Application of the Adaptive Water Governance Project to the management of the Lake Eyre Basin and its connections to the Great Artesian Basin

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Summary

This report applies the findings of the Adaptive Water Governance Project (AWG Project) to water management in South Australia and specifically to the Lake Eyre Basin (LEB) and its linkages to the Great Artesian Basin (GAB). The AWG Project is focused on the role of law in achieving water governance capable of facilitating management, adaptation and transformation in the face of climate change. The AWG Project approach begins with characterisation of a water basin focusing on the interaction between humans and water. It then identifies the potential drivers of change and the legacy impacts that may constrain future options. The final step requires an analysis of the legal framework and authority for water management. This approach allows consideration of the role of law in a basin-specific context.

The analysis of the legal framework begins with the recognition that water management is not designed for adaptability, but for societal goals such as growth or environmental protection. Thus the AWG Project has developed guidelines for a review of the legal authority and management structure that allows for adjustment within and tailored to the existing framework while maintaining the chosen goal of basin management. The guidelines for legal review focus on the political and administrative structure for basin water management, the capacity to adapt and participate within that structure, and the processes required to ensure such aspects as legitimacy, stability, and dispute resolution are recognised when adjusting management for adaptation. The application of these guidelines must be tailored to the specific basin and require an understanding of its development and management history.

The Lake Eyre Basin is one of the largest internally draining basins in the world, covering 1.14 million square kilometres or roughly 15% of Australia, including much of Australia’s outback, and encompasses parts of South Australia, New South Wales, Queensland and the Northern Territory. It is located in the driest portion of Australia and its surface water flows are among the most variable recorded. The basin’s terminal lake, Lake Eyre, or Kati Thanda, as it is known to the traditional owners of the land, the Arabana (or Arabunna or Urabunna) people, is 15.2 metres below sea level and is the fifth largest terminal lake on earth. The Lake Eyre Basin is underlain by and connected to portions of the Great Artesian Basin, one of the largest groundwater basins known. The Great Artesian Basin supports unique mound springs, which host highly vulnerable isolated groundwater-dependent ecosystems. The current discharge from the Great Artesian Basin reflects the remnants of an earlier, wetter climate and is anticipated to decline over time.

The Lake Eyre Basin is sparsely populated and its rivers remain unregulated. Thus it represents the first application of the AWG Project to a relatively undeveloped water system. The primary legacy effect of the human development of water in the basin is the thousands of bores developed in the late 1800s and early 1900s in the Great Artesian Basin for pastoral use. Efforts are underway to cap and control bore flows as pressures within the Great Artesian Basin aquifers decline, but many remain free-flowing. The impact of colonisation and the lack of recognition of Native Title to land and waters until recent years has had a lasting impact on the capacity
of Aboriginal communities in the basin to participate in water management. The anticipated future changes in climate may have even greater impacts on the basin.

Recent studies released by the Goyder Institute indicate that climate change may reduce precipitation and increase temperatures in the southern portion of the basin, thus producing an overall drying effect. In contrast, the northern portion of the basin, which supplies the runoff from monsoonal rains to the basin, may experience increased precipitation and greater extremes. The fragile and highly adapted nature of the basin ecosystem leaves it vulnerable in the face of climate change, with climate change potentially resulting in substantial changes and even transformation of that system to a new regime.

The Lake Eyre and Great Artesian basins are currently managed separately. Lake Eyre Basin is subject to an intergovernmental agreement between the Commonwealth, the states of Queensland and South Australia, and the Northern Territory, which includes decision-making at the ministerial level and input by both a Science Advisory Panel and Community Advisory Committee. The intergovernmental agreement only addresses the avoidance of cross-border impacts and, despite policy statements aspiring to a whole-of-basin management approach, it does not provide the framework or authority for basin-wide management; rather, intra-state water management is the subject of state law.

The application of the AWG Project guidelines to a review of the state water management is the subject of state law. The establishment of a binding dispute-resolution mechanism is recommended, along with criteria and processes to identify who speaks for each community. The criteria should be developed in consultation with Aboriginal people. In addition, local, state and federal governments will need processes to engage with Aboriginal communities on a government-to-government basis rather than as another basin interest group.

- An adaptive management approach is recommended to address the high level of uncertainty associated with understanding the impact of groundwater use and interception on mound springs. However, a purely science-driven implementation of adaptive management will fail if not imbedded in a decision-making process overseen by policy-makers with authority to adjust, and if it not done with coordination between the mining and water sectors.

- The provision of resources for Aboriginal communities to build governance capacity is recommended. Capacity is critical to the ability of Aboriginal communities to self-govern, pursue economic development and co-manage water resources. Basins examined by the AWG Project in North America in which Native American tribes have participated in water and fisheries management decisions on a governmental basis have experienced increased basin resilience, benefiting all basin residents.

- The development of local, state and federal-level processes for engagement with Aboriginal communities on a government-to-government basis on water management is recommended. As the governance capacity of Aboriginal communities increases, local, state and federal governments will need criteria to identify who speaks for each community. The criteria should be developed in consultation with Aboriginal people. In addition, local, state and federal governments will need processes to engage with Aboriginal communities on a government-to-government basis rather than as another basin interest group.

- Participatory processes are necessary to ensure legitimacy in decision-making. The community advisory bodies in the LEB and GAB are appropriate to assist in this role, provided that attention is given to ensuring broad participation from all relevant water-based interest groups in the basin and that the resources are available to enable community members of advisory bodies to obtain input from the constituencies they represent.

- The provision of resources for enforcement, and even the application of water regulations, is recommended. A lack of resources results in the uneven application of regulations, the result being that those who voluntarily comply bear a greater burden. Over time, this reduces the legitimacy of the regulations. This is apparent in the implementation of South Australia’s requirements for bore rehabilitation in the Great Artesian Basin.

- Achieving a balance between flexibility and stability is recommended when implementing flexible management. Flexible tools such as adaptive management can be destabilising if societal as well as ecological needs are not considered when setting time periods for adjustment. This can be accomplished through a public process, but requires a policy-level decision-making body, as opposed to purely scientific implementation.

- The establishment of a binding dispute-resolution mechanism is recommended now, before the next crisis. Many of the planning mechanisms in Australia and, specifically, the cooperative nature of the Lake Eyre Basin Intergovernmental Agreement do not provide mechanisms to reach final resolution on disputes when consensus is not possible. Climate change may push consensus approaches beyond their limit. Establishing clear mechanisms for dispute resolution now, in exchange for some level of certainty in terms of what types and how much development is acceptable on a shared water resource, may prevent intractable conflict in the future.
1. Introduction

This report presents the results of research to identify legal barriers to and opportunities for increased flexibility in water management in South Australia. The research, conducted between late January and April 2015, was made possible by the appointment of Barbara Cosens from the University of Idaho College of Law in the United States as a Goyder Institute Visiting Professor in Public Sector Policy and Management at Flinders University in Adelaide, South Australia.

Section 2 describes the Adaptive Water Governance Project, which forms the basis for this research. Section 3 applies the results of that project to water management in South Australia and in particular to the Lake Eyre Basin and the connected portions of the Great Artesian Basin. Section 3 concludes with recommendations for adjustments to water management in South Australia within the existing legal framework that may enhance adaptation potential as the impacts of climate change unfold.
2. The Adaptive Water Governance Project

Legal systems are inherently adaptable and responsive to new challenges and, at the same time, capable of creating a preference for the status quo, thus posing barriers to adaptation. Understanding the role of law in adaptation is critical to efforts to prepare for accelerated rates of change and surprise as the water-related impacts of climate change unfold. The Adaptive Water Governance Project is a synthesis project supported by the National Socio-Environmental Synthesis Center (Cosens et al. 2014a). The Center was established through funding from the National Science Foundation in the United States. The AWG Project explores the role of law in achieving water governance that is capable of facilitating management, adaptation and transformation in the face of climate change. Through an analysis of the legal framework and the regulations providing the authority for water management, the AWG Project seeks to identify adjustments that remove barriers and to facilitate adaptation.

2.1 Adaptive water governance approach and terminology

Applying the AWG Project requires aligning the legal framework for the management of a specific water basin with the understanding of its ecological system and societal goals and resources—an inherently interdisciplinary problem. Communication is a major challenge in interdisciplinary research and requires the development of a common language and an understanding of the relevant concepts (Repko 2011). The following paragraphs define the term ‘resilience’, which is the theory used by the AWG Project to describe the behaviour of a complex system such as a water basin, and provide a definition of the term ‘adaptive governance’, as it is used by the AWG team.

Resilience: Resilience as used by the AWG Project is a property of complex systems. (The society and ecology of a water basin is a complex system.) Twentieth-century river development and water management assumed that the historic record would inform the present. That assumption may not be accurate in the near future as climate change unfolds. Resilience thinking helps water managers to understand that change in a system can be abrupt and non-linear. Once a system has crossed a particular threshold, not only will its structure and function be different, but it may be difficult to recover (or restore) the original structure and function. This is referred to as a regime shift (Holling 1973, Gunderson and Holling 2002, Walker and Salt 2006). Climate change may push systems close to potential thresholds, threatening the range of ecosystem services that society now enjoys from its water basins. For example, in the basins studied by the AWG Project, sea water intrusion from rising sea level threatens potable groundwater in the Florida Everglades; change from snow to rain dominated precipitation is raising water temperatures critical to salmon runs in the Columbia River basin; and increasing periods of drought are threatening both agricultural diversions and habitat in the Middle Rio Grande River.
2.2 Summary of Adaptive Water Governance Project application in North America

The AWG Project assessed the resilience of six North American water basins (figure 2); Anacostia, Columbia, Klamath, Everglades, Middle Rio Grande and Platte. The results of these six assessments and an introductory article were published in March 2015 in the first Natural Resources & Environmental Law Edition of the Idaho Law Review. The assessments of six North American water basins illustrate that with the onset of climate change some of the water supplies relied on in North America are close to irreversible thresholds, which once crossed will alter the availability of natural ecosystem services and the adequacy of engineered infrastructure, potentially impairing existing water-based economies. However, while vulnerable to climate change, the systems are currently in a state that presents opportunities to increase their capacity for adaptation and governance transformation, given the appropriate resources and legal tools.

Adaptive governance: Governance refers to the means through which goals are selected, decisions are made and action is taken to achieve the goals. It encompasses the laws, regulations, policies and processes of government and includes the formal and informal institutional and societal frameworks in which not only government acts, but also through which private actors seek to influence policy decisions (Huitema et al. 2009, Healey 2006, see more generally, from the resilience and environmental governance literature, Folke et al. 2005, Lemos and Agrawal 2006). Adaptive governance is simply governance that allows adaptive processes to emerge (Chaffin et al. 2014a). Adaptive governance is appropriate when the system is complex (for example, lies within multiple jurisdictions), the system faces change with a degree of uncertainty (for example, climate change) and the system is approaching a potential threshold or regime shift, as evidenced by increasing conflict over resources, increasing scarcity, or actual identification of an approaching threshold.

Figure 2: Adaptive Water Governance Project: Resilience assessment of 6 North American basins – PowerPoint slide
The AWG Project builds on the work of resilience scholars, proponents of adaptive governance and climate scientists by asking four questions concerning the role of law in adaptive water governance:

(1) What is the role of law in setting boundaries by identifying approaching thresholds or tipping points in a resource system?

(2) What is the role of law in creating either a disturbance or window of opportunity by which adaptive forms of governance may emerge?

(3) What is the role of law in redistributing power to bring new voices to the water governance table?

(4) What is the role of law in presenting barriers or actively facilitating adaptive forms of governance?

In the six basin assessments, law played a part in threshold identification through measures such as the establishment of water quality standards and listing of endangered species. Litigation over these issues, as well as water allocation conflict and adjudication, was repeatedly seen to create a disturbance or open a window to the emergence of collaborative processes that were more flexible, adaptive and creative in solving multiple issues. Litigation concerning Native American treaty rights and environmental issues has resulted in new voices at the table in several of the basins. Finally, a synthesis of the six assessments led to an approach to basin characterisation and an analysis of the legal framework and authority for water management that enabled the identification of the barriers and means for the facilitation of adaptive forms of governance. It is the results of this final synthesis, including the guidelines for an analysis of the role of law shown in Table 1, that are applied to the Lake Eyre Basin and its connections to the Great Artesian Basin in this report.

2.3 Basin characterisation approach

The process of basin assessment begins with the characterisation of the current state of the basin’s social-ecological system, identification of potential drivers of change, and identification of the legacy impacts of development and social interaction that may constrain future options. Basin characterisation builds on methods developed by Walker and Salt (2012) and by the Resilience Alliance (2007), by focusing more directly on social-water interaction and the role of governance. The AWG Project approach then turns to an analysis of the legal framework and authority for water management.

2.4 Guidelines for an analysis of the legal framework and authority for water management

The first step in assessing the legal framework is to identify the status of current basin management within the context of three potential governance trajectories (figure 3): (1) recovery; (2) adaptation; and (3) transformation. Three of the North American basins, Klamath (Chaffin et al. 2014B), Columbia (Cosens and Fremier 2014), and Platte (Birge et al. 2014), fall into the category of adaptation, where development has constrained room for adaptation, leaving the basin vulnerable in the face of climate change. In this trajectory, governance must be flexible in order to restore adaptive capability and respond to change. Three of the North American basins have experienced or are close to a regime change, thus lying in the governance trajectory of transformation. The Middle Rio Grande is potentially undergoing an ecological regime shift in the face of extended drought, and the governance response must facilitate that transition if economic dislocation is to be avoided (Benson et al. 2014). The Anacostia has already shifted to an urban basin and thus efforts to restore water quality and aesthetic amenities must take place within a highly engineered system (Arnold et al. 2014). The Florida Everglades is highly vulnerable to sea level rise and salt water intrusion and has been propped up by federal investment, leaving it in a rigidity trap. Thus governance transformation is necessary for navigating a deliberate regime shift (Gunderson et al. 2014).
The Lake Eyre Basin, with its limited development and unregulated rivers, falls in the first, or recovery, category, whereby the focus of management should be on the maintenance of the current ecosystem function. However, the Lake Eyre Basin is also a fragile system, highly adapted to a boom/bust cycle. Climate change presents the potential for rapid movement from the first to the third category; that is, regime shift requiring transformative governance. Therefore the analysis of the role of law below assumes the need for more proactive governance. By placing tools such as adaptive management, recommended for use in the recovery category, in a context of adaptive governance, which contemplates the development of local capacity and collaborative processes, the basin will be better prepared as climate change unfolds. Thus, the basin will be treated as if it lies in the middle or adaptive governance category.

The second step in assessing the legal framework is to analyse the current water management entities, their legal authority and the law governing water allocation and conservation in the basin, using the guidelines for legal analysis developed by the AWG Project. Through assessment of the six North American river basins, the AWG Project has developed an approach to inquiry into the role of law that is focused on three aspects of governance: structure, capacity and process. Table 1 outlines this approach, which is detailed in the following paragraphs.
Table 1: The role of law in adaptive governance

<table>
<thead>
<tr>
<th>Structure:</th>
<th>Polycentricity: multiple centers of authority.</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Redundancy: common management and decision-making functions at multiple scales. Redundancy increases the likelihood that decisions can be made and implemented at the scale of a particular problem.</td>
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<td></td>
<td>Nesting: representation of decision-making and advisory bodies at lower levels in higher level entities. Nesting allows the formation of ad hoc networks in response to surprise, and similar to subsidiarity, increases the potential for local innovation within stable governance at a larger scale.</td>
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<tr>
<td></td>
<td>Complementarity: if one decision body fails to act or act inappropriately than another body can step up</td>
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<td></td>
<td>Subsidiarity: decision-making at the level closest to the resource as possible yet within the context of a government at multiple scales that fosters the conditions for implementation of management decisions. Subsidiarity increases the likelihood that local knowledge will be used, decisions will be tailored to specific problems, and innovation may occur at the local level supported by governance at larger scales.</td>
</tr>
<tr>
<td></td>
<td>Integration: integration of water resources management across sectors that influence water allocation, quality and land development, and of regulation of physically connected resources such as ground and surface water. Integration reduces the possibility of unintended consequences.</td>
</tr>
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<td></td>
<td>Persistence: stability in representation and decision-making bodies to foster legitimacy and trust, potentially reducing response time to surprise.</td>
</tr>
<tr>
<td>Capacity</td>
<td>Adaptive: resources and legal authority to respond to change. Adaptive capacity allows a system of governance to adjust in the face of uncertainty and change.</td>
</tr>
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<td></td>
<td>Participatory: those affected have the right and resources to have a role in decision making. For Indigenous communities, this equates to the capacity for self-determination. Participatory capacity reduces the likelihood of marginalization of portions of society and increases the likelihood that all aspects of a system will be considered in decision making.</td>
</tr>
<tr>
<td>Process</td>
<td>Legitimacy: acceptance of authority because it is perceived to be exercised appropriately and because it is exercised appropriately. Legitimacy is necessary for public support of resource management, and includes requirements for science-based decision making, deliberation, accountability, transparency, consistency, stability, and review and recourse for those aggrieved by a governmental action.</td>
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<td></td>
<td>Procedural justice: transparency, the right to seek review, and engagement at the appropriate level. Procedural justice is necessary to identify unintended consequences, check corruption, and to avoid uneven application of the burden of adaptation. For indigenous communities, procedural justice requires processes allowing engagement at the governmental level.</td>
</tr>
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<td></td>
<td>Problem solving approach: science and interest based collaborative processes. A problem solving approach allows for the possibility of solutions that are beneficial to all and contrasts with political and ideological approaches which are not subject to compromise.</td>
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<td></td>
<td>Balance stability and flexibility: adaptation timeframes that consider both the need for adjustment and the economic need for stability. Balance of stability and flexibility recognizes that while adjustments must occur in the face of change, social systems and particularly economic systems require stability; both must be taken into account.</td>
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<td></td>
<td>Reflection and learning: resources for monitoring and a process for feedback and consideration of new information. The opportunity for reflection and learning assures that response to change will not be rote, and that society will evolve with the approach to management.</td>
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<td></td>
<td>Dispute resolution: process for resolving conflict and making final, binding decisions on tradeoffs regarding scarce resources. Dispute resolution is essential as water scarcity in the face of climate change unfolds. There may come a point when consensus is not possible and unless a system for resolving issues is designed and agreed to beforehand, conflict is likely.</td>
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</table>
Structure: Structure refers to the multi-level, multi-scalar response needed in the face of uncertainty and requires attention to: (1) polycentricity (Huitema et al. 2009), including overlap in the authority to respond (referred to as redundancy and complementarity), the presence of common actors playing a role in management across multiple scales, ranging from local (for example, municipal irrigation district) to basin, to national scales (referred to as nesting) (Ostrom et al. 1961), and keeping the authority for decision-making as close to the individual as possible, yet within a larger government framework that facilitates management implementation and capacity-building (referred to as subsidiarity) (McGinnis 1999); (2) integration – of water resources management across the sectors that influence: water allocation; water quality regulation and land development; and regulation of physically connected resources such as ground and surface water (Cosens and Stow 2014); and (3) stability in both the rules and actors involved in water management (referred to as persistence) (Huitema et al. 2009, Raadgever et al. 2008, Hanna 2008; see also Gunderson 2000 using an analogous definition of adaptive capacity in ecosystems).

It facilitates participation by those affected and provides the tools for innovation, experimentation and evolution at appropriate levels. This is an important area for management of water systems. Not only must managers have authority to experiment, but they will need to play a role in building the capacity of local communities to participate in developing solutions if they are to be successful.

Adaptive capacity at the governmental level is the authority to respond to change. Yet this authority conflicts with the basic goal of law in resource management, which is to provide stability both to encourage economic investment and reduce social conflict. Thus, with the authority to respond to change comes the obligation to ensure that it is exercised in a manner that does not create social instability. For example, a common tool for resource management in the face of uncertainty is adaptive management, in which progress toward a goal is monitored and adjustments are made in the face of the data gathered. Too often, the time period for adjustment considers only the timeframe of the ecological system, without considering the needs of society (Cosens 2013). Appropriate development and the use of adaptive capacity require attention to both.

Participatory capacity addresses the ability of those affected by water management to participate in the development of its goals and the ability of water managers to implement those goals. The 1992 United Nations (UN) Conference on Environment and Development led to the following statement in Agenda 21, which identifies capacity as the crucial ingredient to sustainable development:

37.1 The ability of a country to follow sustainable development paths is determined to a large extent by the capacity of its people and its institutions as well as by its ecological and geographical conditions. Specifically, capacity-building encompasses the country’s human, scientific, technological, organizational, institutional and resource capabilities. A fundamental goal of capacity-building is to enhance the ability to evaluate and address the crucial questions related to policy choices and modes of implementation among development options, based on an understanding of environmental potentials and limits and of needs as perceived by the people of the country concerned. As a result, the need to strengthen national capacities is shared by all countries.

Although focused at the level of national governance, the listing in Agenda 21 of the necessary resources for capacity is equally applicable to local interests. Communities must have not only the right of access to decision-making but the knowledge, time and resources to engage in the substance of decision-making. For the Lake Eyre Basin, this issue will be of particular importance to Aboriginal communities and may extend to local interest groups such as environmental organisations.

Process: The basin assessments suggest that the tension between the competing needs for flexibility and economic stability presents a major barrier to adaptive governance. The AWG Project explores process elements in administrative law as a means for resolving this tension, relying primarily on elements of good governance as an essential factor in promoting both the wellbeing and acceptance of government by society (Cosens et al. 2014, 2015). Good governance focuses on equity and justice and requires that the actions of government be legitimate, transparent, deliberative and inclusive (Franck 1988, Bodansky 1999, Esty 2006, UN World Water Assessment Program 2003, Cosens 2013). It requires the availability of peaceful, just and adequate means for resolving disputes over finite resources. Attention to process can aid in tailoring the balance between flexibility and certainty to local needs and in a manner acceptable to the affected parties. Good process necessarily incorporates elements of ‘good governance’ to assure resilience in the communities affected through attention to legitimacy, equity and justice.
3. Application to the Lake Eyre and Great Artesian basins

This report applies the concepts from the Adaptive Water Governance Project to the unique Lake Eyre Basin in the heart of Australia’s iconic outback (figure 4), where the juxtaposition of vast arid landscapes with mound springs and extensive wetlands gives the region high conservation value. The assessment of the Lake Eyre and Great Artesian basins is the first opportunity to apply the systematic approach developed in the AWG Project and to test its transferability outside the North American setting. A synthesis of the initial six assessments led to the process described above, which focuses the basin-specific inquiry on the interaction between humans and water; the role of governance in that interaction; and specifically the role of law. In relation to state-level management, the analysis will use South Australia as an example. The report will conclude with an application of the legal guidelines for inquiry with the aim of identifying areas in which changes in the law or its implementation may improve management flexibility and the ability of the basin to cope with climate change. This report coincides with review of the policies underlying the management of the Lake Eyre Basin (LEB Ministerial Forum 2014) under the Lake Eyre Basin Intergovernmental Agreement and it is hoped this report will be beneficial to that process.
3.1 Introduction

The Lake Eyre Basin (figure 6) is an internal drainage basin covering 1.14 million square kilometres or roughly 15% of Australia, including much of Australia’s outback. The LEB includes portions of South Australia, New South Wales, Queensland and the Northern Territory. The LEB is one of the largest internally draining basins in the world (Thoms et al. 2009b, LEB Ministerial Forum n.d.). The LEB is located in the driest portion of Australia and its surface water flows are among the most variable known (Kingsford et al. 2014). The basin’s terminal lake, Lake Eyre, or Kati Thanda, as it is known to the traditional owners of the land, the Arabana people, is located in South Australia and includes the low point of the basin, at 15.2 metres below sea level. It is the fifth largest terminal lake on earth (Australian Department of the Environment, Lake Eyre Basin website n.d.).

The LEB is underlain by portions of the massive Great Artesian Basin (figure 6) (McMahon et al. 2005, Keppel et al. 2013). Recharge of the GAB aquifers is limited (McMahon et al. 2005, Keppel et al. 2013, Love et al. 2013a), with the current discharge reflecting the remnants of an earlier, wetter climate (Love et al. 2013b). The GAB supports highly vulnerable isolated groundwater-dependent ecosystems at features referred to as mound springs (Keppel et al. 2013, Love et al. 2013b, see generally Gotch 2013, vol. V).

Figure 5: Lake Eyre on March 27, 2015. The remnants of floods occurring in January 2015. Photo by Eugen Allwine.
Figure 6: Map of the Lake Eyre and Great Artesian Basins and mound springs -- PowerPoint
An intergovernmental agreement among three of the four state/territory governments overlapping the LEB agrees to the ‘avoidance of adverse cross-border impacts’, but leaves internal water management, including water allocation, to the states and territory. The greatest challenges facing the basin are the tension between development and protection — viewed differently by different state governments — and climate change. In addition, basin managers have just begun to consider the implications of the connections between the LEB and the GAB.

### 3.2 Basin characterisation

The LEB/GAB is relatively undeveloped. Assessment of the surface water resources of the LEB in 2008, made the following four key points with respect to the status of the basin (LEB Ministerial Forum Secretariat 2009):

1. The relatively limited hydrological modification and thus absence of interference with ecological processes has left the rivers and catchment in good condition.
2. Lake Eyre Basin is unique in Australia and the world due to its relatively intact nature of its aquatic ecosystem.
3. Knowledge of the structure and function of the LEB rivers is less than that of other Australian river systems.
4. Potential threats to the condition of rivers within the basin include ‘inappropriate’ water resource development, invasive species and increasing intensity of land use.

It should be noted that the 2008 assessment focused on water and did not consider the characteristics and condition of the basin landscape as a whole. Thus, for example, it excluded information on the status of rangelands and soils, which may have experienced greater anthropogenic impacts as the result of grazing than is reflected in the assessment of the water resource (Thoms et al. 2009a).

The characterisation of the LEB will focus first on the biophysical system, followed by human interaction and the sources of change.

#### 3.2.1 The Lake Eyre biophysical system

The LEB is one of those places in the world uniquely defined by both water and its absence. Its major rivers, Cooper Creek, the Diamantina and Georgina rivers (figure 1a and 1b) with headwaters in Queensland, and the Finke with headwaters in the Northern Territory, are dryland rivers, meaning that their inflow is generally less than the rate of evaporation (Thoms et al. 2009b, Leigh et al. 2010). Cooper Creek is believed to have the highest hydrological variability of any major river of its size (Arthington and Balcombe 2011, Kingsford et al. 2014). The LEB receives water during major flood events in the monsoon season of Northern Queensland, where the annual rainfall of 400–500 mm not only exceeds the less than 100 mm at Lake Eyre, but tends to come in short-duration high-intensity storms. Flows may reach Lake Eyre at flood stage during this summer monsoon season (Leigh et al. 2010, Thoms et al. 2009b, Kingsford et al. 2014) (figure 5). The upland rainforests therefore feed the deserts of Australia.

The major floods necessary to convey water all the way from the summer monsoons in the north to Lake Eyre do not occur every year (Leigh et al. 2010, Thoms et al. 2009b, Arthington and Balcombe 2011). Floods from the Georgina River system reach portions of Lake Eyre every two years, whereas floods that fill the entire Lake Eyre occur only about every eight years (Kingsford et al. 2014) (figure 5). Both the high-volume flow in these years and the very low topographic relief in the lower basin combine to connect up to 35% of the basin to form one water body at flood stage (Arthington and Balcombe 2011, Kingsford et al. 2014). The state and territory governments have identified 33 nationally important wetland complexes, covering over five million hectares within the LEB, two of which have been listed as Ramsar wetlands of International Importance (Thoms et al. 2009b).

High flow variability and extreme flood events drive the biological cycle of the LEB (Leigh et al. 2010, Kingsford et al. 2014). The large floods that occur on a decadal frequency connect and re-water isolated wetlands, transport sediment and nutrients, and basically flush and re-set the aquatic system (Leigh et al. 2010, Arthington and Balcombe 2011). The floods provide conduits to isolated waterholes as well as habitat and breeding grounds for many species of fish (Kingsford et al. 2014) (figure 7) and fish (Kerezsy et al. 2013, 2014). The moderate floods that occur more frequently replenish waterholes and serve to maintain habitat quality and thus recruitment of aquatic species (Balcombe and Arthington 2009, Leigh et al. 2010, p. 897, Kerezsy et al. 2011). Sequential floods in upstream areas over a short time period may have a disproportionate influence by filling sponge-like wetlands, allowing subsequent floods of moderate discharge to reach further into the basin (Leigh et al. 2010). As the floods subside, the larger persistent waterholes, which generally form at points of flow confluence, serve as refuges for fish, and those ending up in a waterhole that lasts until the next flood serve as ‘pioneer species’, which recolonise other waterholes when the water returns (Leigh et al. 2010, p. 898, Arthington and Balcombe 2011, Kerezsy et al. 2013). During dry periods, bird species rely on persistent waterholes or move to other basins (Kingsford et al. 2014). Isolation during dry periods results in a variety of species assemblages in different waterholes and contributes to basin-wide biodiversity (Good et al. 2004). Despite the adaptive strategies of species, for example, habitat and dietary generalisation and tolerance of extreme variability, droughts are periods of local extinction and play a major role in shaping ecological community structures (Arthington et al. 2010, Leigh et al. 2010, Kerezsy et al. 2013).

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1. At the time of this writing, the LEB/GAB is undergoing a new assessment. The results are not yet available, but should be taken into consideration when adopting any of the concepts from this report.
Groundwater contributes to waterholes in relatively few locations in the basin (Hamilton et al. 2005, Keppel et al. 2013), and evaporative loss (estimated at greater than 3 m/year) and increasing salinity dominate waterhole hydrology and water quality between flood events (Arthington and Balcombe 2011, Kingsford et al. 2014). The lakes within the basin are both saline (for example, Lake Eyre) and freshwater (for example, Coongie Lakes) (Kingsford et al. 2014).

3.2.2 Connections to the Great Artesian Basin

The Great Artesian Basin, one of the largest groundwater basins in the world, underlies most of the Lake Eyre Basin and extends outside the LEB to the east, ultimately underlying 22% of Australia (McMahon et al. 2005, Keppel et al. 2013) (figure 6). The GAB is actually composed of three sub-basins and two major aquifers (Keppel et al. 2013), with some leakage between aquifers (Keppel et al. 2013, Love et al. 2013b). Recharge of the aquifers is limited (estimates at around 1000 GL/year or 800,000 acre-feet/year) occurs mostly outside the LEB along the Great Dividing Range and does not provide significant recharge to areas within the LEB portion of the basin (McMahon et al. 2005, Keppel et al. 2013, Love et al. 2013a). Some recharge to the deep aquifer is occurring in the LEB along ephemeral rivers (the Finke and Plenty rivers) and along mountain ranges in the western portion of the basin during significant rainfall events (Love et al. 2013a).

Despite limited connection, where surface to ground water connection does occur it is of substantial ecological importance, in particular at a series of features referred to as the mound springs (Keppel et al. 2013, Love et al. 2013b, Kingsford et al 2014) (figure 8a, 8b, 8c). The mounds, formed by carbonate precipitation and sediment deposition from the springs, are one of the unique hydrogeologic features of the Lake Eyre Basin (Love et al. 2013b). These conically shaped springs occur in clusters, with eight major clusters generally along fault lines in the LEB (figure 6), and mark the discharge points from the GAB (McMahon et al. 2005, Keppel et al. 2013, Love et al. 2013b). The discharge rates along the western margin of the basin are a function of paleo-recharge and exceed current recharge, a phenomenon that will result in a decline in spring discharge over time, as recharge and discharge reach a new equilibrium (Keppel et al. 2013, Love et al. 2013a, 2013b). At the same time, due to the impacts of paleo-climate on spring discharge, the springs are quite persistent and not immediately susceptible to a reduction in flow due to climate change (Love et al. 2013b). Relative to anthropogenic discharge at bores (discussed below), the amount of total discharge that occurs at the springs is relatively low—less than 10% of total discharge (Love et al. 2013b).
Figure 8a: Mound Spring showing mound and tail. Photo by Eugene Allwine.

Figure 8b: Mound Spring (name?) Photo by Eugene Allwine.

Figure 8c: Mound Spring in the bed of Lake Eyre. Photo by Eugene Allwine.
Water quality in the mound springs is a function of both aquifer and surface water quality. The water quality in the shallow aquifer ranges from 1000 to 100,000 mg/L of dissolved solids (Keppel et al. 2013), and from less than 300 to greater than 30,000 mg/L in the deep aquifer (Love et al. 2013a). The springs themselves are dominated by sodium chloride, but with carbonate playing a major role and sulphate increasing in the west (Love et al. 2013b). When surface water mixes with spring water, the water quality is improved, and the recharge zones along the Finke and Plenty rivers play an important role in the existence of potable water in springs in the area (for example, Dalhousie Springs) (Love et al. 2013a, 2013b). A reduction in flows related to the change from the paleo-climate to the present has resulted in the acidification of some of the springs, affecting both spring water quality and the chemical composition of the surrounding soils (Love et al. 2013b).

With permanent surface water sources absent in the basin, the mound springs support isolated groundwater-dependent ecosystems (Keppel et al. 2013, Love et al. 2013b, see generally Gotch 2013) (figure 12), and their vulnerable nature has led to their declaration as endangered under the Australian Government’s Environment Protection and Biodiversity Conservation Act 1999 (EPBC; Keppel et al. 2013). The persistence of the springs, documented in the geologic record to be as long as 740,000 years of discharge, is an important factor in the development of their biological communities (Gotch 2013).

Spring pools are home to a number of endemic species of fish and other aquatic species as well as unique vegetation (Gotch 2013) (figure 12). Many are listed under relevant state and national endangered species legislation and also by the International Union for Conservation of Nature (IUCN). The various species identified at the springs show limited dispersal and, conversely, variation in biodiversity among the springs as a whole is high (Gotch 2013). Isolation has allowed the development of unique local communities analogous to the evolutionary history of island biota (Gotch 2013), and thus, similar to the Galapagos Islands, the mound springs are of importance for the study of evolutionary processes (Gotch 2013). At the same time, the limited opportunity for dispersal among spring groups means that these isolated populations are vulnerable in the face of any disturbance (Gotch 2013, Kerezsy et al. 2014). As scattered oases in what is otherwise desert, the springs are also important habitat for wetland and migratory birds (Gotch 2013).

### 3.2.3 Human interaction with the basin

Despite the fact that it covers roughly 15% of Australia (Thoms et al. 2009b), the basin is home to fewer than 60,000 people; that is, less than 1% of the population of Australia (LEB Ministerial Council n.d.). Human alteration of the LEB surface water hydrology is currently minimal, the river system is unregulated, and 97% of the basin aquatic species are thought to be indigenous. Livestock grazing, small homesteads and towns all use limited amounts of water. Tourism in the basin is increasing, with over two million people visiting in 2001 (Kingsford et al. 2014). The LEB contains two Ramsar wetlands (the Coongie Lakes in South Australia and Lake Pinaroo in New South Wales), and has been considered eligible for World Heritage listing.

Due to the intermittent and unpredictable surface water supplies, groundwater is the primary source of water for human survival in the LEB (McMahon et al. 2005, Keppel et al. 2013, Love et al. 2013a). As the only dependable water source in the region, the springs played an important role in Aboriginal history in the area (Keppel et al. 2013, Green et al. 2013, Nursey-Bray et al. 2013). Not only were the springs necessary for survival, but they were central to both the spiritual and cultural activities of the Aboriginal people (Keppel et al. 2013). As noted by Gotch (2013, p. 7): ‘[t]he springs are culturally important to a number of Aboriginal peoples; in the western recharge zone these include Arabunna [Arabana], Lower Southern Arrente, Wokangurr, Kuyani, Deri, Pirlatapa, Malijangapa and Yandruwantha’. Although considerable debate surrounds the timing of the first presence of humans in Australia, charcoal remains indicate their presence at GAB springs as early as 5000 years ago (Gotch 2013).

European settlers first identified the springs in 1865, and they became important resources for travel through the outback, determining the trajectory of early exploration and ultimately the route of the railroad (figure 9) and the telegraph (figure 13) (Keppel et al. 2013, Gotch 2013, Nursey-Bray et al. 2013). In the late 1800s settlers began drilling bores into the artesian portions of the deep aquifer (Keppel et al. 2013). Thousands of these wells were left to flow freely (figure 10), with resulting drops in artesian pressure (keppel et al. 2013). It is estimated that the bores represent 50% of the total natural and anthropogenic discharge from the GAB (Love et al. 2013b).

![Figure 9: Bridge on the old Ghan Railroad line. Photograph by Eugene Allwine.](image-url)
The greatest threat to the surface manifestation of the GAB at the springs and the contribution of groundwater to surface water flow is considered to be pressure decline due to groundwater development (Green et al. 2013). Mining and energy production (oil, conventional gas and more recently coal seam gas, predominantly in the northeast section of the basin; uranium mining in the southern portion of the basin) are considered both the largest users of groundwater in the LEB today and the largest potential source of growth in groundwater use (Keppel et al. 2013, Kingsford et al. 2014). The Olympic Dam uranium mine at Roxby Downs, owned and operated by BHP Billiton, extracts approximately 37 ML/day from bore fields within the GAB (BHP Billiton 2009, 2011). A proposal for a major expansion of the mine indicates that water will be obtained from an aquifer south of the GAB, one that is not connected to it, and no new water licences will be obtained for the GAB (BHP Billiton 2009, 2011). Nevertheless, environmental organisations point out that existing bore fields are not utilised to full capacity and the plan to do so with the expansion may impact on mound springs (Great Artesian Basin Protection Group n.d.). In addition, the potential for increased gas exploration and development in floodplain areas in Queensland and the South Australian portion of the Cooper watershed may have consequences for surface water flows, water quality and floodplain-related nutrient and filtration services (Kingsford et al. 2014).

### 3.2.4 Potential sources of change

In February of 2015, the Goyder Institute released a report by scientists from the Commonwealth Scientific and Industrial Research Organisation (CSIRO) on research downscaling climate model data to predict impacts on water availability in South Australia (Charles and Fu 2015). The results for the South Australian arid lands, which include the southern portions of the LEB, indicate increased drying over the latter half of the century. Precipitation is expected to decrease in all seasons, but particularly in spring. The maximum temperature is predicted to increase in the same region by 2–4 °C. The potential evapotranspiration, which is basically the water demand/use of vegetation, is expected to increase by 5–12%, particularly in spring, corresponding to the temperature increase (Charles and Fu 2015). In contrast, precipitation may increase in the northern part of the basin and may exhibit greater extremes (Kingsford et al. 2014). Scientists working on the use of climate downscaling predictions in water planning in Australia caution that the information must be viewed as presenting only a plausible range of scenarios and that any planning must be adaptable to multiple potential outcomes rather than attempt to optimise for maximum benefit and minimum cost on the assumption of a static prediction for the future (Bates et al. 2010).

Flow alteration as the result of development or climate change that affects any of the six factors considered of ecological relevance to dryland rivers; that is, flow magnitude, frequency, timing, duration, variability and rate of change, could have consequences for basin ecology (Leigh et al. 2010, Arthington and Balcombe 2011, Kingsford et al. 2014). In addition, due to lag times in the response from the biotic system, impacts from changes in hydrology may not be detected immediately (Good et al. 2004).

### 3.2.5 Legacy effects

Unlike the North American basins, the lack of development of the LEB/GAB limits the legacy effects of infrastructure that must be taken into account in future planning. Nevertheless, two legacy impacts of importance should be mentioned. First, the continued uncontrolled flow of water from bores and the need to maintain the infrastructure on rehabilitated bores in the GAB must be addressed (figures 10 and 11). The requirement for bore capping and control already exist; however, resources for enforcement and maintenance are needed.

Figure 10: Habitat created by open bore. Peak bore. Photograph by Eugene Allwine.
Second, Indigenous peoples, including the Arabana, continue to have strong ties to the basin as well as claims to Native Title for lands and waters (Nursey-Bray et al. 2013). The legacy impact of their exclusion from resource management until recent decades cannot be ignored. Meeting the needs of formerly marginalised and therefore vulnerable populations is critical to the adaptability and resilience of water-dependent communities. Furthermore, as illustrated by both the Columbia and Klamath basin assessments (Cosens and Fremier 2014, Chaffin et al. 2014b), increased diversity in the voices, knowledge and values that play a role in water management may be a factor in enhancing our collective ability to respond to change. The need to involve Indigenous communities at a governmental level is addressed below.

### 3.3 Current legal framework of the Lake Eyre Basin and the Great Artesian Basin

Australia has multiple levels of government involved in different aspects of water management. Despite the fact that the state level is the locus of water allocation authority, the federal government has played an increasing role in coordinating and facilitating state water management reform in recent years through agreement with the states and territories. Legal mechanisms are also in place to allow regional-scale planning and coordination for the LEB. The following paragraphs begin with the general state/federal regulation of water, followed by the legal framework specific to the LEB and GAB.

#### 3.3.1 The interplay between federal and state water management in general

Water law in Australia began, as it did in the United States, with the adoption of the common law system of riparian rights from Great Britain (Gartner v. Kidman [1962]). However, it was quickly recognised that the particular circumstances of Australia, including aridity, might call for differences in interpretation (Gartner v. Kidman [1962], Avey and Harvey 2014). Water allocation and the regulation of sewage treatment are matters of state law (Stoeckel et al. 2012), and today all Australian states and territories have adopted statutory schemes for the management and allocation of water (Stoeckel et al. 2012). Water entitlements (as the rights to make consumptive use of water under licences to landowners. The right to use water was allocated to land property rights, are recognised to be much more subject to regulation than water rights in the United States, including curtailment to return water to environmental flows.

The federal government plays a major role in setting water quality standards (Stoeckel et al. 2012) and in environmental law through its participation in numerous international conventions and their implementation by domestic law through instruments such as the Commonwealth’s Environment Protection and Biodiversity Conservation Act 1999. The Australian Constitution s. 51, listing the powers of the Commonwealth, omits water use and Section 100 specifically states that:

![Image]

The Commonwealth shall not, by any law or regulation of trade or commerce, abridge the right of a State or of the residents therein to the reasonable use of the waters of rivers for conservation or irrigation.

Nevertheless, the federal government has played an increasing role in the coordination of water allocation reform in recent years through agreements with the states and territories (National Water Initiative discussed below), and a combination of referral of authority from the states to the Commonwealth (Australian Constitution s. 51 [xxxvii]), federal spending authority (Australian Constitution s. 96), and the Australian Water Act 2007, applicable to the Murray-Darling Basin. For the purposes of the LEB/GAB the National Water Initiative (NWI) is of greatest importance.

Through the Council of Australian Governments (COAG) with membership including ‘the Prime Minister, State and Territory Premiers and Chief Ministers, and the President of the Australian Local Government Association’ (Council of Australian Governments n.d.), the Commonwealth, states, territories and local government developed the Intergovernmental Agreement on a National Water Initiative in 2004, with the governments of New South Wales, Victoria, South Australia, Queensland, the Northern Territory and the Australian Capital Territory signing in 2004, Tasmania signing in 2005 and Western Australia signing in 2006 (Stoeckel et al. 2012).

The National Water Initiative recognised water management as a national issue (NWI s. 3) and agreed to establish a National Water Commission (NWI s. 10), while leaving implementation to the states and territories (NWI s. 20). The objectives of the National Water Initiative include greater attention to environmental flows and the removal of barriers to water trading (NWI s. 23). To address environmental flows, the National Water Initiative calls for planning to identify a consumptive pool that will allow maintenance of a non-consumptive level of environmental flows (NWI s. 23), and an accounting of the consumptive use portion of individual water entitlements to assure they remain within that consumptive pool (NWI s. 28). To facilitate water trading, the property nature of a water entitlement allows it to be mortgaged independently and traded separately from land (NWI s. 31). The National Water Initiative calls for a registration of all water entitlements and trades (NWI s. 59), development of uniform pricing, and the removal of barriers to trade (NWI s. 60).

South Australia’s statutory scheme provides an example of a state approach prior to and following adoption of the National Water Initiative. The South Australian Water Resources Act 1990 allocated water under licences to landowners. The right to use water was attached to the land and the licence expired on transfer of the land (Avey and Harvey 2014). With the Water Resources Act 1997, South Australia implemented a planning approach, with the establishment of catchment boards that included local representation leading the effort (Avey and Harvey 2014). The 1997 Act marked the start of South Australia’s approach to developing allocation plans for water that include both environmental and consumptive uses.

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3 Rather than a definition of the net amount of water diverted that is actually consumed, this relates to the total amount of water diverted for a consumptive use and thus includes net consumption and return flow.
In 2004, with adoption of the National Water Initiative, South Australia revised its water resources management with the passage of the 
Natural Resources Management Act 2004 (SA NRM 2004), reflecting a goal of landscape-scale integrated natural resources management (Avey and Harvey 2014, see generally Mitchell 2014). Under this Act, a water entitlement is the right to a share of the ‘consumptive pool’ designated in the plan for a particular water source (SA NRM Part 3, s. 146(2)); and a water allocation is the amount available for that share in a given year (SA NRM Part 1, s. 3). Shortage is generally shared among water entitlements in South Australia (see Part 3 of the SA NRM setting forth the water licence and allocation scheme). Nevertheless, on some systems certain water rights are classified with a higher rank, meaning that they bear less risk of shortage in dry years (see, for example, Young 2011).

The sources of flexibility in water management include the ability of governments to regulate water allocation without compensation and the ability of individuals to trade water rights. In the transition to water entitlements, it appears that the government at both the state and federal levels in Australia has considerable latitude to reduce allocation without compensation, although experts on Australian water law consider the case law on defining the compensable nature of the former right to water to be still developing (Stoeckel et al. 2012). Two recent cases concerning application of the National Water Initiative in New South Wales to groundwater suggest a substantial degree of latitude for reduction without compensation at a level that would be necessary if a private property right were taken for government use: *ICM Agriculture Pty Ltd v. The Commonwealth* (2009), HCA 51, 9 December 2009, 40 CLR 140 (ICM) and *Arnold v. Minister Administering the Water Management Act 2000* (2010), HCA 3, 10 February 2010, 240 CLR 242 (Arnold). Consistent with these rulings, under the new allocation system South Australian law provides that the Minister of the Department of Environment, Water and Natural Resources (DEWNR) may vary the licence (that is, the entitlement or allocation scheme). Nevertheless, on some systems certain water rights are classified with a higher rank, meaning that they bear less risk of shortage in dry years (see, for example, Young 2011).

The purpose of this Agreement is to provide for the development or adoption, and implementation of Policies and Strategies concerning water and related natural resources in the Lake Eyre Basin Agreement Area to avoid or eliminate so far as reasonably practicable adverse cross-border impacts.

The LEB Intergovernmental Agreement establishes a Ministerial Forum with one Minister from each state (and territory, with the addition of the Northern Territory under the First Amending Agreement of 10 June 2004), and one from the Commonwealth (LEB Intergovernmental Agreement s. 5.2). The Commonwealth member serves as chair (LEB Intergovernmental Agreement s. 5.6), and the Ministerial Forum operates on a consensus basis (LEB Intergovernmental Agreement s. 5.3). The agreement provides a process and forum for raising, but not resolving, issues related
to cross-border impacts on water quantity, quality and flow (LEB Intergovernmental Agreement s. 2.2b), and leaves internal management of the basin to each state (LEB Intergovernmental Agreement s. 4.9).

The work of the Ministerial Forum is enhanced by the Senior Officers Group and by the formation of the LEB Secretariat (LEB Ministerial Forum 2009). The Senior Officers Group is composed of high-level government officials from the state and territorial agencies relevant to LEB water management (Price et al. 2009). According to an assessment of LEB governance completed in 2009, the Senior Officers Group has provided a much needed leadership role beyond that contemplated in the LEB Intergovernmental Agreement (Price et al. 2009). The secretariat performs the administrative function, facilitating coordination, meetings and reporting and thus plays a major role in tracking accountability under the LEB Intergovernmental Agreement (Price et al. 2009).

The LEB Ministerial Forum has the discretion to determine the best means for securing public input including through the establishment of committees (LEB Intergovernmental Agreement s. 5.9). If the Ministerial Forum exercises its discretion in the establishment of committees, the LEB Intergovernmental Agreement specifies the range of interests that must be represented (s. 5.11). The Ministerial Forum has exercised this discretion by establishing a community advisory committee with representation from groups that include Aboriginal, pastoral, agricultural, conservation, and tourist industry interests from within the basin, as well as from interests that make use of the basin resources such as mining, and from governmental management (Lake Eyre Basin Community Advisory Committee). In addition to Aboriginal participation on the Community Advisory Committee, four Aboriginal forums have been held throughout the basin since 2004, for the purpose of exchange of knowledge and as a means for input on water issues (Lake Eyre Basin Aboriginal Forums). The Community Advisory Committee is considered to have the capacity to respond to information on the ground and thus contribute to local adaptation (Price et al. 2009). However, an assessment of the government structure indicates that participation in the LEB Community Advisory Committee is essentially voluntary and suggests that increased resources including a paid part-time position for the chair may be warranted (Price et al. 2009).

The LEB Ministerial Forum also has discretion to seek scientific and technical advice and to establish a scientific panel (LEB Intergovernmental Agreement ss. 7.1, 7.2). The Ministerial Forum has exercised this discretion by establishing a Scientific Advisory Panel (Price et al. 2009) with diverse expertise (for example, hydrology, ecology, Indigenous culture). The Scientific Advisory Panel has played a vital role in assessing the ecological health of the basin’s rivers, sharing knowledge with the Community Advisory Committee and advising the Ministerial Forum (Price et al. 2009).

Although the Ministerial Forum has adopted a ‘whole-of-basin approach’ as one of its six policies (LEB Ministerial Forum n.d.), and the LEB Intergovernmental Agreement itself allows for the establishment of policies on water quality and flows (s. 8.4) and for the adoption of state water plans consistent with the agreement (s. 8.3), the parties have not taken a basin-wide approach (see, for example, Price et al. 2009, p. 13). The LEB Intergovernmental Agreement provides the tools for basin-wide coordination should the parties decide to exercise them, but it does not mandate this approach. In addition, the agreement does not provide a mechanism for dispute resolution or a remedy in the event a cross-border impact is threatened or occurs.

Efforts under the LEB Intergovernmental Agreement, even though aspiring to a basin-wide approach, are, as a legal matter, entirely separate from intra-state management. Ultimately, the focus of the agreement on collecting and exchanging information, the absence of any mandate to coordinate intra-state management, and the absence of any means of recourse or dispute resolution in the event of a disagreement leaves the primary decision-making with respect to LEB management with the states and the territory, each acting independently. By way of example, to maintain the unregulated nature of the LEB rivers, the major tributaries from Queensland were declared wild by the Queensland Government (Wild Rivers Act 2005). Following a change in leadership in that state, the government repealed the wild rivers legislation in 2014. There have been past proposals to build storage for irrigation in Queensland on the largest tributary to the LEB, Cooper Creek (Walker et al. 1997, Thoms et al. 2009b, Kingsford et al. 2014). Leadership in the Queensland Government changed again in 2015, and although it is not clear that irrigation development will ever be pursued, it is clear that the LEB Intergovernmental Agreement gives the downstream state of South Australia only limited diplomatic channels to address any impact of upstream activities and water management.

Independent of the LEB Intergovernmental Agreement, the Commonwealth does have the ability to intervene in an interstate dispute under the Environmental Protection and Biodiversity Conservation Act 1999. Under the Act and its subsequent amendments, actions that might have a significant impact on matters of national environmental significance may be referred to the Australian Department of the Environment for environmental review (EPBC Chapter 4, Part 7, Division 1, s. 69). Of relevance to the LEB, the list of matters of national environmental significance includes Ramsar wetlands, migratory birds, and water resources affected by coal seam gas or large coal mine development (EPBC at Part 7, Division 1).

Lake Eyre Basin Assessments: As part of its effort to develop an implementation plan for assessment of the Lake Eyre Basin, the Commonwealth Department of Environment contracted an outside consultant, Kiri-ganai Research Ltd to review: (1) achievements to date (that is, 2008) (Thoms et al. 2009a); (2) assessment methodology (Thoms et al. 2009b); and (3) governance arrangements in the basin (Price et al. 2009) (see Terms of Reference in Thoms et al. 2009a, Appendix A). The consultants relied on similar theoretical background and literature to that of the Adaptive Water Governance Project (see, for example, the discussion of resilience theory in Thoms et al. 2009b, Price et al. 2009). Thus, while this report disagrees with certain of their recommendations, the author acknowledges that their work made it possible for this research to begin where they left off, and go further. While it is common in academic literature to go to the underlying peer-reviewed sources for a consultant or government report, these reports were made for the purpose of management and are thus highly relevant to the current
governance of the basin. The following paragraphs will briefly discuss the results of the review, leaving in-depth discussion of the approach and the addition of the role of law in governance to the concluding section. It should also be noted that a new assessment is currently underway, but is not available at the time of this writing.

In the review of achievements up to 2009, the consultants found a discrepancy between the stated policy of the Ministerial Forum – to view the basin as a whole – and the internal LEB Secretariat’s, State of the Basin Assessment completed in 2008 (LEB Ministerial Forum 2009), which focused more narrowly on the basin’s water resources and water-dependent ecosystems (Thoms et al. 2009a). The review places the efforts to assess the status of the LEB in the context of other national river assessment processes, including efforts to establish a uniform approach to river and wetland assessment and assessment of the Murray-Darling Basin. The review noted that no research or monitoring program currently exists in the LEB basin to capture the high degree of variability associated with the basin’s dryland rivers (Thoms et al. 2009a) or mechanisms to identify what would indicate a decline in basin health (Thoms et al. 2009a). The review also notes that, rather than follow the assessment plan of the Ministerial Forum, the 2008 assessment followed a more limited approach to river and wetland assessment (Thoms et al. 2009a, 2009b). Given the type of development in the basin (primarily pastoral and mining), the absence of assessment of rangelands and targeted assessment associated with mine sites led the consultants to question whether monitoring in 2009 met the purposes of the LEB Intergovernmental Agreement (Thoms et al. 2009a).

In the second of their reports, the consultants recommend a move to a whole-of-basin assessment approach, with monitoring of six components: physical habitat, fish, water birds, riparian vegetation, water quality and hydrology (Thoms et al. 2009b). The consultants note that current monitoring (as of 2009) focused on compliance issues rather than on aspects useful for indicating the basin’s ecological health, change, decline, and potential thresholds (Thoms et al. 2009b). To capture the high degree of variability in surface water and thus ecosystem status in the basin, they recommended ‘strategic adaptive management’, consisting of the establishment of a vision for the basin, identification of thresholds, and appropriate monitoring (Thoms et al. 2009b, Price et al. 2009). Importantly, the consultants stress the need to tailor the approach to the high degree of variability and specific characteristics of dryland rivers (Thoms et al. 2009b).

A basin-wide approach is certainly the preferred alternative in the current water management literature; however, without authority for basin-wide management, the first step of adaptive management – of establishing goals for the entire basin – is not possible. In 2010, the Ministerial Forum adopted a new implementation plan and the monitoring of hydrology, water quality and fish began in 2011 (LEB Ministerial Forum Secretariat 2012). A report on the assessment of monitoring since 2011 is currently in preparation.

The third report from the consultants addresses governance (Price et al. 2009). In terms of the governance structure, the consultants note that, while the Ministerial Forum provides a high-level platform for coordination, the absence of clear definition for how the Ministerial Forum is to achieve the goals of the LEB Intergovernmental Agreement leads to a gap between the Ministerial Forum and heads of state-level departments (Price et al. 2009). This in turn may reduce response speed and poses problems for clear lines of authority for implementation of Ministerial Forum policies (Price et al. 2009). Nevertheless, the Senior Officers Group has stepped in to fill that void, despite the lack of a mandate to do so (Price et al. 2009). The report recommends a strengthening and formalisation of this role (Price et al. 2009). In addition, the Community Advisory Committee members’ long-standing participation in regional and catchment issues has led to development at the regional level of the capacity to learn and respond (Price et al. 2009). The existence of multiple authorities without clear directives on who does what (for example, although the policies of the LEB Ministerial Forum clearly call for a whole-of-basin approach, the LEB Intergovernmental Agreement clearly does not mandate that) has led to confusion among stakeholders over the roles and authority of the various entities (Price et al. 2009).

To address these issues, the consultants recommend a collaborative approach involving the Community Advisory Committee, the Senior Officers Group, and the Scientific Advisory Panel for assessment of the LEB (Price et al. 2009), and also that the Senior Officers Group be reconstituted as a Ministerial Forum Standing Committee with the authority to decide how Ministerial Forum decisions are to be implemented and to provide the resources to do so (Price et al. 2009). Certain aspects of this recommendation are consistent with the discussion of nesting (below). The recommendation does not address the absence of a forum to develop a common vision and a mechanism for dispute resolution.

3.3.2.2 Coordination with the Great Artesian Basin

In addition to the policy focus on whole-of-basin management, the guiding principles of the LEB Intergovernmental Agreement call for the integrated management of surface and groundwater (s. 3.1f). However, there is currently no integration between the governance of the surface and ground water resources of the Lake Eyre Basin. Coordination is limited to joint meetings of the GAB Coordinating Committee (GABCC) with the various LEB entities. In addition, the GAB has no equivalent to the LEB Intergovernmental Agreement or Ministerial Forum. Instead, intergovernmental cooperation related to the GAB was originally addressed as part of the arrangements addressing other natural resources issues under the Natural Resources Ministerial Council (Price et al. 2009). In 2011, COAG combined the Natural Resources Ministerial Council with the Standing Council on Primary Industries, subsequently, in 2013, eliminating that council (COAG n.d.), thereby leaving the coordination of the GAB uncertain.

The GAB Coordinating Committee is composed of representatives from community organisations and governmental entities. The chair is a political appointee (that is, non-governmental member of the committee) chosen by the Commonwealth Minister for Environment but with the agreement of relevant state and territorial ministries as well as the Commonwealth Minister for Agriculture, Fisheries, and Forestry (GABCC n.d.). Other members are chosen

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5 The LEB Agreement requires a review of the condition of the LEB watercourses and catchments and its repetition every ten years (LEB Agreement s. 10.4).
by the Queensland, New South Wales, South Australian, Northern Territory and appropriate Commonwealth agencies to represent the appointing entity (GABCC n.d.). Currently the GAB Coordinating Committee (of 12) includes one Indigenous representative and five community representatives, three from each of the three states/territory, and one each representing the agricultural and environmental communities (GABCC n.d.). It does not appear to include representation from the primary environmental non-government organisation seeking the basin’s protection — the Great Artesian Basin Protection Group Inc.

The GAB Coordinating Committee is intended to function in an advisory capacity to the Natural Resources Ministerial Council (GABCC n.d.). Its role is to analyse and coordinate policy issues related to the GAB across sectors, advise the Ministerial Council, and review implementation of the Strategic Management Plan, which was developed in 2000 by its predecessor, the GAB Consultative Council.

The GAB Strategic Management Plan was intended for the period of 2000–15, and according to the GAB Coordinating Committee website, will be reviewed and possibly updated in 2015 (Great Artesian Basin Consultative Council 2000a, 2000b cited on GABCC website). The primary focus of the plan was to address the problem of uncontrolled flow of the thousands of bores developed from the 1800s. Although the problem was recognised as early as 1939 (South Australian Arid Lands NRM Board 2009) and individual states had begun the process of bore rehabilitation in the 1980s, many bores still flowed freely (GABCC 2008a). According to the report, a total of 4726 bores were developed. Of those, 1368 no longer flow (Great Artesian Basin Consultative Committee 2000a, 2000b cited on GABCC website). The GAB Coordinating Committee reviewed the status of plan implementation in 2006 (GABCC 2008a), and reported that 1080 bores had been rehabilitated, with some evidence of aquifer pressure recovery (GABCC 2008a). The success of the bore rehabilitation program is tempered by the need for long-term monitoring and maintenance (SA Arid Lands NRM Board 2009). No program to monitor and control bores exists and reports indicate that the policy discussion is currently focused on whether landowners or government should have the responsibility (GABCC 2008b).

The 2008 GAB Coordinating Committee review of the Strategic Management Plan indicates increasing awareness of the ecological value of the mound springs and other discharge areas of the GAB. Considerable effort has gone into the development of a process for the assessment of risk and vulnerability of the various spring complexes, including identification of those springs with unique values (see generally Green et al. 2013). Although the GAB Strategic Management Plan and the review aspire to a basin-wide approach, the management of water allocation from the GAB is a matter of state law and is handled under the natural resources management boards. The native species at the springs are listed under the Australian Environment Protection and Biodiversity Conservation Act 1999.

3.3.3 State water management with a focus on South Australia

South Australia implements the National Water Initiative through the South Australian Natural Resources Management Act which includes the establishment of natural resources management boards for various geographic portions of South Australia. The South Australian Arid Lands Board is responsible for the area that includes South Australia’s portion of the Lake Eyre Basin. Its equivalents in the portions of the basin overlapping other states and the Northern Territory include: the Desert Channels Natural Resources Management Board in Queensland; the Northern Territory Natural Resources Management Board; and the Western Catchment Management Authority in New South Wales (Price et al. 2009).

The natural resources management approach created a communication gap between input to the LEB Ministerial Forum, focused on water, and the intra-state regime, focused more broadly on integrated natural resources management. A review undertaken in 2007 recommended that the scope of the LEB Intergovernmental Agreement be expanded beyond water to include the full range of natural resource issues encompassed by the natural resources management boards (Price et al. 2009). The Ministerial Forum rejected this recommendation as a potential source of confusion between the scope of authority of the natural resources management boards and the entities under the LEB Intergovernmental Agreement (Price et al. 2009). However, efforts were made to bridge the gap by including natural resources management board representation on the LEB Community Advisory Committee (Price et al. 2009).

A 2009 assessment of the governance arrangements in the basin indicates that Community Advisory Committee members perceive the decision-making to be primarily lodged outside the basin and that the difference between interstate governance and intra-state governance bodies has created confusion (Price et al. 2009). The assessment noted that the placement of natural resources management board members on the Community Advisory Committee was intended to address this issue, but has not been entirely successful (Price et al. 2009). In turn, the natural resources management board members believe their expertise is underutilised in the LEB arrangement (Price et al. 2009).

South Australia’s focus on integrated natural resources management sets the stage for conjunctive management of surface and ground water. This has primarily been exercised in the highly developed Murray-Darling Basin and is primarily of concern in the LEB in relation to the surface expressions of the GAB groundwater system. The impact on the groundwater system in general by the practice of allowing bores to flow freely has garnered far more attention.

South Australia’s portion of the GAB is managed pursuant to the Far North Prescribed Wells Area Allocation Plan, adopted in 2005 (SA Arid Lands NRM Board 2009). Under the South Australian Water Resources Act 1997, the area was prescribed (and thus required a plan) due to its limited water supply from the GAB and the

6 Note that the original GAB Consultative Committee 2000 Strategic Management Plan lists 880 bores as requiring rehabilitation (Table 3, p. 20). It is assumed that the difference in numbers in the 2006 review is the result of field identification of additional bores requiring attention.
dependence of ecological systems and the economic pursuits of pastoralism, mining and tourism on its sustainability (SA Arid Lands NRM Board 2009). The plan’s guiding principle is the maintenance of artesian pressure (SA Arid Lands NRM Board 2009 s. 6.1). Water licences are allocated by volume, but can be regulated if declines in pressure are detected (SA Arid Lands NRM Board 2009, s. 5.3). To achieve this, the plan includes four major components: (1) recognition that the current amount of water use is sustainable; thus, lesser restrictions are imposed on uses in existence in 2003 (although stock water use may not be transferred away from the land), and new uses may not impact on existing use (SA Arid Lands NRM Board 2009, ss. 5.6, 6.2, 7.2); (2) separate designation of a pool of water from the consumptive pool for use or co-production by oil or gas development (SA Arid Lands NRM Board 2009, s. 6.2); (3) placement of responsibility for bore rehabilitation and maintenance on the occupier of the land on which the bore is located (SA Arid Lands NRM Board 2009, ss. 6.2, 8.2); and (4) specific measures to protect the mound springs, including prohibition on wells within 5 km of a spring and monitoring to detect any pressure decline (SA Arid Lands NRM Board 2009, s. 6.2). The South Australian plan and the Queensland and New South Wales plans relevant to the GAB have requirements for consultation if drawdown from groundwater pumping might result in an adverse cross-border impact (SA Arid Lands NRM Board 2009).

Figure 11: The author at the capped Dog Fence Bore. Photograph by Eugene Allwine.
The requirement of bore rehabilitation under the Far North Prescribed Wells Area Allocation Plan is separate from and preceded the GAB Sustainability Initiative, in which $100 million was allocated by the Commonwealth and states to a five-year bore rehabilitation plan (discussed above). The GAB Sustainability Initiative substantially increased the number of bores rehabilitated (figure 11). However, as funding for rehabilitation declines, the failure to enforce the requirement of rehabilitation in the plan has led to an uneven playing field, one in which those who have voluntarily complied bear greater cost than those who have not (figure 10). This situation could lead to backsliding over time and is an issue in legitimacy discussed below.

3.3.4 South Australia’s regulation of mines and extraction of petroleum and gas in the Lake Eyre and Great Artesian basins

The two major developments in the South Australian portion of the basin—Santos oil and gas development in the Cooper Basin; and BHP Billiton’s Olympic Dam uranium mine at Roxby Downs—are governed by legislative Acts that are separate from the legislation covering mining, oil and gas, and natural resources management in general.

The Cooper Basin Ratification Act 1975 ratifies an agreement (referred to as an ‘indenture’) between South Australia and numerous oil and gas interests. The 1975 Act gives the governor power to provide the producers with land and to grant licences under the Petroleum Act 1940. The 1975 Act is silent on the use or interception of water, but does include a clause indicating that environmental laws will continue to apply.

The Roxby Downs (Indenture Ratification) Act 1982 ratifies an agreement between South Australia and a group of mining interests acting together in a joint venture. The 1982 Act ratifies the agreement and, among other things, prohibits any action to designate a protected area under the Aboriginal Heritage Act 1979 in any area developed for water supply. The agreement allows exploration for a wellfield to provide water to the mine and potable water to the company town of Roxby Downs. The agreement provides for the issue of a ‘Special Water Licence’ for development of the groundwater identified as required for the period of the mine lease. These provisions were exercised in the development of two wellfields within the GAB (BHP Billiton 2009, 2011). Water extraction may not result in greater than a five-metre decline in the water table. The mining interests are required to monitor and to report use. The Minister for Water Resources may both alter the condition on extraction and order curtailment of pumping if extraction is detrimental to the water resource. The agreement also allows any necessary dewatering for development of the mine and allows use of that water.

3.4 Adaptive water governance analysis

An application of the AWG Project approach to water governance analysis requires first of all the determination of a basin’s governance trajectory; this is based on the basin characterisation and includes an analysis of legacy effects and sources of change. This will be followed by an analysis of the basin’s management scheme using the guidelines for the role of law in adaptive governance (Table 1).

3.4.1 Governance trajectory

The LEB and its linkage to the GAB is the first opportunity for the AWG Project to assess a basin that lies within the first or ‘recovery’ trajectory; that is, a basin with relatively little human alteration and a management goal of maintaining ecological services (figure 3). The LEB rivers are unregulated, with very little diversion for consumptive use. The aquatic species in the basin are predominantly indigenous. Although the development of groundwater is an area of concern, it is not yet having a significant impact on the groundwater-dependent ecosystems it supports. Nevertheless, the arid nature of the region, combined with ecosystems that have adapted to unique localised water regimes, means that the system is vulnerable in the face of climate change and could move quickly from the first governance trajectory to the third, or transition trajectory, as climate change unfolds. Thus, a proactive approach, one that adopts elements of adaptive governance to prepare for change while maintaining the approach the low level of development warrants and can finance, is recommended.

3.4.2 Application of legal guidelines

Table 1 lists the areas of inquiry applicable to the role of law in adaptive governance. However, in their application to any particular water basin, only a few may be relevant to either the legal barriers or the need for facilitation of adaptation. In the context of the LEB/GAB, the following areas are of particular relevance: (1) the structural categories of nesting, persistence and integration; (2) adaptive and participatory capacity; and (3) the process categories of legitimacy, procedural justice, balance between flexibility and stability, and dispute resolution.

3.4.2.1 Structure

Nesting: Nesting requires that individuals involved in decision-making and advisory bodies at local levels of governance be included as representatives in regional and national-level entities. Nesting creates greater potential for adaptive response and integrated management when addressing natural resource issues by taking advantage of the power of persistent social networks in building trust and knowledge and facilitating flow of information and consistency of implementation. Without mandating any legal requirement to manage the basin as a whole, the chances of doing so improve with increased overlap in the players. More importantly for the purposes of adaptation, the relationship, shared knowledge and networks will be in place to allow response to surprise. On the other hand, if policy-makers tried to set up a response framework for every possible outcome of climate change, the result would be expensive and potentially inadequate.

Although the LEB Intergovernmental Agreement aspires to a whole-of-basin approach, it is not clear that a basin-wide authority is politically feasible at this time (see Price et al. 2009, Appendix F). Quite possibly, a crisis such as the millennium drought, which led to the formation of the Murray-Darling Basin Authority, would be necessary in the LEB to create a window of opportunity for basin-wide management. Response in the face of crisis is costly, as illustrated by the fact that the changes to Murray-Darling management triggered by the millennium drought required $13 billion in federal funding to grease the wheels of change...
Integration: Integration pertains to both the integration of water resources management across the sectors that influence water allocation, water quality, and land development and the integration of regulation of physically connected resources such as ground and surface water. Integration reduces the possibility of unintended consequences and increases the likelihood that conflict will be addressed proactively.

The primary focus of application to the LEB/GAB is on ground and surface water connection. This includes: (1) integration of basin-wide coordination and assessment of the LEB surface water resource and the GAB groundwater resource (conjunctive management); and (2) coordination of the state/territory level management of natural resources and regulation of the use and interception of groundwater by mining (cross-sector coordination).

Persistence: Persistence requires a degree of stability in the composition of advisory and decision-making bodies. Persistence fosters legitimacy and trust, potentially reducing the response time to surprise.

As noted above, some legitimacy was lost in the process of South Australia’s change to integrated natural resources management by eliminating long-standing community relations with board representatives from the prior governance structure (Mitchell 2014). The dependence of adaptive response time on relationships and networks requires that participants have longevity in their roles in the basin. This is difficult to achieve in the context of election cycles; however, institutional stability can be provided through the choice of appointees to the Senior Officers Group, the Community Advisory Committee, the Scientific Advisory Panel and natural resources management boards. Ensuring terms of service of at least six years and staggering appointments to provide a degree of institutional memory may serve to span election cycles. In general, rather than respond to the current criticism, South Australia may want to avoid tinkering with the new process, giving time for the necessary relations and networks to form.

Models for proactive approaches to the prevention of harm may be found in situations in which the remedy of compensating after the fact will not meet the goals of natural resources management. This situation is found not only in efforts to protect groundwater-dependent ecosystems but also in efforts to address competition between the use of ground and surface water for agriculture. In this second setting models of a proactive approach have been developed to avoid losing land from production and thus preventing the secondary economic consequences to farming communities and the long-term consequences for food security. This research reveals two models of proactive approaches: (1) the use of pre-emptive mitigation plans in the context of competing ground and surface water use for agriculture; and (2) the use of adaptive management in the context of protection of groundwater-dependent ecosystems.

A mitigation plan is a physical solution that eliminates injury and may be implemented with approval from the managing agency with or without the agreement of the injured surface water user and has been used to resolve conflict between ground and surface water users in the agricultural region of the Eastern Snake Plain of Idaho (Idaho Administrative Code, s. 37.03.11.043). The approach was developed as part of the resolution of a 20-year legal battle and allows solutions to be tailored to the differences between ground and surface water, including the fact that there is generally less than...
a 1-to-1 correlation between the amount of groundwater pumped and its impact on surface water supply. In applying this approach to mining in the GAB, a requirement that the groundwater extracted/intercepted be mitigated (through such measures as desalination and re-injection) and local monitoring be employed to allow adjustment if measures are inadequate might avoid irreversible harm. In the unique setting of the GAB, in which large lag times are likely, recharge is limited and natural discharge reflects the remnants of a much wetter system, a requirement that mitigation plans exceed predicted impacts may both mediate the decline of the system and force the development of extraction technology that reduces impact on water in general.

Adaptive management is an appropriate tool when uncertainty is associated with the results of management or development options. In the case of a fragile system like the mound springs, the actions necessary to fully understand the system (that is, drilling and pump tests) might also destroy it; thus uncertainty is unlikely to be eliminated, despite scientific studies. Adaptive management requires the establishment of a policy guideline (for example, all decisions will err in favour of protection of the mound springs; or all decisions will err in favour of allowing mine development). Only with a policy-level guideline can the scientific implementation of monitoring and incremental adjustment, based on data, proceed. One model for the use of this approach in protecting a fragile hydrologic system is the establishment of the Yellowstone Controlled Groundwater Area in Montana in the US, adjacent to Yellowstone National Park (Montana-National Park Service Compact, Montana Code, s. 85-20-401 Article IV). To establish the area, policy guidelines and initial conditions were set by a decision-making body, with scientific input. Well measuring and reporting was implemented and comprehensive review takes place in five-year increments (Amman et al. 1995). Currently the suggestions for adaptive management in the LEB and GAB are science-based and not accompanied by authority for establishment of policy guidelines (Thoms et al. 2009b, Price et al. 2009). Without this authority, adaptive management is likely to collect useful information, but have a limited impact on decision-making (Cosenis 2010).

### 3.4.2.2 Capacity

**Adaptive capacity:** Adaptive capacity requires the resources and legal authority to respond to change. Adaptive capacity allows a system of governance to adjust in the face of uncertainty and surprise. This capacity in the aspects of water governance captured in the law can be derived from a number of sources including: (1) the authority of government to regulate water in response to change and to implement adaptive management; and (2) the ability of individuals and private entities to adapt through water markets. In the sparsely populated LEB, water markets may have limited application. The following discussion will therefore focus on regulatory authority.7

Whether implementing adaptive management or simply adjusting water management based on changes in precipitation, regulatory entities cannot take action without the authority to make adjustments to water allocations, including interception of water, whether or not defined as a water right. Exactly how courts view the nature of the water right will dictate the degree to which government regulation can play a role in adaptation; that is, the degree to which compensation is required for governmental adjustment of water allocation determines the degree of regulatory flexibility.

In the process of transition from the water licences in existence prior to the National Water Initiative to the current system, which recognises a property right to water, the High Court of Australia reviewed two cases addressing the federal role in reducing the amount of water that could be taken from wells as part of implementation of the Water Act of 2007, the act applicable to the Murray-Darling river system. The High Court found a substantial degree of latitude for regulation without compensation, reasoning that water is a public resource and thus government retains the right to adjust the private right to its use (ICM 2009, Arnold 2010). Implementation of the National Water Initiative to define rights in a manner that facilitates water markets separates and defines a property right in water as distinct from that in land. Nevertheless, it did not change the aspect of water allocation relied on by the High Court: that in issuing a use right to a public resource, the government retains the right to regulate it. Under this reasoning, if the political will exists, the governments of Australia (probably at both state and federal levels) appears to have the power to adjust water rights in the face of change, even after the switch to tradable water rights.

This approach appears equally applicable to the ability of states to adjust yearly water allocations to assure that other needs, including environmental flows, are met. The approach of South Australia in its legislation to implement the National Water Initiative—the *Natural Resource Management Act 2004*—provides an example of the year-to-year flexibility. The Natural Resources Management Act provides for the granting of a licence, referred to as a water access entitlement, and this provides the holder with a *share of water available in the consumptive pool of the water source in question* (NRM Part 3, s. 146[2]). The actual allocation of water in a given year under the licence is determined separately (NRM Part 3, s. 152), thus allowing for adjustment of the consumptive pool relative to the environmental allocation on a yearly basis. The process of making yearly adjustments to allocation is a science-based planning approach to water policy (Avey and Harvey 2012). The ability to implement adaptive management is embedded in this approach because adjustments based on feedback from monitoring may be made yearly in the process of defining allocations.

**Participatory capacity:** Participatory capacity requires that those affected have the right and resources to play a role in decision-making. Participatory capacity reduces the likelihood of marginalisation of portions of society and, in doing so, increases the likelihood that all aspects of a system will be considered in decision-making. Aboriginal communities face the greatest capacity gap for meaningful participation in decision-making in the LEB, and will be the primary focus of this sub-section, although, as noted above, attention should also be given to the inclusion of representatives from local environmental organisations in community advisory groups. In addition, the capacity of state agencies may have been reduced in the process of reform and will be addressed briefly.

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7 Water markets will be addressed by the author in a more general article focused on adaptive governance and implementation of the National Water Initiative in preparation.
For Indigenous communities, the capacity to participate equates to the capacity for self-determination or self-governance. Scholars in Australia assert the need for the greater engagement of Aboriginal communities in the process of stakeholder input to the allocation of environmental flows for the purpose of capturing species-related cultural and subsistence values that have been overlooked (see generally, Finn and Jackson 2011, Jackson et al. 2012). While this is a good first step, this report goes beyond the concept of Aboriginal communities as a stakeholder group and asserts that an Indigenous governmental voice as co-managers is necessary to appropriately represent Aboriginal interests; to achieve Aboriginal self-determination; and to enhance the capacity for adaptation in the basin as a whole. This level of engagement will require (1) development of governance capacity within Aboriginal communities; and (2) a federal/state process to engage with Aboriginal communities at a governmental level. The first is an aspect of participatory capacity discussed here; the second relates to process elements, discussed below.

Although both Australia and the United States began with a foundation in the laws and approach to colonisation brought to their shores by England, they diverged in their definition of the rights of the Indigenous people inhabiting the land they came to colonise. Native American tribes in the United States have followed a rights-based pathway to the development of Indigenous governance capacity. Thus, interpretations of the treaties negotiated in the 1800s have led to greater definition of rights since the mid-1900s, and that recognition has given tribes access to resources to build governance capacity. Governance capacity has, in turn, led to recognition of some tribal governments as co-managers of shared resources (see, for example, Cosens 2012, Cosens and Fremier 2014). A different approach is necessary in Australia.

Australia did not reject the concept of terra nullius (the land belongs to no one) until 1992 (Mabo v. Queensland 1992). In doing so it recognised the concept of ownership of Native Title, but not sovereignty over the land and water to which Native Title extends (Mabo v. Queensland 1992; see also Native Title Act 1993, recognising a very limited Aboriginal right to manage cultural water rights, free of state control). Without a legislative change, a rights-based approach would be difficult in Australia. Nevertheless, claims to Native Title provide sufficient leverage such that new approaches are emerging.

An approach to co-management being led by the Ngarrindjeri Nation on the lower Murray River and Coorong wetlands in South Australia may provide a model for other settings in Australia and beyond, where the ground has not yet been laid for a rights-based approach. The Ngarrindjeri began by building governance capacity through the formation of the Ngarrindjeri Regional Authority (Hemming and Rigney 2014). The authority has simply asserted sovereignty through use of diplomacy by approaching local, state and interstate governments with an offer of co-management. Co-management agreements with the Ngarrindjeri Regional Authority are memorialised using private contracts to render the agreement binding (Hemming and Rigney 2014). The use of a legally binding agreement gives the parties greater protection than reliance on 'consultation' or stakeholder input, thus filling the current void in state or federal definition of Indigenous rights (Hemming et al. 2011).

What both the North American rights-based approach and the Australian diplomacy approach have in common is the development of capacity in governance as the necessary precursor to co-management. Thus, assistance to Aboriginal communities to build capacity should be the first priority in working toward a greater Indigenous voice in water management. A discussion of how to build capacity is beyond the scope of this report, but there are key features in the Ngarrindjeri Nation example worth noting. First, higher education can play a role in facilitating the development of capacity. The outreach and engagement by a university First Nations Centre has been instrumental in providing research and assistance to the Ngarrindjeri Nation (Hemming et al. 2007, 2011, Hemming and Rigney 2014) and serves as an excellent example of the neutral role that higher education might play in capacity-building. Second, federal and interstate restoration funding has been a source of capacity-building for the Ngarrindjeri Nation in Australia (Hemming et al. 2011). Ensuring that Indigenous organisations are eligible for public funding is thus essential to capacity-building.

In addition to giving attention to the capacity of indigenous communities, participatory capacity also requires that science-based agencies have the resources to manage. The consolidation of various boards that accompanied change to integrated natural resource management in South Australia was apparently perceived as a means to create efficiency savings (Mitchell 2014). Yet anyone who has attempted interdisciplinary work knows that integration requires more resources and time than the separate study of single components of a system (see, for example, Repko 2012). While savings might be possible in middle management, attention to restoring on-the-ground science and management positions in state agencies to at least the level that existed prior to the passage of the South Australian Natural Resources Management Act should be a priority.

### 3.4.2.3 Process

The process elements of legitimacy, procedural justice/self-determination, balance between stability and flexibility, and dispute resolution are of particular relevance to the LEB/GAB.

**Legitimacy:** Legitimacy pertains to the acceptance of authority because it is perceived to be exercised appropriately and because it is exercised appropriately. Legitimacy is necessary for public support of resource management and addresses the basic level of confidence and trust people have in those who govern (see, for example, Cosens 2013). In the context of the LEB/GAB, legitimacy is an issue resulting from the frequent changes in recent years in management regimes (addressed above under the structural heading of persistence) and in the failure to follow through on the resources spent on water plans with enforcement. This is apparent in the implementation of the Far North Prescribed Wells Area Water Allocation Plan, in which lack of enforcement has led to a situation whereby those who voluntarily complied with the requirement of bore rehabilitation are spending more on water than those who ignored the requirement. Over time, this will erode the legitimacy of the plan and could result in backsliding. The simple solution: enforce.
Procedural justice: In addition to building the governance capacity of Indigenous communities as discussed above, federal, interstate, state and local governments require the appropriate processes to engage with these communities on a government-to-government basis. The incentive for governments to do so comes from both the uncertainty surrounding Native Title claims (see for example, Hemming et al. 2007), the possibility that the Australian state and federal governments’ past assertion of terra nullius was illegal under English law in the early 1800s (Hemming et al. 2011), and the more positive incentive suggested by assessment of North American basins; that is, that participation of Indigenous communities as co-managers of shared resources is an important component of enhanced general resilience and sustainability (Chaffin et al. 2014b, Cosens and Premier 2014). Engagement at a government-to-government level requires: (1) a process for determining who speaks for an Aboriginal community, and (2) a change from the current approach of consultation with Aboriginal communities as a stakeholder. The development of criteria for local, state, and federal recognition of a particular Aboriginal government as the spokesperson for its people must be done in consultation with Aboriginal communities and may only be possible if addressed in tandem with the development of governance capacity. Once criteria are established and community spokespersons recognised, internal disputes must be left to Aboriginal governance mechanisms to resolve. Only then is self-determination a reality and the legitimacy of engagement achieved.

Models exist for government-to-government engagement with Indigenous communities. The approach of the State of Montana in relation to tribal water right negotiations has been praised for its inclusive, collaborative and innovative process, whereby the sovereignty of the tribes is respected during negotiations (see Cosens 1998, 2003a, 2003b), and may provide a model for governments in Australia. In 1979, the Montana legislature established the Montana Reserved Water Rights Compact Commission (‘Montana Commission’) (Mont. Code Ann 2001, s. 2-15-213), and charged it with negotiating water rights: ‘compacts for the equitable division and apportionment of waters between the state and its people and the several Indian tribes claiming reserved water rights within the State’ (Mont. Code Ann 2001, ss. 85-2-701[2], 702). The Montana Commission acts on behalf of the State and its citizens as a whole (Mont. Code Ann 2001, s. 2-15-212). The commission is composed of representatives of both the Executive and Legislative branches of State government as well as citizen appointees chosen by the Governor (Mont. Code Ann 2001, s. 2-15-212). This mix assures broad representation from elected officials, coordination between the policy-making and implementing branches of government, and assures sufficient stature that the promise of government-to-government negotiations is in fact real. The Montana Commission, Federal and Tribal government representatives are the three parties at the table in negotiations, with each responsible for their own public engagement and each able to accept or refuse any position put forward in discussions (Cosens 1998, 2003a, 2003b).

In Australia this approach could be accomplished by the establishment of a body composed of representatives from both ministerial and departmental levels for engagement with Aboriginal communities. In relation to the LEB/GAB, this type of process at the level of both state and federal government would elevate Aboriginal participation above that of other members of the public. This step is necessary if the desire is to have Aboriginal communities take their place as co-managers in the basin.

Balance between flexibility and stability: The balance between stability and flexibility is particularly critical in adapting to uncertainty. Adaptation timeframes must consider both the need for adjustment and the need for economic stability. There has been limited success in the implementation of adaptive management in complex jurisdictional settings such as a river basin (see, for example, Lee 1993). In addition to the problems of goal setting and the adjustment authority discussed above, a major barrier is the gap between the scientific approach of monitoring and continual adjustment and the need for stability in an economic system (Cosens 2013). Public acceptance of adaptive management requires a balance between the stability needed for economic investment and the flexibility needed to achieve ecological goals (Cosens 2013). A process of negotiation to set the timeframe for adjustment, taking into account both the biologic and social timeframes, is recommended. Although not likely to be an easy negotiation, this is essential to avoid a solution that favours the economy over the environment or ecological services over investment.

This approach is specifically applicable to the goal of managing the GAB to protect the mound springs. The current implementation of adaptive management in the GAB is primarily a science-based approach and lacks the overlay of a decision-making body able to undertake careful deliberation on such issues as trade-offs between mining/gas production and groundwater protection and consideration of the development of a policy on use of an aquifer with limited or no recharge. Without the oversight of a decision-making body, the result will be that the scientific implementation of adaptive management will simply be overridden by the need for stability in the mining industry.

Dispute resolution: Dispute resolution requires a process for resolving conflict and making final, binding decisions on trade-offs regarding scarce resources. Because the time will come when consensus is not possible, it will be essential to have a mechanism in place as water scarcity in the face of climate change unfolds.

Although the LEB Intergovernmental Agreement was established to avoid cross-border impacts to the LEB water resource, it is primarily a diplomatic agreement for coordination, dialogue, and exchange of information. The category of dispute resolution in application to the LEB addresses both the need for a common vision and the need for a decision-making process to address cross-border disputes. Lessons from the review of the Columbia River Treaty between the United States and Canada may provide an approach to creating a common vision for the LEB/GAB.

The Columbia River Treaty, providing for joint development of an international river by the United States and Canada, is currently under review. In the initial stages of the review, entities in the basin, including the Northwest Power and Conservation Council (an interstate body created for power planning and a coordinated
fish and wildlife program [NWPCC n.d.] and Columbia Basin Trust (a provincial entity that brings water education, economic development and climate adaptation planning to the rural portion of the basin in British Columbia [CBT n.d.]) recognised that residents of the basin have more in common across the international border than the existence of the border would suggest and that they might be better able to find solutions to the problems the basin faces than their respective federal governments. Although each country did not have the authority to create a cross-border forum for a dialogue, various entities in the basin, including the NWPCC, the CBT, Native American and First Nation organisations, and environmental NGOs, began to take on that responsibility. The Universities Consortium on Columbia River Governance, made up of representatives of public universities on both sides of the border, facilitated annual meetings to bring basin residents together (UCCRG; n.d.). The Treaty review process is not complete; thus success cannot be claimed. What is important for the LEB/GAB is to recognise that, whereas governmental entities may have absolutely no reason to compromise, neighbours do.

Similar to the people of the Columbia River Basin, it is likely that the people of the LEB have more in common than their respective state/territory governments. A cross-jurisdictional dialogue among the people of the basin to establish a vision for true basin-wide coordination might provide a way forward within the existing government structure and even lay the groundwork for a whole-of-basin approach to governance, should the inevitable crisis occur. If (and the author recognises this is a big IF) the respective state and territory governments could be convinced to accept the outcome of a facilitated in-basin process and memorialise it in mirror legislation in each state/territory, a workable outcome might be achieved.

In addition to the need for a common vision, the LEB/GAB lacks a mechanism to resolve cross-border disputes. No state has an avenue other than diplomacy, or the process under the Environmental Protection and Biodiversity Conservation Act, to raise and resolve a concern with a neighbour’s development of the shared water resource. The absence of a mechanism to resolve disputes among states/territory means that in most circumstances the downstream state bears the risk. To fill this gap, an amendment to the LEB Intergovernmental Agreement is needed, one that provides for referral of a dispute to the Commonwealth and clear guidelines on when referral is allowed or the establishment of a joint interstate dispute resolution body. For referral to the Commonwealth, the bottom line question will be: under what circumstances would Queensland (the upstream state with the greatest potential for water development) and the Commonwealth agree to such a mechanism.

For Queensland, the answer must be certainty in relation to the level of freedom from interference with the development of their water resources. Currently, potential exists for South Australia to raise issues under the Environmental Protection and Biodiversity Conservation Act 1999, but the vague notion of significant harm as the threshold to action under the Act gives Queensland very little guidance on when its level of development might trigger state action. In contrast, a negotiated agreement setting forth the level of development that may occur without interstate and Commonwealth interference would alleviate that uncertainty.

For the Commonwealth, reducing conflict over development is always important for economic investment in a country’s resources and thus should always be of concern for the federal government. But probably of greatest practical importance is avoiding the price tag associated with resolving these issues when the inevitable crisis occurs, as it did in the Murray-Darling Basin during the millennium drought.
4. Conclusions and Implications

The Lake Eyre Basin, and those portions of the Great Artesian Basin hydrologically connected to it, is a relatively undeveloped water basin with unregulated rivers and unique groundwater-dependent ecosystems. This internal drainage system supports an ecosystem that is highly adapted to its boom/bust cycles and as a result, highly vulnerable to changes that may occur as climate change unfolds. The application of the Adaptive Water Governance Project to this system reveals the following potential avenues for increasing the ability of the water management entities and those who rely on the basin to adapt in the face of climate change:

1. Nesting: increase overlap in the appointment of individuals to state and interstate decision-making bodies, scientific advisory and agency science groups, and state and interstate citizen advisory bodies.

2. Persistence: increase stability in appointments and the scope of authority of various state and interstate water management entities.

3. Integration: establish conjunctive management of the Lake Eyre and Great Artesian basins with adjustments to account for the differences between ground and surface water.


5. Participatory capacity: provide the resources for Aboriginal communities to build governance capacity and include representation from local environmental organisations on community advisory committees. Restore capacity for state implementation of natural resources management to at least the level required under the former fragmented management regime.

6. Legitimacy: provide the resources for enforcement and even application of water regulations, in particular for bore rehabilitation and maintenance.


8. Balance between flexibility and stability: ensure these are in balance when implementing flexible management with tools such as adaptive management.

9. Dispute resolution: establish binding dispute resolution mechanisms now, before the next crisis.

Australia is ahead of many western states in the United States in the development of governance mechanisms that will allow water management to respond to climate change. This report identifies additional measures to improve adaptability within the context of the water reform already underway, particularly through legal adjustments that will ensure the tools are available to make hard choices when the next drought inevitably occurs.

Figure 12: Crustaceans found only in mound springs. Photo courtesy of Andrew Love and Travis Gotch
5. Acknowledgments

The author would like to thank the following people for their review and comments on this manuscript (with the disclaimer that all views and recommendations in the report are that of the author):

Dr Angela Arthington, Emeritus faculty, Griffith University, aquatic ecologist and member of the Lake Eyre Basin Science Advisory Panel

Dr Steve Morton, CSIRO Sustainable Ecosystems and chair of the Lake Eyre Basin Science Advisory Panel

Christopher Biesaga, Director of the Great Artesian and Lake Eyre Basins Section, Commonwealth Department of the Environment

Robert Fowler, Professor of Law, University of South Australia

The author would like to thank the following people and entities for their support:

Michele Akeroyd, Director, Goyder Institute for Water Research, for her ongoing advice and support throughout my time in South Australia

Travis Gotch, Senior Ecologist with the South Australian Government, who took me to see the mound springs of the Lake Eyre Basin and shared his knowledge and enthusiasm for these unique groundwater-dependent ecosystems

Professor Phyllis Tharenou, Executive Dean, Faculty of Social and Behavioural Sciences, Matthew Leach and Emma Beams, both of whom served as Executive Officer for the Executive Dean during my Visiting Professorship, and my fabulous assistant, Megan Spyker, all at Flinders University, and all played a role in making this research possible.

Craig Simmons, Director of the National Centre for Groundwater Research and Training, for his advice and support in connecting me to scholars in Australia.

Finally, this project stands on the shoulders of the Adaptive Water Governance Project, a synthesis project on Social-ecological System Resilience, Climate Change & Adaptive Water Governance, co-chairs B. Cosens and L. Gunderson, with the National Socio-Environmental Synthesis Center (SESYNC) under funding from the National Science Foundation DBI-1052875, see <http://www.sesync.org/project/water-people-ecosystems/adaptive-water-governance>.

Figure 13: Water storage building at the historic site of the Strangeways telegraph stations. Photograph by Eugene Allwine.
6. References


Cases and Statutes


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