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South Australian Arid Lands Natura
Resources Management Board

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South Australian Arid Lands Natural Resources Management Board

ASSESSMENT OF THE SOCIAL AMENITY AND PHYSICAL CHARACTERISTICS OF GREAT ARTESIAN BASIN BORE-FED WETLANDS IN SOUTH AUSTRALIA PHASE 1

Assessment of the social amenity and physical characteristics of Great Artesian Basin bore-fed wetlands in South Australia, Phase 1

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FOREWORD

The Great Artesian Basin (GAB) is one of Australia's unique and precious natural resources and is fundamental to the economic and social wellbeing of the state and those inhabiting the South Australian Arid Lands Natural Resources Management Region.

Since the 1880's when the first artesian bores were drilled, pressure has declined in the GAB in areas which has caused some springs and artesian bores to cease flowing. Traditionally, GAB water has been supplied to pastoralists through free-flowing bores, however between 65 and 90% of this water is lost through evaporation and seepage occurring in the drainage lines. Since 1977, South Australia has undertaken initiatives to prevent loss of pressure in the GAB, and the Commonwealth and State Governments have in partnership with landholders, controlled many of the free-flowing bores. However in some areas bore-fed wetlands have significant social, economic and environmental value for the local community, regional visitors and tourists and these wetlands could not persist without the supply of GAB water.

In 2002, following community consultation, the then Arid Areas Catchment Water Management Board (AACWMB) decided that some wetlands have social amenity and economic values that warrant the continued provision of water. As part of this decision the AACWMB undertook a study to build on the knowledge of the social amenity and recreational values of the bore-fed wetlands.

This report documents the social and amenity values as ascribed by landholders and users, and the physical characteristics of 17 bore-fed wetlands in the GAB in South Australia. This work will guide the South Australian Arid Lands Natural Resources Management Board in implementing phase 2, which involves maintaining the social and amenity values through identifying minimum flow rates.

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1. INTRODUCTION

The Great Artesian Basin (GAB) covers an area of 1 711 000 km^2, and underlies parts of Queensland, New South Wales, South Australia and the Northern Territory. The South Australian portion of the GAB covers an area of 377 000 km2 or 38% of the State. An estimated 8 700 000 000 ML of water is held in the GAB. GAB water is up to 2 million years old, dating back to the Pleistocene Period.

This large artesian storage provided a cost-effective supply of water to support the expansion of the pastoral industry into large areas of inland Australia. The first artesian well was drilled in 1878, in New South Wales. Traditionally, stock have been watered by free flowing artesian wells in South Australia since the mid 1880's. There are over 3300 free flowing bores across the whole of the GAB — approximately 880 of these are currently uncontrolled and typically flow into natural drainage depressions or constructed bore drains.

It has long been recognised that the use of uncontrolled free flowing wells reduces aquifer pressure, negatively impacting on natural GAB springs and other artesian wells. Property owners and governments began installing well headworks and pipe networks to control and distribute flows from wells in the mid 1900s. All jurisdictions within the GAB have now agreed that the use of bore drains, as a method to deliver water to stock, can no longer be justified (AACWMB, 2005). In 1999 the Commonwealth and state governments initiated partnership agreements with landholders, called the GAB Sustainability Initiative (GABSI), to share the cost of capping and piping wells. Most Great Artesian Basin (GAB) bore-fed wetlands are to be closed as part of the implementation of the GAB Strategic Management Plan (GABCC, 2000), which was developed by the former GAB Consultative Council in 2000.

However, in some areas GAB water has been flowing into natural channels or constructed bore drains for up to 100 years and in that time has created wetlands of high value to the local community, regional visitors and tourists. These wetlands would be lost if the artificial supply of GAB water was removed.

Following the basin-wide decision to eliminate bore drains as a stock water delivery system, a robust and fair process for comparing the values of wetlands in South Australia entitled "Comparative Valuation of Bore drain Wetlands in South Australia" was developed (Centre for Environmental and Recreation Management (CERM), 2002a). This was to provide a basis for deciding which, if any, wetlands have sufficient values to be allowed an allocation of water subject to a water allocation plan (WAP). The comparisons are based on the social, environmental and economic benefits supported by individual wetlands.

Wetland values are generally enhanced by the wildlife associated with the wetlands. Wildlife sustained in artificial wetlands near homesteads makes a significant contribution to the quality of life of the landholders. Current scientific evidence (see for example CERM 2002a) suggests that justifying the maintenance of bore-fed wetlands on the basis of purely environmental values is problematic. Although some wildlife populations benefit from the maintenance of wetlands, others that are adapted to a landscape without permanent water are disadvantaged. Increased total grazing pressure around wetlands can impact on plant diversity, and wetlands can provide a refuge for feral animals and assist in the spreading of weeds.

Bore-fed wetlands in South Australia do however have social and recreational values that are very important to the community, regional visitors and tourists. These wetlands provide

important educational and leisure settings for families, and also provide an important emotional refuge during drought. Some wetlands provide a focus for visitors to experience attractive natural and cultural features of the area. Given this, the former Arid Areas Catchment Water Management Board (AACWMB) decided some wetlands have social amenity and economic values that warrant the continued provision of water. The draft Far North Water Allocation Plan states that the provision of water allocations to bore-fed wetlands is not to be made for the purpose of watering stock.

It should be noted that in many cases the social and amenity values relate to water birds and other fauna. Supporting these values relies on creating an environment that sustains this fauna and the provision of water will achieve this goal. However, it must be stressed that water provided for this purpose will not be used as a surrogate watering point for stock.

This report documents the social amenity values that are ascribed by landholders to 17 bore-fed wetlands in the GAB in South Australia for which water allocations may be sought under the proposed water allocation plan for the Far North Prescribed Wells Area. Values were identified through a landholder survey based on a component of the comparative assessment methodology (CERM 2002a). Physical assessments were also undertaken to provide further supporting information relating to these values.

Trials to identify the minimum flow rate required to maintain the social amenity values of wetlands approved for allocations will form a second phase of this project following the adoption of the initial WAP. It is intended that when the first five-yearly review of the WAP occurs, minimum flow rates and other management aspects of wetlands will be established in consultation with the landholder.

2. METHODOLOGY

A bore-fed wetland assessment tool was developed, on behalf of the DWLBC, by the Centre fro Environmental and Recreational Management, University of South Australia in consultation with the AACWMB. The scope of the assessment was primarily confined to the social and environmental benefits (CERM, 2002a) and a cursory consideration was given to the economic benefits resulting from tourism.

An output of the assessment was a set of questionnaire and survey forms that formed the basis of a comparative assessment of the bore-fed wetlands and their ongoing/future management. The survey forms were divided into the categories:

- Site Description – physical, biological, vegetation, fauna
- Personal and Community Values
- Summary of Wetland Significance
- Comparative Valuation of a Wetland
- Water Allocation and Wetland Management

The primary focus of this study was to ascertain landholder views and social amenity values of bore-fed wetlands across the GAB where the landholder intends to request an environmental flow allocation under a WAP. Members of the community associated with bore-fed wetlands were interviewed and structured questionnaires were completed. A slightly modified version of the questionnaire as presented in CERM 2002a was used in this study (see Appendix D).

The physical assessment/site description component of the study entailed:

- Field survey of the physical characteristics of bore-fed wetlands and site assessments. This included mapping and describing the physical location and features of wetlands.
- Proximity of bore-fed wetland to natural GAB springs
- Literature review of wetland characteristics including flora and fauna.
- Collation of historical well and flow rate data
- Raising issues for consideration regarding the future management of the wetlands.

Data for individual bore-fed wetlands was summarised and presented to the AACWMB in 2004.

Figure 1.
Bore-fed Wetlands Locations

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3. RESULTS

19 bore-fed wetlands were identified in the draft Far North Water Allocation Plan as possibly requiring a water allocation. In 2003 and 2004 studies were undertaken on 17 of these wetlands to determine the values the wetlands represented to the community, provide baseline descriptions of the wetlands, and identify management issues for individual wetlands.

Field surveys were conducted on 16, and landholder views were obtained for 17, of the bore-fed wetlands. A field survey was not conducted on the wetland attached to Jack Lake 2 Bore as the landholder does not wish to retain the wetland. Table 1 identifies all 19 bore-fed wetlands, their source well, the pastoral lease and where applicable, the date surveyed. The location of the surveyed bore-fed wetlands is shown in Figure 1.

A general summary of the results of the landholder questionnaires follows. Detailed findings from the surveys for each of the individual wetlands can be found in Appendix A, with tabulated results from the landholder questionnaire on Personal and Community Values shown in Appendix B.

Table 1 Bore-fed wetlands in the GAB

Bore-fed Wetland	Source Well Name and Unit Number	Pastoral Lease	Date Surveyed
Callanna	Callanna Bore 2 (6438-95)	Callanna Station	March 2004 October 2004
Clayton	Clayton Bore 2 (6539-9)	Clayton Station	March 2004
Coward Springs	Coward Springs 2 (6239-43)		December 2003
Dulkaninna	Dulkaninna Bore 2 (6539-14)	Dulkaninna Station	Williams, 2002
Goyders	Goyders Lagoon (6643-1)	Clifton Hills Station	June 2003
Jack Lake	Jack Lake 2 (6842-37)	Mungerannie Station	Not to be surveyed
Kalladeina	Kalladeina Bore (6742-1)	Clifton Hills Station	March 2004
Lindon Homestead	Fortville 3 (7039-5)	Lindon Station	February 2004
Lycium	Lycium 1 (6841-139)	Mungerannie Station	February 2004
Mirra Mitta	Mirra Mitta Bore (6642-2)	Cowarie Station	June 2003
Montecollina	Montecollina Bore (6839-3)	Tinga Tingana Station	February 2004
Morphetts'	Morphetts' Bore (6438-87)	Callanna Station	March 2004
Morris Creek	Morris Creek Bore (6439-9)	Finniss Springs	Yet to be surveyed
Muloorina	Muloorina Bore (6439-20)	Muloorina Station	February 2004
Mungerannie	Mungerannie Bore (6641-3)	Mungerannie Station	July 2003
Murnpeowie	Murnpeowie HS Bore (6738-2)	Murnpeowie Station	February 2004
New Kopperamanna	New Kopperamanna 1 (6640-1)	Etadunna Station	March 2004
Purni	Purni 1 (6145-1)	Simpson Desert Regional Reserve	Yet to be surveyed
White Bull	White Bull Bore (6442-2)	Kalamurina Station	March 2004

3.1 Wetland Visitation

The frequency of visitation of a wetland provides an indication as to how significant the asset is to daily life in the region. The survey included questions on the number of times a wetland was visited on average by landholders or their friends and family. 60% of respondents indicated that they visited the wetland at least once a week, and no landholders visited their wetlands less than once a month.

Access for visitors to the region is a potential benefit provided by the presence of wetlands, and the level of visitation by tourists was also assessed. Two of the landholders did not encourage tourist access to their wetlands and this decision was generally related to a fear of vandalism or other interference with bore infrastructure. Of the wetlands where tourist access was encouraged, 53% of respondents indicated visitations occurred on average more than twice per week. In several cases it was noted that the landholders provided facilities such as toilets and spas for tourists at their own cost.

3.2 Landholder Values

Landholders generally expressed similar values relating to the bore-fed wetlands on their properties. The main values described were social and environmental in nature. In many cases it was noted that landholders believed that wetlands contribute to the conservation of wildlife and wetland vegetation. For example 59% of respondents returned the maximum score when describing the importance of the wetland as a drought refuge for wildlife.

Despite the generally held scientific view that the impacts of artificial wetlands in arid areas outweigh any conservation value, only 18% of landholders returned the maximum survey score indicating they strongly believed that bore-fed wetlands contributed to problems with feral animals or the spread of weeds.

Wetlands were common sites for recreation and relaxation although the nature of this interaction varied depending on factors such as the size of the wetland, its proximity to homesteads and whether or not the public accessed the site. Social values included adding to the feeling of belonging, reducing tension, providing a site for entertaining family and visitors and also education opportunities.

From an environmental perspective commonly expressed values included: the conservation of birds, other wildlife and wetland vegetation (4.6 average score from possible maximum of 5); providing a drought refuge for wildlife (4.5); and conservation of fish and aquatic wildlife (4.1).

There was a clear dominance of the value of the wetlands for the conservation and observation of bird species. For example, many landholders maintained their own list of the bird species they had seen at their wetlands.

It was noted during consultations that virtually all pastoralists interviewed currently view the wetlands as viable watering points for stock. In most cases this was seen only as an emergency back-up supply, but a few pastoralists still use the wetlands as watering points during everyday operations.

3.3 Issues for Consideration

The overall value of the bore-fed wetlands must be weighed against the issues for consideration in their future management that are created by not closing them completely.

Each wetland presents a different suite of issues depending on factors such as the pressure and flow rate of the bore, but there are also many common challenges that will be faced by resource managers. These may include but are not limited to:

- Proximity of the bore-fed wetland to, and potential to impact on, GAB Spring ecological communities
- Proximity of the bore-fed wetland to watercourses with permanent natural waterholes
- Pressure variations across the GAB
- The level of use of the wetland and the number of beneficiaries (eg are tourists allowed access, is revenue derived from the site)
- Range of habitat types supported at the site
- Importance of the site historically and culturally

More detailed information relating to the specific issues for consideration for each individual wetland can be found in Appendix A, and the following section includes a discussion of some of the more general considerations for flow management trials.

4. DISCUSSION

The New South Wales (NSW) National Parks and Wildlife Service investigated the environmental and social values of bore-fed wetlands in the NSW portion of the GAB (NSW National Parks and Wildlife Service, 2003) and given the low values ascribed, all bore-fed wetlands in the region were subsequently closed. This study, in contrast, found the community place high values on bore-fed wetlands. Of the 17 bore-fed wetlands assessed for this project, all wetlands except Jack Lake were considered by landholders to be of ecological/conservation significance — particularly for birds.

Landholders also ascribed high value to the bore drains for stock watering. Many bore-fed wetlands at the time of the assessments were being utilised for additional stock watering and/or were important feeding areas for stock during a period of drought, when there was little pasture available.

However, the former AACWMB at its meeting held on 16 August 2004 decided:

- Economic and social/recreational amenity values alone are sufficient reason to justify an amenity allocation to former bore-fed wetlands under the WAP.
- Preservation of those values relies on the maintenance of aquatic habitat.
- Water is to be allocated to facilitate the maintenance of this habitat.
- The provision of water allocations is not made for the purpose of watering stock.

Subsequently the draft WAP for the Far North Prescribed Wells Area (AACWMB, 2005) presented the following criteria relating to bore-fed wetlands:

- Water will not be allocated for new artificial wetlands.
- For bore-fed wetlands granted a water allocation, the allocation is to be assessed during the period of the WAP against the values identified for that wetland.
- Water allocated for bore-fed wetlands cannot be transferred.
- The provision of water allocations to bore-fed wetlands is not to be made for the purpose of watering stock.
- The total flow allocations to bore-fed wetlands in the South Australian portion of the GAB will not exceed 7 ML/day.
- Water for stock and domestic purposes must be taken through a watertight reticulation system.

Hence water allocations for bore-fed wetlands will be to maintain social and amenity values identified within this report, but not for the purpose of watering stock (AACWMB, 2005). Piping and provision of stock troughs through the GABSI mean that bore-fed wetlands should no longer be required for stock watering.

Several landholders propose to relocate bore-fed wetlands to more suitable sites to provide improved social and amenity values, for example closer to the station homestead. As shown above however, the WAP states that water will not be allocated for new artificial wetlands (AACWMB, 2005). This apparent conflict will require consideration.

Similarly in some instances landholders propose to use earthworks to create new waterholes for increased benefit within natural watercourses. This is in conflict with the ***Natural***

Resources Management Act 2004, and the draft Catchment Water Management Plan for the South Australian Arid Lands Region, as a water affecting activity. The Act states that:

> ***127 (5) Subject to this Act, a person must not undertake any of the following activities contrary to an NRM plan applying in the region in which the activity is undertaken:***
>
> ***(g) destroying vegetation growing in a watercourse or lake or growing on the floodplain of a watercourse;***
>
> ***(h) excavating or removing rock, sand or soil from —***
>
> ***(i) a watercourse or lake or the floodplain of a watercourse; or***
>
> ***(ii) an area near to the banks of a lake so as to damage, or create the likelihood of damage to, the banks of the lake;***

The AACWMB ranked the bore-fed wetlands in order of importance, and decided on appropriate approximate flow allocations for individual wetlands, considering the values and information presented in this report with the overall goal of allocating no more than 7 ML/d to wetlands. It should be noted that the current flows are 1.6 - 8.6 ML/d over this goal. Appropriate final water allocations to bore-fed wetlands are to be determined on a case-by-case basis, taking into consideration draft WAP criteria.

Bore-fed wetlands with a water allocation will require a management plan as a condition of the licence. In the first 5-year iteration of the WAP the management plan will require adaptive management flow regime trials to be undertaken that will identify the minimum volume of water required to maintain the identified values. This volume will then represent the volumetric allocation to the wetland under future WAP's.

The fundamental aim of the initial management plan is therefore to identify the minimum volume of water required to maintain the identified values, through trial manipulation of the flow regime and adequate monitoring. The following section discusses some of the issues for consideration in undertaking these trials and other issues that should be addressed under the management plans.

4.1 Considerations for flow management trials

The most fundamental issue is how to minimise the hydrological impact on the GAB resource that supports them, which is to be achieved by ensuring that only the minimum volume of water required to support the values of the wetland is allowed.

This may result in some changes to the dimensions of the wetland. Different habitat types have varying degrees of dependence on the provision of bore water. Vegetation forms a major structural component of the wetland environment, and the reduction in flow to a wetland will impact not only on the extent of open water and mudflats, but also to different degrees on vegetation communities. As discussed by Williams (2002), tall reed beds, sedgelands, samphire, mudflats and open water have high to very high dependence on bore water, whilst shrubland and woodland species have reduced dependence and are less likely to be impacted by reduced flows. The spatial extent, structural complexity and species composition of vegetation associations will potentially be influenced by the water regime but this may also occur on different timescales.

Determining a minimum volume will be different for each location and this will be influenced by the range of habitat types that need to be maintained. In most cases, landholders considered it of high importance to maintain bird populations. Therefore, a key factor in

determining minimum flows is that they are sufficient to maintain the necessary habitats and resources to support bird species present at the wetland.

The current extent of a particular habitat type may however be greater than that required to support the desired value and reducing the extent of the habitat may be the only way to support reduced flows. For example, if a certain area of sedgeland is currently present at a site it may be necessary to determine the minimum extent of sedgeland that will support the same environmental values as the current extent. If the desired value is the presence of wading birds, it may well be possible to achieve a significant reduction in the area of sedgeland without compromising this.

Clearly any reduction in flow rate has the potential to lead to a reduction in wetland area, and the period of transition to the new extent may also lead to management challenges. For example the death and decomposition of emergent macrophytes such as reeds and sedges may create problems with amenity. What is required is an understanding of the minimum flow required to support the *values* that have been identified, rather than to focus on maintaining the existing extent of the wetland itself. This will require management plans with clearly stated goals for management based on the desired values. Incremental flow reduction trials can then be implemented, with decisions on suitable flow volumes supported by monitoring programs that can ensure the maintenance of the key values.

4.2 Issues relating to monitoring

Water allocations are intended to be sufficient to maintain the social and amenity values identified in this report, but at the minimum flow rate possible. It is difficult to predict the response of the bore-fed wetland environment to the reductions in flows necessary to identify the minimum possible flow. This necessitates the use of an adaptive management approach, with incremental flow reductions underpinned by appropriate monitoring of the results of flow trials.

It was suggested by Williams (2002) that bird species and numbers present should be monitored as part of the management plan. Monitoring of both vegetation extent and bird numbers will be good indicators of whether water allocations are maintaining bird habitat.

Bird species exploit bore-fed wetlands in different ways:

- Bird species may rely upon shallow water and mudflat habitats for feeding, while others require dense reed beds for resting and protection.
- Migratory birds utilise bore-fed wetlands as a place to rest and feed as they pass through. According to Williams (2002) waders have benefited from bore-fed wetlands for use during their migration from the northern hemisphere, but the bore-fed wetlands are not obligate habitats.
- Bore-fed wetlands have allowed some birds to extend their distribution (such as crakes, rails, brolgas, reed warblers, grass birds and chats).
- The provision of drinking water is important for woodland species such as pigeons, parrots and finches.

Appendix C provides a summary of inland habitat preferences for known South Australian water birds. Resources such as this can be used to develop an understanding of habitat requirements. This can be used to more closely define the characteristics of the wetland that support bird populations and also provide insights for monitoring.

Other species can also be included in monitoring programs and some of the issues relating to potential target species for monitoring include:

- ***Rare and endangered birds*** Badman (1987), cited in Williams (2002), reports the following species which are significant for South Australia are dependent upon bore-fed wetlands: Baillon's crake, spotless crake, brolga and blue-winged parrot. Additionally grass owls (***Typo capensis***) are reported to inhabit the sedgeland areas of bore-fed wetlands (Williams, 2002), and have been recorded at Coward Springs and Morris Creek bore-fed wetlands. The species is rarely seen in South Australia.
- ***Bird recruitment*** Bore-fed wetlands including Callanna offer permanent habitat to allow, for example, brolga breeding.
- ***Introduced birds*** The number and impact of introduced birds such as sparrows and starlings should be monitored.
- ***Marsupials*** Kangaroos require access to water and are likely to have benefited and rely upon bore-fed wetlands for water. North of the Dingo Fence, Kinhill (1998) stated that dingo predation levels would not allow a significant increase in kangaroo numbers. Most small native mammals have evolved to persist in the arid environment without access to reliable supplies of water, therefore few are expected to have benefited from the provision of permanent water on bore-fed wetlands.
- ***Feral animals*** Foxes and feral cats have benefited from the provision of permanent artificial water supplies, and their presence and impact on native fauna should be monitored closely.
- ***Bats*** Several species of bat have been recorded at bore-fed wetlands (Williams, 2002) these include species adapted to ephemeral water supplies that are thought to obtain sufficient water from their diet without access to free water. Bore-fed wetlands support abundant insect populations, which attract artificially high numbers of insectivorous birds, and may also be a food source for bats.
- ***Native fish*** Native fish inhabit mound springs and bore-fed wetlands. Kinhill (1998) recorded eight species of native fish in South Australian bore-fed wetlands. Other studies including field surveys by DWLBC officers for this project recorded fish in bore-fed wetlands. It is important to note that Williams (2002), found that no fish species found at bore-fed wetlands are considered to be rare, endangered or endemic to bore-fed wetlands, and their conservation would not be threatened if bore-fed wetlands were closed provided their natural waterhole and mound spring habitats remain. It is therefore suggested that native fish monitoring is of limited value, relatively difficult to undertake and potentially damaging to populations.
- ***Weeds and feral animals*** The effect of bore-fed wetlands on any weeds and feral animals should be monitored.
- ***Water quality*** salinity of water should be monitored to ensure it is maintained within suitable limits
- ***Vegetation diversity and abundance*** Plant species numbers and spatial extent of habitats should be monitored.

5. CONCLUSIONS

Landholders clearly value the bore-fed wetlands for social and environmental reasons and justification could be given to providing a water allocation under a WAP, subject to a management plan, including fencing from stock.

The application of human value sets to bore-fed wetlands also poses ethical and philosophical questions. Stock grazing threatens values identified by the community at all bore-fed wetlands (except Coward Springs) visited during this project.

This study has summarised social and recreational values and issues for consideration and potential management actions and trials for the 18 bore-fed wetlands in South Australia's GAB. Phase 1 of the Bore-fed Wetland Assessment Project was completed in June 2005 and has presented issues for consideration with regards to the allocation of water and development of management plans for bore-fed wetlands in South Australia's GAB. Phase 2 will include trials of management including flows before the 2010 review of the WAP. The goal of the former AACWMB was to allocate no more than 7 ML/d of water to bore-fed wetlands, and to maximise benefits and minimise disadvantages of those wetlands, which are maintained.

Preliminary water allocations were set out by the former AACWMB, but further negotiation is required with the landholders to determine appropriate flows and management actions. It is also important that the impact of altered flows to bore-fed wetlands are monitored, and that wetlands are enhanced and any disbenefits such as the impact of feral animals are minimised.

APPENDICES

Appendix A – Bore-fed Wetland Assessment Results

A.1 Morphetts' bore-fed wetland, Callanna Station, Oodnadatta Track

A.1.1 LOCATION

The Morphett's bore-fed wetland is located on Callanna Station, northwest of Marree on the Oodnadatta Track (Fig. 1).

A.1.2 SITE DESCRIPTION

The Morphetts' bore-fed wetland was visited by field officers in March 2004 and is shown in Figures 2–5. See Figure 6 for site sketch of the Morphetts' bore-fed wetland.

- The present owners of Callanna Station drilled the well, Morphetts' Bore, in 1985.
- The wetland is located approximately 8.5 km northwest of Welcome Springs.
- The flow was 3.98 L/s in November 1999. A flow rate of 2 L/s was recorded in October 2004.
- Water temperature of 33^{o}C was recorded at the bore.
- Water is delivered via a short length of 50 mm pipe directly from the wellhead to the bore drain. The bore drain extends 1–3 km, inundating a shallow watercourse and floods out over an adjacent area of flat relief, creating a shallow mudflat area.
- The small wetland contains ***Typha*** spp. reed bed, sedgeland and mudflats, with very sparse shrubland in places around the bore drain.
- Wetland extent varies dependent on season, contracting significantly in the summer months.
- Close proximity to Callanna bore-fed wetland (18 km) and Welcome Springs (8.7 km).
- Badman (1987) recorded 13 species of birds. Brolgas were present in March 2004.

A.1.3 LANDHOLDER VALUES

No tourist access to the bore-fed wetland is currently permitted to avoid disturbances to stock and wildlife. Pastoralists visit several times per week and brings visitors out a few times per year.

It is of high value to Callanna Station for:

- Conservation of wildlife (especially brolgas) and wetland vegetation.
- Drought refuge for wildlife.
- Historical and cultural features.
- Bird watching, education, leisure and reducing tension, feeling of belonging, and spending time with family and friends.

A.1.4 ISSUES FOR CONSIDERATION

- Very low flow to bore-fed wetland (1–2 L/s) in March 2004.
- The small swamp provides a limited range of habitat for birds. However, several brolgas were present in March 2004 in the mudflats. No other flora or fauna records or observations are known to exist that identify the bore-fed wetland as being biologically significant.
- The close proximity of the bore-fed wetland to natural Welcome Springs and therefore the potential for drawdown and ecological impacts on the springs. In making any amenity allocation, consideration of the impact of extraction on the nearby Welcome Springs would be a paramount issue.
- Further consultations and negotiation with the landholder are required in light of the above points.
- Management plan to improve biological diversity is required in order to justify an amenity allocation for a wetland (e.g. fencing to exclude stock, removing any exotic plants).
- Management options include —
    1. Completely close or reduce flow rate to the bore-fed wetland.
    2. Provide alternative stock watering points with remaining flow allocated to maintain a bore-fed wetland with appropriate management to improve habitat.
    3. Provide alternative stock watering points and retain one of the two wetlands on Callanna Station.
- A comparison of the potential impacts resulting from flow reduction options for the bore-fed wetland is presented in Table 2.

Table 2 Potential Impacts of flow reduction options for Morphetts' bore-fed wetland

Close bore-fed wetland	Reduce flows to.5 L/s
Sedgeland, reed beds and mudflats would die off. Brolgas and other birds would use alternative wetland habitat for breeding and feeding.	Reduced extent of sedgeland, reed bed and mudflat habitats. Brolgas and other birds would utilise habitats or use alternative natural wetland habitat for breeding and feeding.

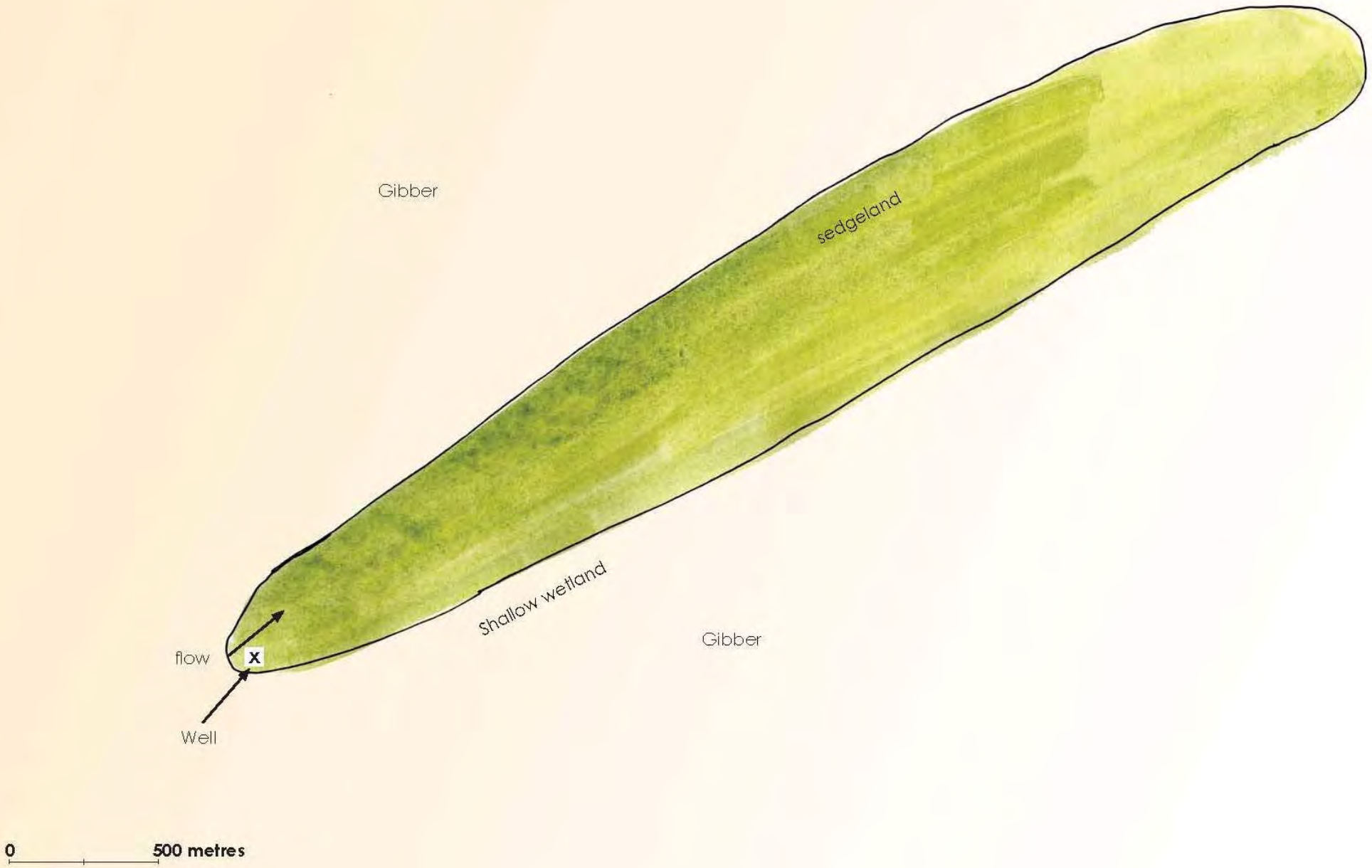
Figure 2 The solar pump at Morphett's bore-fed wetland, March 2004

Figure 3 Inlet to Morphett's bore-fed wetland, March 2004

Figure 4 Inlet to Morphett's bore-fed wetland, March 2004

Figure 5 Brolgas at Morphett's bore-fed wetland, March 2004

Figure 6: Morphett's Bore-Fed Wetland Mud Map



A.2 Callanna bore-fed wetland, Callanna Station, Oodnadatta Track

A.2.1 LOCATION

The Callanna bore-fed wetland is located on Callanna Station, northwest of Marree several kilometres off the Oodnadatta Track (Fig. 1).

A.2.2 SITE DESCRIPTION

The Callanna bore-fed wetland was visited by field officers in March and October 2004 and is shown in Figures 7–12. See Figure 13 for site sketch of the Callanna bore-fed wetland.

The original Callanna well was drilled in the late 1800s and was decommissioned and replaced by Callanna 2 well in 1995. Callanna 2 is approximately 13 km north of Callanna homestead and 13 km northeast of Welcome Springs.

- The flow from the Callanna 2 well in November 1999 was 0.91 L/s. Flow in October 2004 was 0.8 L/s.
- A water temperature of 32^{o}C was recorded.
- Small flow from the well flows down a shallow, natural watercourse, and extends ~1 km.
- The watercourse is predominantly sandy and shallow in nature, draining surrounding gibber plains.
- Habitat includes tall reed beds of ***Typha*** and ***Phragmites***, sedgeland, open water and tall shrubland. The bore-fed wetland is lined with Athel pines near the well, and ***Acacia salicina*** further downstream. Extensive reed beds dominate the channel with fringing ***Myoporum*** species present.
- Sheep were grazing on the bore-fed wetland at the time of assessment in October 2004, and the bore-fed wetland is relied upon as a source of stock water.
- 18 bird species were recorded at Callanna bore-fed wetland by Badman (1987).
- In December 1997, 16 bird species were recorded by Kinhill (1998), and several brolgas were observed in March and October 2004.

A.2.3 LANDHOLDER VALUES

No tourist access to the wetland is permitted to avoid disturbing the stock and wildlife.

It is of high value to Callanna Station for:

- Conservation of wildlife (especially brolgas) and wetland vegetation.
- Drought refuge for wildlife.
- Historical and cultural features.
- Bird watching, education, leisure and reducing tension, feeling of belonging, and spending time with family and friends.

A.2.4 ISSUES FOR CONSIDERATION

- Very low flow to bore-fed wetland.
- The close proximity of the wetland to Welcome Springs and therefore potential for drawdown impact upon springs. In making any amenity allocation, consideration of the impact of extraction on the nearby Welcome Springs would be a paramount issue (Consideration of an amenity allocation to maintain social values justified tempered by proximity to Welcome Springs).
- Further consultation and negotiation with landholder (high social values and currently rely on bore drain for stock).
- Management plan to improve biological diversity be required in order to justify an amenity allocation for a wetland (e.g. fencing, to exclude stock, removal of any exotic plants, etc.).
- Management options include—

    4. Completely close the bore-fed wetland
    5. Provide a very small amenity allocation
    6. Retain one of the two bore-fed wetlands on Callanna Station.

- A comparison of the potential impacts resulting from flow reduction options for the bore-fed wetland is presented in Table 3.

Table 3 Potential Impacts of flow reduction options for Callanna bore-fed wetland

Close bore-fed wetland	Reduce flows to 0.5 L/s
Open water, sedgeland, reed beds and mudflats would die off. Brolgas would use alternative wetland habitat for breeding and feeding.	Reduced extent of permanent water, sedgeland, reed bed and mudflat habitats. Brolgas would utilise habitats or use alternative natural wetland habitat for breeding and feeding.

Figure 7 Inlet to the Callanna bore-fed wetland, October 2004

Figure 8 Callanna bore-fed wetland, March 2004

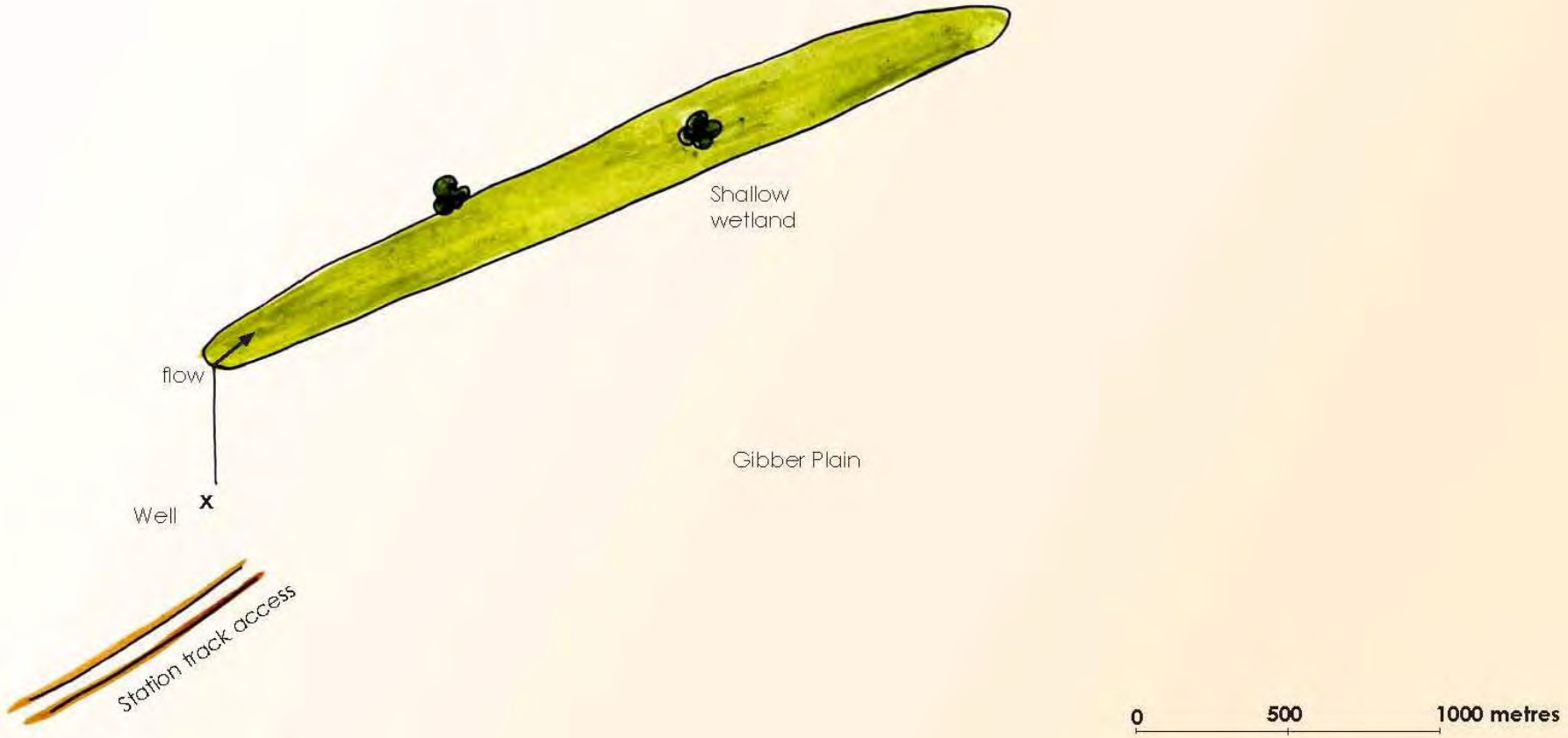
Figure 9 Callanna bore-fed wetland facing north, October 2004

Figure 10 Callanna bore-fed wetland facing east, October 2004

Figure 11 Callanna bore-fed wetland facing south, October 2004

Figure 12 Callanna bore-fed wetland facing west, October 2004

Figure 13: Callanna Bore-Fed Wetland Mud Map



A.3 Goyders bore-fed wetland, Clifton Hills Station, Birdsville Track

A.3.1 LOCATION

The Goyders bore-fed wetland is located on Clifton Hills Station, north of Mungerannie on the Birdsville Track (Fig. 1).

A.3.2 SITE DESCRIPTION

The Goyders bore-fed wetland was visited by field officers in June 2003 and is shown in Figures 14–18. See Figure 19 for site sketch of the Goyders bore-fed wetland.

- Goyders bore-fed wetland was established in 1905 when the well was drilled.
- In the 1998 survey the rate of flow was 10 L/s, and in July 2003 it was estimated at 9 L/s. There have been no recent changes to the flow regime.
- Water discharges from the well to a narrow drain, which extends several hundred metres to the Warburton Creek. Flows within the creek extend a further 17.5 km.
- Waterholes of the Warburton Creek are topped up by flow from the well, and natural rainfall flows. Habitats include open water, shrubland, woodland and sedgeland.

A.3.3 LANDHOLDER VALUES

The Clifton Hills Station community use the wetland during summertime, around once a week. There is no tourist access to the bore-fed wetland, and tourist use is discouraged.

The bore-fed wetland is of high value to Clifton Hills Station for:

- Bird watching, education, recreation, leisure and reducing tension, feeling of belonging, spending time with family and friends and entertaining.

A.3.4 ISSUES FOR CONSIDERATION

- Significant flow to bore-fed wetland.
- Management is to be negotiated through the Clifton Hills Station community and station management at the metropolitan Adelaide office.
- Goyders Lagoon is named amongst the ***Diamantina River Wetland System*** listed in the National Directory of Important Wetlands, with main values being associated with the unmodified nature of the wetland system.
- Maintains several native fish populations. (See figures 16 and 17: Lake Eyre Hardyhead (***Craterocephalus eyresii***); and, Desert Rainbowfish (***Melanotaenia splendida tatei***)).
- The Diamantina River has flowed every year since 1950 at Birdsville. Several waterholes considered to be permanent are located within 10–20 km of the homestead. It is possible that the artificial groundwater input to the creek system is having a detrimental impact on the natural ecology.
- Social and recreational values argue for an allocation dependent upon an impact assessment of the allocation upon surface water dependent ecosystems of Warburton Creek and the Diamantina River System. To consider the option below.

- Pipe water from the well to the pool in the watercourse as proposed by Clifton Hills. Reduce flows significantly to around 0.5–2 L/s. Trials will be required to determine appropriate flow to fill a waterhole that retains the above social values, and does not detrimentally impact on the local stream ecology.
- A comparison of the potential impacts resulting from flow reduction options for the bore-fed wetland is presented in Table 4.

Table 4 Potential Impacts of flow reduction options for Goyders bore-fed wetland

Close bore-fed wetland	Reduce flows to 0.5–2 L/s
Reduced extent of permanent water, but vegetation, fish and birds would be maintained by natural ephemeral billabongs in watercourse.	Reduced extent of permanent water, but vegetation, fish and birds would be maintained by natural ephemeral billabongs in watercourse.

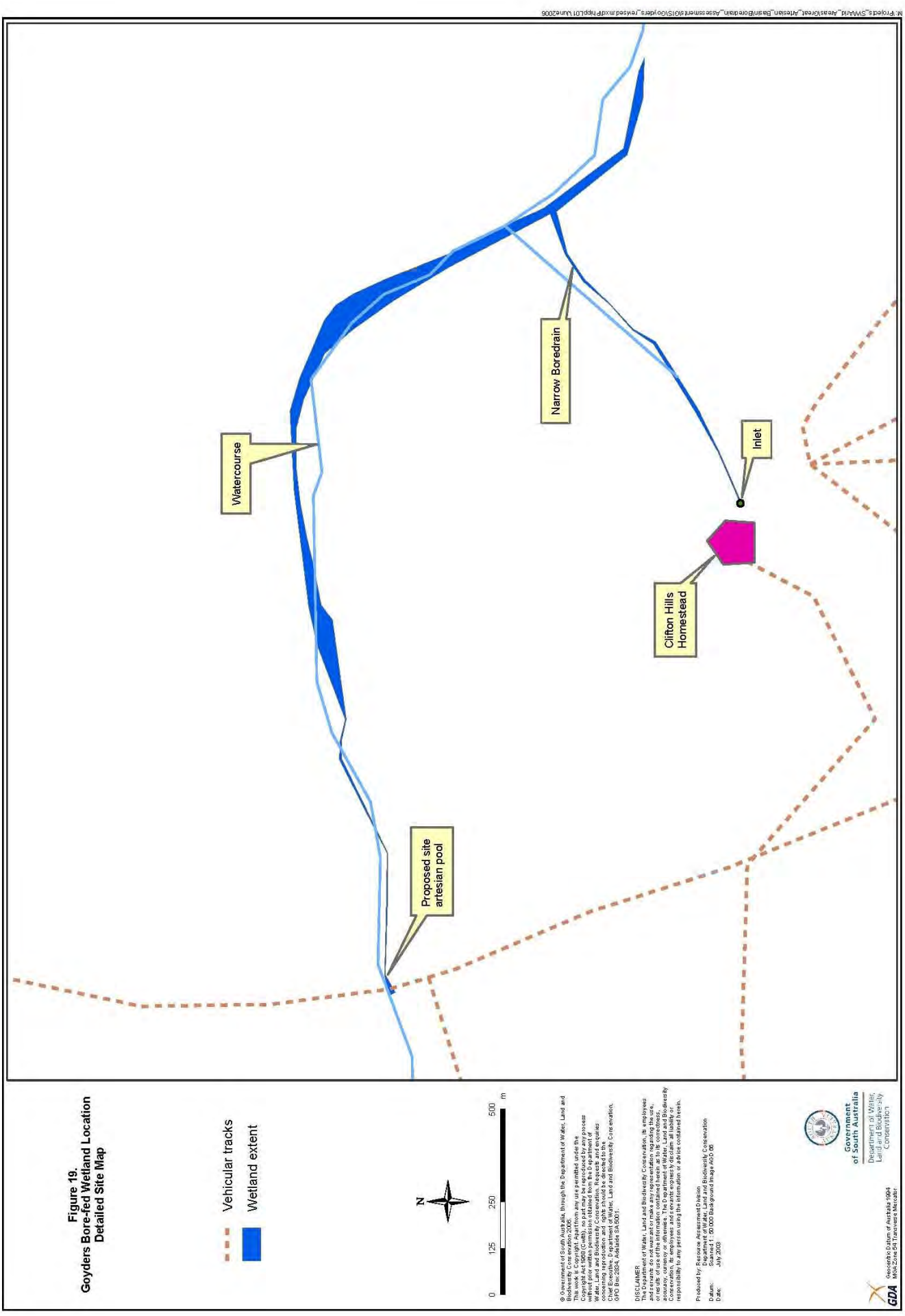
Figure 14 Flow from the Clifton Hills well down the narrow bore-fed wetland from 800 m before entering the Warburton Creek, June 2003

Figure 15 The flow from the well maintains a shallow wetland in the Warburton Creek, June 2003

Figure 16 **Lake Eyre Hardyhead (*Craterocephalus eyresii*) were abundant in Goyders Lagoon downstream of the well, June 2003**

Figure 17 **Desert Rainbowfish (*Melanotaenia splendida tatei*) were abundant in the Warburton Creek downstream of the well, June 2003**

Figure 18 Site of proposed bore-fed wetland (through piping of water) at Clifton Hills in the Warburton Creek


Watercourse
Narrow Boredrain
Inlet
Clifton Hills Homestead
Proposed site artesian pool
Vehicular tracks
Wetland extent
N
0
125
250
500
m
Figure 19.
Goyders Bore-fed Wetland Location
Detailed Site Map
Produced by: Resource Assessment Division
Department of Water, Land and Biodiversity Conservation
Datum: GDA94
Date: July 2009
Scale: Scanned 1:50 000 Background Image A0/D 66
Government of South Australia
Department of Water, Land and Biodiversity Conservation
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GDA
Geocentric Datum of Australia 1994
Map Grid of Australia zone 53

A.4 Kalladeina bore-fed wetland, Clifton Hills and Mungerannie Stations, Birdsville Track

A.4.1 LOCATION

The Kalladeina bore-fed wetland is located on Clifton Hills Station, north of Mungerannie (Fig. 1).

A.4.2 SITE DESCRIPTION

The Kalladeina bore-fed wetland was visited by field officers in March 2004 and is shown in Figures 20 and 21. See Figure 22 for site sketch of the Kalladeina bore-fed wetland.

- Kalladeina Bore was drilled in 1913 and the bore-fed wetland is well established.
- Current flow into the bore-fed wetland was estimated in 2004 at ~26 L/s (the flow could not be accurately measured due to leaking pipe lines).
- Bore shared by Clifton Hills and Mungerannie Stations and is on the boundary of the Waukatana (Mungerannie) and Kanomana (Clifton Hills) pastoral leases. Clifton Hills Station will be requesting a flow allocation to maintain the bore-fed wetland.
- Water presently discharges into a sandy braided watercourse in a tributary of Cooper Creek, and inundates natural waterholes for ~9 km.
- Habitat includes open water of around 1–2 m deep, reed beds, fringing rushes and sedges and riparian woodland.
- No bird lists or other information exists on the bore-fed wetland.

A.4.3 LANDHOLDER VALUES

The Kalladeina bore-fed wetland is used by the community of Clifton Hills Station. Mungerannie Station does not have value in retaining the bore-fed wetland itself. There is no access to tourists.

The Kalladeina bore-fed wetland is of high value to Clifton Hills Management Board who use the bore-fed wetland on average twice per month. Peter and Danielle Weston (Station Managers at the time) completed the questionnaire on behalf of the Clifton Hills Management Board, identifying the following values:

- Conservation of wildlife and wetland vegetation.
- Bird watching, education, leisure, recreation and reducing tension, spending time with family and friends, and entertaining.

A.4.4 ISSUES FOR CONSIDERATION

- Presently there is significant flow to the bore-fed wetland.
- Negotiate management through Clifton Hills Management Board (located in Adelaide).
- The bore is shared by Mungerannie and Clifton Hills Stations. Have previously informally agreed to reduce flow by around 95%.

- Clifton Hills Management Board propose to construct a deeper waterhole for visitor use. (Note that this may be in contravention of the ***NRM Act 2004*** – see Discussion)
- While the social and recreational values are enjoyed by a few, a case can be made for a small amenity allocation.
- Given that the bore-fed wetland is only of social and recreational value to a limited number of people, a very low allocation is required.
- Reduce flows significantly from 26 L/s to 1–2 L/s to provide a waterhole for visitors. A trial will be required to determine appropriate flow to fill a waterhole that retains the identified social values.
- Manage the wetland to improve habitat and amenity value.
- A comparison of the potential impacts resulting from flow reduction options for the bore-fed wetland is presented in Table 5.

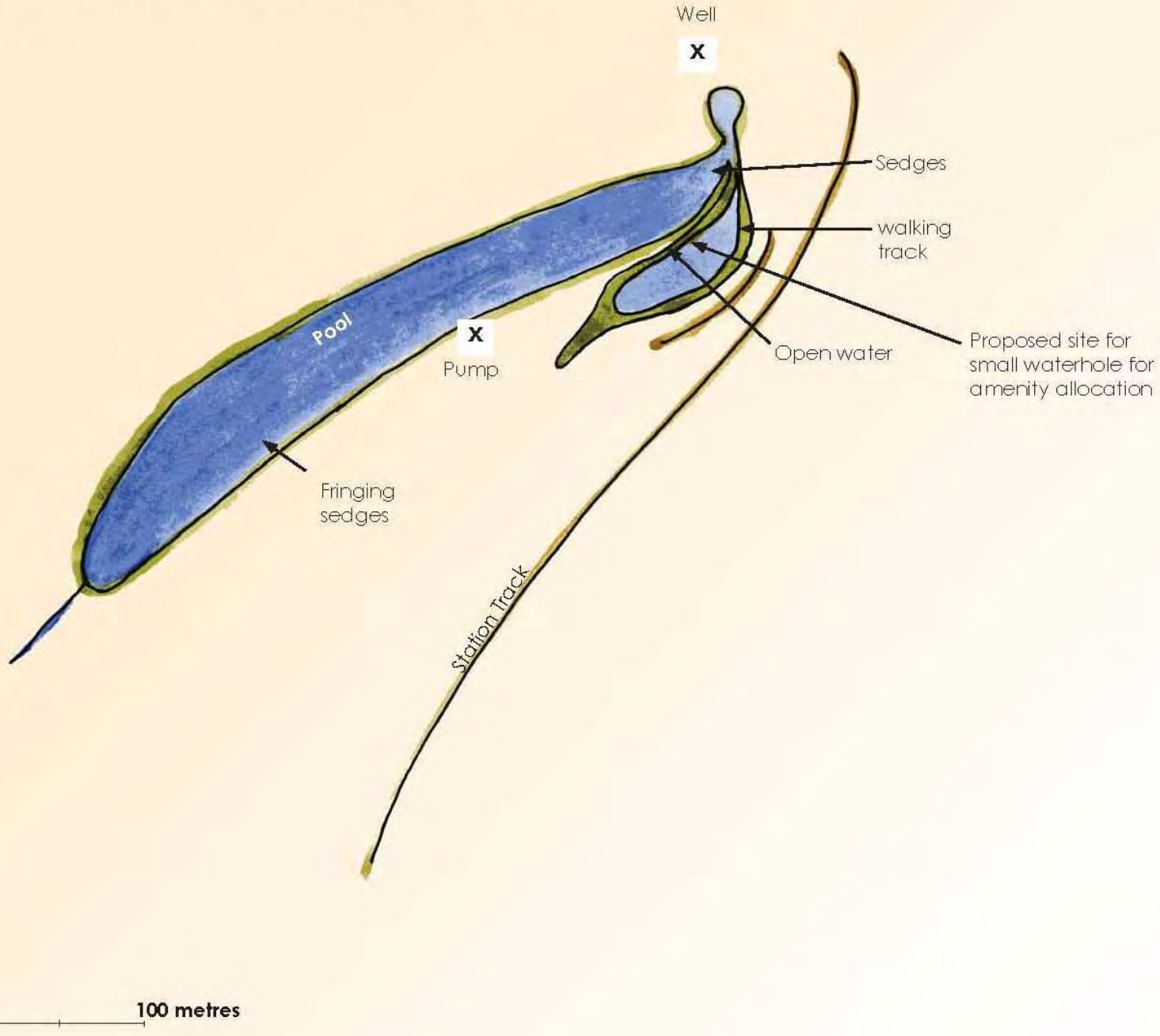
Table 5 Potential Impacts of flow reduction options for Kalladeina bore-fed wetland

Close bore-fed wetland	Reduce flows to 1–2 L/s
Open water, sedgeland, reed beds would die off. Birds would use alternative wetland habitat for breeding and feeding.	Reduced extent of permanent water, sedgeland, reed bed habitats. Birds would utilise habitats or use alternative natural wetland habitat for breeding and feeding.

Figure 20 Kalladeina well which supplies water to the bore-fed wetland, March 2004

Figure 21 Existing Kalladeina bore-fed wetland, March 2004

Figure 22: Kalladiena Bore-Fed Wetland Mud Map



A.5 Clayton bore-fed wetlands, Clayton Station, Birdsville Track

A.5.1 LOCATION

The Clayton bore-fed wetlands are located on Clayton Station, north of Marree on the Birdsville Track (Fig. 1).

A.5.2 SITE DESCRIPTION

The bore-fed wetlands were visited by field officers in March 2004 and are shown in Figures 23–25. See Figure 26 for site sketch of the bore-fed wetlands.

- The Clayton bore-fed wetlands were originally established in 1908 when Clayton Bore was drilled. Clayton 2 Bore was drilled in 1980 and flows from this bore are now used to maintain the bore-fed wetlands.
- In 1999 flow was reduced significantly from 38 L/s and pipes were installed to supply a series of six wetlands along the River Clayton with flow. Flow in September 2004 was 14 L/s.
- Flow to each wetland can be manipulated individually.
- Provides a variety of habitat types including sedgeland and tall reed beds, samphire mudflats, open woodland and shrubland.
- One bore-fed wetland is accessible to tourists and is situated close to a campground. Three other bore-fed wetlands are maintained to provide bird habitat.
- Kinhill (1998) recorded three fish species: Mosquitofish (***Gambusia holbrooki***), Spangled Perch (***Leieoportherapon unicolour***) and Desert Goby ***(Chlamydogobius eremius).***
- Badman (1987) undertook bird surveys on the original bore-fed wetland prior to the installation of piping to supply flow to the six wetlands.
- Toilet and spa facilities and a camping ground are maintained, by Clayton Station, for tourist use.

A.5.3 LANDHOLDER VALUES

Tourists visit the bore-fed wetland closest to the campground several times per day, and also camp at the campground nearby. Landholder visits several times per week.

It is of high value to Clayton Station and tourists for:

- Conservation of wildlife and wetland vegetation.
- Bird watching, education, leisure, recreation and reducing tension, spending time with family and friends and meeting new people.

A.5.4 ISSUES FOR CONSIDERATION

- Camping facilities (spa, toilet) provided and maintained at campground near Birdsville Track by landholder for public use.
- Provide an amenity allocation to maintain at least the first wetland (that which provides the highest benefit), to maintain the social, tourism and recreational values.
- Management options —

  7. Retain current flows (one allocation for the six wetlands).

  8. Reduce flow further through trials to identify flows that maintain identified social, recreational and tourism values.

  9. Negotiate with the lessee to close one or more of the six wetlands.

  10. Develop grazing and management regimes that maximise habitat values and reduce total grazing pressure in the immediate vicinity of the wetlands.

- A comparison of the potential impacts resulting from flow reduction options for the bore-fed wetland is presented in Table 6.

Table 6 Potential Impacts of flow reduction options for Clayton bore-fed wetlands

Close bore-fed wetlands	Reduce flows to 2 L/s
Open water, sedgeland, reed beds and mudflats would die off. Birds would use alternative wetland habitat for breeding and feeding. Fish would be maintained by natural permanent waterholes in Clayton Creek.	Flow would maintain first wetland, other 5 would be closed which will reduce the extent of permanent water, sedgeland, reed bed and mudflat habitats. Brolgas would utilise remaining reed bed habitats or use alternative natural wetland habitat for breeding and feeding.

Figure 23 Clayton bore-fed wetland 1 (this wetland is walking distance from the campground), March 2004

Figure 24 Clayton bore-fed wetland 1, March 2004

Figure 25 Toilet, spa (hidden behind bush on left) and visitors book at the Clayton campground near the bore-fed wetlands, March 2004

Figure 26 Clayton bore-fed wetlands site sketch

A.6 Mirra Mitta bore-fed wetland, Cowarie Station, Birdsville Track

A.6.1 LOCATION

The Mirra Mitta bore-fed wetland is located on Cowarie Station, north of Mungerannie on the Birdsville Track (Fig. 1).

A.6.2 SITE DESCRIPTION

The Mirra Mitta bore-fed wetland was visited by field officers in June 2003 and is shown in Figures 27–29. See Figure 30 for site sketch of the Mirra Mitta bore-fed wetland.

- The bore-fed wetland was established in 1901 when the well was drilled.
- A flow rate of 10 L/s was estimated in 1998 and in June 2003 a measured flow rate of 0.78 ML/d (~9.0 L/s) was recorded.
- Water from the extremely hot, controlled well flows down a 30 m narrow flow line into a pool fringed with sedges then widens to create a very shallow wetland with ***Typha*** Sp. which flows for ~1000 m into Mirra Mitta Creek.
- Habitat includes open water, sedgeland and reed beds with surrounding shrubland and samphire mudflats.

A.6.3 LANDHOLDER VALUES

Landholder visits the wetland several times per week. Landholder does not encourage tourist access.

It is of high value to Cowarie Station for:

- Conservation of wildlife (especially birds) and wetland vegetation.
- Conservation of cultural and historical features.
- Bird watching, education, leisure, recreation and reducing tension, and spending time with family and friends.

A.6.4 ISSUES FOR CONSIDERATION

- Tourist use is discouraged (although it is very close to the Birdsville Track). The owner is concerned with public liability issues associated with tourist access to the site and risk of public tampering with infrastructure.
- Presently significant flow of water into the bore-fed wetland.
- Explore the option of establishing a tourist viewing area away from any infrastructure.
- Reduce flows significantly from 9 L/s to ~3 L/s or less. Trials will be required to determine appropriate flow to retain a pool, its habitat features and associated social values.
- Monitoring of birds and feral animal numbers.
- Piping water from the bore to the wetland in order to reduce evaporation / seepage and reduce public risk.

- Include interpretive signage (subject to funds being available) to explain source of water and the importance of the Great Artesian Basin to the pastoral community.
- A comparison of the potential impacts resulting from flow reduction options for the bore-fed wetland is presented in Table 7.

Table 7 Potential Impacts of flow reduction options for Mirra Mitta bore-fed wetland

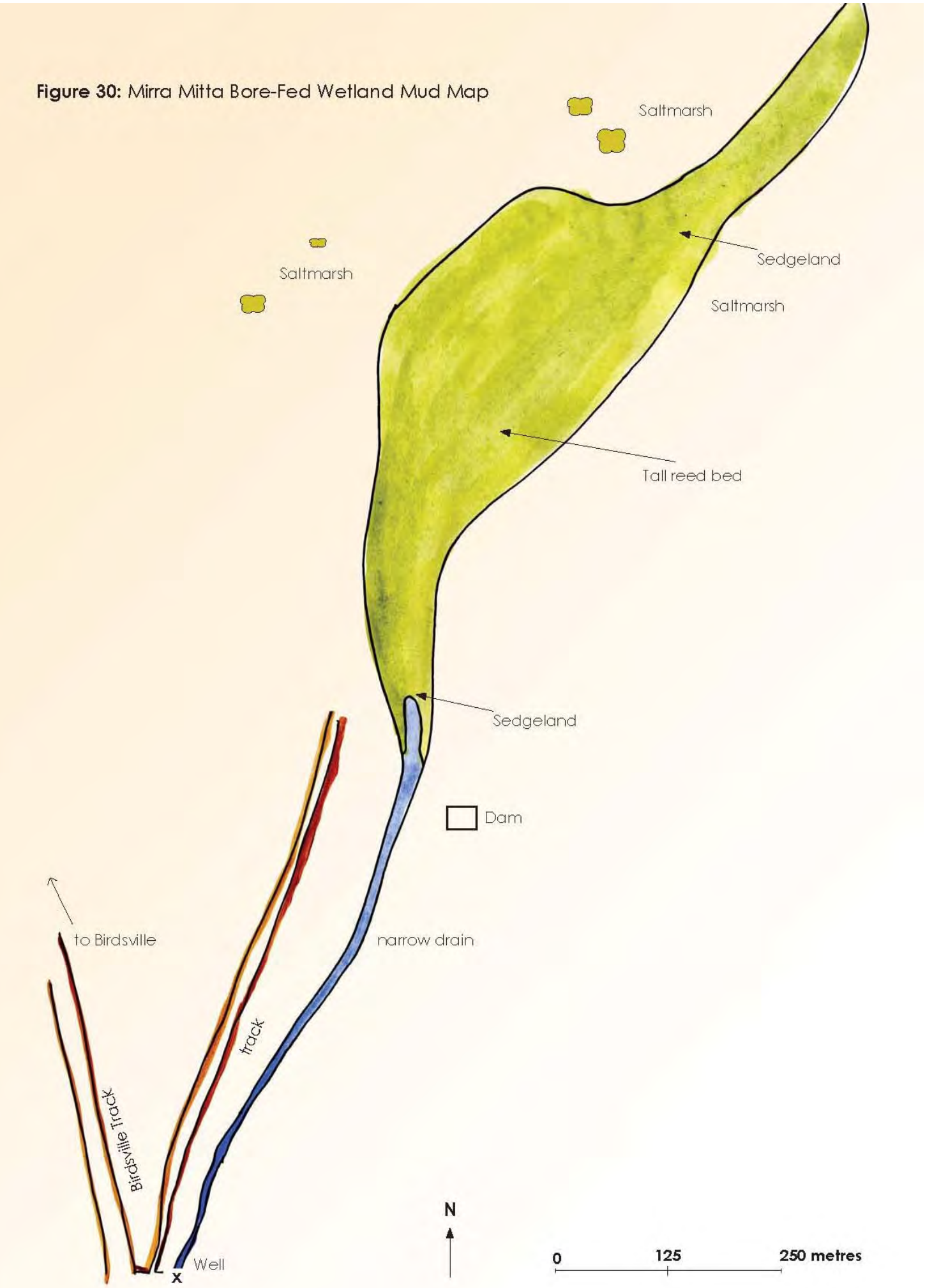
Close bore-fed wetland	Reduce flows to 3 L/s
Open water, sedgeland, reed beds and mudflats would die off. Birds would relocate and use alternative wetland habitat for breeding and feeding.	Reduced extent of open water, sedgeland, reed bed and mudflat habitats. Birds would utilise habitats or relocate and use alternative natural wetland habitat for breeding and feeding.

Figure 27 Mirra Mitta bore-fed wetland: a long, narrow drain widens at this point to create a shallow wetland, June 2003

Figure 28 Sedgeland at the far end of the Mirra Mitta bore-fed wetland, June 2003

Figure 29 Fringing vegetation at Mirra Mitta bore-fed wetland, June 2003

Figure 30: Mirra Mitta Bore-Fed Wetland Mud Map



A.7 New Kopperamanna bore-fed wetland, Etadunna Station, Birdsville Track

A.7.1 LOCATION

The New Kopperamanna bore-fed wetland is located on Etadunna Station, north of Marree on the Birdsville Track (Fig. 1).

A.7.2 SITE DESCRIPTION

The New Kopperamanna bore-fed wetland was visited by field officers in March 2004 and is shown in Figures 31–34. See Figure 35 for site sketch of the New Kopperamanna bore-fed wetland.

- New Kopperamanna 1 bore was drilled in 1949.
- High flowing bore used for watering stock and driving a power turbine. A flow rate of 12.9 L/s was recorded in Jan 2002.
- The New Kopperamanna 1 bore is located several hundred metres off the Birdsville Track, and is accessible via a station track. Infrastructure comprises the bore, power generating turbine and shed.
- Turbine outflows into the narrow constructed bore-fed wetland (2–4 m wide).
- The bore-fed wetland flows across a gibber plain for ~1 km before reaching the Cooper Creek floodplain. A small swamp with open water in the Cooper Creek bed is bordered by reed beds and sedgeland. Flow from the swamp infrequently reaches Lake Killalpaninna after flowing up to 23 km along a narrow channel when assisted by natural rainfall flows.
- Habitats include tall reed beds, sedgeland, open water, mudflats and woodland.
- A total of 38 bird species were recorded at the New Kopperamanna bore-fed wetland by Badman (1987).

A.7.3 LANDHOLDER VALUES

The New Kopperamanna bore-fed wetland is rarely used by Etadunna Station for social purposes (visit twice per month). Visitors are brought out 4–6 times per year. There is no tourist access to the well and bore-fed wetland. Note it is lower value as it is distanced from the homestead, there is no swimming hole and important bird habitat is several kilometres from the well.

It is of medium value to Etadunna Station for:

- Conservation of wildlife and wetland vegetation.
- Bird watching, education and recreation (yabbying, reducing tension, spending time with family and friends and entertaining).

A.7.4 ISSUES FOR CONSIDERATION

- Significant flow.
- Alternate power source may be installed.
- Pastoralist proposes to pipe a small flow to a location close to the house to fill a waterhole – up to 1 L/s. (Note that this may be in contravention of the ***NRM Act 2004*** – see Discussion)
- Vegetation along the narrow bore-fed wetland has been heavily grazed and trampled by cattle.
- Consideration of an amenity allocation of up to 1 L/s to maintain the identified social and recreational values of the wetland appears justified.
- Management options —

    11. If alternative power source is installed, close the existing bore-fed wetland and pipe water to the homestead to fill a constructed waterhole (up to 1 L/s).
    12. Retain flows at current levels required to generate power supply (under a water licence for power generation, not for bore-fed wetland flows). Widen the bore-fed wetland to improve habitat diversity.

- A comparison of the potential impacts resulting from flow reduction options for the bore-fed wetland is presented in Table 8.

Table 8 Potential Impacts of flow reduction options for New Kopperamanna bore-fed wetland

Close bore-fed wetland	Reduce flows to 1 L/s (and relocate to homestead)
Open water, sedgeland, reed beds and mudflats would die off. Birds would relocate and use alternative nearby billabong habitat for breeding and feeding.	Loss of habitats. Birds would relocate and use nearby billabong habitat for breeding and feeding.

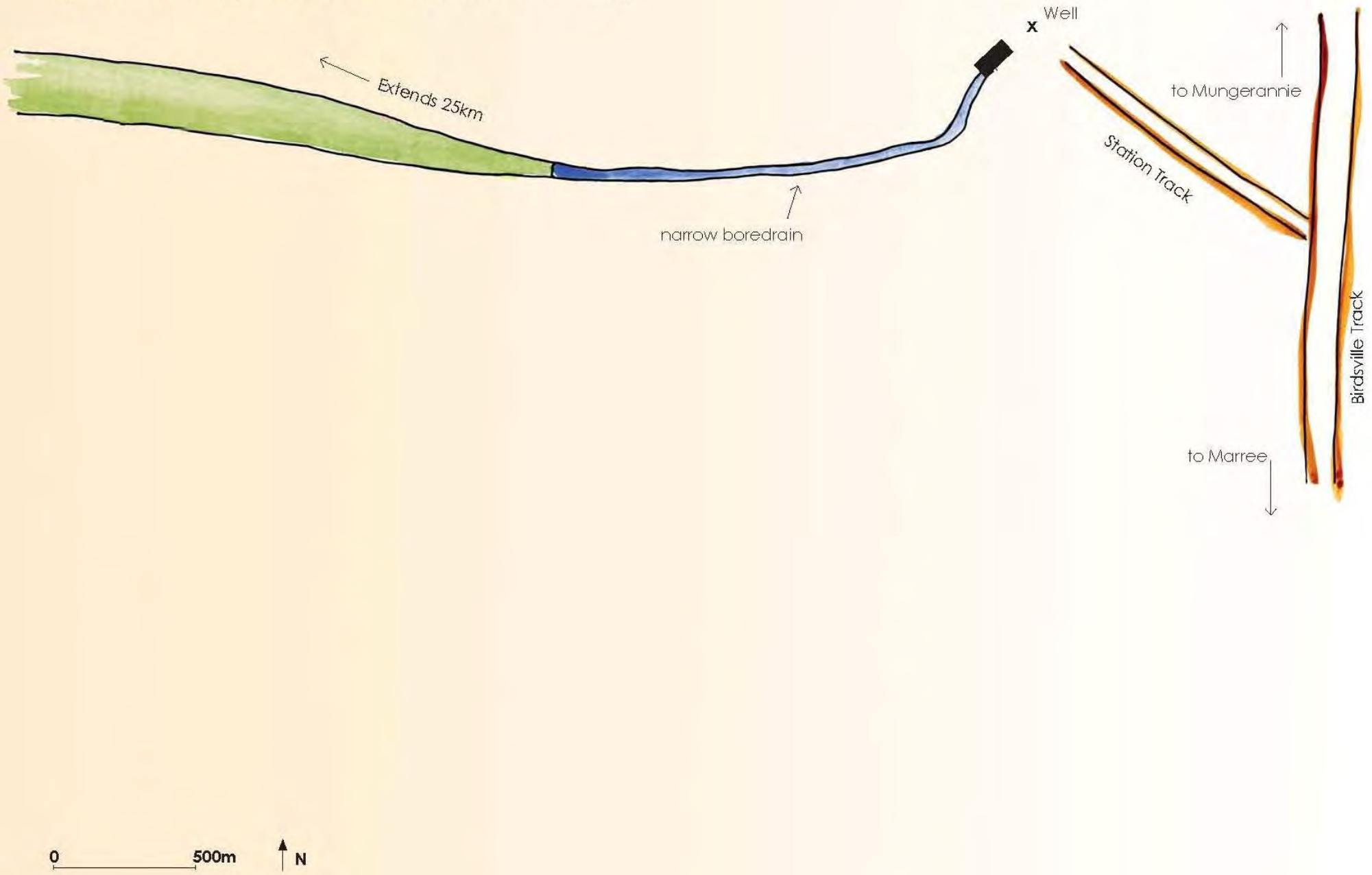
Figure 31 The turbine at New Kopperamanna well where water discharges to the narrow bore-fed wetland, March 2004

Figure 32 Flow from the turbine into the New Kopperamanna bore-fed wetland, March 2004

Figure 33 The narrow New Kopperamanna bore-fed wetland 100 m downstream of the turbine, March 2004

Figure 34 The narrow New Kopperamanna bore-fed wetland several hundred metres downstream of the turbine, March 2004

Figure 35: New Kopperamanna Bore-Fed Wetland Mud Map



A.8 White Bull bore-fed wetland, Kalamurina Station, Birdsville Track

A.8.1 LOCATION

The White Bull bore-fed wetland is located on Kalamurina Station, north of Mungerannie on the Birdsville Track (Fig. 1).

A.8.2 SITE DESCRIPTION

The White Bull bore-fed wetland was visited by field officers in March 2004 and is shown in Figures 36–39. See Figure 40 for site sketch of the bore-fed wetland.

- The bore was drilled and a bore-fed wetland was established in 1968.
- The White Bull bore was relined in 1998, and flow subsequently reduced. Flow is currently ~39 L/s, which is required to maintain control of the bore.
- Flow from three pipes flows into a very broad and lengthy bore-fed wetland flowing ~25 km and inundates several waterholes in the Warburton Creek.
- Habitat of the bore-fed wetland includes extensive sedgelands and reed beds, areas of open water, mudflats and also significant fringing eucalypt woodland and shrubland.
- The White Bull bore-fed wetland is located 55 km from Kalamurina Homestead with public access permitted via a station track, subject to road condition and payment of a small road maintenance fee. Camping is also permitted.

A.8.3 LANDHOLDER VALUES

Station community visit the wetland on average twice per month. Several small groups of tourists visit per week.

It is of high value to Kalamurina Station and tourists for:

- Conservation of wildlife and wetland vegetation.
- Bird watching, education, leisure, recreation and reducing tension, spending time with family and friends, entertaining and meeting new people.

A.8.4 ISSUES FOR CONSIDERATION

- High flow rate at White Bull well is kept at its current flow rate to prevent instability of the bore and loss of control of the flow.
- Access to the bore-fed wetland is via 55 km track and information provided for tourists. Fee charged for road maintenance. Provides a unique tourist experience accessing station tracks.
- Presently provides backup water supply for Kalamurina Station, and a water point for stock.
- A small allocation in the vicinity of 1–2 L/s to maintain the social and tourism values is warranted. Trials will be required to determine an appropriate flow rate, which retains the identified social and tourism values.

- Monitor birds and feral animals.
- Remove stock access.
- Permanent inundation of ephemeral waterholes, in the Warburton Creek, alters their ecology and is an issue that must be addressed.
- Status of the bore (hot, very high pressure) and issues relating to its stability and control must be determined in ascertaining a suitable allocation.
- A comparison of the potential impacts resulting from flow reduction options for the bore-fed wetland is presented in Table 9.

Table 9 Potential Impacts of flow reduction options for White Bull bore-fed wetland

Close bore-fed wetland	Reduce flows to 1–2 L/s
Open water, sedgeland, reed beds and mudflats would die off. Birds would relocate and use natural billabong habitat for breeding and feeding. Possible reduction in numbers of feral animals and dingoes.	Significantly reduced extent of open water, sedgeland, reed bed and mudflat habitats. Birds would utilise habitats or relocate and use alternative natural billabong habitat for breeding and feeding.

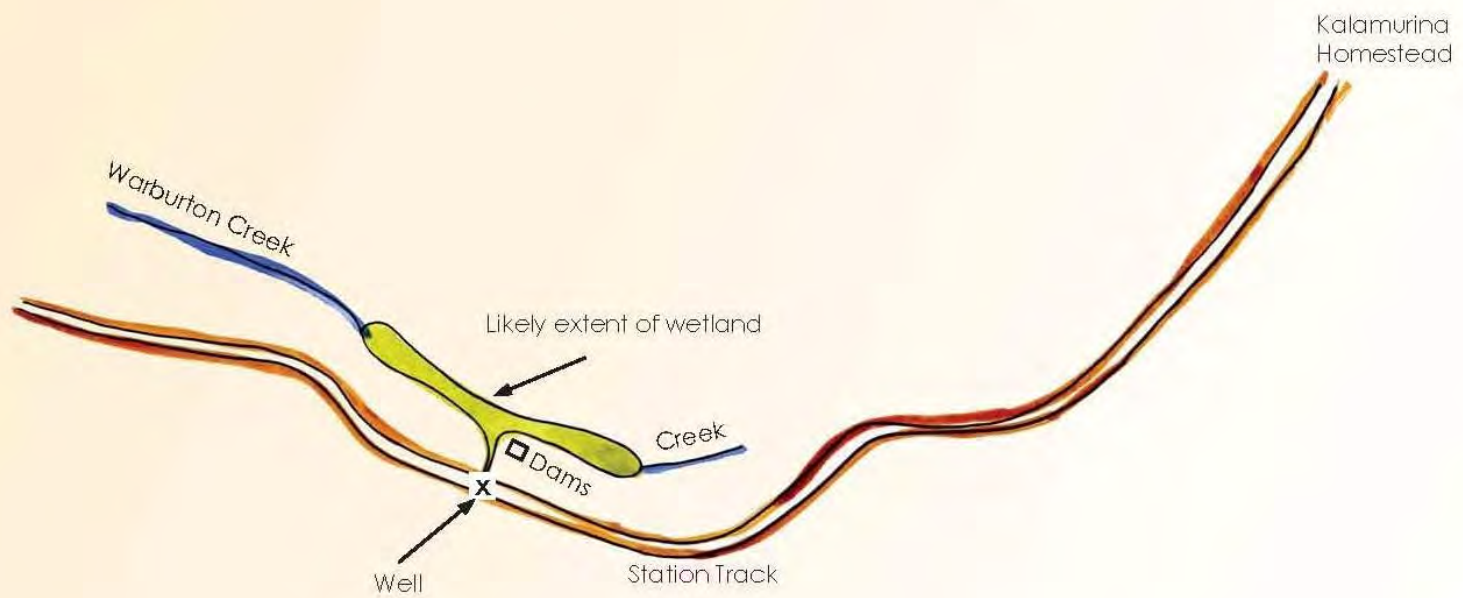
Figure 36 Three pipes deliver extremely hot water to the White Bull bore-fed wetland (to bleed pressure from the well), March 2004

Figure 37 The start of the extensive White Bull bore-fed wetland, March 2004

Figure 38 White Bull bore-fed wetland 100 m downstream of the well, March 2004

Figure 40 Shallow sedgeland habitat 1 km downstream of well at White Bull bore-fed wetland, March 2004

Figure 41: White Bull Bore-Fed Wetland Mud Map



0 15 km N

A.9 Lindon Homestead bore-fed wetland, Strzelecki Track

A.9.1 LOCATION

The Lindon Homestead bore-fed wetland is located on Lindon Station, off the Strzelecki Track (Fig. 1).

A.9.2 SITE DESCRIPTION

The Fortville 3 bore-fed wetland was visited by field officers in February 2004 and is shown in Figures 42 and 43. See Figure 44 for site sketch of the Lindon Homestead bore-fed wetland.

- Bore-fed wetland established in 1980 in a claypan adjacent to homestead.
- Flow from the Fortville 3 well was estimated at 1–2 L/s in February 2004.
- The 300 m^2 shallow bore-fed wetland has no instream or fringing water dependent vegetation.
- Provides shallow open water habitat for waders and deeper pelican pond was constructed close to the house in 2003. Adjacent casuarina grove provides some shelter / shade for wildlife.
- Homestead is designed to look out onto the bore-fed wetland.
- Stock presently water directly from the bore-fed wetland and water is also pumped from the bore-fed wetland to stock watering points.

A.9.3 LANDHOLDER VALUES

There is no tourist access to the bore-fed wetland.

It is of high value to the landholder for:

- Conservation of wildlife (especially birds).
- Bird watching, education, leisure, recreation and reducing tension, spending time with family and friends, and entertaining.

A.9.4 ISSUES FOR CONSIDERATION

- No submerged or emergent macrophytes within or adjacent to the bore-fed wetland. Casuarina grove provides some bird habitat.
- A consideration of a small amenity allocation to maintain social and recreational values appears justified.
- Reduce flows through trials with landholder to appropriate flow that retains the above social values (estimated 0.5–1 L/s may be adequate).
- Monitor birds.
- Fence the bore-fed wetland to exclude stock and feral animals.
- Relatively ‘young’ wetland will mature and the range of flora and fauna present will increase with time increasing the amenity values.
- Ensure that weeds are managed.

- A comparison of the potential impacts resulting from flow reduction options for the bore-fed wetland is presented in Table 10.

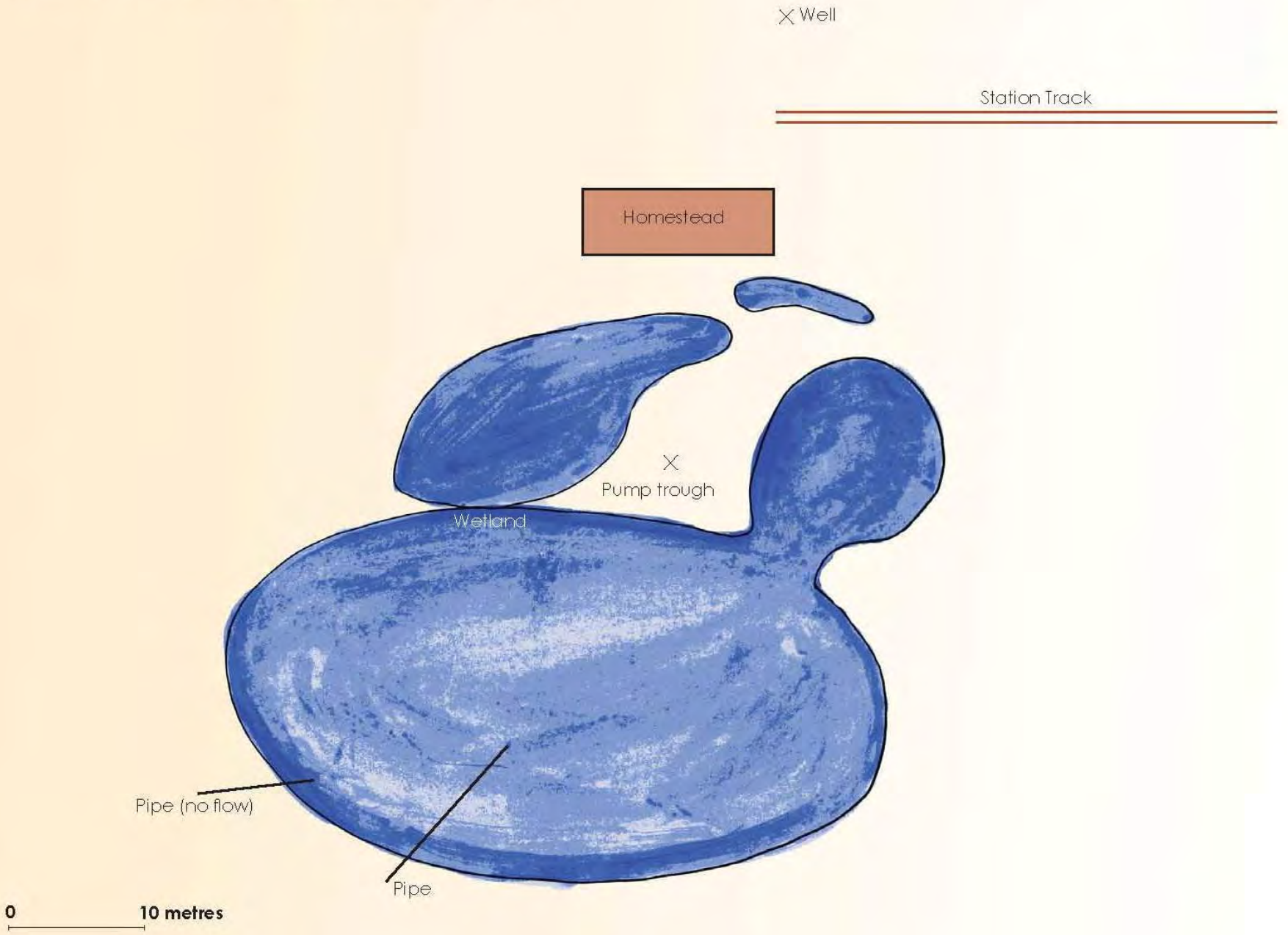
Table 10 Potential Impacts of flow reduction options for Lindon Homestead bore-fed wetland

Close bore-fed wetland	Reduce flows to 0.5–1 L/s
Birds would relocate and use alternative wetland habitat for breeding and feeding.	Reduced extent of open water and shallow water habitats. Birds would utilise habitats or relocate and use alternative natural wetland habitat for breeding and feeding.

Figure 42 The Lindon Homestead bore-fed wetland at Lindon Homestead, February 2004

Figure 43 The deeper 'pelican pond' part of Fortville 3 bore-fed wetland at Lindon Homestead, February 2004

Figure 44: Lindon Station Bore-Fed Wetland Mud Map



A.10 Montecollina bore-fed wetland, Tinga Tingana Station, Strzelecki Track

A.10.1 LOCATION

The Montecollina bore-fed wetland is located on Tinga Tingana Station, on the Strzelecki Track (Fig. 1).

A.10.2 SITE DESCRIPTION

The Montecollina bore-fed wetland was visited by field officers in February 2004 and is shown in Figure 45. See Figure 46 for site sketch of the Montecollina bore-fed wetland.

- Montecollina Bore was drilled in 1903 and re-lined in 1991.
- Flow rate in September 2004 was 1.7 L/s from the Montecollina Bore.
- The Montecollina bore-fed wetland is located on Tinga Tingana Station, which is currently leased by Lindon Station.
- A pipe from the well discharges to a constructed ground tank 32 x 36 m, which is used by Transport SA for 30 consecutive days twice a year for road maintenance. During that time usage is 500 kL/d. The dam overflows to form a shallow wetland, surrounded by sandhills. Interpretive signage, rainwater tank, campgrounds, shelter, table and toilets were installed and are maintained by the Department for Environment and Heritage (DEH).
- Access is via a road from the Strzelecki track; vehicular access is restricted.
- A stop over for people travelling between Innamincka and Leigh Creek.
- Habitat of the bore-fed wetland includes shrubland, samphire flat and dunefield.

A.10.3 LANDHOLDER VALUES

DEH District Ranger, North East Deserts District, completed the wetland values questionnaire:

- The DEH position is that there is no biological advantage in maintaining an artificial wetland in an arid environment. Identified low value for conservation of wildlife and vegetation, drought refuge.
- It is believed to contribute significantly to feral animal problems and spread of weeds in the area.
- Provides opportunities for exercise, setting for entertaining; other values low.
- Importance to tourists. Moderate importance — attractiveness of the place; opportunities for exercise and other activities; opportunity to appreciate nature and beauty; place to study nature. Low importance — for viewing birds and other wildlife and to meet new people.

Raylene Ogilvy (Lindon Station) also completed the survey. It is of high value to Lindon Station and tourists for:

- Conservation of wildlife and wetland vegetation.
- Bird watching, education, leisure, recreation, reducing tension, spending time with family and friends, entertaining, relaxing and getting away from it all.

A.10.4 ISSUES FOR CONSIDERATION

- Provides a rest area for travellers.
- Contributes to feral animal and weed proliferation.
- The bore is required for emergency stock water (but not the bore-fed wetland).
- An amenity allocation to maintain tourism, social and recreational values appears justified.
- Flows that meet Transport SA requirements for water for road maintenance will provide sufficient flow to maintain a small area of wetland, which will satisfy identified tourist values.
- Monitor birds and control feral animals.
- A comparison of the potential impacts resulting from flow reduction options for the bore-fed wetland is presented in Table 11.

Table 11 Potential Impacts of flow reduction options for Montecollina bore-fed wetland

Close bore-fed wetland	Reduce flows to 1 L/s
Open water and fringing habitats would die off. Birds would relocate and use alternative wetland habitat for breeding and feeding. Numbers of feral animals would decrease.	Reduced extent of open water and sedgeland habitats. Birds would utilise habitats or relocate and use alternative natural billabong habitats for breeding and feeding.

Figure 45 The shallow Montecollina bore-fed wetland set amongst sandhills, July 2004

Figure 46 Montecollina bore-fed wetland site sketch

A.11 Mungerannie bore-fed wetland, Mungerannie Station, Birdsville Track

A.11.1 LOCATION

The Mungerannie bore-fed wetland is located on Mungerannie Station at Mungerannie on the Birdsville Track (Fig. 1).

A.11.2 SITE DESCRIPTION

The Mungerannie bore-fed wetland was visited by field officers in July 2003, March and September 2004 and is shown in Figures 47–51. See Figure 52 for site sketch of the Mungerannie bore-fed wetland.

- The Mungerannie well was drilled in 1900, with an estimated yield at that time of 31.6 L/s. The flow inundated the ephemeral Derwent River, creating a large pool and shallow flood out area flowing up to 2 km downstream.
- The Mungerannie well was recently capped and piped through the GABSI. A bore flow rate of 11.6 L/s was measured in October 1986 and in July 2003 a flow rate, supplying the bore-fed wetland, of 6.5 L/s was measured (table 12).
- Flow has been reduced significantly by station managers and in September 2004 was 1.5 L/s.
- Three pipes of 50–100 mm diameter currently provide flow to the wetland at different locations and also supply the Mungerannie Roadhouse and Mungerannie Homestead with bore water. Flows to the wetland fluctuate subject to other demands on the supply from Mungerannie Station and Mungerannie Roadhouse. One pipe directly enters the hot tub with temperature control being achieved by use of a tap on the tub, which subsequently alters the flow into the wetland.
- A large pool and sedgeland is present during winter months and during drier months wetland size decreases to a pool of acceptable size to maintain wetland values.
- Habitats of the bore-fed wetland include open water, mudflats, tall reed beds, tall shrubland, woodland coolibah sandplains, dunefield and sedgeland.
- The Badman survey of 1987 recorded 32 species of birds, but there are believed to be up to 110 species present from various observations.
- Fish species recorded by Hammer (pers. comm. SA Museum) include Spangled Grunter (***Leipotherapon unicolour)*** and the small exotic Mosquitofish ***(Gambusia holbrooki).*** Mosquitofish were also recorded again in July 2003 by the DWLBC ecologists.
- The wetland is a popular tourist destination with camping sites around the wetland.
- Flow properties for the bore-fed wetland are shown in Table 12.

Table 12 Flow and water quality, July 2003, Mungerannie bore-fed wetland

Location	Location Description	Flow (L/s)	Temp (ºC)	Ms/c	pH	O_2 (mg/L)
Pool 1	Small pool upstream of wetland		27.8	1298	8.4	4.27
Pipe 1	GPS 0270627, 6898448	3.12	49.5			
Pipe 2	Near green rainwater tank	1.02				
Pipe 3	At the hot pool	2.5				
Total flow		6.64				

A.11.3 LANDHOLDER VALUES

There are significant tourism values associated with the bore-fed wetland, and associated economic value to Mungerannie Roadhouse for the tourists it attracts.

The wetland is of high value to Mungerannie community (hotel, station) and tourists for:

- Conservation of wildlife and wetland vegetation.
- Bird watching, education, leisure, recreation and reducing tension, spending time with family and friends, feeling of belonging, entertaining and meeting new people.

A.11.4 ISSUES FOR CONSIDERATION

- Significant tourist destination (40 000 tourists visit Mungerannie bore-fed wetland per year).
- Central location for Birdsville Track community events.
- It may be possible to reduce flow further and improve biological diversity through manipulations to flow regime — wetting and drying.
- Given the high social, recreational, tourism and economic values, an amenity allocation appears justified for the wetland.
- The bore-fed wetland should be fenced to prevent stock access and improve habitat value.
- Monitoring of birds species.
- Management options include—

13. Retain flows at current levels (wetland extends further in wet months and dries back significantly but retains diversity of bird habitat in dry months).
14. Implement flow trials to reduce flow further and improve biological diversity: maintain summer flows and decrease winter flows significantly through trials to determine flow which maintains pool habitat of wetland and some wading bird habitat, and associated tourism and economic benefits. Winter flows of around 3–5 L/s or less may be appropriate.

- A comparison of the potential impacts resulting from flow reduction options for the bore-fed wetland is presented in Table 13.

Table 13 Potential Impacts of flow reduction options for Mungerannie bore-fed wetland

Close bore-fed wetland	Maintain flows of 6.5 L/s
Open water, sedgeland, reed beds and mudflats would die off. Birds would relocate and use alternative wetland habitat for breeding and feeding. Fish would persist in natural billabongs.	Reduced but sufficient extent of open water, sedgeland, reed bed and mudflat habitats. Habitats are sufficient to maintain birds and native fish species.

Figure 47 The Mungerannie bore-fed wetland, July 2003

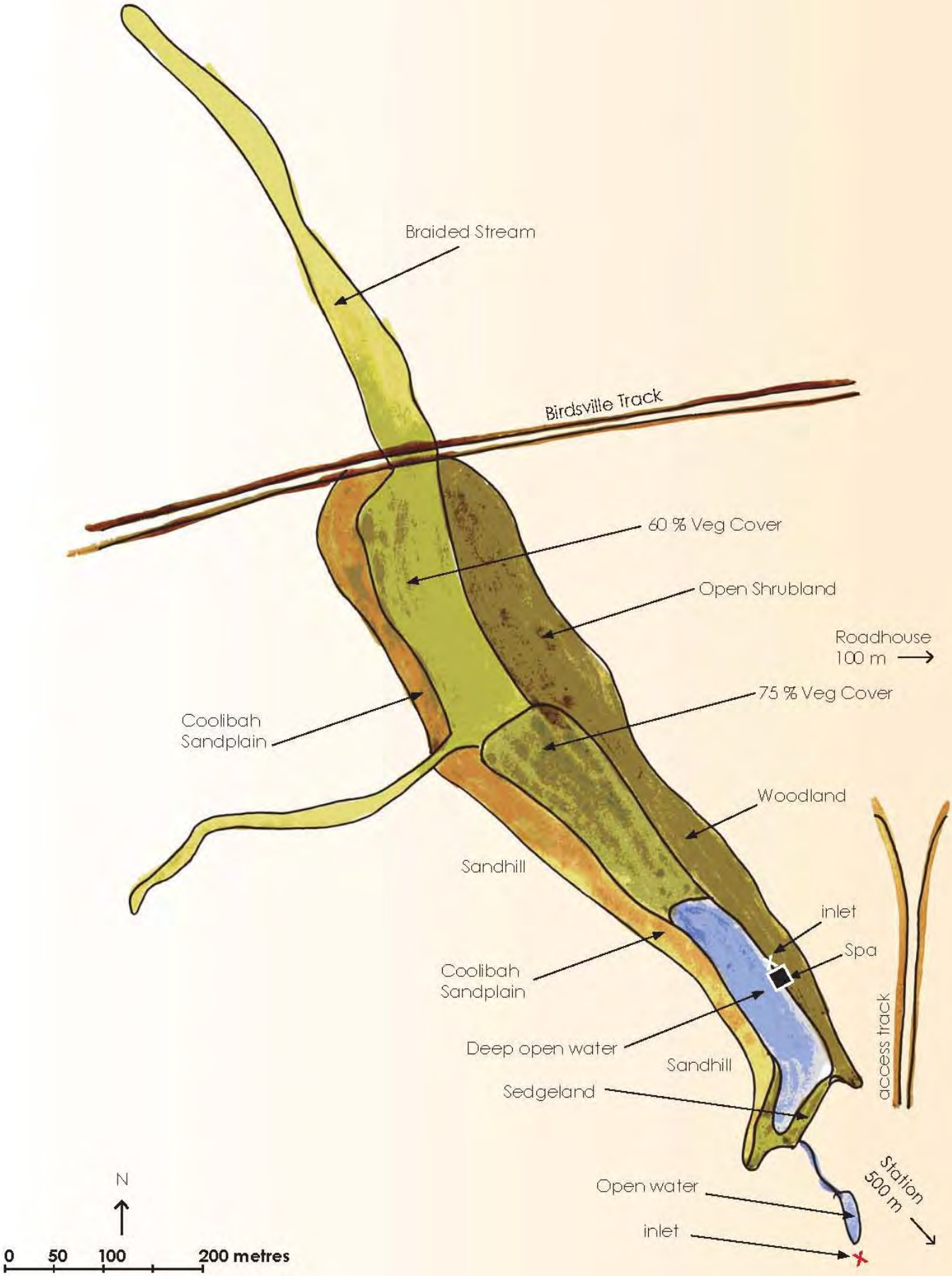
Figure 48 The inlet to pool 1 of Mungerannie bore-fed wetland (this pool is not accessible to tourists and could possibly be closed), July 2003

Figure 49 The hot pool (another inlet to the wetland), which is frequently used by visitors and locals, July 2003

Figure 50 View from the Birdsville Track of Mungerannie bore-fed wetland in July 2003: the wetland extended across the Birdsville Track

Figure 51 View from the Birdsville Track of Mungerannie bore-fed wetland in February 2004: the wetland had dried back considerably (Birdsville Track in foreground)

Figure 52: Mungerannie Bore-Fed Wetland Mud Map



A.12 Lycium bore-fed wetland, Mungerannie Station, Moomba to Sellicks Camp road

A.12.1 LOCATION

The Lycium bore-fed wetland is located on Mungerannie Station, northeast of Mungerannie on the Moomba to Sellicks Camp Road off the Birdsville Track (Fig. 1).

A.12.2 SITE DESCRIPTION

The Lycium bore-fed wetland was visited by field officers in February 2004 and is shown in Figures 53–55. See Figure 56 for site sketch of the Lycium bore-fed wetland.

- Lycium 1 Bore was drilled by Santos in 1989 as a petroleum exploration well and converted to a water well.
- The bore yield of Lycium 1 in October 1995 was 10.8 L/s. Current flow is required to maintain control of the bore. Flow will be accurately measured in 2006 — gas in the pipeline has made flow measurement difficult.
- Located 10 km southeast of Beach Petroleum Sellicks Camp on the Cooper Creek.
- Flow from the bore enters the Cooper Creek floodplain where it inundates waterholes in the natural channel, extending ~8.5 km downstream.
- Habitat includes open water, reed beds and woodland.
- An outstation was constructed 100 m from the well in 2004.

A.12.3 LANDHOLDER VALUES

The Mungerannie station community visit the bore-fed wetland on average once per week. Tourists and visitors pass through two or more times a week. Tourists pay a small camping fee at Mungerannie to camp at Lycium. Lycium bore-fed wetland is of value to Mungerannie Station for:

- Conservation of wildlife and wetland vegetation.
- Bird watching, education, leisure, recreation and reducing tension, feeling of belonging, spending time with family and friends, entertaining and meeting new people.

A.12.4 ISSUES FOR CONSIDERATION

- Landholder would appreciate enough flow to fill a swimming hole (0.5 L/s possibly) for use by the outstation.
- Isolated location, tourists and locals using the back track to/from Mungerannie visit and camp at the waterhole.
- Tourism, social and recreational values argue for an amenity allocation.
- Reduce flows significantly to provide a waterhole for future residents of the outstation, visitors and tourists.
- A comparison of the potential impacts resulting from flow reduction options for the bore-fed wetland is presented in Table 14.

Table 14 Potential Impacts of flow reduction options for Lycium bore-fed wetland

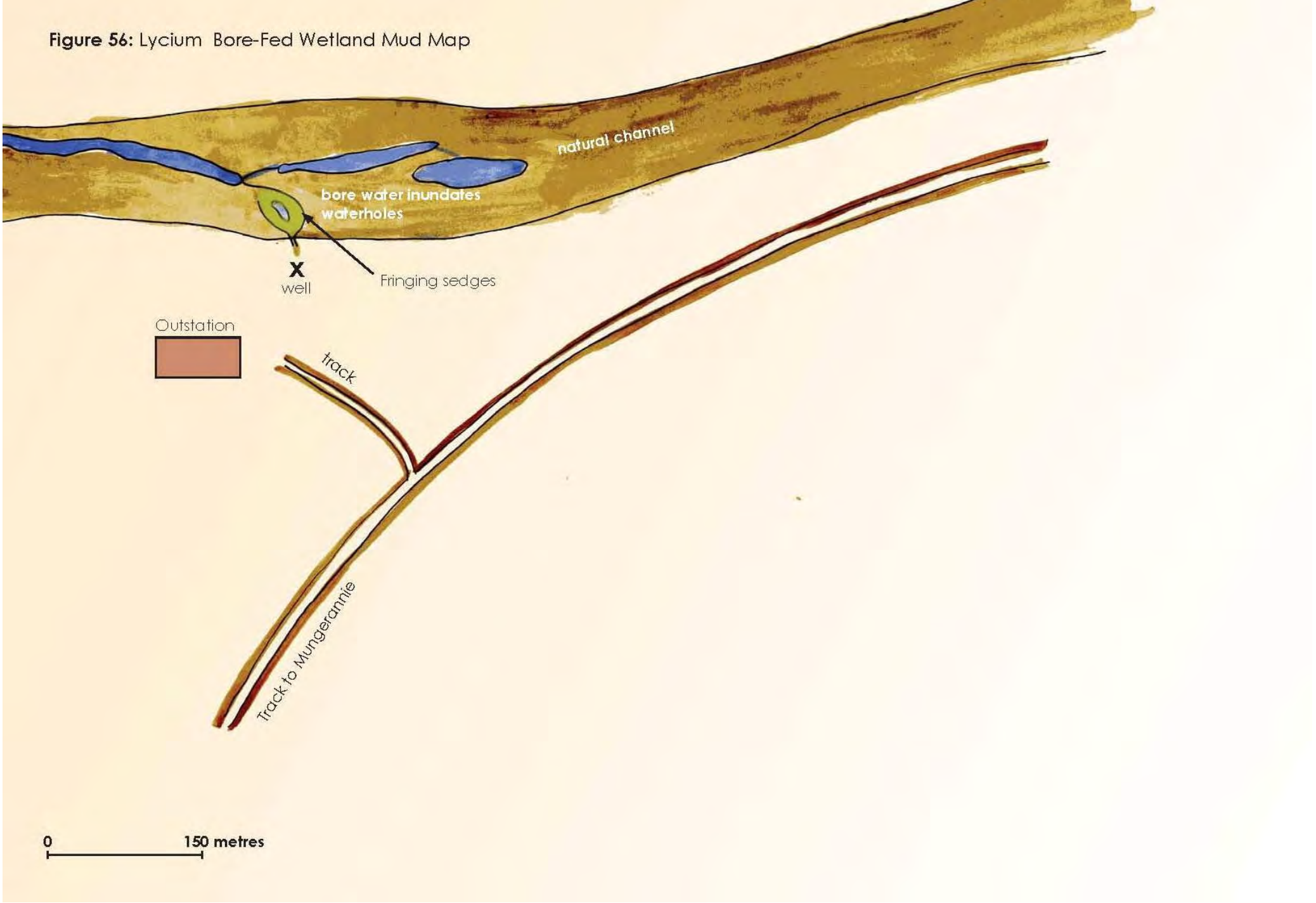
Close bore-fed wetland	Reduce flows to 0.5 L/s
Open water, sedgeland, reed beds and mudflats would die off. Birds would relocate and use alternative billabong habitat for breeding and feeding.	Reduced extent of open water, sedgeland, reed bed and mudflat habitats. Birds would utilise habitats or relocate and use alternative natural billabong habitat for breeding and feeding.

Figure 53 Current inlet pipe from the Lycium 1 bore into the Cooper Creek, February 2004

Figure 54 Flow from the Lycium 1 bore into the Cooper Creek, February 2004

Figure 55 Presently there is significant inundation of the Cooper Creek from Lycium 1 bore, February 2004

Figure 56: Lycium Bore-Fed Wetland Mud Map



A.13 Jack Lake bore-fed wetland, Mungerannie Station

A.13.1 LOCATION

The Jack Lake bore-fed wetland is located on Mungerannie Station (Fig. 1).

A.13.2 SITE DESCRIPTION

The Jack Lake bore-fed wetland was not visited by field officers, but images from a previous visit 2002 are shown in Figures 57 and 58.

- The Jack Lake well was originally drilled by Santos in 1987 as a petroleum exploration well and completed as a water well.
- The author did not visit the site, but spoke to Rodney Fullarton (Manager). Flow is only retained to prevent instability of the well.
- Jack Lake bore-fed wetland extends for ~2 km.

A.13.3 LANDHOLDER VALUES

- Rarely visited. A wetland is not required for amenity use.

A.13.4 ISSUES FOR CONSIDERATION

- Significant flow, bore drain to be piped through the GABSI program.
- Bore-fed wetland allocation not requested. No further action necessary.

Figure 57 The inlet to the extensive Jack Lake bore-fed wetland, 2002

Figure 58 Jack Lake bore-fed wetland, 2002

A.14 Murnpeowie bore-fed wetland, Murnpeowie Station, Strzelecki Track

A.14.1 LOCATION

The Murnpeowie bore-fed wetland is located on Murnpeowie Station, off the Strzelecki Track (Fig. 1).

A.14.2 SITE DESCRIPTION

The Murnpeowie bore-fed wetland was visited by field officers in February 2004 and is shown in Figures 59 and 60. See Figure 61 for site sketch of the Murnpeowie bore-fed wetland.

- The Murnpeowie HS bore was originally drilled in 1910 and the bore drain established in Twin Creek, a few kilometres from Murnpeowie homestead. Water from the bore is stored in a tank, and it overflows to a second tank, which overflows to the drain. The two tanks are used as balancing storages for pumps to windmills and a diesel pump to deliver water to various parts of the station. Flow to the bore-fed wetland is influenced by the demand by other uses, including stock water and domestic supplies. The existing wetland maintains a small, shallow flood-out area with reed beds.
- A bore yield of 6 L/s was estimated in September 1986 and a flow rate, of 1.7 L/s, to the bore-fed wetland was measured in October 2004.
- The existing bore-fed wetland is to be closed, and landholder proposes establishment of a new permanent waterhole in existing channel of the creek using well water.
- No bird lists or other studies exist for the bore-fed wetland.

A.14.3 LANDHOLDER VALUES

The landholders visit the bore-fed wetland 2–3 times a week, and take visitors there 4–6 times a year. There is no tourist access to the bore-fed wetland.

It is of high value to Murnpeowie Station for:

- Conservation of wildlife and wetland vegetation.
- Bird watching, education, leisure, recreation and reducing tension, spending time with family and friends, entertaining, and relaxing.

A.14.4 ISSUES FOR CONSIDERATION

- The landholders wish to close the existing bore-fed wetland and direct flow via a pipe to a nearby waterhole in Twin Creek, which is a more appropriate setting for recreational use. This is in contradiction with the ***Natural Resources Management Act 2004*** (see Discussion).
- The landholder proposes to fence the proposed bore-fed wetland to restrict stock access to only a small downstream section for drinking.
- A small allocation for the proposed bore-fed wetland could be justified to maintain existing social and recreational values identified through this study.

- Provide adequate flows to satisfy social values, to be determined through trials. It is estimated that flows of the order of 0.5 L/s (or less) will be required to maintain a wetland at proposed site.
- A comparison of the potential impacts resulting from flow reduction options for the bore-fed wetland is presented in Table 15.

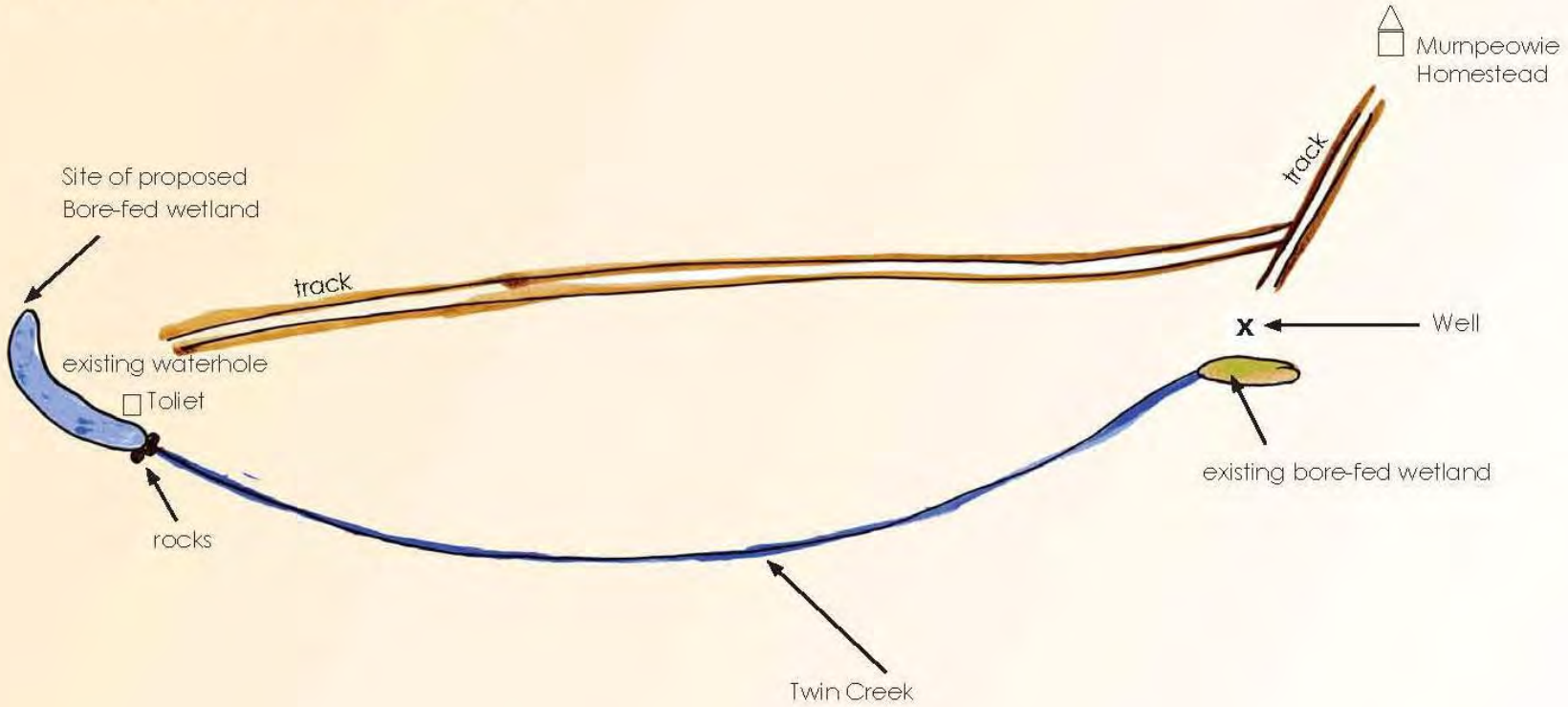
Table 15 Potential Impacts of flow reduction options for Murnpeowie Homestead bore-fed wetland

Close bore-fed wetland	Reduce flows to 0.5 L/s
Open water, sedgeland, reed beds and mudflats would die off. Birds would relocate and use alternative billabong habitat for breeding and feeding.	Re-establishment of wetland habitat at alternative location. Birds would utilise habitats or relocate and use alternative natural billabong habitat for breeding and feeding.

Figure 59 The balancing storage tanks at Murnpeowie, which overflow into the bore-fed wetland, 2004

Figure 60 The shallow Murnpeowie bore-fed wetland, 2004

Figure 61: Murnpeowie Bore-Fed Wetland Mud Map



0 200 metres

A.15 Coward Springs bore-fed wetland, Oodnadatta Track (private lease)

A.15.1 LOCATION

The Coward Springs bore-fed wetland is located at the Coward Springs Camp Ground, north-west of Marree on the Oodnadatta Track (Fig. 1).

A.15.2 SITE DESCRIPTION

The Coward Springs bore-fed wetland was visited by field officers in December 2003 and is shown in Figures 62 and 63. See Figure 64 for site sketch of the Coward Springs bore-fed wetland.

- The Coward Springs land is maintained under a miscellaneous crown lease for conservation and tourist camping purposes. The 1996 Heritage Agreement area includes part of the old Ghan railway line, part of the old township and the bore-fed wetland. Railway buildings are now restored and the site managed as a tourist and camping site.
- The original Coward Springs bore was drilled in 1887. The flow was reduced to a moderate uncontrolled flow by concreting in 1967. The bore was controlled through the NHT in 1993. Two bores now exist at the site but only one supplies water to the wetland.
- Three wetlands radiate from the well, and the entire wetland extends for ~1 km, but is seasonally variable. The bore-fed wetland is fenced to exclude stock.
- Habitat of the bore-fed wetland includes open water, mudflats, sedgelands, samphire flats, tall shrubland and woodland. Supports fish, crustaceans, insects and a range of birds. Rare desert mouse and other mammals have been recorded. All of the reptile species recorded at Coward Springs bore-fed wetland are common and have an extensive range and distribution (Williams, 2002).
- The bore-fed wetland is surrounded by gibber with low vegetation. Several ecological studies have been conducted on the wetland. A total of 129 species of bird have been recorded (Prue Coulls, landholder Coward Springs bore-fed wetland, pers. comm., 2004).
- The campground includes toilets, shaded campsites and a hot tub.
- The bores and wetland are located approximately 2 km east of the Coward Springs spring group.

A.15.3 LANDHOLDER VALUES

Coward Springs campground is a popular tourist destination. The bore-fed wetland is an important drawcard for the campground business and has high conservation value to the managers.

It has high values for:

- Conservation of wildlife, wetland vegetation and historical features.
- Drought refuge for wildlife.

- Feeling of belonging, education opportunities, viewing birds and other wildlife, setting for entertaining family and friends, leisure, recreation and reducing tension, and a place to appreciate nature and beauty and spend quality time with family and friends.

A.15.4 ISSUES FOR CONSIDERATION

- Significant flow in close proximity to GAB springs — with potential impact on GAB springs.
- A well managed, amenable site providing good facilities for tourists.
- DEH undertook surveys of plant diversity, vegetation associations and their condition and threats to vegetation in 2001, and a subsequent management plan identified threats to the vegetation including:

  15. Reduction of water flow from the bores (loss of diversity and silting of wetland).
  16. Rabbit grazing.
  17. Pedestrian traffic. A management plan was written to deal with these issues. Photo points were established.

  The Management Plan written for Coward Springs in 2002 recommended that flows remain at current rate to maintain vegetation but this plan is not attached to the Heritage Agreement (Vicky Linton, DWLBC, pers. comm., 2004).
- Managers are happy to undertake flow trials on the wetland, especially to enhance habitats for birds, but are concerned about the flow being reduced further. Managers believe the impact of reduced flow since capping could be significant.
- Tourism, recreational, economic and social values could justify an amenity allocation.
- Retain current flows or reduce through trials that retain habitat and social values. (Trials should consist of flow manipulations to mimic / enhance natural wetting–drying cycles).
- Test (model) draw down impact of flow to wetland (for subsequent impact on GAB springs), and determine whether it is necessary to reduce well flow into the wetland.
- A comparison of the potential impacts resulting from flow reduction options for the bore-fed wetland is presented in Table 16.

Table 16 Potential Impacts of flow reduction options for Coward Springs bore-fed wetland

Close bore-fed wetland	Reduce flows through trials
Open water, sedgeland, reed beds and mudflats would die off. Birds would relocate and use alternative wetland/mound spring habitat for breeding and feeding.	Reduced extent of open water, sedgeland, reed bed and mudflat habitats. Birds and fish would utilise habitats or relocate and use alternative natural wetland/mound spring habitat for breeding and feeding.

Figure 62 Spa at the inlet of the Coward Springs bore-fed wetland, December 2003

Figure 63 The Coward Springs bore-fed wetland, December 2003

Figure 64 Coward Springs bore-fed wetland site sketch

A.16 Muloorina bore-fed wetland, Muloorina Station, Oodnadatta Track

A.16.1 LOCATION

The Muloorina bore-fed wetland is located on Muloorina Station, north of Marree off the Oodnadatta Track (Fig. 1).

A.16.2 SITE DESCRIPTION

The Muloorina bore-fed wetland was visited by field officers in February 2004 and is shown in Figures 65–67. See Figure 68 for site sketch of the Muloorina bore-fed wetland.

- The well was originally established in 1983, with flow from the power generating turbine flowing down a narrow channel entering the Frome River channel and forming a deep, extensive bore-fed wetland.
- In 1998 flow rate from the turbine into the wetland was 23 L/s (Kinhill, 1998). An agreement has been made to install a restrictor for 10 L/s winter flows and 15 L/s summer flows.
- Habitats of the wetland include tall reed beds, open water, tall shrubland and woodland. A total of 84 bird species were recorded by Badman (1987) and several species of fish were recorded (four native, one introduced).
- Kinhill undertook detailed biological studies in 1998 including environmental water requirements. Spangled Grunter, Mosquitofish and Desert Rainbowfish were recorded.
- The wetland and associated campground is located on a public access road to Lake Eyre South and is a popular camping spot with good facilities.

A.16.3 LANDHOLDER VALUES

The Muloorina Station community visit the bore-fed wetland on average once per week. Tourists and visitors pass through daily. Camping is encouraged, and facilities are provided for tourists. Tourists visiting Lake Eyre stop at the bore-fed wetland.

It is of high value to Muloorina Station and tourists for:

- Conservation of wildlife and wetland vegetation.
- Bird watching, education, leisure, recreation (swimming, fishing and yabbying) and reducing tension, feeling of belonging, spending time with family and friends, and entertaining and meeting people.

A.16.4 ISSUES FOR CONSIDERATION

- The Muloorina bore-fed wetland campground has good existing facilities, currently maintained by station staff on a daily basis, and also features interpretive signage.
- Social, recreational and tourism values could justify an amenity allocation.
- Reduce flow further through trials to identify flows that retain social values.
- Consider installing a pipe to supply water directly from the well to the wetland.

- Introduction of a wetting and drying regime should be trialled. This will improve biological diversity in the wetland. Note an agreement has already been made to install a restrictor for summer flows of 15 L/s and winter flows of 10 L/s. Trials with lower flow rates (less than 10 L/s) should be conducted.
- A comparison of the potential impacts resulting from flow reduction options for the bore-fed wetland is presented in Table 17.

Table 17 Impacts of flow options, Muloorina bore-fed wetland

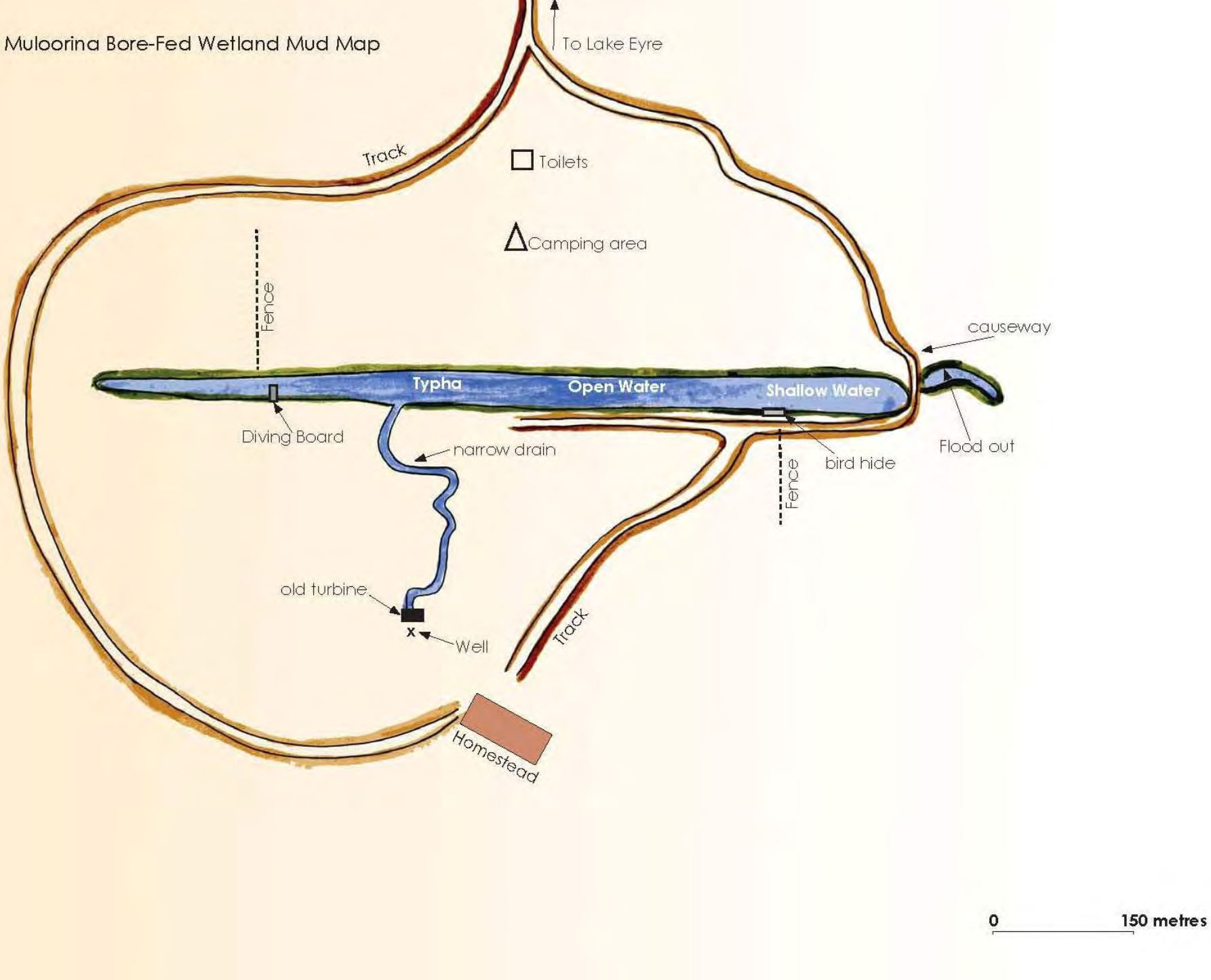
Close bore-fed wetland	Reduce flows through trials
Open water, sedgeland, reed beds and mudflats would die off. Birds would relocate and use alternative wetland habitat for breeding and feeding.	Reduced extent of open water, sedgeland, reed bed and mudflat habitats. Birds would utilise habitats or relocate and use alternative natural billabong habitat for breeding and feeding.

Figure 65 Pontoon on the Muloorina bore-fed wetland, March 2004

Figure 66 Toilet facilities at the Muloorina camping ground, March 2004

Figure 67 Birdhide at Muloorina bore-fed wetland, March 2004

Figure 68: Muloorina Bore-Fed Wetland Mud Map



A.17 Dulkaninna bore-fed wetland, Dulkaninna Station, Birdsville Track

A.17.1 LOCATION

The Dulkaninna bore-fed wetland is located on Dulkaninna Station, north of Marree on the Birdsville Track (Fig. 1).

A.17.2 SITE DESCRIPTION

The Dulkaninna bore-fed wetland was visited by Williams in 2002 and is shown in Figures 69 and 70. See Figure 71 for site sketch of the Dulkaninna bore-fed wetland.

- The well was drilled in 1896 and bore-fed wetland established, 400 m east of the Birdsville Track.
- A bore yield of 17 L/s was measured in 1998. In 2004 the flow rate to the wetland was measured at 4.7 L/s.
- Water is piped from the well to the wetland in the watercourse. Formerly used for hydroelectric power generation.
- Wetland habitats identified by Badman (1987) include sedgeland, open water, mudflats and woodland. A total of 54 bird species recorded by Badman (1987), including 10 species of conservation significance. Sixty-five species of birds have been identified from other observations throughout the year.
- It is possible that since Badman's survey in 1987 the biological diversity has increased through the exclusion of stock.
- A site visit was not conducted, by field officers, as part of this project.

A.17.3 LANDHOLDER VALUES

Owner and family visit the bore-fed wetland two or more times per week. They do not encourage tourists en masse as they do not have the resources to manage their impact. However, they do allow small groups and individuals to visit, especially when research based.

It is of high value to Dulkaninna Station for:

- Conservation of wildlife and wetland vegetation and historical features.
- Drought refuge for wildlife.
- Feeling of belonging, education opportunities, viewing birds and other wildlife, setting for entertaining, leisure, recreation and reducing tension, conservation of wildlife, a place to appreciate nature and beauty, and spend quality time with family and friends.

A.17.4 ISSUES FOR CONSIDERATION

- Flows have been reduced, and water piped directly to the wetland.
- A draft heritage agreement was developed for Dulkaninna but has not been signed by the station manager, therefore is not applicable (Vicky Linton, DWLBC, pers. comm., 2004).
- Improvement of wetland health by mimicking the wetting and drying cycles of a natural wetland through
    - Seasonal manipulation of flow rates, or
    - Seasonal variation in evaporation rates, or
    - A combination of both.
- Management options include—

    18. Retain flows at current levels.

    19. Reduce flows through trials to retain identified values.

- A comparison of the potential impacts resulting from flow reduction options for the bore-fed wetland is presented in Table 18.

Table 18 Potential Impacts of flow reduction options for Dulkaninna bore-fed wetland

Close bore-fed wetland	Reduce flows to less than 5 L/s through trials
Open water, sedgeland, reed beds and mudflats would die off. Birds would relocate and use alternative wetland habitat for breeding and feeding.	Reduced extent of open water, sedgeland, reed bed and mudflat habitats. Birds would utilise habitats or relocate and use alternative natural wetland habitat for breeding and feeding.

Figure 69 Dulkaninna bore-fed wetland (courtesy of Williams, 2002)

Figure 70 Dulkaninna bore-fed wetland (courtesy of Williams, 2002)

Figure 71: Dulkaninna Bore-Fed Wetland Mud Map

Source: Adapted form Williams, A 2002

Appendix B – Tabulated Landholder Survey Results

Table B-1. Bore-fed wetland personal values

Wetland	Conservation of birds and other wildlife	Conservation of fish and other aquatic wildlife	Conservation of wetland vegetation	Conservation of historical/cultural features	Assists in drought refuge for wildlife	Contributes to feral animal problems in the area	Contributes to the spread of weeds in the area	Other
Morphetts	5	5	5	5	5	1	1	
Callanna	5	5	5	5	5	1	1	
Goyders	5	1	5	4	5	4	1	
Kalladeina	5	3	5	5	5	1	1	
Clayton	5	5	5	5	5	1	1	
Mirra Mitta	5	4	4	5	5	3	3	
New Kopperamanna	3	4	5	1	5	5	1	
White Bull	5	3	5	3	5	2	1	
Lindon Homestead	5	5	5	1	5	1	1	Stock watering 5
Montecollina (DEH)	1	1	1	1	1	5	4	
Montecollina (landholder)	5	5	5	5	5	3	1	Bore is required for stock water.
Mungerannie	5	5	5	5	5	5	5	Community events
Lycium	5	5	5	1	5	1	1	
Jack Lake								
Murnpeowie	5	5	5	3	0	3	1	1
Coward Springs	5	5	5	5	5	1	2	
Muloorina	5	5	5	5	5	2	1	
Dulkaninna	5	4	4	5	5	1	1	

Numerical rating based on the scale: 1 = Low value; 5 = High value

Table B-2. Personal benefits of bore-fed wetland

Wetland	Contributes to the character and attractiveness of this place	Provides opportunities for exercise and other activities	Provides education opportunities for family and friends	Provides opportunities for viewing birds and other wildlife	Provides enjoyable setting for entertaining friends/visitors	Contributes to a more relaxed, less stressful life	Provides destination for tourists and other visitors	Contributes to a feeling of belonging and appreciation of area	Provides opportunity to conserve the environment	Provides opportunity to appreciate nature and beauty	Provides a place to study nature and/or conduct research	Provides a place to spend quality time with family and friends	Provides opportunity to meet new people	Provides opportunity to relax and get away from it all	Other
Morphetts	5	5	5	5	5	5	1	5	5	5	4	4	1	4	Makes property viable - 5
Callanna	5	5	5	5	5	5	1	5	5	5	4	4	1	4	Makes property viable - 5
Goyders	5	5	5	5	5	5	1	5	5	5	5	5	1	5	
Kalladeina	5	4	1	4	5	5	5	4	5	4	4	5	1	5	
Clayton	5	3	5	5	5	5	5	5	5	5	5	5	5	5	
Mirra Mitta	4	4	5	5	4	4	1	3	5	5	5	4	1	4	
New Kopperamanna	4	1	5	5	5	1	1	1	2	5	4	5	4	1	
White Bull	5	4	5	5	5	5	5	5	4	5	5	5	5	5	
Lindon Homestead	5	5	5	5	5	5	1	5	5	5	5	5	1	5	Stock watering - 5
Montecollina (DEH)	1	3	1	1	2	1	1	1	1	1	1	1	1	1	
Montecollina (landholder)	5	5	5	5	5	5	5	5	5	5	5	5	5	5	Safety stop off-emergency water for people passing through
Mungerannie	5	5	5	5	5	5	5	5	5	5	5	5	5	4	
Lycium	5	5	5	5	5	5	5	5	5	5	5	5	3	5	
Jack Lake Murnpeowie	5	5	4	5	5	5	5	5	5	5	5	5	1	5	
Coward Springs	5	4	2	5	5	5	5	5	5	5	5	5	5	5	
Muloorina	5	5	5	5	5	5	5	5	5	5	5	5	5	5	

Wetland	Contributes to the character and attractiveness of this place	Provides opportunities for exercise and other activities	Provides education opportunities for family and friends	Provides opportunities for viewing birds and other wildlife	Provides enjoyable setting for entertaining friends/visitors	Contributes to a more relaxed, less stressful life	Provides destination for tourists and other visitors	Contributes to a feeling of belonging and appreciation of area	Provides opportunity to conserve the environment	Provides opportunity to appreciate nature and beauty	Provides a place to study nature and/or conduct research	Provides a place to spend quality time with family and friends	Provides opportunity to meet new people	Provides opportunity to relax and get away from it all	Other
Dulkaninna	5	5	5	5	5	5	4	5	4	5	4	5	2	1	

Numerical rating based on the scale: 1 = Low value; 5 = High value

Table B-3. Landholder views of tourism/visitor benefits of bore-fed wetland

Wetland	Contributes to the character and attractiveness of this place	Provides opportunities for exercise and other activities	Provides education opportunities for family and friends	Provides opportunities for viewing birds and other wildlife	Provides enjoyable setting for entertaining friends/visitors	Contributes to a more relaxed, less stressful life	Provides destination for tourists and other visitors	Contributes to a feeling of belonging and appreciation of area	Provides opportunity to conserve the environment	Provides opportunity to appreciate nature and beauty	Provides a place to study nature and/or conduct research	Provides a place to spend quality time with family and friends	Provides opportunity to meet new people	Provides opportunity to relax and get away from it all
Morphetts	5	4	4	5	4	4	4	4	5	5	5	4	1	5
Callanna	5	4	4	5	4	4	4	4	5	5	5	4	1	5
Goyders	5	4	5	5	5	5	1	5	5	5	5	5	4	5
Kalladeina	3	5	3	5	5	5	3	3	5	5	3	5	1	5
Clayton	5	4	3	5		4	5	4	5	5	4	5	5	5
Mirra Mitta	5	5	5	5	3	4	4	4	4	5	5	4	4	4
New Kopperamanna	No visitation encouraged													
White Bull	5	3	5	5	5	5	5	3	5	5	5	5	3	5
Lindon Homestead	No visitation encouraged													
Montecollina (DEH)	3	3	1	2	1	1	1	1	1	3	3	1	2	1
Montecollina (landholder)	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Mungerannie	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Lycium	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Murnpeowie	5	4	4	5	5	5	1	4	3	5	1	5	1	5
Coward Springs	5	5	5	4	5	5	5	4	5	5	5	5	5	5
Muloorina	5	5	4	5	4	5	5	4	4	5	3	5	5	5
Dulkaninna	5	4	4	4	4	2	4	5	5	5	4	2	2	5

Numerical rating based on the scale: 1 = Low value; 5 = High value

Table B-4. Visitation rates

Wetland	How often do you or other family members visit the wetland?						How often do tourists/visitors visit the wetland?					
	Two or more times per week	Once per week	Twice per month	Once per month	Four to six times per year	Less than once every 6 months	Two or more times per week	Once per week	Twice per month	Once per month	Four to six times per year	Less than once every 6 months
Morphetts	X											X
Callanna	X											X
Goyders		X									X	
Kalladeina				X					X			
Clayton	X						X					
Mirra Mitta	X						X					
New Kopperamanna			X								X	
White Bull		X					X					
Lindon Homestead	X											X
Montecollina (DEH)							X					
Montecollina (landholder)							X					
Mungerannie	X						X					
Lycium		X					X					
Jack Lake												
Murnpeowie	X										X	
Coward Springs	X						X					
Muloorina	X						X					
Dulkaninna	X										X	

Table B-5. Other questions/comments

Wetland	Do you encourage visitor use of the wetland?	Other than watering stock: are money making activities supported by the existence or use of the wetland?	Management notes to take into consideration
Morphetts	No; too far from track, disturb wildlife and stock, cause damage.	No	Viability of the property relies upon bore drains-issues with pipes and tanks
Callanna	No; too far from track, disturb wildlife and stock, cause damage.	No	Viability of the property relies upon bore drains-issues with pipes and tanks
Goyders	Not tourists, only selected visitors, family, friends, researchers	No	Socially important for family and friends. If it wasn't there birds would leave the area as there is no permanent water until the top end of the property
Kalladeina	Not tourist, but family friends, neighbours, responsible visitors	No	
Clayton	Yes; infrastructure is provided.	No	WMC usage has dropped 5m in 2 yrs. Relies solely on head pressure. Proximity of WMC conde of depression and problems Clayton experience pushing water around property.
Mirra Mitta	No; major water controlling infrastructure present-don't want it interfered with. Also water is very hot so risk of personal injury high - liability risk to management	No	
New Kopperamanna	Don't encourage tourists but bring friends out.	No but bore is used for stock watering and power generation	Flow needs to be maintained for power generation - earthworks for more of a wetland at the site would be good, and piping to homestead for a wetland near the house would be good.
White Bull	Yes; Visit homestead, sign in and get map etc to go to wetland	No; charge tourists a fee for road maintenance	
Lindon Homestead	No	No	Would be lost without it.
Montecollina (DEH)	No; but maintain facilities.	No	The wetland is seen to be causing feral animal problems.
Montecollina (landholder)	DEH maintain facilities. Use is not actively encouraged.	No but TSA uses bore for roads maintenance	
Mungerannie	Yes; camping	Yes - camping and hotel business	40 000 tourists per year visit Mungerannie
Lycium	Yes; camping spot, which is booked through the Mungerannie Roadhouse - people welcome provided respect is shown for the area.	No	Outstation built in 2004 at Lycium site.
Murnpeowie	Only invited guests - can come as often as they want as long as they abide by the rules.	No	It has been a waste of water, want to put in a more efficient, user friendly wetland.
Coward Springs	Yes	Yes	Linked to business, want to maintain at current flow. Seen as a conservation project
Muloorina	Yes	No	

Wetland	Do you encourage visitor use of the wetland?	Other than watering stock: are money making activities supported by the existence or use of the wetland?	Management notes to take into consideration
Dulkaninna	No; do not encourage tourists, as don't have resources to manage their impact. Do allow small groups and individuals to visit especially when research based.	No	

Appendix C - South Australian water birds — inland habitat preference

Common name	MH	Habitat preference	Nesting preference	Diet	Feeding
Australian pelican	D	Large open water	Low islands or sand spits, on ground	Carnivore, fish mostly, also insects and crustaceans	Herding fish into shallows to feed
Black swan		Large open water permanent not specific	Not specific, on islands, in reeds, or among shrubs	Herbivore, mostly leaves and shoots of aquatic plants also grasses	Can secure food only to depth of 1 m
Australian wood duck	D	Grasslands and pasture associated near wetlands (terrestrial)	Tree hollows	Herbivore, mostly grasses, also grains and insects	Mostly grazing on land
Pacific black duck	S	Open water with dense fringing vegetation, not specific	Often in tree hollows, less on the ground amongst bushes	Omnivore, mostly seeds and vegetative material, sedges smartweeds and grasses	Not specific, dabble water surface, sift mud, strip seeds
Australian shelduck	M S	Large open water, along the shoreline of shallow habitats (prefer salt affected wetlands)	Often in tree hollows, less on the ground amongst bushes and rabbit burrows	Omnivore, mostly vegetation and invertebrates, some molluscs	Not specific, dabble water surface, sift mud, strip seeds
Grey teal	D	Large shallow inland waters, not specific	Often in tree hollows, less on the ground amongst bushes and reeds	Omnivore, mostly seeds and vegetative material, sedges smartweeds and grasses	Not specific, dabble water surface, sift mud, strip seeds
Pink-eared duck	D	Large shallow inland waters, (aquatic)	Usually over water in trees, cane grass, lignum, chenopods	Omnivore, mostly invertebrates also algae and floating seeds	Filter feeder limited to water and sifting mud
Hardhead	D	Open deep water with dense fringing vegetation, (aquatic) (uncommon on salt affected wetlands)	In dense reeds, on islands and lignum, melaleuca	Omnivore, mostly aquatic plants also molluscs and crustaceans	Mostly from diving also dabbling and strip seeds
Blue-billed duck	M	Large open water permanent with fringing vegetation (aquatic)	In dense vegetation, reeds, lignum, melaleuca, occasionally on ground	Omnivore, plant material and insects also molluscs and crustaceans	Mostly from diving also surface of the water and strip seeds
Australasian shoveller		Large open water permanent with fringing vegetation (aquatic)	On the ground in grassy sites usually close to waters edge	Omnivore, mostly insects also seeds	Feed off the surface of the water
Pacific (white-necked) heron	D	Shallow inland waters and flooded lands, with sparse grasses, herbs, sedges, rushes,	Nest on limbs in trees	Carnivore, small aquatic and terrestrial animals (rarely fish) also molluscs and crustaceans	Standing, stalking and striking prey. Feed in shallow water <7 cm and steep banked waters.

Common name	MH	Habitat preference	Nesting preference	Diet	Feeding
		Eleocharis. Not specific			
White-faced heron	N	Not specific, river systems, floodplains, swamps, fresh and saline	Nest in trees not necessarily near water	Carnivore, a wide range of vertebrates and invertebrates also crustaceans	Standing, stalking and striking prey in shallow waters.
Great egret		Open shallow floodplain waterbodies permanent, not specific	Nest in upper parts of trees standing in water 7–15 m above ground	Carnivore, mostly fish also insects, crustaceans, molluscs and birds	Standing, stalking and striking prey in shallow waters. Forage in shallow waters <30 cm deep
Little egret		Open shallow floodplain waterbodies, with abundant aquatic veg. and little to no emergent veg.	Nest on limbs in trees from water level to 7.m above	Carnivore, mostly fish (mainly <2 cm) also insects, crustaceans	Standing, stalking and striking prey in shallow waters. Forage in shallow waters <10–15 cm deep
Nankeen night heron	N	Open shallow floodplain waterbodies permanent, with wooded edges and / or tall sedges and reeds	Nest in trees, on top of shrubs, lignum and reed beds	Carnivore, mostly fish also animals, insects and crustaceans	Nocturnal. Standing, stalking and striking prey in shallow waters and pursue prey on land.
Glossy ibis	M	Floodplain waterbodies, along the shoreline of shallow habitats with abundant aquatic flora. (Prefer freshwater, avoid dry ground)	Nest on top and in lignum at 10–50 cm above water level	Carnivore, mostly aquatic invertebrates, also molluscs, crustaceans and insects	Slowly walking sifting mud, water surface and from grasses
Straw-necked ibis		Shallow wetlands, grasslands with trees, shrubs and reeds	Nest amongst lignum, reeds and sedges, on ground on islands or over water<1.m deep	Omnivore, mostly a wide range of vertebrates and invertebrates also crustaceans, molluscs some seeds and plant material	Feed by probing into ground or vegetation into shallow water
Royal spoonbill		Not specific, wetlands, grasslands along shallow margins	In trees, lignum, reeds and rushes usually over water 0.5–1.5 m deep in trees 1–15 m high or reeds 0.5–1.5 m high.	Omnivore, mostly fish also crustaceans, aquatic insects and vegetable matter	Wading sweeping, probing, grabbing in shallow water <40 cm. Substrate of sand, mud and clay
Yellow-billed spoonbill		Shallow wetlands, with abundant aquatic flora with sparse or low vegetation	Nest often in tree side branches 2–8 m high over water	Carnivore, mostly aquatic insects also crustaceans and fish	Wading sweeping, probing, grabbing in shallow water <40 cm. Substrate of sand, mud and clay
Brolga	S	Near open shallow wetlands (swamps and marshes) <2 m deep	Prefer nesting in marshes <50 cm deep and meadows <30 cm deep, on the ground or small island, sedge and rushes,	Omnivore, mostly tubers of sedges (particularly Eleocharis) and pasture, also insects molluscs and crustaceans	Slowly walking grazing and digging, also striking prey

Common name	MH	Habitat preference	Nesting preference	Diet	Feeding
			grasses or cane grass and lignum, occasionally floating nests		
Great cormorant	N D	Deep open lakes / marshes and major rivers, permanent	Not specific, trees, bushes, lignum, rocks, on ground near water	Carnivore, predominantly fish also crustaceans and insects	Most taken by pursuit diving, also wading in shallows
Pied cormorant	S	Deep open lakes / marshes and major rivers, permanent, with fringing trees and islands	In trees and dense shrubs (lignum)	Carnivore, predominantly fish also insects	All food taken by pursuit diving
Little black cormorant	D	Deep open lakes / marshes and major rivers, permanent >1 m deep, 90% on wetlands >100 ha	Flooded trees away from land in vegetated swamps and lakes	Carnivore, predominantly fish also crustaceans	Most taken by pursuit diving
Little pied cormorant	D	Open lakes / marshes and major rivers, use smaller wetlands than other cormorant spp.	In trees, bushes, lignum and snags around 2.8 m above water	Carnivore, prey on crustaceans more and take fish taken less often than other cormorants	Food taken by a succession of dives taking more sedentary prey in shallow waters
Australian darter		Open lakes / marshes and major rivers, permanent smooth water >50 cm deep	In branches of flooded trees around 3.5 m above water	Omnivore, predominantly fish also insects and occasionally vegetable matter	All food taken by pursuit diving
Hoary-headed grebe	D	Open lakes / marshes and major rivers, 100–500 m wide and 0.5–3 m deep with submerged veg. (avoid dense waterweeds)	Off shore in floating waterweeds or amongst sedges, saltmarsh, lignum and canegrass	Carnivore, primarily aquatic arthropods also fish	Most taken by deep diving pecking inverts from sediments and vegetation
Australasian grebe	D	Shallow wetlands, along steep gradient shoreline with fringing reeds and submerged vegetation	In shallow water among emergent plants and bushes or attached to overhanging branches	Omnivore, aquatic arthropods, fish, molluscs, vegetable matter and seeds	Wide range of methods, diving, picking from surface water, snatching insects from emergent veg.
Dusky moorhen		Open waterbodies permanent, with fringing emergent and submerged vegetation also adjacent grassed areas	In dense vegetation, lignum, cane grass, reed beds, rushes and sedges	Omnivore, vegetable matter, seeds, molluscs, insects, carrion	Feed on land and shallow water (up to 30 cm deep) amongst floating veg. or in open water 100 m from cover
Purple swamphen		Not specific, around the margins of wetlands and adjacent grasslands	In reed beds and rushes	Omnivore, mainly aquatic veg. also seeds, insects, fish animals	Feed in dense reed beds gleaning insects and seeds, dig roots and rhizomes also graze grass

Common name	MH	Habitat preference	Nesting preference	Diet	Feeding
Black-tailed native-hen	D	Open shallow wetlands to more saline conditions, not specific	Near water in swamps of red gum, lignum, cane grass, chenopod shrubs, grasses and small islets	Omnivore, seeds, vegetable and insects	Gleans from ground and water surface
Eurasian coot	D	Open shallow wetlands with fringing emergent and submerged vegetation, often with open deep water >2 m	In lignum, sword grass, rushes and forks of shrubs (melaleuca)	Herbivorous, mainly aquatic veg. seeds and grasses.	Graze on land and glean from water surface, dive for shoots and scrape algae
Australian spotted crake		Not specific, around the margins of wetlands (<5 cm water) with dense fringing vegetation	In dense vegetation, bushes, lignum, rushes, sedges and grass	Omnivore, seeds (sedges, chenopods, legumes), also insects, molluscs and crustaceans	Foraging on the ground, wading, gleaning and probing
Spotless crake		Not specific, around the margins of wetlands with dense fringing vegetation	Usually over water in dense vegetation, reeds, rushes, grass tussocks and bushes	Omnivore, seeds, grasses, insects, molluscs and crustaceans	Mostly foraging on the ground, gleaning mudflats, reed beds, shallow water
Baillon's crake	M	Not specific, around the margins of wetlands with dense fringing vegetation and abundant floating vegetation (may prefer fluctuating water levels)	In dense vegetation above shallow water within 20 m of waters edge	Omnivore, mostly aquatic insects also seeds, molluscs and crustaceans	Gleans among floating veg. reeds and marshy ground
Masked Lapwing	S	Open shallow wetlands, with short grassed areas at the margins, also adjacent open plains	Nest on ground in short grass (<12 cm) or stony ground also on small islands and floating reeds	Omnivore, molluscs, worms, insects, crustaceans and occasionally seeds	Stalk, run, glean and probe
Banded lapwing		Not specific, near water open plains and margins of dry swamps	On ground in a range of open dry habitats	Omnivore, seeds, leaves, molluscs, worms, insects	Stalk, run, glean and probe, seldom wade in shallow water
Red-kneed dotterel		Open floodplain wetlands along the open shallow margins, avoid tree lined and/ or the more saline wetlands	Not specific, on ground along the shore or islets where samphire and shrubs can conceal nests	Omnivore, seeds, molluscs, worms, insects	Glean and probe and tremble feet to disturb prey in wet sand / mud
Black-fronted dotterel	S	Open floodplain wetlands along the shallow margins	Nest on ground in stony areas or stone strewn sand	Omnivore, worms, molluscs, and crustaceans also insects, occasionally seeds	Forage at waters edge glean and probe into mud
Red-capped plover		Saline wetlands along the open shallow mudflats with sparse	Not specific, on ground along the shore or islets, usually near	Omnivore, worms, molluscs, and crustaceans also insects, and	Forage stop-run-peck, seldom

Common name	MH	Habitat preference	Nesting preference	Diet	Feeding
		fringing vegetation	water >40 m	vegetable matter	wade in shallow water
Black-winged stilt	D	Open shallow wetlands, with short grassed areas, not specific	Not specific, on ground	Omnivore, mainly invertebrates, also molluscs and crustaceans, occasionally vegetable material and seeds	Diurnal and nocturnal wide range of foraging, pecking, pursuit, filtering, probing and raking
Branded stilt	D	Saline wetlands along the open shallow mudflats	On ground on small islands in salt lakes with scattered samphire, occasionally on sand spits 1–1.5 m above water level and besides shallow water 10–60 cm deep	Omnivore, mainly crustaceans, also molluscs insects, vegetation matter and seeds	Forage at waters edge wading, pecking, scything and probe into mud
Red-necked avocet	D	Saline wetlands along the open shallow mudflats, not specific	Not specific, on ground along the shore or islets of salt lakes above water level	Omnivore, invertebrates, molluscs and crustaceans, occasionally vegetable material and seeds	Wading in shallow water scything, gleaning from water surface

Source: South Australian Aquatic Biota Database (DWR)

NOTE: the information provided in these tables has been condensed from material, sourced from the South Australian Aquatic Biota Database (DWR, 2001).

Key: MH = migration habits; D = dispersive, S = sedentary, M = migratory.

Appendix D - Landholder Value Survey Form

This survey is a modified version of the 'Site Description' and 'Personal and Community Values' surveys as presented in CERM, 2002a.

Part A – Site Description

1. **Bore manager name/s and contact details?**

2. **Nature of wetland? (e.g. constructed bore drain, natural channel, flood-out, other)**

3. **Year of wetland establishment?**

4. **Distance to nearest GAB springs (km)?**

5. **Distance to nearest GAB bore drain (km)?**

6. **Is the current rate of flow into the wetland known?**

7. **Is the temperature of water entering the wetland known?**

8. **Have there been any recent changes in the water regime?**

9. **What sources of information on the physical & biological characteristics of this wetland exist that you are aware of?** (eg. scientific assessments, reports, monitoring programs, bird lists etc.)

10. **Have you any additional comments pertaining to site description?**

Part B - Personal and Community Values

Name of respondent

Respondents' relationship to the wetland

(1) Why is this wetland valuable to you?

(2) The following items relate to environmental benefits Score the items from 1 to 5 according to how important you feel they should be in determining the value of this particular wetland, where 1= low importance and 5=high importance.

a. Conservation of birds and other wildlife

b. Conservation of fish and other aquatic wildlife

c. Conservation of wetland vegetation

d. Conservation of historical/cultural features

e. Assists in drought refuge for wildlife

f. Contributes to feral animal problems in the area

g. Contributes to the spread of weeds in the area

h. Other

(3) Which item do you consider to be the most important?

(4) Using the above data to guide your discussion, identify and rank the four environmental attributes that you believe are most important in guiding assessment of wetland valuation.

(5) The following items pertain to personal benefits.

Score the following from 1 to 5 according to how important you feel they should be in determining the value of this particular wetland, where 1= unimportant and 5=high importance.

a. Contributes to the character and attractiveness of this place

b. Provides opportunities for exercise and other activities

c. Provides education opportunities for family and friends

d. Provides opportunities for viewing birds and other wildlife

e. Provides enjoyable setting for entertaining friends/visitors

f. Contributes to a more relaxed, less stressful life

g. Provides destination for tourists & other visitors

h. Contributes to a feeling of belonging & appreciation of area

i. Provides opportunity to conserve the environment

j. Provides opportunity to appreciate nature and beauty

k. Provides a place to study nature and/or conduct research

l. Provides a place to spend quality time with family and friends

m. Provides opportunity to meet new people

n. Provides opportunity to relax and "get away from it all"

o. Other

(6). Which item do you consider to be the most important?

(7) Using the above data to guide your discussion, identify and rank the four personal benefits that you perceive should be most important in guiding assessment of wetland value.

(8) Using the same scale, and discussing amongst yourselves, how important do you think these benefits are to tourists and other visitors when they visit the wetland?

a. Contributes to the character and attractiveness of this place

b. Provides opportunities for exercise and other activities

c. Provides education opportunities for family and friends

d. Provides opportunities for viewing birds and other wildlife

e. Provides enjoyable setting for entertaining friends/visitors

f. Contributes to a more relaxed, less stressful life

g. Provides destination for tourists & other visitors

h. Contributes to a feeling of belonging & appreciation of area

i. Provides opportunity to conserve the environment

j. Provides opportunity to appreciate nature and beauty

k. Provides a place to study nature and/or conduct research

l. Provides a place to spend quality time with family and friends

m. Provides opportunity to meet new people

n. Provides opportunity to relax and "get away from it all"

o. Other

(9) Using the above data to guide your discussion, identify and rank the four personal benefits that you perceive are most important to visitors.

(10) Now, again referring to the same set, indicate how significantly you feel that benefit would be impacted if a closed delivery system was implemented. Use the following:

1. = No impact – benefit is not important to me or could be easily achieved through participating in a different activity or using a different setting.

2. = Minor impact - without much difficulty I could achieve similar benefit through alternate means
3. = Some impact – achieving a similar benefit would require inconvenient changes to my life.
4. = Moderate impact - would be difficult but possible to achieve the benefit through alternate means
5. = Significant impact – could not achieve the benefit through alternate means.

a. Contributes to the character and attractiveness of this place

b. Provides opportunities for exercise and other activities

c. Provides education opportunities for family and friends

d. Provides opportunities for viewing birds and other wildlife

e. Provides enjoyable setting for entertaining friends/visitors

f. Contributes to a more relaxed, less stressful life

g. Provides destination for tourists & other visitors

h. Contributes to a feeling of belonging & appreciation of area

i. Provides opportunity to conserve the environment

j. Provides opportunity to appreciate nature and beauty

k. Provides a place to study nature and/or conduct research

l. Provides a place to spend quality time with family and friends

m. Provides opportunity to meet new people

n. Provides opportunity to relax and “get away from it all”

o. Other

(11) On average, how often would you or members of your family visit the wetland?

a. Two or more times per week (more than 100 times per year)

b. About once per week (~50 times per year)

c. About twice per month (~25 times per year)

d. About once per month (~12 times per year)

e. About four to six times per year (~ 4 to 6 per year)

f. Less than once every six months (less than 2 times a year)

(12) On average, how often would tourists or visitors to the district visit the wetland?

a. Two or more times per week (more than 100 times per year)

b. About once per week (~50 times per year)

c. About twice per month (~25 times per year)

d. About once per month (~12 times per year)

e. About four to six times per year (~ 4 to 6 per year)

f. Less than once every six months (less than 2 times a year)

(13) Do you encourage visitor use of this wetland?

(14) Other than watering stock; are money-making activities supported by the existence or use of the wetland?

(15) Estimated annual earnings of those activities

Are there any other details that you believe should be taken into consideration when analysing this information?

End of survey, thank you for taking the time to participate

SHORTENED FORMS

Units of measurement commonly used (SI and non-SI Australian legal)

Name of unit	Symbol	Definition in terms of other metric units	Quantity
day	d	24 h	time interval
gigalitre	GL	10^6 m^3	volume
hectare	ha	10^4 m^2	area
hour	h	60 min	time interval
kilolitre	kL	1 m^3	volume
kilometre	km	10^3 m	length
litre	L	10^{-3} m^3	volume
megalitre	ML	10^3 m^3	volume
metre	m	base unit	length
millilitre	mL	10^{-6} m^3	volume
minute	min	60 s	time interval
second	s	base unit	time interval
year	y	365 or 366 days	time interval

AACWMB Arid Areas Catchment Water Management Board

DEH Department for Environment and Heritage

DWLBC Department of Water, Land and Biodiversity Conservation

GAB Great Artesian Basin

GABSI Great Artesian Basin Sustainability Initiative (GABSI

EC electrical conductivity (µS/cm)

My million years

pH acidity

ppm parts per million

ppt parts per trillion

TDS total dissolved solids (mg/L)

WAP water allocation plan

GLOSSARY

Act. The ***Water Resources Act 1997*** (South Australia).

Adaptive management. A management approach, often used in natural resource management, where there is little information and/or a lot of complexity and there is a need to implement some management changes sooner rather than later. The approach is to use the best available information for the first actions, implement the changes, monitor the outcomes, investigate the assumptions and regularly evaluate and review the actions required. Consideration must be given to the temporal and spatial scale of monitoring and the evaluation processes appropriate to the ecosystem being managed.

Aquifer. An underground layer of rock or sediment which holds water and allows water to percolate through.

Aquifer, confined. Aquifer in which the upper surface is impervious and the water is held at greater than atmospheric pressure. Water in a penetrating well will rise above the surface of the aquifer.

Artesian. Under pressure such that when wells penetrate the aquifer water will rise to the ground surface without the need for pumping.

Baseflow. The water in a stream that results from groundwater discharge to the stream. (This discharge often maintains flows during seasonal dry periods and has important ecological functions.)

Basin. The area drained by a major river and its tributaries.

Biological diversity (biodiversity). The variety of life forms: the different life forms including plants, animals and micro-organisms, the genes they contain and the ***ecosystems (see below)*** they form. It is usually considered at three levels — genetic diversity, species diversity and ecosystem diversity.

Biota. All of the organisms at a particular locality.

Bore. ***See well.***

Bore-fed wetland. A wetland which is maintained by water supplied by a well.

Catchment. A catchment is that area of land determined by topographic features within which rainfall will contribute to runoff at a particular point.

Catchment water management board. A statutory body established under Part 6, Division 3, s. 53 of the Act whose prime function under Division 2, s. 61 is to implement a catchment water management plan for its area.

Catchment water management plan. The plan prepared by a CWMB and adopted by the Minister in accordance with Part 7, Division 2 of the Water Resources Act 1997.

CWMB. Catchment Water Management Board.

EC. Abbreviation for electrical conductivity. 1 EC unit = 1 micro-Siemen per centimetre (µS/cm) measured at 25 degrees Celsius. Commonly used to indicate the salinity of water.

Ecological processes. All biological, physical or chemical processes that maintain an ecosystem.

Ecological values. The habitats, the natural ecological processes and the biodiversity of ecosystems.

Ecology. The study of the relationships between living organisms and their environment.

Ecosystem. Any system in which there is an interdependence upon and interaction between living organisms and their immediate physical, chemical and biological environment.

Environmental values. The uses of the environment that are recognised as of value to the community. This concept is used in setting water quality objectives under the Environment Protection (Water Quality) Policy, which recognises five environmental values — protection of aquatic ecosystems, recreational water use and aesthetics, potable (drinking water) use, agricultural and

aquaculture use, and industrial use. It is not the same as ecological values, which are about the elements and functions of ecosystems.

Environmental water provisions. Those parts of environmental water requirements that can be met, at any given time. This is what can be provided at that time with consideration of existing users' rights, social and economic impacts.

Environmental water requirements. The water regimes needed to sustain the ecological values of aquatic ecosystems, including their processes and biological diversity, at a low level of risk.

Ephemeral streams / wetlands. Those streams or wetlands that usually contain water only on an occasional basis after rainfall events. Many arid zone streams and wetlands are ephemeral.

Floodplain. Of a watercourse means: (a) the floodplain (if any) of the watercourse identified in a catchment water management plan or a local water management plan; adopted under Part 7 of the Water Resources Act 1997; or (b) where paragraph (a) does not apply — the floodplain (if any) of the watercourse identified in a development plan under the Development Act 1993, or (c) where neither paragraph (a) nor paragraph (b) applies — the land adjoining the watercourse that is periodically subject to flooding from the watercourse.

GAB. Great Artesian Basin.

Gigalitre (GL). One thousand million litres (1 000 000 000).

GIS (geographic information system). Computer software allows for the linking of geographic data (for example land parcels) to textual data (soil type, land value, ownership). It allows for a range of features, from simple map production to complex data analysis.

GL. ***See gigalitre.***

Groundwater. ***See underground water.***

Habitat. The natural place or type of site in which an animal or plant, or communities of plants and animals, lives.

Hydrogeology. The study of groundwater, which includes its occurrence, recharge and discharge processes and the properties of aquifers. ***(See hydrology.)***

Hydrology. The study of the characteristics, occurrence, movement and utilisation of water on and below the earth's surface and within its atmosphere. ***(See hydrogeology.)***

Indigenous species. A species that occurs naturally in a region.

Land. Whether under water or not and includes an interest in land and any building or structure fixed to the land.

Licence. A licence to take water in accordance with the Water Resources Act 1997. ***(See water licence.)***

Licensee. A person who holds a water licence.

Macro-invertebrates. Animals without backbones that are typically of a size that is visible to the naked eye. They are a major component of aquatic ecosystem biodiversity and fundamental in food webs.

Megalitre (ML). One million litres (1 000 000).

ML. ***See megalitre.***

Owner of land. In relation to land alienated from the Crown by grant in fee simple — the holder of the fee simple; in relation to dedicated land within the meaning of the ***Crown Lands Act 1929*** that has not been granted in fee simple but which is under the care, control and management of a Minister, body or other person — the Minister, body or other person; in relation to land held under Crown lease or licence — the lessee or licensee; in relation to land held under an agreement to purchase from the Crown — the person entitled to the benefit of the agreement; in relation to any other land — the Minister who is responsible for the care, control and management of the land or, if no Minister is responsible for the land, the Minister for Environment and Heritage.

Pasture. Grassland used for the production of grazing animals such as sheep and cattle.

Prescribed area, surface water. Part of the State declared to be a surface water prescribed area under the Water Resources Act 1997.

Prescribed water resource. A water resource declared by the Governor to be prescribed under the Act, and includes underground water to which access is obtained by prescribed wells. Prescription of a water resource requires that future management of the resource be regulated via a licensing system.

Prescribed well. A well declared to be a prescribed well under the Water Resources Act 1997.

PWA. Prescribed wells area.

PWCA. Prescribed watercourse area.

Recharge area. The area of land from which water from the surface (rainfall, streamflow, irrigation, etc.) infiltrates into an aquifer. ***(See artificial recharge, natural recharge.)***

Rehabilitation (of waterbodies). Actions that improve the ecological health of a waterbody by reinstating important elements of the environment that existed prior to European settlement.

t to restrictions.

Riparian zone. That part of the landscape adjacent to a water body, that influences and is influenced by watercourse processes. This can include landform, hydrological or vegetation definitions. It is commonly used to include the in-stream habitats, bed, banks and sometimes floodplains of watercourses.

Seasonal watercourses or wetlands. Those watercourses and wetlands that contain water on a seasonal basis, usually over the winter/spring period, although there may be some flow or standing water at other times.

Stock use. The taking of water to provide drinking water for stock other than stock subject to intensive farming (as defined by the Act).

Surface water. (a) water flowing over land (except in a watercourse), (i) after having fallen as rain or hail or having precipitated in any another manner, (ii) or after rising to the surface naturally from underground; (b) water of the kind referred to in paragraph (a) that has been collected in a dam or reservoir.

To take water. From a water resource includes (a) to take water by pumping or syphoning the water; (b) to stop, impede or divert the flow of water over land (whether in a watercourse or not) for the purpose of collecting the water; (c) to divert the flow of water in a watercourse from the watercourse; (d) to release water from a lake; (e) to permit water to flow under natural pressure from a well; (f) to permit stock to drink from a watercourse, a natural or artificial lake, a dam or reservoir.

Underground water (groundwater). Water occurring naturally below ground level or water pumped, diverted or released into a well for storage underground.

Volumetric allocation. An allocation of water expressed on a water licence as a volume (e.g. kilolitres) to be used over a specified period of time, usually per water use year (as distinct from any other sort of allocation).

Water affecting activities. Activities referred to in Part 4, Division 1, s. 9 of the Act.

Water allocation. (a) in respect of a water licence means the quantity of water that the licensee is entitled to take and use pursuant to the licence; (b) in respect of water taken pursuant to an authorisation under s. 11 means the maximum quantity of water that can be taken and used pursuant to the authorisation.

Water allocation plan. A plan prepared by a CWMB or water resources planning committee and adopted by the Minister in accordance with Division 3 of Part 7 of the Act.

Water licence. A licence granted under the Act entitling the holder to take water from a prescribed watercourse, lake or well or to take surface water from a surface water prescribed area. This grants the licensee a right to take an allocation of water specified on the licence, which may also include conditions on the taking and use of that water. A water licence confers a property right on the holder of the licence and this right is separate from land title.

Water plans. The State Water Plan, catchment water management plans, water allocation plans and local water management plans prepared under Part 7 of the Act.

Watercourse. A river, creek or other natural watercourse (whether modified or not) and includes: a dam or reservoir that collects water flowing in a watercourse; and a lake through which water flows; and a channel (but not a channel declared by regulation to be excluded from the this definition) into which the water of a watercourse has been diverted; and part of a watercourse.

Water-dependent ecosystems. Those parts of the environment, the species composition and natural ecological processes, which are determined by the permanent or temporary presence of flowing or standing water, above or below ground. The in-stream areas of rivers, riparian vegetation, springs, wetlands, floodplains, estuaries and lakes are all water-dependent ecosystems.

Well. (a) an opening in the ground excavated for the purpose of obtaining access to underground water; (b) an opening in the ground excavated for some other purpose but that gives access to underground water; (c) a natural opening in the ground that gives access to underground water.

Wetlands. Defined by the Act as a swamp or marsh and includes any land that is seasonally inundated with water. This definition encompasses a number of concepts that are more specifically described in the definition used in the Ramsar Convention on Wetlands of International Importance. This describes wetlands as areas of permanent or periodic/intermittent inundation, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tides does not exceed six metres.

REFERENCES

Arid Areas Catchment Water Management Board, 2005. ***Draft Water Allocation Plan.*** Arid Areas Catchment Water Management Board.

Badman, F.J., 1987. ***Bore drains and the birds of inland South Australia – A study of the relationships of bore drains to native bird populations in the Far North of South Australia.*** Nature Conservation Society of South Australia.

Centre for Environmental and Recreation Management (CERM), 2002a. ***Assessing the environmental and social benefits of bore drain wetlands created by Great Artesian Basin bore water in South Australia.*** University of South Australia. Centre for Environmental and Recreation Management.

Centre for Environmental and Recreation Management (CERM), 2002b. ***Companion document to 'Assessing the environmental and social benefits of bore drain wetlands created by Great Artesian Basin Bore water in South Australia'***. University of South Australia. Centre for Environmental and Recreation Management.

Great Artesian Basin Consultative Council (GABCC), 2002. ***Great Artesian Basin Strategic Management Plan September 2000.***

Kinhill Environmental Sciences, 1998. ***Assessment of the biological, social and recreational significance of bore drains in the vicinity of Borefield B South Australia.*** Kinhill Environmental Sciences.

Williams, A., 2002. Evaluation of descriptors of the environmental attributes of Great Artesian Basin bore drains. ***University of South Australia. Masters thesis*** (unpublished).