floodplain to investigate the role and application of groundwater management in dealing holistically with the ecological needs of the floodplain. Groundwater management may provide significant floodplain benefit to areas beyond the influence of surface water management and may provide additional floodplain protection during times when proposed new surface water infrastructure will not be in operation

Proposed Works

Yet to be determined but could incorporate production bores to lower groundwater tables or to create a freshwater lens in key locations on the floodplain.

Cost

Only available on the completion of further investigations.

Ecological Benefits

Potential benefits to floodplain vegetation are yet to be determined. A groundwater management scheme for the floodplain would be designed specifically to improve the condition through the lowering of saline groundwater levels.

Potential Ecological Risks

Nil

Potential Operating Regime And Water Use

Operating regime is yet to be determined. Any groundwater pumping would involve extraction of highly saline groundwater.

Table 6: Summary of project costs

Options	Items	Item Costs $	Total Cost $
Large scale water manipulations	Installation of new environmental regulating infrastructure	46,000,000	46,000,000
Establishing a sustainable diversion limit	Modelling sustainable diversion limit Surface water monitoring system	30,000 30,000	60,000
Flexible water extraction	Modelling of impact of water level changes on Pike Floodplain Pump modification & relocation	90,000 2,000,000	2,090,000
Reducing siltation in anabranch creeks	Desilting, willow removal and removal of weeds on floodplain	50,000	50,000
Floodplain management options	Pest plant and animal control Recreational management	340,000 150,000	490,000
Removal of grazing on the floodplain	Removal of grazing on perpetual lease	Confidential negotiation	
Future investigations	Groundwater investigations	280,000	2,300,000
	Examine viability of Groundwater management scheme	150,000	
	Hydraulic modelling	100,000	
	Surface water monitoring program	200,000	
	Detail design replacement of Margaret Dowling Creek and Deep Creek Inlet structures	150,000	
	Detailed design for environmental infrastructure on the floodplain (environmental regulators, fishways, by-pass regulators, blocking banks)	900,000	
	Sodic Soil investigations	50,000	
Project management & monitoring	Four year program (3 FTEs Project manager, Project Officer & Ecologist)	300,000 per annum	1,200,000
		TOTAL	46,190,000

*Please note that these costs are estimates only and will be further refined as the project progresses

APPROVALS

SA MURRAY-DARLING BASIN NATURAL RESOURCES MANAGEMENT BOARD

The Pike Floodplain Plan has been endorsed by the River Murray Environmental Manager, SA Murray-Darling Basin Natural Resources Management Board for endorsement under the South Australian River Murray Floodplain Planning Guidelines.

SA DEVELOPMENT ACT

Planning SA has advised that:

The establishment of structures on watercourses and the floodplain for hydrological manipulation purposes is not a prescribed activity that requires development approval under the Development Act 1993 (nor a Major Development declaration).

Therefore the management of any potential environmental, social and economic impacts can be adequately addressed by the SA MDB Board's internal assessment and decision making processes.

EPBC ACT

An EPBC referral will need to be submitted to the Australian Government (Department of Environment and Water) prior to the installation of any new regulating infrastructure on the floodplain.

NATIVE TITLE

Native title has been extinguished on the Pike floodplain.

SA CONSTRUCTING AGENT REVIEW

SA Water are expected to be the constructing agents for all new and modified infrastructure on the Pike floodplain. An ongoing operation and maintenance budget should be provided such that SA Water can appropriately resource the requirements of the proposed new infrastructure. Previously the Pike-Mundic Irrigation Association have operated, owned and maintained all infrastructure on the Pike floodplain (principally for irrigation outcomes). SA Water is represented on the PIP Reference Committee and is expected to provide technical reviews for all concept and detailed designs.

FISH PASSAGE TASK FORCE (FPTF)

The concept designs for all the proposed fishways should be reviewed and endorsed by the FPTF, or equivalent body.

PIP REFERENCE COMMITTEE

The PIP Reference Committee will be involved in reviewing and endorsing all new and modified infrastructure for the Pike floodplain. This Committee has also been involved in reviewing and endorsing this Implementation Plan.

It is proposed that the Pike Implementation Plan project be managed in a partnership arrangement between the regional NRM Board, Department for Water and Department for Environment and Natural Resources (DENR). The PIP Reference Committee will retain governance responsibility for the integrated project.

Following approval to proceed to detailed design, the management arrangements may transfer to SA Water (an Agent of the SA Constructing Authority) overseen through an agreement with DFW. SA Water will still however report to the PIP Reference Committee.

Following detailed design, the Constructing Agent (SA Water) will conduct a comprehensive review of the cost estimate. Following this review, the final designs and cost estimates will be re-submitted to potential investors for endorsement. Prior to construction tenders being let, DFW will remain the project proponent and the design and construction delivery will be managed through a MoU between DFW, DENR the SA MDB NRM Board, SA Water and the Pike community.

The construction of all new regulating infrastructure will be subject to an open and competitive tender process, likely to be managed by SA Water. The actual cost of construction will not be known until the project is completed; however the scope for variation beyond the tender is reduced.

Other significant partners besides the funding organisation (possibly DFW Murray Futures program) are SA Water, River Murray Water and the Murray-Darling Basin Authority (MDBA).

ROLES AND RESPONSIBILITIES

The management of the Pike Floodplain is the responsibility of a number of government agencies within South Australia. The PIP project involves a number of committees that contribute to the planning and integration of management actions at the site.

DFW has responsibility for implementing the Floodplain Management Plan and coordinating the Pike integrated floodplain project. DFW also manages the SIS and the Sustainable Water Supply components of the PIP project.

It is highly likely that SA Water will be the Constructing Agency for the site and will ultimately be responsible for the operation of new flow management structures on the Pike floodplain, including the proposed Pike environmental regulators.

The Department for Environment and Natural Resources (DENR) is the landowner for the majority of the Pike floodplain and manager for the Pike River Conservation Park. DENR provides biodiversity and land management support to the PIP project. The Pike River Conservation Park is managed in accordance with the National Parks and Wildlife Act (1972) and park management plan (1994). DENR also has primary responsibility for the management of natural, historical and cultural features as well as visitors. The Pike floodplain has numerous existing leases over the property, which provides for certain land management activities. The management of pest plants and animals is the responsibility of both DENR and the lessees.

TIME FRAMES

Detailed design and construction of the two inlet structures could commence in 2011-12 and be completed within 12 months. Additional investigations are required before the proposed downstream environmental regulators are proven to be viable. All going well however, it is conceivable that detailed design and construction of floodplain infrastructure could commence in 2012-13 and be completed within 2 years subject to approval requirements being met.

CONSTRUCTION RISKS

Overall the construction risks are considered low and include:

- Delays on receipt of approvals for works- this is dependant on relevant bodies responding within appropriate and acceptable timelines to ensure that construction can commence as soon as design and planning have been completed.
- Availability of contractors.
- Floods or significant rain events.
- Considerable time and cost associated with undertaking Environmental Impact Statements (if required) in order to gain necessary approvals.
- Gaining access to private property for construction purposes

A comprehensive risk management strategy will need to be prepared prior to any construction being undertaken. This will form a part of the construction plan.

FURTHER INVESTIGATIONS AND MONITORING

INVESTIGATIONS

A number of investigations need to be conducted in order to more fully scope the design of environmental regulating structures and to ensure appropriate operation of structures, e.g. maximise ecological benefit and minimise risk.

They are:

- Groundwater investigations to develop an understanding of groundwater processes and to quantify salinity and vegetation condition impacts associated with a range of surface water management regimes.
- Investigate the viability of a complementary groundwater management scheme to provide benefits to floodplain vegetation health.
- Hydraulic modelling to (1) improve understanding of the potential risks and their management; (2) Assessment of the volume of water used during operation of regulators; (3) Determine optimal operation of new structures to enhance floodplain inundation and complement other floodplain restoration activities.
- Establish and management of a robust surface water monitoring program including (1) Key monitoring locations for flow and salinity; (2) Establish and maintain a surface water monitoring network within the Pike anabranch system; (3) Determine flows and salt loads throughout the system over a range of flows and inundation regimes.
- Detailed design for replacement of Margaret Dowling Creek and Deep Creek inlet structures to facilitate fish passage, improve capacity to seasonally manipulate wetland and creek water levels and maximise flowing habitats.
- Ecological risk assessment and operating regime for new and existing infrastructure thereby maximising ecological benefit whilst minimising potential risks and impacts.
- Sodic Soil Investigations- Map areas on the Pike floodplain where sodic and severely salinised soils exist. To develop a remediation strategy to rehabilitate these soils to improve ecological function.

Plate 11: Mundic Billabong adjacent to Bank B complex

- Scientifically Robust Ecological Monitoring Program in order to assess the impact of management actions such as hydrological manipulation and removal of livestock grazing. Capacity to investigate changes through time and in response to management actions within an adaptive management framework.

MONITORING

A range of baseline monitoring has been undertaken on the Pike floodplain including:

- Tree condition monitoring (21 permanent transects);
- Under-storey vegetation condition (Stratified permanent transects across different soil types, vegetation associations, grazing regimes and hydrological regimes) ;
- Fish and in-stream habitats.
- Groundwater and surface water monitoring;

This baseline monitoring has provided an assessment of current condition and will also help determine the effectiveness of management interventions.

The groundwater, surface water and tree health monitoring is also being used to calibrate the Pike hydrodynamic, groundwater and WINDS vegetation models.

FUTURE RESEARCH

Groundwater management may provide significant floodplain benefit to areas of the floodplain beyond the influence of surface water management and may provide additional floodplain protection during times when proposed new surface water infrastructure is not in operation. This could potentially involve extending the benefit of the current SIS scheme to include groundwater wells on the floodplain.

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Government of South Australia

Department for Water