CULTURAL FLOWS

FIELD WORK RESULTS & FINDINGS REPORT

NATIONAL CULTURAL FLOWS RESEARCH PROJECT

For First Nations People, water is a sacred source of life. The natural flow of water sustains aquatic ecosystems that are central to our spirituality, our social and cultural economy and wellbeing. The rivers are the veins of Country, carrying water to sustain all parts of our sacred landscape. The wetlands are the kidneys, filtering the water as it passes through the land.

First Nations Peoples have rights and a moral obligation to care for water under their law and customs. These obligations connect across communities and language groups, extending to downstream communities, throughout catchments and over connected aquifer and groundwater systems.

The project partners acknowledge all of the Traditional Owners across Australia who care for the waterways that sustain our Country. We pay deepest respects to their Ancestors and Elders who have protected and maintained water resources for thousands of years, and passed on the knowledge, stories and lessons through the generations.

We acknowledge the nations of Murray Lower Darling Rivers Indigenous Nations and Northern Basin Aboriginal Nations who continue to fight for their inherent right to water, and who had a pivotal role in creating and directing the National Cultural Flows Research Project.

We thank the Murrawarri and Nari Nari Nations who worked tirelessly as part of the research team to develop the cultural flows assessment approaches for this project.

This report has been prepared by Rural Solutions South Australia for the Cultural Flows Planning and Research Committee as part of the National Cultural Flows Research Project, developed by and for First Nations with the aim of helping to embed First Nations' water allocations in Australia's water management framework. Funding for the Research Project has been generously provided by the Murray Darling Basin Authority, the Commonwealth Environmental Water Office, the National Water Initiative, and the Department of Families, Housing, Community Services and Indigenous Affairs. Report authored by Dr John Mackenzie, Dr Rhonda Butcher, Dr Chris Gippel, Peter Cottingham, Rowena Brown, Klynton Wanganeen, Thomas Kloeden and Tamarind Meara.

Cover photo: Arthur Mostead – Gurra Gurra Creek near Berri SA, courtesy of Murray-Darling Basin Authority. Artwork 'Cultural flows' by Luke Penrith. Cover graphic design by Mazart Design Studio.

Key Acronyms and Abbreviations

AEO	Aboriginal environmental outcomes
AHD	Australian height datum
AIATSIS	Australian Institute of Aboriginal and Torres Strait Islander Studies
ANOSIM	Analysis of Similarities
CAL	Cultural Access Licence
CEWH	Commonwealth Environment Water Holder
CEWO	Commonwealth Environmental Water Office
EPBC Act	*Environmental Protection, Biodiversity and Conservation Act 1999 Cwth*
IPA	Indigenous Protected Area
MDBA	Murray Darling Basin Authority
MERI	Monitoring, Evaluation, Reporting and Implementation
MNDWI	Modified Normalized Difference Water Index
NBAN	Northern Basin Aboriginal Nations
MLDRIN	Murray Lower Darling Rivers Indigenous Nations
NAILSMA	North Australian Indigenous Land and Sea Management Alliance
NCFRP	National Cultural Flows Research Project
NEP	Nation Engagement Plan
NNTC	National Native Title Council
NPWS	National Parks and Wildlife Services
NSW	New South Wales
OEH	Office of Environment and Heritage
OLI	Operational Land Imager
RSSA	Rural Solutions SA
SSMI	Single Site-Multiple-Intervention
Spp.	Species
TAK	Traditional Aboriginal Knowledge
TOA	Top-of-Atmosphere
TIRS	Thermal Infrared Sensor

EXECUTIVE SUMMARY

The National Cultural Flows Research Project ("the Project") is a national research project driven by and for Aboriginal people. The project aim is to secure a future where Aboriginal water allocations are embedded within Australia's water planning and management regimes, delivering cultural, spiritual, social, environmental and economic benefit to communities in the Murray-Darling Basin and beyond (NCFRP 2014).

This research relies on the participation of members of the Aboriginal Nations at two case study sites within the Murray Darling Basin to investigate and measure the cultural values of water to Aboriginal people. The Project will assess both tangible and intangible facets of water delivered to achieve cultural outcomes, with the primary focus of developing methodologies that will record and assess Aboriginal cultural values and uses regarding watering requirements.

This report expands upon the methodological and preliminary research information published in previous Project Reports (see NCFRP 2016b, NCFRP 2016c, NCFRP 2016d, NCFRP 2016e, NCFRP 2017b, NCFRP 2016g, NCFRP 2016h, NCFRP 2016i and NCFRP 2017a). In particular, the reports covering the assessment of cultural water values, development of the monitoring framework and the planning for implementation of a cultural flow trial (noting a flow trial was not conducted during the field work as originally planned) are particularly salient to the results presented here.

This report documents the methodological approach and outcomes of the field research undertaken as part of Component Three of the project from July to December 2016. During this period, the project team and Research Partners for the Toogimbie Indigenous Protected Area (IPA) and Gooraman Swamp case study sites worked together in order to:

- Establish cultural flow objectives for the sites including measurable ecological and socio-cultural targets.
- Develop ecological and socio-cultural monitoring frameworks to assess the benefits of a cultural flow allocation.
- Undertake ecological and socio-cultural baseline assessments at both sites. And
- Develop an implementation plan for a cultural flow watering trial at Toogimbie.

Due to the intervention of a natural flooding event at the Toogimbie IPA site, the scheduled flow trial and associated assessment activities could not be undertaken as originally planned. Instead, a post-flood environmental assessment was undertaken which enabled the before and after effects of the flood to be compared.

Key findings

- **The process of defining the water requirements for a cultural flow is tantamount to enabling Aboriginal water management**. This remains a core goal of national water reform. Enabling Aboriginal water management through the mechanism of a cultural flow creates legitimacy for Aboriginal water management objectives that are otherwise marginalised in water planning decisions.

- **There are important similarities between the ecological outcomes from a natural flooding event and the intended Aboriginal Environmental Outcomes (AEO) from a planned cultural flow.** The post-flood monitoring of ecological outcomes showed a reduction in exotic vegetation species, significant improvements in lignum health and an

increase in bird activity at the site. These results are consistent with the confirmed cultural objectives and intended AEO and serve to demonstrate the beneficial outcomes from cultural watering at the site and from Aboriginal water management objectives generally.

- **The participatory research process itself improved Research Partner/s knowledge and confidence in the management of Country, and contributed directly to methods for use and protection of Traditional Aboriginal Knowledge (TAK),** and to new monitoring techniques and reporting protocols for capturing the ecological and social benefits of Aboriginal water management. These outcomes were evident despite the absence of cultural water at either case study site.

- **The process assisted Research Partners in surfacing TAK, which is consistent with the cultural regeneration experienced in other Aboriginal communities as a consequence of access to land**. Activities connected to "bringing Country back" have been shown to have corresponding regenerative effects on landscapes, cultural practice, knowledge exchange, health and even language. Cultural regeneration has direct and demonstrable flow-on effects linked to increased confidence, capacity and self-reliance that comes with access to Country. Cultural water access appears to promote the same outcomes.

National Implications

The process used to establish cultural flow objectiveswith the Research Partners in planning, monitoring and assessment activities provides salient lessons for the development of a nationally consistent methodological framework for establishing cultural flow entitlements. These lessons include:

- **Cultural flow planning is an intensive engagement process**. Setting cultural flow objectives requires significant investments of time, at least partially as a result of integrating information from multiple technical and cross-cultural perspectives in order to arrive at a consensus position. This process is compounded when the feasibility of flow objectives is contested.

- **The framework may need to accommodate procedures for the resolution of disputes** in instances where there is disagreement regarding the management objectives for the cultural water. The extensive process of objective setting demonstrated the potential of conflicting knowledge and values and the irreducible presence of uncertainty in water planning and decision-making can limit consensus and stall the process.

- **Aboriginal people around the Country will need to be resourced appropriately, including via dedicated capacity building investment, to facilitate the implementation of cultural water management**. This investment will have direct, measurable benefits on the quality of life of Aboriginal people. Resourcing for informed participation assists in reducing the need for conflict resolution.

- This research has confirmed **the need to prioritise TAK in the ecological characterisation research nationally.** TAK has clear value to the management of water resources generally, and especially in the context of climate change and adaptation.

- This research has shown that the **methods for cultural water planning are available, and can be drawn and adapted a range of tools associated with water management** from non-Aboriginal contexts, including the Monitoring, Evaluation, Reporting and

Improvement (MERI) framework, program logic and tools and methods adapted from participatory environmental monitoring.

- Ongoing cultural flow research presents **an important opportunity to work with Aboriginal Research Partners across the country to identify ways that these tools can be adapted and shared to further contribute** to an ongoing national cultural water management framework dialogue.

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1 INTRODUCTION

1.1 Background / overview of NCFRP

The National Cultural Flows Research Project ("the Project") seeks to trial, evaluate and recommend rigorous and defendable methods and knowledge for water reform with the aim of securing water entitlements for the benefit of Aboriginal people across Australia - it's driven by Aboriginal people for Aboriginal people NNTC, 2014).

This research relies on the participation of members of the Aboriginal Nations as Research Partners at two case study sites both within the Murray Darling Basin to investigate and measure the cultural values of water for Aboriginal people. Case study sites include:

- Toogimbie Indigenous Protected Area (IPA) Wetlands, near Hay New South Wales (NSW).
- Gooraman Swamp, near Weilmoringle in far north western NSW.

The project has drawn on a range of scientific research methodologies and generations of cultural knowledge to:

1. Provide Australia with a greater understanding of Aboriginal values relating to water and other natural resources.
2. Provide Aboriginal people with information to ensure that Aboriginal water requirements and preferences can be reflected in water planning and management policy.
3. Inform the development of new governance approaches to water management that incorporate aspects of Aboriginal governance and capacity building.

To achieve this, the Project originally aimed to assess both tangible and intangible facets of water delivered to achieve cultural outcomes, with the primary focus of developing methodologies that will record and assess Aboriginal cultural values and uses regarding watering requirements. This information will be used as an evidence base to demonstrate the range of environmental and public benefit outcomes that can be attained through the establishment of an allocation for "cultural flows" under a statutory water plan.

The definition of "cultural flows" that has been adopted for the purposes of the Project was endorsed by representatives from 31 Aboriginal nations at a joint meeting of the Murray Lower Darling River Indigenous Nations (MLDRIN) and the Northern Basin Aboriginal Nations (NBAN) and presented in The Echuca Declaration, September 2010 as:

> *"…water entitlements that are legally and beneficially owned by the Indigenous Nations of a sufficient and adequate quantity and quality to improve the spiritual, cultural, environmental, social and economic conditions of those Nations. This is our inherent right".*
>
> - The Echuca Declaration (MLDRIN 2007)

The research approach is built around a water planning and adaptive management framework, combining cultural, ecological and hydrological components. The long-term view is that the information collected from this project will inform future Australian water resource planning and implementation processes more generally and will provide further evidence for a proposed National Cultural Flows Framework. Critically, this work will seek to address the gap between the accumulating knowledge and understanding of water-related values and practices, and the limited capacity for this knowledge to translate into substantive water planning or management initiatives for the protection and enhancement of these identified values.

Oversight of the Project is by the National Cultural Flows Planning and Research Committee (the Research Committee). The Research Committee represents its member organisations: MLDRIN; NBAN and the Northern Australia Land and Sea Management Alliance (NAILSMA) along with representatives from the office of Commonwealth Environmental Water Holder (CEWH), Murray Darling Basin Authority (MDBA), National Native Title Council (NNTC) and nominated state government agencies.

Established in March 2011, the Research Committee has an ongoing role to ensure that the research meets the needs of Aboriginal people and organisations, is conducted with the Free, Prior and Informed Consent (FPIC) of Aboriginal participants and has regard to Aboriginal decision-making processes. The Project, as originally designed by the NCFRP consisted of the following components (NCFRP 2014):

- **One**: Describe the Aboriginal cultural water values and needs across Australia (completed January 2014).
- **Two**: Develop and use methodologies to describe and measure the cultural water uses, values and needs of particular Australian Aboriginal communities.
- **Three**: Quantify water volumes to meet cultural values and needs (both Murrawarri and Nari Nari) and scientific assessment of a trial flow at Toogimbie IPA Wetlands.
- **Four**: Develop and implement a monitoring methodology of the ecological and socioeconomic, health and wellbeing outcomes of cultural flows and analyse how they compare with environmental flow outcomes.
- **Five:** Recommend policy, legal, and institutional changes that will enable the implementation of cultural flows.
- **Six**: Building the capacity of Aboriginal organisations to build support for cultural water provisions and to implement recommendations for improved local and national water management, planning, policies and laws.

1.1.1 Our Scope

As part of a multidisciplinary team, Rural Solutions SA was engaged to deliver Components Two, Three and Four of the Project; working with the Research Committee, case study nation Research Partners and Authorised Knowledge Holders to develop modelling methodologies and watering strategies that can act as a rigorous evidence base for future cultural flow needs assessments. Key deliverables included:

- Development and implementation key plans to inform how the project will be delivered.
- Development and use of a set of methodologies at each case study sites that:
    - Determine the historical and contemporary cultural uses and values of water.
    - Provide an authoritative basis from which to determine volumetric requirements and develop indicators and baselines for measuring the impacts of cultural flows at the sites.
- Quantification of water volumes and flow regimes required to meet the uses and values identified by each case study Nation, by:
    - Conducting a trial flow at Toogimbie IPA Wetlands.
    - Conducting hydrological modelling at Toogimbie Wetlands and Gooraman Swamp.

- Development and implementation of a monitoring methodology of the ecological and socio-economic outcomes of cultural flows, and analyse how they compare with environmental flow outcomes (this report).
- Preparation of a Draft National Cultural Flows Assessment Report, including a proposed Framework to provide a step by step guide to the decision making process for planning, water delivery and assessment of a cultural flow for national application.

1.2 About this Report

This report forms part of the suite of deliverables comprising Component Three of the Project, and documents findings from the field research, including ecological and socio-cultural monitoring, conducted to specify or quantify cultural water volumes to meet the cultural water needs of the two case study communities. Other previous reports that inform this work include:

- National Cultural Flows Research Project Engagement Strategy (NCFRP 2016b).
- Nari Nari and Murrawarri Nation Engagement Plans (NCFRP 2016g and 2016i).
- Aboriginal Water Interests for Establishing Cultural Flows (NCFRP 2016c).
- Gooraman Swamp and Toogimbie Cultural Flow Monitoring and Evaluation Plans (NCFRP 2016d and 2016e).
- Toogimbie and Gooraman Swamp Ecological Characterisation Report (NCFRP 2017a).
- Hydrological and hydraulic modelling report (NCFRP 2017b).
- Various Field Work Results and Findings Report.

This report presents initial implications to inform development of a national framework for cultural flows. These will be further refined as part of a the subsequent stages of the research (Component Four) to determine water requirements to support cultural values applicable across a range of water planning and management contexts. Component Four will be conducted from April to October 2017.

Table 1 outlines the research activities and steps undertaken in the preparation of this report.

Table 1: Research objectives, stages and activities for the field work results and findings report

Research Objectives	Activities Conducted
Undertake baseline condition monitoring	• Trial the draft cultural flow assessment methodology to record a baseline assessment of the conditions of the trial sites. • Conduct baseline condition monitoring (aligned to the Research Partner nominated indicators) at case study areas.
Implement watering trial at Toogimbie and associated assessment	• Engage Research Partners at Toogimbie to assist with design and implementation of assessments prior to the delivery of flow where appropriate (to describe pre-flow conditions) and after the cultural flows (to assess outcomes). • Engage with the Key Nation Contacts to identify opportunities for work experience in use of sampling design, sampling frequency and methods, and data management options. This would include two-way capacity building. • Undertake post flow assessments of the cultural and wellbeing outcomes of the watering trial at Toogimbie using the trial

	methodology. The methodology will be evaluated, reported, and improved in an adaptive management process. • Use the results from the Toogimbie watering trial to refine hydraulic and conceptual models as required
Report field work results and findings	• Document the methodology of the planned watering trial (Toogimbie IPA), baseline assessment (Gooraman Swamp) and field work findings (this report).

1.2.1 Key Considerations

This report varies from the original Project plan (NCFRPa) in two important ways.

1. The report was originally intended to only report on the flow trial at Toogimbie. However, given the importance of the information gathered to date and the implications of the field work at the Gooraman Swamp case study, this report has been consequently expanded to include the findings from the field work conducted at Gooraman Swamp. This information is primarily associated with baseline monitoring undertaken by Research Partners and the Project Team at the site.

2. The flow trial intended for the Toogimbie case study was abandoned as a consequence of a major natural flood event in the Murrumbidgee River at the time of the scheduled trial. The natural flood inundated much of the area intended to receive the cultural flow in the trial, and was a larger volume of water than the amount that had been intended for the flow trial.

Although the field trial application of a cultural water allocation was not undertaken, a pre-trial or baseline survey of cultural and ecological values was undertaken, creating the opportunity to measure the impact of a major natural flood as an alternative exercise. The intervention of a flood event made it impossible for the flow-trial to proceed as planned, and as such, this report has been adapted to be more accurately described as a before and after flood study at the Toogimbie site. The value of the revised report is in its ability to demonstrate the change of conditions resulting from a natural flow event, with some critical correspondence with the identified cultural flow objectives.

1.3 Report structure and purpose

This report is divided into four main components:

1. **Cultural flow planning:** this section reviews the information and demonstrates the process by which Research Partners at both case study sites established a consensus view of cultural flow objectives and how these objectives can be used as the basis for determining cultural water requirements. This section has **direct relevance for the development of a proposed national cultural flows framework** (to be developed as part of Component Four of the project).

2. **Field work and changes to the project outcomes:** this section provides some background to the flood event that led to the abandonment of the field trial at the Toogimbie IPA. Additionally, this section describes the hydraulic and hydrological characteristics of the natural flood event and how it differed from the intended application of a cultural flow

under the trial. The flood also provided an opportunity to **validate some aspects of the performance of the hydrological and hydraulic models** associated with natural overbank processes.

3. **Results:** these two sections report on the findings from each case study site in terms of establishing **cultural flow objectives and ecological and socio-cultural monitoring** and assessment associated with cultural flows. The Toogimbie case study also provides an overview of additional planning and implementation requirements associated with the delivery of a cultural flow in a trial scenario.

4. **Evaluation:** the final section examines the learnings from the field work and forwards a series of recommendations to consider in the next stage, **a proposed national cultural flows framework**. These recommendations will be considered in the final report for Component Four of the Project (but are presented here to provide an initial update of that work in progress).

1.4 Definition of cultural flows

The current accepted definition of cultural flows, and the definition adopted in the Project, is:

> *"Water entitlements that are legally and beneficially owned by Indigenous Nations of a sufficient and adequate quantity and quality to improve the spiritual, cultural, environmental, social and economic conditions of those Indigenous Nations. This is our inherent right". (MLDRIN 2007)*

This definition was endorsed by representatives from 31 Aboriginal Nations at a joint meeting of MLDRIN and NBAN under the Echuca Declaration in September 2010. This definition identifies the two (2) core requirements of a cultural flow:

1. That the entitlement be legally and beneficially owned by Aboriginal Nations, and
2. That the use of the water be unrestricted other than determined by those nations to improve quality of life for Aboriginal people.

> *"Cultural Flows are water rights that we hold in our own name and are not held in trust by Government AND provide us with enough clean water to improve all parts of our lives.*
>
> *Our lives will be improved by cultural flows if: the rivers and creeks get a proper amount of water at the right times; the health of our spirit, body and mind is improved and strengthened - the land, water and people are one; if our Country is healthy enough that we can look after and use our Country according to our culture…; recognition by all Australians that this is our Country and that we need to be listened to when we talk about our Country.*
>
> *We are the only ones who can decide if our Country and our lives have improved."*
>
> *– Plain English Definition of Cultural Flows, Echuca Declaration (MLDRIN 2007).*

The current approach to cultural flows reflects the needs of Aboriginal communities to have their interests and rights in water given the commensurate status and security of legally enforceable tenure granted to other consumptive water users, rather than being defined on the basis of environmental or cultural heritage requirements (non-consumptive uses). This approach refutes

the assumption that Aboriginal water are limited to environmental or cultural heritage interests, and more appropriately reflects the diversity of Aboriginal water interests. For example, Aboriginal interests include commercial interests that Aboriginal communities may have in developing water resources or in participating in water markets and trading. This approach would establish cultural flow allocations that could be temporarily traded when water was not required, or to provide water access to Aboriginal communities downstream, subject to the discretion of the Aboriginal water entitlement holder.

The current definition of cultural flows is also used to mark the distinction between outcomes for Aboriginal people derived from environmental water as opposed to cultural water. The term "Aboriginal Environmental Outcomes" (AEO) is used to capture the benefits to Aboriginal people obtained intentionally or incidentally as a consequence of environmental flows or environmental water. Some of the values that Aboriginal people have may be protected or enhanced by environmental flows, and this highlights the importance of including Aboriginal people in environmental flow assessment and in ongoing environmental water management. For example, environmental flows may be used to increase populations of culturally significant fish species or be used to ensure the continued health of vegetation species in key water sites. These outcomes are not assured in the setting or management of environmental flows in the absence of adequate Aboriginal participation.

However, as illustrated in Figure 1, Aboriginal environmental outcomes are conceptually distinct from cultural flows. It includes the role of custodians ensuring the balance of all things remains as made by the creator as per creation stories. As such, Aboriginal environmental outcomes are considered part of cultural obligations to the creator. Other components are the continuation of creation stories through Lore - song, dance, ceremony, art, trade, and marriage. The tangible physical benefits to community and Country is a result of the whole, which includes spirituality.

> *That spiritual connection is hard to explain under this system. Because the environmental system is about the ecology. This is about the spirit. So that's our religion to a certain extent. Part of our religion. That would be the equivalent of a church - kind of. That would be connected to other stories as well. That's why this research is important, because of what it can show. F.Hooper pers. comm. 2015 (Key Nation Contact, Murrawarri Provisional Council of State)*

Cultural flows are water entitlements legally owned and beneficially managed by Aboriginal Nations. This water may be used to assist in the achievement of AEOs, but this is entirely at the discretion and according to the needs of each Aboriginal Nation itself. Under this approach, if the cultural flow entitlement is managed in such a way as to accrue an economic return, that return will be obtained by the Aboriginal Nation holding the property right in the water entitlement.

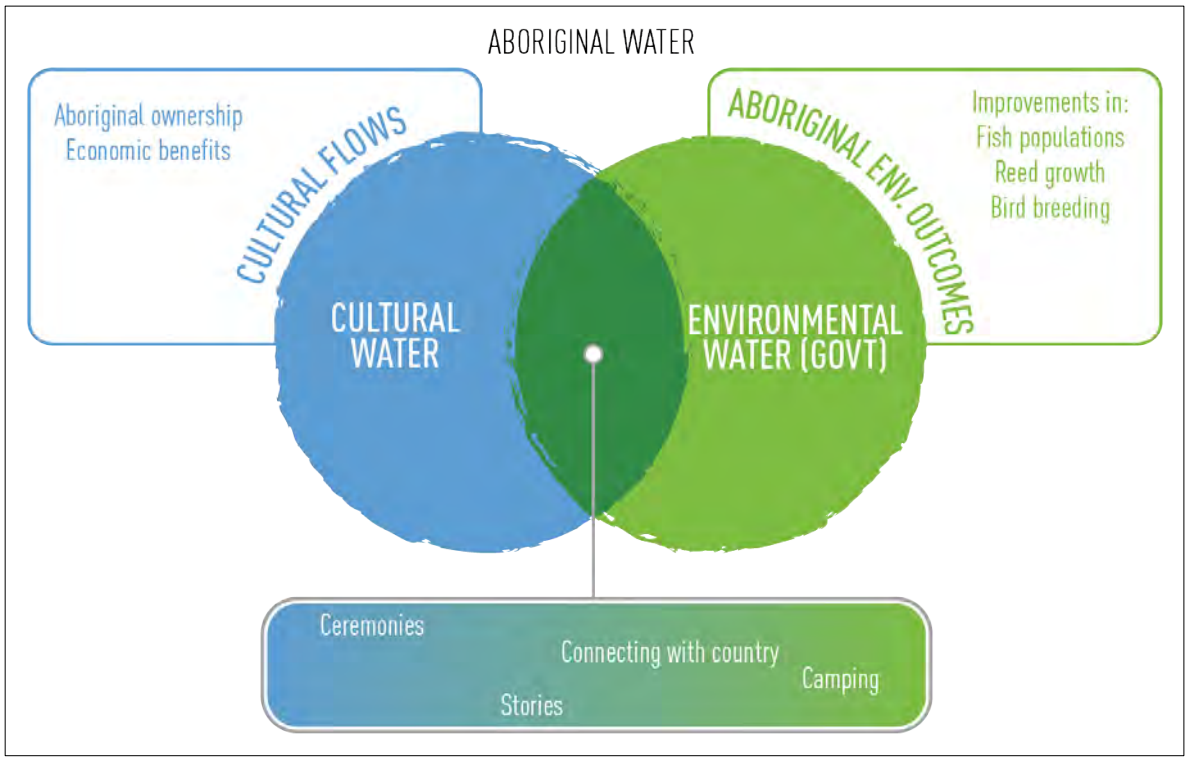


Figure 1: Distinction between environmental and cultural water (MLDRIN 2010)

It is noted that the ownership and control of a cultural flow water entitlement leads to specific and measurable benefits of Aboriginal people in and of itself. For example, there are identified identity, esteem and empowerment benefits associated with the increased capacity to fulfil cultural obligations to care for and manage Country. Similarly, the increased visibility as a recognised and valued stakeholder by government and others involved in water management has flow-on benefits for governance, planning and leadership. When understood in the context of potential economic returns from the entitlement, the full value of cultural flows, including but not limited to the environmental value, for Aboriginal households, communities and Nations becomes apparent.

The Echuca Declaration (MLDRIN 2010) provides additional guidance on the process for determining the water requirements of Aboriginal communities. Under this approach, the pivotal objective in determining the quantity and appropriate mechanism for water entitlements acquired and transferred to the Aboriginal Nations for cultural flows must be sufficient to ensure that Aboriginal Nations can achieve substantial and measurable cultural flow outcomes. This report demonstrates the process by which these cultural flow outcomes were determined in two, distinct, case study scenarios – Toogimbie IPA and Gooraman Swamp.

1.5 Links to environmental flows

Most environmental flow methodologies currently applied in Australia would be considered holistic by the users, even though they might often focus on a limited range of ecosystem components, or use a limited number of key ecological assets (sites, communities or species) to represent the needs of entire river systems. Most holistic environmental flow methodologies take an ecological asset-based approach. Ecological asset-based policies focus on protecting key identifiable assets such as biodiversity, threatened species, native species, species of high conservation value, certain habitats, areas of high conservation value, ecosystem services, or the

relative health of ecosystems. While no consistent and clear definition of ecological assets has yet emerged in the literature, it is commonplace for policy documents to refer to 'key' or 'significant' ecological assets. As implied by the terminology used, ecological asset-based environmental flow methodologies do not usually include social, economic or cultural values among the assets. An implicit assumption is that social, economic or cultural values that depend on an ecologically healthy river are provided for by the environmental flow. In practice, this might not be true, as the environmental flow assessment process might recommend pursuit of a level of river health that is distant from the purest definition of ecological integrity. This approach to environmental flow assessment does not necessarily exclude social, economic or cultural water requirements. They could be included in a post-assessment trade-off phase that considers the impact of the recommended environmental flow regime on other users.

At any site, the likelihood of cultural water needs being met by an environmental flow allocation (assuming one is available) depends to a large degree on whether Aboriginal Nations and their cultural values were included in the assessment that defined the environmental flow needs. Inclusion of 'human livelihoods and well-being that depend on these ecosystems' as a value or demand for environmental water is common in South Africa, but assessments in Australia usually focus on biological, chemical and physical ecosystem components and processes. This is despite cultural water needs technically falling within the scope of environmental flows as defined by the 'Brisbane Declaration on Environmental Flows'[1], proclaimed at the 10th International River symposium and International Environmental Flows Conference, held in Brisbane, Australia, on 3 to 6 September 2007:

> "*Environmental flows describe the quantity, timing, and quality of water flows required to sustain freshwater and estuarine ecosystems and the human livelihoods and well-being that depend on these ecosystems*".

Assuming that cultural values are not usually included in the assets targeted by an environmental flow allocation, satisfaction of cultural water needs would be an incidental benefit of an environmental flow allocation.

A comprehensive scientific investigation of how well environmental flows meet cultural water needs of a particular site requires availability of two independent assessments undertaken using standard methodological practice, one for cultural flows and one for environmental flows. The Project undertook cultural flow assessments at Toogimbie IPA and Gooraman Swamp, and while the objectives included protection of what might be considered ecological assets in the context of an environmental flow assessment, independent environmental flow assessments were not undertaken at these sites. Therefore, it was not possible to make a direct comparison of environmental flow and cultural flow needs of the two sites.

In the absence of a mechanism to allocate water for the specific purpose of meeting cultural needs, an Aboriginal community could potentially seek an allocation under the existing framework for provision of environmental water, in the hope that cultural water needs could be incidentally met. However, a limitation is that the intended benefit of the water would need to be couched in terms of environmental assets, as environmental water is usually held and applied exclusively for the purpose of achieving environmental objectives. For example, all Commonwealth water use must contribute to the achievement of one or more of the following objectives:

- To protect and restore water-dependent ecosystems of the Murray-Darling Basin.
- To protect and restore the ecosystem functions of water-dependent ecosystems.

[1] URL: http://www.watercentre.org/news/declaration (accessed 2 February 2017).

- To ensure water-dependent ecosystems are resilient to climate change and other risks and threats.
    - (Commonwealth Environmental Water Office 2013, p. 24; see also pp. 22-23)

The target assets for Commonwealth water are specifically ecological in nature: "*threatened species and ecological communities, and listed migratory species; and the ecological and conservation values of the assets(s)…*" (Commonwealth Environmental Water Office 2013, p. 25). Among the seven categories of expected outcomes of application of Commonwealth water, one mentioned cultural benefits, but only as a supplementary benefit: "*the potential ancillary social, cultural and economic benefits from undertaking the watering action*" (Commonwealth Environmental Water Office 2013, p. 25). Thus, under current policy, using environmental water allocations for the purpose of indirectly meeting cultural water needs would be a haphazard approach.

1.6 Project Methodology

The overall methodology for the Project was intended to achieve four specific outcomes in the case studies and field research:

1. To achieve an understanding of the historical and contemporary cultural uses and values of, and cultural aspirations for, water at the two case study sites, such that the uses, values and aspirations can be appropriately represented.
2. To describe connections between the hydrological regime, water availability and cultural practices and aspirations at the case study sites.
3. To develop rigorous and defensible methodologies to describe and quantify these water uses and values to enable an integrated assessment of the resource and facilitate hydrological modeling. And,
4. To contribute to a monitoring and evaluation framework that can be used to measure the effectiveness of the cultural flow implementation.

A key outcome from the Project overall is to present a method capable of application on a national scale to support Aboriginal people to define their own cultural flow requirements. To fulfil this overarching objective, the method has prioritised:

- Transparent and replicable techniques for the identification and quantification of uses, values and aspirations.
- Effective integration within the water planning regime and with other technical assessments informing management objectives.
- Monitoring and evaluation methods conducive to participatory monitoring and evaluation in terms of accessibility, ease of use and cost-effectiveness. And,
- Quantifiable targets, standards and indicators that can be used to evaluate the success of cultural flow objectives.

1.6.1 Aboriginal research and engagement approach

Both the methodology documented in this report (and the engagement practice associated with the Project more generally) is informed by a commitment to best practice in Aboriginal research and engagement. This includes: a strictly upheld requirement of Free, Prior and Informed Consent (FPIC) for all Research Partners; Intellectual Property (IP) protection; capacity building; and the purposeful pursuit of research outcomes that explicitly benefit Aboriginal people in response to needs identified by Aboriginal people.

1.6.2 Participatory Action Research (PAR)

The research includes the application of PAR principles, a research process that recognises and respects Aboriginal peoples' rights, responsibilities and ownership of the research. Under a PAR methodology, all participants in the research process, including Research Committee members, case study partners and technical advisers, co-generate knowledge through collaborative communicative processes and through the joint implementation of findings. This approach treats the diversity of experience and capacities within a group as an opportunity for enriching both research and action, and encourages research that is widely inclusive and builds shared ownership of the process and findings. As collaborators and partners, participants in the research have informed project design, consultation and monitoring methods and had direct input into the processes used in field research activities documented in this report.

PAR consists of three recurring stages: inquiry, action, and reflection. Through the cycle of these stages, the knowledge and understanding gained in the inquiry process lead to social action, and reflections on this action lead to construction of new understandings, forming the basis of new areas of inquiry. PAR is a process for change and emergence, driven by those most affected by the topic, where the researchers become facilitators of social learning and dialogue, rather than experts or possessors of privileged knowledge.

In this process the Research Committee, Project Team, Research Partners are equal partners in the research process. Our commitment to PAR principles is reflected in the approach which has prioritised:

- Engaged enquiry with the Aboriginal and other Research Partners as co-researchers.
- A flexible and responsive process that may encompass building trust and developing a common understanding.
- Collaborative identification of the research problem, preferred methods of gathering data, and interpreting meaning. And,
- Achieving a beneficial outcome that meets the needs of the Traditional Owners.

Table 2: PAR design principles

Objectives	PAR Design Principles
Building social learning	1. The process should recognise the cultures, livelihood, identity and values of partners. 2. The process should create prospects of gain and incentives for participation.
Meaningful participation	3. Participation is voluntary and provided on the condition of free, prior and informed consent. 4. The process should offer participants an exit option. 5. The process should enhance and build the skills, knowledge and capacity of participants through targeted capacity building and engagement activities.
Time and resource responsiveness	6. Stakeholders should be engaged early in the pilot process. 7. The roles of all Research Partners, including their risks associated with their participation, should be clear and transparent. 8. How the information and knowledge generated by the Project will be used, and for what purpose should be agreed to prior to any further steps in the process.

	9. Time and resource commitments of stakeholders should be outlined before participation. 10. The process should be time and cost effective.
Relevance to Aboriginal people	11. The process should act to strictly protect intellectual and other property rights of Aboriginal people. 12. The process should respond to needs explicitly identified by Aboriginal people. 13. The outcomes from the process should have direct and demonstrable benefits for Aboriginal people.

1.6.3 Broader application of the methodology

Limitations to the further application of this methodology beyond the life of this Project relate to the high level of resource requirements associated with both Aboriginal research and PAR. The PAR method is time and resource intensive, and is highly dependent upon capacity building and the development of effective working relationships between participants. The form of community engagement required by this approach places a much higher emphasis on the provision of information, early engagement, agreed objectives and transparency of process than would typically be required of other water planning initiatives. Similarly, the context of the case study locations for this project were especially conducive to this methodological approach. In both of the case studies for this project, the Aboriginal community have access to land holdings where a water entitlement can be used, an ongoing cultural connection to Country and to cultural management practices of the Country, and well defined authority and established within the community for decision-making on water matters. Under these conditions, the proposed method has been applied successfully to date. However, refinements to the method may be required in circumstances where:

- The Aboriginal community does not have access to security of land tenure.
- Ongoing cultural connections to Country and to the management of Country have been compromised by dislocation and dispossession of Traditional Owners.
- Traditional Owners with authority to speak about water are remote or otherwise difficult to locate.
- The community has limited experience with natural resource planning and management, or limited capacity to participate in resource management planning activities. Or,
- Research and planning associated with cultural water may impact on native title determinations or other legal proceedings.

1.6.4 Case study Site Selection

In November 2015 two (2) case study sites were selected and confirmed by the Research Committee for the Project:

1. **Toogimbie IPA** near Hay is the selected site within the MLDRIN area. And,
2. **Gooraman Swamp** near Weilmoringle is the selected site within the NBAN area

The two sites were selected as a point of contrast and comparison in a regulated and unregulated system respectively. The case study sites for the Project are shown in Figure 2 and Figure 3.

Figure 2: Location of Toogimbie Case study site in relation to topographic features

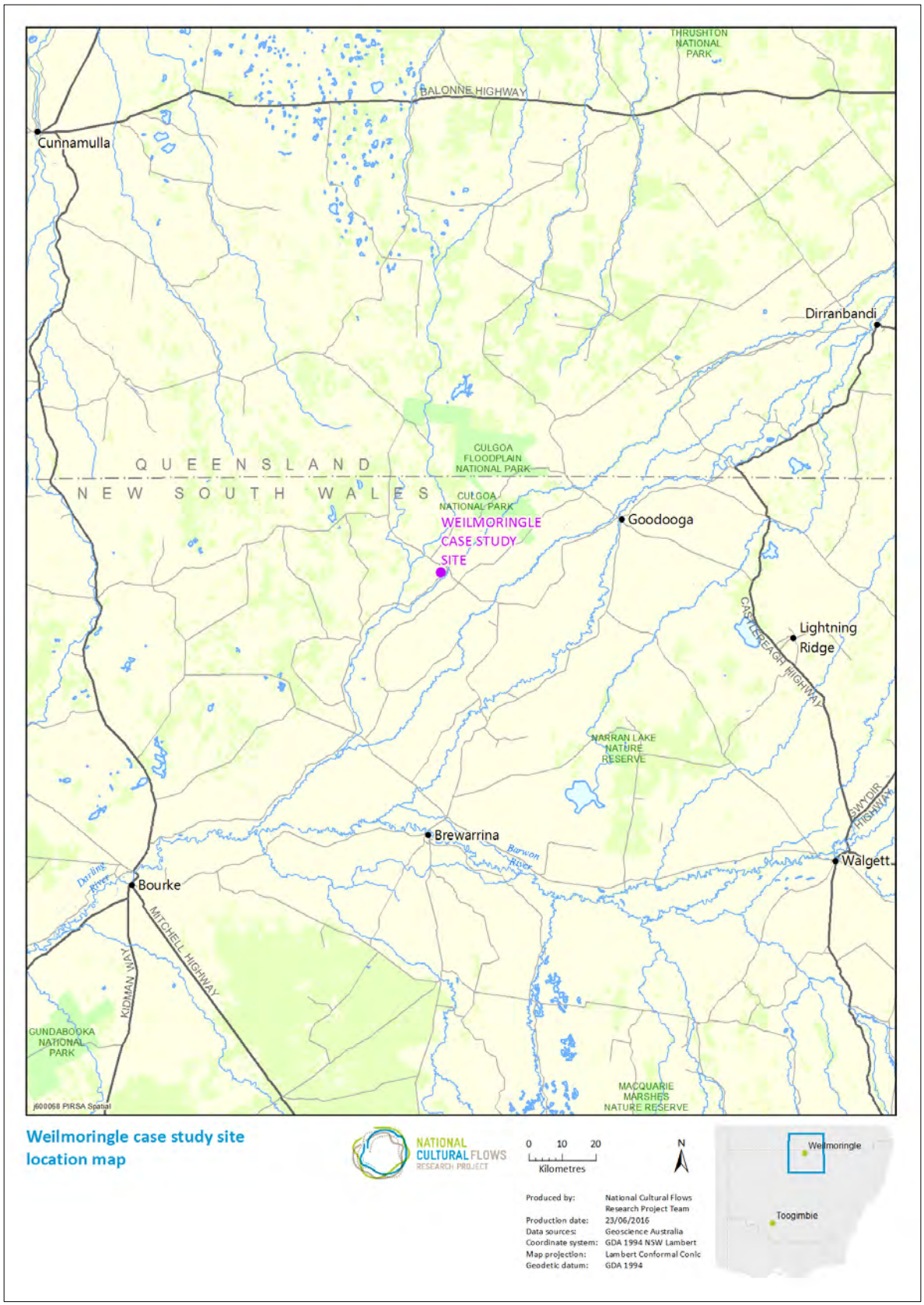


Figure 3: Location of Gooraman Swamp (at Weilmoringle) case study site in relation to topographic features

2 CULTURAL FLOW PLANNING

2.1 Establishing relationships with communities

This research utilised a participatory approach supported by a collaborative research agreement in the form of a Nation Engagement Plan (NEP). Drawing on the overarching NCFRP communication and engagement strategy, the NEP provided a guide for the meaningful and practical engagement between the project team, Research Partners and Authorised Knowledge Holders at each case study site. Integrating cultural protocols and guidelines, such as the Australian Institute of Aboriginal and Torres Strait Islander Studies (AIATSIS) Guidelines for Ethical Research in Australian Indigenous Studies and FPIC, each NEP covered the following:

- Management of cultural and IP;
- Agreed principles, protocols, roles and responsibilities;
- Communication, capacity building and remuneration;
- Activities, schedule and requirements; and
- Monitoring and evaluation of services.

The NEP process provided a platform for the project team and Research Partners to collaboratively address any concerns early and build the foundation for a strong relationship and mutual understanding for the latter stages of the project.

2.2 Engaging Research Partners

Developing strong relationships with the Research Partners and Authorised Knowledge Holders of each case study site was critical to the successful completion of the preliminary flow trial planning and site assessments. Drawing on the agreed NEP, the project team, led by the project manager, conducted a series of phone meetings during the project conception and inception stages to establish a clear and transparent flow of communication. From these initial meetings, site visits were scheduled and conducted with the Research Partners, project team and research manager at each site. During these early meetings and site visits, the principles and critical process of obtaining of FPIC was carried out.

Between site visits and key project milestones, informal meetings and conversation were conducted on an ad-hoc basis to allow the Research Partners to contribute to the research process and where necessary make informed decisions before progressing to the next phase of the program.

The first site visits focused on providing the Research Partners and Authorised Knowledge Holders with the opportunity to consider the purpose of the project, the research (how it would be done), their aspirations for the planned flow trial (or in the case of Gooraman Swamp a potential flow) and contributing to the national discourse on Aboriginal water rights, planning and policy. The subsequent site visits focused on building Research Partner capacity through monitoring agreed ecosystem specific ecological and social indicators.

At the conclusion of each site visit, the key messages and results were consolidated and shared with the Research Partners for input and approval (where necessary). Through this collaborative process, the values, aspirations and objectives for the project were revised and refined. The applied engagement approach is provided diagrammatically in Figure 4 below.

"The engagement approach of the project has been perfect. Right from the first meeting you didn't come and tell us what and how to do things. You always made us feel included and part of something" – K. Schade pers. comms. 2016 (Key Nation Contact - Nari Nari Tribal Council)

2.2.1 Engagement considerations

From commencement of the research, the capacity and availability of the Research Partners, including Key Nation Contact, community facilitator and Authorised Knowledge Holders were key considerations for the project team and research process.

This consideration was of particular importance when planning visits to Gooraman Swamp, as many of the Research Partners resided some distance and/or had limited access to the case study site. To manage this, the key nation contact in consultation with the project team adapted the timing of the site visits to coincide with significant social events on Country to maximise Research Partner participation, capacity and engagement.

Figure 4: An overview of the engagement process undertaken at case study sites

2.3 Establishing cultural water needs with communities

The engagement process was designed to collaboratively identify Research Partner aspirations and long-term objectives that could be achieved through access to a cultural water allocation. In turn, the Research Partners worked to refine and express these objectives so that the specific water requirements or a water regime necessary to achieve those objectives could be determined. In both case studies, the cultural water requirements, flow objectives and water management arrangements were refined through an iterative and collaborative process as envisaged by the process documented in the Component 2 Preliminary Findings report (NCFRP 2016c).

As a result of emerging cultural, ecological and hydrological information, both the flow objectives and the water management arrangements were refined through several iterations. This is consistent with the principles and approach of adaptive management, and is similar to water planning assessments where management objectives are assessed against feasibility and risks associated with the provision of that water.

In order to facilitate the development of water requirements associated with a cultural flow in a transparent and replicable way, the following steps were required see Figure 5 and detailed description below.

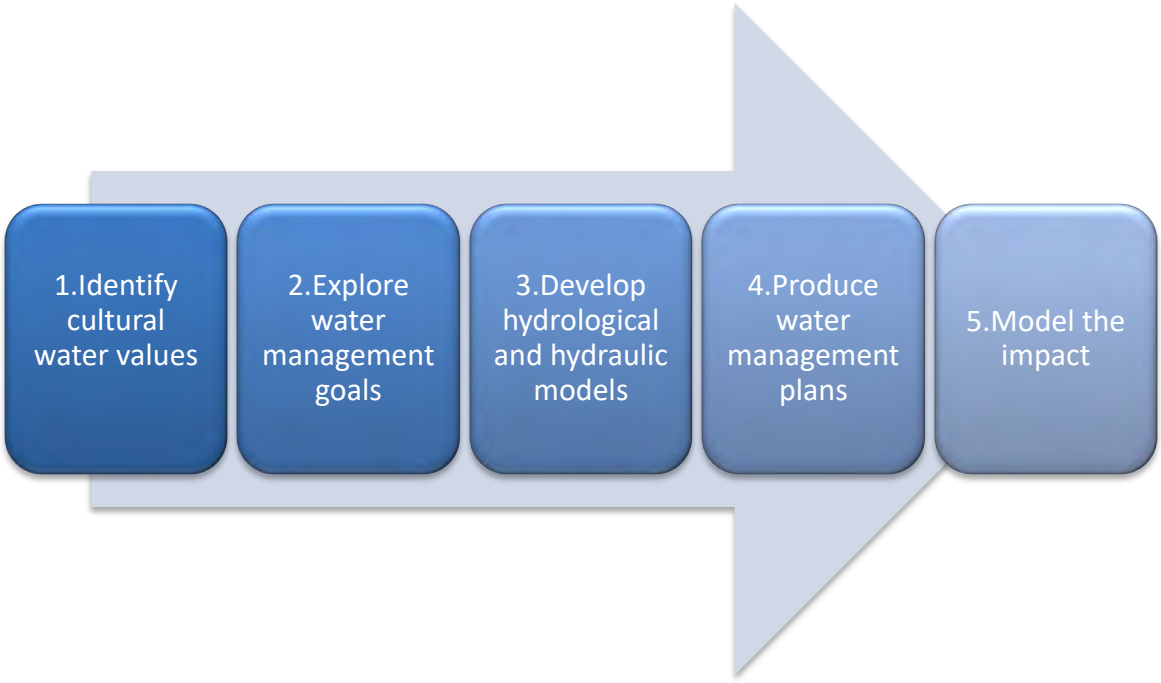


Figure 5: Establishing cultural water needs

1. **Identify cultural water values:** Research Partner aspirations, uses and values for the water resource were elicited, appropriately represented, leading to the development of a conceptual model of the relationship between **water regime and the water interests**, including cultural assets, values and uses. The primary purpose of the model in this case was to establish a shared understanding of this overall assembly of resource-dependant values and to facilitate common agreement about the extent to which changes in water availability may impact on those values. Outcomes from the synthesis included the articulation of a shared priority of values, however it may be sufficient for the representative groups to come to an appreciation of the values to be considered. In both case studies, the conceptual model developed was presented in the form of a program

logic, linking water management across short, intermediate and long-term time horizons to Research Partner aspirations generally.

2. **Explore water management goals:** The identified water management goals were expressed as cultural flow objectives. **Cultural flow objectives** refer to agreed high-level goals for the management of a cultural water entitlement, and identify the elements of the cultural flow regime required to service, protect and enhance Aboriginal water values and help meet Research Partner aspirations. Each of the flow objectives were in turn linked to cultural objectives and **Aboriginal Environmental Objectives (AEO)**, which enabled Research Partners to use this information to prioritise objectives and consider appropriate monitoring targets. The flow objectives were subjected to intensive iterative review by the Research Partners and by technical experts in order to establish the technical feasibility and to assist in setting water requirements. Information gathered on Aboriginal water values was used in conjunction with **background ecological and hydrological information** to develop a conceptual model to demonstrate the connections between the hydrological regime, water availability and the cultural flow objectives.

3. **Develop hydrological and hydraulic models**: This information was used to specify the detailed hydraulic (width, depth velocity) and hydrological (ML/d) requirements necessary to achieve the cultural flow objectives. **Hydraulic and hydrological modelling** was undertaken to assess whether the flow objectives could be achieved within the constraints of the resource. If it is not feasible, the cultural flow objectives could be re-iterated or refined, with improved understanding of the available options and constraints.

4. **Produce water management plans:** Management plans to achieve the cultural flow objective were developed. In most cases, the cultural flow objectives require an allocation of water from the **consumptive pool, and supplemented by a watering plan** to assist the Research Partners in determining the most effective use of the available water. This stage is important so that the range of management alternatives can be considered.

5. **Model the impact:** In the final instance, and subject to the demand and security of the resource, it may be necessary to model the impact of the provision of the cultural flow on the system as a whole, including the risks of the proposed management arrangement on environmental water and the security of the resource.

2.4 Traditional Aboriginal Knowledge (TAK)

A critical step in planning a cultural flow is to establish an understanding of the cultural knowledge of natural ecosystems held by the Research Partner/s specifically relating to water. This will include site specific characteristics of the past or desired water regime to be achieved by water management as well as the ecological responses of culturally important species and ecosystems to water as it moves across Country. This is often referred to as TAK.

TAK refers to how the knowledge is acquired and used, not necessarily its antiquity, although in some systems this is also an aspect of TAK. TAK is typically holistic in outlook and adaptive by nature, gathered over generations by observers whose lives depended on this information and its use (Berkes et al. 2000; Berks 2012).

TAK refers both to ways of knowing, (the learning process) and also to information, or knowledge as the thing known (Berkes 2012). For example knowledge of species names, life cycles, habits, habitats, etc. is best described as information and often has strong overlap with ‘Western’ science.

Most TAK exists as oral forms held by Aboriginal custodians with widely dispersed records such as artworks, private journals, linguistic dictionaries, unpublished reports, community publications, academic journal articles, books, photos and videos contributing to documented knowledge (Ens et al. 2015). TAK has been trialed and tested over thousands of years, with the knowledge gained being handed down through the generations in song, dance, and ceremony. Ceremony, particularly those including many Nation groups had forums equivalent to scientific conferences and seminars whereby this knowledge was shared with others. TAK is shared among Nation groups and it is very rare for it to be the sole domain of just one group. These processes led to the creation of song lines and story lines that go across the whole of Australia.

The work of Dykes et al. (2006) collating the names and uses of plants by the Murrawarri is a good example of TAK information specific to the case study sites that has been captured using contemporary scientific approaches, but which fundamentally relies of the Aboriginal knowledge of the Murrawarri (see section 3.5.2 of the *Toogimbie and Gooraman Swamp Ecological Character Report*, NCFRP 2017).

Aboriginal knowledge extends to include knowledge regarding resource use, medical processes, sourcing and preparation of food, water use, implement construction (i.e. woomera) and use, among others. Spiritual and religious knowledge are key elements of TAK.

In planning a cultural flow, it is essential to capture this knowledge as it will illustrate each community's understanding of connectivity of aquatic resources across the landscape, identify key species of cultural significance that may respond to cultural water management, which will in turn inform the development of objectives and selection of indicators.

The output of this step in the planning process will be a list of existing sources of TAK (oral stories, publications, species lists, etc.) relevant to the site to receive cultural water. This will inform the development of an Ecological Character[2] Description (see NCFRP 2017a) which will describe the sites location and physical attributes as well as the components, processes, functions and services and benefits provided by the site. From this information a conceptual understanding of how culturally significant aspects of the site will respond to water management will be developed. The application of the Aboriginal Waterways Assessment tool (MDBA 2016) may assist in informing the content of the Ecological Character Description by providing a baseline condition assessment.

In Component Three, examples of TAK relating to black swan, lignum and nardoo were developed and are presented in the Ecological Character report (NCFRP 2017a). Existing documented TAK was limited for the case study sites with the exception of Dykes et al. (2006). However, examples of TAK were observed during the field work, for example the Murrawarri smoking ceremony (Figure 6) and its connection to the spirit trees and safe passage through sacred Country is based on the protocols established thousands of years ago. In addition, the painting of the mural on the water tank is a means of passing of knowledge and showing the connection of the spring to the river and how that is an early warning system for flooding in the area (Figure 7). In addition, Research Partners from each case study nation provided lists of culturally significant water dependent

[2] Ecological character is defined by Ramsar Convention as

species that were either recorded from the site, were desirable as target species for water management, and/or were significant to the Research Partners in terms of promoting wellbeing.

We know which trees are Coolabah and which are Black box by looking at if it has its sleeves [rolled] up or down... If the bark is high [on the trunk] it is a blackbox, if it is low it is a Coolabah. This is how we know"- Fred Hooper pers. comms. 2016 (Key Nation Contact - Murrawarri Provisional Council of State)

Figure 6: Murrawarri Return to Country smoking ceremony 2016

Figure 7: Murrawarri Return to Country mural 2016

Text Box 1: Example of Traditional Ecological Knowledge relating to Lignum.
Note: The TAK noted in the example below is for demonstrative purposes only and is not representative of all Aboriginal communities or individuals. TAK will vary depending on cultural context.

Lignum is a large shrub which grows on the flood plains, in intermittent wetlands, billabongs and alongside creeks and rivers in areas where the black box and red river gums are plentiful (Williams and Sides, 2008:89). It provides nesting opportunities, cover and safety for a variety water birds.

The importance of lignum to Aboriginal people is not so much in its use, but rather in the role it plays within the ecosystem. As a valuable food source, lignum helps support an array of birds and native animals (such as *Durrawiyung, Burrurgiyan* and *Wululu* – teal and pink-eared ducks and straw-necked ibis) and in-turn supports hunting and tucker for Aboriginal people (McKemey and White, 2011:129; Williams and Sides, 2008:89). When healthy and bountiful, lignum can provide excellent cover for Aboriginal people when hunting.

Lignum bush recorded at Toogimbie IPA post 2016 flood. Image © NCFRP.

2.5 Objective setting

Setting the cultural flow objectives for the two case study sites drew on the historical and contemporary cultural uses, values and aspirations for water at the two case study sites identified in Component Two of the Project. The participatory research used to identify these values included desktop review, group workshops, site visits, participant observation at field events and one on one interviews. This information was then used to create a model to describe connections between the hydrological regime, water availability and cultural practices and aspirations at the case study sites. The methods used to do this varied for each of the case studies, based on the engagement preferences of the Research Partners in those locations.

The process of converting this into cultural flow objectives involved similar methods of collaboration, including discussions, group workshops and online communication. Multiple rounds of iteration and adaptation were required to establish consensus and understanding amongst Research Partners and the NCFRP Project Team.

The resulting cultural flow objectives have been expressed, following Wilkinson et al. (2007), with associated cultural and environmental targets, with both satisfying SMART (specific, measurable, achievable, realistic and time-bound) criteria. These targets have been classified separately as Cultural Water Objectives or AEO, with a recognition by all Research Partners that this distinction is largely arbitrary. There is a high degree of overlap between these categories, as the achievement of cultural objectives depends upon and enables the environmental goals.

These targets were then used to establish the water requirements for cultural flows, and the monitoring framework for their evaluation. For example, in the Murrawarri case study, one of the objectives which satisfied both cultural and environmental aspirations was the improved condition of ceremonial and spiritually significant wetland plant species at Gooraman Swamp through the application of cultural water. Water requirements for these species can be accurately described with reference to both traditional and technical ecological knowledge, and these water requirements can be modelled to demonstrate the conditions required for their achievement. In turn, the monitoring approach can be expanded to include tree health assessment.

This process was undertaken for each of the specified cultural and environmental water targets.

2.5.1 Objective setting methods in Toogimbie

Research Partners at the Toogimbie site expressed a strong preference for deliberative group discussions as the preferred method of information sharing with an emphasis on working towards consensus. Facilitated group discussions both on site and in a workshop context were identified as the data gathering activity for this study area. During the pre-flow trial meeting, the Research Partners shared the concept of *"mawambal"* (working together) as a way to describe this approach to planning and management. The group also has a high level of knowledge and experience associated with planning and management of the site, including with the use of program logic approaches to monitoring. Prior to the deliberate processes undertaken to identify and determine the water requirements for the Toogimbie IPA, existing data and information compiled for the site were reviewed. Given the history of land management of the site, there were a number of sources of information provided by Research Partners that were used to assist in the determination of aspirations, uses and values of the site connected to the water resource.

The group decided that an extension of their existing program logic for the site would be a suitable framework for the development of a conceptual model for cultural flows in this context. This

model was then re-developed in consultation with the Nari Nari prior to and during the pre-flow assessment visit. Key changes to the objectives as a result of this iteration included the expanded use of Aboriginal language, a clarification of plant and animal species of cultural and conservation significance, and a revised prioritisation of the cultural water objectives. In particular, greater priority was placed on the involvement of intergenerational knowledge transfer and mental health as both an objective of cultural water and as an area of monitoring. Table 3 documents summarises the research conducted to date.

Table 3: Methods used in the Toogimbie IPA Case Study

Field trip	Meeting objectives	Methods used
February to March 2016 - Skype connection	Collaboratively develop agreed Nation engagement plan. Identify and confirm Research Partners, FPIC, roles, responsibilities and expectations. Plan project site visit.	Informal conversations Facilitated meetings
March 2016, Hay Local Aboriginal Land Council Office, Hay NSW and Toogimbie IPA.	Provide an overview of the project, including expectations, roles, engagement and participation. Satisfy Research Partner requirements for FPIC. Identify resource management goals, project aspirations and engagement preferences of the Research Partners.	Group presentation Facilitated group discussion Site visit
April to May 2016 – Skype connection	Review meeting outcomes, identify what worked well and what could be improved. Discuss next steps, key milestones and objectives. Plan cultural flow aspirations site visit.	Informal conversations Facilitated meetings
June 2016, Hay Local Aboriginal Land Council Office, Hay NSW and Toogimbie IPA.	Identify and document aspirations, uses and values and their relative importance to the Research Partners Review and clarify cultural information gathered to date. Compile/collate information collated into visual, diagrammatic, or narrative form for review by the Research Partners and participants.	Site visit Semi-structured group interviews Facilitated program logic workshop
July to August 2016 – Skype connection	Review meeting outcomes, identify what worked well and what could be improved. Discuss next steps, key milestones and objectives.	Informal conversations Facilitated meetings

	Plan pre-flow (baseline) project site visit.	
September 2016, Hay Local Aboriginal Land Council Office, Hay NSW and Toogimbie IPA.	Undertake a baseline assessment of identified ecological and social indicators. Confirm and prioritise flow objectives for trial and long-term water management. Confirm research questions for watering trial. Agree on preferred and alternative flow arrangements specified in flow trial plan.	Field monitoring (pre-flow ecological and social) Facilitated group discussion (community/regional well-being) Review of monitoring tools/approaches
October to November 2016 – Skype connection	Review meeting outcomes, identify what worked well and what could be improved. Review and validate data recorded. Discuss next steps, key milestones and objectives. Plan post-flood site visit.	Informal conversations
December 2016, Toogimbie IPA.	Undertake a post-flood assessment of identified ecological and social indicators. Amend preferred and alternative flow management for future cultural flow allocation as required. Conduct evaluation focus group on the project overall.	Field monitoring (post-flood ecological) Facilitated group discussion Formal focus group
December 2016 to January 2017 – Skype connection	Review and validate data recorded. Discuss next steps, key milestones and objectives.	Informal conversations

2.5.2 Objective setting methods at Gooraman Swamp

Murrawarri Research Partners indicated a desire for a broad array of information gathering techniques, including site visits, one to one interviews, video documentation and facilitated discussions, in order to best capture the existing site knowledge and values. There was a stronger emphasis on diverse methods to involve Research Partners in providing data and information, highlighting the importance of this information in informing trade-off decisions about future cultural water and the legacy value of documenting this information beyond the project.

Personal and group interviews were conducted with key research informants and knowledge holders throughout each of the field visits, and opportunistically as the Project Team were available on site. These interviews were recorded by video and/or audio recording. Supplementary analysis has been undertaken where relevant data sources were recommended by Research

Partners, and specific information on the cultural significance and obligations associated with vegetation management was used to clarify priority environmental objectives.

The data from the transcribed interviews and other document have been used to generate a conceptual model according to the same program logic used in the Toogimbie case study (See NCFRP 2016c for detailed information). Both the program logic and the cultural flow objectives derived from the model were reviewed by Research Partners via correspondence, and subsequently refined during the November field visit.

Key changes to the objectives as a result of these iterations confirmed the Research Partner's opposition to infrastructure-dependent off-stream watering for Gooraman Swamp, and clarified the extent of connectivity between culturally significant water-dependent sites across Murrawarri Country. Research Partners were also able to provide local knowledge on historical fish populations, especially Murray Cod, in order to ground-truth the SMART targets developed for the AEO. Table 4 below summarises the methods used in the Gooraman case study.

Table 4: Methods used in the Gooraman Swamp Case Study

Field trip	Meeting objectives	Methods used
February to March 2016 - Skype connection	Collaboratively develop agreed Nation engagement plan. Identify and confirm Research Partners, FPIC, roles, responsibilities and expectations. Plan project site visit.	Informal conversations Facilitated meetings
March 2016, Weilmoringle.	Provide an overview of the project, including expectations, roles, engagement and participation. Satisfy Research Partner requirements for FPIC. Identify resource management goals, project aspirations and engagement preferences of the Research Partners.	Group discussion Site visit
April to May 2016 – Skype connection	Review meeting outcomes, identify what worked well and what could be improved. Discuss next steps, key milestones and objectives. Plan cultural flow aspirations site visit.	Informal conversations Facilitated meetings
May 2016, Ledknapper Nature Reserve, Northern NSW.	Identify and document aspirations, uses and values and their relative importance to the Research Partners.	Participant observation (Back to Country weekend) Group presentation and forum

		One to one and small group interviews Video documentation
October to November 2016 – Skype connection	Review meeting outcomes, identify what worked well and what could be improved. Review and validate data recorded. Discuss next steps, key milestones and objectives. Plan baseline assessment site visit.	Informal conversations
November 2016, Gooraman Swamp and Weilmoringle.	Clarify conceptual modelling of the relationships between flow and Aboriginal uses and values. Confirm cultural flow objectives, including AEO Undertake a baseline assessment of identified ecological and social indicators. Complete FPIC process.	Site visit Field monitoring (baseline ecological) Group discussion
December 2016 to January 2017 – Skype connection	Review and validate data recorded. Review preliminary results and discuss next steps	Informal conversations

2.6 Establishing hydrological and hydraulic needs to achieve cultural outcomes

Hydrological and hydraulic investigations provide the means for quantifying how much water is required to meet cultural needs. While aspirations for water might be well understood in cultural terms, it is necessary to define cultural water needs in terms of how much water, when, how long and how often. Without this information, the water allocation required to meet the needs cannot be calculated. The relevant characteristics of individual events, or a long-term water regime, are: timing, magnitude, frequency, duration, extent, depth and in some cases, velocity and rates of rise and fall in water level. To enable modelling, information on these characteristics of cultural flow objectives must be supplied using standard units.

Initially, it is likely that difficulties will be experienced in documenting some of the details of cultural flow regimes due to lack of specific information about the objectives, or incomplete understanding of the relevant hydrological and hydraulic processes. Specifying the events required to satisfy the cultural water objectives is an uncertain process that requires iterative interaction between all project partners. Any specifications that remain highly uncertain throughout the entire assessment process can be refined through adaptive management of cultural flows. After tabulating the characteristics of the events that will satisfy each cultural water objective, it should be possible to contract the list of events whilst still satisfying all of the objectives. This is done by grouping objectives that have similar hydrological and hydraulic requirements, whereby all

objectives in the group would be satisfied by a particular event. Effectively, the cultural water requirements are then described according to a set of hydrological components. Hydrological components are a way of simplifying a variable wetland water level or river flow regime into a form that can be more readily described, understood and managed.

The process of quantifying cultural watering objectives in hydrological and hydraulic terms is informed by hydraulic and hydrologic investigations. These investigations involve accessing available climate, hydrology, hydraulic and topographic data to develop an understanding of how water would enter and spread over the site under natural flooding conditions (presuming it is a riverine floodplain site), and how often this would happen under natural, current and future river flow scenarios. If cultural water is to be artificially delivered to the site, then this process too is modelled. Based on this, and other information, the long term watering objectives are established. A long-term (100 years or longer) model is created that simulates how often and to what extent the site will be watered, through both the program of artificial watering, and through natural flood events that happen to occur. This model, termed *Long-Term Site Hydrology Model*, simulates how much cultural water would be required in each year of the time series. The primary uses of the long-term site hydrology model in the assessment process are to assist development of cultural water objectives, evaluate how well the objectives are likely to be met in the long term, and statistically describe the range and average of the annual water volume water required to satisfy the objectives. The volume required will vary from year to year depending on the management objectives (if cyclic), the recent and current climate, and the recent or current occurrence of natural flooding at the site.

The long-term site hydrology model is based on a cyclic or regular watering plan that is anticipated will meet the required cultural water objectives for the site over the long-term. However, each year, use of the allocation will require development of a watering plan. In general, this plan will be guided by the long-term objectives and plan, but it might incorporate adjustments based on results of any monitoring, recent weather or flooding events, and forecast events. For this task, a different hydrological model was developed. This model, termed *Cultural Water Annual Allocation Estimator* (NCFRP 2017b) is based on the same principles as the long-term model, but runs only for the recent past and near future. As the proposed date of application of a water allocation approaches the timeframe of the near future, knowledge of the sources of hydrological variability improves. This information can be used to narrow uncertainty in the modelled volume of water that will be required to meet cultural water needs for that year.

3 DEVELOPING A WATERING PLAN

In 2016, the Commonwealth Environmental Water Holder agreed to provide water to allow a preliminary flow trial at Toogimbie IPA (NCFRP 2016h). The flow trial planning process (outlined below and in Figure 8) summarised the basis for the water trial and important considerations such as the objectives of water delivery, clarification of the timing, volume and duration of watering, assessment of potential risks associated with water delivery, rules for commencing and ceasing flows, and indicative costs (see NCFRP 2016h for further details).

3.1 Outline of Toogimbie process

The timing and iterative nature of the NCFRP meant that a water trial planning process commenced at the beginning of the project. While water delivery would not normally be planned prior to the development of watering objectives, the project sought to engage with water delivery partners early, so that provisions could be made in the annual water allocation process conducted by the CEWH and NSW government departments (NSW Office for Environment and Heritage and Water NSW). Postponing engagement with water delivery partners until watering objectives were confirmed would have increased the difficulty of securing water for the trial (proposed for September 2016) with the desired timing and volume.

Commencing development of the water trial plan early in the project (i.e. before watering objectives had been clarified) meant several iterations to the plan was required. An important lesson learnt was that time is required for engagement with the Research Partners in order to come to a common understanding of what might be feasible watering objectives, both for a water trial and in to the future assuming ongoing access to water. For example, ongoing discussions raised the possibility of extending the focus of the water trial to include provision of breeding habitat for black swan (see section 3.1.3), an important species to the Research Partners. This required additional infrastructure, as well as consideration of modelling to determine the volume of water that might be required.

The general process for developing the water trial plan (NCFRP 2016h) included addressing the following (Figure 8):

- Iterative discussions and confirmation of watering objectives with the Research Partners – ***what are the objectives to be achieved with water delivery***?
- Iterative modelling or other assessment of the volume and timing of water delivery to meet stated objectives – ***how much water is needed and when should it be delivered***?
- Iterative discussions of the process for ordering and delivering water from the water holder and delivery by partner organisations – ***what is the process for ordering and delivering water for delivery***?
- Assessment of delivery infrastructure with the Research Partners, water holder and water delivery – ***how will water be delivered to, and managed on the site***?
- What decision rules will be applied to managing water at the site – ***what are the rules to commence or cease watering, including risk identification and mitigation***?
- What are the expected ***costs for securing a water allocation and delivering water***?
- What monitoring and evaluation arrangements are in place – ***how will the volume of water be monitored and how will effectiveness of watering be assessed***?

All the above are important steps in the planning process, and link directly with the watering objective setting process, as well as monitoring and assessment arrangements.

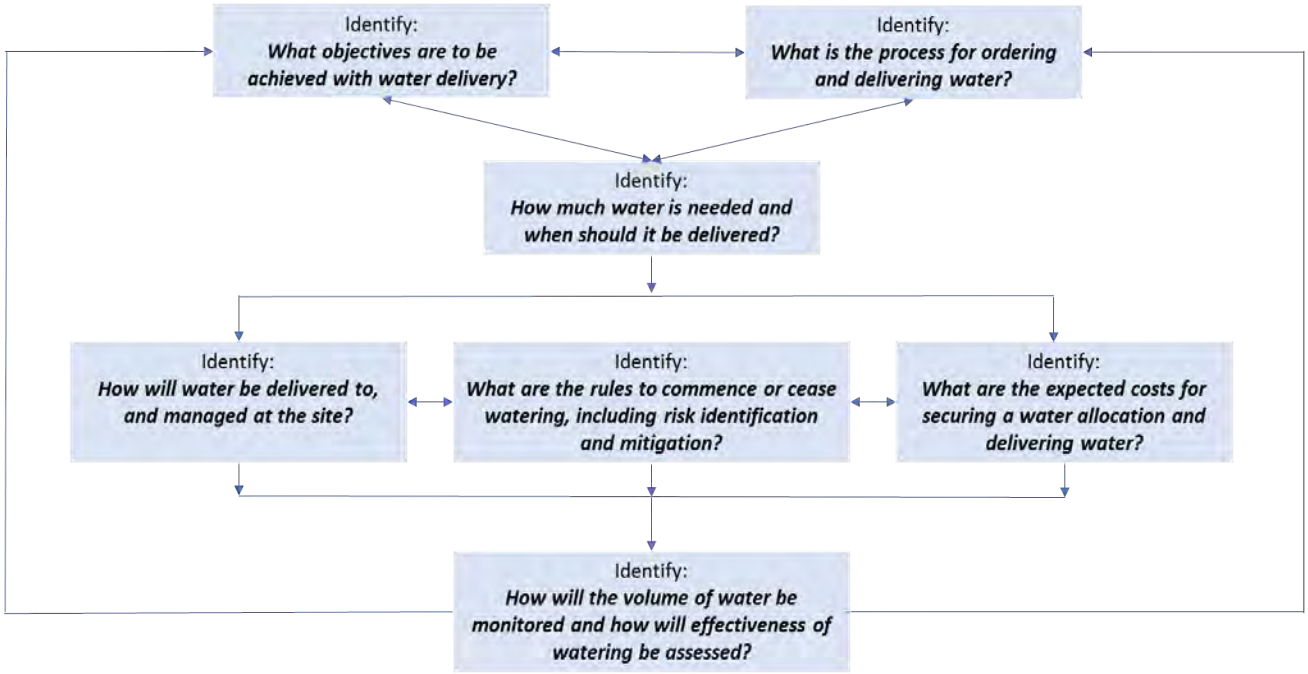


Figure 8. Overview of the water planning process.

3.1.1 Nari Nari – Commonwealth Environmental Water Holder agreement

During preparation of the flow trial plan, a separate but related agreement was prepared between the Nari Nari and CEWH that when implemented would facilitate Nari Nari access to Commonwealth water for approved purposes in the future. While the agreement was in preparation during the latter months of 2016, as of 10th February 2017, administrative delays have meant that the agreement is yet to be ratified and implemented. It is anticipated that the agreement will be in place to allow the Nari Nari to access Commonwealth water by April 2017.

3.1.2 Implications of the September-October 2016 flood event at Toogimbie IPA

While planning for the water trial was undertaken in good faith and associated monitoring activities commenced, a large flood in September-October 2016 meant that the trial delivery of Commonwealth water was disrupted. Thus, the study moved from a trial delivery of Commonwealth water to a study of the impact(s) of a large natural flood. While the results provide valuable information and allowed ongoing training of Research Partners and Toogimbie IPA rangers in monitoring techniques, they do not reflect the results of a managed cultural or, environmental flow.

The occurrence of a natural flood event highlighted the need to retain flexibility in the objectives that might be achieved with water delivery, or in response to natural events such as flooding. For example, environmental watering programs often take an adaptive approach, where the objectives of watering in any given year can be varied to suit conditions. For example, SKM (2011) proposed broad-scale functional and ecological objectives under different water availability scenarios for annual watering in the Murrumbidgee system:

- Extreme dry years: avoid damage to key environmental assets.
- Dry years: ensure ecological capacity for recovery.

- Median years: maintain ecological health and resilience.
- Wet years: improve and extend healthy and resilient aquatic ecosystems.

Practical examples of these scenarios might be that in a dry year, an objective might be to deliver environmental water (e.g. as a large flow pulse for many weeks) to promote fish breeding that otherwise might not occur. Alternatively in a wet year, there may be sufficient water present in waterways for fish to breed; the objective that year might be to maintain habitat for juvenile fish to survive (e.g. maintain base flow within river reaches).

The Commonwealth Environmental Water Office (CEWO) also take a variable approach to environmental allocations based on environmental water availability (CEWO 2014). The concept of having variable objectives depending on prevailing climatic or water availability conditions could also be considered for watering to achieve cultural outcomes.

Table 5. Potential Commonwealth watering actions and applicable resource availability scenarios for the Murrumbidgee Catchment in 2015–16 (adapted from CEWO 2015).

Watering action	2015–16 Basin annual environmental watering priority(s)	Resource availability scenarios action is likely to be pursued under		
		Low – very low	Moderate	High – very high
Mid-Murrumbidgee reconnection	• Basin-wide flow variability and longitudinal connectivity • Basin-wide in-stream and riparian vegetation • Mid-Murrumbidgee Wetlands • Basin-wide waterbird habitat and future population recovery • Basin-wide native fish habitat and movement • Silver perch	Unlikely	Yes	Yes
Mid-Murrumbidgee wetland – infrastructure assisted delivery	• Basin-wide in-stream and riparian vegetation • Mid-Murrumbidgee Wetlands • Basin-wide waterbird habitat and future population recovery	Yes	Yes	No
Mid-Yanco Creek Anabranches and Wetlands	• Basin-wide flow variability and longitudinal connectivity • Basin-wide in-stream and riparian vegetation	Yes	Yes	No

	• Basin-wide waterbird habitat and future population recovery • Basin-wide native fish habitat and movement			
Lowbidgee Wetlands (Critical habitat requirements (drought refuge, southern bell frog etc.))	• Basin-wide in-stream and riparian vegetation • Basin-wide waterbird habitat and future population recovery • Basin-wide native fish habitat and movement	Yes	Yes	Yes

3.1.3 Establishment of a black swan breeding rookery

The black swan is an important totem species to the Research Partners. During the implementation of the monitoring and evaluation plan, the Research Partners sought to include the construction of a swan rookery to promote breeding by the species in the future. Observations and anecdotal evidence collected by the Research Partners indicate that swan will breed at Toogimbie IPA when breeding habitat is available.

Although originally beyond the scope of the project, the Nari Nari, with support from the CEWO, purchased infrastructure (piping) to connect the rookery to the main water distribution channel at Toogimbie IPA. The pipe was installed in February 2017, in time for watering to commence later in 2017 (e.g. April to October).

The establishment of the swan rookery was an example of Research Partners becoming increasingly confident in their tacit knowledge of ecosystem and cultural responses to watering. It also highlighted the need for multiple iterations of the objectives and outcomes that might be sought from the delivery of water for cultural purposes, as well as the benefits of taking a flexible approach to implementing water delivery and monitoring plans.

3.2 Linking monitoring to objectives

The monitoring and evaluation framework developed for both sites used the identified aspirations and watering objectives to formulate a series of key evaluation questions to be addressed by monitoring. Indicators were then selected to best capture the achievement of those objectives, including both socio-cultural and environment outcome indicators. Standard methods have been included for each indicator, along with data collection and management standards. These are detailed in the following results chapter of this report.

The framework varied between single-site, single-intervention (SSSI) assessment for the flow trial, and single-site, multiple-intervention (SSMI) assessment to assess change over multiple watering events. In both cases, the intervention here refers to the delivery of the cultural flow. Sampling is to occur at the site both before and after the delivery of water so that the inference of the delivered flow being responsible for cultural and environmental (in isolation from other conditions or events) outcomes is increased – the study design was that of a before-after-intervention.

3.3 Downstream risks

Delivering a cultural water allocation to a floodplain wetland site would usually be through one of two mechanisms. One is to pump water from a nearby river source, and the other would be to artificially boost river flows through dam release, or by preventing upstream diversions and abstractions, to spill water into the wetland. Pumping water could take place without necessarily raising river flows to compensate for the volume withdrawn. In this case, downstream of the site would experience reduced river flows, which could disadvantage other users and could cause environmental harm. If the river level was raised through a release from storage in anticipation of the cultural water being pumped out, then the river from the storage to the site would experience higher flows that it would have otherwise. This could have both negative and positive environmental impacts. Such a flow would usually be contained within the banks to avoid negative social and economic impacts.

If the cultural water objectives include passing water through the floodplain wetland site and then returning some of most of it back to the river at a point downstream, there could be both negative and positive environmental impacts. The quality characteristics of the water are likely to change during passage through the wetland. While some aspects of water quality could be considered to have “improved” (such as reduced suspended solids concentration), other variables might change in an undesirable direction.

When cultural water is delivered to a site by boosting river flows through releases from an upstream source, there is risk of flooding along the river system from the source and downstream past the site. Increased general flooding of the entire river system could be viewed by some stakeholders as undesirable, and desirable by others. Boosting river flows at the site by reducing or eliminating upstream diversions for agriculture, would likely meet with resistance.

4 TOOGIMBIE FIELD WORK

4.1 Cultural significance of the case study site

The Toogimbie IPA is situated on the broad floodplain of the lowland Murrumbidgee River downstream from the rural town of Hay, in western NSW. In March 2004, the Toogimbie IPA was formally declared, and has since been continually owned and managed by the Nari Nari Tribal Council. Toogimbie Station covers approximately 7,000 hectares, of which 5,000 hectares is the declared IPA Conservation Area. The IPA site is managed by the Nari Nari Tribal Council through culturally informed land management practices to promote environmental restoration of the largely degraded site, whilst ensuring the protection and enhancement the local Aboriginal culture and history.

The Hay area was once part of a major Aboriginal trade route and large social and cultural network (DEWR 2007). Much of the cultural history of the local Aboriginal people was disrupted by European settlement. Toogimbie IPA activities seek to preserve important assets such as protecting scarred trees, campsites and burial mounds, as well as helping to reconnect the people to their land. Toogimbie IPA represents both a visual and spiritual link between the health of the land, its water systems and its people.

Toogimbie IPA centred upon the Toogimbie wetland as a site of cultural significance for contemporary cultural practice and the transmission of inter-generational knowledge, through environmental restoration, wetland rehabilitation and Aboriginal land management. This environmental restoration is not intended to restore the Toogimbie wetland itself to a pre-development condition, but to manage the landscape in order to re-establish species and conditions of cultural and conservation significance at a whole of landscape scale. In this way, the site is managed mainly for conservation through purposeful intervention. Work conducted on Toogimbie IPA over the past decade demonstrates the significance of a culturally-defined ecosystem for the preservation of both regional biodiversity and cultural identity. Toogimbie has a critical role in landscape scale conservation by protecting key ecological assets, including species and habitats, in an area that has undergone substantial modification.

Water is vital to the rehabilitation of the wetlands, and the Aboriginal land management practices on the site are conducted as part of the fulfilment and demonstration of broader social arrangements and cultural practices. Knowledge of water stories and cultural history varies amongst the Research Partners, however there is a deep commitment to and understanding of the way in which culture is enacted and re-enacted as practice whenever members of the community are on the site. As Nari Nari Research Partners express it:

> *"Cultural practice always happens when people are on Country".- J. Woods, pers. comm 2016 (Research Partner –Nari Nari Tribal Council)*

In this way, the management aspirations reflect the significance of Toogimbie as a site of cultural regeneration and as a place of education, learning, well-being and capacity.

The importance of the Toogimbie wetlands in building personal and cultural resilience for the Nari Nari is reiterated throughout the documentation relating to the site that express its values ecological and social values. Centrally, the Nari Nari Tribal Council have identified their vision and long-term aspirations for the Toogimbie IPA site, in a Plan of Management:

"The Tribal Lands will be a place of pride for Aboriginal people. The land will be protected, its cultural and natural values enhanced, creating a quality environment for present and future generations". – (Nari Nari Tribal Council 2012)

These natural and cultural values are further specified in the Management Plan as:

- Significant nesting and breeding area for wetland birds.
- Shrubland and plains country managed for noxious and feral species.
- Riparian zones, stream bank areas and the Murumbidgee River – habitat for native aquatic and mammal species.
- Future potential of wetland to attract regional threatened species.
- Maintenance of bush medicine and food sources for generations to come.
- Refuge for wildlife in a developed landscape (farmland, irrigation, river regulation).
- Sense of ownership, pride and connection to Country.
- Physical reconnection to culture and Country.
- Location of significant sites, including burial sites and occupation sites.
- Socio-economic potential for community.
- Traditional harvest (Fish/hunt/gather foods and medicine).
- Cultural knowledge, stories, experience as a community.

Although these values are not expressed specifically in relation to water, there is an implicit relationship between the fulfilment of these management goals and access to water. The availability of an appropriate cultural water allocation has been the limiting factor of efforts on the Toogimbie site to re-establish vegetation and biodiversity for environmental and cultural benefit.

"What we're doing here is unique. And we want to share that – with non-Aboriginal people too. To be able to say, this is where we've got to, this is who we are, this is what we do. The Nari Nari has been like a training centre or a training hub. Have a look at the young people who come through here, they've all been trained on this country…. When we teach, we teach what we know about the landscape and about the culture, then it's up to them whether they want to go on to study science or other things. We've been successful – a lot of boys and girls have come through our system. Some of gone on to National Parks jobs, CMA jobs, water jobs…. People have told us that there's opportunities for tourism, and getting people to come by from the road, but for me it's always been about the training. This is a place you can train and learn, and feel good about that". – Jamie Woods pers. comms. 2016 (Research Partner - Nari Nari Tribal

4.2 Research Partner Participation

On site meetings and field work was conducted between March and December 2016. Table 6 provides a list of the Research Partners and NCFRP Project Team that participated at Toogimbie IPA.

Table 6: Research Partner and NCFRP Project Team participation

Field Trip Date	Nari Nari Tribal Council	NCFRP Project Team
Inception Meeting	Ian Woods	John MacKenzie

(March 2016)	Krista Schade Jamie Woods Tara Dixon Josephine Goulding Kerry Parker	Klynton Wanganeen Tamarind Meara
Aspiration Meeting (April 2016)	Ian Woods Krista Schade Jamie Woods Tara Dixon Josephine Goulding Kerry Parker	John MacKenzie Chris Gippel Tamarind Meara
Pre- Flow Trial (Baseline assessment) (June 2016)	Ian Woods Krista Schade Jamie Woods Tara Dixon Josephine Goulding Kerry Parker	John MacKenzie Peter Cottingham Tom Kloeden Klynton Wanganeen Tamarind Meara
Post –Flow Trial (December 2016)	Ian Woods Krista Schade Jamie Woods Tara Dixon Josephine Goulding Kerry Parker	John MacKenzie Peter Cottingham Tom Kloeden Klynton Wanganeen Tamarind Meara

4.3 Research Partner aspirations for cultural flows

The long term aspirational goal of the Toogimbie IPA expressed by Research Partners is **to re-establish cultural management of Country at the Toogimbie site, including the cultural practices associated with law, ceremony, trade, language and education for inter-generational knowledge exchange in a contemporary setting**.

Since the establishment of the property as an IPA in 2004, the site has been managed using culturally informed land management practices to promote environmental restoration of the largely degraded site. Concurrently, site management has also sought the protection and enhancement the local Aboriginal culture and history. Community leadership and participation in rehabilitating the system to a healthy riparian and floodplain environment has played a significant role in re-engagement of the community to Country, contributing to community wellbeing and reconnection to country for the Research Partners. The Research Partners recognise the importance of establishing refuge for wildlife in a highly developed and modified landscape consisting of extensive farmland, irrigation infrastructure and river regulation. In this way, the management aspirations reflect the significance of Toogimbie as a site of cultural regeneration

and as a place of education, learning, well-being and capacity, for Aboriginal and non-Aboriginal people.

Watering has been central to the restoration of the site to date. Water infrastructure on Toogimbie station has allowed the Research Partners to water the wetlands in a way that emulates the historical flood regime prior to upstream development. Key to the restoration of the Toogimbie wetlands has been the Nari Nari's access to a 2150ML Cultural Access Licence (CAL). There are, however, key limitations on the CAL that limit its suitability for the achievement of the long term aspirational goals of the Research Partners. A formally constituted cultural flow entitlement is seen to redress the inadequacies of the current arrangements.

Primary cultural flow objectives

The resulting cultural flow objectives specified for the Toogimbie site are:

- Ownership and management of a cultural water allocation including quantities, timing and resource requirements for cultural, socio-economic, and environmental outcomes in place by 2020 to replace current CAL.
- Obtain a sufficient volume of water to re-habilitate the whole of the natural floodplain including cells 1-4 and house wetland by 2020.
- Establish a return flow pathway to improve lateral connectivity between the floodplain and river, with return waters contributing to carbon cycling, movement of biota, and improved water quality.
- Establish a water regime conducive to establishment and maintenance of floodplain habitat suitable to support foraging and breeding of culturally significant waterbird species.

These objectives cannot be achieved by the application of an environmental flow for a number of identified reasons. Firstly, one of the central objectives identified by the Research Partners was ownership of a water entitlement in order for the community to actively participate in the water planning and management of the Murrumbidgee River catchment with the same status and on equal terms as other users in the system. Neither the current allocation nor the targeted application of environmental water can facilitate this. Ownership of a water entitlement reflects the Research Partner's aspiration of cultural independence, but is further linked to long-term sustainability of management interventions, to the emergence of new community leaders and to improved community governance. Management of a water entitlement can provide a platform for improving governance, and would make a direct contribution to community esteem.

Environmental water would not be appropriate given that the restoration of the ecology of the site has significant socio-economic potential for the community. A cultural water allocation was seen by the Research Partners contributing directly to achievement of economic independence through enterprise development and water trading. This type of economic activity is consistent with cultural responsibility and contributes to the sense of ownership, pride and connection to Country (for example, establishing cultural tourism activities, including use of the site for science and research tourism). Employment, training and education outcomes are linked to cultural management of the wetland, which in turn contributes to the maintenance and regeneration of cultural knowledge and practice.

A cultural flow would also contribute directly to the sustainability and protection of the site as an educational facility for intergenerational transfer of cultural knowledge and practice and as an exemplary demonstration site of Aboriginal management of Country. Cultural management of the Toogimbie site also contributes to the ongoing protection and preservation of significant cultural heritage sites, including burial and occupation sites, connected to the belief in the continuing spiritual presence of ancestors in the landscape. In the longer term, these outcomes were also

linked to long-term sustainability of management interventions and to cultural regeneration. Prior experience in the management of the site has already demonstrated the capacity for cultural regeneration, as new knowledge is developed or adapted through learnings on site management.

Cultural management was also intended to enhance the qualities of the site as a significant nesting and breeding area for wetland birds of cultural significance, especially the Black Swan (D*huundhuu*). It was noted that the birds of cultural and iconic significance to the Research Partners do not have the same priority for environmental outcomes, and are not likely to be targeted in environmental flow conditions or events.

Animal species targeted by these cultural flow objectives includes threatened species such as the Southern Bell Frog (G*ulaangga*), but also animals of historical and cultural importance such as kangaroo, emu and koalas, which may be less relevant from a conservation perspective. This is also true of the vegetation priorities to be targeted by a cultural flow. The restoration and maintenance of vegetation for bush medicine, craft, ceremonial artefacts and food sources would not necessarily be targeted by environmental water. Specifically identified vegetation includes the native grasses such as White Top and Wallaby Grass (associated with food, weaving and habitat for hunting grounds), Common Nardoo - *Nagaadha* (traditional food source), Old Man Weed - *Budhaay* (traditional medicine species), Cumbungi (artefact construction and food source) common reed – *Gubudha* (weaving, construction, ceremony and food source). These vegetation outcomes are linked directly to re-establishing traditional harvest activity of the site, to enable sharing of cultural knowledge, stories and experiences as a community.

4.3.1 Flow Trial Objectives

For the purposes of the project, a clearly defined cultural flow objective was also required for the purposes of a flow trial. Although the flow trial was a limited intervention, it was recognised that the trial itself should be embedded within the long-term management regime for the site. The cultural flow objective for the trial was agreed as:

- Establish a watering intervention that would be consistent with the long-term management regime to improve condition of dominant floodplain vegetation by 2020.

This flow objective was seen to contribute to medium term to long term site rehabilitation goals of reducing the extent of weed species, improving soil condition and reducing erosion in the wetland site, and contribute to the establishment of more culturally desirable vegetation on site.

4.4 Objectives for Toogimbie

4.4.1 Cultural Water Objectives

The following objectives were developed with, by and for the Nari Nari Research Partners.

1. Acquire a permanent, **tradeable water allocation** for Aboriginal cultural, socio-economic, or Aboriginal Environmental Outcomes by 2020, to enable the achievement of cultural and economic independence through enterprise development and water trading.
2. Increased **involvement of Aboriginal people** in the practice of *Mawambal* at Toogimbie by bringing people together in management, recreational and cultural activities on Country, with an emphasis on young people through elders, and increased inclusivity of activities undertaken on site.

3. Increased **use of the site as an educational facility** for intergenerational transfer of cultural knowledge, language and practice and as an exemplary demonstration site of Aboriginal management of Country and management of the Aboriginal Estate by 2020.
    a. Improved condition of, and access to floodplain medicinal plants (Old man weed, Nardoo, Pig face, Native Geranium/ Australian Cranesbill) by 2020.
    b. Improved condition of bushfood plants found on the floodplain (Native Carrot (*Dirramaay*), Native yam/ Black fellows Yam (*Murnang*), Phargmites (*Gubudha*) by 2020.
    c. Promote seed set of key floodplain plant species (Wild Flax (*Warrug*), Boree/Myall (*Buuri*), Cooba/Black Sallee (*Guba*), Miljee (*Garal*), River Cooba (*Yumang)* to allow seed collection activities by 2025.
4. Improved **on-site management** through access to new information and long term planning.
    a. Increased involvement of Nari Nari in action research and training, and increase in partnerships and collaboration with science, conservation, health, youth, cultural or research organisations.
    b. New planning and management initiatives for the site launched based on new information, data, and Aboriginal science or research findings.
    c. Revision of strategic and management plans for site based on new information, data or knowledge.
5. **New enterprise development** at Toogimbie site that contributes to community self-determination, with profits directed to social development, training, capacity-building and skill building in the community.
6. **Increase in employment of Aboriginal people** at Toogimbie as employees or volunteers, including the number of Aboriginal people connected to Toogimbie who obtain permanent employment.
7. Improved **community health and well-being** outcomes for community members involved with Toogimbie site, including supported recovery, improved self-reported health status and well-being benefits associated with increased harvest and use of traditional medicinal plants.
8. **Re-establish and maintain condition of culturally significant plant and animal species** to allow both cultural and language regeneration and the continued practice of cultural activities by 2020.
    a. Improved condition of water dependent riverine and floodplain plant species of exceptional cultural importance, including Lignum - *Gweeargal* (*Duma florulenta*), Nardoo - *Nagaadha* (*Marsilea drumondii*), and common reed - *Gubudha* (*Phragmites australis*).
    b. Increased number of successful breeding events of culturally important waterbird species by 2020, including Black Swans (*Dhuundhuu/Ngiyaran*) and local raptor species (eagles (*Maliyan/Yibaay*), hawks (*Dunandinang/Baga-daa/dhirril*) and kites).
9. Investigate options for **formal, permanent recognition of the Toogimbie wetland** site values, under the Aboriginal Place provision of the National Parks and Wildlife Act (1974) or other appropriate mechanism (such as Ramsar and World Heritage Declaration).

4.4.2 Aboriginal Environmental Objectives

1. **Reduce** prevalence of **introduced flora and weed species** and increase abundance of native vegetation within wetland cells by 2020.

2. Establish a **permanent refuge** within the site to allow provision of vital habitat in drought conditions and secure source populations of obligate aquatic species (i.e. frogs (*Gulaangga*) by 2020.
3. Provide habitat to **support threatened Southern bell frog** *Gulaangga* (*Litoria raniformis*) by 2020.
4. **Improve condition of floodplain vegetation**, including lignum - *Gweeargal* (*Duma florulenta*) nardoo - *Nagaadha* (*Marsilia drummondii*), common reed - *Gubudha* (*Phragmites australis*), Wild Flax - *Warrug* (*Linum marginal*), Boree/Myall – *Buuri* (*Acacia pendula*), Cooba/Black Sallee - G*uba* (*Acacia salincina*), Miljee - *Garal* (*Acacia oswaldi*) and River Cooba – *Yumang* (*Acacia stenophylla*)
    a. Increase condition of lignum by 20% by 2020.
        i. Establish water regime in one or more cells to favour vigorous growth of lignum. Frequency of events ever two (2) to three (3) years, depth not critical but to be less than 1m; duration of three (3) to seven (7) months commencing as per natural for the region. Avoid continuous inundation.
5. Improve **foraging and breeding habitat** for waterbirds by 2025.
    a. Increase number of successful breeding events of non-colonial nesting species by 30% by 2025 (targeted species includes: black swan (*Dhuundhuu/Ngiyaran*) and grey teal, but potentially include rails and crakes, cryptic species such as bitterns and snipe).
        i. Establish water regime in one or more cells to favour breeding conditions for black swan (*Dhuundhuu/Ngiyaran*). Depth to be maintained at >60cm (preferably greater if feasible) for a duration of nine (9) months commencing in late winter to early spring, rate of fall to be managed to prevent premature nest exposure. Dry interval between wet phases three (3) months to promote productivity boom. Frequency of events, one (1) in every two (2) years.
    b. Increase number of successful breeding events (i.e. to fledging) of colonial nesting species by 50% by 2025.
        i. Target species to include pelicans (*Gulambali/Birriyag*) and spoonbills (*Murrugaya*).
        ii. Establish water regime in one or more cells to favour breeding conditions for straw-necked ibis. Maintain depth at 0.5-1.0m, duration of nine (9) to 12 months commencing in late winter spring. Frequency of events, one in every three (3) years.
    c. Re-habilitate habitat to support Australian migratory species known to frequent the Murrumbidgee and lower Murrumbidgee floodplains[3] with increased abundance recorded in three (3) out of four (4) targeted surveys by 2025.

As cultural and environmental outcomes are closely interlinked, cultural watering objectives 3, 7, 8 and 9 (listed in the previous section) are particularly dependent on the AEOs listed above.

[3] Known migratory species to frequent the floodplains: Great Egret (*Ardea alba*) Caspian Tern *Sterna caspia*, Marsh Sandpiper *Tringa stagnatilis*, Sharp-tailed Sandpiper *Calidris ferruginea*, Common Greenshank Tringa nebularia, White-bellied Sea-Eagle Haliaeetus leucogaster, Glossy Ibis Plegadis falcinellus, Latham's Snipe *Gallinago hardwickii*, Cattle Egret *Ardea ibis*, Curlew Sandpiper *Calidris ferruginea*, Red-necked Stint *Calidris ruficollis* and the Black-tailed Godwit *Limosa limosa.*

4.5 Cultural and environmental values

The cultural and environmental values are captured in several locations.

The Ecological Character Description (NCFRP 2017a) details the cultural values identified in the management plan for Toogimbie IPA (Nari Nari Tribal Council 2012) attached to the site as (not necessarily all water dependent):

- A sense of ownership and connection to Culture and Country.
- A place to share and experience knowledge, stories and practices as a community.
- A place to visit and reconnect physically to Culture and Country.
- The location of significant Aboriginal sites, especially burial and occupation sites.
- Socio-economic potential for community.
- Maintenance of bush medicine and food sources for generations to come.
- A place to harvest fish, hunt and gather foods and medicinal plants.
- The potential to gather and share Cultural knowledge, stories and experiences with others.

4.5.1 Toogimbie IPA Traditional Aboriginal Knowledge

As mentioned in section 2.4 there is limited published and publicly available TAK documented for the Toogimbie case study site. Research into TAK has not taken place and the Nari Nari Research Partners are seeking to rectify this through the use of cultural water and ongoing stewardship of the IPA.

"The project [NCFRP] has triggered so many memories and stories, which I have never shared or spoken about with family or friends about my life and culture". -Ian Woods *pers. comms. 2016 (Research partner – Nari Nari Tribal Council)*

An aspiration of the Nari Nari is to lead research into TAK on their Traditional lands for the benefit of all Nari Nari in the first instance and to use the resulting research to further use Toogimbie as and education place for all. This includes research into theirs' and neighboring languages to add to the TAK. Some TAK has been recorded during field trips associated with the cultural watering and include the following:

"My understanding of the wetland has increased [as a result of the project]. I always knew lignum needed to be watered, but not how much, or how often in order for it to be healthy"

"The Nari Nari understand that wetlands and rivers are connected systems, and that what occurs upstream is significant and impacts on what happens downstream."

"Aboriginal stewardship (cultural obligations) of water resources acknowledges downstream users".

"The science backs up the cultural data and our science".
– Ian Woods*, pers.comms 2016 (Research Partner – Nari Nari Tribal Council)*

4.5.2 Culturally significant flora and fauna

Flora and fauna identified as culturally significant at the Toogimbie IPA are listed in Table 7.

Table 7: Culturally significant species at Toogimbie IPA (Williams and Sides 2008).

Wiradjuri name (if known)	Common name	Scientific name
dhuundhuu / ngiyaran / gunyig	Black swan	*Cygnus atratus*
maliyan / yibaay / bagadaa	Wedge tail eagle	*Aquila audax*
burrurgiyan	Straw necked ibis	*Threskiornis spinicollis*
gulambali / gulaygali / birriyag	Pelican	*Pelecanus conspicillatus*
murrugaya	Spoonbills	*Platalea regia* (Royal spoonbill) *Platalea flavipes* (Yellow spoonbill)
	Hawk	Several possible species
gulaangga (frog)	Southern bell frog	*Litoria raniformis*
gweeargal	Lignum	*Duma floruenta*
nagaadha	Nardoo	*Marsilea* sp.
budhaay	Old man weed	*Centipeda cunninghamii*
bulaguy / miranggul	Old man saltbush	*Atriplex nummularia*
gubudha	Common reed	*Phragmites australis*
gulumba / gulibaa	Box tree, coolabah	*Eucalyptus microtheca*

The Toogimbie IPA management plan (Nari Nari Tribal Council 2012) identifies environmental values attached to the site that the Nari Nari community seeks to improve by the use of cultural and environmental water. These include:

- Significant nesting and breeding area for wetland bird species.
- Shrubland and plains country, unaffected by stock, and with noxious and feral species controlled.
- Riparian zones, streambank areas and the Murrumbidgee River - habitat for native aquatic and mammal species.
- The potential to attract regional threatened species, once habitat is further established and improved. And,
- A protected area within surrounding farmland.

Text Box 2: Aboriginal values of the Black Swan.

Note: The following example of TAK is for demonstrative purposes only. It is not intended to be representative of all Aboriginal communities or individuals. TAK will vary depending on cultural context. Information provided is based on the shared cultural knowledge of Narungga Elders from Yorke Peninsula, South Australia

Black Swans

When a non-Aboriginal person looks at a black swan they look at a beautiful wild bird. When an Aboriginal person looks at the black swan through our unique cultural lens, we see something much more than the majestic beauty of the wild bird. We see the connectedness of the black swan to the cultural and spiritual wellbeing and other aspects which the black swan brings to the lives of Aboriginal people.

Historically there is a whole education aspect to what the swan 'is'. In simple terms it is food and so is the egg. The feathers were used for down to sleep on before mattresses became commonplace and on occasion used as quills to write with. In Aboriginal society the importance of totems or Tjukurpa's are well documented and totemic responsibility is for the sustainability of the particular totem. Totems have a spiritual connection to the creation and these connections are passed down through the lore, via songs, stories and ceremony. Every living thing has its place and role in the world. Education and transference of knowledge of is important.

In relation to the black swan, the hunting of it is a process which includes mastering the skills of making and using the various implements made from a variety of natural materials. This leads on to knowledge of what type of wood and where to source the wood. What implements are used or needed to make the spear, boomerangs, wadi's and woomera's to be used and the stone used to cut and fashion the wood into the right shape and size.

- Stone is needed to make the axe and knife that is used to cut and shape the wood to make the tools.
- Kangaroo sinew and gum from a particular tree is needed to form the bond which will ensure the sharpened stone is fixed to the wooden handle to make the stone axe.
- Fire is needed to close the bond.

Often one or more of the materials required to complete the above activities (fire, stone, wood), would be sourced through trade as there are not many places where all the required raw materials are readily available.

Once the swan is captured, the sharing of the meat is not a simple thing. Particular parts of the bird are eaten by different members of the family. This is to ensure that all share the bounty, but the hierarchy of what is eaten and by whom are historical and culturally defined. While the meat from the body is consumed, the wings will often be used as a broom to keep the camp sites clean.

When available, the eggs are considered an excellent source of food. To collect them, first you need to prepare a scoop. This makes gathering the egg easier and ensures you are not bitten by a snake (who also wants the egg for food). The scoop is usually made from a branch with a fork cut to affix a woven net / basket. To make the scoop, you need a long thin branch with a fork on the end. Cut the branch about six inches above the fork and then attach a net that is woven from the rushes on the banks of the river.

To prepare the rushes, first they need to be dried and have the fibers broken so that they are pliable for weaving. The small woven basket is attached to the branch where the fork is cut using kangaroo sinew, gum and heat from the fire to consolidate the melting of the sinew. This is the same method when making the stone and hunting tools.

To access the best nests a canoe is often required. This is made by taking bark from a large tree, leaving behind what is now referred to as a culturally modified or scarred tree. While making the canoe you also have to make paddles and a couple of coolamons to gather other food. This is a lengthy process which take times. Not all trees are suitable for canoe or coolamon production. Once removed the wood is treated and smoked prior to use.

To make all of these things it takes time and if you don't take notice of the weather and the season, you will miss the optimum time to harvest. The swan eggs will be all hatched and not suitable for eating. So knowledge of the seasons and breeding cycles of the swan is critical.

Some of the eggs are eaten by cooking in the ashes and others are blown so that they can be used for making ornaments. All of this is about survival, the spiritual connectedness to the environment and the education of children to ensure the knowledge and practices are passed on. There is a reason for every living thing to be here on earth and the creation stories tell how things come to be.

As you can see there is much more to the swan in Aboriginal society than looking at its beauty. There is a whole spiritual, cultural and education process that leads to the catching, eating and cultural use of the bird. Catching a swan is not a moment in time activity. These ares extensive and important cultural practices, learning and teachings that go into the activity. This ensures the cultural wellbeing and survival of Aboriginal people throughout millennia, by knowing our role in keeping and maintaining the balance between the spirit world and the terrestrial world.

These connections outlined here for the swan are also important for other species of water birds, bush foods and plants such as the emu, nardoo and lignum.

Text Box 3: TAK relating to Nardoo.
Note: The TAK noted in the example below is for demonstrative purposes only and is not representative of all Aboriginal communities or individuals. TAK will vary depending on cultural context.

Nardoo is an important plant for Aboriginal people. Although well-known for its potential contribution to the demise of Burke and Wills, nardoo is one of many poisonous plants that Aboriginal people eat (McKemey and White, 2011:207). Children would be educated in the importance of knowing which plants to eat, which has a poisonous effect on the body and how to treat or prepare the plant to ensure it is safe to eat.

Nardoo is an aquatic fern found in damp and wet areas, where it can often form a dense mat on the edge of billabongs and other still areas of water (Williams and Sides, 2008:88). The plant is easily identifiable owing to its four leaflets, which resemble a four-leaf clover (McKemey and White, 2011:207). The spores of the plant are contained in a small, hard sporocarp, which is the part eaten by Aboriginal people (not the leaves).

The sporocarp seeds once collected are dried before being ground into a flour and then mixed with a little water to form dough. The dough is cooked in the ashes to make small loaves of bread, or it is mixed with a larger quantity of water and drunk as a thin porridge or gruel (McKemey and White, 2011:207).

To prepare the flour, grinding stones would be required. If the community did not have access to the correct stone (raw) material, they would be required to trade with neighbouring communities. As the stones are quite heavy, rather than carry them from place to place, they would often be turned upside down and stored in a safe place for people travelling through or for a particular ground when they returned (HLALC & Schade, 2008:26).

Yandruwandha elder, Benny Kerwin (cited in Hercus and Sutton 1986) explained to Gavan Breen how the nardoo was prepared:

> "*Ngardu ngala, parndringa ngandra, nga pinakanga nhulu pitjili. Ngapala ngapa kurrari nga thayinga ngapali. Kathi thukali ngala thayi-rnangatji marna-ngadikinitji mandri-rnanga. Kathi thukali, walya kalpurru thalpali or walya darlamurruli, ngarru kathi thukali mandri-rnanga*."
>
> "Then there is the nardoo. They crush it and then rock it in a coolamon. Then they pour the water on it and eat it with the water…They eat it by spooning it into their mouths with a mussel [shell], not with a coolabah leaf or with bark, only with a mussel".

Ian Woods, an elder of the Nari Nari, remembers in addition to eating, nardoo was used to make flour. The flour would be placed on the ground encircling the base of the tree as a bait for possums. The possums would be attracted to the flour, making them easier to hunt. Once captured, the fur of the possum would then be used to make skin cloaks and other bits of equipment, while the meat would be consumed (Woods pers. comms 2016).

4.6 Site location description

The Toogimbie IPA is located on the floodplain of the Murrumbidgee River in southwestern NSW, at the eastern margin of the main Lowbidgee Floodplain that extends from Hay downstream to the Murray River (NSW OEH & NSW Office of Water 2014). The Toogimbie property covers approximately 7,500 hectares, of which approximately 4,600 hectares is included in the Toogimbie IPA and 2,900 hectares held under lease. Approximately 2,000 hectares (MDW Ltd 2011, Smits 2014) across the north of the property is floodplain that is inundated from the Murrumbidgee River when river levels exceed 26,000 ML/d (Figure 9). This area includes a river bank/riparian terrace and low-lying floodplain with flood runners. There are also higher depressions flooded from rainfall runoff.

Within the Toogimbie IPA, approximately 900 hectares are contained in four previous irrigation bays (cells), of which three have the potential to receive water as part of the cultural watering trial (Figure 10). The fourth cell is considered unlikely to be watered as the infrastructure (e.g. embankments) at the western boundary is currently insufficient to contain water on site. The floodplain and associated flood runners within cells 1 to 3 and house wetland are the main area of interest at this stage for the cultural watering because they are enclosed by embankments, enabling water management between each of the cells. Cell 4 was intended to operate as a control for cultural water trial; however, the 2016 flood event prevented this.

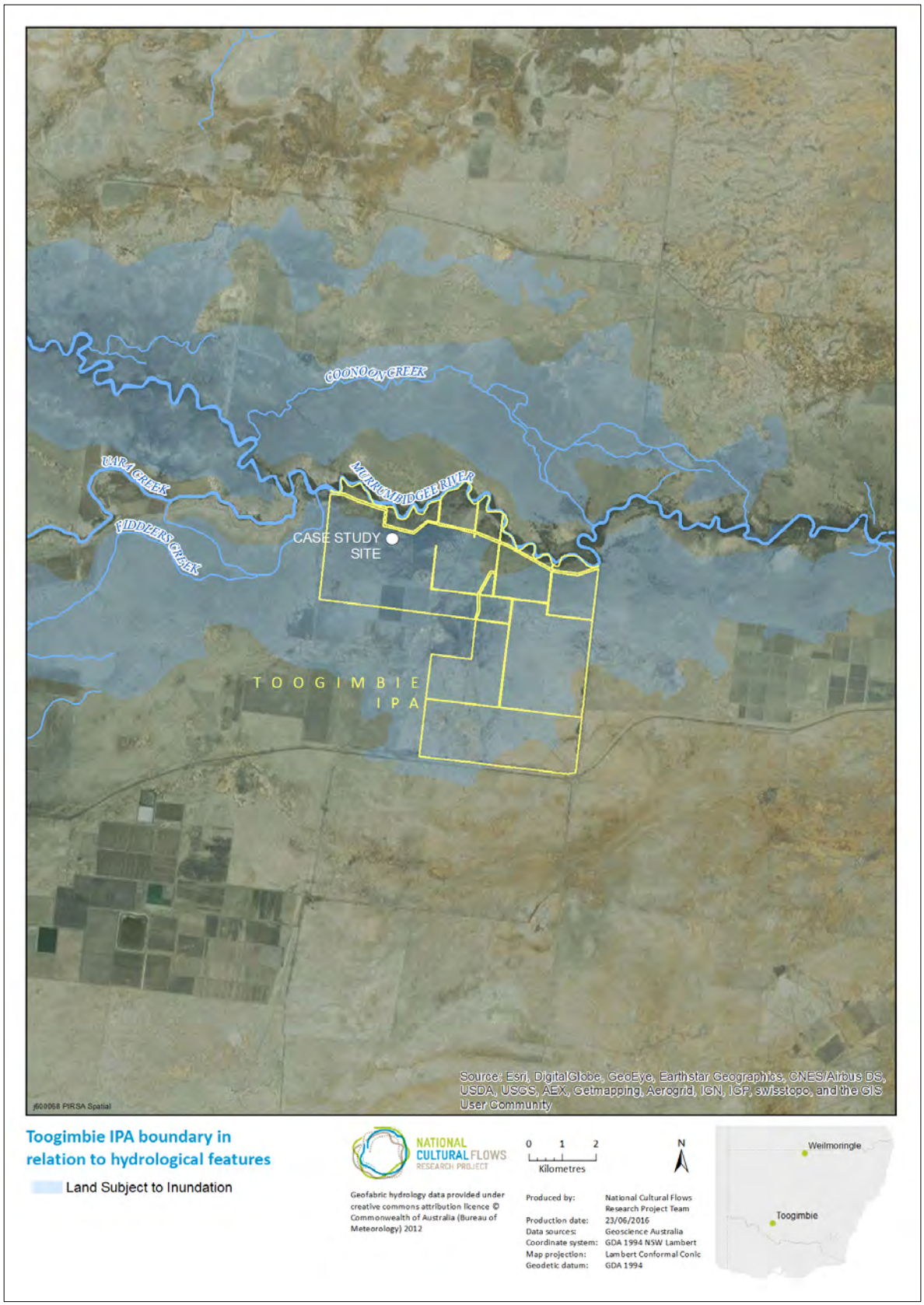


Figure 9: Case study site in relation to Toogimbie IPA and hydrological features

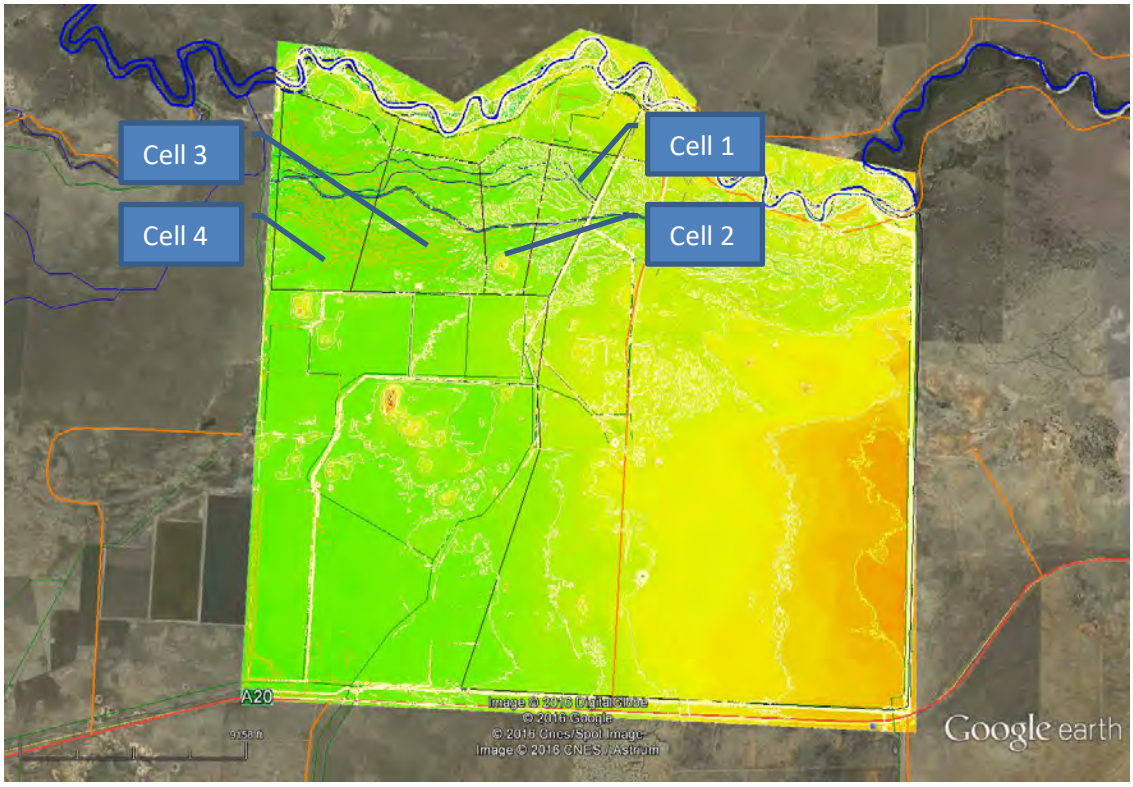


Figure 10: Locality of the watering units (cells) that will be the focus of the cultural watering trial and control cell 4 (C. Gippel, pers. comm. 2016).

4.7 Ecological monitoring and assessment at Toogimbie IPA

The 2016 flood interrupted the planned delivery of water to Toogimbie IPA. It was, therefore, necessary to reconsider the watering objectives and key evaluation questions outlined in the Toogimbie Indicator Framework and Methodology Report (Monitoring and Assessment Plan) (NCFRP 2016e) in terms of whether the flood had the effect(s) that were to be evaluated as part of the planned watering event (e.g. Table 8). Another effect of the 2016 flood was that each of Cells 2 to 4 were inundated, which meant that Cell 4 could not be used as a 'control' as intended in the water trial study design (NCFRP 2016e). Thus, the results can only say that there were differences in the pre- and post-flood conditions (where differences were noted), and that it was not possible to confidently assign responses to the flood alone.

4.7.1 Ecological monitoring approach

The ecological monitoring undertaken at Toogimbie IPA followed that detailed in the Toogimbie Monitoring and Assessment Plan (NCFRP 2016e). The vegetation watering objectives, key evaluation questions, and monitoring variables are summarised in Table 8, and are shown pictorially in Figure 11 and Figure 12.

Table 8: Vegetation watering objectives and key evaluation related to the 2016 flood event

Watering objective	Key Evaluation Questions	Indicators
Increased abundance and extent of bush	Did the 2016 flood event increase the abundance or extent of key	Abundance and/or extent of Nardoo (*Marsilea*

Watering objective	Key Evaluation Questions	Indicators
tucker, medicinal and economic plant species. Increased extent and condition of lignum. Reduced extent and abundance of weed species	bush tucker, medicinal, economic and icon species? Did the 2016 flood event improve the condition of the Lignum community? Did the 2016 flood event increase the extent of the Lignum community? Did the 2016 flood decrease the abundance and extent of weed species?	*drummondii*) and Old Man Weed (*Centipedia cunninghamii*). Lignum condition. Extent of the Lignum (*Duma florulenta*) community. Abundance and extent of weed species.

Monitoring involved (i) vegetation species assemblages, vegetation form and lignum health, and (ii) bird species abundance, at three sites in each of Cells 2, 3 and 4 (Figure 11). Due to time and resource constraints, it was only possible to measure frog species abundance at two sites in each of Cells 2, 3 and 4. The monitoring activities have been summarised in Table 9, and are shown pictorially in Figure 12. Also presented in Table 9 are recommendations for timing and frequency of future monitoring events.

Table 9: Summary of monitoring activities at each site within Cells 2 to 4 at Toogimbie IPA

Theme	Sampling site monitoring activity	Assessment approach	Recommended Timing and Frequency
Vegetation	• Floristics (species cover) within a 20 m x 20 m quadrat. • Vegetation form along a 100 metre transect. • Lignum health assessment (n = 30 bushes).	• Graphs and summary statistics to show pre- and post-flood vegetation species cover (quadrat) and vegetation form (transect). • Pre- and post-flood comparison of native vs. exotic species diversity and foliage cover. • Pre- and post-flood comparison of lignum health.	• Repeat annually in spring, with additional surveys to correspond with flood/watering events (pre inundation plus 3 post inundation sampling events spaced 6 weeks apart).
Birds	• Species abundance recorded at way-points and along a 250 m meandering transect.	• Graphs and summary statistics to show pre- and post-flood bird species abundance. • Non-metric multidimensional scaling, analysis of	• Sampling to occur 1 month before flood/watering events, then every month for 3 months post inundation

Theme	Sampling site monitoring activity	Assessment approach	Recommended Timing and Frequency
		similarity and similarity percentage.	
Frogs	• Species abundance at two call detection points separated by at least 200 m at each site, and within two 50 m x 10 m visual detection quadrats.	• Graphs and summary statistics to show pre- and post-flood frog species abundance. • Non-metric multidimensional scaling, analysis of similarity and similarity percentage.	• Sampling to occur 1 month before flood/watering events, then every month for 3 months post inundation

Graphical presentations of results were prepared using Microsoft Excel 2016, while exploratory ordinations (pattern assessment) and statistics were performed using the statistical package PAST version 3.14 (Hammer 2016). Non-metric multidimensional scaling (nm-MDS, Taguchi and Oono 2005) was used to explore patterns in species assemblages pre- and post-flood, while analysis of similarity (one-way and two-way without replication ANOSIM, Clarke 1993, Clarke and Warwick 1994) was used to explore differences in species assemblages (birds, frogs) both pre- and post-flood and between sites. The species accounting for most of the pre- and post-flood and between site differences were identified using the similarity percentage routine (SIMPER, Clarke 1993). Raw data were normalised by being transformed (square root (n+1)) prior to running the NM MDS, ANOSIM and SIMPER analyses.

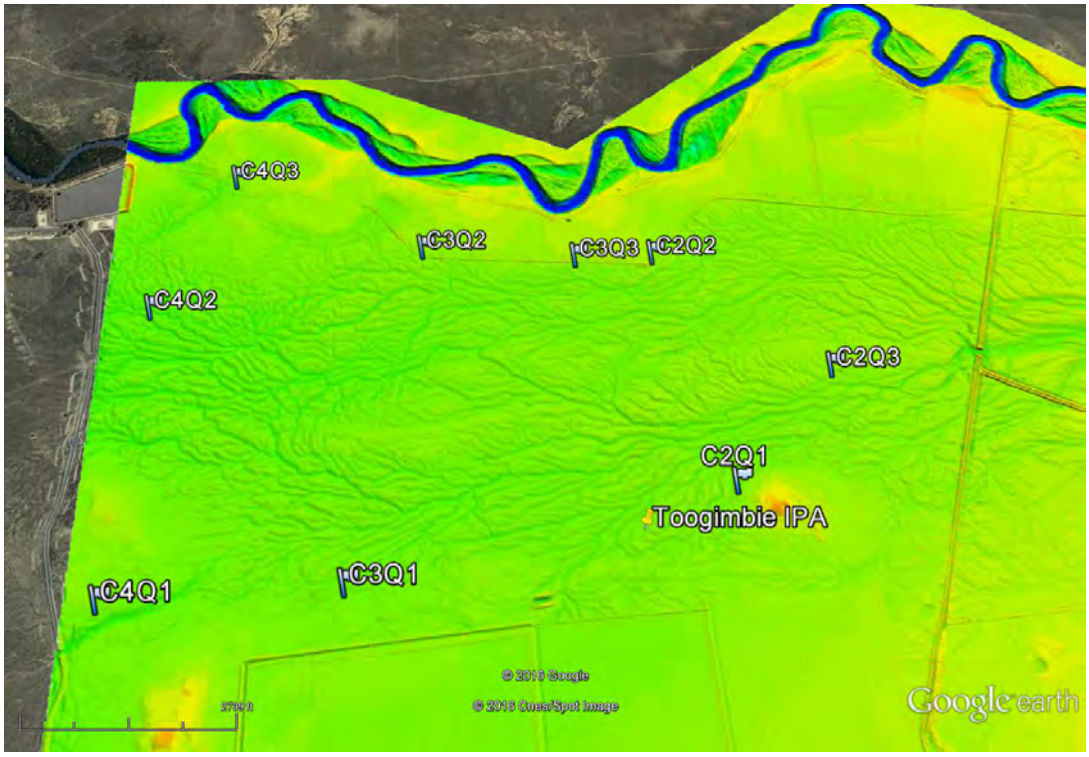


Figure 11: Locality of sampling sites within Cells 2 to 4 at Toogimbie IPA (C. Gippel, pers. comm. 2016).

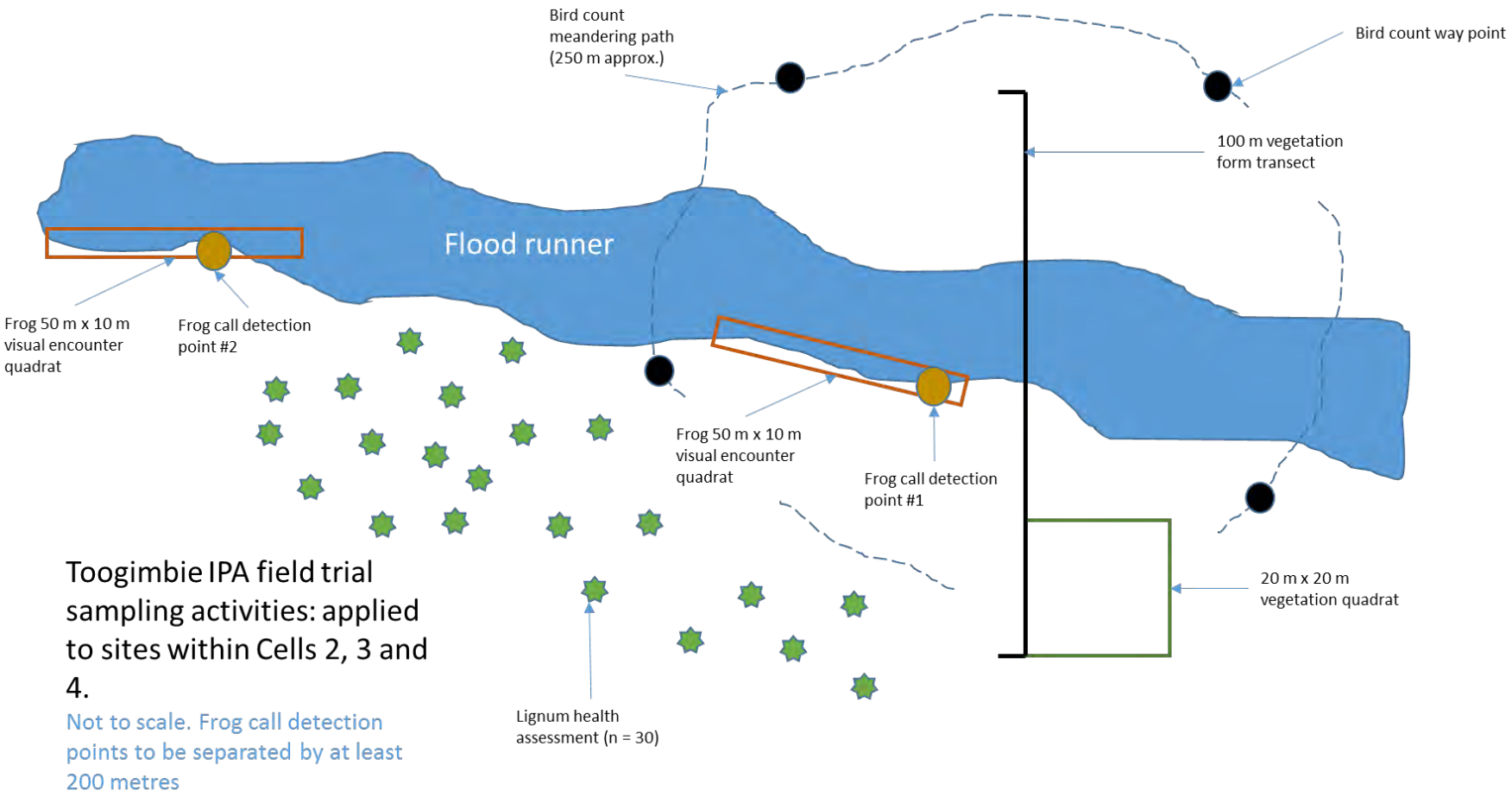


Figure 12: Diagram showing the monitoring activity at each site at Toogimbie IPA.

4.7.2 Ecological monitoring results

Vegetation Community Condition (quadrats)

Vegetation community condition monitoring used NSW OEH standard methods (OEH 2015), consistent also with the approach used for vegetation surveys and mapping across floodplain systems in NSW (Eco Logical Australia 2015). Within 3 randomly located 20 m x 20 m quadrats per cell (9 quadrats for the 3 cells surveyed), the following data was collected:

- Species present.
- Foliage Cover (%, by species).
- % cover of litter (e.g. non-attached plant matter such as leaves etc.).
- % cover of bare ground.
- Species abundance (number of individuals of each species).
- Height and strata information for each species.

Other data usually recorded with this methodology includes crown extent and canopy extent for any tree species present, as well as fallen timber length. These were not applicable in this instance due to the absence of trees and therefore fallen timber.

For each quadrat:

- Corners were marked using star droppers.
- The locations of the NE corner labelled and location recorded using a handheld Garmin 62 csx GPS unit.
- Four site photographs were taken from various angles.

Each quadrat was sampled prior to the flood event (7th and 8th of September 2016) and following the flood event as soon as the site was accessible (13th and 14th of December 2016).

Species Lists

Table 10 presents the list of species observed within the vegetation quadrats at Toogimbie during the pre-flood monitoring, while Table 11 presents species recorded during the post-flood monitoring. During pre-flood monitoring 27 species were recorded (ten exotic species and 17 native species). During post-flood monitoring 26 species were recorded (nine exotic species and 17 native species). 13 species were recorded during both pre- and post-flood monitoring (three exotic and ten native species).

Species found in either pre- or post-flood monitoring but not both, generally fall into one of the following categories:

- Short lived annual species.
- Cool season species (pre-flood conditions) vs. warm season species (post-flow conditions). This can include perennial species whose above-ground parts die off at certain times of year.
- Species that respond to flooding. This could include soil seed bank species that germinate after flooding, perennial species that emerge after flooding, or species introduced by floodwaters.

The points above should be considered when interpreting the different species assemblages for pre- and post-flood, as some differences will be flood related, and others won't.

Table 10: Toogimbie Species List: Pre-flood event

Species	Common Name
Brachyscome sp.	Daisy
Bulbine bulbosa	Bulbine Lily
**Capsella bursa-pastoris*	Shepherd's Purse
Centipeda cunninghammii	Old Man Weed
Chenopodium nitrariaceum	Nitre Goosefoot
Duma florulenta	Tangled Lignum
**Echium plantagineum*	Patterson's Curse
Eleocharis pallens	Pale Spike-rush
**Erodium cicutarium*	Cut-leaf Heron's-bill
Erodium crinitum	Blue Heron's-bill
Geranium retrorsum	Grassland Geranium
Haloragis aspera	Rough Raspwort
**Hordeum lepinorum*	Wall Barley-grass
**Lactuca serriola*	Prickly Lettuce
**Lolium rigidum*	Wimmera Ryegrass
Ludwigia peploides	Water Primrose
Marsilea drummondii	Common Nardoo
**Medicago minima*	Furry Medic
**Medicago polymorpha*	Burr Medic
Plantago cunninghammii	Clay Plantain
Ranunculus pumilio	Ferny Buttercup
Rhodanthe corymbiflora	Grey Sunray
Scleroblitum atriplicinum	Purple Goosefoot
Sclerolaena muricata	Five-spine Bindyi
Senecio glossanthus	Slender Groundsel
**Sisymbrium erysimoides*	Smooth Mustard
**Sonchus oleraceus*	Sow-thistle

Table 11: Toogimbie Species List: Post-flood event

Species	Common Name
Agrostis avenacea	Blown Grass
Alternanthera denticulata	Lesser Joyweed
Brachyscome sp.	Daisy
Bulbine bulbosa	Bulbine Lily
Centipeda cunninghammii	Old Man Weed
Chamaesyce drummondii	Caustic Weed
Chenopodium nitrariaceum	Nitre Goosefoot
**Citrullus sp.*	Wild Melon
Duma florulenta	Tangled Lignum
Eleocharis pallens	Pale Spike-rush
Erodium crinitum	Blue Heron's-bill
**Euphorbia terracina*	False Caper
Haloragis aspera	Rough Raspwort
**Heliotropium curassavicum*	Smooth Heliotrope
**Lactuca serriola*	Prickly Lettuce
Marsilea drummondii	Common Nardoo
**Phyla canescens*	Lippia
Phyllanthus lacunarius	Lagoon Spurge
Rumex bidens	Mud Dock
Rumex sp.	Dock
Sclerolaena muricata	Five-spine Bindyi
**Sisymbrium erysimoides*	Smooth Mustard
Solanum esuriale	Quena
**Solanum nigrum*	Blackberry Nightshade
**Sonchus oleraceus*	Sow-thistle
**Xanthium spinosum*	Bathurst Burr

Culturally significant species

Species identified as being culturally significant to the Research Partners were recorded within the vegetation quadrats both pre- and post-flood. A summary of changes in distribution (no. of sites detected) and abundance for each of these species are presented in Table 12. Other species not identified by the Research Partners as having particular cultural significance, but reportedly used by other Aboriginal groups used for food and medicine (Bulbine Lily – *Galagang* and Bush Tomato - *Miidyum*) have also been included as they showed increased distribution and abundance in the post-flood monitoring data.

Table 12: Summary of changes in distribution

Species	Common Name	No. of Sites Detected		Total Abundance Recorded	
		Pre-Flood	Post-Flood	Pre-Flood	Post-flood
Centipeda cunninghamii	Old man weed	1	2	300	200
Marsilea drummondii	Nardoo	2	7	110	375
Geranium retrorsum	Grassland geranium	4	0	140	0
Erodium crinitum	Crowfoot	8	5	4065	32
Bulbine bulbosa	Bulbine lily	3	1010	5	3036
Solanum esuriale	Bush tomato	0	2	0	32

From this data it can be seen that nardoo (*Nagaadha*) appeared to increase in both distribution and abundance within the vegetation quadrats following the flow event and Old Man Weed was found at one more location but less individual plants were recorded after the flood event. Opportunistic observations did appear to show that Old Man Weed (*Budhaay*) had increased in distribution and abundance in other areas located outside of the quadrats following the flow event, particularly on the margins of flood runners. Both of these species would be expected to increase following flooding and this appears to have been supported by observations at Toogimbie.

Both the Grassland geranium and Crowfoot were observed at less sites and in lower numbers following the flood event, although this is likely due to the lifecycle of these plants, with the above ground parts of these plants typically dying off in early summer. The only way to determine if these species will increase their distribution and abundance will be to repeat the monitoring program in 2017.

Both Bulbine lily (*Galagang*) and Bush tomato (*Miidyum*) were observed to have increased both distribution and abundance following the flood event. In the absence of a control site it can't be definitively stated that these species have increased due to flooding as opposed to seasonal factors, but it does seem likely that the floodwaters have benefited these species.

Species Diversity – Native vs. Exotic

To compare the prevalence of native and exotic species across the entire Toogimbie site, the number of times native species were recorded within quadrats was compared within the number of times exotic species were recorded within quadrats. This data is presented in Table 13.

Table 13: Native vs. exotic species diversity (no. of spp. recorded) within vegetation quadrats at Toogimbie

	Native spp. Diversity		Exotic spp. Diversity	
Cell	**Pre-Flood**	**Post-Flood**	**Pre-Flood**	**Post-Flood**
C2Q1	10	9	6	3

C2Q2	14	9	4	5
C2Q3	8	13	5	5
C3Q1	11	6	4	3
C3Q2	6	11	3	4
C3Q3	8	9	5	3
C4Q1	5	7	5	3
C4Q2	7	7	4	3
C4Q3	3	7	5	5
Total	72.00	78.00	41.00	34.00
Averages (spp./site)	8.00	8.67	4.56	3.78

When considering data from individual quadrats the data is inconsistent, with some showing an increased proportion of native species and decline in exotic species, while others show the opposite response. The overall trend across the entire site is that native species were encountered more often and exotic species less often during the post-flood monitoring. This data is displayed in Figure 13 and Figure 14.

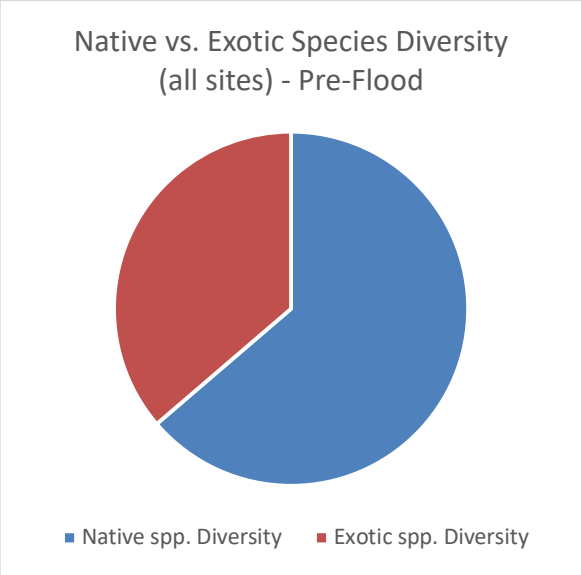


Figure 13: Pre-Flood native vs. exotic species diversity at Toogimbie

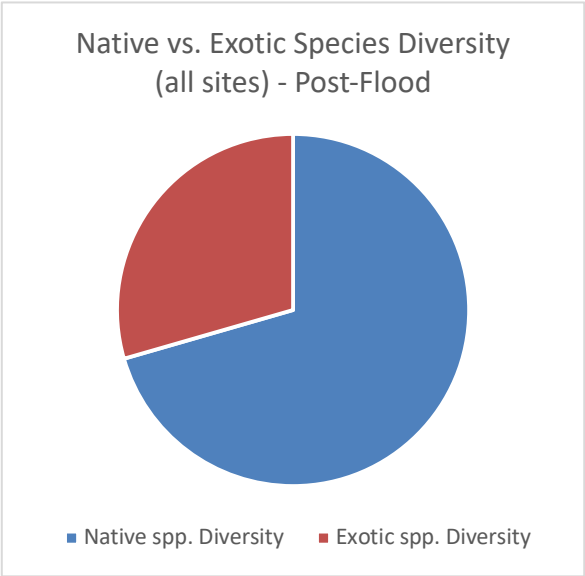


Figure 14: Post-flood native vs. exotic species diversity at Toogimbie

Foliage Cover – Native vs. Exotic (as % of total foliage cover)

Foliage cover can be used in this study to demonstrate what proportion of each site is dominated by native versus exotic species. The foliage cover percentages recorded in the field were expressed as a percentage of the total area, including bare ground and litter. For this analysis these figures were converted into a percentage of total foliage cover only (excluding litter and bare ground) to allow straightforward comparison between the pre- and post-flood monitoring data.

When this data was considered there was a dramatic shift from vegetation communities dominated by exotic species pre-flood (mainly introduced grasses, e.g. Wimmera ryegrass) to vegetation communities dominated by native species post-flood (mostly native forbs, e.g. Lagoon spurge). The change in the proportion of area of the sites occupied by native and introduced species before and after the flood are presented in Figure 15 and Figure 16.

A clear visual representation of the changes that were observed at one particular vegetation quadrat (Cell 4, Quadrat 1) is provided in Figure 17 and Figure 18. From these photographs it can clearly be seen that the site is dominated by grasses prior to the flood event, but following the flood event, this grass cover has been converted to decomposing litter, with the vegetation dominated by the native Tangled lignum and Bulbine lillies (the native Lagoon spurge and Blown grass were also dominant at this site but not clearly visible in the photograph). An improvement in lignum condition is also obvious.

It is reasonable to conclude that the shift toward native species dominated vegetation communities following the flood event is strongly influenced by the flood event itself, due to the dominance of species known to respond to flood events (e.g. Lagoon spurge). It is also fair to say that some of the decline in the dominance of exotic species can be attributed to the time of year, as the exotic cool season grasses (e.g. Wimmera ryegrass) would have naturally died off by December anyway. Without a control site to compare data with, the magnitude of each influence cannot be definitively stated.

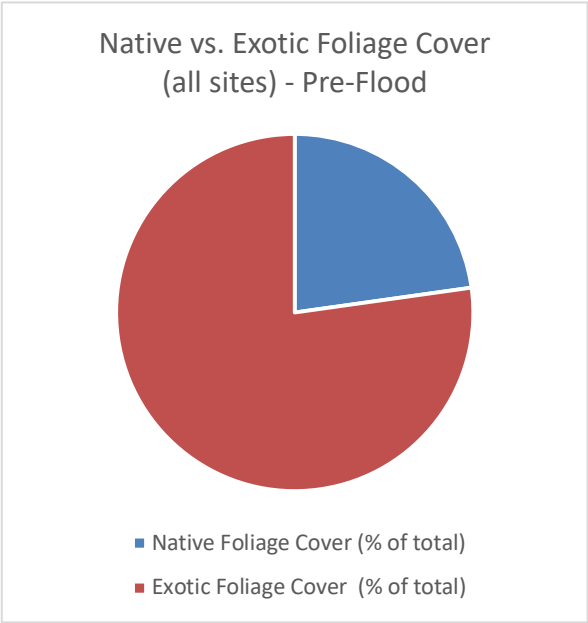


Figure 15: Pre-flood native vs. exotic species foliage cover (as % of total foliage cover)

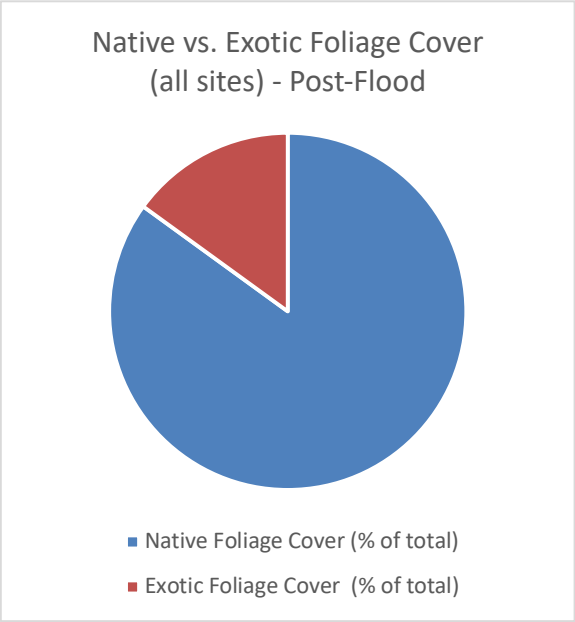


Figure 16: Post-flood native vs. exotic species foliage cover (as % of total foliage cover)

Figure 17: Pre-flood site photograph - Cell 4 Quadrat 1. Note dominance of introduced grasses.

Figure 18: Post-flood site photograph - Cell 4 Quadrat 1. Note improved lignum condition and emergence of numerous Bulbine lilies.

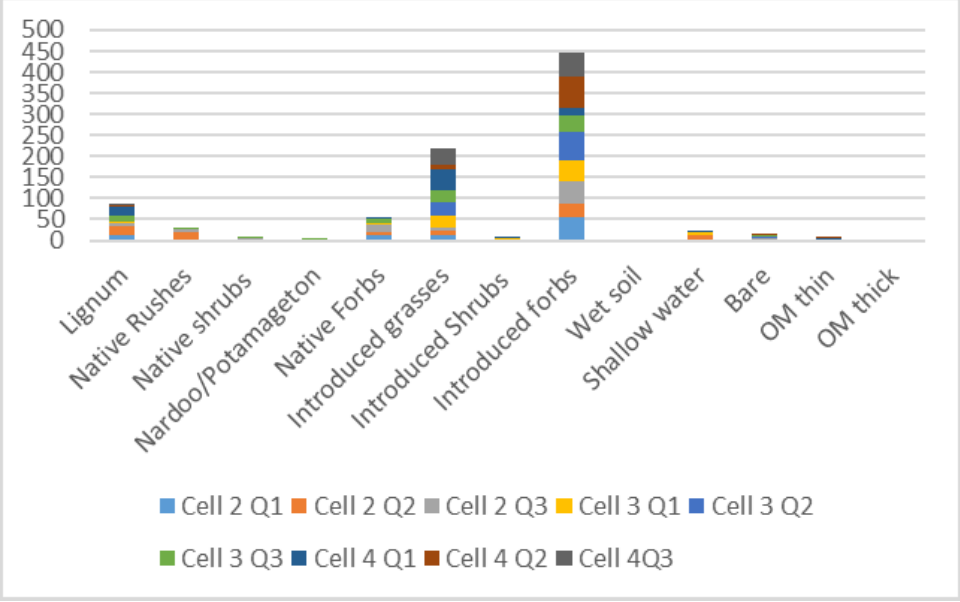
Other Information

Other information can be derived from the vegetation community condition data, such as proportion of bare ground and litter that make up the total ground cover, and information on the structural composition of the vegetation. This information is not being specifically addressed at this time as it isn't directly related to the cultural objectives identified by the Research Partners for this project. It may still prove valuable in the future as the Research Partners continue to add to or modify their objectives for the site. One example might be that traditional uses for certain species that have been recorded at the site are re-discovered, providing insight into how these species may respond to flow events and guiding future management. Another example might be that certain changes to vegetation structure would be considered desirable to improve habitat for culturally important fauna species. The point here is that recording and keeping of ecological data (and continuing to develop the associated skills) could have future value both to the Research Partners and broader Nari Nari community should they wish to expand their monitoring program or objectives for the site.

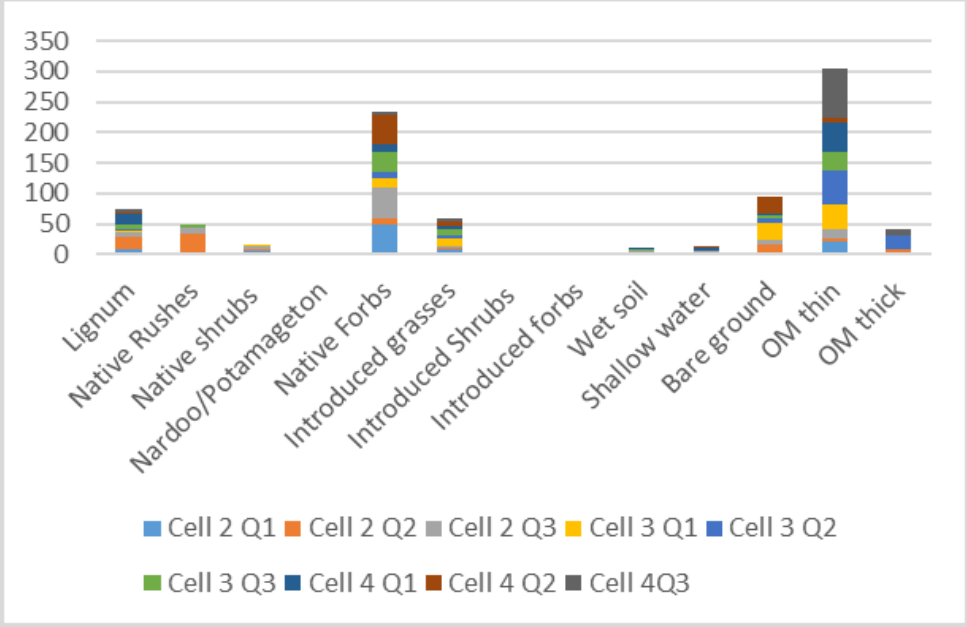
Vegetation form (transects)

The assessment of vegetation form was included to provide an alternative approach to the quadrat assessment described in the previous section, as well as for consistency with the transect approach used for previous vegetation assessment projects undertaken at Toogimbie IPA (Smits 2014).

Vegetation prior to the flood was dominated by introduced forbs (e.g. burr medic, *Medicago polymorpha*) and introduced grasses (e.g. rye grass *Lolium* spp. and barley grass, *Hordeum* spp.) (Figure 19 and Figure 20). Following the flood, vegetation form was dominated by remnant organic matter (presumably of the forbs and grasses that existed pre-flood), native forbs (predominantly lagoon spurge) and bare ground dominated post-flood. There was also a slight reduction in lignum cover (although improved health – see lignum health section, below) post-flood, presumably due to dead or weak branches being removed by floodwaters.

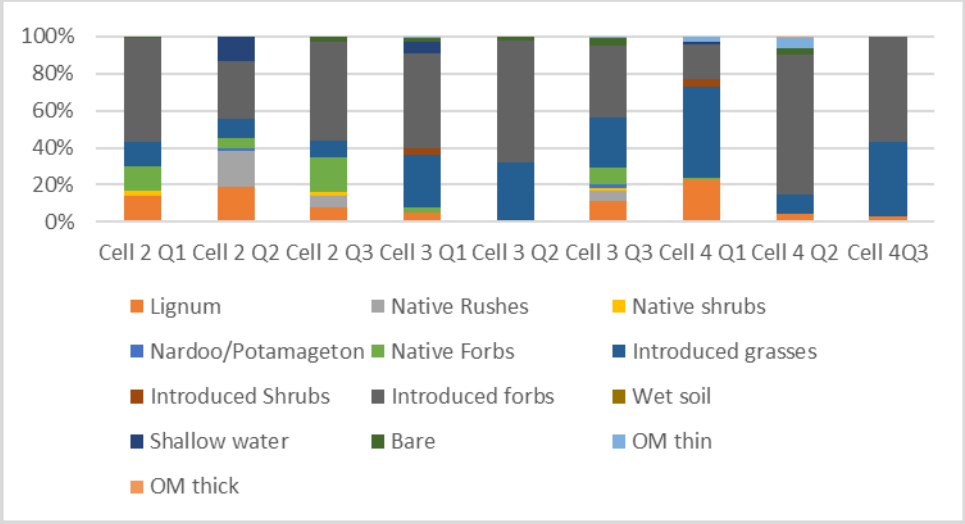


(a)

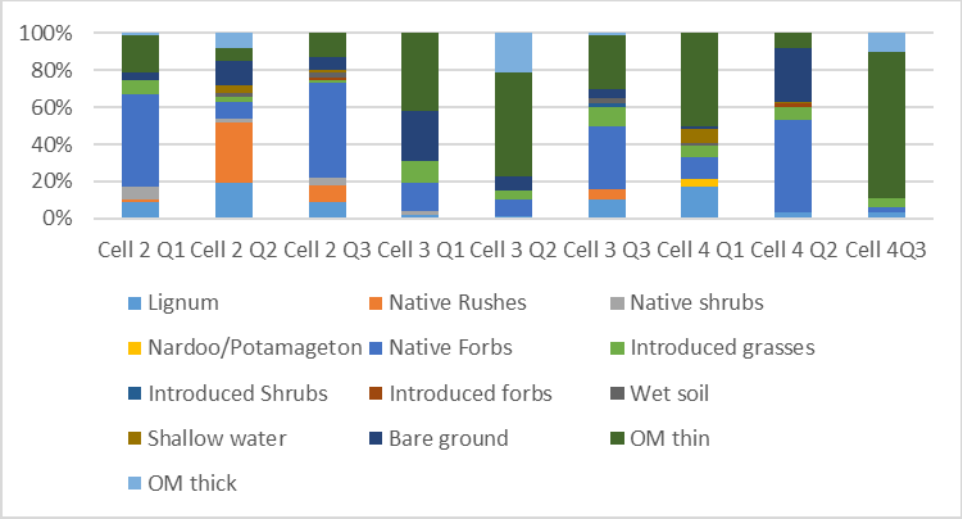


(b)

Figure 19: Comparison of vegetation form across all sites (a) pre-flood and (b) post-flood.



(a)



(b)

Figure 20: Comparison of form at each site (a) pre-flood and (b) post-flood.

Ordination using nm-MDS showed a clear separation of the vegetation forms recorded pre- and post-flood (Figure 21). Notable was the tighter clustering for the pre-flood sampling, due to the dominance of the introduced forbs and grasses, which carpeted much of the groundcover at each site. The greater of separation of sites of the post-flood period was due to the large reduction in introduced forbs and grasses, and greater variation in the proportion of native forbs (e.g. Lagoon spurge, *Phyllanthus lacunarius,* Figure 22), organic matter and bare ground. The pattern of greater annual and perennial groundcover in Cell 2 and greater proportion of organic matter cover and bare ground in Cells 3 and 4 in the post-flood sampling was similar to that recorded by Smits (2014) in the same cells in April 2014. See Appendix 2 Part A and B for detailed vegetation data.

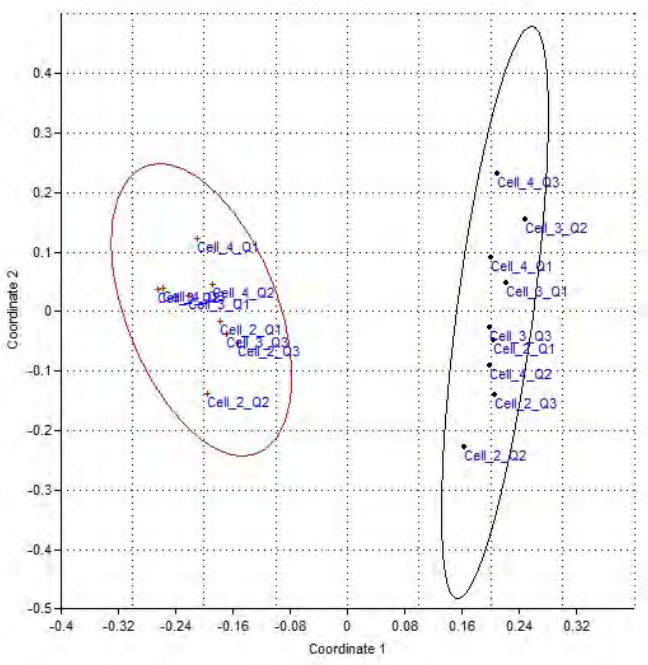


Figure 21: MDS ordination of pre-flood (red) and post-flood (black) vegetation form.

Figure 22: Emerging Lagoon spurge (Cell 4) that carpeted areas of each cell in December 2016 (Photo: Peter Cottingham).

Lignum health

Lignum condition was assessed within each cell at Toogimbie, with 30 individual plants assessed in the vicinity of each of the nine vegetation monitoring sites (270 plants in total). The same plants were assessed both before and after the flood event to provide an indication of any changes to the proportion of viable stems (viability) and crown colour that had occurred post-flood. Table 14 shows the category scoring system used to measure each variable.

Table 14: Lignum viability and condition scoring system

Viability		Colour	
Score	**%Viability**	**Score**	**Colour of viable crown**
6	>95%		
5	>75% to 95%	5	All green
4	>50% to<75%	4	Mainly green
3	>25% to 50%	3	Half green, half yellow/brown
2	>5% to 25%	2	All yellow/brown
1	>0% to 5%	1	Mainly yellow/brown
0	0%	0	No viable stems

The viability and colour score data for all lignum plants assessed were averaged to provide basic overall measures of lignum condition at the site pre- and post-flood. This data is displayed in Figure 23.

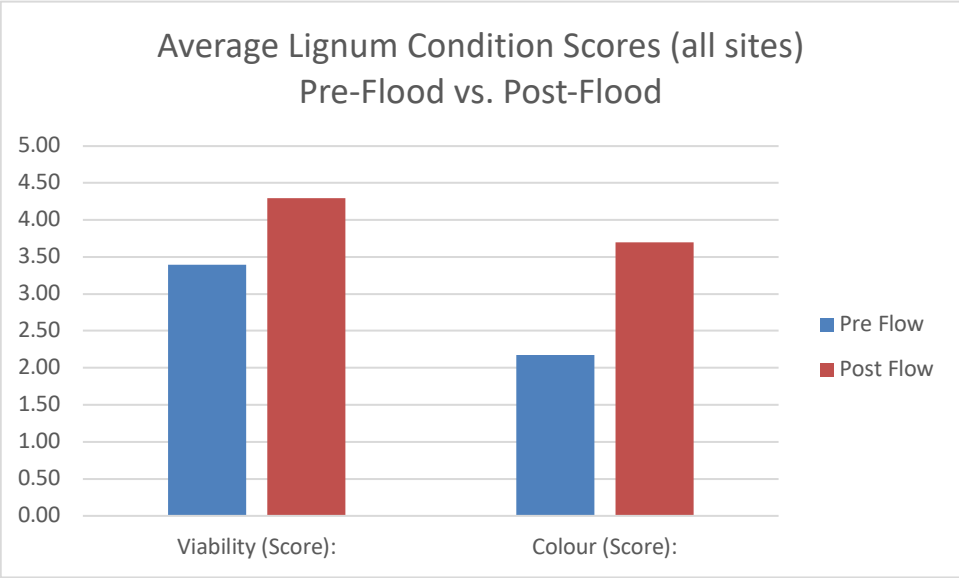


Figure 23: Average lignum condition scores pre-flood vs post-flood

Figure 24 and Figure 25 show the same data presented in Figure 23, but broken down into the three cells (irrigation bays), showing that the trend is consistent across all sites and not skewed by any anomalous data.

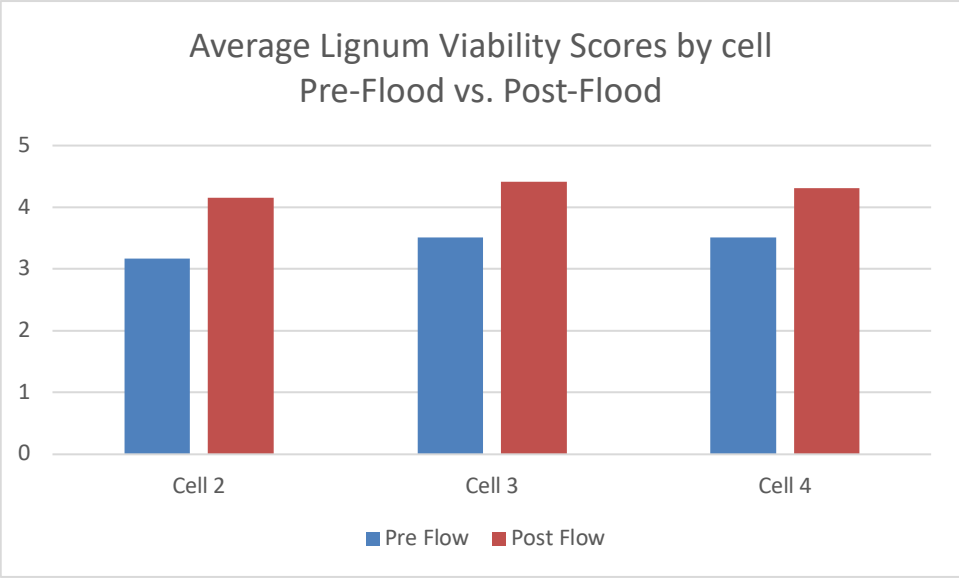


Figure 24: Average lignum viability scores by cell pre-flood vs post-flood

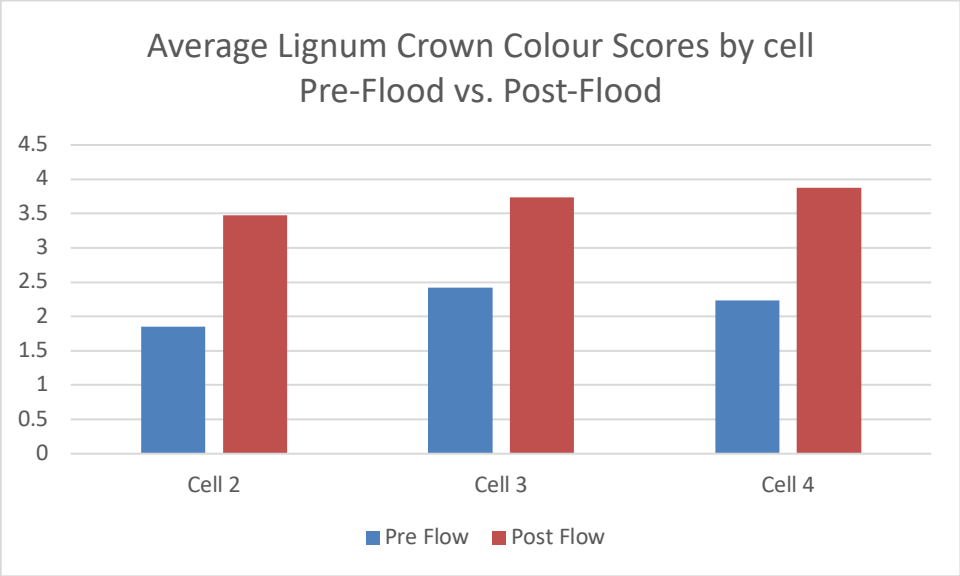


Figure 25: Average lignum colour scores by cell pre-flood vs post-flood

The data for all sites/cells shows obvious improvements in both lignum viability and colour following the flood event. Average viability went from category score 3 (>25% to 50% viability) pre-flood to category score 4 (>50% to 75%) post-flood, and average colour went from category score 2 (all yellow/brown) pre-flood to category score 3 (half green, half yellow/brown) post-flood. Figure 26 and Figure 27 show lignum plants displaying the typical change in condition that was observed.

Figure 26: Typical lignum condition pre-flood

Figure 27: Typical lignum condition post-flood

Aerial imagery taken over the vegetation sampling sites will show variations in vegetation greenness and extent of lignum cover at each site. Lignum extent is not expected to increase significantly as a result of a single watering or flood event. Increased lignum extent is more likely to be a result of longer term favourable conditions, such as more regular watering of the site, which might occur with regular favourable seasons within a certain period, or potentially as a result of a cultural water allocation. See Appendix 2 Part C for detailed lignum data results.

Birds

The objectives and key evaluation questions that were relevant, given the 2016 flood event, are listed in Table 15.

Table 15: Wetland bird watering objectives and key evaluation related to the 2016 flood event

Watering objective	Key Evaluation Questions	Indicators
Increased frequency of migratory or colonial nesting waterbird breeding. **Increased species richness of water birds.** **Increased abundance of water bird and associated shrubland species.**	Did the 2016 flood event increase the frequency of breeding for migratory, colonial-nesting or icon species? Did the 2016 flood event increase water bird species richness? Did the 2016 flood event increase the abundance of	Breeding pairs of: • Black swan D*huundhuu/Ngiyaran /Gunyig* (*Cygnus atratus*) • White necked heron (*Ardea pacifica)* • Australian pelican *Gulambali/ Gulaygali/Birriyag* (*Pelecanus conspicillatus*)

Watering objective	Key Evaluation Questions	Indicators
	water and associated shrubland bird species?	• Any JAMBA/CAMBA/ROKAMBA listed species Waterbird species richness Waterbird species abundance, including that of: • Black swan • White-necked heron • Whistling Kite (*Haliastur sphenurus)* • Pacific black duck (*Anas superciliosa)* • Wood duck (*Chenonetta jubata*) • Mountain duck (*Tadorna tadornoides*) • White ibis (*Threskiornis moluccus*) • Straw-necked ibis (*Threskiornis spinicollis*) • Yellow rosella (*Platycercus elegans flaveolus)*, • White-winged fairy-wren (*Malurus leucopterus)*, • Red-capped robin (*Petroica goodenovii)*

Over 20 bird species were recorded across Cells 2 to 4 during the pre- and post-flood periods (Appendix 1). However, this number under-represents the actual number of species present, as there were multiple but unidentified species assigned to the 'unidentified raptor' and 'cryptic shrubland' groups. These groups were established to account for sightings where bird identification and abundance was difficult (e.g. distance or behaviour made identification difficult). For example, individuals of species such as the Australian reed warbler (*Acrocephalus australis*) and Little grass bird (*Megalurus gramineus*) were sighted, often in the same area, but their number could not be confirmed. They were therefore assigned to 'cryptic shrubland' group.

Galah (*Eolophus roseicapilla*), cryptic shrubland species (e.g. Australian reed warbler, little grass bird, white faced chat *Epthianura albifrons*) and straw-necked ibis B*urrurgiyan* were the most abundant bird species recorded across Cells 2 to 4 (Figure 28). Straw-necked ibis, Black duck and White faced heron were the most abundant waterbird species recorded.

Bird abundance was higher in the pre- (n = 419) than in the post-flood sampling period (n = 307) (Figure 29). The number of species present was also high pre-flood (n = 19) than post-flood (n = 14), and ordination (nm MDS) results suggest that there was a significant difference in bird populations between the two surveys (Figure 30). This was confirmed from ANOSIM results (Table 16), and SIMPER analysis suggested the differences were due to reduced Galah and increased

Straw-necked ibis and Cryptic shrubland birds in the post-flood sampling period (Table 17). There was no significant difference in bird populations between cells.

The presence of raptors, and waterbirds such as Black duck, Straw-neck ibis, White ibis, Australian shelduck, and White-face heron was of particular importance to the Research Partners for both cultural and environmental reasons. Of these species, only Straw-neck ibis *Burrurgiyan* abundance increased following the flood. Other species of interest to the Research Partners (e.g. black swan *Dhuundhuu/Ngiyaran/Gunyig*) were not recorded within the Cells during either the pre- or post-flood assessments. However, they were noted to have bred locally at Toogimbie IPA during the flood (Figure 31).

See Appendix 2 Part D for detailed Toogimbie bird survey data.

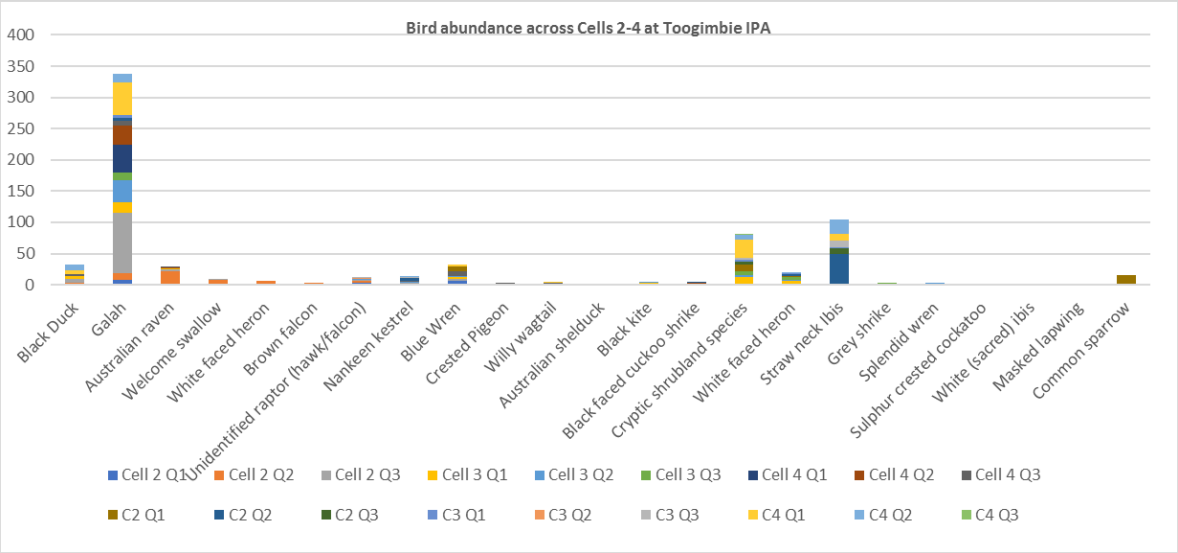


Figure 28: Bird abundance across all sites in Cells 2 to 4 at Toogimbie IPA.

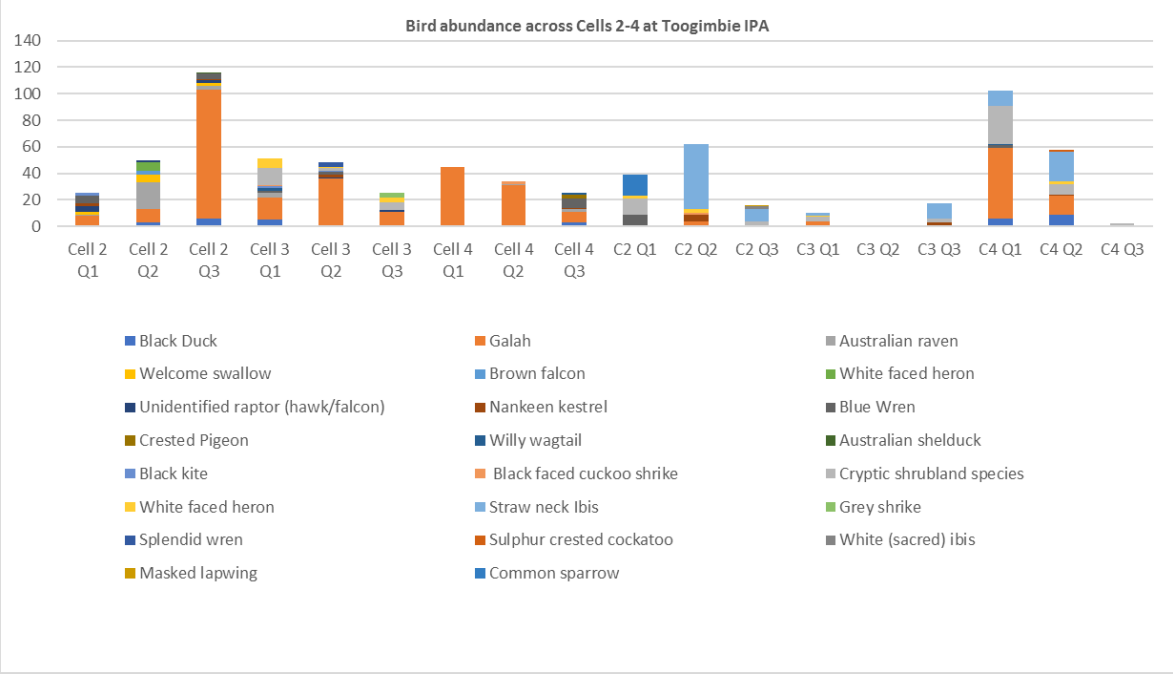


Figure 29: Comparison of pre- and post-flood bird abundance across all sites in Cells 2 to 4 at Toogimbie IPA.

Table 16: p vales for two-way ANOSIM of bird population data. Significant differences between populations are marked in orange.

	Correlation, R	p-value
Difference Pre-flood versus Post-flood	0.519	0.004
Difference between Cells	0.086	0.204

Table 17: PRIMER results showing the species most responsible for differences in bird populations.

Taxon	Contribution	Cumulative %	Mean abundance Pre-flood	Mean abundance Post-flood
Galah	4.8	24.2	5.1	2.3
Straw-neck Ibis	2.7	37.6	1.0	3.0
Cryptic shrubland species	1.9	47.1	1.6	2.5

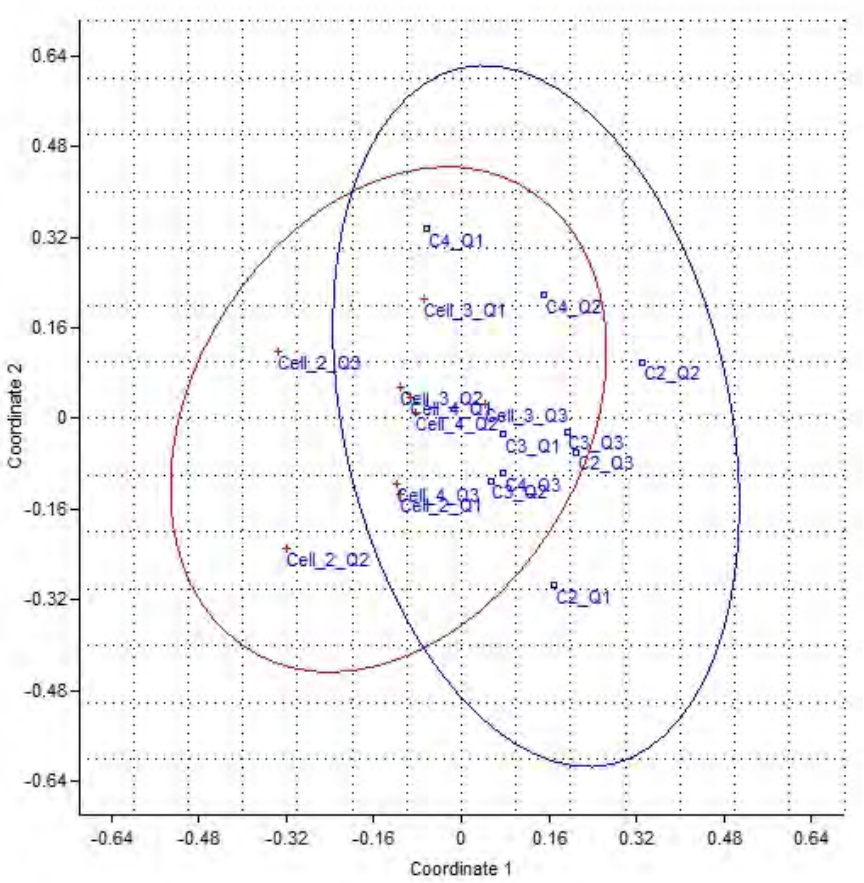


Figure 30: Comparison of pre- (red) and post-flood (black) bird populations in cells 2 to 4 at Toogimbie IPA.

Figure 31: Swans Dhuundhuu/Ngiyaran/Gunyig and cygnets on the adjacent Murrumbidgee river, following breeding at Toogimbie IPA in October 2016 (Photo: courtesy of Jamie Woods).

Figure 32: Immature White-fronted chat (Epthianura albifrons), one of numerous cryptic shrubland species recorded Toogimbie IPA (Photo: Peter Cottingham).

Frogs

Table 18: Frog objectives, key evaluation questions and indicators

Watering objective	Key Evaluation Questions	Indicators
Increased frog species richness.	Did the 2016 flood event increase frog species?	Frog species richness and abundance.

Five frog species were recorded across Cells 2 to 4 during the pre- and post-flood periods. Spotted Marsh Frog (*Limnodynastes tasmaniensis*), Beeping Frog (plains froglet) (*Crinia parinsignifera*) and Southern Bell Frog *Gulaangga* (*Litoria raniformis*) were recorded in both surveys, while the Barking Marsh Frog (*Limnodynastes fletcheri*) and Peron's Tree Frog (*Litoria peroni*) were only recorded during the post-flood survey. The most abundant species were the Beeping Frog and the Spotted Marsh Frog (Figure 33).

Overall, frog abundance (Figure 34) was higher in the pre-flood period (n = 367 across three species) compared with the post-flood period (n= 93 across 5 species). Further investigation is required to establish the extent to which this was related to factors such as the dispersal of frog populations during the flood, increased predation, and the completion of breeding by the frogs recorded pre-flood in September 2016. Additional sampling in the months following watering (or the flood in this instance) is warranted to see if frog populations increase in time after the flood.

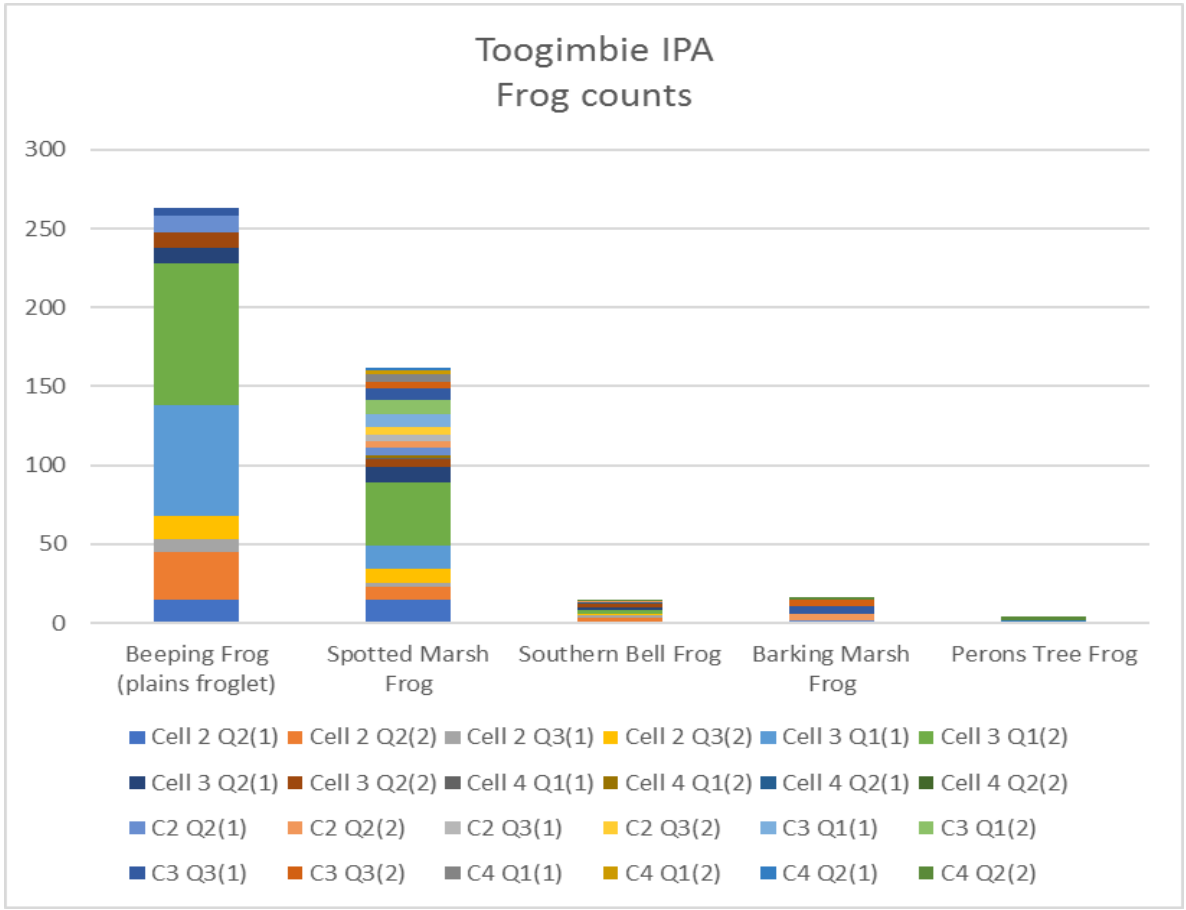


Figure 33: Frog abundance across all sites in Cells 2-4 at Toogimbie IPA.

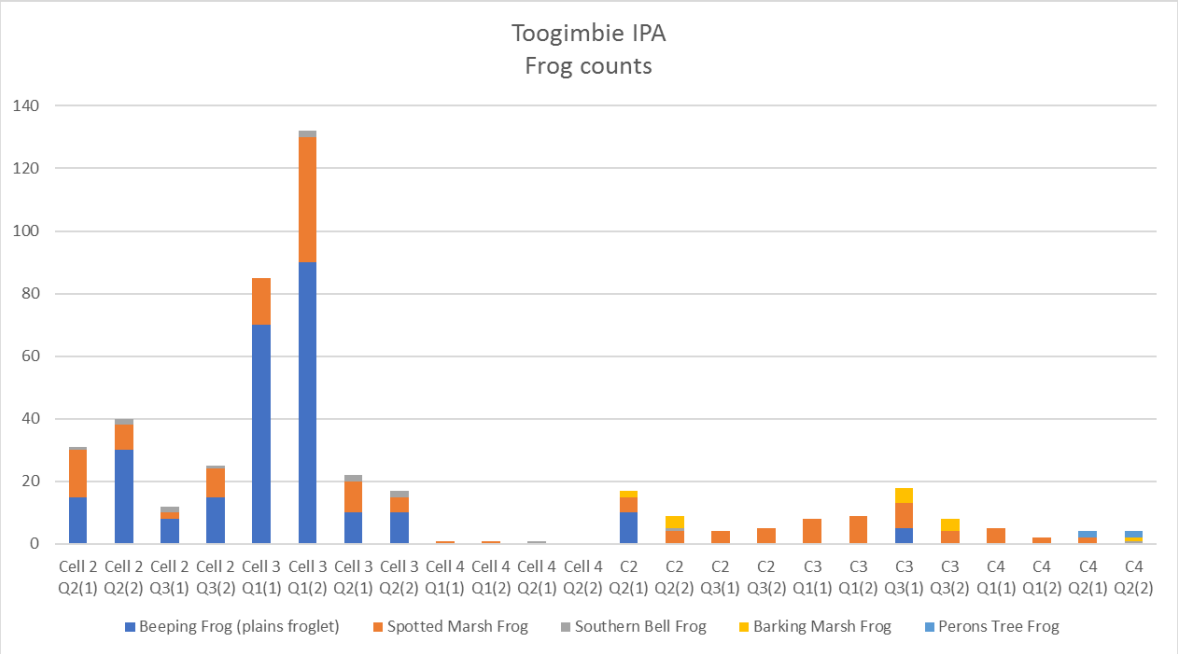


Figure 34: Comparison of pre- and post-flood frog abundance across all sites in Cells 2-4 at Toogimbie IPA.

Ordination (nm MDS) results showed a separation of the frog populations that occurred pre- and post-flood (Figure 35). ANOSIM results indicated that there were substantial between survey and between site differences in frog populations (Table 19). However, there was no significant difference between the pre- and post-flood populations recorded in Cell 2 and Cell 3, despite a significant difference between the pre- or post-flood populations (i.e. populations in Cells 2 and 3 responded in a similar fashion to the flood). PRIMER analysis indicated that this was due to the lower number of Beeping Frogs and Spotted Marsh Frogs, along with the presence of Barking Marsh Frog recorded in the post-flood.

See Appendix 2 Part E for detailed Toogimbie frog survey data.

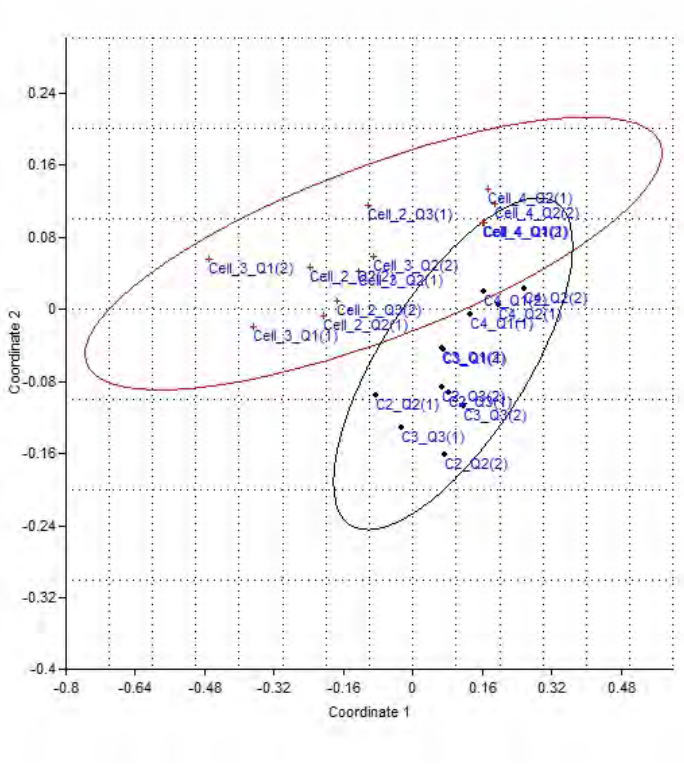


Figure 35: Comparison of pre- (red) and post-flood (black) frog populations in cells 2-4 at Toogimbie IPA.

Table 19: p vales for two-way ANOSIM of frog population data. Significant differences between populations are marked in orange.

	Cell 2	Cell 3	Cell 4	C2	C3	C4
Cell 2	0.000	0.451	0.025	0.027	0.031	0.027
Cell 3	0.451	0.000	0.029	0.027	0.029	0.027
Cell 4	0.025	0.029	0.000	0.031	0.033	0.030
C2	0.027	0.027	0.031	0.000	0.631	0.287
C3	0.031	0.029	0.033	0.631	0.000	0.056
C4	0.027	0.027	0.030	0.287	0.056	0.000

Note: Sites denoted by 'Cell *' represent pre-flood data, while sites denoted as 'C *' represent post-flood data.

Table 20: PRIMER results showing the species mostly responsible for differences in frog populations.

Taxon	Contribution to differences in populations	Cumulative %	Mean abundance Pre-flood	Mean abundance Post-flood
Beeping frog (plains froglet)	28.4	48.2	20.7	1.3
Spotted marsh frog	16.3	75.8	8.8	4.7
Barking marsh frog	3.8	82.3	0.0	1.3

4.7.3 Summary of ecological findings

Key findings of the ecological monitoring results for Toogimbie are summarised in Table 21. These results show how a number of cultural objectives appear to have been satisfied by observed ecological changes following the 2016 flood event. It needs to be highlighted that these results are not conclusive due to the uncontrolled nature of the flood event, and the resultant lack of a control site to determine if these changes are completely the result of flooding or if other factors are responsible.

Table 21: Summary of outcomes from the 2016 flood event

Watering objective	Key Evaluation Questions	Summary of outcomes
Increased abundance and extent of bush tucker, medicinal and economic plant species.	Did the 2016 flood event increase the abundance or extent of key bush tucker, medicinal, economic and icon species?	Results suggest the flood resulted in an increase in distribution and abundance of culturally significant vegetation species such as Nardoo *Nagaadha* (*Marsilea drummondii)* and Old Man Weed *Budhaay* (*Centipeda cunninghamii*).
Increased extent and condition of lignum.	Did the 2016 flood event increase the condition of the Lignum community?	Results showed a clear improvement in Lignum condition (viability and greenness) following the flood event.
Reduced extent and abundance of weed species	Did the 2016 flood event decrease the abundance and extent of weed species?	Results showed a significant reduction in abundance and extent (represented by foliage cover) of exotic vegetation at all sites following the flood event.
Increased frog species richness.	Did the 2016 flood event increase frog species?	Results suggest the flood resulted in an increased number of frog species present, but lower overall frog abundance.
Increased species diversity and abundance of water bird and associated shrubland species.	Did the 2016 flood event result in increased bird species diversity and abundance?	Results were not able to show an increase in bird species diversity and abundance following the December 2016 flood.

4.7.4 Comparison of natural flood versus managed flow outcomes

The arrival of the natural flood at Toogimbie IPA in September-October 2016 was a departure from the planned (pumped) delivery of water from the Murrumbidgee River. Natural floods can have numerous ecological benefits, such as providing organic matter and nutrients that are cycled during floods (e.g. Boulton and Brock 1999) to support pulses of productivity. This in turn

contributes to food webs and provides the food base for higher organisms such as frogs, fish and waterbirds. The connectivity between different floodplain areas, and associated plant and animal habitats, also plays an important role in the dispersal and recruitment of organisms. Even though much of the Murrumbidgee River floodplain has been cleared for development such as agriculture (NSW OEH and Office of Water 2011), there remains a mosaic of environments, ranging from terrestrial habitats that are seldom flooded to aquatic environments that are permanently wet. For many species (e.g. waterbirds, native fish), floods can trigger breeding events, migration, and dispersal (e.g. Wassens et al. 2016, Brandis et al 2011). This, along with the mosaics of habitat that result from flooding contributes to maintaining biodiversity in the region.

Native remnant vegetation along the Murrumbidgee River corridor is mainly dominated by communities of river red gum along river banks and black box woodlands and lignum and nitre goosefoot swamps along the flood flow paths away from the river. These species are flood dependent and rely on frequent inundation for general health and regeneration. While delivering water directly from the river (pumping) can provide the watering needs of these plant species, other benefits such as boosts to aquatic production from increased nutrient availability are unlikely to be met to the same extent. Despite this, the flood event did have the desired outcome of greatly reducing the prevalence of weed species and promoting the grown of native plant species across the study area, as was anticipated with the delivery of a cultural flow. The condition of lignum increased, as would have been expected under a planned cultural flow event, and species of special interest to Research Partners, such as old man weed, increased in abundance following the flood, much as anticipated.

While the number of frog species present at Toogimbie IPA increased from three to five species following the flood, frog abundance was noted to decrease. Frog abundance was expected to be maintained or even increase with the delivery of a planned cultural water event. Reduced frog abundance was presumably due at least in part to dispersal of individuals by the flood. However, it may also have been influenced by frogs having completed their breeding cycle, resulting less calling (and therefore detection) by males during the post-flood field trip in December 2016. Since then, anecdotal reports by Research Partners suggest that frog activity increased significantly as the 2016/17 summer progressed (Ian Woods, NNTC, pers. comm.). This highlights the need for repeat (follow-up) surveys to monitor post-watering events over a greater time period that was possible for this project.

The number of bird species and abundance was also noted to have decreased following the flood, rather than increase as was expected with the delivery of a cultural watering event. Large scale floods are known to stimulate migration and breeding of waterbirds, the effects of which can vary at local, regional and national scales (e.g. Roshier et al. 2002). For example, waterbirds may disperse during floods to take advantage of feeding and breeding habitats elsewhere. Waterbirds may also respond depending on the status of wetting and drying cycles. While bird abundance and species number declined at Toogimbie IPA after the December 2016 flood, it is expected that species and abundance numbers would increase at the site under a cultural flow event, particularly if it occurred when the nearby landscape was dry. This expectation is supported by observations of the response of waterbirds to the newly established swan rookery (Figure 36).

Figure 36. Visitation by hundreds of waterbirds at the newly established swan rookery at Toogimbie IPA, March 2017 (photo: Jamie Woods).

4.8 Social, health and wellbeing evaluation and assessment at Toogimbie

4.8.1 Social monitoring approach

Socio-cultural assessment for the Toogimbie site was extrapolated from the program logic and from the cultural targets identified in the cultural flow objectives. Some of the key targets identified were not conducive to monitoring, such as the achievement of a permanent tradeable water allocation or the establishment of formal protection of the site's wetland values. Key areas for monitoring socio-cultural outcomes related to cultural flows were identified to include (see NCFRP 2016c):

- Monitoring of communal events at the site (including attendance, duration, youth involvement, elder involvement, Aboriginal / non-Aboriginal involvement, volunteering, participant satisfaction).
- Monitoring of employment status of Nari Nari employees (employment at Toogimbie or long-term employment at other locations).
- Monitoring of volunteer and in-kind contributions to the management of the (number of volunteer hours, estimated value of in-kind contributions).
- Monitoring of harvest activities at Toogimbie with estimated actual or implied economic value (hunting, fishing, bush medicine, art and crafts, artefacts etc.).
- Monitoring complaints to Council, State environmental agencies or other relevant body associated with dust and erosion from Toogimbie.
- Self-reported health and well-being of community members, including psychological distress, positive wellbeing, self-esteem, sense of support.
- Monitoring of changes in perceptions in health factors for the community.

The objectives, key evaluation questions and indicators for the cultural outcomes theme are summarised in the table below.

Table 22: Toogimbie cultural flow objectives, evaluation questions and indicators

Watering objective	Key Evaluation Questions	Indicators
Increased feeling of wellbeing by Nari Nari people due to the improved environmental condition of Toogimbie IPA **Increased health of the Nari Nari and wider Aboriginal community** **Increased involvement of Aboriginal people in management, recreational and cultural activities on site, with an emphasis on Elders and young people.** **Improved community governance on site due to access to new information, skills, cultural knowledge and resources.** **Increased knowledge preservation (including language), and cultural regeneration across generations of Nari Nari** **Enhanced site management for animal and vegetation species of cultural significance to enable customary practice** **Improved capacity for enterprise development including cultural, conservation and science tourism** **Improved long-term, science and culture-based site planning** **Acquire a permanent, tradeable water allocation for Aboriginal cultural, socio-economic, or Aboriginal Environmental Outcomes**	Did cultural flows increase mental health and well-being of Nari Nari people and others after visiting Toogimbie IPA? Did cultural flows increase the number of Aboriginal people involved with recreational and cultural activities at the Toogimbie IPA? Did cultural flows contribute to employment, training or educational outcomes for Nari Nari people? Did cultural flows result in the increased use of medicinal plants? Did cultural flows increase the foods and materials (for customary use) collected at Toogimbie IPA? Did cultural flows increase the presence of wetland birds of cultural or iconic significance? Did cultural flows increase traditional knowledge preservation and regeneration? Did cultural flows result in increased tourism numbers at Toogimbie IPA? Did management of cultural flows lead to improved long-term science and culture-based planning at Toogimbie IPA? Did management of cultural flows acquire a permanent, tradeable water allocation? Did management of cultural flows provide formal and permanent	Personal mental health and wellbeing index Abundance or extent of key floodplain, medicinal or food plant species, including reeds (e.g. Phragmites, Typha), Nardoo, Old man saltbush and Lignum. Number of research and management collaborations with science, conservation, health or cultural or research organisations Frequency, duration and number of participants (including the number of young people and elders) at cultural events*. Participant satisfaction at cultural events*. Number of tourism visits, (including length of stay, revenue generated, ratio of Aboriginal/non-Aboriginal participants) Five-yearly updates of Toogimbie IPA management plans based on best available science and cultural knowledge. Review of governance arrangements for succession planning of site management

Formal and permanent recognition of the Toogimbie wetland **Increase in employment of Aboriginal people at Toogimbie as employees or volunteers,**	recognition of the Toogimbie wetland?	

4.8.2 Socio-cultural indicators

In addition to this framework, socio-cultural indicators and appropriate methods were developed for the monitoring the changes associated with the single intervention event of the flow trial. In this case, the socio-cultural flow trial objectives – to establish a water regime to improve condition of dominant floodplain vegetation by 2020 – would not be immediately reflected in the monitoring framework designed to assess change over the intermediate time horizon. As a result, Research Partners developed a series of indicators based on the anticipated observable changes in the context of the watering trial, and the achievement of criteria that would define a 'successful' cultural watering event. The general monitoring framework was structured around the "Most Significant Change" (MSC) approach, where survey and other data gathering instruments are used to supplement personal and group accounts of change in order to isolate specific accounts of change that can be characterised as the most significant (Davies and Dart 2005).

The versatility of the MSC approach to participatory monitoring and evaluation at an intervention level derives from compatibility with action research more generally. Data generated through the collection of stories allowed Research Partners to assess outcomes based on the values most relevant to them. The process involves the collection of significant change stories from participants before, during and after the process, and the collaborative sharing of those stories in a way that enables participants to assess their 'significance'. Because the process is structured around reflective learning, it facilitates analysis and social learning and supports the conceptualising of impact at a group or organisational level. As a qualitative monitoring technique, it is also especially conducive to the emergence of unanticipated outcomes – this was highly valued by the Toogimbie Research Partners who wanted to ensure a rich, complex picture of the outcomes of the process was captured by the research.

Accounts of change resulting from the flow trial and data gathering based on the indicators developed in consultation with the Research Partners were to be expressed in terms of:

- Personal (self-reported) health and wellbeing
- Community/regional health and well-being
- Event-based participant evaluation
- Estimated generated value of flow event
- Improved knowledge, site management and planning

It was recognised that the estimated generated value of the flow event for the planned trial would help to contribute to monitoring tools and practices that would be applicable to the assessment of outcomes from water trading should a tradeable entitlement become available. Although not relevant in the context of the planned trial, the range of benefits generated from the temporary trade of the cultural water allocation to either other users or to downstream Aboriginal communities was identified as a priority area for monitoring, and a major objective of a cultural water allocation more generally. It was further recognised that the benefits of water trading were

not merely economic, but had important cultural esteem impacts associated with community self-reliance.

4.8.3 Social monitoring results

In order to generate monitoring data, a series of survey instruments and monitoring protocols were developed in consultation with Research Partners. These instruments are provided in Appendix 3, and include:

- Personal Health and Wellbeing Self-Assessment Survey.
- Community/Regional Wellbeing Assessment Survey.
- Event Participant Evaluation form.
- Post-flow focus group protocol.

In addition, in order to assess estimate generated value, Research Partners recorded employment hours, volunteer hours and other in-kind contributions from the community that could be linked to the planned flow trial. In this instance, it was not expected that the planned trial itself would generate returns in terms of employment or enterprise – however accounting for financial and in-kind resources generated by the cultural flow trial would serve to demonstrate the potential of cultural flows to contribute to self-reliance and employment.

The **Personal Health and Well-being Survey** was based on indicators formulated for the Australian Aboriginal and Torres Strait Islander Health Survey (ABS 2013). The instrument measures a number of aspects of health and well-being, including the experience of psychological distress, statements of positive wellbeing, self-esteem, and perceived sense of social support. These indicators are used to establish an index of personal well-being as related to the level of involvement and experience of the Toogimbie site.

Open questions were added to the instrument to capture relative change of survey participants based on their involvement over time. Data gathering and handling protocols were discussed with the Research Partners, given the context of potentially sensitive information provided through these surveys. The link with the national ABS study is useful, but not definitive, for establishing a comparison at regional, state and national scales of personal well-being for Aboriginal people involved in the management of Country at Toogimbie.

Establishing a baseline

Baseline information has been provided through ABS data, specifically the Australian Aboriginal and Torres Strait Islander Health Survey (AATSIHS) (ABS 2013) and the National Aboriginal and Torres Strait Islander Social Survey (ABS 2016). This data is provided for bench-marking and illustrative purposes only, given the limitations of this information at the scale required for meaningful interpretation of change. Both of these instruments are designed to produce reliable data at national, state and remoteness level scales, and where it is provided at an Aboriginal Regional scale, the ABS identifies the disaggregation process introduces increased sampling error. For the purposes of the personal health and wellbeing survey at the Toogimbie site, this data does provide a useful standard against which the results of the survey can be assessed, and evaluated and compared over time. Under the ABS geography,Aboriginal Region Scale identifies thirty-seven Aboriginal Regions loosely based on the former Aboriginal and Torres Strait Islander Commission (ATSIC) boundaries – the Toogimbie site is located within the Riverina-Orange Region.

For the 2012-13 AATSIHS, information on mental health and well-being was collected using the Kessler Psychological Distress Scale (K5) questions, Multidimensional Scale of Perceived Social Support questions, and other positive well-being questions. These questions were adapted in consultation with the Research Partners at the site. For the purposes of benchmarking, the K5 measure of psychological distress is especially relevant. K5 is a subset of five questions from a larger scale consisting of 10 questions designed to measure levels of negative emotional states experienced by people in the four weeks prior to interview. The 2012-13 NATSIHS included questions from the K5 to provide a broad measure of people's social and emotional well-being. Respondents were asked about how often in the four weeks prior to interview they felt: nervous, without hope, restless or jumpy, everything was an effort, or so sad that nothing could cheer them up. For each question, an answer was provided using a five-level response scale, based on the amount of time a person reported experiencing the problem. The response scale ranged between all of the time, most of the time, some of the time, a little of the time, or none of the time. Responses were aggregated, resulting in a minimum possible score of 5 and a maximum possible score of 25. Low scores (5-11) indicate low levels of psychological distress and high scores (12-25) indicate high levels of psychological distress. In 2012 to 13, three in ten (30.1%) of Aboriginal and Torres Strait Islander people aged 18 years and over had experienced high or very high levels of psychological distress in the four weeks before the survey (24.0% of men compared with 35.8% of women). Figure 37 shows the results of this index relevant to Toogimbie at a regional, state and national scale. It is noted that the men in the Riverina-Orange region experience psychological distress well below the state and national average, but given limitations of the sample size in this instance, this result is considered unreliable by the ABS.

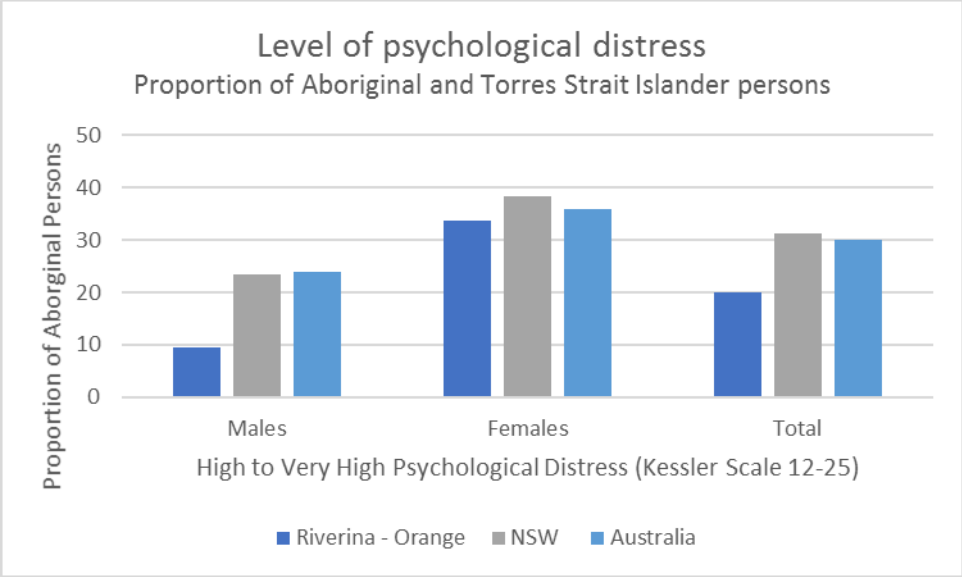


Figure 37: Level of Psychological Distress

Similarly, the survey includes questions relating to the experience of stressors, defined by the AATSIHS to include a wide range of stressful experiences, such as serious illness, accident, mental illness; pregnancy, overcrowding at home, job loss, gambling problems, legal issues and so forth. The specific nature of the stressor is not included, only whether there is an experience of stressors in the respondent's life within the previous 12 months. The following figures (Figure 38 and Figure 39) are from the 2013 AATSIHS, and show that regionally both males and females in the region have higher experience of stressors than the state and national average, proportions of Aboriginal people reporting three or more stressors was significantly larger than the Riverina-Orange region.

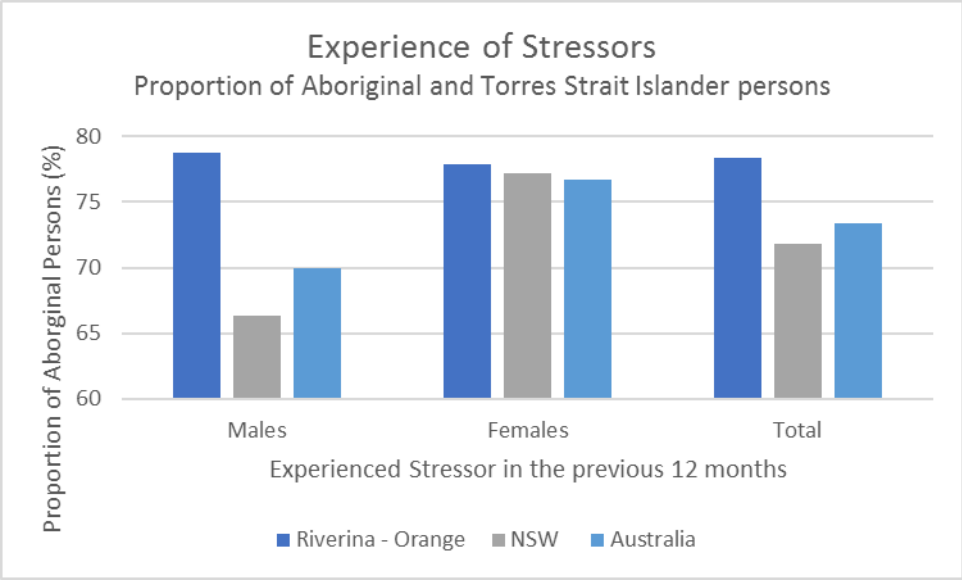


Figure 38: Experience of Stressors between genders (AATSIHS 2013)

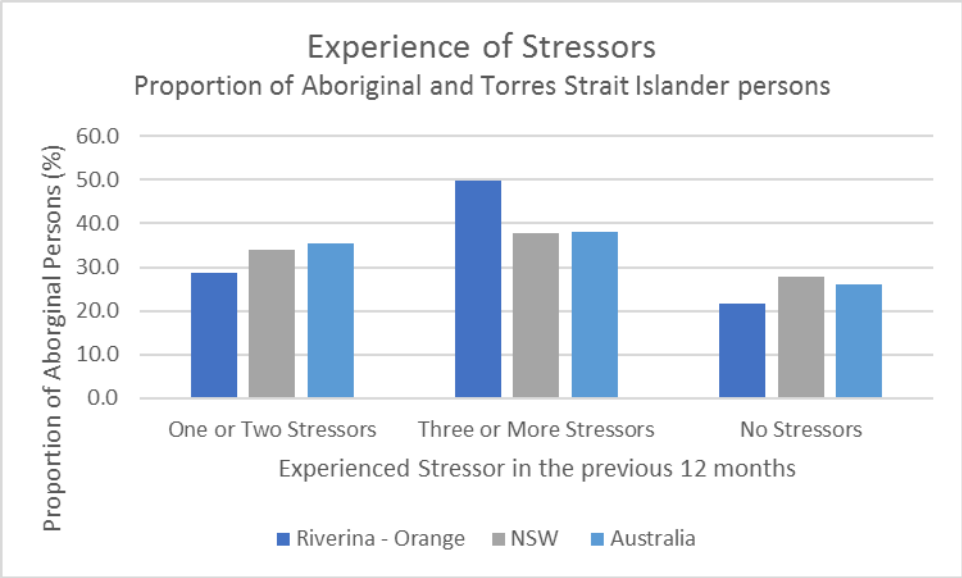


Figure 39: Experience of multiple Stressors (AATSIHS 2013)

The **Community Health Survey** is a survey for Research Partners and select members of the community to evaluate key health factors for the community as a whole. This approach recognises that the factors contributing to personal health and well-being are linked with the perception of community health, including condition of the local economy, housing availability, access to services and community safety. These assessments were supplemented with a Likert scale questionnaire derived from factors identified in Aboriginal well-being research that contribute to strengthening self-esteem, pride, cultural and spiritual connection and positive states of wellbeing at a community scale. For example, statements in the questionnaire include:

- Our community is strongly connected to Country, land, family and spirit.
- Our community provides a strong and positive social network for Aboriginal people.
- We foster a strong sense of identity and being part of culture.
- Our community supports one another in times of crisis.

This instrument recognises that health factors, including those impacted by cultural flows, must be considered holistically. This is especially relevant in the context of Aboriginal health. For example, the 1989 National Aboriginal Health Strategy (NAHS) noted that:

> *Health to Aboriginal peoples is a matter of determining all aspects of their life, including control over their physical environment, of dignity, of community self-esteem, and of justice. It is not merely a matter of the provision of doctors, hospitals, medicines or the absence of disease and incapacity. (NAHS 1989)*

The Community Health survey is intended to reflect a broad definition of community-scale health, and to reflect the growing field of research on the social determinants of Aboriginal health. In particular, it recognises that connection to Country, land, family and spirit has direct relationship to community and personal health and well-being for Aboriginal people. Into the longer term, it is hoped that the monitoring by the Nari Nari with this instrument will add weight to the body of evidence that shows the link between cultural management of Country and community health outcomes explicitly.

The **Participant Evaluation Survey** was designed to be completed by people involved in events (recreational, management, scientific, educational and so forth) at the IPA site directly linked to the cultural flow. The type of events typically associated with the site include field days, open days, school tours, back to Country, volunteering and working bees. The survey was to provide Nari Nari with direct feedback on the organisation of the event, but to also capture changes in experience, knowledge or attitudes of participants.

The **Post-Flow Focus Group** was designed to involve Research Partners directly involved in the trial, and additional members of the community nominated by the Research Partners. It was intended that these participants would have some degree of familiarity with the project, but would not necessarily have been involved in the setting of objectives or the implementation of the trial. Questions focused on the personal change of participants in terms of knowledge, experiences, and attitudes, but also included general questions about the structure of the trial process and recommendations for future implementation.

In order to generate data and input into the survey beyond the Research Partners, a site open day in mid-November was scheduled, where the personal and community health self-assessment could be conducted by Research Partners with the broader community to establish a pre-flow baseline. Participants would also complete the event evaluation survey based on their experience at the site. Additionally, a modified event evaluation survey was sent to local school students who had participated in a site visit prior to the application of cultural water. Further similar events were scheduled during the flow trial to establish the data for a before-during-after comparison. However, due to the flood event at the site, these events were postponed, and the specified monitoring and evaluation methods were not appropriate for socio-cultural change associated with a natural event. As such, only the post-flow focus group could be conducted as intended.

4.8.4 Discussion

Establishing an evidence base to demonstrate the socio-cultural and economic benefits from the cultural flow trial was clearly frustrated by the flood event at the Toogimbie site. Scheduled events were postponed, the opportunities for additional events engendered by the availability of water were not realised, and site management activities were not possible. The socio-cultural outcomes that can be reported upon were strictly limited to the Research Partners because of factors

beyond their control (flood event). Some general observations regarding the impact of the Project on the Research Partners are possible and relevant, based on the reporting themes and the post-flow evaluation focus group.

Personal (self-reported) health and wellbeing

Participants involved in the fieldwork conducted in preparation for the flow trial and in measuring the impact of the flood identified a high level of improvement in their personal well-being as a direct consequence of their involvement in the project. This was especially in relation to personal confidence and the health impacts of their improved understanding of managing Country. Access to Country and the active participation in the management of Country is increasingly recognised as a major factor in Aboriginal health. This is in addition to the physical benefits of being involved in land management activities – these benefits are not insubstantial and have been shown to include improved health outcomes in diet, mental health and lowered risk of diabetes, kidney disease and cardiovascular disease. Participation in the cultural management of Country has been shown to contribute to strengthening self-esteem, self-worth, pride, cultural and spiritual connection and positive states of wellbeing.

Improved knowledge, site management and planning

In the evaluation discussions, the contribution of the Project to improved knowledge and capacity-building for the management of the site was the most frequently cited change resulting from the Project. Participants identified improved scientific and cultural literacy, improved understanding of ecological processes relating to the wetland, and improved confidence in the use of technology and methods associated with environmental monitoring. In addition, the impact on personal self-confidence of Research Partners and the confidence in the group as a whole in their management of the site was noticeably improved through the course of the project.

> *I think you can attribute this to the [National Cultural Flows] project, because it's has to do with the improved confidence that we've been talking about. We have the confidence to know that cultural flows are a priority for us here, and we believe in what we know now. Therefore, we will seek funding to suit this work, and not wait each year for [the funding body] to tell us that this year's priority is carbon credits or water quality or what have you. K. Schade pers comms, 2016 (Key Nation Contact – Nari Nari Tribal Council).*

Participants also reflected on the way that the discussions undertaken in planning for the cultural flow contributed to the re-discovery of Aboriginal science, as memories and knowledge were re-interpreted and contextualised as TAK. One participant discussed how the project triggered memories and stories that he had not previously shared with family or friends about his life and culture. These experiences result in the types of cultural regeneration associated with expanded the opportunities for cultural management of Country.

For other respondents, the Project confirmed the validity of the rehabilitative work done at the site over the past decade. The environmental monitoring was seen to validate the cultural management efforts. This too gave participants confidence to advocate for a permanent cultural water allocation and for increased support from government agencies.

> *"Before we used to apply for a project if the funding was there. Now, if we put in for a project, it's going to be part of our plan. So now we can tell government why we are doing it – and not just to fit into their criteria" - I. Wood pers comms, 2016 (Research partner – Nari Nari Tribal Council).*

Unanticipated outcomes attributable to the flood event included the increased understanding of the impact of high velocity flooding of the site and the movement of water in the absence of regulation or control. Understanding unregulated flood events impact on sediment and vegetation in particular will guide the future application of cultural water.

Tools developed through the Project, including the multi-year site watering plan and the community health surveys, will be used in ongoing management of the site and for reporting. In addition, the process of articulating group aspirations has given Research Partners clarity of direction and renewed purpose in terms of proactively seeking funding and support for rehabilitation of the site. As respondents stated, they will now actively seek funding and resourcing options that assist us in achieving the objectives developed for Toogimbie through the process, rather than responding reactively and ad hoc to available grant options and conditions:

> *In the past, we have been reactive to what funding has been around, whereas now we are starting to become proactive. "We have this project that we want to do, how can we fund it?" Or "we have these ideas, how do we get there? "Rather than saying, "Envirofund is out, this year the priority is salinity, what can we do?" - K. Schade pers comms, 2016 (Key Nation Contact – Nari Nari Tribal Council).*

This will likely contribute to increased involvement of the Research Partners and the broader Nari Nari community in partnerships with supporting organisations, and has already led to the revision of strategic and management plans on the site. Both of these targets were stated objectives of the cultural flow allocation, and were achieved through the process of planning for a cultural flow allocation.

Regional Health and Wellbeing

Given that the participation in the Project was limited to the Research Partners, the impacts of the Project on regional and community health were limited. However, the learning and confidence gained by Project partners yield benefits for the region in the longer term. The Research Partners spoke about their plans to establish gender and age specific community programs at Toogimbie, and to involve neighbouring, upstream or downstream communities in future programs and education initiatives. Similarly, there was a strong commitment by the partners to sharethe knowledge and information acquired during the course of the Project both witin their own and with other communities in the Lowbidgee and around the country.

4.9 Research Partner experience and perspectives

> *"It's the capacity building component of this project that makes it different from all the others. Each and every research partner that participated in the project has learnt so much. The confidence we now have in our knowledge, practices and skillset is amazing" - K. Schade pers comms, 2016 (Key Nation Contact - Nari Nari Tribal Council)*

During the evaluation focus group conducted, Research Partners from Nari Nari provided feedback on their experiences of the field research and their participation in the Project as a whole. Responses highlighted improved knowledge about the wetland and its management, and improved confidence of participants in undertaking environmental assessments. The accessibility of the monitoring tools was highly valued, and the two-way capacity building for aspects of the project was also seen to be a major contributing factor to the success of the project overall.

Respondents also valued the application of the participatory action research and stressed the importance of the engagement approach adopted by the Project. From the partners' perspective, the approach allowed the community to set the terms of the process and was responsive to the needs and concerns of the participants throughout. Participants indicated that their confidence in the capacity of the project to influence government policy increased over time, and especially as a consequence of participation in the field work. From the Research Partner perspective, the findings from the environmental monitoring confirmed the cultural understanding and TAK. This has strengthened the community confidence in their own management efforts, and their confidence to present the case for cultural flows to policy-makers.

Participation in the project has had a permanent impact on the management efforts at Toogimbie. The partners have now identified cultural flows as a priority, and have resolved to actively seek funding and resourceing options to assist with achieving the objectives set through the project. Similarly, future reporting on management activities undertaken as part of the IPA monitoring process will include key indicators that have been set by the cultural flow planning undertaken by the Project.

5 FIELD TRIAL APPLICATION OF CULTURAL WATER AT TOOGIMBIE IPA

The following chapter provides an excerpt of the Toogimbie hydrological model developed and detailed in NCFRP Hydrological and Hydraulic Modelling Report (2017b).

5.1 Background to the field trial, its abandonment and alternative

A field trial application of cultural water at Toogimbie was planned for spring 2016. The main of objective of the trial was to test hypotheses concerning the relationships between application of cultural water and achievement of cultural water objectives, as well as to gain experience in the logistics and practicalities of delivering and managing cultural water.

The planning process was assisted by use of the *Cultural Water Annual Allocation Estimator* (NCFRP 2017b), which predicts short-term future wetland hydrology on the basis of recent historical climate, current wetland water level, statistically-generated future climate, and intended water management strategy.

Around the time that the field trial was to be implemented a major natural flood event occurred in the Murrumbidgee River. This resulted in abandonment of the flow trial, as the natural flood was a much larger event than was intended for the flow trial.

Although field trial application of a cultural water allocation was not undertaken, pre-trial surveys of cultural and ecological values were undertaken, creating the opportunity to measure the impact of a major natural flood as an alternative exercise. To assist assessment of these impacts, this section describes the hydraulic and hydrological characteristics of the natural flood event. The flood also provided an opportunity to validate some aspects of the performance of the hydrological and hydraulic models associated with natural overbank processes.

5.2 Hydrological characteristics of the 2016 natural flood event

The hydrological statistics for the event are based on computed mean daily discharge data rather than data recorded at shorter time steps, as mean daily discharge is the variable most often used in flow regime characterisation, and is the variable used in the modelling sections of this report. It should be noted that more frequently observed river flow data would result in flood peaks higher than indicated by mean daily data, which is the reason why standard flood frequency analysis uses peak instantaneous flow data.

The September-October 2016 flood event in the lower Murrumbidgee caused major flood warnings to be issued for Hay. At the DS Hay Weir gauge, the flood had two peaks, with the first at 45,081 ML/d on 5/10/2016 and the second at 56,919 ML/d on 18/10/2016. Since the gauged record became available in 1982, the peak of the 2016 event was the second largest recorded. The largest event was 66,934 ML on 20/03/2012; two events of a magnitude similar to the 2016 event occurred, 53,246 ML/d on 26/12/2010 and 53,372 ML/d on 29/04/1989. Over the 36 year long period since 1982, 13 independent flood events exceeding 26,000 ML/d at DS Hay Weir (the threshold for commence to flow at Toogimbie) occurred, which is an average of 1 every 2.7 years.

The total hydrograph of the 2016 flood at DS Hay Weir was defined over 107 days (15 weeks or 3.5 months) from 28/08/2016 to 12/12/2016, which covers the period when flow first rose from baseflow to when it receded back to a similar baseflow level prior to rising again (Figure 40). The event was also recorded downstream at DS Maude Weir gauge (Figure 40). The hydrograph at DS Maude Weir illustrates the effect of floodplain losses between Hay and Maude. The total event volume at DS Hay Weir was 2675 GL, and at DS Maude Weir it was 1669 GL, a net loss of 1006 GL of water from the main river channel (Figure 40).

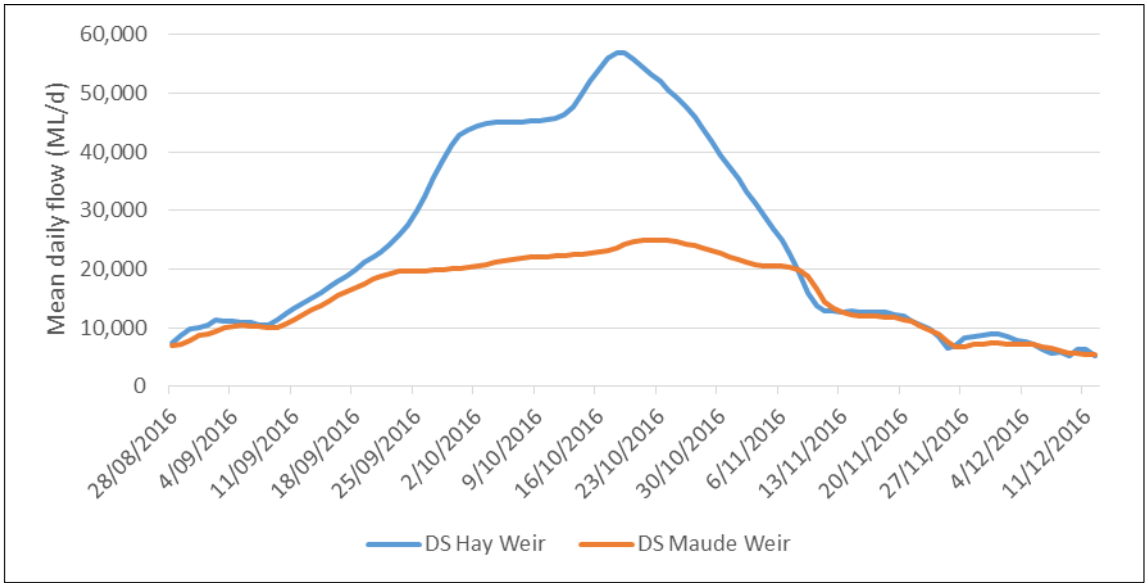


Figure 40. Hydrograph of 2016 flood event, recorded at DS Hay Weir and DS Maude Weir gauges.

Over the 2016 flood period, flow exceeded 26,000 ML/d at DS Hay Weir for 43 days, from 24/09/2016 to 5/11/2016 (Figure 41). The hydraulic relationship developed in the project suggests that this was the approximate period when floodwaters would have first entered, filled, flowed through, and then drained from Toogimbie. Detailed observations of hydrological and hydraulic phenomena were not made in the field at Toogimbie during the flood, partly because of inaccessibility. Observations of flood extent are potentially available from Landsat satellite imagery.

While inundation of the floodplain by floodwaters was the dominant hydrological process at Toogimbie from late-September to December, the processes of rainfall, evapotranspiration and seepage to the soil continued to contribute to the water balance, and therefore affected the presence and amount of water on the floodplain surface. Thus, interpretation of water extent on the floodplain also needs to take these factors into account, as does interpretation of biological monitoring data.

Rainfall data from Hay Airport AWS (075019) and DataDrill modelled rainfall for Toogimbie were similar (Figure 42), so DataDrill data were used to infill 7 missing observations from the Hay Airport AWS record from 1/12/2016 to 7/12/2016. Applying a pan to open water factor of 0.7 to DataDrill modelled Pan evaporation data, and a soil seepage rate of 2 mm per day, which is appropriate for high clay soils, an approximation was made of the cumulative surface water presence due to the combined effects of rainfall, evapotranspiration and seepage, over September to December (Figure 42). These data suggest that prior to the 2016 flood event, the floodplain at Toogimbie likely had ponded water present in depressions, which also would have had contributions from surface runoff from the surrounding higher land.

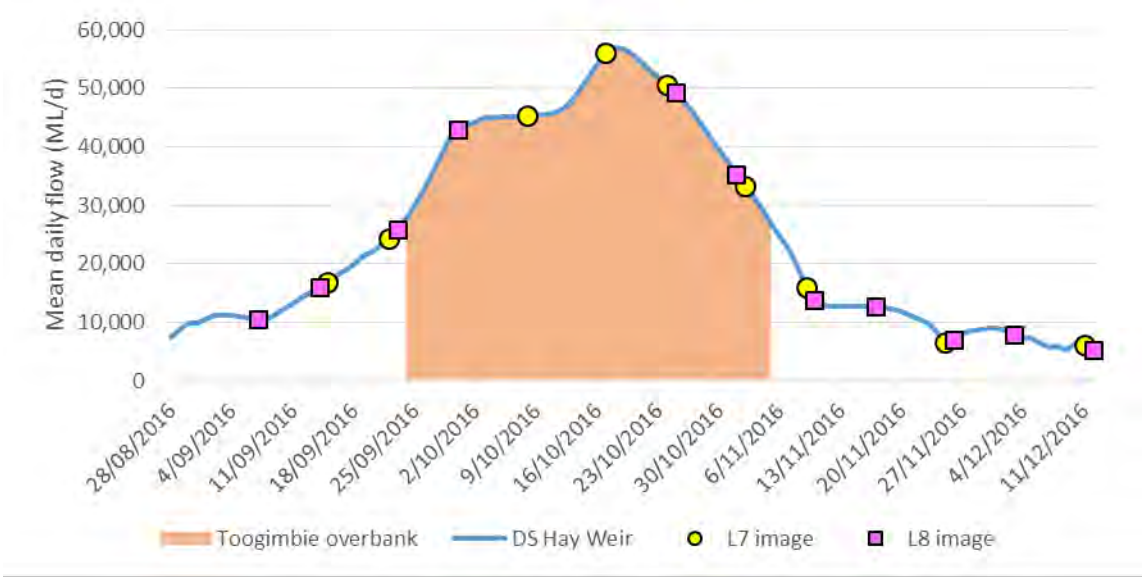


Figure 41. Hydrograph of 2016 flood event, recorded at DS Hay Weir, indicating period when flow exceeded commence to flow threshold at Toogimbie.

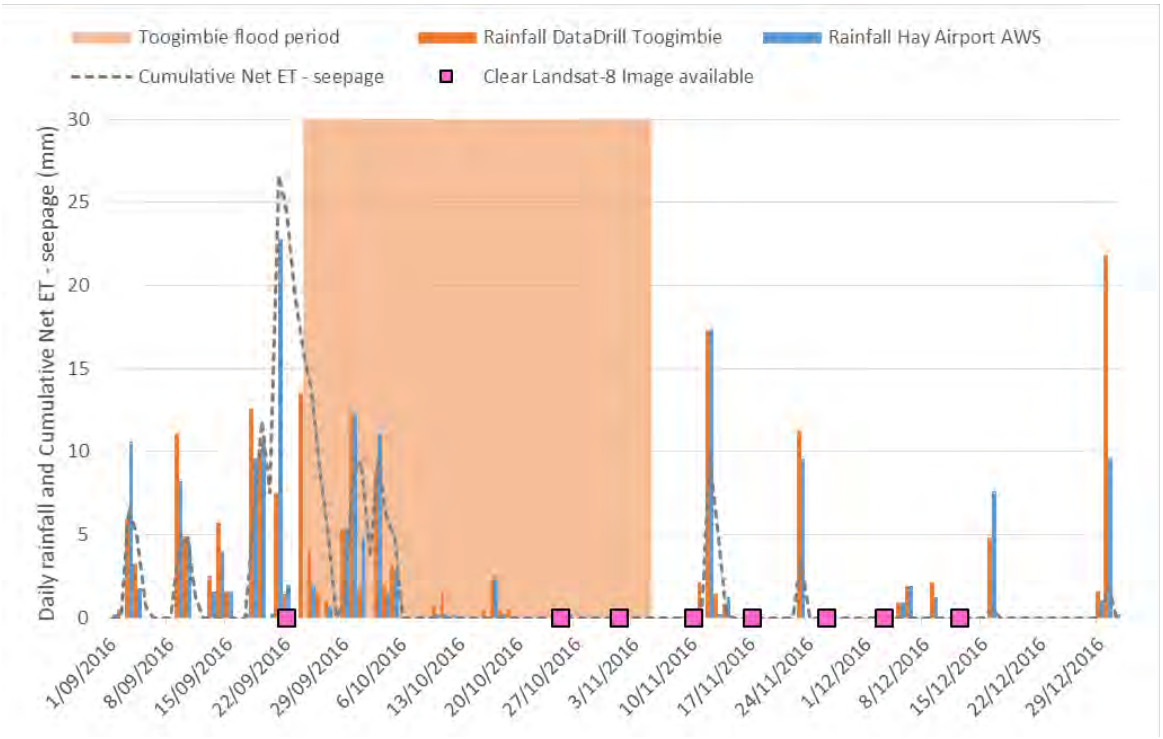


Figure 42. Rainfall and approximate water balance for Toogimbie over September to December, and dates with clear Landsat-8 satellite imagery available.

5.3 Hydraulic characteristics of the 2016 natural flood event

For the 2016 flood event, Landsat-8 OLI (Operational Land Imager) and TIRS (Thermal Infrared Sensor), and Landsat-7 Enhanced Thematic Mapper Plus (ETM+) satellites were operational. With

overlapping images available, the frequency of images at Toogimbie was Landsat-8 every 8-days and Landsat-7 every 8-days, offset by one day. Not all images were useful, due to obscuration of the surface by cloud. All Landsat-7 scenes collected since 30 May 2003 have data gaps (banding) due to Scan Line Corrector failure.

Over the period of the 2016 flood event, 13 Landsat 8 images were available covering Toogimbie, but 2 of these were obscured by cloud (Table 23 and Figure 42). Over this flood period, 12 Landsat 7 images were, but 3 of these were obscured by cloud (Table 23 and Figure 42). Despite these gaps, the time series of available satellite data over the flood period is sufficiently detailed for establishing the extent of floodplain inundation over time (Figure 43 and Figure 44).

The Landsat natural colour images captured in September prior to inundation of the site by the flood suggest that Cell 2 and House wetland were wetter, or at least had different vegetation, than the other cells (Figure 43. This is consistent with the greater volumes of managed water delivered to those two cells over recent years (NCFRP 2017b), and could also reflect contributions of significant local rainfall throughout September (Figure 42).The available satellite images do not indicate the exact date that overbank flow first entered Toogimbie, but the commence to flow relationship established in this report suggests it would have started on 24th or 25th September. The first image to show floodwaters within the site was 30/09/2016 (Figure 43). This image clearly shows extensive inundation in Cell 7 on the eastern side of the site, but no inundation in Cell 4 on the western side of the site. The other cells are not visible due to cloud cover, so it is uncertain how far water had spread over the site at this time. This image bears a resemblance to the Landsat-7 image of Toogimbie captured on 19/03/2012, close to the peak of the largest flood on record since 1982, when mean daily discharge was 65,003 ML/d at DS Hay Weir (NCFRP 2017b). By 8/10/2016 the entire site, with the exception of Cell 6 (proposed Swan Rookery), was extensively inundated (Figure 43). Floodwaters did not breach the banks surrounding Cell 6 at any time during the 2016 event, but the northern bank separating it from Cell 5 was almost overtopped. Cell 5 (House) was wet prior to the flood. Although located at a relatively high elevation in the landscape and surrounded by embankments, floodwaters entered House Wetland both from Cell 5 and the river via Billabong. The available data from the 2016 event suggest that it might take around 1 week for floodwaters to spread through Toogimbie.

The maximum inundation observed by satellite imagery occurred on 24th and 25th October 2016, (Figure 43) which is 1 week after the flood peaked upstream at DS Hay Weir gauge (Figure 41). This time difference is partly explained by travel time of the flood peak from Hay to Toogimbie (~2 days), and partly the unlikelihood that a Landsat image was captured on the day of maximum inundation. Toogimbie remained extensively inundated until at least 2/11/2016 (Figure 43 and Figure 44). However, Landsat images from 9th and 10th November indicate that at this time the floodplain was rapidly draining (Figure 44). This observation is consistent with the river falling below the flow threshold at Toogimbie on 6/11/2016 (Figure 41). By December, there appears to be relatively little ponded water remaining on the site (Figure 44), although water would have remained in the soil and as open water in narrow channels.

Table 23. List of Landsat satellite image availability for 2016 flood event at Toogimbie.

Landsat satellite	Date of image	Flow at DS Hay Weir (ML/d)	Image quality (all Landsat-7 images are SLC-off)
L8	7/09/2016	10538	Partially obscured by cloud
L8	14/09/2016	15977	Partially obscured by cloud
L7	15/09/2016	16961	Clear/banding
L7	22/09/2016	24279	Clear/banding
L8	23/09/2016	25799	Clear
L8	30/09/2016	42960	Partially obscured by cloud
L7	1/10/2016	43839	Obscured by cloud
L7	8/10/2016	45280	Clear/banding
L8	9/10/2016	45375	Obscured by cloud
L8	16/10/2016	54054	Obscured by cloud
L7	17/10/2016	56097	Partially obscured by cloud/banding
L7	24/10/2016	50643	Clear/banding
L8	25/10/2016	49230	Clear
L8	1/11/2016	35315	Clear
L7	2/11/2016	33234	Clear/banding
L7	9/11/2016	15951	Clear/banding
L8	10/11/2016	13702	Clear
L8	17/11/2016	12694	Clear
L7	18/11/2016	12563	Obscured by cloud
L7	25/11/2016	6498	Clear/banding
L8	26/11/2016	6976	Clear
L8	3/12/2016	7910	Clear
L7	4/12/2016	7537	Obscured by cloud
L7	11/12/2016	6173	Clear/banding
L8	12/12/2016	6173	Clear

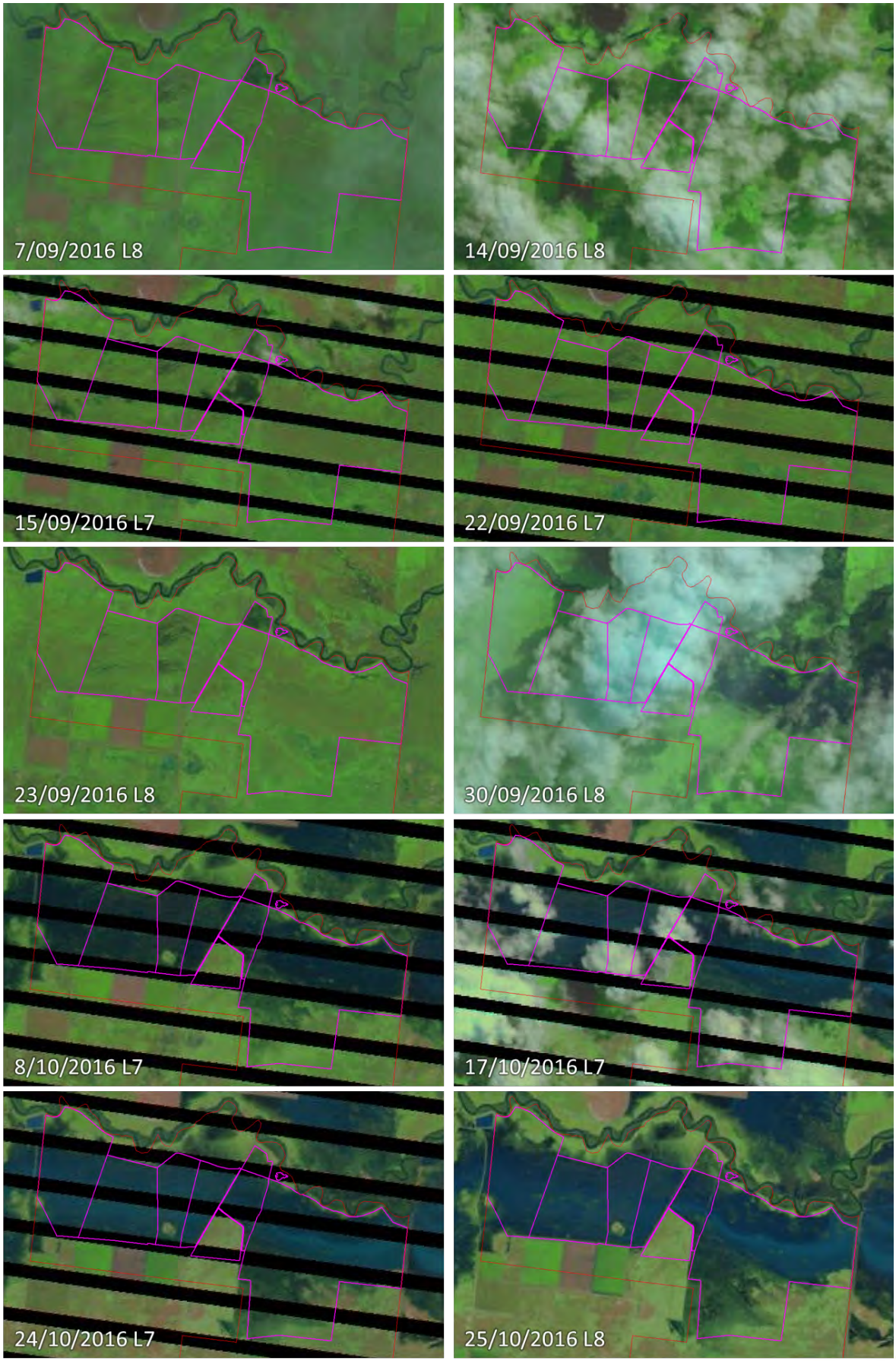


Figure 43. Sep-Oct Landsat-7 and -8 natural colour imagery of 2016 flood at Toogimbie

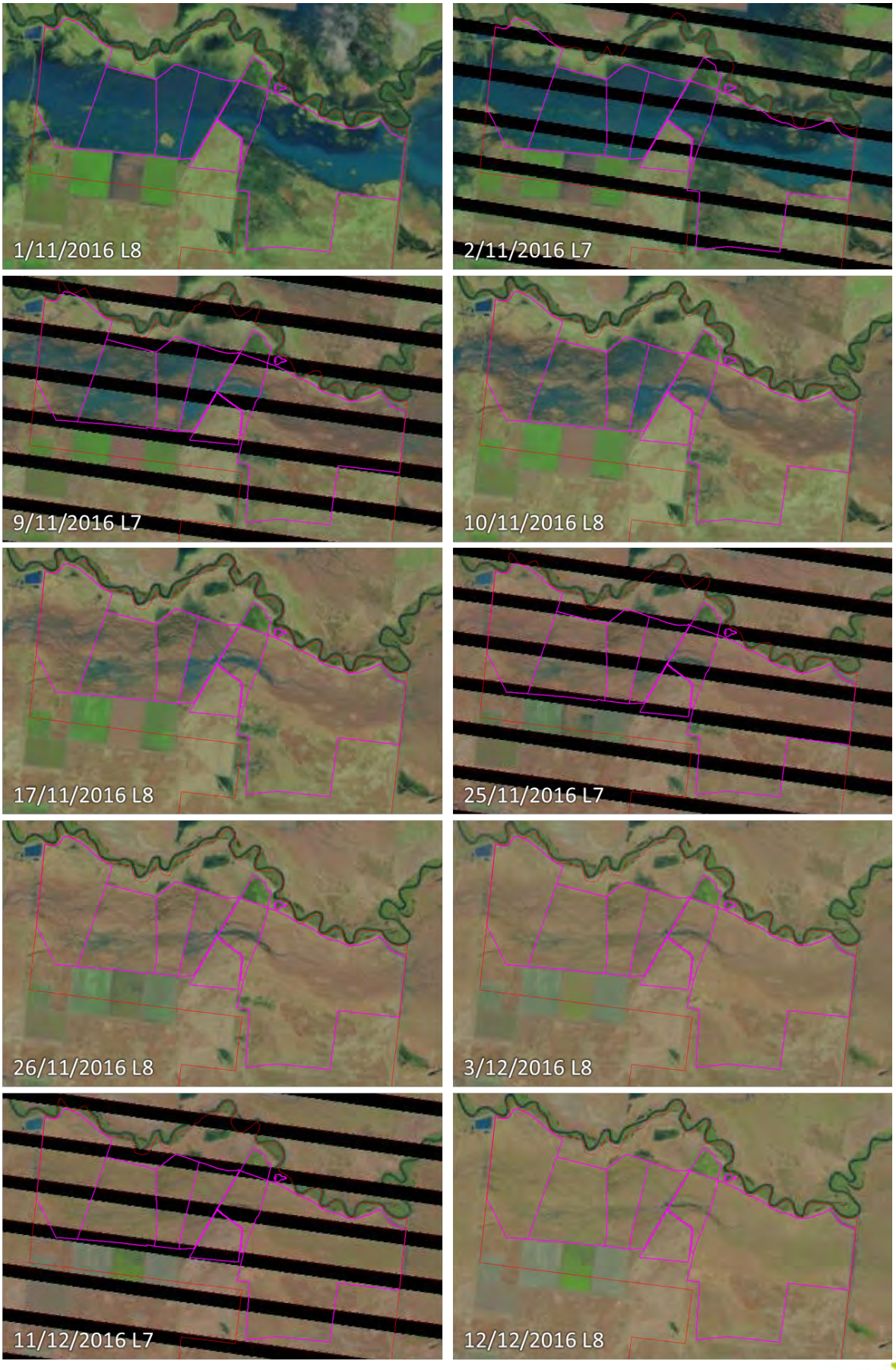


Figure 44. Nov-Dec Landsat-7 and -8 natural colour imagery of 2016 flood at Toogimbie

The Modified Normalized Difference Water Index (MNDWI) was calculated for the 8 dates with cloud-free Landsat-8 imagery between 23/09/2016 and 12/12/2016 for the area within Toogimbie IPA boundary (Table 23 and Figure 45). The image from 7/09/2016 was also evaluated, but the cloud created too much interference to give a reliable result. The MNDWI was calculated from rescaled band 3 and 6 raw DN data converted to the top-of-atmosphere (TOA) planetary reflectance.

The temporal pattern of area of water on the surface of the entire IPA (Figure 45) followed the pattern of the flood hydrograph (Figure 46), indicating a high level of hydraulic connection between floodplain and river, although the ongoing reduction in surface water area after the overbank period is also due to evaporative loss. This suggests that the cells do not pond large areas of water for long periods of time. Under a managed situation, maintenance of reasonably high water levels in the cells would require constant pumped inflows. Also, of relevance to interpretation of monitoring data, is the observation that the area of ponded water on the site was greater on 23/09/2016 (121.1 ha), prior to the flood event, than on the dates 26/11/2016 (53.9 ha), 3/12/2016 (21.3 ha) and 12/12/2016 (17.0 ha) (Figure 46).

During the overbank period of the flood, the area of water in the current, or potential future, managed cells, constituted the vast majority of water over the IPA, but this was not the case when the river flow was in-channel (Figure 45 and Table 24). Just prior to the flood event, extensive rainfall (Figure 41) caused surface water to pond on land near the river north of the cells, and on land in the southern part of the IPA. After the flood, surface water persisted on land close to the river, north of Cells 1 and 2 (Figure 45).

The total area of land inundated during the peak of the flood event within the IPA (1791 ha), and over the current and potential future managed cells (1554 ha) (Table 24), greatly exceeded the area that would be inundated when all the cells were at full managed level for current conditions, a total area of 457 ha. This constitutes a significant hydraulic difference between a natural flood event and managed (pumped) watering of the cells, especially given that only Cells 1, 2, 3, House and Billabong can currently be managed. The maximum area of water that can be managed across these cells is 284 ha. The second main hydraulic difference between a natural flood event and managed watering is that natural flooding would involve flowing water, while under managed (pumped) watering, inflowing water would move across the cells very slowly, and when full, would remain quiescent.

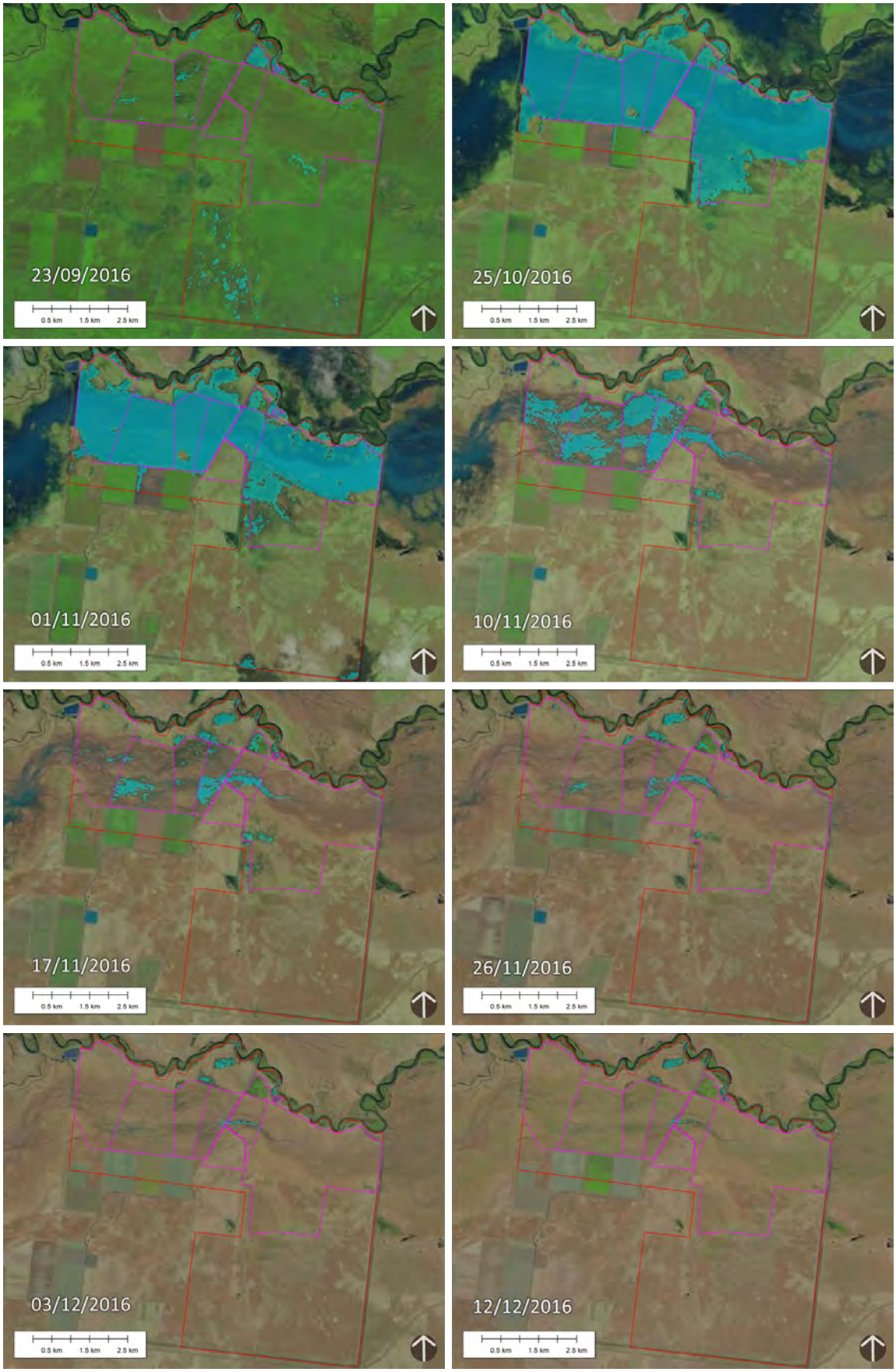


Figure 45. Positive MNDWI values (water present) within Toogimbie IPA, and Landsat-8 natural colour images, for spring 2016 flood event.

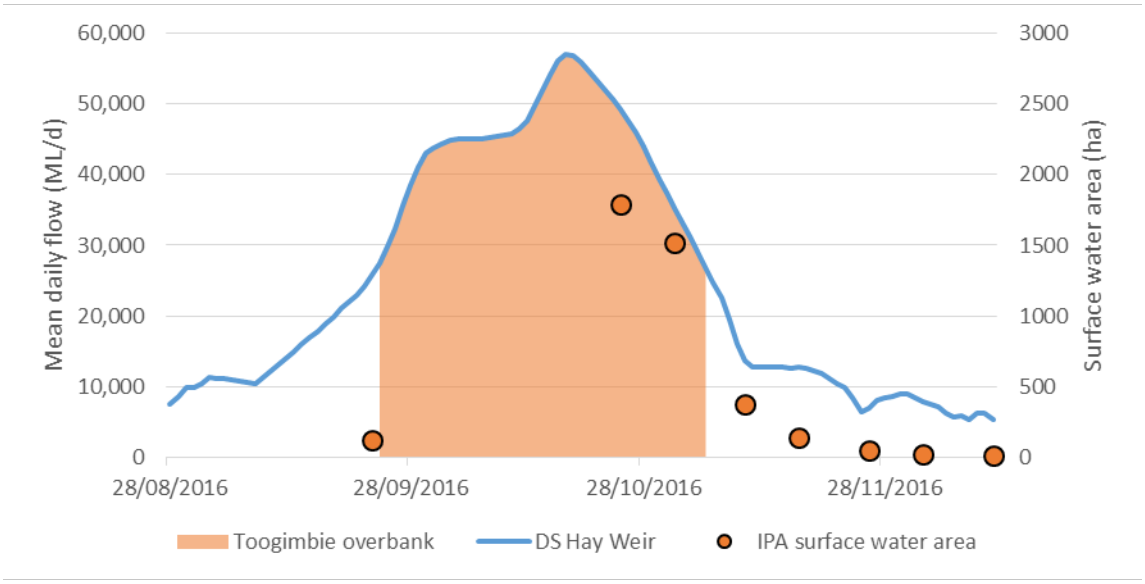


Figure 46. Hydrograph of 2016 flood event, recorded at DS Hay Weir, flood period at Toogimbie, and water surface area over entire IPA determined by Landsat-8 MNDWI.

Table 24. Water surface area at Toogimbie during spring 2016 flood event, estimated by application of MNDWI to available clear Landsat-8 imagery.

Areas	Water surface area on dates of available Landsat-8 imagery (ha)							
	23/09/2016	25/10/2016	01/11/2016	10/11/2016	17/11/2016	26/11/2016	03/12/2016	12/12/2016
Cell 1	0.1	114.8	114.8	68.9	29.4	9.0	1.1	0.8
Cell 2	6.8	133.3	132.4	71.0	3.9	0.0	0.0	0.0
Cell 3	3.7	252.1	253.3	96.3	27.5	4.0	0.2	0.1
Cell 4	0.0	261.7	231.7	61.7	5.7	0.5	0.0	0.0
Cell 5	0.0	91.8	86.8	21.3	16.2	8.4	3.4	1.4
Cell 6 (Swan rookery)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cell 7	9.9	678.5	496.8	16.0	11.4	3.2	0.1	0.2
Cell 8 (House)	21.4	19.6	13.7	6.9	7.1	2.5	0.0	0.0
Cell 9 (Billabong)	2.5	2.4	2.4	1.7	0.5	0.5	0.2	0.4
Total within cells	44.5	1554.3	1331.9	343.8	101.6	28.2	4.9	2.8
Total outside cells	76.8	236.1	182.3	34.5	34.6	26.0	16.3	14.1
Total within IPA	121.3	1790.5	1514.2	378.3	136.2	54.1	21.2	17.0

6 GOORAMAN FIELD WORK

6.1 Cultural Significance of the case study site

> *"I'd like to see them days come back again…. But never again"….*
>
> *…"Gooromon, borded by red sandhills, was at the time covered with two metres of clear water, full of fish and alive with birds"…*
>
> - (R.Campbell pers.comms. (cited in Creamer 1985)

Gooraman Swamp is located on Murrawarri Country on the floodplain of the Culgoa River in northern NSW, approximately 20 kilometres (km) southwest of the Culgoa National Park. The Culgoa River is a branch of the Ballone River that rises in southern Queensland. The river flows in a southwesterly direction for approximately 490 km from downstream of St George in southern Queensland to its confluence with the Darling River in NSW, between Bourke and Brewarrina.

The cultural significance of the site for the Murrawarri is connected to the *Mundaguddah*, the name that the Murrawarri give to the Rainbow Serpent (Creamer 1985:7). The *Mundaguddah* travels across Murrawarri Country through the subterranean channels, thereby linking together a series of significant water sites through this Country and throughout the Murray-Darling system. The presence and movement of the *Mundaguddah* relies on sufficient quantities of water present at key sites: an important waterhole in the Culgoa River, the Gerrara Springs and Gooraman Swamp.

> *It is believed that the Mundaguddah used to travel 80 kilometres to Gerara Station which has a permanent water spring that never goes dry. When the floodwaters come up at Weilmoringle, the Spring at Gerara Station changes its natural clear colour of water to a dirty brown colour. This is how many of the Aboriginal people living at Gerara Station knew that the Culgoa River was in flood. How the Mundaguddah used to travel from Weilmoringle to Gerara Station is unknown, but it is believed that there must be a tunnel leading right through, big enough for the Mundaguddah to travel to and from each place. The Mundaguddah has never been seen, but many of the Aboriginal people still talk about it today and believe its legend is true.*
>
> - J. Byno, pers. comms. (cited in Cremer 1985:11)

Each of these sites has associated cultural practices, obligations and established cultural prohibitions linked to water availability, and Research Partners noted that all three water sites have been varyingly impacted by upstream development. Gooraman Swamp is the home of the *Mundaguddah* (Cremer 1985 6-8):

To get water in the river – that's why I wanted to link both Gooraman Swamp and the Mundaguddah water hole, because there is a correlation. There's a connection there from the Mundaguddah waterhole to the Gooraman Swamp, and that's of cultural significance. And that's the difference between the environmental flow and the cultural flow. Because [getting water to Gooraman Swamp] is fulfilling our cultural purposes. If we look at the two, some of it will overlap. So for example, the Mundaguddah waterhole and Gerrara Springs will fall into the environmental flow category. Because if you get in the Culgoa, down to Weilmoringle, and you fill that waterhole up, and you have enough water flowing down the system, then there are a number of waterholes, the connection to this place here. [Gooraman Swamp] is his home. The connection then allows him to travel. It's the same – there are all different names for him all through the Murray. There's a common connection. – F.Hooper, pers. comms. 2016 (Research Partner – Murrawarri Provisional Council of State).

Murrawarri Traditional Owners have cultural obligations to maintain the ecological health of the site. In particular, there is a responsibility to maintain the health of the river red gums, as spirit trees, which represent the continuing presence of the ancestors in the landscape and establish means of communication with those ancestors (Creamer 1985). There is a deep spiritual significance to the health of the river red gums at Gooraman Swamp. Further, a wide range of ecological and cultural values at the site that would be re-established and protected as a consequence of the restoration of Gooraman Swamp to its historical flow patterns. For example, having water in Gooraman Swamp was the key driver of the return of migratory birds to the site, and assist in the proliferation of bushfood species, including iconic fauna species relied upon for hunting and the availability of plant species for medicine and practice.

Restoration of the historical water regime at Gooraman Swamp is vital to the resumption of Aboriginal and traditional land management at the site. The appropriate conditions for seed gathering, the re-establishment of fire management techniques and the reduction in weed species were all connected to getting water to the Swamp at the appropriate time and duration. Traditional land management by authorised Traditional Owners on their own Country was seen as integral to improved cultural esteem and identity benefits that are connected to the fulfilment of cultural management, and this is consistent with the experience of cultural management of Country around Australia. Cultural management of Country is linked to the long-term aspirational goals of Murrawarri Research Partners, who articulated strong connections between the health of the water sites, access and availability of those sites for cultural practice, and the intergenerational exchange of knowledge. In this case, increased cultural management includes the obligations to downstream communities to maintain the home and protect the spirit of the *Mundaguddah*. The lack of capacity to fulfil those obligations under the current water regime has had an impact on the spiritual and emotional life of the Traditional Owners in the community.

A cultural water requirement was seen as crucial to the restoration of that historical water regime, including the patterns of flooding and the wet/dry cycle associated with significant off-river sites such as Gooraman Swamp. It was recognised by all Murrawarri partners that the changed conditions of the river due to upstream development was having a negative impact on both environmental values instream and for the riparian ecology, and that this in turn had a cultural and social impact on the community. The Murrawarri aspirations for water management at the Gooraman Swamp site relate primarily to correcting the negative impacts of the current flow regime, and specifically those impacts on the culturally significant sites, processes and practices derived from the historical flow regime of the Culgoa River. In the absence of a cultural water allocation, water delivery to Gooraman Swamp based on overbank flows from the Culgoa River during flood events is entirely dependent on diversion and storage of flood flows upstream of Weilmoringle.

6.2 Research Partner Participation

On site meetings and field work was conducted between March and November 2016. Table 25 provides a list of the Research Partners and NCFRP Project Team that participated at Gooraman Swamp. Refer to fieldtrip reports for detailed participation information.

Table 25: Research Partner and NCFRP Project Team participation

Fieldtrip and Date	Murrawarri Research Partners	NCFRP Project Team
Inception Meeting (March 2016)	Josie Byno Phillip Sullivan	John Mackenzie Klynton Wanganeen Tamarind Meara
Aspiration Meeting (May 2016)	Fred Hooper Josie Byno Vera Dixon Doris May Shillingsworth	John Mackenzie Chris Gippel Klynton Wanganeen Tamarind Meara
Baseline Assessment (November 2016)	Fred Hooper Kitra Hooper John Byno Shane Kelly	John Mackenzie Tom Kloeden Klynton Wanganeen Tamarind Meara

6.3 Research Partner aspirations for cultural flows

Similar to the Toogimbie site, the Murrawarri aspirations for cultural flows relate primarily to the capacity of a cultural water allocation to assist in re-establishing cultural management of Country, including lore, ceremony, trade, education and language. In contrast to the other case study, however, the Murrawarri aspirations for water management at the Gooraman Swamp site relate primarily to correcting the negative impacts of the current flow regime, and specifically those impacts on the culturally significant sites, processes and practices derived from the historical flow regime of the Culgoa River. A cultural flow was seen as crucial to the restoration of that historical water regime, including the patterns of flooding and the wet/dry cycle associated with significant off-river sites such as Gooraman Swamp. It was recognised by all Research Partners that the changed conditions of the river due to upstream development was having a negative impact on both environmental values instream and for the riparian ecology, and that this in turn had a cultural and social impact on the community. The cultural flow objectives, as a result, reflect the desire of the community for redress of the current situation where significant sites, including Gooraman Swamp and hydrologically and spirituality connected places in the region, were not receiving adequate water.

Primary cultural flow objectives

As agreed by the Research Partners, the two key objectives for cultural water at the site were:

a) Re-establish a water regime at Gooraman Swamp to match the no-development (no large-scale water resources development) flood pattern through enhanced flow in the Culgoa River to ensure that it is available for cultural practice and supports cultural economy and wellbeing.
b) Murrawarri ownership and management of cultural water allocation including quantities, timing and resource requirements for cultural, socio-economic, and environmental outcomes in place by 2020.

Although these aspirations are framed in terms of water access in the Culgoa River, it was understood by the Research Partners that using in-stream flows in the river would restore the traditional watering cycle of Gooraman Swamp, and innumerable other significant sites connected to the Culgoa River system. Discussions with the Research Partners discussed the possibility of infrastructure dependent off-stream watering for the site as a means to assist in the achievement of these objectives. However, the infrastructure option was seen to encroach too heavily on the landscape, and to fail to satisfy the objectives at a whole of Country landscape scale. Restoration of the water regime at Gooraman Swamp is a key priority, and necessary for Murrawarri Research Partners to fulfil cultural obligations to maintain the ecological health of the site. In particular, there is a responsibility to maintain the health of the river red gums, as spirit trees, or the continuing presence of the ancestors in the landscape and the means of communication with those ancestors. There is a deep spiritual significance to the health of the river red gums at Gooraman Swamp, which depends on a flow regime that is no longer satisfied in the altered system (refer to NCFRP 2017b for detailed hydrological modelling).

Restoration of a no-development (no large-scale water resources development) flow at Gooraman Swamp would also assist in the protection of the cultural values of the interconnected water places in the area associated with the movement of *Mundaguddah* (Rainbow Serpent). The *Mundaguddah* travels across Murrawarri Country through the subterranean channels, thereby linking together a series of significant water places through Murrawarri Country and throughout the Murray-Darling system. In particular, the presence and movement of the *Mundaguddah* relies on sufficient quantities of water present at an important waterhole in the Culgoa River, the Gerrara Springs and Gooraman Swamp. Gooraman Swamp additionally has significant cultural

connectivity to identified waterhole sites at Dhirranbul, Bonneda and in the Culgoa National Park. Each of these sites has associated cultural practices, obligations and established cultural prohibitions linked to water availability.

A cultural flow entitlement was additionally seen by the Research Partners to enable them to fulfil their custodial responsibility for vegetation management at the site. Each clan group within the Murrawarri has custodial responsibility for the management of different vegetation types, as part of a holistic cultural management regime. Alterations to water availability in the system limit the fulfilment of those obligations. This custodial responsibility of the Murrawarri extends to other nations downstream, under Aboriginal lore.

Cultural flow objectives connected to the Culgoa River were also seen to generate flow-on cultural benefits, especially those associated with increased river-based activity. The intersection of recreational, social, educational and spiritual values occur through river conditions conducive to increased community activity. In particular, the association and community interaction engendered by a healthy fish population and a healthy riparian corridor was seen to have a high degree of impact on quality of life and contribute to the desirability to maintain connection to Country into the longer term. As such, the cultural flow objectives expressed in terms of environmental outcomes that would:

- Improve the condition of dominant long-lived floodplain vegetation for which Murrawari have a custodial responsibility by 2020. This includes river red gum (riparian and floodplain), black box and coolibah dominated floodplain woodlands and associated understories.
- Increase the abundance of native fish harvest species in Culgoa River including cod, yellow-belly and catfish.
- Ensure hydraulic factors (including depth and water velocity) and water quality targets associated with optimal swimming conditions in community swimming locations.

As was the case at the Toogimbie site, ownership of a water allocation is pivotal to enable the Murrawarri to actively participate in water planning and management with the same status and on equal terms with other water users in the system.

6.4 Objectives for Gooraman Swamp

6.4.1 Aboriginal Cultural Objectives

1. **Re-establish the historical water regime** at Gooraman Swamp to match the no-development flood pattern through increasing baseflows of the Culgoa River and to ensure Aboriginal law for maintaining longitudinal connectivity to downstream communities is achieved by 2020.
2. **Establish an agreement on cultural management** of water for cultural, socio-economic and Aboriginal environmental outcomes by 2020.
3. **Re-establish and maintain condition of culturally significant** ceremonial, spiritual and exceptional value plant species (as per Dykes et al. 2006) to allow continued practice of cultural activities by 2020.
    a. Improved condition of water dependent riverine and floodplain plant species of exceptional cultural importance, including Wirrara (lignum, *Duma florulenta*), Thawinj-thawinj (Nardoo, *Marsilea drumondii*), Kimay (yam, *Triglochin* sp.).
    b. Improved condition of floodplain and wetland plant species of ceremonial and spiritual significance by 2020, including Kuruwa (river red gum/ghost gum,

Eucalyptus camaludensis) and Wumbul (tea tree / swamp paperbark, *Melaleuca trichostachya*).

4. Increased use of Country for **intergenerational training** and community participation in cultural activities by 2020.
    a. Improved condition of, and access to floodplain food, artefact and medicinal plants including quinine (*Alstonia constricta*), Gidgee (stinking wattle – *Acacia cambadgei*), native orange (bumble tree – *Capparis mitchellii*), Quandong (*Santalum acuminatum*), weilbilland Snotty gobbles *Thupppie* (mistletoe – Lysiana, Amyema and Dendrophthoe species) by 2020.
    b. Increased abundance of key fish harvest species (especially cod (*Maccullochella peelii*), but also yellow-belly (*Macquaria ambigua*), and catfish (*Tandanus tandanus*) by 2020.
    c. Increased abundance of key terrestrial harvest species (kangaroo, emu including eggs, echidna, and wild turkey[4]) by providing improved floodplain habitat (foraging areas) by 2020.
    d. Promote seed set of key floodplain plant species to allow seed collection activities (lignum, willbill, gidgee, snotty gobble, nardoo) by 2025.
    e. Increased cultural management activity including seed collection and fire management by 2025.
5. **Improved water quality** in the Culgoa River to increase community use for recreational activities (i.e. swimming and fishing) by 2020.

6.4.2 Aboriginal Environmental Objectives

1. **Improved condition** of riverine and floodplain river red gum *Kuruwa* (*Eucalyptus camaldulensis*), black box (*Eucalyptus largiflorens*), river coolabah (*Eucalyptus coolabah*) dominated woodlands at Weilmoringle IPA by 30% by 2025.
2. Restore **resilient populations** of cod (*Maccullochella peelii*), yellow-belly (*Macquaria ambigua*), and catfish (*Tandanus tandanus*) in the Culgoa River by 2025.
    a. Increase abundance of yellow-belly by 30% by 2025.
    b. Recruitment of mature cod by 2020.
    c. Increase abundance of catfish by 10% by 2025.
    d. Population age structure of target species includes recent recruits, sub-adults and adults in at least seven (7) years in ten (10) for catfish, and nine (9) years in ten (10) for cod and yellow-belly.
    e. Population age structure of target fish species indicates a large recruitment event one (1) year in seven (7), demonstrated by a cohort representing >50% of the population.
3. Improve **condition of habitat** for waterbirds, including targeted species – including pelicans, water hens, swans, wild turkey, cranes, spoonbills, ibis, wood ducks and grass parrots
    a. Increase breeding success of target species (i.e. to fledging), in particular colonial nesting species, with two successful events by 2025.
    b. Re-habilitate nesting habitat for Australian migratory species with increased abundance recorded in three (3) out of four (4) targeted surveys by 2025.

[4] Unclear what the precise species is here – respondents felt that it may be currently classified as endangered.

6.5 Cultural and environmental values

Cultural values associated with Gooraman Swamp and its surrounds, including the Culgoa River, have been identified from ongoing discussions, meetings and field visits with the Murrawarri Research Partners. Values attached to the site include (not necessarily all water dependent):

- A sense of connection and obligation to culture and Country.
- A place to visit and reconnect physically to culture and Country.
- The location of sites of significance and associated cultural practices.
- A source of bush medicine, food and natural resources that can maintain or improve the health of Murrawarri.
- A source of socio-economic potential for Murrawarri.

"When you come back on Country, it's like an energy that comes from the earth and flows through your body. It regenerates you. And that's what happens when people come home, when they come back from the city. Because when they are in the city, they are on other people's Country. When they are on Country, they are learning about their own culture. They're learning in a way that's educational and cultural... Coming home, coming back on Country – it regenerates kids. They feel that they can be free. But in the city they're restricted by laws, restricted by another culture, restricted by another lot of processes and they are trying to navigate those processes. Through our culture, you can instill certain disciplines without them really knowing or understanding the details or the intricacies. And that's the way that Aboriginal people are taught. We weren't taught all the intricacies about how things work – it was learning through being on country, doing things on country." - Fred Hooper, pers.comms 2016 (Key nation Contact - Murrawarri Provisional Council of State)

6.5.1 Gooraman Swamp Traditional Aboriginal Knowledge

Published and publicly available Aboriginal knowledge and TAK was found to be limited at the Gooraman Swamp case study site, apart from the work done by Dykes et al. (2006) recording TAK from the Murrawarri. Some TAK was shared during the fieldtrip associated with the project and include the following, but this represents only a small part of the TAK held by the Murrawarri (see below and overleaf).

Cultural water is important …"*because if you get in the Culgoa, down to Weilmoringle, and you fill that waterhole up, and you have enough water flowing down the system, then there are a number of waterholes, the connection to this place here. [Gooraman Swamp] is his home. The connection then allows him to travel. It's the same – there are all different names for him all through the Murray. There's a common connection.... We need the cultural flow to fulfil our spiritual side of it, into Gooraman Swamp*."

"Prior to the extraction of water for the extensive cotton and agricultural practices, the Culgoa had a banker flow approximately every 12 months with a major flood event reaching Gooraman Swamp approximately every three years."

-Fred Hooper, pers. comms. 2016 (Key Nation Contact, Murrawarri Provisional Council of State)

"Cultural flows research and all this stuff with the Murray Darling – we are three years behind everyone else. Could be more. Because all of the environmentalists have got their science in, and we are still collecting our science. And the proposal is that any decision in the Murray Darling Basin would be based on science. Well, what about Aboriginal science? From that perspective, we need to work to help get the scientists to think that way as well. It's difficult. Bringing those two sciences together can tell the story.

"Once you fulfil the water requirements of Gooraman Swamp, it also triggers all of these Aboriginal environmental outcomes. Because once the swamp is full, the birdlife come back. A lot of the people from Weilmoringle were evacuated out during the 2011 floods. So they have never seen the results of the flood at the swamp. We'd sit there of an afternoon, and there would be thousands and thousands of birds just coming back to nest. It was full for probably nine months, or it at least had water in it for eight or nine months. I don't know whether you've seen all the old nests in the trees? It's also a breeding place for all different types of birds. Including migratory birds that came in, like pelicans, brolgas coming back."

- *Fred Hooper, pers. comms. 2016 (Key Nation Contact, Murrawarri Provisional Council of State)*

6.5.2 Culturally significant flora and fauna

Culturally significant species at Gooraman Swamp include those listed in Table 26. In addition species identified as having exceptional, spiritual, ceremonial, and medicinal or food value by Dykes et al. (2006) are also of cultural significance. These are captured in detail in the *Toogimbie and Gooraman Swamp Ecological Character Description Report* (NCFRP 2017a).

Table 26: Culturally significant species identified by the Murrawarri (Dykes et al. 2006).

Murrawarri name	Common name	Scientific name
	Murray cod	*Maccullochella peelii*
	Yellow belly	*Macquaria ambigua*
	Catfish	*Tandanus tandanus*
Kuruwa	River red gum	*Eucalyptus camaldulensis*
	Black box	*Eucalyptus largiflorens*
	River coolabah	*Eucalyptus coolibah*
Wumbul	Swamp paperbark	*Melaleuca trichostachya*
Wirrara	Lignum	*Duma florulenta*
Wirpil, Willpill	Dogwood	*Eremophila bignoniiflora*
Mururru	Gidgee - ring	*Acacia cambagei 'ringed'*
Thupppie	Snotty gobble	*Diplatia grandibractea*
	Emu	*Dromaius novaehollandiae*
	Wild turkey	
	Echidna	*Tachyglossus aculeatus*
	Identified water bird species including: cranes, spoonbills, ibis, wood ducks, divers (diving kingfishers?) and grass parrots	Various species including: *Platalea regia, P. flavipes, Threskiornis spinicollis, T. moluccus, Chenonetta jubata,* among others.

Most data sourced during the preparation of the Gooraman Swamp Ecological Character Description (see NCFRP 2017a), including the vegetation surveys and identification of culturally

significant plants, are regionally based assessments. Where information can be attributed to being specific to the site this is noted in the reports.

The environmental values attributed to Gooraman Swamp (Hunter 2005, NPWS 2002), include:

- Streambank, riparian and floodplain vegetation in a region that has been cleared of much of its native vegetation. This includes contiguous vegetation communities such as coolibah-black box woodland.
- Streambank vegetation that provides structural habitat (e.g. snags, undercuts) for native fish in the Culgoa River.
- Wetland and floodplain habitat for plant and animal species, including threatened reptile, bird and mammal species.

Text Box 4: Emu.
Note: The TAK noted in the example below is for demonstrative purposes only and is not representative of all Aboriginal communities or individuals. TAK will vary depending on cultural context.

For Aboriginal people the seasons dictate and connect creation and emu in a special way.

The emu, as with the black swan, is a well-known part of the Aboriginal diet. It is consumed at various stages of its life from egg to adult, with both eggs and chicks favoured. Knowing the habits of the emu and the different roles of the adult male and female is vital in being able to both harvest and hunt them. Teaching children how to track is very important and often done in the sand. It is part of the cultural upbringing of the child and ensures the transference of knowledge from one generation to the next.

The egg, once collected is carved for decoration. In order to carve the egg you have to have the proper stone tools and know the egg intimately. This enables you to get the right shades by going to the right depth and angle in the carving process to build the picture you are carving. If you collect the egg too late in the season, the shell will have weaked and will not be suitable for carving. In addition to decorating, the shell of the egg is often used as a drinking or water container. Half shells can be made into a cup and when the eggs are blown and cleaned they can be used to carry and store water by blocking the ends with small bits of wood.

The emu is able to find water for drinking when it is not obvious to other animals or birds and for this reason they are vital to the Aboriginal way of life. In observing the tracks and movements of the emu, people are able to locate valuable sources of water, in much the same way that coastal groups watch shags fly low over the sea to spot where the schools of fish are.

Some members of the group will have the emu as their totem or Tjukurpa. The emu is an important part of storytelling and is represented symbolically and physically (through feathers) in dance and ceremonies across Australia. The significance of the emu to Aboriginal life and its connection to the creation can be seen via the Milky Way. The Southern Cross is the beak of the emu and it is visible in the night sky during the times when the emu egg is suitable for harvesting. If harvested too soon you cannot remove the yolk from the egg, and if left too late, it is not a viable food source owing to the fact the chick has already begun form.

6.6 Site location description

Found in north central NSW, near the Queensland border, the Weilmoringle IPA covers an area of 3,500 hectares. Gooraman Swamp is located entirely within the IPA boundary (Figure 47). Weilmoringle is located on the floodplain of the Culgoa River, approximately 20 km southwest of the Culgoa National Park. Gooraman Swamp and surrounding land is situated within the western district of the Darling Riverine Plains Bioregion. The bioregion is characterized by extensive floodplains of 10 major rivers: the Barwon-Darling, Culgoa, Birrie, Bokhara, Narran, Gwydir, Namoi, Castlereagh, Macquarie and Bogan.

The area surrounding Gooraman Swamp is comprised of Northern Riverine Woodlands, which is a habitat type that includes river red gum woodlands along river frontages and extensive coolibah–black box woodlands on the floodplains of the Culgoa River. As noted by the National Parks and Wildlife Services (NPWS) (2002) and Hunter (2005), the riverine woodlands on the Culgoa River floodplain (particularly in the nearby Culgoa National Park) are the largest and least disturbed area of contiguous coolibah woodland left in NSW.

Figure 47: Gooraman Swamp case study site in relation to Weilmoringle IPA boundary and key hydrological features.

6.7 Ecological monitoring and assessment at Gooraman Swamp

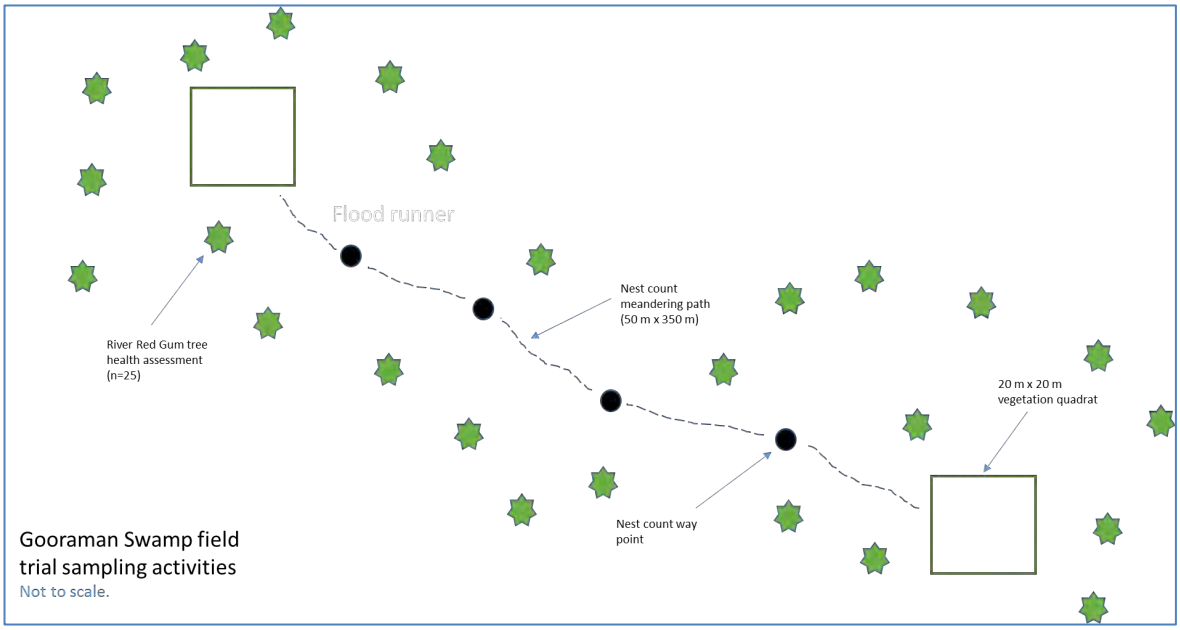
6.7.1 Ecological monitoring approach

The ecological monitoring undertaken at Gooraman Swamp followed that detailed in the *Gooraman Swamp Indicator Framework and Methodology Report* (NCFRP 2016d). Monitoring was undertaken at two locations, (i) Gooraman Swamp and (ii) at a site on the Culgoa River. The monitoring activities at each site are summarised in Table 27, and are shown pictorially in Figure 48. Also presented in Table 27 are recommendations for timing and frequency of future monitoring activities. Graphical presentations of results were prepared using Microsoft Excel 2016.

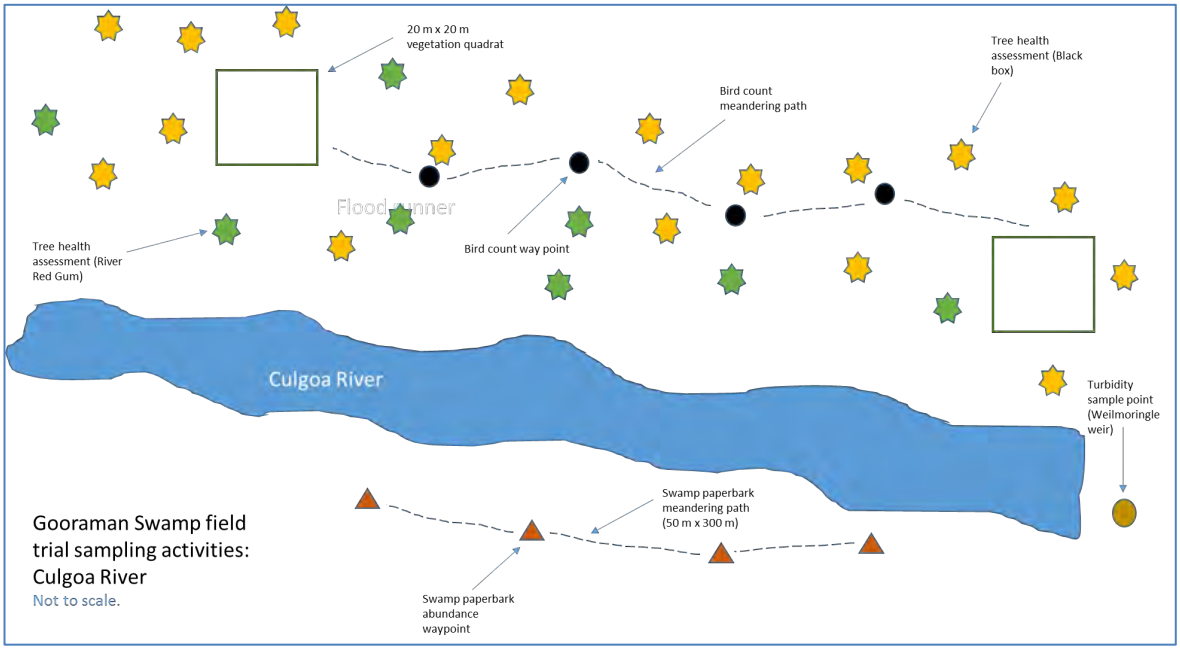
Table 27: Summary of monitoring activities at each site

Theme	Site monitoring activity	Assessment approach	Recommended Timing and Frequency
Vegetation	• Floristics (species cover) within two 20 metre x 20 metre quadrats at both Gooraman Swamp and along the Culgoa River. • River red gum *Kuruwa* (Gooraman Swamp) and black box (Gooraman Swamp and the Culgoa River) health assessment. • Swamp paperbark abundance along a meandering 300 metre x 50 metre transect along the Culgoa River.	• Summary of vegetation species diversity and species lists for each site. • Summary of river red gum and black box tree health. • Proposed methodology for monitoring paperbark abundance, using height class distribution.	• Floristics surveys and tree health assessments to be repeated annually in spring, with additional surveys to correspond with flood events (pre and post inundation). • Swamp paperbark surveys to be conducted twice annually, in autumn and spring.
Birds	• Species abundance recorded at way-points and along a 250 metre meandering transect along the Culgoa River. • Bird nest abundance along a 250 metre meandering transect along the Culgoa River.	• Summary statistics of bird species abundance (Gooraman Swamp and Culgoa River). • Summary of bird nest abundance (Gooraman Swamp).	• Species abundance surveys to be conducted over three consecutive mornings, monthly. • Bird nest abundance to be repeated annually in spring, with additional surveys to

Theme	Site monitoring activity	Assessment approach	Recommended Timing and Frequency
			correspond with flood events (during and post inundation).
Water quality	• Turbidity measurement in the Culgoa River	• Reporting of baseline turbidity reading.	• Monthly readings, increasing to weekly readings during significant flow events.
Native animals	• Fishing and hunting participant's well-being assessment. • Number of fish caught per angling hour. • Number of kangaroo caught per hunting hour.	• Summary and narrative of fishing and hunting participant wellbeing. • Summary of fish and kangaroo catch per unit effort.	• Every 3 months (e.g. Jan, Apr, Jul, Oct), with monthly assessments during flood events.



(a)



(b)

Figure 48: Diagram showing the monitoring activity at each site at (a) Gooraman Swamp and (b) along the Culgoa River.

6.7.2 Ecological monitoring results

Vegetation Community Condition (quadrats)

Vegetation community condition monitoring was undertaken in both Gooraman Swamp, and on the floodplain adjacent to the Culgoa River just downstream of Weilmoringle.

Vegetation community condition monitoring used NSW OEH standard methods (OEH 2015), consistent also with the approach used for vegetation surveys and mapping across floodplain systems in NSW (Eco Logical Australia 2015). At both locations two (2) randomly located 20 m x 20 m quadrats were set up in representative vegetation types for each site, and the following data was collected:

- Species present.
- Foliage Cover (%, by species).
- % cover of litter (e.g. non-attached plant matter such as leaves etc.).
- % cover of bare ground.
- Species abundance (number of individuals of each species).
- Height and strata information for each species.
- Crown extent and canopy openness for overstorey tree species.
- Length of fallen timber (total metres).

For each quadrat:

- Corners were marked using star droppers.
- The locations of the NE corner labelled and location recorded using GPS.
- Four site photographs were taken from various angles.

Representative site photographs of each vegetation monitoring location are presented in Figure 49 and Figure 50.

Figure 49: Gooraman Swamp vegetation monitoring site - Quadrat 2

Figure 50: Culgoa River site - Quadrat 1

Species Lists

Two species lists were developed from the vegetation community condition monitoring. Table 28 presents the list of species recorded within the two (2) vegetation quadrats sampled from Gooraman Swamp.

Table 29 presents the list of species recorded at the two Culgoa River sites.

Table 28: Gooraman Swamp Vegetation Species List

Species	Common Name
**Lactuca serriola*	Wild Lettuce
**Lycium ferocissimum*	African Boxthorn
**Polygonum aviculare*	Wireweed
**Solanum nigrum*	Blackberry Nightshade
Abutilon sp.	Lantern Bush
Acacia stenophylla	River Cooba
Alternanthera denticulata	Lesser Joyweed
Calotis cuneifolia	Purple Burr-daisy
Centipeda cunninghamii	Old Man Weed
Chenopodium anidiophyllum	Mallee Goosefoot
Chenopodium pumilio	Clammy Goosefoot
Chrysocephalum apiculatum	Common Everlasting

Species	Common Name
Einadia nutans	Climbing Saltbush
Enchylaena tomentosa	Ruby Saltbush
Eucalyptus camaldulensis	River Red Gum *Kuruwa*
Graminae sp.	Grass (unidentified)
Helichrysum sp.	Everlasting
Melhania oblongifolia	Velvet Hibiscus
Myoporum montanum	Western Boobialla
Nicotiana sp	Tobacco Bush
Plantago sp.	Plantain
Rhagodia spinescens	Spiny Saltbush
Rumex sp.	Dock
Salsola kali	Buckbush
Schoenia ramosissima	Dainty Everlasting
Sclerolaena intricata	Tangled Bindyi
Sclerolaena stelligera	Star Bindyi
Sclerolaena tricuspis	Three-spined Bindyi
Senecia qudridentatus	Cotton Fireweed
Tetragonia tetragonioides	Warrigal Spinach

Table 29: Culgoa River Vegetation Species List

Species	Common Name
**Malva parviflora*	Small-flowered Marshmallow
Acacia stenophylla	River Cooba
Atalaya hemiglauca	Whitewood
Atriplex suberecta	Lagoon Saltbush
Calotis scabiosifolia	Rough Burr Daisy
Chenopodium nitrariaceum	Nitre Goosefoot
Chrysocephalum apiculatum	Common Everlasting
Duma florulenta	Tangled Lignum
Einadia nutans	Climbing Saltbush
Eremophila bignoniiflora	Willpill (Dogwood)
Eryngium plantagineum	Eryngo
Eucalyptus microtheca	Coolibah
Lepidium hyssopifolium	Peppercress

Species	Common Name
Plantago cunninghamii	Sago Weed
Salsola kali	Buckbush
Sclerolaena anisacanthoides	Yellow Bindyi
Sclerolaena convexula	Tall Bindyi
Sclerolaena diacantha	Grey Bindyi
Sclerolaena stelligera	Star Bindyi
Sclerolaena tricuspis	Three-spined Bindyi
Sida sp. 1	Sida
Sida sp. 2	Sida
Solanum esuriale	Quena
Sporobulus mitchellii	Rat's-tail Couch
Tetragonia teragonioides	Warrigal Spinach
Teucrium racemosum	Grey Germander

30 species were recorded at Gooraman Swamp (including four (4) exotic species), and 26 species were recorded at the Culgoa River site (including one introduced species). These species lists can be used as a record of the species observed at a point in time during what could be considered a pre-flow scenario. If the same monitoring work is completed following a flood event vegetation responses will be able to be analysed. Analysis could focus on vegetation responses relevant to the cultural objectives identified by the Research Partners, in particular changes in abundance of culturally significant species (e.g. Willbill, Lignum *Wirrara*, River red gum *Kuruwa*, Black box and Coolabah).

Complete vegetation community condition data is presented in Appendix 2 Part E.

Tree Health

A tree health assessment was conducted using *The Living Murray* method (Souter *et al.,* 2010), summarised below. The tree health assessment considered two (2) species, *Eucalyptus camaldulensis* (River red gum *Kuruwa*) and *Eucalyptus largiflorens* (Black box).

Indicators of current condition used in the assessment were:

- Crown Extent – the extent to which the crown outline fills the space that would be occupied by the normally foliated crown of a reference tree of similar age and shape.
- Crown Density – the inverse of the measure of foliage transparency (the amount of skylight visible through the live, normally foliated portion of the crown).

The Crown Extent and Crown Density variables were assigned category scores as per Table 30 (overleaf).

Table 30: Crown extent and density categories

Category	Description	Percentage
0	None	0%
1	Minimal	1 – 10%
2	Sparse	11 – 20%
3	Sparse-medium	21 – 40%
4	Medium	41 – 60%
5	Medium-major	61 – 80%
6	Major	81 – 90%
7	Maximum	91 – 100%

Indicators of the future trend of tree health used in the assessment were:

- New tip growth – the growth of new shoots from the peripheral tips of the tree branches at the edge of the crown.
- Epicormic growth – the sprouting of new shoots from the main trunk or primary branches of the tree.
- Reproduction – the combined relative abundance of buds, flowers and/or fruits.
- Mistletoe – the relative abundance of mistletoe plants found on a tree.
- Leaf die-off – the relative abundance of dead leaves on the tree.

These indicators were assigned category scores as per Table 31.

Table 31: Future trend indicator categories

Category	Description	Definition
0	Absent	Effect is not visible
1	Scarce	Effect is present within the assessable crown but not readily visible
2	Common	Effect is clearly visible throughout the assessable crown
3	Abundant	Effect dominates the appearance of the assessable crown

Bark condition was also assessed for each tree, and assigned category scores as per Table 32. Long-term dead trees were not assessed in this survey therefore Category 4 is not applicable.

Table 32: Bark condition categories

Category	Description
0	Intact bark
1	Minor cracking – cracks limited in number and bark still held in place
2	Moderate cracking – numerous cracks but bark still held in place
3	Extensive cracking – numerous deep cracks which are lifting the bark off the sapwood
4	No bark (long-term dead tree)

25 trees were assessed at both the Gooraman Swamp site and Culgoa River site, with trees selected in the vicinity of the vegetation community condition quadrats. At Gooraman Swamp all of the assessed trees were *Eucalyptus camaldulensis* (River Red Gum *Kuruwa*). At the Culgoa River site both *Eucalyptus camaldulensis* and *Eucalyptus largiflorens* (Black Box) trees were assessed (four River Red Gum and 21 Black Box).

Table 33 and Table 34 display the distribution of scores for Crown Extent and Crown Density for both sites.

Table 33: Crown extent and density score distributions – Gooraman Swamp

		Eucalyptus camaldulensis	
Category Score	**Description**	**Crown extent score frequency**	**Crown density score frequency**
0	None	1	0
1	Minimal	0	1
2	Sparse	6	6
3	Sparse-medium	12	9
4	Medium	6	8
5	Medium-major	0	1
6	Major	0	0
7	Maximum	0	0

Table 34: Crown extent and density score distributions – Culgoa River

		Eucalyptus camaldulensis		*Eucalyptus largiflorens*	
Category Score	**Description**	**Crown extent score frequency**	**Crown density score frequency**	**Crown extent score frequency**	**Crown density score frequency**
0	None	0	0	0	0
1	Minimal	0	0	0	0
2	Sparse	0	0	0	0
3	Sparse-medium	0	2	13	15
4	Medium	4	2	8	6
5	Medium-major	0	0	0	0
6	Major	0	0	0	0
7	Maximum	0	0	0	

At Gooraman Swamp only 11 of the 25 trees assessed had epicormic growth, but 18 trees had new tip growth. Most trees had minimal leaf die-off, rated as “sparse” or less. A large percentage of the assessed trees had intact bark. Only three (3) trees showed signs of reproduction. None of the assessed trees had mistletoe.

At the Culgoa River site 20 of the 25 trees assessed had epicormic growth, and all trees had new tip growth. Most trees had minimal leaf die-off, rated as “sparse” or “minimal”. Most of the assessed trees had intact bark. No trees showed signs of reproduction. Two (2) of the assessed trees had mistletoe.

Full tree health data for both sites is presented in Appendix 2 Part F This data can be used as a record of tree health observed at a point in time during what could be considered a pre-flow scenario. If the same monitoring work is completed following a flood event vegetation responses will be able to be analysed to determine what changes in tree health and reproduction occur as a response to the flooding.

Paperbark abundance

A survey of river paperbark (*Melaleuca trichostachya*) tree abundance was not undertaken during the monitoring visit in November 2016, but a methodology was discussed with the Research Partners to provide a way for them to monitor the growth and recruitment of Swamp paperbark in response to seasonal conditions and flow events.

The methodology proposed is to record the number of paperbark trees that fall within certain size classes along a defined 300 metre stretch of the Culgoa River (both banks). As most paperbark trees will be found right on the banks of the river a nominal 50 metre transect width is used to provide a survey area of 1.5 hectares. Height classes proposed to be used for monitoring are:

- Seedlings (<10 cm).
- Juveniles (10 cm to <1 m).
- Small trees (1 m to <2 m).
- Trees 2m high or greater.

It is recommended that the paperbark survey be completed twice annually, in autumn and spring.

Fishing and hunting

A fishing and hunting wellbeing assessment was not undertaken during the November 2016 monitoring visit, but a methodology for the assessment was co-developed with Research Partners to provide a method and proforma to monitor the number and species of fish and/or fauna caught, and wellbeing of participants involved was designed for future use (see Appendix 4).

Bird surveys

Bird surveys were conducted along defined transects at both Gooraman Swamp and the Culgoa River sites, with transects running between the two (2) vegetation monitoring quadrats established at each location. Each survey took approximately 30 minutes, with birds identified visually and by their calls.

The Gooraman Swamp site was relatively quiet in terms of bird activity at the time of the survey, which is likely due to the fact that the survey was undertaken during the afternoon (due to time constraints). Only seven birds in total were observed, including six (6) species. An emu was sighted at Gooraman, notable due to the cultural importance of the emu to the Murrawarri.

Table 35: Bird species recorded at the Gooraman Swamp site

Species	Number
Willy wagtail	1
Magpie Lark (Peewee)	1
Kookaburra	1
White Plumed Honey eater	2
Noisy Friarbird	1
Emu	1

The Culgoa River site was surveyed during the morning time period when birds were more active, with a resulting increase in the number of birds identified. Ten (10) bird species were identified, with 27 individual birds counted.

Table 36: Bird species recorded at the Culgoa River site

Species	Number
Hobby Falcon	1
Australian Raven	1
Tree Martin	10
Pied butcherbird	1
White Plumed Honeyeater	2
Black Faced Cuckoo Shrike	1
Noisy Friarbird	2
Willy Wagtail	3
Bar Shouldered Dove	4
Grey Shrike Thrush	1
Red Capped Robin	1

The differences between the number of birds sighted at the two (2) locations can be partly attributed to the time of day surveys were undertaken, as well as the obvious differences between the sites, including vegetation type and availability of water.

This baseline data should be added to by conducting regular surveys (e.g. monthly), in order to develop a more complete species list for each site, and to allow the Murrawarri to track changes in the bird communities through the seasons and in response to flooding.

Bird Nest abundance

Gooraman swamp appears to be an important breeding site for various large wetland bird species. Numerous large stick nests are present in the lower limbs of the Red gum trees in the swamp, which are likely to be the nests of ibis and spoonbill species.

As a way of monitoring nesting activity in the swamp a nest count was undertaken along a defined transect running between the two vegetation monitoring quadrats (the same transect used for the bird survey). Nests were counted within an area extending approximately 25 metres either side of the 350 m transect, which represents an area of approximately 1.75 hectares. 80 nests were counted along this transect in 2016, which equates to approximately 46 nests per hectare. This baseline figure can be used to monitor changes in nest density along the same transect in future years, and in particular following flood events.

River Turbidity

Turbidity of the Culgoa River water is an important water quality parameter for the Research Partners, due to the cultural importance of swimming in the river as a community activity. Reduced turbidity of the river water is preferable to make swimming safer and more enjoyable, and it is hoped that improved river flows would improve turbidity levels.

A turbidity measurement was taken from the Culgoa River at the weir, using a turbidity tube. This site is easily accessible and can be used for ongoing turbidity monitoring. The baseline turbidity reading taken on the 27th of November 2016 was 160 Nephelometric Turbidity Units (NTU). There was no flow in the river at the time, downstream of the weir was essentially dry.

It is recommended that the Research Partners or community representatives continue to monitor turbidity at the weir using their turbidity tube. It is suggested that monthly readings are taken, with readings to be taken more regularly (e.g. weekly) during and following significant flow events to determine if increased flows result in improved river turbidity. If possible a river gauge height should also be recorded at the same time as the turbidity reading to help correlate turbidity with river level and hence flow rate. It is expected that turbidity may increase at the early stages of a flow event, but improve after the peak flow has passed.

6.8 Social, health and wellbeing evaluation and assessment at Gooraman Swamp

6.8.1 Social monitoring approach

Monitoring and evaluation of socio-cultural outcomes from cultural water at the Gooraman Swamp were focused on establishing a baseline of condition of key indicators, to ensure a framework is in place in the event of a cultural flow allocation. The Research Partner aspirations connected to the site, as well as the specified cultural flow objectives, will require a long term perspective. Specifically, the key objectives are intergenerational, and the assessment framework assumes a medium to long-term view will be required to achieve the stated objectives; hence the objectives are expected to be achieved within a 15-year timeframe.

It should be noted the scope of this work focuses predominantly on monitoring medium-term outcomes directly related to the delivery of a potential cultural flow to Gooraman Swamp in the near future. However, this does not preclude other activities, particularly those that are not site-based activities, such as liaison with government agencies and water user groups to have cultural flow delivery inserted into watering sharing plans, co-management activities and other water management initiatives. Objectives, key evaluation questions and indicators for the cultural outcomes theme are summarised in Table 37.

Table 37: Cultural flow objective, evaluation and indicators for the Murrawarri

Watering objective	Key Evaluation Questions	Indicators
Increased feeling of wellbeing by Murrawarri people due to the improved environmental condition of Gooraman Swamp.	Did cultural flows increase the feeling of well-being by Murrawarri people after visiting Gooraman Swamp or the Culgoa River?	Well-being parameters developed in consultation with the Murrawarri. Assessment of social/recreational activities

Increased health of the Murrawarri community.		associated with the Culgoa River (including attendance, duration, youth involvement, community satisfaction).
Improved community governance due to a greater attachment to Country by Murrawarri people.		
Increased knowledge preservation and regeneration between generations of Murrawarri.	Did cultural flows create additional opportunities for knowledge exchange and cross-generational community interaction?	Extent of practices associated with cultural management of Country, including learning (e.g. fire management, seed collecting, and weed management).
Increased sustenance and income derived from harvesting of plants and animals, and from tourism.	Did cultural flows increase traditional harvest or cultural management practices undertaken by Murrawarri people?	Extent of harvest activities associated with traditional food and medicine species at Gooraman Swamp.

6.8.2 Social monitoring results

Given the significance of riverine activity, and especially fishing, for the Research Partners in terms of satisfying a range of social, economic and cultural benefits, fish population in the Culgoa River could serve as an important indicator. However, the techniques available for fish population monitoring are not likely to be suitable in this location. In consultation with Research Partners, the monitoring framework for socio-cultural outcomes is designed to focus more on community activity/-ies, including harvest, social and recreational activities. For harvest and cultural management activities including: fishing, seed collecting, weed management and fire management, the survey instrument developed incorporates both an estimated economic value of activity (including person hours and estimated harvest value) and an associated well-being self-assessment surveys. This survey is designed to enable the Research Partners to report a baseline of activity in terms of:

- Monitoring of the practices associated with cultural management of Country, including communal and learning associated with cultural management activities (including fire management, seed collecting, weed management).
- Monitoring of harvest activity (location, species, attendance, participation, duration, satisfaction, youth/elder involvement, estimated value).
- Monitoring of social and recreational activities associated with the Culgoa River (including attendance, duration, youth involvement, community satisfaction).

Ongoing discussions with the Research Partners will determine how best to utilise these surveys in order to establish the extent of change reasonably attributable to cultural flows in the event of an allocation.

6.8.3 Discussion

Given the absence of a flow trial at this location, the baseline assessment of activity (management, harvest, social and recreational) for both the Culgoa and the Gooraman Swamp sites found very low levels of activity. Discussions with Research Partners confirmed that the types of impacts to be monitored were wholly dependent on the level of water in the Culgoa River. As one respondent explained:

> *If we get a flow, we can set aside a period during that flow. And we can say, for a week, we will measure the amount of people who go down to the river, the amount of activity on the river, during that flow period. But as a baseline, if you take now for instance, well, chances are there isn't going to be much activity down there. Certainly, there's not going to be fishing. There might be a little swimming and that sort of thing. But then, when water starts flowing over the weir, there's people down here trying to catch them with their hands! But for now, we'd just say that there's minimal activity without that flow. - F. Hooper pers. comms, 2016 (Key nation contact – Murrawarri provisional council of state).*

It was also suggested that weather conditions be reported in the event of a future flow event, as this too has a significant impact on the way in which the river is used, and how those socio-cultural values can be fulfilled in these times. However, scope constraints of the Project provide no capacity for a follow-up survey during a future flow event. Additionally, there are no resources currently available to resource monitoring for socio-cultural changes into the future. Both of these factors significantly limit the utility of monitoring and evaluation activities at this site, and this is compounded as the cultural outcomes anticipated with water delivery to Gooraman have a medium to long term time horizon. Instead, we have focused on establishing the framework for monitoring, such that if a cultural flow allocation becomes available in the future, the process by which monitoring the outcomes of those flows is specified and able to be supported with reduced resourcing requirements.

6.9 Research Partner experience and perspectives

Project evaluation has not yet been conducted with the Research Partners at the Gooraman Swamp case study site. These experiences and perspectives will be documented as part of the final field trip in May 2017, which will involve presentation of the project findings and provide the opportunity for community feedback on the Project, its results and implications.

7 CONCLUSION

7.1 Evaluation and Key Learnings to date

The key learning from the field research presented here is that the work conducted to establish the water requirements for cultural flows is, in essence, the work required to facilitate Aboriginal water management in a more general and holistic sense. In this regard, the purpose of a cultural flow is to enable Aboriginal water management. It is clear from the case studies that a cultural flow developed according to the priorities and aspirations of Aboriginal participants will achieve both cultural and environmental outcomes, and generally the separation of these categories is arbitrary and analytical. In some instances, a cultural flow is likely to achieve similar outcomes to an environmental allocation or a natural flood event, but this does not mean that environmental water is sufficient to meet the objectives of a cultural flow. **The key distinguishing feature of cultural flows is that Aboriginal people collaboratively determine how the water will be used**. **Defining that water as a cultural flow creates legitimacy of / for Aboriginal water management objectives and would allow communities to make meaningful planning and management decisions without having to justify and rationalise the value of those decisions.**

Further, this Project has also demonstrated that **the process of establishing cultural flow objectives and the field research conducted to assess the outcomes of those objectives were seen as highly beneficial by Research Partners against a diverse range of criteria. In particular, the process itself was seen to improve community knowledge and confidence in the management of Country.** This was a key observation from the Nari Nari Research Partners, who valued the contribution of the project to improving their understanding of effective management and sharing TAK, but also in terms of communicating and reporting the outcomes of their management of the site from both ecological and social benefits. The process of preparing for the trial and flow planning will result in permanent changes to their reporting protocols associated with the management of the IPA. Similarly, the participants in the field monitoring at Gooraman Swamp reflected on the way that their involvement in this project demystified the technical aspects of environmental monitoring, and that this has enabled a greater appreciation and added a new perspective to their current cultural management activity.

The process also assisted the Nari Nari Research Partners in particular in the surfacing of cultural knowledge. It enabled participants to reconsider and re-contextualise information that was known by the Research Partners, but not framed in the context of TAK or considered salient to the cultural management of Country. This is analogous to experiences reported in the literature of other Aboriginal communities, where new uses, practices and forms of cultural expression have re-emerged as a consequence of access to land and water, both in Australia and overseas (Carson et al. 2007; Sayer 2007; Wells and McShane 2004). In this instance, this cultural renewal was evident despite the absence of an application of cultural water to the study site. **There is an established and growing literature that demonstrates for Aboriginal people who get access to land, activities connected to "bringing Country back" have corresponding regenerative effects on landscapes, cultural practice, knowledge exchange, health and even language. Within the context of this case study, there is evidence that cultural flows do likewise. Cultural regeneration has direct and demonstrable flow-on effects linked to increased confidence, capacity and self-reliance that comes with access to Country**.

At both case study sites, there remains a high degree of confidence in the capacity of cultural water to deliver a wide range of social and community benefits. In particular, **both case study Nations remain adamant that cultural water can be an equitable and cost-effective means to address social disadvantage through the generation of employment, training and enterprise opportunities**. A major goal of the field research was to provide an evidence base to support this

assertion. Given the abandonment of the trial due to a natural flood, the Project has not produced the supporting information necessary to validate this assumption. However, there is evidence to support individual and social learning outcomes for participants, and this aligns with the chain of intended outcomes specified by participants in both program logics.

In terms of project outcomes, the impact of the flood event at Toogimbie is ambiguous. **The flooding prevented the flow trial from proceeding, which limited the extent of the evidence base that the Project was attempting to generate through the trial**. In particular, monitoring of the social objectives from cultural water was severely limited due to the cancellation of events at the site central to data collection. On the other hand, **the post-flood monitoring of ecological outcomes was able to highlight positive impacts from the application of water at the site**, including reduction in exotic vegetation species, significant improvements in lignum health and an increase in bird activity at the site. These results are consistent with the confirmed Cultural objectives and intended AEOs, and serves to **demonstrate the culturally positive outcomes derived from inundation at the site**. This evidence base **strengthens the case for the achievement of culturally relevant environmental outcomes from the watering events**, despite the fact that the watering in this case was not as planned or controlled as had been intended.

Working through the process of identifying flow objectives and the development of water management interventions to meet those objectives, highlights differences between environmental and cultural water. For example, the types of plant and animal species prioritised in a cultural flow assessment differ in emphasis from those traditionally relevant for environmental flow assessment. This is especially the case for vegetation species with traditional uses or spiritual significance, but which are relatively common. For example, it is unlikely that an environmental flow assessment would prioritise Old Man Weed (*Centipeda cunninghamii*) as in the cultural flow assessment; however environmental flow objectives are likely to have an incidental positive impact on the abundance and health of this species. In both case study locations, the argument that cultural flows can achieve environmental outcomes, but environmental flows cannot achieve cultural outcomes was consistently re-iterated. The case studies are suggestive of this conclusion, however **how environmental flows and cultural flows differ will be context dependent and site specific, and will likely be subject to a high degree of variability over time**. It is not yet possible to make definitive claims about the disparity of cultural and environmental flow goals. **The differences in terms of why certain outcomes are valued or prioritised may result in different water management regimes over time. This strengthens the case for considering cultural flows as a (core) component of Aboriginal water management.**

A further important learning is derived from the Murrawarri case study, which demonstrates that **the achievement of cultural flow objectives may not be possible without significant changes to the upstream water management regime and infrastructure**. In the current context, there is no capacity for the volumes of water required to effectively deliver the cultural flow objectives as specified to be delivered to the site. The Murrawarri case is likely to be similar to most other determinations of cultural flows around the country, where Aboriginal values associated with key water sites and with the river system itself are best protected and enhanced under a pre-development flow regime. Consideration of how to restore pre-development conditions in the highly-modified landscapes is beyond the scope of this study, but is likely to be an ongoing point of contention in the cultural flows discourse.

7.2 Considerations for a proposed national Framework

Component Four of the Project will provide a proposed framework to determine water requirements to support cultural values applicable across a range of water planning and management contexts. The work to develop this framework is currently proceeding, however there are a number of contributions to this national framework that are directly attributable to the learnings from the desktop and field research reported here.

- **Allow sufficient time for objective setting**. The process of setting cultural flow objectives required more time and re-iterations than was initially planned in the Project schedule. This is partially as a result of involving multiple technical and cross-cultural perspectives in order to arrive at a consensus position. This process is compounded when the revised objectives are no longer feasible from a cultural, ecological or hydrological perspective, or the consequences of otherwise agreed and achievable objectives create unacceptable risk to the security of the resource at a whole of landscape scale.

- **Clarify the limits of water management objectives**. There are always limits to the capacity of a watering regime to deliver the full suite of desired objectives, and some tradeoffs are inevitable in this regard. It is important to emphasise the limits of planning with Research Partners to avoid creating expectations that cannot be delivered in the context of water management.

- **Incorporate dispute management strategies**. The framework may need to accommodate procedures for the resolution of disputes in instances where there is disagreement regarding the management objectives for the cultural water. Although not evident either of the case studies presented here, the extensive process of objective setting demonstrated the potential of conflicting knowledge and values and the irreducible presence of uncertainty in water planning and decision-making to limit consensus and stall the process.

- **Prioritise TAK**. TAK refers to customary, traditional or otherwise cultural knowledge of the natural ecosystems held by the community specifically relating to water. This knowledge is diverse and under-documented, and can exhibit a range of forms including site specific characteristics associated with past or desired water conditions or observed ecological responses of culturally important species and ecosystems to water.

- **Refine existing water management tools and frameworks**. Work conducted in the project has drawn and adapted a range of tools associated with water management from non-Aboriginal contexts, including the MERI framework, program logic and tools and methods adapted from participatory environmental monitoring. The modifications required for these tools to be appropriate for establishing cultural flow requirements are minor, but significant. There is an important opportunity to work with the project partners to identify ways that these tools can be adapted as the foundation of a national cultural flows framework.

7.3 Where to next?

The upcoming stages of the project will involve Research Partners in progressing the findings from the case studies towards Components Three and Four. Specifically:

- **On ground monitoring** and additional derived data from the field work will be used to finalise the hydrological modelling undertaken for the two case study sites. This information will be made available to Research Partners to assist in future water planning and management.

- **A final round of field trips** will be conducted at both Toogimbie and Gooraman Swamp to present the draft final report and to gather Research Partner feedback on the reports, findings and proposed national framework. The Gooraman Swamp field visit will include an evaluation process for Research Partners to reflect on their experiences and perspectives of the Project overall.

- The field work findings will be used to **analyse synergies and differences** between cultural and environmental flows. This analysis will be presented as a summary to guide future Project components' recommendations for policy, legal, and institutional changes to enable the implementation of cultural flows.

- The project team will use the desktop and field research to **propose a pilot framework** to determine water requirements to support cultural values for the national context. Key learnings from this and other reports will be captured in that framework to maximise its relevance for Aboriginal peoples across the country to advance cultural flow policy discussions.

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9 TERMS AND DEFINITIONS

Aboriginal	The people who are the original inhabitants of the land.
Aboriginal Environmental Objectives	The values and benefits derived by Aboriginal people from environmental water.
Aboriginal Environmental Outcomes	The term "Aboriginal environmental outcomes" has been developed to describe and communicate the benefits to Aboriginal people that can be derived from environmental watering. Aboriginal environmental outcomes result from healthier rivers and wetlands, for example improved fish populations, more reeds that can be harvested and increased bird breeding events. In essence, Aboriginal environmental outcomes provide tangible physical benefits to community, culture and Country (MLDRIN 2007). This definition was endorsed by representatives of the Murray Lower Darling Rivers Indigenous Nations (MLDRIN) and Northern Basin Aboriginal Nations (NBAN) and is recognised by the Murray Darling Basin Authority (MDBA), Victorian Environmental Water Holder (VEWH) and Department of Environment, Land, Water and Planning (DELWP).
Adaptive management	A rigorous and evidence-based approach to the management of natural resources, including water, that seeks continuous improvement by ensuring that management actions adapt in response to changes or to feedback. An adaptive management approach would identify targets towards the achievement of sustainability and public benefit, but also include a monitoring system to measure progress and achievements against the targets, and a response system that enables modifying interventions in response to the findings.
Authorised Knowledge Holder	A person, normally a Traditional Owner, who has been provided cultural and/or traditional knowledge of a particular place or thing through customary law and is recognised by the Traditional Owner community to have the authority to speak on or share that particular knowledge where appropriate.
Community	A group of people living in the same place or having a particular characteristic in common (e.g. people living in a suburb or town).
Collaboration	Collaboration is a condition that takes place when people work together to address a shared problem or concern with a commitment to a beneficial outcome. Collaboration requires the shared input or pooling tangible and intangible resources (such as information, knowledge, money or labour) to solve problems which no party can solve individually.
Cultural flows	Water entitlements that are legally and beneficially owned by Indigenous Nations of a sufficient and adequate quantity and quality to improve the spiritual, cultural, environmental, social and economic conditions of those Indigenous Nations. This is our inherent right.

	This definition was developed by representatives from 12Aboriginal nations at a meeting of the Murray Lower Darling River Indigenous Nations (MLDRIN) and adopted by the Northern Basin Aboriginal Nations (NBAN) -The Echuca Declaration, September 2010 (MLDRIN 2007).
Cultural Water	Perpetual or ongoing entitlements to exclusive access to a share of water from a specified consumptive pool which are owned by Aboriginal Nations and managed at the discretion of those Nations.
Cultural Watering Objectives	The values and benefits derived by Aboriginal people from cultural water.
Deliberation	Deliberation is a form of participation in collective decision-making which allows for information exchange, sharing diverse perspectives and their significance, careful consideration of different opinions and joint evaluation of alternatives.
Environmental flows	Environmental flows describe the quantity, timing, and quality of water flows required to sustain freshwater and estuarine ecosystems and the human livelihoods and well-being that depend on these ecosystems.
Ground truthing	Information obtained from ground level, rather than interpretation or remotely obtained data (i.e. aerial imagery, etc.)
Indigenous Protected Area	Voluntarily dedicated by Aboriginal groups on Aboriginal owned or managed land or sea country. They are recognised by the Australian Government as an important part of the National Reserve System, protecting the nation's biodiversity for the benefit of all Australians (www.dpmc.gov.au).
Key Contact	The nominated key contact for each case study area, as provided in the case study area applications to the National Cultural Flows Research Project.
Nation facilitator	Nominated member from each case study area Nation that will receive support and training to participate in the facilitation of research engagement activities. The nominated Nation Facilitator will support the Project Team to conduct engagement sessions and workshops in a culturally respectful and appropriate manner, to suit local needs and issues; and the two-way flow of information and ideas between the Project Team and participants / Traditional Owners.
Nation	An aggregate of people that are united by a shared descent, culture and/or language and who inhabit a particular state or territory and who have a shared body of law and custom.
Participatory action research	An applied research methodology in which research and practice are mutually reinforcing, such that the findings of research directly inform the practice, or the observations from practice direct the objectives of research.

The Project	The National Cultural Flows Research Project.
Project Team	Rural Solutions SA Project Team (including Rural Solutions SA staff and subcontractors).
Research Committee	National Cultural Flows Planning and Research Committee.
Research Partner	A Traditional Owner, individual of the Research Committee and/or community nominated participant who is recognised as speaking for country. Individuals may be involved in any/all aspects of the National Cultural Flows Research Project.
Social learning	Social learning describes the process that occurs when people learn by engaging one another, sharing diverse perspectives and experiences, and developing a common framework of understanding and basis for joint action. As distinct from individual learning, the deliberation and dialogue that comprises in social learning allows people to share diverse perspectives and experiences, which can also build relationships.
Stakeholder	A person with an interest or concern to any and/or all aspects of the National Cultural Flows Research Project.
Traditional Owner	The Aboriginal person or people who possess rights, interests and responsibilities for an area of Country. These rights, interests and responsibilities are defined by traditional law and custom and are also handed down through this customary law. Traditional Owners are recognized as having a primary interest in the land and their existence is not contingent on recognition of such under non-Aboriginal law.
Values	Values can be considered as normative assessments about what is important, desirable or ethical. Values are typically categorised according to a series of descriptors that reflect who holds those values (for example, community values, Aboriginal values, core values) or a taxonomy of knowledge domains (environmental, social, economic and cultural). Values become social or cultural as a consequence of their similar expression across populations (social) or of their coherence into relatively stable forms that provide the basis of a group identity and common practice (cultural).
Water allocation	The specific volume of water allocated to water access entitlements in a given water year or allocated as specified within a water resource plan.
Water plans	Statutory plans for surface and/or ground water systems, developed in consultation with all relevant stakeholders on the basis of best scientific, cultural and socio-economic assessment, to provide secure ecological outcomes and resource security for users. Water planning describes the activities and processes undertaken to prepare a water plan, or to contribute to the adaptive management of a water plan.

Ecological Terminology and Definitions

ANOSIM	Analysis of similarity. A statistical method primarily employed to compare the variation in species abundance and composition among sampling units.
Aquatic ecosystem	Ecosystems that depend on flows, or periodic or sustained inundation/ waterlogging for their ecological integrity (e.g. wetlands, rivers, karst and other groundwater-dependent ecosystems, saltmarshes and estuaries) but do not generally include marine waters (defined as areas of marine water the depth of which at low tide exceeds six meters, but to be interpreted by jurisdictions). See also “ecosystem”.
Assessment (wetland)	The identification of the status of, and threats to, wetlands as a basis for the collection of more specific information through monitoring activities. See also “condition” and “condition assessment”.
Benefits	Benefits/services are defined in accordance with the Millennium Ecosystem Assessment definition of ecosystem services as "the benefits that people receive from ecosystems (Ramsar Convention 2005a), Resolution IX.1 Annex A). See also “Ecosystem Services”.
Biodiversity	Biodiversity, or biological diversity, means the variety of life or variety of living things; and living things means plants, and animals, and microbes, and fungi, their DNA, and ecosystems. Biodiversity, in the full sense of the term, is not monitored and is not readily quantified.
Biota	The animal and plant life of a particular region or habitat.
Conceptual model	Conceptual models can take a number of forms. They are often defined as a type of diagram which shows a set of relationships between factors that are believed to impact or lead to a target condition; a diagram that defines theoretical entities, objects, or conditions of a system and the relationships between them. In the context of this project conceptual models will illustrate the response of cultural and ecological values to the delivery of cultural flows.
Condition (ecosystem, vegetation, community, species)	The state or health of individual animals or plants, communities or ecosystems. Condition of an ecosystem, vegetation type, ecological community or species describes whether, and how much, it differs from an unimpacted or reference state. Condition can be described using a number of attributes. For example in assessing vegetation condition, the most commonly-used attributes are abundance or extent, vegetation structural features, species composition, nativeness, age structure and vigour. Condition is referential, meaning the vegetation attributes at a site are compared to a reference condition or benchmark or ideal state for that site. In the case of a species, typically a tree, or a stand of trees, condition means vigour, and condition describes how vigorous the canopy

	appears to be. Condition is based on observations of the canopy such as canopy cover, foliage density, and extent of dieback.
Condition assessment	A means to assess long-term changes in natural conditions and to assess long-term changes resulting from widespread anthropogenic activity.
Diversity	Diversity is the number of entities in a sample and the evenness of their abundance; in the case of species diversity, number and evenness are combined into a single value, using a diversity index. Most often diversity means species diversity, but other types of diversity can be described and reported on such as structural diversity, community diversity, genetic diversity and functional diversity in ecological studies: in these cases, 'diversity' is used rather loosely to mean variability, with no standard quantitative measures. The term 'biodiversity' is not the same as species diversity and has its own meaning.
Ecological character	The combination of the ecosystem components, processes and benefits/services that characterise the wetland at a given point in time. [Within this context, ecosystem benefits are defined in accordance with the MEA definition of ecosystem services as "the benefits that people receive from ecosystems".] (Resolution IX.1 Annex A) (Ramsar 2012).
Ecological community	An assemblage of organisms characterised by a distinctive combination of species occupying a common environment and interacting with one another (ANZECC and ARMCANZ 2000).
Ecosystems	The complex of living communities (including human communities) and non-living environment (Ecosystem Components) interacting (through Ecological Processes) as a functional unit which provides inter alia a variety of benefits to people (Ecosystem Services) (Millennium Ecosystem Assessment 2005).
Ecosystem components	Include the physical, chemical and biological parts of a wetland.
Ecosystem processes	Are changes or reactions which occur naturally within wetland ecosystems. They may be physical, chemical or biological. This equates to process such as carbon cycling, denitrification, acidification, sedimentation, migration, breeding, reproduction, etc.
Ecosystem functions	Are activities or actions which occur naturally in wetlands as a product of the interactions between the ecosystem structure and processes. Functions as defined by Ramsar include flood water control; nutrient, sediment and contaminant retention; food web support; shoreline stabilization and erosion controls; storm protection; and stabilization of local climatic conditions, particularly rainfall and temperature.
Ecosystem services	The benefits that people receive or obtain from an ecosystem. The components of ecosystem services are provisioning (for example food and water), regulating (for example flood control), cultural (for example spiritual, recreational), and supporting (for example nutrient cycling,

	ecological value). (Millennium Ecosystem Assessment 2005). See also "Benefits".
Geomorphology	The study of the evolution and configuration of landforms.
Goal	A goal is a concise, general statement of the overall purpose of a program. For example: "To ensure that environmental water allocations provide the greatest ecological benefits to receiving waterbodies" or "To manage wetlands to provide habitat for breeding migratory birds".
Indicator (ecological)	Refers to a representative, measurable parameter which convey useful information concerning ecosystem condition. These can be physico-chemical and/or biological. Ecological indicators assess the condition of the environment, and can provide an early warning signal of changes in the environment. They can also be used to diagnose the cause of an environmental problem. Ideally the suite of indicators used in a monitoring program should represent key information about structure, function, and composition of the ecological system (Dale and Beyer 2001).
Intervention	A management activity that seeks to change an ecosystem's state or condition and achieve a management objective. In this case the intervention is the delivery of a cultural flow. See also intervention monitoring.
Intervention monitoring	Supports the evaluation of management interventions by quantifying the response to specific management interventions.
Inventory (wetland)	The collection and/or collation of core information for wetland management, including the provision of an information base for specific assessment and monitoring activities.
Monitoring (wetland)	Collection of specific information for management purposes in response to questions derived from assessment activities, and the use of these monitoring results for implementing management. (Note that the collection of time-series information that is not question-driven from wetland assessment should be termed surveillance rather than monitoring). The key aspects of an environmental monitoring program therefore are: • It is specific and hypothesis driven (i.e. it answers a specific question); • It involves the collection of information over time (i.e. multiple sampling events); and • It is used to inform ecosystem management.
Multi-dimensional scaling	A data presentation approach used to visualize and explore complex data in a graphical environment.
Richness	Richness is the number recorded. It is most commonly used to refer to species, as in species richness. See "species richness".
SIMPER	Similarity percentage: a statistical routine that explores contribution of each species (or other variable) to the observed similarity (or

	dissimilarity) between samples. It is often used to identify the species that are most important in creating the observed pattern of similarity.
Species richness	The number of species recorded, for example, in a sample. Species richness is sensitive to sampling effort (number of quadrats, size of quadrats, total area sampled).
Traditional Ecological Knowledge	A cumulative body of knowledge, innovations and beliefs evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and their environment. Traditional knowledge tends to be collectively owned and takes the form of stories, songs, folklore, proverbs, cultural values, beliefs, rituals, community laws, local language, and agricultural practices, including the development of plant species and animal breeds. – Adapted by Berkes (2012) and United Nations (2014).

Hydrological and Hydraulic Terminology and Definitions

Dimensions (number of) modelled (in numerical hydraulic modelling)	Hydraulic models can be classified into 1D, 2D and 3D, where D means dimension. The dimension referred to here is space. • 1D model represents flow properties (depth and velocity) only in the longitudinal (downstream, X) direction. Such models are usually used to predict velocity averaged across the transversal (width, Y) and vertical (depth, Z) dimensions of a cross-section. • 2D model represents flow properties along either the longitudinal (X) and transversal (X) directions, or the longitudinal (X) and vertical (Z) directions. Such models are usually used to predict the depth and magnitude and direction (X, Y) of mean vertical velocity at points. • 3D model represents the depth and magnitude, direction and vertical distribution (X, Y, Z) of velocity at points. Due to the computation time, difficulty in model set-up, uncertainty of results, and inability to characterise project objectives in 3D, such models are normally used only in research applications, or in small areas. 1D models provide a reliable representation of the hydraulic conditions in river channels, while 2D models can represent the hydraulic conditions on floodplain surfaces. Most river-floodplain situations involve both of these conditions, so a linked 1D-2D model is appropriate.
Fluvial geomorphology	The study of landforms shape (morphology) and processes associated with flowing water. The morphology of a channel or wetland influences the distribution of hydraulic conditions (depth, extent, velocity). Over time, as the site is subjected to flow events (either naturally or artificially generated events), the morphology can be expected to change. Fluvial geomorphology might be relevant in the context of a cultural flows assessment, depending on the site characteristics and the objectives.

Hydraulic	Certain physical characteristics of, usually, moving water. In this report the characteristics of interest are rate of flow, or velocity (m/s), depth of water from the bed or ground (m), direction of flow (bearing in degrees), bed shear stress, or force acting on the bed (N/m^2), volume of water within a bounded area (m^3), area of water within a bounded area (m^2), and location of water (defined by geographical coordinates).
Hydraulic model	There are practical limitations to measuring hydraulic variables. A hydraulic model describes the relationship between the spatial distribution of a hydraulic variable (such as water depth and presence) and river hydrology, or artificial flow delivery. The relationship can be developed using an empirical or numerical modelling approach.
Hydraulic model (empirical)	Developed from multiple observations of water extent measured using satellite imagery, aerial photography, a sensor on a low-altitude UAV (unmanned aerial vehicle), or on ground survey and water flow in the river, or flow pumped or diverted to the site, measured at the same time. With enough data points, the relationship will provide a sufficiently reliable prediction of the maximum extent of inundation that can be expected for given river flow conditions, or given inflows to the site. The distribution of water depth for any given water extent can be predicted if the topography of the site has been characterised, by LiDAR or ground survey. Provided input data are available, empirical models are relatively inexpensive to develop.
Hydraulic model (numerical)	Predicts water extent, flow rate, and flow direction, on the basis of good quality topographic data obtained by LiDAR or ground survey and well-known equations that describe the physics of water flow. Numerical models are uncertain, and require calibration against empirical data from observed flow events to provide reliable predictions. Due to high data demands, high level of spatial and temporal resolution, high data processing demands, and high-level technical modelling skills required, numerical hydraulic models are expensive to develop and expensive to run.
Hydrological	Having characteristics related to the water cycle and its individual components. In this report, it usually refers to the temporal (over time) pattern of water flow (ML/d), water level from a datum (m), water extent (ha or m^2), rainfall (mm), seepage (mm) and/or evapotranspiration (mm or ML). The flow could be in a river, or into and /or out of a floodplain wetland, of cultural significance.
Hydrological component (of a wetland water regime)	The main elements of a wetland water regime, comprising Dry period, Constant level, Small inundation event, Moderate inundation event and Large inundation event.
Hydrological event	A hydrological phenomenon, in the case of this report, of relevance to cultural water needs. An event could be a period of no water, stable water level or flow, or a rise and fall in water levels in a river of wetland.

Hydrological model	Can overcome practical limitations to measuring hydrological variables. A hydrological model predicts how much water will be present in a river or wetland at any time. It relates to rainfall, evapotranspiration and seepage through time using mathematical algorithms that describe fundamental physical processes. Two common types of model are the rainfall-runoff model (predicts river flow from rainfall), and the wetland water balance model.
Hydrological time series	Basic hydrological data concerning events, and long term hydrology are time series and can be plotted as a simple line-chart showing the observed value over time. Normally these data are simplified using statistics to characterise central tendency, dispersion, frequency, duration, and rates of change.
Scenario (in hydrological modelling)	A set of conditions that apply to the input data of a hydrological model, usually simulating a current, future or past condition, such as climate change, pre-water resources development, or with cultural flows.
Time scale (long-term hydrological)	In the order of 50 – 100 years, which is long enough to characterise the likelihood of hydrological events of cultural interest occurring in the future, under assumed conditions.
Time-scale (event)	In the order of days, weeks or months.
Water balance model (wetland)	Operates at the scale of an individual wetland to predict the water level and extent of inundation over time. Can be used to predict wetland water level and extent over the long-term scale.
Water loss	In a waterbody such as a floodplain wetland, water loss incurred through evapotranspiration and seepage to the ground (which is later lost to evaporation or transferred to a neighbouring hydrological system).
Water quality	The collective physical and chemical properties of water that are usually assessed relative to tolerable and preferred ranges specific to the use of the water or waterbody, including by aquatic organisms. Water quality is commonly investigated using historical data from established monitoring programs, and can also be predicted using a coupled hydrology-water quality model. Water quality might be relevant in the context of a cultural flows assessment, depending on the site characteristics and the objectives.
Water resource model	Hydrological models can operate at a large scale. For management of water resources of large areas, whole of catchment models are used, such as eWater Source catchments, MSM_Bigmod (predicts the flow in the River Murray), REALM (often used in Victoria) and IQQM (often used in Queensland and NSW). These hydrological models also contain some *hydraulic* components, to explain how certain characteristics of flow are modified through time and movement. Such models also have water quality prediction capability.

Water use	Refers to how much water is used over time through events, either natural or controlled (managed) events, such as delivering water to satisfy cultural water needs. In this context, water use means the difference between the water that was available for use at the beginning of the event, and how much is available after the event.
Water year	A period of 12 months over which annual hydrological statistics are calculated and water accounting and management are conducted. The start of the water year depends on the seasonality of the river and is usually within the low flow period. For the Murray-Darling Basin, the conventional water year is July to June, such that each irrigation season belongs entirely within one year, and it avoids splitting summer flood events originating in the northern Basin into separate years.

10 APPENDIX 1: BIRD LIST RECORDED AT TOOGIMBIE IPA

Common name	Scientific name
Black Duck	
Galah	
Australian raven	
Welcome swallow	
White faced heron	
Brown falcon	
Unidentified raptor (hawk/falcon)	
Nankeen kestrel	
Blue Wren	
Crested Pigeon	
Willy wagtail	
Australian shelduck	
Black kite	
Black faced cuckoo shrike	
Cryptic shrubland species (e.g. reed warbler, brown song lark, white faced chat)	
White faced heron	
Straw neck Ibis	
Grey shrike	
Splendid wren	
Sulphur crested cockatoo	
White (sacred) ibis	
Masked lapwing	
Common sparrow	

11 APPENDIX 2: ECOLOGICAL DATA

Toogimbie Vegetation Community Condition Data

Pre-Flood Data

Site:	Toogimbie	**Quadrat ID:**	C2Q1	**Date:**	8/09/2016	**Observers:**	TK, TD, IW		
Zone:	55	**Easting:**	267468	**Northing:**	6172538				
Dimensions (m):	20x20	**Photo 1:**	107-1568	**Photo 2:**	107-1569	**Photo 3:**	107-1570	**Photo 4:**	107-1571
% Litter:	15	**% Bare Ground:**	20	**Fallen timber length (m):**	0				

Species	**Common Name**	**Native/Exotic**	**% Foliage Cover**	**Crown Extent**	**Canopy openness**	**Abundance**	**Upper Height (m)**	**Lower Height (m)**	**Strata Type**
**Echium plantagineum*	Patterson's Curse	Exotic	<1	-	-	1	0.4	0.4	L
**Erodium cicutarium*	Cut-leaf Heron's-bill	Exotic	<1	-	-	15	0.3	0.2	L
**Hordeum lepinorum*	Wall Barley-grass	Exotic	<1	-	-	30	0.3	0.2	L
**Lolium rigidum*	Wimmera Ryegrass	Exotic	20	-	-	600000	0.5	0.1	L
**Medicago polymorpha*	Burr Medic	Exotic	15	-	-	12000	0.45	0.1	L
**Sisymbrium erysimoides*	Smooth Mustard	Exotic	7	-	-	3500	1	0.2	L
Brachyscome sp.	Daisy	Native	2	-	-	1000	0.4	0.01	L
Bulbine bulbosa	Bulbine Lily	Native	<1	-	-	3	0.3	0.2	L
Chenopodium nitrariaceum	Nitre Goosefoot	Native	2	-	-	5	1.5	1.2	M
Duma florulenta	Tangled Lignum	Native	1	-	-	35	1.7	0.6	T
Erodium crinitum	Blue Heron's-bill	Native	<1	-	-	50	0.4	0.2	L
Geranium retrorsum	Grassland Geranium	Native	<1	-	-	10	0.3	0.2	L
Plantago cunninghammii	Clay Plantain	Native	15	-	-	60000	0.1	0.05	L
Rhodanthe corymbiflora	Grey Sunray	Native	<1	-	-	15	0.3	0.2	L
Scleroblitum atriplicinum	Purple Goosefoot	Native	<1	-	-	200	0.2	0.1	L
Senecio glossanthus	Slender Groundsel	Native	3	-	-	3000	0.5	0.2	L

Site:	Toogimbie	Quadrat ID:	C2Q2	Date:	8/09/2016	Observers:	TD, IW, TK		
Zone:	55	Easting:	267415	Northing:	6173773				
Dimensions (m):	20x20	Photo 1:	107-1576	Photo 2:	107-1577	Photo 3:	107-1578	Photo 4:	107-1579
% Litter:	15	% Bare Ground:	10	Fallen timber length (m):	0				

Species	Common Name	Native/Exotic	% Foliage Cover	Crown Extent	Canopy openness	Abundance	Upper Height (m)	Lower Height (m)	Strata Type
**Lolium rigidum*	Wimmera Ryegrass	Exotic	30			60000	0.6	0.2	L
**Medicago polymorpha*	Burr Medic	Exotic				40000	1.2	0.1	L
**Sisymbrium erysimoides*	Smooth Mustard	Exotic	1			30	1.2	0.2	L
**Sonchus oleraceus*	Sow-thistle	Exotic	<1			1	0.3	0.3	L
Centipeda cunninghammii	Old Man Weed	Native	<1			300	0.2	0.1	L
Chenopodium nitrariaceum	Nitre Goosefoot	Native	<1			1	1.5	1.5	L
Duma florulenta	Tangled Lignum	Native	10			20	2.5	0.3	T
Eleocharis pallens	Pale Spike-rush	Native				70	0.3	0.1	L
Erodium crinitum	Blue Heron's-bill	Native	<1			50	0.4	0.2	L
Geranium retrorsum	Grassland Geranium	Native	<1			50	0.5	0.2	L
Haloragis aspera	Rough Raspwort	Native	<1			300	0.3	0.1	L
Ludwigia peploides	Water Primrose	Native				150	0.2	0.1	L
Marsilea drummondii	Common Nardoo	Native	<1			100	0.1	0.1	L
Plantago cunninghammii	Clay Plantain	Native	<1			50	0.2	0.1	L
Ranunculus pumilio	Ferny Buttercup	Native	1			2000	0.2	0.05	L
Rhodanthe corymbiflora	Grey Sunray	Native				10	0.3	0.1	L
Sclerolaena muricata	Five-spine Bindyi	Native				3	0.2	0.1	L

Senecio quadridentatus	Cotton Fireweed	Native	<1			20	0.2	0.1	L

Site:	Toogimbie	**Quadrat ID:**	C2Q3	**Date:**	8/09/2016	**Observers:**	TK		
Zone:	55	**Easting:**	268064	**Northing:**	6172996				
Dimensions (m):	20x20	**Photo 1:**	107-1580	**Photo 2:**	107-1581	**Photo 3:**	107-1582	**Photo 4:**	107-1583
% Litter:	3	**% Bare Ground:**	30	**Fallen timber length (m):**	0				

Species	**Common Name**	**Native/Exotic**	**% Foliage Cover**	**Crown Extent**	**Canopy openness**	**Abundance**	**Upper Height (m)**	**Lower Height (m)**	**Strata Type**
**Erodium cicutarium*	Cut-leaf Heron's-bill	Exotic	<1			20	0.2	0.1	L
**Lolium rigidum*	Wimmera Ryegrass	Exotic	25			80000	0.4	0.1	L
**Medicago polymorpha*	Burr Medic	Exotic	25			60000	0.4	0.1	L
**Medicago polymorpha*	Burr Medic	Exotic	<1			10	0.2	0.1	L
**Sisymbrium erysimoides*	Smooth Mustard	Exotic	10			11000	0.8	0.1	L
Brachyscome sp.	Daisy	Native	<1			200	0.2	0.1	L
Chenopodium nitrariaceum	Nitre Goosefoot	Native	2			40	1.3	0.2	L
Duma florulenta	Tangled Lignum	Native	1			5	1.6	0.5	T
Geranium retrorsum	Grassland Geranium	Native	<1			50	0.4	0.1	L
Plantago cunninghammii	Clay Plantain	Native	3			20000	0.2	0.1	L
Ranunculus pumilio	Ferny Buttercup	Native	<1			10	0.1	0.1	L
Rhodanthe corymbiflora	Grey Sunray	Native	<1			15	0.3	0.1	L
Senecio glossanthus	Slender Groundsel	Native	<1			300	0.3	0.1	L

Site:	Toogimbie	Quadrat ID:	C3Q1	Date:	8/09/2016	Observers:	TK, TD		
Zone:	55	Easting:	265749	Northing:	6172445				
Dimensions (m):	20x20	Photo 1:	107-1577	Photo 2:	107-1558	Photo 3:	107-1559	Photo 4:	107-1560
% Litter:	2	% Bare Ground:	28	Fallen timber length (m):	0				

Species	Common Name	Native/Exotic	% Foliage Cover	Crown Extent	Canopy openness	Abundance	Upper Height (m)	Lower Height (m)	Strata Type
**Capsella bursa-pastoris*	Shepherd's Purse	Exotic	<1			2	0.3	0.3	L
**Hordeum lepinorum*	Wall Barley-grass	Exotic	<1			10	0.4	0.2	L
**Lolium rigidum*	Wimmera Ryegrass	Exotic	15			60000	0.6	0.1	L
**Medicago polymorpha*	Burr Medic	Exotic	15			25000	0.3	0.05	L
**Sisymbrium erysimoides*	Smooth Mustard	Exotic	5			800	0.7	0.2	L
Brachyscome sp.	Daisy	Native	1			700	0.2	0.1	L
Bulbine bulbosa	Bulbine Lily	Native	<1			7	0.3	0.15	L
Chenopodium nitrariaceum	Nitre Goosefoot	Native	<1			1	1.4	1.4	T
Duma florulenta	Tangled Lignum	Native	<1			7	1	0.8	M
Erodium crinitum	Blue Heron's-bill	Native	10			3000	0.3	0.1	L
Marsilea drummondii	Common Nardoo	Native	<1			10	0.15	0.05	L
Plantago cunninghammii	Clay Plantain	Native	20			800000	0.1	0.05	L
Rhodanthe corymbiflora	Grey Sunray	Native	<1			20	0.2	0.1	L
Scleroblitum atriplicinum	Purple Goosefoot	Native	2			1000	0.15	0.05	L
Senecio glossanthus	Slender Groundsel	Native	1			700	0.2	0.05	L

Site:	Toogimbie	**Quadrat ID:**	C3Q2	**Date:**	7/09/2016	**Observers:**	TK, JG		
Zone:	55	**Easting:**	266313	**Northing:**	6174040				
Dimensions (m):	20x20	**Photo 1:**	107-1550	**Photo 2:**	107-1551	**Photo 3:**	107-1552	**Photo 4:**	107-1553
% Litter:	5	**% Bare Ground:**	40	**Fallen timber length (m):**	0				

Species	**Common Name**	**Native/Exotic**	**% Foliage Cover**	**Crown Extent**	**Canopy openness**	**Abundance**	**Upper Height (m)**	**Lower Height (m)**	**Strata Type**
**Lolium rigidum*	Wimmera Ryegrass	Exotic	30			160000	0.5	0.2	L
**Medicago polymorpha*	Burr Medic	Exotic	15			20000	0.3	0.1	L
**Sisymbrium erysimoides*	Smooth Mustard	Exotic	2			200	0.6	0.1	L
Duma florulenta	Tangled Lignum	Native	<1			3	0.6	0.4	L
Erodium crinitum	Blue Heron's-bill	Native	<1			300	0.3	0.1	L
Plantago cunninghammii	Clay Plantain	Native	1			2000	0.1	0.1	L
Rhodanthe corymbiflora	Grey Sunray	Native	<1			100	0.2	0.1	L
Scleroblitum atriplicinum	Purple Goosefoot	Native	3			5000	0.1	0.1	L
Senecio glossanthus	Slender Groundsel	Native	<1			500	0.3	0.2	L

Site:	Toogimbie	Quadrat ID:	C3Q3	Date:	8/09/2016	Observers:	TK, TD, AM		
Zone:	55	Easting:	267041	Northing:	6173836				
Dimensions (m):	20x20	Photo 1:	107-1563	Photo 2:	107-1564	Photo 3:	107-1565	Photo 4:	107-1566
% Litter:	3	% Bare Ground:	10	Fallen timber length (m):	0				

Species	Common Name	Native/Exotic	% Foliage Cover	Crown Extent	Canopy openness	Abundance	Upper Height (m)	Lower Height (m)	Strata Type
**Erodium cicutarium*	Cut-leaf Heron's-bill	Exotic	<1			30	0.3	0.1	L
**Hordeum lepinorum*	Wall Barley-grass	Exotic	<1			10	0.3	0.1	L
**Lolium rigidum*	Wimmera Ryegrass	Exotic	32			350000	0.6	0.2	L
**Medicago polymorpha*	Burr Medic	Exotic	35			280000	0.4	0.2	L
**Sisymbrium erysimoides*	Smooth Mustard	Exotic	3			500	1	0.2	L
Brachyscome sp.	Daisy	Native	<1			10	0.2	0.1	L
Duma florulenta	Tangled Lignum	Native	3			20	2.2	1	T
Erodium crinitum	Blue Heron's-bill	Native	<1			15	0.3	0.1	L
Geranium retrorsum	Grassland Geranium	Native	<1			30	0.3	0.05	L
Plantago cunninghammii	Clay Plantain	Native	10			40000	0.2	0.05	L
Rhodanthe corymbiflora	Grey Sunray	Native	<1			30	0.3	0.1	L
Scleroblitum atriplicinum	Purple Goosefoot	Native	<1			300	0.2	0.1	L
Senecio glossanthus	Slender Groundsel	Native	2			1000	0.4	0.1	L

Site:	Toogimbie	**Quadrat ID:**	C4Q1	**Date:**	7/09/2016	**Observers:**	TK, KS		
Zone:	55	**Easting:**	264750	**Northing:**	6172583				
Dimensions (m):	20x20	**Photo 1:**	107-1541	**Photo 2:**	107-1542	**Photo 3:**	107-1543	**Photo 4:**	107-1544
% Litter:	55	**% Bare Ground:**	15	**Fallen timber length (m):**	0				

Species	Common Name	Native/Exotic	% Foliage Cover	Crown Extent	Canopy openness	Abundance	Upper Height (m)	Lower Height (m)	Strata Type
**Hordeum lepinorum*	Wall Barley-grass	Exotic	<1			300	0.4	0.2	L
**Lactuca serriola*	Prickly Lettuce	Exotic	<1			1	0.1	0.1	L
**Lolium rigidum*	Wimmera Ryegrass	Exotic	20			800000	0.5	0.2	L
**Medicago polymorpha*	Burr Medic	Exotic	5			2000	0.2	0.1	L
**Sisymbrium erysimoides*	Smooth Mustard	Exotic	<1			50	0.2	0.1	L
Bulbine bulbosa	Bulbine Lily	Native	1			1000	0.3	0.2	L
Duma florulenta	Tangled Lignum	Native	10			12	1.8	1	T
Erodium crinitum	Blue Heron's-bill	Native	1			100	0.4	0.2	L
Rhodanthe corymbiflora	Grey Sunray	Native	<1			100	0.2	0.2	L
Sclerolaena muricata	Five-spine Bindyi	Native	<1			10	0.2	0.1	L

Site:	Toogimbie	**Quadrat ID:**	C4Q2	**Date:**	7/09/2016	**Observers:**	TD, KS, TK		
Zone:	55	**Easting:**	264990	**Northing:**	6173962				
Dimensions (m):	20x20	**Photo 1:**	107-1545	**Photo 2:**	107-1546	**Photo 3:**	107-1547	**Photo 4:**	107-1548
% Litter:	5	**% Bare Ground:**	30	**Fallen timber length (m):**	0				

Species	**Common Name**	**Native/Exotic**	**% Foliage Cover**	**Crown Extent**	**Canopy openness**	**Abundance**	**Upper Height (m)**	**Lower Height (m)**	**Strata Type**
**Erodium cicutarium*	Cut-leaf Heron's-bill	Exotic	<1			50	0.1	<.1	L
**Lolium rigidum*	Wimmera Ryegrass	Exotic	15			50000	0.4	0.2	L
**Medicago polymorpha*	Burr Medic	Exotic	40			100000	0.4	0.1	L
**Sisymbrium erysimoides*	Smooth Mustard	Exotic	<1			60	0.6	0.2	L
Brachyscome sp.	Daisy	Native	<1			50	0.2	0.1	L
Duma florulenta	Tangled Lignum	Native	1			10	1.8	0.4	T
Erodium crinitum	Blue Heron's-bill	Native	<1			200	0.15	0.1	L
Plantago cunninghammii	Clay Plantain	Native	5			40000	0.1	0.05	L
Rhodanthe corymbiflora	Grey Sunray	Native	<1			50	0.2	0.1	L
Scleroblitum atriplicinum	Purple Goosefoot	Native	<1			50	0.1	<.1	L
Senecio glossanthus	Slender Groundsel	Native	<1			500	0.3	0.1	L

Site:	Toogimbie	**Quadrat ID:**	C4Q3	**Date:**	8/09/2016	**Observers:**	TD, IW, TK		
Zone:	55	**Easting:**	265440	**Northing:**	6174671				
Dimensions (m):	20x20	**Photo 1:**	107-1572	**Photo 2:**	107-1573	**Photo 3:**	107-1574	**Photo 4:**	107-1575
% Litter:	5	**% Bare Ground:**	<1	**Fallen timber length (m):**	0				

Species	**Common Name**	**Native/Exotic**	**% Foliage Cover**	**Crown Extent**	**Canopy openness**	**Abundance**	**Upper Height (m)**	**Lower Height (m)**	**Strata Type**
**Erodium cicutarium*	Cut-leaf Heron's-bill	Exotic	4			350	0.6	0.2	L
**Hordeum lepinorum*	Wall Barley-grass	Exotic	28			300000	0.6	0.2	L
**Lolium rigidum*	Wimmera Ryegrass	Exotic	28			350000	0.7	0.2	L
**Medicago polymorpha*	Burr Medic	Exotic	12			120000	0.5	0.2	L
**Sisymbrium erysimoides*	Smooth Mustard	Exotic	7			400	1.2	0.3	L
Duma florulenta	Tangled Lignum	Native	12			9	2.5	1.8	T
Erodium crinitum	Blue Heron's-bill	Native	4			350	0.8	0.4	L
Senecio glossanthus	Slender Groundsel	Native	<1			300	0.6	0.2	L

Post-Flow Data

Site:	Toogimbie	**Quadrat ID:**	C2Q1	**Date:**	13/12/2016	**Observers:**	TK, TD		
Dimensions (m):	20x20	**Photo 1:**	1704	**Photo 2:**	1705	**Photo 3:**	1706	**Photo 4:**	1707
% Litter:	25	**% Bare Ground:**	15	**Fallen timber length (m):**	0				

Species	**Common Name**	**Native/Exotic**	**% Foliage Cover**	**Crown Extent**	**Canopy openness**	**Abundance**	**Upper Height (m)**	**Lower Height (m)**	**Strata Type**
**Euphorbia terracina*	False Caper	Exotic	1			200	0.2	0.1	L
**Sisymbrium erysimoides*	Smooth Mustard	Exotic	2			150	1	0.5	L
**Xanthium spinosum*	Bathurst Burr	Exotic	<1			30	0.1	0.05	L
Agrostis avenacea	Blown Grass	Native	2			1000	0.2	0.05	L
Chenopodium nitrariaceum	Nitre Goosefoot	Native	4			5	1.4	1.2	H
Duma florulenta	Tangled Lignum	Native	3			58	1.2	0.3	M
Erodium crinitum	Blue Heron's-bill	Native	<1			3	0.1	0.05	L
Haloragis aspera	Rough Raspwort	Native	10			3000	0.3	0.05	L
Marsilea drummondii	Common Nardoo	Native	<1			250	0.1	0.1	L
Phyllanthus lacunarius	Lagoon Spurge	Native	35			30000	0.15	0.05	L
Rumex bidens	Mud Dock	Native	<1			4	0.3	0.1	L
Rumex sp.	Dock	Native	<1			4	0.3	0.2	L

Site:	Toogimbie	Quadrat ID:	C2Q2	Date:	13/12/2016	Observers:	TK		
Dimensions (m):	20x20	Photo 1:	1687	Photo 2:	1688	Photo 3:	1689	Photo 4:	1690
% Litter:	40	% Bare Ground:	5	Fallen timber length (m):	0				

Species	Common Name	Native/Exotic	% Foliage Cover	Crown Extent	Canopy openness	Abundance	Upper Height (m)	Lower Height (m)	Strata Type
**Citrullus sp.*	Wild Melon	Exotic	<1			3	0.1	0.05	L
**Euphorbia terracina*	False Caper	Exotic	<1			100	0.1	0.05	L
**Phyla canescens*	Lippia	Exotic	1			50	0.05	0.05	L
**Sisymbrium erysimoides*	Smooth Mustard	Exotic	<1			15	0.7	0.5	L
**Xanthium spinosum*	Bathurst Burr	Exotic	<1			10	0.1	0.05	L
Agrostis avenacea	Blown Grass	Native	12			20000	0.2	0.05	L
Alternanthera denticulata	Lesser Joyweed	Native	<1			15	0.2	0.1	L
Chenopodium nitrariaceum	Nitre Goosefoot	Native	1			1	1.7	1.7	M
Duma florulenta	Tangled Lignum	Native	12			35	3	0.3	H
Eleocharis pallens	Pale Spike-rush	Native	12			2000	0.4	0.05	L
Haloragis aspera	Rough Raspwort	Native	8			4000	0.2	0.1	L
Marsilea drummondii	Common Nardoo	Native	<1			60	0.1	0.05	L
Phyllanthus lacunarius	Lagoon Spurge	Native	8			10000	0.1	0.05	L
Rumex bidens	Mud Dock	Native	<1			5	0.2	0.1	L

Site:	Toogimbie	Quadrat ID:	C2Q3	Date:	14/12/2016	Observers:	TK, TD, KS		
Dimensions (m):	20x20	Photo 1:	1720	Photo 2:	1721	Photo 3:	1723	Photo 4:	1724
% Litter:	12	% Bare Ground:	30	Fallen timber length (m):	0				

Species	Common Name	Native/Exotic	% Foliage Cover	Crown Extent	Canopy openness	Abundance	Upper Height (m)	Lower Height (m)	Strata Type
**Citrullus sp.*	Wild Melon	Exotic	<1			10	0.2	0.05	L
**Euphorbia terracina*	False Caper	Exotic	1			300	0.2	0.05	L
**Lactuca serriola*	Prickly Lettuce	Exotic	<1			10	0.1	0.05	L
**Sisymbrium erysimoides*	Smooth Mustard	Exotic	2			300	0.7	0.3	L
**Xanthium spinosum*	Bathurst Burr	Exotic	<1			12	0.1	0.05	L
Agrostis avenacea	Blown Grass	Native	1			300	0.2	0.05	L
Alternanthera denticulata	Lesser Joyweed	Native	<1			100	0.1	0.05	L
Brachyscome sp.	Daisy	Native	<1			200	0.02	0.01	L
Bulbine bulbosa	Bulbine Lily	Native	<1			1	0.3	0.3	L
Centipeda cunninghammii	Old Man Weed	Native	<1			100	0.02	0.01	L
Chenopodium nitrariaceum	Nitre Goosefoot	Native	2			55	1.5	0.1	M
Duma florulenta	Tangled Lignum	Native	2			44	1.6	0.15	H
Eleocharis pallens	Pale Spike-rush	Native	<1			5	0.2	0.1	L
Erodium crinitum	Blue Heron's-bill	Native	<1			25	0.1	0.05	L
Haloragis aspera	Rough Raspwort	Native	4			800	0.2	0.1	L
Marsilea drummondii	Common Nardoo	Native	<1			30	0.2	0.05	L
Phyllanthus lacunarius	Lagoon Spurge	Native	45			80000	0.1	0.05	L
Rumex bidens	Mud Dock	Native	<1			1	0.2	0.2	L

Site:	Toogimbie	Quadrat ID:	C3Q1	Date:	13/12/2016	Observers:	TK, TD		
Dimensions (m):	20x20	Photo 1:	1708	Photo 2:	1709	Photo 3:	1710	Photo 4:	1711
% Litter:	40	% Bare Ground:	45	Fallen timber length (m):	0				

Species	Common Name	Native/Exotic	% Foliage Cover	Crown Extent	Canopy openness	Abundance	Upper Height (m)	Lower Height (m)	Strata Type
**Euphorbia terracina*	False Caper	Exotic	3			400	0.3	0.1	L
**Lactuca serriola*	Prickly Lettuce	Exotic	<1			20	0.1	0.05	L
**Sisymbrium erysimoides*	Smooth Mustard	Exotic	2			600	1.1	0.5	L
Agrostis avenacea	Blown Grass	Native	2			2000	0.1	0.05	L
Chenopodium nitrariaceum	Nitre Goosefoot	Native	<1			1	1.4	1.4	H
Duma florulenta	Tangled Lignum	Native	1			9	1.3	0.3	M
Haloragis aspera	Rough Raspwort	Native	1			350	0.2	0.1	L
Marsilea drummondii	Common Nardoo	Native	<1			3	0.1	0.05	L
Phyllanthus lacunarius	Lagoon Spurge	Native	5			4000	0.2	0.1	L

Site:	Toogimbie	Quadrat ID:	C3Q2	Date:	13/12/2016	Observers:	TK, TD, JW, AM		
Dimensions (m):	20x20	Photo 1:	1695	Photo 2:	1696	Photo 3:	1697	Photo 4:	1698
% Litter:	75	% Bare Ground:	5	Fallen timber length (m):	0				

Species	Common Name	Native/Exotic	% Foliage Cover	Crown Extent	Canopy openness	Abundance	Upper Height (m)	Lower Height (m)	Strata Type
**Euphorbia terracina*	False Caper	Exotic	2			200	0.2	0.1	L
**Lactuca serriola*	Prickly Lettuce	Exotic	<1			1	0.03	0.03	L
**Sisymbrium erysimoides*	Smooth Mustard	Exotic	<1			40	0.6	0.4	L
**Xanthium spinosum*	Bathurst Burr	Exotic	<1			7	0.1	0.05	L
Agrostis avenacea	Blown Grass	Native	5			1500	0.2	0.05	L
Alternanthera denticulata	Lesser Joyweed	Native	1			500	0.1	0.05	L
Brachyscome sp.	Daisy	Native	<1			100	0.05	0.04	L
Bulbine bulbosa	Bulbine Lily	Native	<1			29	0.4	0.2	L
Chamaesyce drummondii	Caustic Weed	Native	<1			10	0.1	0.05	L
Duma florulenta	Tangled Lignum	Native	<1			3	0.6	0.2	H
Erodium crinitum	Blue Heron's-bill	Native	<1			1	0.03	0.03	L
Marsilea drummondii	Common Nardoo	Native	<1			6	0.1	0.1	L
Phyllanthus lacunarius	Lagoon Spurge	Native	10			3000	0.2	0.1	L
Rumex sp.	Dock	Native	<1			1	0.3	0.3	L
Sclerolaena muricata	Five-spine Bindyi	Native	<1			5	0.2	0.05	L

Site:	Toogimbie	Quadrat ID:	C3Q3	Date:	13/12/2016	Observers:	TK, TD, AM, IW		
Dimensions (m):	20x20	Photo 1:	1691	Photo 2:	1692	Photo 3:	1693	Photo 4:	1694
% Litter:	25	% Bare Ground:	5	Fallen timber length (m):	0				

Species	Common Name	Native/Exotic	% Foliage Cover	Crown Extent	Canopy openness	Abundance	Upper Height (m)	Lower Height (m)	Strata Type
**Euphorbia terracina*	False Caper	Exotic	5			5000	0.2	0.1	L
**Sisymbrium erysimoides*	Smooth Mustard	Exotic	<1			150	0.7	0.3	L
**Xanthium spinosum*	Bathurst Burr	Exotic	<1			1	0.1	0.1	L
Agrostis avenacea	Blown Grass	Native	20			10000	0.1	0.05	L
Alternanthera denticulata	Lesser Joyweed	Native	<1			200	0.2	0.05	L
Brachyscome sp.	Daisy	Native	1			1000	0.05	0.02	L
Bulbine bulbosa	Bulbine Lily	Native	<1			1	0.2	0.2	L
Chamaesyce drummondii	Caustic Weed	Native	<1			1	0.05	0.05	L
Duma florulenta	Tangled Lignum	Native	3			31	1.8	0.3	H
Haloragis aspera	Rough Raspwort	Native	<1			15	0.3	0.1	L
Marsilea drummondii	Common Nardoo	Native	<1			20	0.1	0.05	L
Phyllanthus lacunarius	Lagoon Spurge	Native	30			40000	0.15	0.05	L

Site:	Toogimbie	Quadrat ID:	C4Q1	Date:	14/12/2016	Observers:	TD, TK, IW		
Dimensions (m):	20x20	Photo 1:	1712	Photo 2:	1713	Photo 3:	1714	Photo 4:	1715
% Litter:	80	% Bare Ground:	4	Fallen timber length (m):	0				

Species	Common Name	Native/Exotic	% Foliage Cover	Crown Extent	Canopy openness	Abundance	Upper Height (m)	Lower Height (m)	Strata Type
**Euphorbia terracina*	False Caper	Exotic	1			3000	0.15	0.05	L
**Lactuca serriola*	Prickly Lettuce	Exotic	<1			40	0.15	0.02	L
**Solanum nigrum*	Blackberry Nightshade	Exotic	<1			1	0.05	0.05	L
Agrostis avenacea	Blown Grass	Native	1			3000	0.2	0.05	L
Bulbine bulbosa	Bulbine Lily	Native	3			3000	0.4	0.1	L
Duma florulenta	Tangled Lignum	Native	5			13	1.8	1.7	H
Erodium crinitum	Blue Heron's-bill	Native	<1			1	0.05	0.05	L
Phyllanthus lacunarius	Lagoon Spurge	Native	1			2000	0.15	0.05	L
Sclerolaena muricata	Five-spine Bindyi	Native	<1			1	0.05	0.05	L
Solanum esuriale	Quena	Native	<1			12	0.05	0.02	L

Site:	Toogimbie	Quadrat ID:	C4Q2	Date:	14/12/2016	Observers:	TK, TD, IW		
Dimensions (m):	20x20	Photo 1:	1716	Photo 2:	1717	Photo 3:	1718	Photo 4:	1719
% Litter:	20	% Bare Ground:	69	Fallen timber length (m):	0				

Species	Common Name	Native/Exotic	% Foliage Cover	Crown Extent	Canopy openness	Abundance	Upper Height (m)	Lower Height (m)	Strata Type
**Citrullus sp.*	Wild Melon	Exotic	<1			1	0.05	0.05	L
**Euphorbia terracina*	False Caper	Exotic	2			2000	0.1	0.02	L
**Heliotropium curassavicum*	Smooth Heliotrope	Exotic	<1			20	0.03	0.01	L
Agrostis avenacea	Blown Grass	Native	1			2000	0.15	0.02	L
Brachyscome sp.	Daisy	Native	1			2000	0.05	0.02	L
Centipeda cunninghammii	Old Man Weed	Native	<1			100	0.03	0.01	L
Duma florulenta	Tangled Lignum	Native	1			24	2	0.4	H
Eleocharis pallens	Pale Spike-rush	Native	<1			1 alive	0.2	0.05	L
Haloragis aspera	Rough Raspwort	Native	<1			40	0.1	0.02	L
Marsilea drummondii	Common Nardoo	Native	<1			6	0.15	0.1	L
Phyllanthus lacunarius	Lagoon Spurge	Native	5			30000	0.05	0.02	L

Site:	Toogimbie	Quadrat ID:	C4Q3	Date:	12/12/2016	Observers:	TK, TD, KS		
Dimensions (m):	20x20	Photo 1:	1699	Photo 2:	1700	Photo 3:	1701	Photo 4:	1702
% Litter:	80	% Bare Ground:	1	Fallen timber length (m):	0				

Species	Common Name	Native/Exotic	% Foliage Cover	Crown Extent	Canopy openness	Abundance	Upper Height (m)	Lower Height (m)	Strata Type
**Citrullus sp.*	Wild Melon	Exotic	<1			1	0.05	0.05	L
**Euphorbia terracina*	False Caper	Exotic	1			250	0.2	0.05	L
**Lactuca serriola*	Prickly Lettuce	Exotic	<1			1	0.1	0.1	L
**Sisymbrium erysimoides*	Smooth Mustard	Exotic	<1			50	0.6	0.4	L
**Xanthium spinosum*	Bathurst Burr	Exotic	<1			1	0.1	0.1	L
Agrostis avenacea	Blown Grass	Native	1			500	0.2	0.1	L
Bulbine bulbosa	Bulbine Lily	Native	<1			5	0.3	0.2	L
Duma florulenta	Tangled Lignum	Native	15			12	2.2	2	H
Erodium crinitum	Blue Heron's-bill	Native	<1			2	0.1	0.05	L
Phyllanthus lacunarius	Lagoon Spurge	Native	<1			350	0.1	0.05	L
Rumex sp.	Dock	Native	<1			1	0.3	0.3	L
Solanum esuriale	Quena	Native	<1			20	0.1	0.05	L

Appendix B - Toogimbie vegetation form data

Status	Site	Native grasses	Lignum	Native Rushes	Native shrubs	Nardoo or Potamageton	Native Forbs	Introduced grasses	Introduced Shrubs	Introduced forbs	Wet soil	Shallow water	Bare	OM thin	OM thick
Pre-flood	Cell 2 Q1	0	14	0	3	0	13	13	0	56	0	0	1	0	0
Pre-flood	Cell 2 Q2	1	19	19	0	1	6	10	0	31	0	13	0	0	0
Pre-flood	Cell 2 Q3	0	8	6	2	0	19	9	0	53	0	0	3	0	0
Pre-flood	Cell 3 Q1	0	5	0	0	0	3	28	4	51	0	6	2	1	0
Pre-flood	Cell 3 Q2	0	0	0	0	0	0	32	0	66	0	0	2	0	0
Pre-flood	Cell 3 Q3	0	11	6	1	2	9	27	0	39	0	0	4	1	0
Pre-flood	Cell 4 Q1	0	23	0	0	0	1	49	4	19	0	1	0	3	0
Pre-flood	Cell 4 Q2	0	4	0	0	0	0	11	0	75	0	0	4	5	1
Pre-flood	Cell 4 Q3	0	3	0	0	0	0	40	0	57	0	0	0	0	0
Post-flow	Cell 2 Q1	0	9	1	7	0	50	8	0	0	0	0	4	20	1
Post-flow	Cell 2 Q2	0	19	33	2	0	9	3	0	0	2	4	13	7	8
Post-flow	Cell 2 Q3	0	9	9	4	0	51	2	0	1	3	1	7	13	0
Post-flow	Cell 3 Q1	0	2	0	2	0	15	12	0	0	0	0	27	42	0
Post-flow	Cell 3 Q2	0	1	0	0	0	9	5	0	0	0	0	8	56	21
Post-flow	Cell 3 Q3	0	10	6	0	0	34	10	2	0	3	0	5	29	1
Post-flow	Cell 4 Q1	0	17	0	0	4	12	6	0	0	2	7	2	50	0
Post-flow	Cell 4 Q2	0	3	0	0	0	50	7	0	2	0	1	29	8	0
Post-flow	Cell 4 Q3	0	3	0	0	0	3	5	0	0	0	0	0	79	10

Appendix C – Toogimbie Lignum Health Data

Toogimbie Pre-Flood Lignum Health Data

Date:	Site:	ID:	WPT:	Long	Lat	Viability (Score):	Viability (%):	Colour (Score):	Observers:	Image #:
8/09/2016	Cell 3 / South / Q1	1	139	-34.56131567	144.4478782	5	80	4	JG, KP, IW, JM, TM.	105-0547
8/09/2016	Cell 3 / South / Q1	2	140	-34.56133445	144.4479645	3	45	1	JG, KP, IW, JM, TM.	105-00548
8/09/2016	Cell 3 / South / Q1	3	141	-34.56133755	144.4479634	2	30	1	JG, KP, IW, JM, TM.	549
8/09/2016	Cell 3 / South / Q1	4	142	-34.5614409	144.4482449	4	65	3	JG, KP, IW, JM, TM.	550
8/09/2016	Cell 3 / South / Q1	5	143	-34.56151189	144.4483224	4	75	4	JG, KP, IW, JM, TM.	
8/09/2016	Cell 3 / South / Q1	6	144	-34.56161818	144.4483137	4	60	3	JG, KP, IW, JM, TM.	
8/09/2016	Cell 3 / South / Q1	7	145	-34.56163804	144.4484436	2	25	1	JG, KP, IW, JM, TM.	
8/09/2016	Cell 3 / South / Q1	8	146	-34.56168598	144.4484994	3	30	2	JG, KP, IW, JM, TM.	
8/09/2016	Cell 3 / South / Q1	9	147	-34.56168263	144.448659	4	60	3	JG, KP, IW, JM, TM.	
8/09/2016	Cell 3 / South / Q1	10	148	-34.56183988	144.4486924	4	75	4	JG, KP, IW, JM, TM.	
8/09/2016	Cell 3 / South / Q1	11	149	-34.5617517	144.4488874	4	65	3	JG, KP, IW, JM, TM.	
8/09/2016	Cell 3 / South / Q1	12	150	-34.56172773	144.4490122	3	30	1	JG, KP, IW, JM, TM.	
8/09/2016	Cell 3 / South / Q1	13	151	-34.56161206	144.4490862	2	20	2	JG, KP, IW, JM, TM.	
8/09/2016	Cell 3 / South / Q1	14	152	-34.56155472	144.4490995	3	30	1	JG, KP, IW, JM, TM.	
8/09/2016	Cell 3 / South / Q1	15	153	-34.56151801	144.449132	4	60	4	JG, KP, IW, JM, TM.	
8/09/2016	Cell 3 / South / Q1	16	154	-34.56137485	144.4488987	5	95	5	JG, KP, IW, JM, TM.	
8/09/2016	Cell 3 / South / Q1	17	155	-34.56135641	144.4487231	3	30	1	JG, KP, IW, JM, TM.	
8/09/2016	Cell 3 / South / Q1	18	156	-34.56134853	144.4486919	2	20	2	JG, KP, IW, JM, TM.	
8/09/2016	Cell 3 / South / Q1	19	157	-34.56134325	144.4486882	4	75	4	JG, KP, IW, JM, TM.	
8/09/2016	Cell 3 / South / Q1	20	158	-34.56137661	144.4485762	3	30	1	JG, KP, IW, JM, TM.	
8/09/2016	Cell 3 / South / Q1	21	159	-34.56140033	144.44852	3	35	2	JG, KP, IW, JM, TM.	
8/09/2016	Cell 3 / South / Q1	22	160	-34.56138507	144.4484506	2	20	1	JG, KP, IW, JM, TM.	
8/09/2016	Cell 3 / South / Q1	23	161	-34.56120319	144.4484418	4	60	3	JG, KP, IW, JM, TM.	
8/09/2016	Cell 3 / South / Q1	24	162	-34.56118139	144.4484086	2	10	1	JG, KP, IW, JM, TM.	
8/09/2016	Cell 3 / South / Q1	25	163	-34.56109984	144.4483953	3	40	1	JG, KP, IW, JM, TM.	

Date:	Site:	ID:	WPT:	Long	Lat	Viability (Score):	Viability (%):	Colour (Score):	Observers:	Image #:
8/09/2016	Cell 3 / South / Q1	26	164	-34.56109724	144.4483926	2	20	1	JG, KP, IW, JM, TM.	
8/09/2016	Cell 3 / South / Q1	27	165	-34.56104569	144.4483144	2	15	1	JG, KP, IW, JM, TM.	
8/09/2016	Cell 3 / South / Q1	28	166	-34.56110193	144.4482306	2	25	1	JG, KP, IW, JM, TM.	
8/09/2016	Cell 3 / South / Q1	29	167	-34.56111819	144.4481365	3	20	1	JG, KP, IW, JM, TM.	
8/09/2016	Cell 3 / South / Q1	30	168	-34.5611368	144.4479796	4	75	3	JG, KP, IW, JM, TM.	
8/09/2016	Cell 2 /North / Q2	1	259	-34.54986893	144.4663311	4	50	3	JG, KP, JM	
8/09/2016	Cell 2 /North / Q2	2	260	-34.54994973	144.4663385	4	70	3	JG, KP, JM	
8/09/2016	Cell 2 /North / Q2	3	261	-34.55000639	144.4663212	3	40	2	JG, KP, JM	
8/09/2016	Cell 2 /North / Q2	4	262	-34.5500229	144.4663923	4	50	4	JG, KP, JM	
8/09/2016	Cell 2 /North / Q2	5	263	-34.54997504	144.4664372	4	55	3	JG, KP, JM	
8/09/2016	Cell 2 /North / Q2	6	264	-34.55003187	144.4664414	3	40	4	JG, KP, JM	
8/09/2016	Cell 2 /North / Q2	7	265	-34.55000941	144.4665114	4	60	3	JG, KP, JM	
8/09/2016	Cell 2 /North / Q2	8	266	-34.54993338	144.4665065	4	60	3	JG, KP, JM	
8/09/2016	Cell 2 /North / Q2	9	267	-34.54988041	144.4665663	4	60	1	JG, KP, JM	
8/09/2016	Cell 2 /North / Q2	10	268	-34.54983498	144.4666571	4	55	1	JG, KP, JM	
8/09/2016	Cell 2 /North / Q2	11	269	-34.54983372	144.4666804	3	30	1	JG, KP, JM	
8/09/2016	Cell 2 /North / Q2	12	270	-34.54981545	144.46666	4	60	3	JG, KP, JM	
8/09/2016	Cell 2 /North / Q2	13	271	-34.54973482	144.4666431	3	40	1	JG, KP, JM	
8/09/2016	Cell 2 /North / Q2	14	272	-34.54966432	144.4666237	4	50	1	JG, KP, JM	
8/09/2016	Cell 2 /North / Q2	15	273	-34.5496665	144.4667033	3	30	1	JG, KP, JM	
8/09/2016	Cell 2 /North / Q2	16	274	-34.54968218	144.4667211	4	60	3	JG, KP, JM	
8/09/2016	Cell 2 /North / Q2	17	275	-34.54971336	144.4668421	4	40	1	JG, KP, JM	
8/09/2016	Cell 2 /North / Q2	18	276	-34.5496251	144.4667956	3	30	1	JG, KP, JM	
8/09/2016	Cell 2 /North / Q2	19	277	-34.54964077	144.4668362	3	50	3	JG, KP, JM	
8/09/2016	Cell 2 /North / Q2	20	278	-34.54964211	144.4668885	3	40	1	JG, KP, JM	
8/09/2016	Cell 2 /North / Q2	21	279	-34.54961789	144.4669189	3	40	1	JG, KP, JM	
8/09/2016	Cell 2 /North / Q2	22	280	-34.54957103	144.4670084	3	40	1	JG, KP, JM	

Date:	Site:	ID:	WPT:	Long	Lat	Viability (Score):	Viability (%):	Colour (Score):	Observers:	Image #:
8/09/2016	Cell 2 /North / Q2	23	281	-34.54955469	144.4670969	3	25	1	JG, KP, JM	
8/09/2016	Cell 2 /North / Q2	24	282	-34.54947732	144.467118	3	50	1	JG, KP, JM	
8/09/2016	Cell 2 /North / Q2	25	283	-34.54941488	144.4672083	4	60	4	JG, KP, JM	
8/09/2016	Cell 2 /North / Q2	26	284	-34.54930717	144.467066	3	30	1	JG, KP, JM	
8/09/2016	Cell 2 /North / Q2	27	285	-34.54930868	144.4670783	3	35	3	JG, KP, JM	
8/09/2016	Cell 2 /North / Q2	28	286	-34.54931522	144.467001	3	40	1	JG, KP, JM	
8/09/2016	Cell 2 /North / Q2	29	287	-34.54937976	144.4669789	2	20	4	JG, KP, JM	
8/09/2016	Cell 2 /North / Q2	30	288	-34.54939552	144.4669504	4	70	3	JG, KP, JM	
8/09/2016	Cell 4 / Site 3	1	229	-34.54100833	144.4456058	5	75	4	JG, KD.	
8/09/2016	Cell 4 / Site 3	2	230	-34.54102979	144.4455515	5 4	80 55	5 3	JG, KD. JG, KD.	
8/09/2016	Cell 4 / Site 3	3	231	-34.54104605	144.4454829	4	75	4	JG, KD.	
8/09/2016	Cell 4 / Site 3	4	232	-34.54110917	144.4454433	5	75	3	JG, KD.	
8/09/2016	Cell 4 / Site 3	5	233	-34.54115007	144.4453573	4	60	1	JG, KD.	
8/09/2016	Cell 4 / Site 3	6	234	-34.54114052	144.4453248	4	60	3	JG, KD.	
8/09/2016	Cell 4 / Site 3	7	235	-34.54121972	144.4452545	4	50	3	JG, KD.	
8/09/2016	Cell 4 / Site 3	8	236	-34.54120221	144.4451815	3	40	1	JG, KD.	
8/09/2016	Cell 4 / Site 3	9	237	-34.54123146	144.4451851	4	70	3	JG, KD.	
8/09/2016	Cell 4 / Site 3	10	238	-34.54129944	144.4452049	4	70	4	JG, KD.	
8/09/2016	Cell 4 / Site 3	11	239	-34.54143615	144.4451991	4	55	3	JG, KD.	
8/09/2016	Cell 4 / Site 3	12	240	-34.5414478	144.4451736	5	80	4	JG, KD.	
8/09/2016	Cell 4 / Site 3	13	241	-34.54157545	144.4452493	4	70	4	JG, KD.	
8/09/2016	Cell 4 / Site 3	14	242	-34.54157914	144.4453381	4	60	4	JG, KD.	
8/09/2016	Cell 4 / Site 3	15	243	-34.54154905	144.4454213	4	70	4	JG, KD.	
8/09/2016	Cell 4 / Site 3	16	244	-34.54151519	144.4454451	3	30	1	TG, KD, JM.	
8/09/2016	Cell 4 / Site 3	17	245	-34.54151041	144.4455246	4	50	1	TG, KD, JM.	
8/09/2016	Cell 4 / Site 3	18	246	-34.54150831	144.4455878	4	70	3	TG, KD, JM.	

Date:	Site:	ID:	WPT:	Long	Lat	Viability (Score):	Viability (%):	Colour (Score):	Observers:	Image #:
8/09/2016	Cell 4 / Site 3	19	247	-34.54147026	144.4456135	4	50	1	TG, KD, JM.	
8/09/2016	Cell 4 / Site 3	20	248	-34.54139021	144.4457014	5	90	5	TG, KD, JM.	
8/09/2016	Cell 4 / Site 3	21	249	-34.54131721	144.4458166	3	40	3	TG, KD, JM.	
8/09/2016	Cell 4 / Site 3	22	250	-34.5411929	144.4458699	4	70	3	TG, KD, JM.	
8/09/2016	Cell 4 / Site 3	23	251	-34.54113783	144.4459457	5	75	3	TG, KD, JM.	
8/09/2016	Cell 4 / Site 3	24	252	-34.5411546	144.4457881	3	35	1	TG, KD, JM.	
8/09/2016	Cell 4 / Site 3	25	253	-34.54114144	144.4457718	4	65	3	TG, KD, JM.	
8/09/2016	Cell 4 / Site 3	26	254	-34.54108159	144.4456819	3	40	3	TG, KD, JM.	
8/09/2016	Cell 4 / Site 3	27	255	-34.54106575	144.4456666	4	55	3	TG, KD, JM.	
8/09/2016	Cell 4 / Site 3	28	256	-34.54101093	144.4457305	3	40	1	TG, KD, JM.	
8/09/2016	Cell 4 / Site 3	29	257	-34.54102694	144.4457266	2	25	1	TG, KD, JM.	
8/09/2016	Cell 4 / Site 3	30	258	-34.54087405	144.4457971	3	40	3	TG, KD, JM.	
7/09/2016	Cell 4 / North / Q2	1	64	-34.54758419	144.439923	1	5	2	TM, KW, JM, IW, JG	109 - 0041
7/09/2016	Cell 4 / North / Q2	2	65	-34.54765962	144.4399604	3	40	1	TM, KW, JM, IW, JG	109 - 0042
7/09/2016	Cell 4 / North / Q2	3	66	-34.54775836	144.4400519	3	35	1	TM, KW, JM, IW, JG	109 - 0043
7/09/2016	Cell 4 / North / Q2	4	67	-34.54782684	144.4400879	3	30	2	TM, KW, JM, IW, JG	109 - 0044
7/09/2016	Cell 4 / North / Q2	5	68	-34.54791477	144.4401107	3	40	2	TM, KW, JM, IW, JG	109 - 0045
7/09/2016	Cell 4 / North / Q2	6	69	-34.54800622	144.4401874	3	45	1	TM, KW, JM, IW, JG	109 - 0046
7/09/2016	Cell 4 / North / Q2	7	70	-34.54800311	144.4402735	3	40	1	TM, KW, JM, IW, JG	109 - 0047
7/09/2016	Cell 4 / North / Q2	8	71	-34.54790387	144.4403157	2	25	2	TM, KW, JM, IW, JG	109 - 0048
7/09/2016	Cell 4 / North / Q2	9	72	-34.54782709	144.4402427	4	65	1	TM, KW, JM, IW, JG	109 - 0049
7/09/2016	Cell 4 / North / Q2	10	73	-34.54753742	144.4405284	5	75	3	TM, KW, JM, IW, JG	109 - 0050
7/09/2016	Cell 4 / North / Q2	11	74	-34.54741177	144.4404083	2	20	2	TM, KW, JM, IW, JG	109 - 0051
7/09/2016	Cell 4 / North / Q2	12	75	-34.54727649	144.4402907	3	35	1	TM, KW, JM, IW, JG	109 - 0052
7/09/2016	Cell 4 / North / Q2	13	76	-34.54713299	144.4399753	4	65	3	TM, KW, JM, IW, JG	109 - 0053
7/09/2016	Cell 4 / North / Q2	14	77	-34.54711916	144.4397563	3	35	1	TM, KW, JM, IW, JG	109 - 0054
7/09/2016	Cell 4 / North / Q2	15	78	-34.54718999	144.4396526	3	50	1	TM, KW, JM, IW, JG	109 - 0055

Date:	Site:	ID:	WPT:	Long	Lat	Viability (Score):	Viability (%):	Colour (Score):	Observers:	Image #:
7/09/2016	Cell 4 / North / Q2	16	79	-34.54722377	144.4393986	4	50	1	KW, TM, IA, KP, JG	1009 - 056
7/09/2016	Cell 4 / North / Q2	17	80	-34.547308	144.4392943	4	65	3	KW, TM, IA, KP, JG	1009 - 057
7/09/2016	Cell 4 / North / Q2	18	81	-34.54737908	144.4388952	5	75	4	KW, TM, IA, KP, JG	009 - 058
7/09/2016	Cell 4 / North / Q2	19	82	-34.5475696	144.4388907	3	40	4	KW, TM, IA, KP, JG	009 - 059
7/09/2016	Cell 4 / North / Q2	20	83	-34.54759441	144.4392565	3	45	1	KW, TM, IA, KP, JG	009 - 060
7/09/2016	Cell 4 / North / Q2	21	84	-34.54778125	144.4393179	4	60	3	KW, TM, IA, KP, JG	009 - 062
7/09/2016	Cell 4 / North / Q2	22	85	-34.54818073	144.439238	2	10	2	KW, TM, IA, KP, JG	009 - 063
7/09/2016	Cell 4 / North / Q2	23	86	-34.54837359	144.4393502	2	10	2	KW, TM, IA, KP, JG	009 - 064
7/09/2016	Cell 4 / North / Q2	24	87	-34.548415	144.4394896	2	20	1	KW, TM, IA, KP, JG	009 - 065
7/09/2016	Cell 4 / North / Q2	25	88	-34.54852539	144.4397913	3	35	2	KW, TM, IA, KP, JG	009 - 066
7/09/2016	Cell 4 / North / Q2	26	89	-34.54836161	144.4399832	3	40	1	KW, TM, IA, KP, JG	009 - 067
7/09/2016	Cell 4 / North / Q2	27	90	-34.54815776	144.4399043	3	45	1	KW, TM, IA, KP, JG	009 - 068
7/09/2016	Cell 4 / North / Q2	28	91	-34.54797395	144.4399217	3	45	1	KW, TM, IA, KP, JG	009 - 069
7/09/2016	Cell 4 / North / Q2	29	92	-34.5477556	144.4395181	1	5	2	KW, TM, IA, KP, JG	009 - 070
7/09/2016	Cell 4 / North / Q2	30	93	-34.54752895	144.4397708	3	45	1	KW, TM, IA, KP, JG	009 - 071
7/09/2016	Cell 4 / South / Q1	1	34	-34.56008588	144.4369188	5	75-95	3	JM, JG, KP, KW.	
7/09/2016	Cell 4 / South / Q1	2	35	-34.56006451	144.437	4	50-75	1	JM, JG, KP, KW.	109 - 0012
7/09/2016	Cell 4 / South / Q1	3	36	-34.56012469	144.4370701	3	25-50	2	JM, JG, KP, KW.	
7/09/2016	Cell 4 / South / Q1	4	37	-34.5601122	144.4370652	4	50-75	3	JM, JG, KP, KW.	
7/09/2016	Cell 4 / South / Q1	5	38	-34.56009879	144.4370597	4	50-75	3	JM, JG, KP, KW.	
7/09/2016	Cell 4 / South / Q1	6	39	-34.56004171	144.4370641	5	80	4	JM, JG, KP, KW.	
7/09/2016	Cell 4 / South / Q1	7	40	-34.56005948	144.4371302	4	65	3	JM, JG, KP, KW.	109 - 0014
7/09/2016	Cell 4 / South / Q1	8	41	-34.56007297	144.4372705	4	50-55	3	JM, JG, KP, KW.	109 - 0015
7/09/2016	Cell 4 / South / Q1	9	42	-34.56009694	144.4373337	4	65	3	JM, JG, KP, KW.	109 - 0016
7/09/2016	Cell 4 / South / Q1	10	43	-34.56019158	144.437505	5	58	4	JM, JG, KP, KW.	109 - 0017
7/09/2016	Cell 4 / South / Q1	11	44	-34.56019208	144.437526	4	50	1	JM, JG, KP, KW.	109 - 0018
7/09/2016	Cell 4 / South / Q1	12	45	-34.56007649	144.4376038	5	75	4	JM, JG, KP, KW.	109 - 0020

Date:	Site:	ID:	WPT:	Long	Lat	Viability (Score):	Viability (%):	Colour (Score):	Observers:	Image #:
7/09/2016	Cell 4 / South / Q1	13	46	-34.5599863	144.4376512	3	25	2	JM, JG, KP, KW.	109 - 0021
7/09/2016	Cell 4 / South / Q1	14	47	-34.56000273	144.4377366	4	65-70	3	JM, JG, KP, KW.	109 - 0022
7/09/2016	Cell 4 / South / Q1	15	48	-34.55988413	144.4376541	3	45	1	JM, JG, KP, KW.	109 - 0023
7/09/2016	Cell 4 / South / Q1	16	49	-34.55990986	144.4375755	3	35	3	JM, KW, KP, TM, IW.	109 - 0024
7/09/2016	Cell 4 / South / Q1	17	50	-34.55986812	144.4374671	3	45	1	JM, KW, KP, TM, IW.	109 - 0025
7/09/2016	Cell 4 / South / Q1	18	51	-34.55959654	144.4374673	5	80	4	JM, KW, KP, TM, IW.	109 - 0026
7/09/2016	Cell 4 / South / Q1	19	52	-34.55959118	144.4371686	4	70	3	JM, KW, KP, TM, IW.	109 - 0027
7/09/2016	Cell 4 / South / Q1	20	53	-34.55966435	144.4371572	2	25	1	JM, KW, KP, TM, IW.	109 - 0028
7/09/2016	Cell 4 / South / Q1	21	54	-34.55965891	144.4370721	4	60	3	JM, KW, KP, TM, IW.	109 - 0029/30/31
7/09/2016	Cell 4 / South / Q1	22	55	-34.5597563	144.436972	3	40	1	JM, KW, KP, TM, IW.	109 - 0032
7/09/2016	Cell 4 / South / Q1	23	56	-34.55982252	144.4368907	3	35	1	JM, KW, KP, TM, IW.	109 - 0033
7/09/2016	Cell 4 / South / Q1	24	57	-34.55986426	144.4367941	4	60	1	JM, KW, KP, TM, IW.	109 - 0034
7/09/2016	Cell 4 / South / Q1	25	58	-34.55999083	144.4368627	2	20	1	JM, KW, KP, TM, IW.	109 - 0035
7/09/2016	Cell 4 / South / Q1	26	59	-34.56006484	144.4366619	3	35	1	JM, KW, KP, TM, IW.	109 - 0036
7/09/2016	Cell 4 / South / Q1	27	60	-34.56021873	144.4367498	3	35	1	JM, KW, KP, TM, IW.	109 - 0037
7/09/2016	Cell 4 / South / Q1	28	61	-34.5602557	144.4368487	3	40	1	JM, KW, KP, TM, IW.	109 - 0038
7/09/2016	Cell 4 / South / Q1	29	62	-34.56028285	144.4369884	4	65	3	JM, KW, KP, TM, IW.	109 - 0039
7/09/2016	Cell 4 / South / Q1	30	63	-34.56034211	144.4371282	4	65	1	JM, KW, KP, TM, IW.	109 - 0040
7/09/2016	Cell 3 / North / Q2	1	94	-34.54731697	144.4542947	4	60	1	TM, JM, JG, KP, KW	009 - 071
7/09/2016	Cell 3 / North / Q2	2	95	-34.5475924	144.4540989	4	70	1	TM, JM, JG, KP, KW	009 - 073
7/09/2016	Cell 3 / North / Q2	3	96	-34.547653	144.454277	5	75	4	TM, JM, JG, KP, KW	009 - 074
7/09/2016	Cell 3 / North / Q2	4	97	-34.54790832	144.454389	4	65	4	TM, JM, JG, KP, KW	009 - 075
7/09/2016	Cell 3 / North / Q2	5	98	-34.54803153	144.4544352	5	80	4	TM, JM, JG, KP, KW	009 - 076
7/09/2016	Cell 3 / North / Q2	6	99	-34.54814058	144.4544086	3	30	1	TM, JM, JG, KP, KW	009 - 077/078
7/09/2016	Cell 3 / North / Q2	7	100	-34.54807704	144.4542456	5	75	4	TM, JM, JG, KP, KW	009 - 079
7/09/2016	Cell 3 / North / Q2	8	101	-34.54820814	144.4545114	5	80	4	TM, JM, JG, KP, KW	009 - 080
7/09/2016	Cell 3 / North / Q2	9	102	-34.54822758	144.4545885	4	70	3	TM, JM, JG, KP, KW	009 - 081

Date:	Site:	ID:	WPT:	Long	Lat	Viability (Score):	Viability (%):	Colour (Score):	Observers:	Image #:
7/09/2016	Cell 3 / North / Q2	10	103	-34.54827989	144.4547409	4	70	3	TM, JM, JG, KP, KW	009 - 082
7/09/2016	Cell 3 / North / Q2	11	104	-34.5483161	144.4548293	5	75	3	TM, JM, JG, KP, KW	009 - 083
7/09/2016	Cell 3 / North / Q2	12	105	-34.54832557	144.4548351	5	85	4	TM, JM, JG, KP, KW	009 - 084
7/09/2016	Cell 3 / North / Q2	13	106	-34.54830419	144.4550072	5	90	4	TM, JM, JG, KP, KW	009 - 085/086
7/09/2016	Cell 3 / North / Q2	14	107	-34.54837343	144.4551123	5	85	4	TM, JM, JG, KP, KW	009 - 087
7/09/2016	Cell 3 / North / Q2	15	108	-34.54841626	144.4552789	4	65	3	TM, JM, JG, KP, KW	009 - 088
7/09/2016	Cell 3 / North / Q2	16	109	-34.5483166	144.4553415	5	85	4	TM, JM, JG, KP, KW	009 - 089
7/09/2016	Cell 3 / North / Q2	17	110	-34.54815575	144.4552963	5	75	3	TM, JM, JG, KP, KW	009 - 090
7/09/2016	Cell 3 / North / Q2	18	111	-34.54816405	144.4552837	4	70	3	TM, JM, JG, KP, KW	009 - 091
7/09/2016	Cell 3 / North / Q2	19	112	-34.54812281	144.4553351	5	80	4	TM, JM, JG, KP, KW	009 - 092
7/09/2016	Cell 3 / North / Q2	20	113	-34.54802172	144.4554064	4	65	3	TM, JM, JG, KP, KW	009 - 093
7/09/2016	Cell 3 / North / Q2	21	114	-34.54786372	144.4553516	3	40	1	TM, JM, JG, KP, KW	009 - 094
7/09/2016	Cell 3 / North / Q2	22	115	-34.54774344	144.4552264	3	45	1	TM, JM, JG, KP, KW	009 - 095
7/09/2016	Cell 3 / North / Q2	23	116	-34.54757161	144.4551289	4	60	1	TM, JM, JG, KP, KW	009 - 096
7/09/2016	Cell 3 / North / Q2	24	117	-34.54753566	144.4550272	3	40	1	TM, JM, JG, KP, KW	009 - 097
7/09/2016	Cell 3 / North / Q2	25	118	-34.54749668	144.4550208	4	55	3	TM, JM, JG, KP, KW	
7/09/2016	Cell 3 / North / Q2	26	119	-34.54747329	144.4549327	2	15	2	TM, JM, JG, KP, KW	
7/09/2016	Cell 3 / North / Q2	27	120	-34.54740465	144.4548664	2	25	1	TM, JM, JG, KP, KW	
7/09/2016	Cell 3 / North / Q2	28	121	-34.54739207	144.4548853	3	40	1	TM, JM, JG, KP, KW	
7/09/2016	Cell 3 / North / Q2	29	122	-34.54730675	144.454721	3	45	1	TM, JM, JG, KP, KW	
7/09/2016	Cell 3 / North / Q2	30	123	-34.54729518	144.4547237	4	55	1	TM, JM, JG, KP, KW	
8/09/2016	Cell 2 / South / Q1	1	199	-34.56074411	144.4668234	3	40	1	KP, JG, JM	
8/09/2016	Cell 2 / South / Q1	2	200	-34.56074721	144.4668216	3	35	1	KP, JG, JM	
8/09/2016	Cell 2 / South / Q1	3	201	-34.56071142	144.4666968	2	25	1	KP, JG, JM	
8/09/2016	Cell 2 / South / Q1	4	202	-34.56065903	144.4666809	3	40	3	KP, JG, JM	
8/09/2016	Cell 2 / South / Q1	5	203	-34.56058863	144.4667581	3	40	2	KP, JG, JM	
8/09/2016	Cell 2 / South / Q1	6	204	-34.56053272	144.4667435	3	30	1	KP, JG, JM	

Date:	Site:	ID:	WPT:	Long	Lat	Viability (Score):	Viability (%):	Colour (Score):	Observers:	Image #:
8/09/2016	Cell 2 / South / Q1	7	205	-34.56050238	144.4666456	2	25	1	KP, JG, JM	
8/09/2016	Cell 2 / South / Q1	8	206	-34.56056583	144.4665568	3	50	3	KP, JG, JM	
8/09/2016	Cell 2 / South / Q1	9	207	-34.5605634	144.466557	4	55	3	KP, JG, JM	
8/09/2016	Cell 2 / South / Q1	10	208	-34.56066197	144.4664961	2	10	1	KP, JG, JM	
8/09/2016	Cell 2 / South / Q1	11	209	-34.56078862	144.4664204	4	60	3	KP, JG, JM	
8/09/2016	Cell 2 / South / Q1	12	210	-34.56079641	144.4664453	3	40	3	KP, JG, JM	
8/09/2016	Cell 2 / South / Q1	13	211	-34.56079574	144.4664912	4	70	3	KP, JG, JM	
8/09/2016	Cell 2 / South / Q1	14	212	-34.56086632	144.4664644	4	50	1	KP, JG, JM	
8/09/2016	Cell 2 / South / Q1	15	213	-34.56087722	144.4664397	4	50	1	KP, JG, JM	
8/09/2016	Cell 2 / South / Q1	16	214	-34.5609084	144.4664882	2	25	2	KP, JG, JM	
8/09/2016	Cell 2 / South / Q1	17	215	-34.56095701	144.46646	2	25	1	KP, JG, JM	
8/09/2016	Cell 2 / South / Q1	18	216	-34.56100252	144.4663883	3	25	1	KP, JG, JM	
8/09/2016	Cell 2 / South / Q1	19	217	-34.56101443	144.4663314	4	70	3	KP, JG, JM	
8/09/2016	Cell 2 / South / Q1	20	218	-34.56103723	144.4663189	4	75	3	KP, JG, JM	
8/09/2016	Cell 2 / South / Q1	21	219	-34.56105282	144.4663243	3	50	3	KP, JG, JM	
8/09/2016	Cell 2 / South / Q1	22	220	-34.56110487	144.4663997	3	35	1	KP, JG, JM	
8/09/2016	Cell 2 / South / Q1	23	221	-34.56115122	144.4663445	3	45	1	KP, JG, JM	
8/09/2016	Cell 2 / South / Q1	24	222	-34.56124702	144.4662831	3	50	1	KP, JG, JM	
8/09/2016	Cell 2 / South / Q1	25	223	-34.56124183	144.4662342	2	20	1	KP, JG, JM	
8/09/2016	Cell 2 / South / Q1	26	224	-34.56123345	144.4661994	3	30	1	KP, JG, JM	
8/09/2016	Cell 2 / South / Q1	27	225	-34.56127024	144.4660749	4	50	2	KP, JG, JM	
8/09/2016	Cell 2 / South / Q1	28	226	-34.56148373	144.4662613	4	50	1	KP, JG, JM	
8/09/2016	Cell 2 / South / Q1	29	227	-34.56149429	144.4663206	3	40	3	KP, JG, JM	
8/09/2016	Cell 2 / South / Q1	30	228	-34.54085989	144.4456287	2	15	1	KP, JG, JM	
8/09/2016	Cell 3 / Site 3	1	169	-34.54915345	144.4624335	1	5	2	JG, JM, KP, IW	
8/09/2016	Cell 3 / Site 3	2	170	-34.54916443	144.4624371	4	55	3	JG, JM, KP, IW	
8/09/2016	Cell 3 / Site 3	3	171	-34.54918144	144.46244	4	50	3	JG, JM, KP, IW	

Date:	Site:	ID:	WPT:	Long	Lat	Viability (Score):	Viability (%):	Colour (Score):	Observers:	Image #:
8/09/2016	Cell 3 / Site 3	4	172	-34.54925545	144.4624408	2	5	2	JG, JM, KP, IW	
8/09/2016	Cell 3 / Site 3	5	173	-34.54928135	144.4624851	2	10	1	JG, JM, KP, IW	
8/09/2016	Cell 3 / Site 3	6	174	-34.54928999	144.4624819	3	40	3	JG, JM, KP, IW	
8/09/2016	Cell 3 / Site 3	7	175	-34.5493987	144.4625345	5	80	4	JG, JM, KP, IW	
8/09/2016	Cell 3 / Site 3	8	176	-34.5494308	144.4626394	3	35	1	JG, JM, KP, IW	
8/09/2016	Cell 3 / Site 3	9	177	-34.5494909	144.4626483	4	60	3	JG, JM, KP, IW	
8/09/2016	Cell 3 / Site 3	10	178	-34.54956315	144.4627166	4	60	3	JG, JM, KP, IW	
8/09/2016	Cell 3 / Site 3	11	179	-34.54965334	144.4625779	3	45	4	JG, JM, KP, IW	
8/09/2016	Cell 3 / Site 3	12	180	-34.54971738	144.4625339	3	50	3	JG, JM, KP, IW	
8/09/2016	Cell 3 / Site 3	13	181	-34.54970271	144.4624811	4	55	3	JG, JM, KP, IW	
8/09/2016	Cell 3 / Site 3	14	182	-34.5497271	144.462433	3	45	1	JG, JM, KP, IW	
8/09/2016	Cell 3 / Site 3	15	183	-34.54970112	144.4623162	3	40	1	JG, JM, KP, IW	
8/09/2016	Cell 3 / Site 3	16	184	-34.54962728	144.4623317	4	60	4	JG, JM, KP, IW	
8/09/2016	Cell 3 / Site 3	17	185	-34.54958931	144.4623037	5	85	5	JG, JM, KP, IW	
8/09/2016	Cell 3 / Site 3	18	186	-34.5495075	144.4621414	5	80	4	JG, JM, KP, IW	
8/09/2016	Cell 3 / Site 3	19	187	-34.54938496	144.4620898	3	35	1	JG, JM, KP, IW	
8/09/2016	Cell 3 / Site 3	20	188	-34.54923475	144.4620471	3	45	3	JG, JM, KP, IW	
8/09/2016	Cell 3 / Site 3	21	189	-34.54917884	144.4620588	1	5	2	JG, JM, Kp, TM.	
8/09/2016	Cell 3 / Site 3	22	190	-34.54910508	144.4619927	3	50	3	JG, JM, Kp, TM.	
8/09/2016	Cell 3 / Site 3	23	191	-34.54916283	144.4619391	4	65	3	JG, JM, Kp, TM.	
8/09/2016	Cell 3 / Site 3	24	192	-34.54915806	144.4618443	4	70	4	JG, JM, Kp, TM.	
8/09/2016	Cell 3 / Site 3	25	193	-34.54899159	144.4616947	3	30	1	JG, JM, Kp, TM.	
8/09/2016	Cell 3 / Site 3	26	194	-34.54897583	144.461711	3	30	1	JG, JM, Kp, TM.	
8/09/2016	Cell 3 / Site 3	27	195	-34.54895245	144.4617707	4	75	3	JG, JM, Kp, TM.	
8/09/2016	Cell 3 / Site 3	28	196	-34.54887299	144.4618369	4	65	3	JG, JM, Kp, TM.	
8/09/2016	Cell 3 / Site 3	29	197	-34.54890501	144.4619106	3	45	1	JG, JM, Kp, TM.	
8/09/2016	Cell 3 / Site 3	30	198	-34.54886117	144.4623366	3	25	1	JG, JM, Kp, TM.	

Date:	Site:	ID:	WPT:	Long	Lat	Viability (Score):	Viability (%):	Colour (Score):	Observers:	Image #:
8/09/2016	Cell 2 / Site 3	1	289	-34.55707007	144.4733972	3	40	3	JG, KP, JM.	
8/09/2016	Cell 2 / Site 3	2	290	-34.55700318	144.473247	4	50	1	JG, KP, JM.	
8/09/2016	Cell 2 / Site 3	3	291	-34.55700696	144.4731524	3	35	1	JG, KP, JM.	
8/09/2016	Cell 2 / Site 3	4	292	-34.55702137	144.4731021	2	20	3	JG, KP, JM.	
8/09/2016	Cell 2 / Site 3	5	293	-34.55702866	144.4730943	4	50	1	JG, KP, JM.	
8/09/2016	Cell 2 / Site 3	6	294	-34.55716294	144.4730447	3	40	1	JG, KP, JM.	
8/09/2016	Cell 2 / Site 3	7	295	-34.55716336	144.4730598	3	40	1	JG, KP, JM.	
8/09/2016	Cell 2 / Site 3	8	296	-34.55716437	144.4730722	3	35	1	JG, KP, JM.	
8/09/2016	Cell 2 / Site 3	9	297	-34.5571554	144.4732306	3	25	1	JG, KP, JM.	
8/09/2016	Cell 2 / Site 3	10	298	-34.55716789	144.473257	3	40	1	JG, KP, JM.	
8/09/2016	Cell 2 / Site 3	11	299	-34.5571875	144.4733461	2	25	1	JG, KP, JM.	
8/09/2016	Cell 2 / Site 3	12	300	-34.5571953	144.4733683	3	30	3	JG, KP, JM.	
8/09/2016	Cell 2 / Site 3	13	301	-34.55717166	144.4735123	3	40	4	JG, KP, JM.	
8/09/2016	Cell 2 / Site 3	14	302	-34.55750224	144.4734125	3	50	4	JG, KP, JM.	
8/09/2016	Cell 2 / Site 3	15	303	-34.55746268	144.4733888	3	40	1	JG, KP, JM.	
8/09/2016	Cell 2 / Site 3	16	304	-34.55746201	144.4733796	3	25	1	JG, KP, JM.	
8/09/2016	Cell 2 / Site 3	17	305	-34.55746788	144.4732843	3	40	1	JG, KP, JM.	
8/09/2016	Cell 2 / Site 3	18	306	-34.55745036	144.4732499	4	50	1	JG, KP, JM.	
8/09/2016	Cell 2 / Site 3	19	307	-34.55742027	144.4732301	2	20	1	JG, KP, JM.	
8/09/2016	Cell 2 / Site 3	20	308	-34.55738322	144.4731571	3	45	1	JG, KP, JM.	
8/09/2016	Cell 2 / Site 3	21	309	-34.5573486	144.4731625	4	60	3	JG, KP, JM.	
8/09/2016	Cell 2 / Site 3	22	310	-34.55729789	144.4730956	4	50	4	JG, KP, JM.	
8/09/2016	Cell 2 / Site 3	23	311	-34.55732396	144.473038	2	20	1	JG, KP, JM.	
8/09/2016	Cell 2 / Site 3	24	312	-34.55744642	144.4729806	2	30	1	JG, KP, JM.	
8/09/2016	Cell 2 / Site 3	25	313	-34.55744701	144.4729634	3	40	3	JG, KP, JM.	
8/09/2016	Cell 2 / Site 3	26	314	-34.557562	144.4730417	3	30	1	JG, KP, JM.	
8/09/2016	Cell 2 / Site 3	27	315	-34.55759092	144.4731234	3	30	1	JG, KP, JM.	

Date:	Site:	ID:	WPT:	Long	Lat	Viability (Score):	Viability (%):	Colour (Score):	Observers:	Image #:
8/09/2016	Cell 2 / Site 3	28	316	-34.55758866	144.4732107	3	40	1	JG, KP, JM.	
8/09/2016	Cell 2 / Site 3	29	317	-34.55760886	144.4732086	3	40	3	JG, KP, JM.	
8/09/2016	Cell 2 / Site 3	30	318	-34.55757005	144.4733419	3	25	1	JG, KP, JM.	

Toogimbie Post-Flow Lignum Health Data

Date:	Site:	ID:	WPT:	Long	Lat	Viability (Score):	Viability (%):	Colour (Score):	Observers:	Image #:
13/12/2016	Cell 3 / South / Q1	1	139	-34.56131567	144.4478782	4	70	4	JM, Kerri, Alanna	240
13/12/2016	Cell 3 / South / Q1	2	140	-34.56133445	144.4479645	5	80	4	JM, Kerri, Alanna	241
13/12/2016	Cell 3 / South / Q1	3	141	-34.56133755	144.4479634	5	40	4	JM, Kerri, Alanna	242
13/12/2016	Cell 3 / South / Q1	4	142	-34.5614409	144.4482449	5	95	5	JM, Kerri, Alanna	243
13/12/2016	Cell 3 / South / Q1	5	143	-34.56151189	144.4483224	5	85	4	JM, Kerri, Alanna	244
13/12/2016	Cell 3 / South / Q1	6	144	-34.56161818	144.4483137	5	90	5	JM, Kerri, Alanna	245
13/12/2016	Cell 3 / South / Q1	7	145	-34.56163804	144.4484436	5	85	5	JM, Kerri, Alanna	246
13/12/2016	Cell 3 / South / Q1	8	146	-34.56168598	144.4484994	3	40	3	JM, Kerri, Alanna	243
13/12/2016	Cell 3 / South / Q1	9	147	-34.56168263	144.448659	5	80	4	JM, Kerri, Alanna	248
13/12/2016	Cell 3 / South / Q1	10	148	-34.56183988	144.4486924	5	75	4	JM, Kerri, Alanna	249
13/12/2016	Cell 3 / South / Q1	11	149	-34.5617517	144.4488874	5	80	4	JM, Kerri, Alanna	250
13/12/2016	Cell 3 / South / Q1	12	150	-34.56172773	144.4490122	4	70	4	JM, Kerri, Alanna	251
13/12/2016	Cell 3 / South / Q1	13	151	-34.56161206	144.4490862	4	70	4	JM, Kerri, Alanna	252
13/12/2016	Cell 3 / South / Q1	14	152	-34.56155472	144.4490995	5	75	4	JM, Kerri, Alanna	253
13/12/2016	Cell 3 / South / Q1	15	153	-34.56151801	144.449132	5	80	4	JM, Kerri, Alanna	254
13/12/2016	Cell 3 / South / Q1	16	154	-34.56137485	144.4488987	5	90	4	JM, Kerri, Alanna	255
13/12/2016	Cell 3 / South / Q1	17	155	-34.56135641	144.4487231	4	70	4	JM, Kerri, Alanna	256
13/12/2016	Cell 3 / South / Q1	18	156	-34.56134853	144.4486919	5	80	4	JM, Kerri	238
13/12/2016	Cell 3 / South / Q1	19	157	-34.56134325	144.4486882	5	85	4	JM, Kerri	237

Date:	Site:	ID:	WPT:	Long	Lat	Viability (Score):	Viability (%):	Colour (Score):	Observers:	Image #:
13/12/2016	Cell 3 / South / Q1	20	158	-34.56137661	144.4485762	4	60	3	JM, Kerri	236
13/12/2016	Cell 3 / South / Q1	21	159	-34.56140033	144.44852	5	80	4	JM, Kerri	235
13/12/2016	Cell 3 / South / Q1	22	160	-34.56138507	144.4484506	5	80	4	JM, Kerri	234
13/12/2016	Cell 3 / South / Q1	23	161	-34.56120319	144.4484418	4	65	4	JM, Kerri	233
13/12/2016	Cell 3 / South / Q1	24	162	-34.56118139	144.4484086	5	80	4	JM, Kerri	233
13/12/2016	Cell 3 / South / Q1	25	163	-34.56109984	144.4483953	4	60	3	JM, Kerri	231
13/12/2016	Cell 3 / South / Q1	26	164	-34.56109724	144.4483926	4	75	4	JM, Kerri	230
13/12/2016	Cell 3 / South / Q1	27	165	-34.56104569	144.4483144	3	30	1	JM, Kerri	229
13/12/2016	Cell 3 / South / Q1	28	166	-34.56110193	144.4482306	4	70	4	JM, Kerri	226
13/12/2016	Cell 3 / South / Q1	29	167	-34.56111819	144.4481365	4	50	3	JM, Kerri	227
13/12/2016	Cell 3 / South / Q1	30	168	-34.5611368	144.4479796	5	85	4	JM, Kerri	228
13/12/2016	Cell 2 /North / Q2	1	259	-34.54986893	144.4663311	5	80	4	JM, Kerri	224
13/12/2016	Cell 2 /North / Q2	2	260	-34.54994973	144.4663385	5	85	4	JM, Kerri	225
13/12/2016	Cell 2 /North / Q2	3	261	-34.55000639	144.4663212	4	50	3	JM, Kerri	223
13/12/2016	Cell 2 /North / Q2	4	262	-34.5500229	144.4663923	5	80	4	JM, Kerri	239
13/12/2016	Cell 2 /North / Q2	5	263	-34.54997504	144.4664372	5	80	4	JM, Kerri	222
13/12/2016	Cell 2 /North / Q2	6	264	-34.55003187	144.4664414	5	80	4	JM, Kerri	221
13/12/2016	Cell 2 /North / Q2	7	265	-34.55000941	144.4665114	4	70	4	JM, Kerri	220
13/12/2016	Cell 2 /North / Q2	8	266	-34.54993338	144.4665065	5	80	4	JM, Kerri	219
13/12/2016	Cell 2 /North / Q2	9	267	-34.54988041	144.4665663	4	50	3	JM, Kerri	218
13/12/2016	Cell 2 /North / Q2	10	268	-34.54983498	144.4666571	4	60	3	JM, Kerri	217
13/12/2016	Cell 2 /North / Q2	11	269	-34.54983372	144.4666804	5	75	4	JM, Kerri	216
13/12/2016	Cell 2 /North / Q2	12	270	-34.54981545	144.46666	5	80	5	JM, Kerri	215
13/12/2016	Cell 2 /North / Q2	13	271	-34.54973482	144.4666431	5	75	4	JM, Kerri	214
13/12/2016	Cell 2 /North / Q2	14	272	-34.54966432	144.4666237	4	70	4	JM, Kerri	213
13/12/2016	Cell 2 /North / Q2	15	273	-34.5496665	144.4667033	5	80	4	JM, Kerri	212
13/12/2016	Cell 2 /North / Q2	16	274	-34.54968218	144.4667211	5	80	4	JM, Kerri	211

Date:	Site:	ID:	WPT:	Long	Lat	Viability (Score):	Viability (%):	Colour (Score):	Observers:	Image #:
13/12/2016	Cell 2 /North / Q2	17	275	-34.54971336	144.4668421					
13/12/2016	Cell 2 /North / Q2	18	276	-34.5496251	144.4667956					
13/12/2016	Cell 2 /North / Q2	19	277	-34.54964077	144.4668362	5	95	5	GJ	
13/12/2016	Cell 2 /North / Q2	20	278	-34.54964211	144.4668885	4	60	4	GJ	
13/12/2016	Cell 2 /North / Q2	21	279	-34.54961789	144.4669189				GJ	
13/12/2016	Cell 2 /North / Q2	22	280	-34.54957103	144.4670084	5	80	4	GJ	
13/12/2016	Cell 2 /North / Q2	23	281	-34.54955469	144.4670969				GJ	
13/12/2016	Cell 2 /North / Q2	24	282	-34.54947732	144.467118	3	50	3	GJ	
13/12/2016	Cell 2 /North / Q2	25	283	-34.54941488	144.4672083				GJ	
13/12/2016	Cell 2 /North / Q2	26	284	-34.54930717	144.467066	5	75	4	GJ	
13/12/2016	Cell 2 /North / Q2	27	285	-34.54930868	144.4670783	5	80	4	GJ	
13/12/2016	Cell 2 /North / Q2	28	286	-34.54931522	144.467001	4	70	4	GJ	
13/12/2016	Cell 2 /North / Q2	29	287	-34.54937976	144.4669789	3	50	3	GJ	
13/12/2016	Cell 2 /North / Q2	30	288	-34.54939552	144.4669504	4	75	4	GJ	
13/12/2016	Cell 4 / Site 3	1	229	-34.54100833	144.4456058	5	80	4	GJ	
13/12/2016	Cell 4 / Site 3	2	230	-34.54102979	144.4455515	5	80	4	GJ	
13/12/2016	Cell 4 / Site 3	3	231	-34.54104605	144.4454829	3	50	3	GJ	
13/12/2016	Cell 4 / Site 3	4	232	-34.54110917	144.4454433				GJ	
13/12/2016	Cell 4 / Site 3	5	233	-34.54115007	144.4453573	4	70	4	GJ	
13/12/2016	Cell 4 / Site 3	6	234	-34.54114052	144.4453248	4	60	3	GJ	
13/12/2016	Cell 4 / Site 3	7	235	-34.54121972	144.4452545	3	50	3	GJ	
13/12/2016	Cell 4 / Site 3	8	236	-34.54120221	144.4451815	4	75	4	GJ	
13/12/2016	Cell 4 / Site 3	9	237	-34.54123146	144.4451851	5	85	5	GJ	
13/12/2016	Cell 4 / Site 3	10	238	-34.54129944	144.4452049	5	85	4	GJ	
13/12/2016	Cell 4 / Site 3	11	239	-34.54143615	144.4451991	5	85	4	GJ	
13/12/2016	Cell 4 / Site 3	12	240	-34.5414478	144.4451736	5	90	4	GJ	
13/12/2016	Cell 4 / Site 3	13	241	-34.54157545	144.4452493				GJ	

Date:	Site:	ID:	WPT:	Long	Lat	Viability (Score):	Viability (%):	Colour (Score):	Observers:	Image #:
13/12/2016	Cell 4 / Site 3	14	242	-34.54157914	144.4453381	5	80	4	GJ	
13/12/2016	Cell 4 / Site 3	15	243	-34.54154905	144.4454213	4	75	3	GJ	
13/12/2016	Cell 4 / Site 3	16	244	-34.54151519	144.4454451	6	95	5		
13/12/2016	Cell 4 / Site 3	17	245	-34.54151041	144.4455246					
13/12/2016	Cell 4 / Site 3	18	246	-34.54150831	144.4455878	5	85	4	JM, KP,AM	
13/12/2016	Cell 4 / Site 3	19	247	-34.54147026	144.4456135	5	80	4	JM, KP,AM	
13/12/2016	Cell 4 / Site 3	20	248	-34.54139021	144.4457014	4	65	4	JM, KP,AM	
13/12/2016	Cell 4 / Site 3	21	249	-34.54131721	144.4458166	4	60	4	JM, KP,AM	
13/12/2016	Cell 4 / Site 3	22	250	-34.5411929	144.4458699	5	80	4	JM, KP,AM	
13/12/2016	Cell 4 / Site 3	23	251	-34.54113783	144.4459457	3	40	3	JM, KP,AM	
13/12/2016	Cell 4 / Site 3	24	252	-34.5411546	144.4457881	4	60	4	JM, KP,AM	
13/12/2016	Cell 4 / Site 3	25	253	-34.54114144	144.4457718	4	50	3	JM, KP,AM	
13/12/2016	Cell 4 / Site 3	26	254	-34.54108159	144.4456819	5	70	4	JM, KP,AM	
13/12/2016	Cell 4 / Site 3	27	255	-34.54106575	144.4456666	5	90	4	JM, KP,AM	
13/12/2016	Cell 4 / Site 3	28	256	-34.54101093	144.4457305	5	80	4	JM, KP,AM	
13/12/2016	Cell 4 / Site 3	29	257	-34.54102694	144.4457266	3	40	3	JM, KP,AM	
13/12/2016	Cell 4 / Site 3	30	258	-34.54087405	144.4457971	4	65	4	JM, KP,AM	
14/12/2016	Cell 4 / North / Q2	1	64	-34.54758419	144.439923	4	75	4	JM, KP,AM	
14/12/2016	Cell 4 / North / Q2	2	65	-34.54765962	144.4399604	5	80	4	JM, KP,AM	
14/12/2016	Cell 4 / North / Q2	3	66	-34.54775836	144.4400519	5	75	4	JM, KP,AM	
14/12/2016	Cell 4 / North / Q2	4	67	-34.54782684	144.4400879	5	85	4	JM, KP,AM	
14/12/2016	Cell 4 / North / Q2	5	68	-34.54791477	144.4401107	5	80	4	JM, KP,AM	
14/12/2016	Cell 4 / North / Q2	6	69	-34.54800622	144.4401874	4	65	4	JM, KP,AM	
14/12/2016	Cell 4 / North / Q2	7	70	-34.54800311	144.4402735	5	80	4	JM, KP,AM	
14/12/2016	Cell 4 / North / Q2	8	71	-34.54790387	144.4403157	5	80	4	JM, KP,AM	
14/12/2016	Cell 4 / North / Q2	9	72	-34.54782709	144.4402427	4	70	3	JM, KP,AM	
14/12/2016	Cell 4 / North / Q2	10	73	-34.54753742	144.4405284	4	50	4	JM, KP,AM	

Date:	Site:	ID:	WPT:	Long	Lat	Viability (Score):	Viability (%):	Colour (Score):	Observers:	Image #:
14/12/2016	Cell 4 / North / Q2	11	74	-34.54741177	144.4404083	3	45	3	JM, KP,AM	
14/12/2016	Cell 4 / North / Q2	12	75	-34.54727649	144.4402907	4	60	4	JM, KP,AM	
14/12/2016	Cell 4 / North / Q2	13	76	-34.54713299	144.4399753	4	70	4	JM, KP,AM	
14/12/2016	Cell 4 / North / Q2	14	77	-34.54711916	144.4397563	4	65	4	JM, KP,AM	
14/12/2016	Cell 4 / North / Q2	15	78	-34.54718999	144.4396526	4	70	4	JM, KP,AM	
14/12/2016	Cell 4 / North / Q2	16	79	-34.54722377	144.4393986	5	90	5	JM, KP,AM	
14/12/2016	Cell 4 / North / Q2	17	80	-34.547308	144.4392943	4	60	4	JM, KP,AM	
14/12/2016	Cell 4 / North / Q2	18	81	-34.54737908	144.4388952					
14/12/2016	Cell 4 / North / Q2	19	82	-34.5475696	144.4388907	1	70	4	JM, Kerri, Alanna	257
14/12/2016	Cell 4 / North / Q2	20	83	-34.54759441	144.4392565	5	85	4	JM, Kerri, Alanna	259
14/12/2016	Cell 4 / North / Q2	21	84	-34.54778125	144.4393179	5	85	4	JM, Kerri, Alanna	260
14/12/2016	Cell 4 / North / Q2	22	85	-34.54818073	144.439238	4	70	4	JM, Kerri, Alanna	261
14/12/2016	Cell 4 / North / Q2	23	86	-34.54837359	144.4393502	4	70	4	JM, Kerri, Alanna	262
14/12/2016	Cell 4 / North / Q2	24	87	-34.548415	144.4394896	5	85	4	JM, Kerri, Alanna	263
14/12/2016	Cell 4 / North / Q2	25	88	-34.54852539	144.4397913	5	85	4	JM, Kerri, Alanna	265
14/12/2016	Cell 4 / North / Q2	26	89	-34.54836161	144.4399832	5	85	4	JM, Kerri, Alanna	265
14/12/2016	Cell 4 / North / Q2	27	90	-34.54815776	144.4399043	3	40	3	JM, Kerri, Alanna	266
14/12/2016	Cell 4 / North / Q2	28	91	-34.54797395	144.4399217	4	55	3	JM, Kerri, Alanna	267
14/12/2016	Cell 4 / North / Q2	29	92	-34.5477556	144.4395181	3	40	3	JM, Kerri, Alanna	268
14/12/2016	Cell 4 / North / Q2	30	93	-34.54752895	144.4397708	5	90	4	JM, Kerri, Alanna	268
14/12/2016	Cell 4 / South / Q1	1	34	-34.56008588	144.4369188	5	90	5		1090.145
14/12/2016	Cell 4 / South / Q1	2	35	-34.56006451	144.437	5	75	4		146
14/12/2016	Cell 4 / South / Q1	3	36	-34.56012469	144.4370701	4	70	4		147
14/12/2016	Cell 4 / South / Q1	4	37	-34.5601122	144.4370652	5	80	4		148
14/12/2016	Cell 4 / South / Q1	5	38	-34.56009879	144.4370597	4	70	4		149
14/12/2016	Cell 4 / South / Q1	6	39	-34.56004171	144.4370641	3	40	1		140
14/12/2016	Cell 4 / South / Q1	7	40	-34.56005948	144.4371302	5	80	4		151

Date:	Site:	ID:	WPT:	Long	Lat	Viability (Score):	Viability (%):	Colour (Score):	Observers:	Image #:
14/12/2016	Cell 4 / South / Q1	8	41	-34.56007297	144.4372705	4	65	4		152
14/12/2016	Cell 4 / South / Q1	9	42	-34.56009694	144.4373337	5	75	4		153
14/12/2016	Cell 4 / South / Q1	10	43	-34.56019158	144.437505	4	60	3		154
14/12/2016	Cell 4 / South / Q1	11	44	-34.56019208	144.437526	5	80	4		155
14/12/2016	Cell 4 / South / Q1	12	45	-34.56007649	144.4376038	5	70	4		156
14/12/2016	Cell 4 / South / Q1	13	46	-34.5599863	144.4376512	4	60	4		157
14/12/2016	Cell 4 / South / Q1	14	47	-34.56000273	144.4377366	5	90	5		158
14/12/2016	Cell 4 / South / Q1	15	48	-34.55988413	144.4376541	3	40	3		159
14/12/2016	Cell 4 / South / Q1	16	49	-34.55990986	144.4375755	4	70	4		160
14/12/2016	Cell 4 / South / Q1	17	50	-34.55986812	144.4374671	3	50	3		162
14/12/2016	Cell 4 / South / Q1	18	51	-34.55959654	144.4374673	5	85	4		162
14/12/2016	Cell 4 / South / Q1	19	52	-34.55959118	144.4371686	4	85	4		163
14/12/2016	Cell 4 / South / Q1	20	53	-34.55966435	144.4371572	4	75	4		164
14/12/2016	Cell 4 / South / Q1	21	54	-34.55965891	144.4370721	4	75	5		165
14/12/2016	Cell 4 / South / Q1	22	55	-34.5597563	144.436972	4	70	4		166
14/12/2016	Cell 4 / South / Q1	23	56	-34.55982252	144.4368907	5	75	4		167
14/12/2016	Cell 4 / South / Q1	24	57	-34.55986426	144.4367941	4	60	4		168
14/12/2016	Cell 4 / South / Q1	25	58	-34.55999083	144.4368627	5	70	4		169
14/12/2016	Cell 4 / South / Q1	26	59	-34.56006484	144.4366619	4	75	4		170
14/12/2016	Cell 4 / South / Q1	27	60	-34.56021873	144.4367498	4	60	4		171
14/12/2016	Cell 4 / South / Q1	28	61	-34.5602557	144.4368487	4	75	4		172
14/12/2016	Cell 4 / South / Q1	29	62	-34.56028285	144.4369884	4	65	4		173
14/12/2016	Cell 4 / South / Q1	30	63	-34.56034211	144.4371282	5	80	5		174
13/12/2016	Cell 3 / North / Q2	1	94	-34.54731697	144.4542947	0	0	0	GJ	
13/12/2016	Cell 3 / North / Q2	2	95	-34.5475924	144.4540989	4	60	3	GJ	
13/12/2016	Cell 3 / North / Q2	3	96	-34.547653	144.454277	3	25	1	GJ	
13/12/2016	Cell 3 / North / Q2	4	97	-34.54790832	144.454389				GJ	

Date:	Site:	ID:	WPT:	Long	Lat	Viability (Score):	Viability (%):	Colour (Score):	Observers:	Image #:
13/12/2016	Cell 3 / North / Q2	5	98	-34.54803153	144.4544352	3	25	1	GJ	
13/12/2016	Cell 3 / North / Q2	6	99	-34.54814058	144.4544086	4	65	4	GJ	
13/12/2016	Cell 3 / North / Q2	7	100	-34.54807704	144.4542456	5	90	4	GJ	
13/12/2016	Cell 3 / North / Q2	8	101	-34.54820814	144.4545114	3	50	4	GJ	
13/12/2016	Cell 3 / North / Q2	9	102	-34.54822758	144.4545885	4	70	3	GJ	
13/12/2016	Cell 3 / North / Q2	10	103	-34.54827989	144.4547409	5	80	5	GJ	
13/12/2016	Cell 3 / North / Q2	11	104	-34.5483161	144.4548293	4	70	4	GJ	
13/12/2016	Cell 3 / North / Q2	12	105	-34.54832557	144.4548351	5	80	4	GJ	
13/12/2016	Cell 3 / North / Q2	13	106	-34.54830419	144.4550072	5	80	4	GJ	
13/12/2016	Cell 3 / North / Q2	14	107	-34.54837343	144.4551123	4	60	3	GJ	
13/12/2016	Cell 3 / North / Q2	15	108	-34.54841626	144.4552789	4	50	3	GJ	
13/12/2016	Cell 3 / North / Q2	16	109	-34.5483166	144.4553415	5	80	4	GJ	
13/12/2016	Cell 3 / North / Q2	17	110	-34.54815575	144.4552963	4	75	4	GJ	
13/12/2016	Cell 3 / North / Q2	18	111	-34.54816405	144.4552837	4	70	4	GJ	
13/12/2016	Cell 3 / North / Q2	19	112	-34.54812281	144.4553351	4	60	3	GJ	
13/12/2016	Cell 3 / North / Q2	20	113	-34.54802172	144.4554064	4	75	4	GJ	
13/12/2016	Cell 3 / North / Q2	21	114	-34.54786372	144.4553516	0	0	0	GJ	
13/12/2016	Cell 3 / North / Q2	22	115	-34.54774344	144.4552264	5	80	4	GJ	
13/12/2016	Cell 3 / North / Q2	23	116	-34.54757161	144.4551289	5	85	4	GJ	
13/12/2016	Cell 3 / North / Q2	24	117	-34.54753566	144.4550272	5	85	4	GJ	
13/12/2016	Cell 3 / North / Q2	25	118	-34.54749668	144.4550208	4	70	4	GJ	
13/12/2016	Cell 3 / North / Q2	26	119	-34.54747329	144.4549327	4	70	4	GJ	
13/12/2016	Cell 3 / North / Q2	27	120	-34.54740465	144.4548664	4	80	4	GJ	
13/12/2016	Cell 3 / North / Q2	28	121	-34.54739207	144.4548853	5	90	4	GJ	
13/12/2016	Cell 3 / North / Q2	29	122	-34.54730675	144.454721	3	40	3	GJ	
13/12/2016	Cell 3 / North / Q2	30	123	-34.54729518	144.4547237	5	90	4	GJ	
13/12/2016	Cell 2 / South / Q1	1	199	-34.56074411	144.4668234	2	10	1	JM, AM, KP	

Date:	Site:	ID:	WPT:	Long	Lat	Viability (Score):	Viability (%):	Colour (Score):	Observers:	Image #:
13/12/2016	Cell 2 / South / Q1	2	200	-34.56074721	144.4668216	3	40	3	JM, AM, KP	
13/12/2016	Cell 2 / South / Q1	3	201	-34.56071142	144.4666968	3	30	1	JM, AM, KP	
13/12/2016	Cell 2 / South / Q1	4	202	-34.56065903	144.4666809	3	30	1	JM, AM, KP	
13/12/2016	Cell 2 / South / Q1	5	203	-34.56058863	144.4667581	3	50	2	JM, AM, KP	
13/12/2016	Cell 2 / South / Q1	6	204	-34.56053272	144.4667435	4	60	3	JM, AM, KP	
13/12/2016	Cell 2 / South / Q1	7	205	-34.56050238	144.4666456	3	30	3	JM, AM, KP	
13/12/2016	Cell 2 / South / Q1	8	206	-34.56056583	144.4665568	2	20	1	JM, AM, KP	
13/12/2016	Cell 2 / South / Q1	9	207	-34.5605634	144.466557	3	45	3	JM, AM, KP	
13/12/2016	Cell 2 / South / Q1	10	208	-34.56066197	144.4664961	5	80	4	JM, AM, KP	
13/12/2016	Cell 2 / South / Q1	11	209	-34.56078862	144.4664204	4	65	4	JM, AM, KP	
13/12/2016	Cell 2 / South / Q1	12	210	-34.56079641	144.4664453	4	60	3	JM, AM, KP	
13/12/2016	Cell 2 / South / Q1	13	211	-34.56079574	144.4664912	5	80	4	JM, AM, KP	
13/12/2016	Cell 2 / South / Q1	14	212	-34.56086632	144.4664644	4	60	4	JM, AM, KP	
13/12/2016	Cell 2 / South / Q1	15	213	-34.56087722	144.4664397	5	80	4	JM, AM, KP	
13/12/2016	Cell 2 / South / Q1	16	214	-34.5609084	144.4664882	3	50	3	JM, AM, KP	
13/12/2016	Cell 2 / South / Q1	17	215	-34.56095701	144.46646	4	65	4	JM, AM, KP	
13/12/2016	Cell 2 / South / Q1	18	216	-34.56100252	144.4663883	4	70	4	JM, AM, KP	
13/12/2016	Cell 2 / South / Q1	19	217	-34.56101443	144.4663314	3	35	3	JM, AM, KP	
13/12/2016	Cell 2 / South / Q1	20	218	-34.56103723	144.4663189	5	75	4	JM, AM, KP	
13/12/2016	Cell 2 / South / Q1	21	219	-34.56105282	144.4663243	4	60	3	JM, AM, KP	
13/12/2016	Cell 2 / South / Q1	22	220	-34.56110487	144.4663997	2	10	1	JM, AM, KP	
13/12/2016	Cell 2 / South / Q1	23	221	-34.56115122	144.4663445	3	25	1	JM, AM, KP	
13/12/2016	Cell 2 / South / Q1	24	222	-34.56124702	144.4662831	3	40	3	JM, AM, KP	
13/12/2016	Cell 2 / South / Q1	25	223	-34.56124183	144.4662342	3	50	3	JM, AM, KP	
13/12/2016	Cell 2 / South / Q1	26	224	-34.56123345	144.4661994	4	70	4	JM, AM, KP	
13/12/2016	Cell 2 / South / Q1	27	225	-34.56127024	144.4660749	4	60	3	JM, AM, KP	
13/12/2016	Cell 2 / South / Q1	28	226	-34.56148373	144.4662613	3	30	1	JM, AM, KP	

Date:	Site:	ID:	WPT:	Long	Lat	Viability (Score):	Viability (%):	Colour (Score):	Observers:	Image #:
13/12/2016	Cell 2 / South / Q1	29	227	-34.56149429	144.4663206	3	25	2	JM, AM, KP	
13/12/2016	Cell 2 / South / Q1	30	228	-34.54085989	144.4456287	4	60	3	JM, AM, KP	
13/12/2016	Cell 3 / Site 3	1	169	-34.54915345	144.4624335	5	85	4	GJ	175
13/12/2016	Cell 3 / Site 3	2	170	-34.54916443	144.4624371	5	90	4	GJ	176
13/12/2016	Cell 3 / Site 3	3	171	-34.54918144	144.46244	4	60	4	GJ	177
13/12/2016	Cell 3 / Site 3	4	172	-34.54925545	144.4624408	5	95	5	GJ	178
13/12/2016	Cell 3 / Site 3	5	173	-34.54928135	144.4624851	4	65	4	GJ	179
13/12/2016	Cell 3 / Site 3	6	174	-34.54928999	144.4624819	4	60	3	GJ	
13/12/2016	Cell 3 / Site 3	7	175	-34.5493987	144.4625345	4	60	4	GJ	186
13/12/2016	Cell 3 / Site 3	8	176	-34.5494308	144.4626394	3	45	3	GJ	187
13/12/2016	Cell 3 / Site 3	9	177	-34.5494909	144.4626483	6	95	5	GJ	184
13/12/2016	Cell 3 / Site 3	10	178	-34.54956315	144.4627166	5	85	4	GJ	185
13/12/2016	Cell 3 / Site 3	11	179	-34.54965334	144.4625779	3	40	3	GJ	188
13/12/2016	Cell 3 / Site 3	12	180	-34.54971738	144.4625339	5	90	4	GJ	
13/12/2016	Cell 3 / Site 3	13	181	-34.54970271	144.4624811	5	90	4	GJ	190
13/12/2016	Cell 3 / Site 3	14	182	-34.5497271	144.462433	5	90	4	GJ	191
13/12/2016	Cell 3 / Site 3	15	183	-34.54970112	144.4623162	5	85	4	GJ	192
13/12/2016	Cell 3 / Site 3	16	184	-34.54962728	144.4623317	5	80	4	GJ	193
13/12/2016	Cell 3 / Site 3	17	185	-34.54958931	144.4623037	5	80	4	GJ	194
13/12/2016	Cell 3 / Site 3	18	186	-34.5495075	144.4621414	5	85	4	GJ	195
13/12/2016	Cell 3 / Site 3	19	187	-34.54938496	144.4620898	6	80	4	GJ	196
13/12/2016	Cell 3 / Site 3	20	188	-34.54923475	144.4620471	6	95	5	GJ	197
13/12/2016	Cell 3 / Site 3	21	189	-34.54917884	144.4620588	5	85	4	GJ	198
13/12/2016	Cell 3 / Site 3	22	190	-34.54910508	144.4619927	5	10	4	GJ	199
13/12/2016	Cell 3 / Site 3	23	191	-34.54916283	144.4619391	4	60	4	GJ	200
13/12/2016	Cell 3 / Site 3	24	192	-34.54915806	144.4618443	5	85	4	GJ	201
13/12/2016	Cell 3 / Site 3	25	193	-34.54899159	144.4616947	5	95	5	GJ	202

Date:	Site:	ID:	WPT:	Long	Lat	Viability (Score):	Viability (%):	Colour (Score):	Observers:	Image #:
13/12/2016	Cell 3 / Site 3	26	194	-34.54897583	144.461711	5	60	3	GJ	203
13/12/2016	Cell 3 / Site 3	27	195	-34.54895245	144.4617707	5	90	4	GJ	
13/12/2016	Cell 3 / Site 3	28	196	-34.54887299	144.4618369	4	75	4	GJ	205
13/12/2016	Cell 3 / Site 3	29	197	-34.54890501	144.4619106	5	80	4	GJ	206
13/12/2016	Cell 3 / Site 3	30	198	-34.54886117	144.4623366					
14/12/2016	Cell 2 / Site 3	1	289	-34.55707007	144.4733972	5	80	4	JM,KP, AM	270
14/12/2016	Cell 2 / Site 3	2	290	-34.55700318	144.473247	4	70	4	JM,KP, AM	271
14/12/2016	Cell 2 / Site 3	3	291	-34.55700696	144.4731524	5	80	4	JM,KP, AM	272
14/12/2016	Cell 2 / Site 3	4	292	-34.55702137	144.4731021	4	70	4	JM,KP, AM	273
14/12/2016	Cell 2 / Site 3	5	293	-34.55702866	144.4730943	5	75	4	JM,KP, AM	274
14/12/2016	Cell 2 / Site 3	6	294	-34.55716294	144.4730447	4	70	3	JM,KP, AM	275
14/12/2016	Cell 2 / Site 3	7	295	-34.55716336	144.4730598	5	80	4	JM,KP, AM	276
14/12/2016	Cell 2 / Site 3	8	296	-34.55716437	144.4730722	4	75	4	JM,KP, AM	277
14/12/2016	Cell 2 / Site 3	9	297	-34.5571554	144.4732306	5	80	4	JM,KP, AM	278
14/12/2016	Cell 2 / Site 3	10	298	-34.55716789	144.473257	5	80	4	JM,KP, AM	279
14/12/2016	Cell 2 / Site 3	11	299	-34.5571875	144.4733461	4	55	3	JM,KP, AM	280
14/12/2016	Cell 2 / Site 3	12	300	-34.5571953	144.4733683	4	70	4	JM,KP, AM	281
14/12/2016	Cell 2 / Site 3	13	301	-34.55717166	144.4735123	4	70	4	JM,KP, AM	
14/12/2016	Cell 2 / Site 3	14	302	-34.55750224	144.4734125	4	60	4	JM,KP, AM	
14/12/2016	Cell 2 / Site 3	15	303	-34.55746268	144.4733888	3	50	3	JM,KP, AM	
14/12/2016	Cell 2 / Site 3	16	304	-34.55746201	144.4733796	4	60	4	JM,KP, AM	
14/12/2016	Cell 2 / Site 3	17	305	-34.55746788	144.4732843	5	75	4	JM,KP, AM	
14/12/2016	Cell 2 / Site 3	18	306	-34.55745036	144.4732499	4	50	3	JM,KP, AM	
14/12/2016	Cell 2 / Site 3	19	307	-34.55742027	144.4732301	5	75	4	JM,KP, AM	
14/12/2016	Cell 2 / Site 3	20	308	-34.55738322	144.4731571	5	80	4	JM,KP, AM	
14/12/2016	Cell 2 / Site 3	21	309	-34.5573486	144.4731625	5	80	4	JM,KP, AM	
14/12/2016	Cell 2 / Site 3	22	310	-34.55729789	144.4730956	5	80	5	JM,KP, AM	

Date:	Site:	ID:	WPT:	Long	Lat	Viability (Score):	Viability (%):	Colour (Score):	Observers:	Image #:
14/12/2016	Cell 2 / Site 3	23	311	-34.55732396	144.473038	5	80	4	JM,KP, AM	
14/12/2016	Cell 2 / Site 3	24	312	-34.55744642	144.4729806	5	80	4	JM,KP, AM	
14/12/2016	Cell 2 / Site 3	25	313	-34.55744701	144.4729634	5	75	4	JM,KP, AM	
14/12/2016	Cell 2 / Site 3	26	314	-34.557562	144.4730417	5	90	5	JM,KP, AM	
14/12/2016	Cell 2 / Site 3	27	315	-34.55759092	144.4731234	5	85	4	JM,KP, AM	
14/12/2016	Cell 2 / Site 3	28	316	-34.55758866	144.4732107	4	70	3	JM,KP, AM	
14/12/2016	Cell 2 / Site 3	29	317	-34.55760886	144.4732086	4	60	3	JM,KP, AM	
14/12/2016	Cell 2 / Site 3	30	318	-34.55757005	144.4733419	4	60	3	JM,KP, AM	

Appendix C – Toogimbie Bird Survey Data

			(AM/PM):	(AM/PM):					(0-8)
Cell 2 / North / Q2		82,83,84,85	3:15pm	3:45pm	Black duck	3	KW, TM	Sunny, Cloud increasing, Gusty winds, Wind increasing	3
Cell 2 / North / Q2		82,83,84,86	3:15pm	3:45pm	Galah	10	KW, TM	Sunny, Cloud increasing, Gusty winds, Wind increasing	3
Cell 2 / North / Q2		82,83,84,87	3:15pm	3:45pm	Australian raven	20	KW, TM	Sunny, Cloud increasing, Gusty winds, Wind increasing	3
Cell 2 / North / Q2		82,83,84,88	3:15pm	3:45pm	Welcome swallow	6	KW, TM	Sunny, Cloud increasing, Gusty winds, Wind increasing	3
Cell 2 / North / Q2		82,83,84,89	3:15pm	3:45pm	Brown falcon	3	KW, TM	Sunny, Cloud increasing, Gusty winds, Wind increasing	3
Cell 2 / North / Q2		82,83,84,90	3:15pm	3:45pm	White faced heron	6	KW, TM	Sunny, Cloud increasing, Gusty winds, Wind increasing	3
Cell 2 / North / Q2		82,83,84,91	3:15pm	3:45pm	Unidentified raptor (hawk/falcon)	2	KW, TM	Sunny, Cloud increasing, Gusty winds, Wind increasing	3
Cell 4 / Site 3		77,78,79,80	1:44pm	2:40pm	Galah	8	JW, TM	Cloud building, Wind increasing	2 to 3
Cell 4 / Site 3		77,78,79,82	1:44pm	2:40pm	Nankeen kestrel	1	JW, TM	Cloud building, Wind increasing	2 to 3
Cell 4 / Site 3		77,78,79,83	1:44pm	2:40pm	Blue wren	7	JW, TM	Cloud building, Wind increasing	2 to 3
Cell 4 / Site 3		77,78,79,84	1:44pm	2:40pm	Crested pigeon	3	JW, TM	Cloud building, Wind increasing	2 to 3
Cell 4 / Site 3		77,78,79,85	1:44pm	2:40pm	Black duck	3	JW, TM	Cloud building, Wind increasing	2 to 3
Cell 4 / Site 3		77,78,79,86	1:44pm	2:40pm	Australian raven	2	JW, TM	Cloud building, Wind increasing	2 to 3
Cell 4 / Site 3		77,78,79,87	1:44pm	2:40pm	Willy wagtail	1	JW, TM	Cloud building, Wind increasing	2 to 3
Cell 2 / Site 3		90,91,92,93	16:50	17:40	Unidentified raptor (hawk/falcon)	2	KW, TM	Cloudy.	7
Cell 2 / Site 3		90,91,92,93	16:50	17:40	Australian raven	3	KW, TM	Cloudy.	7
Cell 2 / Site 3		90,91,92,93	16:50	17:40	Nankeen kestrel	1	KW, TM	Cloudy.	7
Cell 2 / Site 3		90,91,92,93	16:50	17:40	Black duck	4	KW, TM	Cloudy.	7
Cell 2 / Site 3		90,91,92,93	16:50	17:40	Galah	97	KW, TM	Cloudy.	7

Cell 2 / Site 3		90,91,92,93	16:50	17:40	Blue wren	4	KW, TM	Cloudy.	7
Cell 2 / South / Q1		86,87,88,89	16:00	16:35	Welcome swallow	2	TM, KW, PC, JW	Sunny with cloud developing	3
Cell 2 / South / Q1		86,87,88,89	16:00	16:35	Nankeen kestrel	2	TM, KW, PC, JW	Sunny with cloud developing	3
Cell 2 / South / Q1		86,87,88,89	16:00	16:35	Galah	8	TM, KW, PC, JW	Sunny with cloud developing	3
Cell 2 / South / Q1		86,87,88,89	16:00	16:35	Blue wren	6	TM, KW, PC, JW	Sunny with cloud developing	3
Cell 2 / South / Q1		86,87,88,89	16:00	16:35	Australian raven	1	TM, KW, PC, JW	Sunny with cloud developing	3
Cell 2 / South / Q1		86,87,88,89	16:00	16:35	Unidentified raptor (hawk/falcon)	4	TM, KW, PC, JW	Sunny with cloud developing	3
Cell 2 / South / Q1		86,87,88,89	16:00	16:35	Black kite	2	TM, KW, PC, JW	Sunny with cloud developing	3
Cell 4 / South / Q1					Galah	45	JG, TD, PC, JW	Sunny	4
Cell 3 / South / Q1		127,128,129, 130,131,132	7:50am	8:25am	Blue wren	2	PC, KW, TM, JM.	Sunny	0
Cell 3 / South / Q1		127,128,129, 130,131,132	7:50am	8:25am	Galah	5	PC, KW, TM, JM.	Sunny	0
Cell 3 / South / Q1		127,128,129, 130,131,132	7:50am	8:25am	Australian raven	3	PC, KW, TM, JM.	Sunny	0
Cell 3 / South / Q1		127,128,129, 130,131,132	7:50am	8:25am	Black faced cuckoo shrike	1	PC, KW, TM, JM.	Sunny	0
Cell 3 / South / Q1		127,128,129, 130,131,132	7:50am	8:25am	Cryptic shrubland species (e.g. reed warbler, brown song lark, white faced chat)	13	PC, KW, TM, JM.	Sunny	0
Cell 3 / South / Q1		127,128,129, 130,131,132	7:50am	8:25am	White faced heron	7	PC, KW, TM, JM.	Sunny	0
Cell 3 / South / Q1		127,128,129, 130,131,132	7:50am	8:25am	Willy wagtail	2	PC, KW, TM, JM.	Sunny	0

Cell 3 / South / Q1		127,128,129, 130,131,132	7:30am	8:25am	Straw neck ibis	120 (in transit)	PC, KW, TM, JM	Sunny	0
Cell 3 / South / Q1					Galah	12	PC	Sunny	1
Cell 3 / South / Q1					Black faced cuckoo shrike	1	PC	Sunny	1
Cell 3 / Site 3		71,72,73,74,75	12pm		Galah	11	PC	Sunny	0
Cell 3 / Site 3		71,72,73,74,75	12pm		Unidentified raptor (hawk/falcon)	1	PC	Sunny	0
Cell 3 / Site 3		71,72,73,74,75	12pm		Cryptic shrubland species (e.g. reed warbler, brown song lark, white faced chat)	6	PC	Sunny	0
Cell 3 / Site 3		71,72,73,74,75	12pm		White face heron	4	PC	Sunny	0
Cell 3 / Site 3		71,72,73,74,75	12pm		Grey shrike	3	PC	Sunny	0
Cell 4 / North / Q2					Galah	31	PC, JW		3
Cell 4 / North / Q2					Australian raven	1	PC, JW		3
Cell 4 / North / Q2					Black faced cuckoo shrike	2	PC, JW		3
Cell 3 / North / Q2		134, 135, 136,137, 138	8:30am		Galah	36	PC, JM, TM, KW	Sunny	0
Cell 3 / North / Q2		134, 135, 136,137, 138	8:30am		Blue wren	2	PC, JM, TM, KW	Sunny	0
Cell 3 / North / Q2		134, 135, 136,137, 138	8:30am		Cryptic shrubland species (e.g. reed warbler, brown song lark, white faced chat)	2	PC, JM, TM, KW	Sunny	0
Cell 3 / North / Q2		134, 135, 136,137, 138	8:30am		Blue wren?	3	PC, JM, TM, KW	Sunny	0
Cell 3 / North / Q2		134, 135, 136,137, 138	8:30am		Black kite	1	PC, JM, TM, KW	Sunny	0
Cell 3 / North / Q2		134, 135, 136,137, 138	8:30am		Nankeen kestrel	2	PC, JM, TM, KW	Sunny	0

		138			White faced heron	1	PC, TM, KW	Sunny	6
Cell 4 / North / Q2	TM	52, 53, 54, 55, 56, 58	7:30am	8am	Black duck	9	PC, TM, KW	Cloudy	3 to 4
Cell 4 / North / Q2	TM	52, 53, 54, 55, 56, 58	7:30am	8am	Straw neck ibis	22	PC, TM, KW	Cloudy	3 to 4
Cell 4 / North / Q2	TM	52, 53, 54, 55, 56, 58	7:30am	8am	Galah	14	PC, TM, KW	Cloudy	3 to 4
Cell 4 / North / Q2	TM	52, 53, 54, 55, 56, 58	7:30am	8am	Reed warbler	8	PC, TM, KW	Cloudy	3 to 4
Cell 4 / North / Q2	TM	52, 53, 54, 55, 56, 58	7:30am	8am	Sulphur crested cockatoo	2	PC, TM, KW	Cloudy	3 to 4
Cell 4 / North / Q2	TM	52, 53, 54, 55, 56, 58	7:30am	8am	Nankeen kestrel	1	PC, TM, KW	Cloudy	3 to 4
Cell 4 / North / Q2	TM	52, 53, 54, 55, 56, 58	7:30am	8am	White faced heron	2	PC, TM, KW	Cloudy	3 to 4
Cell 2 / Site 3	TM	90, 91, 92, 93	11:30am	12pm	Straw neck ibis	9	PC, TM, KW	Cloudy	6
Cell 2 / Site 3	TM	90, 91, 92, 93	11:30am	12pm	Reed warbler	4	PC, TM, KW	Cloudy	6
Cell 2 / Site 3	TM	90, 91, 92, 93	11:30am	12pm	White (Sacred) ibis	2	PC, TM, KW	Cloudy	6
Cell 2 / Site 3	TM	90, 91, 92, 93	11:30am	12pm	Masked lapwing	1	PC, TM, KW	Cloudy	6
Cell 2 / South / Q1	TM	86-89	7:15am	7:40am	Reed warbler	12	PC, TM, KW	Cloudy	4to5
Cell 2 / South / Q1	TM	86-89	7:15am	7:40am	White faced Heron	2	PC, TM, KW	Cloudy	4to5
Cell 2 / South / Q1	TM	86-89	7:15am	7:40am	Common sparrow	16	PC, TM, KW	Cloudy	4to5
Cell 2 / South / Q1	TM	86-89	7:15am	7:40am	Blue wren	9	PC, TM, KW	Cloudy	4to5
Cell 3 / South / Q1	TM	128-131	8:20pm	9pm	Galah	4	PC, TM, KW	Cloudy	3
Cell 3 / South / Q1	TM	128-131	8:20pm	9pm	Reed warbler	3	PC, TM, KW	Cloudy	3
Cell 3 / South / Q1	TM	128-131	8:20pm	9pm	Straw neck ibis	2	PC, TM, KW	Cloudy	3
Cell 3 / South / Q1	TM	128-131	8:20pm	9pm	White faced heron	1	PC, TM, KW	Cloudy	3
Cell 4 / South / Q1	TM	47-50	8am	8:30am	Black duck	6	PC, TM, KW	Cloudy	5 to 6
Cell 4 / South / Q1	TM	47-50	8am	8:30am	Cryptic shrubland species (e.g. reed warbler, brown song lark, white faced chat)	29	PC, TM, KW	Cloudy	5 to 6
Cell 4 / South / Q1	TM	47-50	8am	8:30am	Straw neck ibis	11	PC, TM, KW	Cloudy	5 to 6

Cell 3 / North / Q2	TM	134, 135, 136,137, 138	11:50	12:20pm	Unidentified raptor (hawk/falcon)	1	PC, TM, KW	Cloudy	3 to 4
Cell 3 / Site 3	TM	71 to 75	10:15am	10:45am	Straw neck ibis	11	PC, TM, KW	Sunny	2
Cell 3 / Site 3	TM	71 to 75	10:15am	10:45am	Reed warbler	3	PC, TM, KW	Sunny	2
Cell 3 / Site 3	TM	71 to 75	10:15am	10:45am	Unidentified raptor (hawk/falcon)	1	PC, TM, KW	Sunny	2
Cell 3 / Site 3	TM	71 to 75	10:15am	10:45am	Nankeen kestrel	2	PC, TM, KW	Sunny	2
Cell 2 / North / Q2	TM	82 to 85	9:00	9:30am	Straw neck ibis	49	PC, TM, KW	Sunny	2
Cell 2 / North / Q2	TM	82 to 85	9:00	9:30am	White faced heron	3	PC, TM, KW	Sunny	2
Cell 2 / North / Q2	TM	82 to 85	9:00	9:30am	Nankeen kestral	5	PC, TM, KW	Sunny	2
Cell 2 / North / Q2	TM	82 to 85	9:00	9:30am	Black faced cuckoo shrike	1	PC, TM, KW	Sunny	2
Cell 2 / North / Q2	TM	82 to 85	9:00	9:30am	Galah	4	PC, TM, KW	Sunny	2

Appendix D – Toogimbie Frog Survey Data

				(AM/PM):	(AM/PM):				
7.09.2016	House Wetland: listening point 1	PIRSA #2	124	7.40pm	8.00pm	Night	Southern Bell Frog	3	NCI
							Emerald-Spotted Frog	20	
							Beeping Frog (plains froglet)	20	
							Spotted Marsh Frog	25	
							Giant banjo frog	1	
7.09.2016	House Wetland: listening point 2	PIRSA #2	124	7.40pm	8.00pm	Night	Southern Bell Frog	3	
							Emerald-Spotted Frog	8	
							Beeping Frog (plains froglet)	20+	
							Spotted Marsh Frog	20+	
							Giant banjo frog	1	
8.09.2016	Cell 2 / North / Q2 : listening point 1	PIRSA #2	320	8:00pm	8:30pm	Night	Beeping Frog (plains froglet)	15	TM
							Spotted Marsh	15	
							Southern Bell Frog	1	
8.09.2016	Cell 2 / North / Q2: listening point 2					Night	Beeping Frog (plains froglet)	30+	
							Spotted Marsh	8	
							Southern Bell Frog	2	
8.09.2016	Cell 2 / Site 3: listening point 1					Night	Beeping Frog (plains froglet)	8	
							Spotted Marsh	2	
							Southern Bell Frog	2	
8.09.2016	Cell 2 / Site 3: listening point 2					Night	Beeping Frog (plains froglet)	15	
							Spotted Marsh	9	
							Southern Bell Frog	1	
8.09.2016	Cell 3 / South / Q1: listening point 1	PIRSA #2	319			Night	Beeping Frog (plains froglet)	70	TK
							Spotted Marsh	15	
							Southern Bell Frog	0	
8.09.2016	Cell 3 / South / Q1: listening point 2	PIRSA #2				Night	Beeping Frog (plains froglet)	90	
							Spotted Marsh	40	
							Southern Bell Frog	2	
7.09.2016	Cell 3 / North / Q2: Listening point 1	PIRSA #2	125	8.40pm		Night	Spotted Marsh	10	PC,J
							Beeping Frog (plains froglet)	10	
							Groaning Frog	2	
7.09.2016	Cell 3 / North / Q2: Listening point 2	PIRSA #2	126	8.40pm		Night	Spotted Marsh	5	
							Beeping Frog (plains froglet)	10	
							Groaning Frog	2	
7.9.2016	Cell 4 / South / Q1:listening point 1	55 264670 6172550	3	9:10pm	9:30pm	Night	Spotted Marsh	1	TK, J
7.9.2016	Cell 4 / South / Q1:listening point 2	55 264688 6172727	4	9:10pm	9:30pm	Night	Spotted Marsh	1	TK, J
7.9.2016	Cell 4 / North / Q2: Listening Point 1	55 264817 6173910	1	8:40pm	8:50pm	Night	Southern Bell Frog	1	TK, J
7.9.2016	Cell 4 / North / Q2: Listening Point 2	55 264822 6174078	2	8:55pm	9:05pm	Night	no frogs	0	TK, J

							Beeping froglet	10	
							Spotted Marsh	5	
13.12.16	Cell 2 / North / Q2:Listening Point 2			9:55pm	10:20pm	Night	Spotted Marsh	4	F
							Southern Bell Frog	1	
							Barking marsh frog	4	
	Cell 2/ Site 3: Listening Point 1							0	F
	Cell 2 /Ssite 3: Listening Point 2							0	F
14.12.16	Cell 3 / South / Q1:Listening Point 1	Tam	133-134	9:05 PM	9:30 PM	Night	Spotted Marsh	8	T
14.12.16	Cell 3 / South / Q1:Listening Point 2			9:05 PM	9:30 PM	Night	Spotted Marsh	9	F
13.12.16	Cell 3 / Site 3:Listening Point 1			10:20pm	10:45pm	Night	Barking	5	T
							Spotted Marsh	8	
							Beeping	5	
13.12.16	Cell 3 / Site 3:Listening Point 2			10:20pm	10:45pm	Night	Barking	4	F
							Spotted Marsh	4	
13.12.2016	Cell 3 / North / Q2: Listening point 1	55 266369 6174159		10:25pm	10:45pm	Night	Southern Bell Frog	1	TK, A
							Spotted Marsh	2	
							Perrons Tree Frog	1	
13.12.2016	Cell 3 / North / Q2: Listening point 2	55 266535 6174214		10:25pm	10:45pm	Night	Spotted Marsh	1	TK, A
14.12.2016	Cell 4 / South / Q1:listening point 1	55 264850 6172681		7:22am	7:32am	Day	Spotted Marsh	5	T
14.12.2016	Cell 4 / South / Q1:listening point 2						Spotted Marsh	2	F
13.12.2016	Cell 4 / North / Q2: Listening Point 1	55 265565 6174915		9:58pm	10:18pm	Night	Spotted Marsh	2	TK, A
							Perrons Tree Frog	2	TK, A
13.12.2016	Cell 4 / North / Q2: Listening Point 2	55 265710 6174861		9:58pm	10:18pm	Night	Perrons Tree Frog	2	
							Barking Marsh Frog	1	
							Southern Bell Frog	1	

Appendix E – Weilmoringle Vegetation Community Condition Data

Site:	Gooraman Swamp	**Quadrat ID:**	1	**Date:**	26/11/2016	**Observers:**	TK, KH, SK, KW, TM		
Zone:	55K WPT 321	**Easting:**	489974	**Northing:**	6763555				
Dimensions (m):	20x20	**Photo 1:**	101-0565	**Photo 2:**	101-0566	**Photo 3:**	101-0567	**Photo 4:**	101-0568
% Litter:	75	**% Bare Ground:**	7	**Fallen timber length (m):**	30				

Species	**Common Name**	**Native/Exotic**	**% Foliage Cover**	**Crown Extent**	**Canopy openness**	**Abundance**	**Upper Height (m)**	**Lower Height (m)**	**Strata Type**
*Lactuca serriola	Wild Lettuce	Exotic	<1			10	0.3	0.1	L
*Lycium ferocissimum	African Boxthorn	Exotic	<1			30	0.7	0.2	L
*Polygonum aviculare	Wireweed	Exotic	<1			1	0.05	0.05	L
Abutilon sp.	Lantern Bush	Native	<1			20	0.3	0.1	L
Acacia stenophylla	River Cooba	Native	<1			1	0.7	0.7	L
Alternanthera denticulata	Lesser Joyweed	Native	<1			3	0.05	0.05	L
Calotis cuneifolia	Purple Burr-daisy	Native	<1			4	0.3	0.2	L
Centipeda cunninghamii	Old Man Weed	Native	<1			100	0.1	0.05	L
Chrysocephalum apiculatum	Common Everlasting	Native	<1			5	0.4	0.3	L
Einadia nutans	Climbing Saltbush	Native	<1			35	0.4	0.2	L
Enchylaena tomentosa	Ruby Saltbush	Native	<1			11	0.4	0.2	L
Eucalyptus camaldulensis	River Red Gum	Native	60	300m^2	70%	8	14	10	H
Graminae sp.	Grass	Native	<1			1	0.05	0.05	L

Melhania oblongifolia	Velvet Hibiscus	Native	<1			70	0.2	0.1	L
Myoporum montanum	Western Boobialla	Native	<1			7	0.5	0.1	L
Plantago sp.	Plantain	Native	<1			5	0.05	0.05	L
Rhagodia spinescens	Spiny Saltbush	Native	2			93	0.8	0.3	L
Rumex sp.	Dock	Native	<1			1	0.3	0.3	L
Schoenia ramosissima	Dainty Everlasting	Native	<1			2	0.3	0.2	L
Sclerolaena intricata	Tangled Bindyi	Native	<1			3	0.6	0.2	L
Sclerolaena tricuspis	Three-spined Bindyi	Native	<1			5	0.5	0.3	L
Senecia qudridentatus	Cotton Fireweed	Native	<1			3	0.3	0.2	L

Site:	Gooraman Swamp	**Quadrat ID:**	2	**Date:**	26/11/2016	**Observers:**	TK, AM, FH, SK		
Zone:	55 WPT 322	**Easting:**	0490330	**Northing:**	6763623				
Dimensions (m):	20x20	**Photo 1:**	101-0571	**Photo 2:**	101-0572	**Photo 3:**	101-0573	**Photo 4:**	101-0574
% Litter:	65	**% Bare Ground:**	15	**Fallen timber length (m):**	70				

Species	**Common Name**	**Native/Exotic**	**% Foliage Cover**	**Crown Extent**	**Canopy openness**	**Abundance**	**Upper Height (m)**	**Lower Height (m)**	**Strata Type**
*Lycium ferocissimum	African Boxthorn	Exotic	1			71	0.3	0.2	L
*Solanum nigrum	Blackberry Nightshade	Exotic	<1			3	0.4	0.2	L
Acacia stenophylla	River Cooba	Native	1			18	1.4	0.2	L
Chenopodium anidiophyllum	Mallee Goosefoot	Native	6			51	0.3	0.2	L
Chenopodium pumilio	Clammy Goosefoot	Native	<1			3	0.3	0.1	L
Einadia nutans	Climbing Saltbush	Native	1			15	0.3	0.1	L
Enchylaena tomentosa	Ruby Saltbush	Native	1			11	0.3	0.2	L
Eucalyptus camaldulensis	River Red Gum	Native	43	280m^2	60%	2	14	14	H
Helichrysum sp.	Everlasting	Native	<1			8	0.6	0.3	L
Melhania oblongifolia	Velvet Hibiscus	Native	<1			2	0.2	0.2	L
Myoporum montanum	Western Boobialla	Native	1			42	1.3	0.1	L
Nicotiana sp	Tobacco Bush	Native	7			121	1.1	0.3	L
Rhagodia spinescens	Spiny Saltbush	Native	1			27	0.5	0.1	L
Salsola kali	Buckbush	Native	<1			4	0.2	0.1	L

Sclerolaena stelligera	Star Bindyi	Native	less - 1			6	0.1	0.1	L
Tetragonia tetragonioides	Warrigal Spinach	Native	<1			1	0.3	0.3	L
unknown	White flower	#N/A	<1			4	0.2	0.1	L

Site:	Culgoa River	**Quadrat ID:**	1	**Date:**	27/11/2016	**Observers:**	TK, JB, AM, KH		
Zone:	55K WPT 126 ™	**Easting:**	0492535	**Northing:**	6764025				
Dimensions (m):	20x20	**Photo 1:**	101-0581	**Photo 2:**	101-0582	**Photo 3:**	101-0583	**Photo 4:**	101-0584
% Litter:	35	**% Bare Ground:**	45	**Fallen timber length (m):**	0				

Species	**Common Name**	**Native/Exotic**	**% Foliage Cover**	**Crown Extent**	**Canopy openness**	**Abundance**	**Upper Height (m)**	**Lower Height (m)**	**Strata Type**
Acacia stenophylla	River Cooba	Native	5	35m^2	30%	27	7	1.5	H
Atalaya hemiglauca	Whitewood	Native	<1	1m^2	80%	1	6	6	M
Atriplex suberecta	Lagoon Saltbush	Native	1			130	0.4	0.2	L
Calotis scabiosifolia	Rough Burr Daisy	Native	<1			30	0.1	0.05	L
Chenopodium nitrariaceum	Nitre Goosefoot	Native	<1			2	0.6	0.5	L
Duma florulenta	Tangled Lignum	Native	1			34	1.3	0.5	M
Einadia nutans	Climbing Saltbush	Native	<1			50	0.3	0.1	L
Eremophila bignoniiflora	Willbill	Native	3			5	5.5	2.4	M
Eremophila bignoniiflora	Willbill	Native	<1			2	0.2	0.1	L
Eucalyptus microtheca	Coolibah	Native	<1			3	0.2	0.08	L
Sclerolaena anisacanthoides	Yellow Bindyi	Native	5			300	0.3	0.1	L
Sclerolaena convexula	Tall Bindyi	Native	1			50	0.3	0.2	L
Sclerolaena diacantha	Grey Bindyi	Native	<1			30	0.2	0.1	L
Sclerolaena tricuspis	Three-spined Bindyi	Native	<1			5	0.5	0.4	L

Sclerolaena tricuspis	Three-spined Bindyi	Native	3			150	0.4	0.1	L
Sida sp. 1	Sida	Native	<1			2	0.2	0.1	L
Sida sp. 2	Sida	Native	<1			2	0.05	0.05	L
Solanum esuriale	Quena	Native	<1			1	0.05	0.03	L
Sporobulus mitchellii	Rat's-tail Couch	Native	<1			200	0.05	0.05	L
Tetragonia teragonioides	Warrigal Spinach	Native	<1			12	0.2	0.1	L
Teucrium racemosum	Grey Germander	Native	<1			60	0.3	0.1	L

Site:	Culgoa River	**Quadrat ID:**	2	**Date:**	17/11/2016	**Observers:**	TK, JB, AM, KM		
Zone:	55K WPT 127 ™	**Easting:**	0492750	**Northing:**	6764332				
Dimensions (m):	20x20	**Photo 1:**	101-0585	**Photo 2:**	101-0586	**Photo 3:**	101-1587	**Photo 4:**	101-0588
% Litter:	15	**% Bare Ground:**	16	**Fallen timber length (m):**	0				

Species	**Common Name**	**Native/Exotic**	**% Foliage Cover**	**Crown Extent**	**Canopy openness**	**Abundance**	**Upper Height (m)**	**Lower Height (m)**	**Strata Type**
*Malva parviflora	Small-flowered Marshmallow	Exotic	<1			8	0.5	0.3	L
Acacia stenophylla	River Cooba	Native	<1	$10m^2$	25%	11	5	2	H
Atriplex suberecta	Lagoon Saltbush	Native	6			65	0.3	0.2	L
Chrysocephalum apiculatum	Common Everlasting	Native	<1			1	0.3	0.3	L
Duma florulenta	Tangled Lignum	Native	10			45	2	4.5	M
Einadia nutans	Climbing Saltbush	Native	<1			10	0.3	0.1	L
Eremophila bignoniiflora	Willbill	Native	2	$8m^2$	50%	1	4.5	2	H
Lepidium hyssopifolium	Peppercress	Native	<1			10	0.5	0.3	L
Plantago cunninghamii	Sago Weed	Native	<1			3	0.2	0.1	L
Salsola kali	Buckbush	Native	<1			6	0.4	0.2	L
Sclerolaena anisacanthoides	Yellow Bindyi	Native	7			221	0.5	0.05	L
Sclerolaena convexula	Tall Bindyi	Native	9			93	0.5	0.2	L
Sclerolaena diacantha	Grey Bindyi	Native	8			100	0.4	0.2	L

Sclerolaena stelligera	Star Bindyi	Native	2			19	0.4	0.2	L
Sclerolaena tricuspis	Three-spined Bindyi	Native	<1			5	0.4	0.2	L
Tetragonia teragonioides	Warrigal Spinach	Native	2			150	0.4	0.2	L
unknown	dry daisy big	#N/A	<1			10	0.3	0.2	L
unknown	dry daisy small	#N/A	20			1500	0.2	0.1	L
unknown	shiny weed	#N/A	<1			11	0.2	0.1	L

Appendix F – Weilmoringle Tree Health Data

Site: **Gooraman Swamp**

Date: **26/11/2016**

Tree ID Number	Species	Crown Extent Category	Crown Extent %	Crown Density Category	Crown Density %	Epicormic Growth Scale	Epicormic Growth State	Reproduction Scale	Crown Growth Scale	Leaf Die Off Scale	Leaf Damage Scale	Mistletoe Scale	Bark Form	DBH (cm)	WPT	Comments/Photo #
1	Red Gum	4	90	4	85	0		0	2	0	1	0	intact	195,287	94	
2	Red Gum	3	60	3	60	0		0	1	1	1	0	intact	330	95	
3	Red Gum	3	65	3	75	0		0	2	2	2	0	intact	165	96	
4	Red Gum	4	85	4	80	0		0	1	0	1	0	cracked	118	97	
5	Red Gum	3	60	3	50	0		0	0	1	2	0	intact	165	98	
6	Red Gum	3	45	3	50	1	inactive	0	0	2	2	0	cracked	163	99	
7	Red Gum	4	80	5	90	2	active	1	2	0	2	0	intact	268	100	
8	Red Gum	4	85	4	90	0		0	0	1	2	0	intact	271	101	
9	Red Gum	3	55	2	45	0		0	0	2	2	0	intact	262	102	
10	Red Gum	3	25	4	85	1	active	3	3	0	2	0	intact	290	103	

11	Red Gum	3	65	3	75	2	active	2	3	1	1	0	cracked	260	104	
12	Red Gum	4	95	4	91	0		0	3	1	1	0	cracked	120,60	105	
13	Red Gum	0	2	1	5	1	active	0	1	2	2	0	cracked	354	106	
14	Red Gum	3	70	4	85	2	active	0	1	1	2	0	intact	276	107	
15	Red Gum	2	20	2	30	0		0	2	1	1	0	cracked	276	108	
16	Red Gum	2	25	2	23	1	active	0	0	1	2	0	intact	186,146,89	109	
17	Red Gum	2	24	2	20	0		0	1	1	2	0	intact	363,100	110	
18	Red Gum	3	25	3	25	0		0	1	1	1	0	intact	86	111	
19	Red Gum	4	75	4	80	1	active	0	1	1	1	0	intact	459	112	
20	Red Gum	3	30	2	25	1	active	0	1	1	2	0	intact	200	113	
21	Red Gum	3	40	3	70	1	active	0	1	1	1	0	intact	155	114	
22	Red Gum	2	25	2	20	1	active	0	0	2	2	0	intact	295	115	
23	Red Gum	2	24	3	40	0		0	2	1	1	0	intact	145	116	
24	Red Gum	2	25	3	40	0		0	0	1	1	0	cracked	388	117	
25	Red Gum	3	70	4	80	0		0	1	1	1	0	intact	164	118	

Site: **Culgoa River, Weilmoringle - Eastern Bank**
Date: **27/11/2016**

Tree ID Number	Species	Crown Extent Category	Crown Extent %	Crown Density Category	Crown Density %	Epicormic Growth Scale	Epicormic Growth State	Reproduction Scale	Crown Growth Scale	Leaf Die Off Scale	Leaf Damage Scale	Mistletoe Scale	Bark Form	DBH (cm)	WPT	Comments/Photo #
1	Black Box	4	75	3	60	1	active	0	1	1	1	0	intact	113,64,120,74	331	
2	Black Box	4	80	4	45	2	inactive	0	3	1	1	0	intact	410	332	
3	Black Box	3	55	3	90	1	active	0	2	1	1	0	intact	325	333	
4	Black Box	3	70	3	50	0	active	0	1	1	0	0	intact	125	334	
5	Black Box	4	80	4	48	1	inactive	0	1	1	1	2	cracked	325	335	Heartwood termite damage
6	Black Box	4	78	4	40	1	inactive	0	2	1	1	0	intact	121,143	336	
7	Red Gum	4	71	3	26	1	active	0	1	1	1	0	intact	144,267	337	
8	Black Box	3	40	3	60	2	inactive	0	1	1	1	0	intact	187,233	338	
9	Black Box	3	35	3	83	0	active	0	1	1	1	0	intact	87,162,86	339	
10	Black Box	4	76	4	43	0	active	0	2	1	1	0	intact	237	340	

11	Black Box	3	34	3	80	0	active	0	1	2	1	0	intact	68,77,63	341	
12	Black Box	3	50	3	50	0	inactive	0	2	1	1	0	intact	52,60,100	342	
13	Black Box	3	55	3	80	1	active	0	2	1	1	0	intact	21,54,78	343	
14	Black Box	4	70	3	60	1	active	0	1	1	2	0	intact	343	344	109-0127
15	Black Box	4	85	4	75	1	inactive	0	3	0	1	0	intact	460	345	109-0128
16	Black Box	3	65	3	55	1	active	0	2	1	1	0	intact	287	346	109-0129
17	Red Gum	4	76	3	60	1	active	0	1	1	1	0	intact	96	347	109-0130
18	Black Box	3	50	3	83	1	active	0	1	1	1	1	intact	75,88,282	348	109-0131
19	Black Box	3	34	3	89	1	inactive	0	1	1	1	0	intact	46	349	109-0132
20	Black Box	3	35	3	60	1	active	0	2	1	1	0	cracked	462	350	109-0133
21	Red Gum	4	76	4	30	3	active	0	2	1	1	0	intact	135	351	109-0134
22	Black Box	3	55	3	35	1	active	0	1	2	2	0	cracked	295	352	109-0135
23	Red Gum	4	76	4	80	2	active	0	2	1	1	0	intact	37	353	109-0136
24	Black Box	4	80	3	30	2	active	0	2	2	1	0	cracked	318	354	109-0137
25	Black Box	3	70	4	30	2	active	0	2	1	1	0	intact	87	355	109-0138

12 APPENDIX 3: SOCIAL AND WELLBEING SELF EVALUATION

12.1 Personal Health Self-Assessment Questionnaire

Please take a moment to complete this survey.

This survey will help us to understand the impact that our work at Toogimbie is having on the lives of the people in our community.

The survey is completely voluntary, and you can answer as many questions as you like. You can stop filling in this survey any time you want to.

The information you provide will be treated confidentially, and will not be made available in any way that identifies you as the person who provided this information.

We will use this information to improve the way we work here at Toogimbie.

How often do you come to Toogimbie?					
More than once a month	About once a month	Several times a year	About once a year	Less than once a year	I've never been to Toogimbie

Thinking back over the last four weeks, how often have you:							
	All of the time	Most of the time	Some of the time	A little of the time	None of the time	Unsure	Do not want to say
Felt calm and peaceful?							
Been a happy person?							
Felt full of life?							
Had a lot of energy?							
Feet proud of who you are?							
Felt able to sort out your own problems?							

How often in the past four weeks have you:							
	All of the time	Most of the time	Some of the time	A little of the time	None of the time	Unsure	Do not want to say
Felt nervous?							
Felt like you didn't have hope?							
Been feeling restless or jumpy?							
Felt like everything was an effort?							

Thinking about other times in your life, this last four weeks has felt:			
Better than usual	Same as usual	Worse than usual	Unsure or Don't want to say

How well do the following statements apply to you?							
	Strongly agree	Agree	Neither agree or disagree	Disagree	Strongly disagree	Unsure	Do not want to say
I have little control over the things that happen to me.							
There is really no way I can solve some of the problems I have.							
There is little I can do to change many of the important things in my life.							
I often feel helpless in dealing with the problems of life.							
Sometimes I feel that I'm being pushed around in life.							
What happens to me in the future mostly depends on me.							

I can do just about anything I really set my mind to do.							
How well do the following statements apply to you?							
	Strongly agree	Agree	Neither agree or disagree	Disagree	Strongly disagree	Unsure	Do not want to say
My family and friends really try to help me.							
I get the emotional support and help I need from my family.							
I can talk about my problems with my family.							
My family is willing to help me make decisions.							
I can count on my friends when things go wrong.							
I can talk about my problems with my friends.							

How was your experience of the Toogimbie Indigenous Protected Area?

Was this your first visit to Toogimbie?	
Yes	No

In just a few words, describe what you expected to see before your visit:

Describe how your visit to Toogimbie compared with what you expected to see:

Based on your day at Toogimbie, to what extent do you agree with the following statements:							
	Strongly agree	Agree	Neither agree or disagree	Disagree	Strongly disagree	Unsure	Do not want to say
I am feeling inspired by my time at Toogimbie.							

I had sufficient opportunity to raise questions and to present my ideas.							
The organisers were responsive to my concerns and questions.							
I found it easy to understand the information that was presented.							
I understand how Toogimbie helps to sustain the connection between people and culture.							
I understand how Toogimbie helps people who have suffered disconnection from their traditional Country to return and reconnect.							
I believe that this event contributes to the handing on of culture, traditions and knowledge.							
My understanding of cultural and Aboriginal land management has improved.							
I think that other people involved were satisfied with the day.							
I would recommend other people visit Toogimbie.							

In your own words, describe the most memorable part of your visit to Toogimbie:

Thinking about your visit, describe how your visit to Toogimbie made you feel:

What surprised you the most about your visit to Toogimbie?

Based on your experience in the activity at Toogimbie, to what extent do you agree with the following statements:							
	Strongly agree	Agree	Neither agree or disagree	Disagree	Strongly disagree	Unsure	Do not want to say

My understanding of Nari Nari landscapes, features and stories has improved.							
My understanding of traditional and cultural land management activities has improved.							
My understanding of the involvement of the Nari Nari in the protection of cultural landscapes has improved.							
My knowledge of water management has improved.							
I have a greater respect for Nari Nari knowledge, places, objects and cultural obligations.							
I have a better understanding of the working with Traditional Owners in a culturally appropriate way.							

13 APPENDIX 4: GOORAMAN SWAMP FISHING AND HUNTING PROFORMA

Date?	Times? (Start time / end time / total break time)	Who? (Which household members)	Where? (Location)	Species	Catch Anything? (Number you caught)		Types of fishing? (methods used)	Weather Condition? (Sunny, raining, cloudy)
Day/ month	*Start / End / Break*	*Name*	*Culgoa River, Weilmoringle*		*Kept*	*Released*		