THE BASIN PLAN IMPLEMENTATION

NSW Groundwater Environmental Monitoring, Evaluation and Reporting Plan

Schedule H

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Dr Jodie Dabovic, Water Science Programs, Ourimbah.

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Glossary

Abbreviation	Description
BPEOM	Basin Plan Environmental Outcomes Monitoring—Fish
BWS	Basin-wide Environmental Watering Strategy
CEWH	Commonwealth Environmental Water Holder
DPE	Department of Planning and Environment
ECA	environmental contingency allowance
EEC	endangered ecological community
EOM Working Group	Environmental Outcomes Monitoring Working Group
ES	End of system function
GDE	groundwater-dependent ecosystems
HEW	held environmental water
IPART	NSW Independent Pricing and Regulatory Tribunal
LTWP	long-term watering plan
MDBA	Murray–Darling Basin Authority
MER	monitoring, evaluation and reporting
NV	Native vegetation
PEW	planned environmental water
WM Act	*Water Management Act 2000*
WRP	water resource plan
WSP	water sharing plan

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1. Introduction

The Murray–Darling *Basin Plan 2012* (the Basin Plan) seeks to establish a sustainable and long-term adaptive management framework for Basin water resources, optimising social, economic and environmental outcomes through the management of water resources, and improving water security for all users of Basin water resources.

Water resource plans (WRPs) come into effect in 2020 and set limits on the quantities of surface water and groundwater that can be taken for consumptive purposes, establish rules to meet environmental and water quality objectives, and document potential and emerging risks to water resources. Long-term watering plans (LTWP) have been developed to set long-term ecological outcomes, and to guide WRP development. When NSW signed the Basin Plan Implementation Agreement, it committed to preparing WRPs and to link the State's water management to them.

Monitoring, evaluation and reporting (MER) programs improve the performance of plans through measuring, assessing and communicating the effectiveness of a plan's activities and outcomes. NSW will undertake MER for WRPs and LTWPs which will also contribute to the Commonwealth MER program for the Basin Plan. This document describes the expected groundwater environmental MER programme for all NSW groundwater WRPs. For an overview of the MER approach, refer to the NSW MER Framework https://www.environment.nsw.gov.au/SavingOurSpecies/140594mersite.htm.

This MER program covers the following groundwater WRPs.

- Lachlan Alluvium (GW10)
- Gwydir Alluvium (GW15)
- NSW Border Rivers Alluvium (GW18)
- Macquarie-Castlereagh Alluvium (GW12)
- Namoi Alluvium (GW14)
- Murray Alluvium (GW8)
- Murrumbidgee Alluvium (GW9)
- Darling Alluvium (GW7)
- NSW Great Artesian Basin Shallow (GW13)
- Western Porous Rock (GW6) / Eastern Porous Rock (GW16)
- Lachlan and South Western Fractured Rock (GW11) / New England Fractured Rock and Northern Basalts (GW17)

1.1. Document map

This environmental MER plan is designed to meet the Basin Plan requirements for the monitoring of water resources as outlined in Sections 10.46, 13.14 and Schedule 12 matters 8, 9, and 12 of the Basin Plan and as guided by the Basin Plan WRP Requirements Position Statement 10A, specifying Schedule 12 Water Resource Monitoring.

The document maps in Table 1 and Table 2 summarise where the Basin Plan requirements are addressed in this document, or indicate where another document will meet the requirements.

In general this document will:

- provide the framework for collection, analysis and reporting on the critical information needed to determine whether and how the groundwater WSPs are meeting their purpose, environmental objectives and targets
- guide and facilitate data collection and information provision that aligns with Basin Plan planning timescales indicated in Schedule 12
- ensure that NSW's MER activities in the Murray–Darling Basin meet the Basin Plan requirements for accountability and transparency, to underpin learning and improvement
- provide the principal mechanism to reinforce, review and refine activities as part of an ongoing adaptive management process.

Table 1. Basin Plan requirements and where each is addressed in this MER plan.

Basin Plan MER requirement		Location in MER Plan of contributing information	
Chapter 4, 4.03(3)(e)		Section 3	All Sections
Chapter 10, Part 10 Measuring and Monitoring			
10.46(1)	Monitoring water resources	MER Plan specifically Section 3 and Appendices A to J	Table 3 – Groundwater source integrity objective, corresponding performance indicators and MER sites Table 4 - Vegetation GDE objective, corresponding performance indicators and MER sites
Chapter 13, Program for monitoring and evaluating the effectiveness of the Basin Plan			
13.03(2)	Basin States are to enable evaluations by collecting, analysing and reporting information (including data) in a fit for purpose manner.	MER Plan specifically Section 3	All Sections
13.04	Principles to be applied in monitoring and evaluating the effectiveness of the Basin Plan.	Section 3	All Sections
13.04	Principle 3	Section 4	4.1 Reporting
13.04	Principle 4	Section 2	Ref Figure 3 - Program logic
13.04	Principle 5	Section 2	All Sections
13.04	Principle 6	Section 1	Section 1.3 Other MER Programs
13.04	Principle 7	Section 3	Table 3 - Aquifer integrity objective, corresponding performance indicators and MER sites Table 4 - Vegetation GDE objective, corresponding performance indicators and MER sites
13.04	Principle 8		Section 1.2 Other MER Programs
13.04	Principle 9 A risk-based approach should be used for investment in monitoring and evaluation	Section 3	Table 3 - Aquifer integrity objective, corresponding performance indicators and MER sites Table 4 - Vegetation GDE objective, corresponding performance indicators and MER sites
		Section 3	Table 3 - Aquifer integrity objective, corresponding performance indicators and MER sites Table 4 - Vegetation GDE objective, corresponding performance indicators and MER sites
13.04	Principle 10	Section 4	4.1 Reporting
13.04	Principle 11	Section 4	All sections
13.14	Reporting requirements for Basin States, the Department etc.	Section 4	4.1 Reporting
Schedule 12—Matters for evaluation and reporting requirements			
Matter 8	The achievement of environmental outcomes at an asset scale.	MER Plan	All Sections
Matter 9	The identification of environmental water and the monitoring of its use.	MER Plan	All Sections
Matter 12	Progress towards the water quality targets in Chapter 9.	MER Plan	To be included once program has been approved

Table 2. Other Basin Plan reporting matters that may require environmental monitoring.

Basin Plan MER requirement		Location of contributing information
Chapter 10, Part 5 Interception activities		
10.24	Monitoring impact of interception activities	Not applicable (See WRP chapter 5.6)
Chapter 10, Part 10 Measuring and Monitoring		
10.44	Information relating to measuring take—water access entitlements	See WRP chapters 5.6 and 7.1 and Schedule I
10.45	Supporting measuring	See WRP chapter 7.1
Schedule 12—Matters for evaluation and reporting requirements		
Matter 4	The effectiveness of the management of risks to Basin water resources.	To the extent that monitoring undertaken for another purpose is relevant to Matter 19 reporting, that monitoring may be used by NSW to fulfil reporting obligations MER also provides information to inform this matter NSW annual reporting to MDBA NSW WRP/WSP Implementation Plan/s
Matter 10	The implementation of the environmental management framework (Part 4 of Chapter 8).	NSW annual reporting to MDBA MER also provides information to inform this matter
Matter 14	The implementation of the water quality and salinity management plan, including the extent to which regard is had to the targets in Chapter 9 when making flow management decisions.	MER also provides information to inform this matter Water Quality Management Plan NSW annual reporting to MDBA
Matter 18	The efficiency and effectiveness of the operation of water resource plans, including in providing a robust framework under a changing climate.	MER also provides information to inform this matter NSW WRP/WSP Implementation Plan
Matter 19	Compliance with water resource plans.	To the extent that monitoring undertaken for another purpose is relevant to Matter 19 reporting, that monitoring may be used by NSW to fulfil reporting obligations NSW Natural Resources Access Regulator prepares, publishes and implements risk- based compliance monitoring plans for the State, including for the Basin

1.2. Plan scope and relationship to other documents

Water resource plans (WRPs) have several components including water sharing plans (WSPs), water quality management plans (WQMPs), risk assessments and incident response guides (Figure 1). WRPs use a risk-based approach to guide the management of water resources and sit alongside long-term watering plans (LTWPs) that aim to deliver the environmental objectives of the Basin-wide Watering Strategy, and guide the use of environmental water. The MER program described in this plan has been designed to deliver outcomes for both WRP components such as WSPs, WQMP and the LTWP. This is achieved through the alignment of environmental objectives between the documents and a risk-based approach to determining monitoring priorities (Figures 1 and 2).

Implementation of any MER program is dependent on having a defined, long-term budget. Given WSPs span a 10-year period, and LTWPs aim for 10–20 year life span, it is likely that budgets and priorities will change and refocus during this time. The aim is to maintain an MER program and report on environmental outcomes every 5 years. However, the ability to implement all aspects of this plan will be subject to available future funding.

The following points outline the scope of this MER plan and its relationship with other documents and monitoring programs:

This MER plan addresses the environmental objective monitoring only—other MER will be addressed in other documents. Hence not all Basin Plan Schedule 12 reporting requirements are addressed in this document. Refer to

- Table 2 and Figure 2 for more information.
- General MER approach, context, and finer scale monitoring program details are provided in several other reports and plans. This document should also be read in conjunction with the NSW MER Framework (https://www.environment.nsw.gov.au/SavingOurSpecies/140594mersite.htm).
- WSPs share water between the environment and extractive water users to achieve economic, social, cultural and environmental outcomes within 10-year time frames. WQMPs set objectives to contribute to the management of water resources for predefined water quality targets. LTWPs set long-term (10– 20 year) objectives to improve environmental outcomes through the use of planned and held environmental water, to benefit rivers, surface and groundwater-dependent ecosystems.
- This plan focuses on outcomes for groundwater-dependent environmental assets. Separate MER plans will be prepared for each surface water WRP area.
- It is anticipated that the MER for vegetation groundwater-dependent ecosystems (GDEs) and associated wetlands are complementary to the proposed surface water MER for vegetation.
- This plan interacts with various Commonwealth-funded programs (e.g. Long-term Intervention Monitoring; LTIM) for the terrestrial vegetation groundwater dependent ecosystems (GDEs) condition programs. It was also developed according to the principles outlined in the NSW MER Framework (co- authored by the NSW Department of Planning and Environment – Biodiversity & Conservation, NSW Department of Planning and Environment – Water and the NSW Department of Primary Industries—Fisheries; https://www.environment.nsw.gov.au/SavingOurSpecies/140594mersite.htm) to ensure consistency, collaboration (not duplication) and efficient MER implementation across the main water resource management organisations in the NSW Government. In this way, MER underpins more effective and sustainable water allocations between the environment and extractive water users, and better evaluation of WSP and LTWP performance.

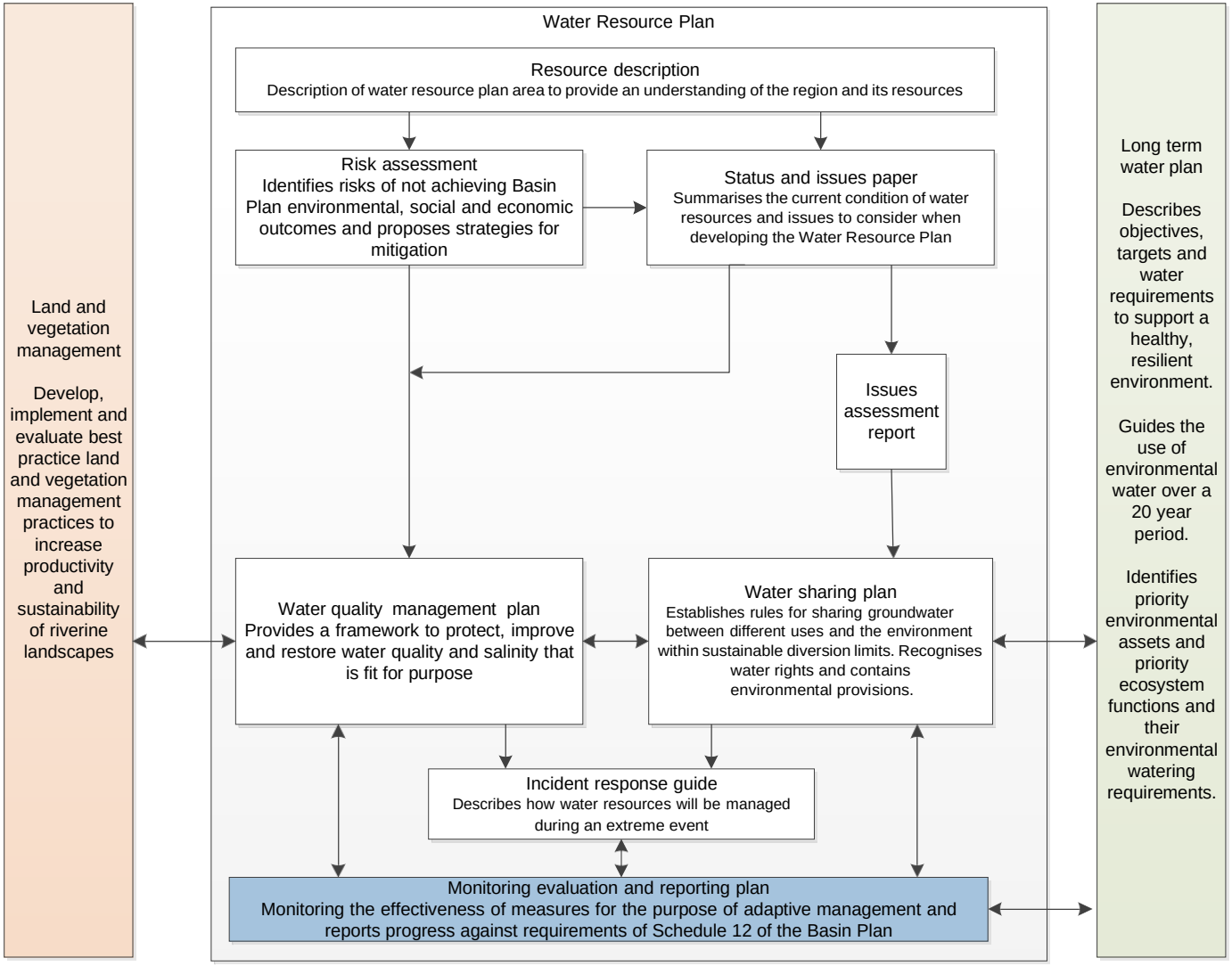

Figure 1. Components of water resource plans

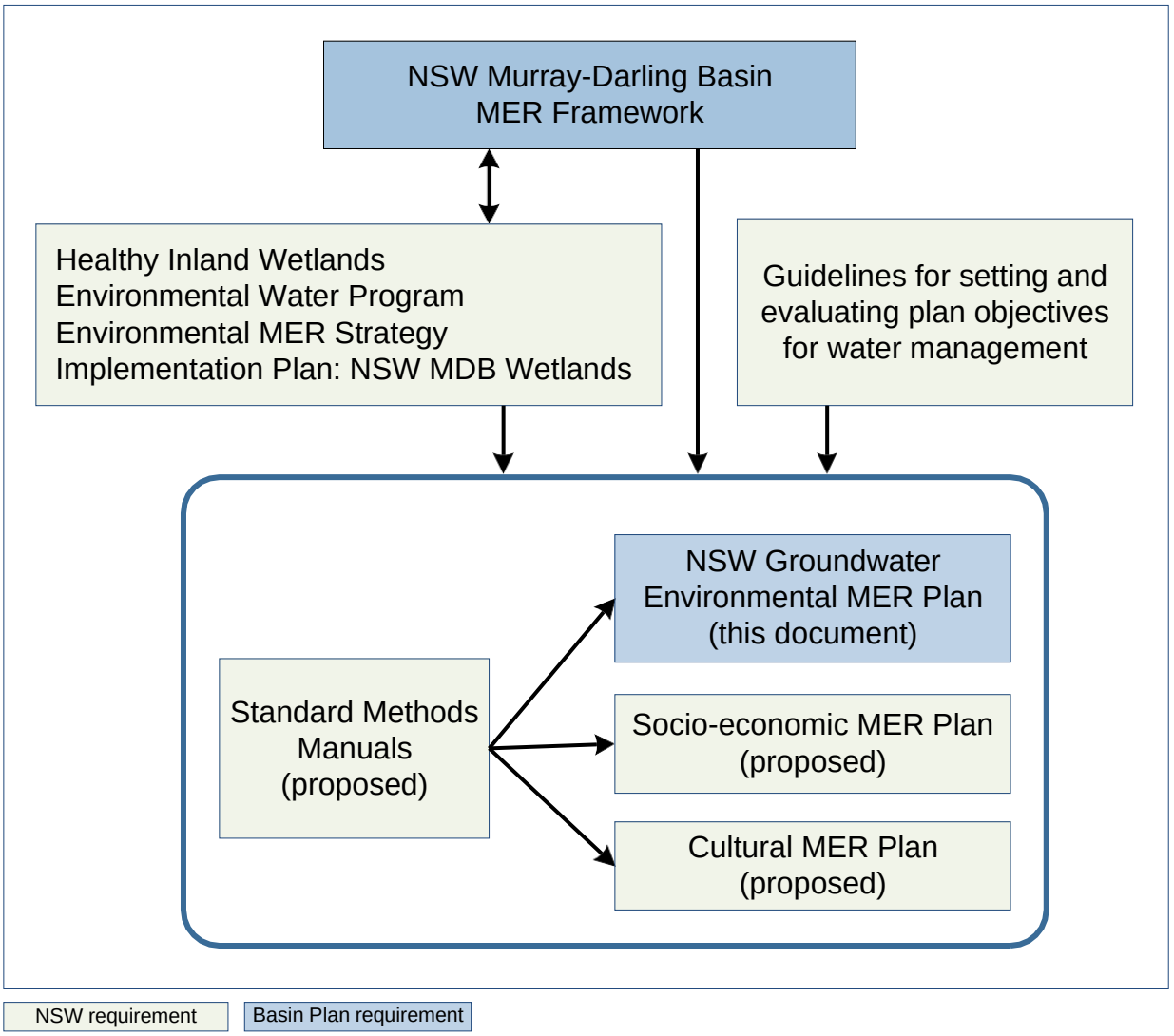

Figure 2. MER plans and interaction with other documents and programs.

2. Program logic for groundwater environmental MER

A program logic model is a schematic representation that describes how a program is intended to work by linking activities with outputs, immediate impacts and longer-term outcomes. A full description of the approach can be found in the NSW MER framework. Using a program logic has several benefits including:

- providing a systematic and integrated approach to program planning, implementation, evaluation and reporting
- clarifying activities and intended outcomes, thus illustrating the change process underlying a program
- identifying program assumptions and enabling testing of how these assumptions are supported by evidence
- providing a clear explanation of program concepts that can be used to engage stakeholders and provide direction to related project plans
- providing a framework for identifying areas where evaluation will be most important, and informing the development of meaningful evaluation questions.

As WRPs do not contain a specific set of objectives, monitoring activities are driven by the environmental and water quality objectives contained within the WSP, WQMP and LTWP for each WRP area. Evaluations are based around the three themes of effectiveness, efficiency and appropriateness.

The following objectives are described for groundwater:

- LTWPs do not contain specific objectives for individual groundwater-dependent environmental assets.
- All groundwater WSPs contain two environmental objectives focusing on groundwater dependent vegetation including associated wetlands and the integrity of groundwater resources.
- All groundwater WSPs contain one water quality objective focusing on salinity.
- All WQMPs contain objectives to meet predefined water quality targets for each groundwater resource.
- The WSP water quality objective and WQMP objectives were developed in alignment with the surface water objectives for the same asset.

A program logic (Figure 3) was developed to illustrate the links between the WSP's and WQMP objectives, the strategies (and underlying plan rules) to achieve them, and the performance indicators to monitor success and evaluate the plan's effectiveness. For further information on how the environmental objectives were developed, please refer to NSW Department of Industry (2017) G*uide to the development and alignment of environmental objectives*.

Additionally, information has been prepared which details the links and alignment between WSP, LTWP and Basin Watering Strategy objectives (see Appendices L and M). This alignment of objectives recognises that some ecosystems and communities will rely on surface water management via a WRP and LTWP and groundwater management via a WRP for different components of their life-cycle. For example, a river red gum community may require flooding (managed via a LTWP) to encourage recruitment, but access to groundwater (managed via a groundwater sharing plan) to maintain its condition.

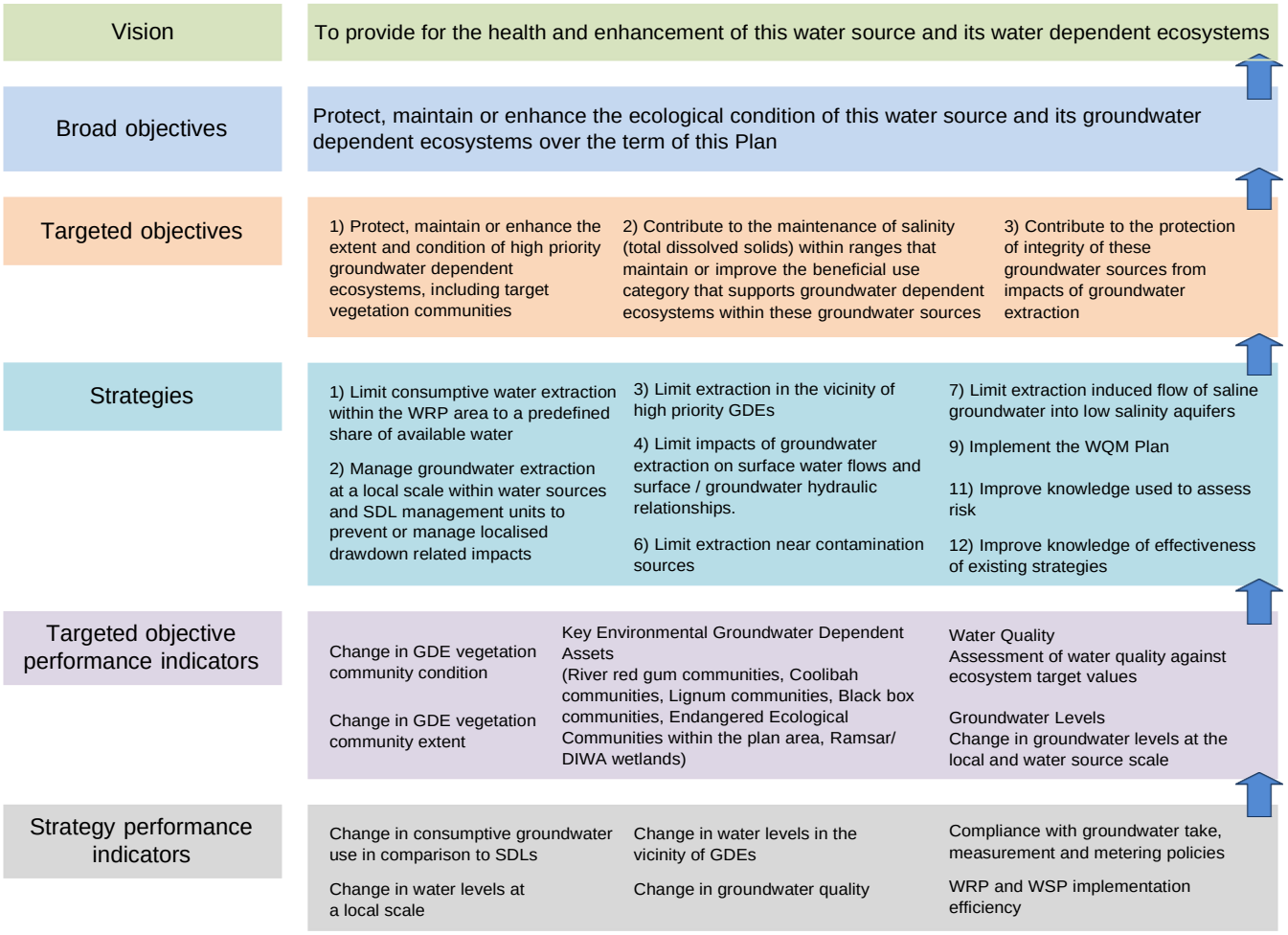

Figure 3. Ecological objective setting program logic.

Strategies are those used in the WRP to address risk and are numbered to allow for cross referencing. Strategies not included are either not directly relevant to the listed environmental objectives, or will be addressed through included strategies.

3. Environmental monitoring activities

The program logic approach is applied to identify where it was most appropriate to conduct monitoring activities to investigate how groundwater WSPs protect, maintain or enhance the extent and condition of groundwater-dependent vegetation, maintain the integrity of groundwater resources via maintaining groundwater levels and contribute to water quality targets.

The process included consideration of:

- the groundwater risk assessments
- groundwater extraction pressures
- the current distribution of groundwater monitoring bores and ecological performance indicators
- identification of groundwater sources where there are opportunities to conduct research and monitoring activities collaboratively with other government agencies or universities
- where information can be transferable across waters sources.

Monitoring may be described at the water source or management zone scale and is variable between WSPs. These planning units are used because they are the scale at which groundwater is managed and for which data is available in NSW. Water sources are planning units established by WSPs and there may be several water sources within a sustainable diversion limit (SDL) resource unit. Note that not all water sources have an assigned environmental or water quality objective and performance indicator.

There are two possible reasons for this:

- There are groundwater dependent assets in every water source, but some are not affected by extraction pressure (this is reflected in risk assessment results). Assuming extraction pressure doesn't change[1], these are considered most likely to maintain their current ecological condition, and were excluded from the MER sampling regime.
- Sites were prioritised for selection according to whether there was relevant historic data (from previous survey programs) at the site; whether it is currently included in a relevant survey program, and/or whether it can be accessed for field survey work (if required).

Thus, the frequency and type of monitoring activities conducted at each site will depend on the nature of the questions being investigated, the performance indicator, and the availability and type of data already available to inform the approach.

There is a core set of indicators that will always be monitored. Chief among these are groundwater levels and the measurement of take (see the WRP chapters 5.6 and 7.1, and Appendices A to J of this report), because the presence and abundance of water is a key driver of GDE condition, response and resilience. Water quality will also be included, as will data on vegetation extent and condition.

The NSW Department of Planning and Environment currently monitors groundwater level,pressure and quality through its network of groundwater observation bores across New South Wales (refer to Appendices A–K). The groundwater monitoring network plays an important role in:

- assessing groundwater conditions
- managing groundwater, including groundwater access and extraction
- providing data for the development of groundwater sharing plans.

[1] For some water sources this assumption will likely not hold. A key component of MER activities was to identify those water sources with high ecological value where extraction pressure could change (from 'low' to 'medium' or 'high'), so these could be included in the adaptive management regime.

Groundwater level and pressure data collected from monitoring bores can be plotted and analysed at a water source scale to assess long and short-term changes in the system, used to inform and calibrate models, and this data is used to identify areas where there may be a potential management issue. The manually monitored sites are read every four to twelve weeks. Groundwater level data is also available in real-time via telemetry from realtimedata.waternsw.com.au/water.stm.

For selected groundwater sources, the corresponding environmental objectives, performance indicators for potential MER areas are listed in Tables 3 and 4. Note that once MER projects are approved for the 2019/20 budget, this MER plan will be updated with any additional projects.

Water quality monitoring may be undertaken in the future if an appropriate monitoring program is approved and implemented. Potential monitoring locations are yet to be determined but would be guided by medium and high risk outcomes described in the relevant risk assessments for relevant water quality risks (i.e. R2, QL3 and QL5). Proposed salinity level monitoring would also inform the effectiveness of water management measures in meeting relevant water sharing plan objectives through salinity level performance indicators linked to environmental, economic, Aboriginal cultural and social objectives.

Table 3. Groundwater sources integrity objective with corresponding performance indicators and MER sites.

Objective	Performance indicators	Water source/management zone	Site(s)
Contribute to the protection of the integrity of these groundwater sources from impacts of groundwater extraction	• Groundwater level monitoring	Lachlan Alluvium	• Groundwater levels at approximately 250 sites (Appendix A, Figure 5)
	• Groundwater level monitoring	Gwydir Alluvium	• Groundwater levels at approximately 50 sites (Appendix B, Figure 8)
	• Groundwater level monitoring	Macquarie-Castlereagh Alluvium	• Groundwater levels at approximately 170 sites (Appendix C, Figure 11)
	• Groundwater level monitoring	NSW Border Rivers	• Groundwater levels at approximately 30 sites (Appendix D, Figure 14)
	• Groundwater level monitoring	Namoi Alluvium	• Groundwater levels at approximately 630 sites (Appendix E, Figure 17)
	• Groundwater level monitoring	Murray Alluvium	• Groundwater levels at approximately 90 sites (Appendix F, Figure 21)
	• Groundwater level monitoring	Murrumbidgee Alluvium	• Groundwater levels at approximately 230 sites (Appendix G, Figure 24)
	• Groundwater level monitoring	Darling Alluvium	• Groundwater levels at approximately 240 sites (Appendix H, Figure 27)
	• Groundwater level monitoring	NSW GAB Shallow	• Groundwater levels at approximately 120 sites (Appendix I, Figure 30)
	• Groundwater level monitoring	NSW MDB Fractured Rock	• Groundwater levels at approximately 60 sites (Appendix J, Figure 33)
	• Groundwater level monitoring	NSW MDB Porous Rock	• Groundwater levels at approximately 500 sites (Appendix K, Figure 34)

Note: The monitoring of groundwater levels within the MDB will be undertaken regardless of the risk assessment outcomes as this is required to provide resource information for characterisation of the groundwater sources and their response to climate and extraction.

Table 4. Vegetation GDE objective, corresponding performance indicators and MER sites.

Objective	Performance indicators	Water source/ management zones/ risk outcomes	Sites(s)
Protect, maintain or enhance the extent and condition of high priority groundwater dependent ecosystems, including target vegetation communities	Vegetation extent and condition • River red gum communities • Black box communities • Lignum communities • Blakely's red gum- yellow box woodlands EEC • Western grey box woodlands EEC Appendix A, Figure 6	**Lachlan Alluvium** Upper Lachlan Alluvial • High & medium risks	• Groundwater levels from approximately 150 sites (Appendix A, Figure 5) • Extent using MDBA extent mapping Condition using remote sensing vegetation indices for evaporation transpiration and other modelled information (e.g. stand condition assessment tool) (Collaboration work with Geoscience Australia and MDBA))
	Vegetation extent and condition • River red gum communities • Black box communities • Coolibah communities • Lignum communities • Coolibah-black box EEC Appendix A, Figure 6	**Lachlan Alluvium** Lower Lachlan Alluvial • High risk	• Groundwater levels from approximately 90 sites (Appendix A, Figure 5) • Extent using MDBA extent mapping Condition using remote sensing vegetation indices for evaporation transpiration and other modelled information (e.g. stand condition assessment tool) (Collaboration work with Geoscience Australia and MDBA))
	Vegetation extent and condition	**Lachlan Alluvium** Belubula Alluvial • Low risk	• Not monitoring for extent or condition due to low risk
	Vegetation extent and condition • River red gum communities • Coolibah communities • Lignum communities • Ramsar/DIWA wetlands Appendix B, Figure 9	**Gwydir Alluvium** Lower Gwydir Alluvial • High risk	• Groundwater levels from approximately 50 sites (Appendix B, Figure 8) • Extent using MDBA extent mapping • Condition using remote sensing vegetation indices for evaporation transpiration and other modelled information (e.g. stand condition assessment tool) (Collaboration work with Geoscience Australia MDBA) • DPE Biodiversity and Conservation undertake condition monitoring in Gwydir wetlands
	Vegetation extent and condition • River red gum communities Appendix B, Figure 9	**Gwydir Alluvium** Upper Gwydir Alluvial • High risk • No metered usage	• No monitoring bores located in this water source • Assumed that Gwydir regulated river is providing groundwater recharge in this area • No monitoring is proposed

Objective	Performance indicators	Water source/ management zones/ risk outcomes	Sites(s)
	Vegetation extent and condition • River red gum communities Appendix D, Figure 15	**NSW Border Rivers Alluvium** • Low risk • Medium risk in downstream of Keetah Bridge management zone	• No monitoring is proposed
	Vegetation extent and condition • River red gum communities Appendix C, Figure 12	**Macquarie-Castlereagh Alluvium** Lower Macquarie Management Zones 1 to 4 • High & medium risks	• Groundwater levels from approximately 130 sites (Appendix C, Figure 11) • Extent using MDBA extent mapping • Condition using remote sensing vegetation indices for evaporation transpiration and other modelled information (e.g. stand condition assessment tool) (Collaboration work with Geoscience Australia and MDBA)
	Vegetation extent and condition • River red gum communities Appendix C, Figure 12	**Macquarie-Castlereagh Alluvium** Upper Macquarie • Medium risk	• Groundwater levels from approximately 40 sites (Appendix C, Figure 11) • Extent using MDBA extent mapping • Condition using remote sensing vegetation indices for evaporation transpiration and other modelled information (e.g. stand condition assessment tool) (Collaboration work with Geoscience Australia and MDBA)
	Vegetation extent and condition Appendix C, Figure 12	**Macquarie-Castlereagh Alluvium** Talbragar • Medium risk	• No proposed monitoring due to limited high priority GDEs in this management zone
	Vegetation extent and condition Appendix C, Figure 12	**Macquarie-Castlereagh Alluvium** Bell, Castlereagh, Cudgegong • Low risk	• No proposed monitoring
	Vegetation extent and condition • River red gum communities • Coolibah communities • Lignum communities • Blakely's red gum- yellow box woodlands EEC • Western grey box woodlands EEC Appendix E, Figure 18	**Namoi Alluvium** Lower Namoi Alluvial • High risk	• Groundwater levels from approximately 250 sites (Appendix E, Figure 17) • Extent MDBA extent mapping • Condition using remote sensing vegetation indices for evaporation transpiration and other modelled information (e.g. stand condition assessment tool) (Collaboration work with Geoscience Australia and MDBA)

Objective	Performance indicators	Water source/ management zones/ risk outcomes	Sites(s)
	Vegetation extent and condition • River red gum communities • Coolibah communities • Lignum communities • Blakely's red gum- yellow box woodlands EEC • Western grey box woodlands EEC Appendix E, Figure 18	**Namoi Alluvium** Upper Namoi Alluvial management zones 2 to 5, 7 to 9 & 11 • High & medium risks	• Groundwater levels from approximately 330 sites (Appendix E, Figure 17) • Extent using MDBA extent mapping • Condition using remote sensing vegetation indices for evaporation transpiration and other modelled information (e.g. stand condition assessment tool) (Collaboration work with Geoscience Australia and MDBA)
	Vegetation extent and condition • River red gum communities • Blakely's red gum- yellow box woodlands EEC Appendix E, Figure 18	**Namoi Alluvium** Peel Alluvial • Medium risk	• No proposed monitoring due to limited High Priority GDEs in the water source which is limited to the narrow riparian zone
	Vegetation extent and condition Appendix E, Figure 18	**Namoi Alluvium** Upper Namoi management zones 1, 6, 10 & 12, Manilla and Upper Namoi Tributaries Alluvial • Low risk	• No proposed monitoring
	Vegetation extent and condition Appendix F, Figure 22	**Murray Alluvium** Billabong Alluvial • Low risk	• No proposed monitoring
	Vegetation extent and condition • River red gum communities Appendix F, Figure 22	**Murray Alluvium** Upper Murray Alluvial • High risk	• Groundwater levels from approximately 20 sites (Appendix F, Figure 21) • Extent using MDBA extent mapping • Condition using remote sensing vegetation indices for evaporation transpiration and other modelled information (e.g. stand condition assessment tool) (Collaboration work with Geoscience Australia and MDBA)

Objective	Performance indicators	Water source/ management zones/ risk outcomes	Sites(s)
	Vegetation extent and condition • River red gum communities • Black box communities Ramsar/DIWA wetlands Appendix F, Figure 22	**Murray Alluvium** Lower Murray shallow • Medium risk	• Groundwater levels from approximately 30 sites (Appendix F, Figure 21) • Extent using MDBA extent mapping • Condition using remote sensing vegetation indices for evaporation transpiration and other modelled information (e.g. stand condition assessment tool) (Collaboration work with Geoscience Australia and MDBA)
	Vegetation extent and condition • River red gum communities Appendix G, Figure 25	**Murrumbidgee Alluvium** Wagga Wagga Alluvial, Gundagai & Mid Murrumbidgee Zone 3 • Medium risk	• Groundwater levels from approximately 130 sites (Appendix G, Figure 24) • Extent using MDBA extent mapping • Condition using remote sensing vegetation indices for evaporation transpiration and other modelled information (e.g. stand condition assessment tool) (Collaboration work with Geoscience Australia and MDBA)
	Vegetation extent and condition • River red gum communities • Coolibah communities • Lignum communities • Black box communities • Western grey box woodlands EEC • Ramsar/DIWA wetlands Appendix G, Figure 25	**Murrumbidgee Alluvium** Lower Murrumbidgee Shallow • Medium risk	• Groundwater levels from approximately 241 sites (Appendix G, Figure 24). • Extent using MDBA extent mapping. • Condition using remote sensing vegetation indices for evaporation transpiration and other modelled information (e.g. stand condition assessment tool) (Collaboration work with Geoscience Australia and MDBA).
	Vegetation extent and condition Appendix G, Figure 25	**Murrumbidgee Alluvium** Bungendore & Kyeamba management zones • Low risk	• No proposed monitoring
	Vegetation extent and condition Appendix H, Figure 28	**Darling Alluvium** • Low risk	• No proposed monitoring

Objective	Performance indicators	Water source/ management zones/ risk outcomes	Sites(s)
	Vegetation extent and condition Ramsar/DIWA wetlands Appendix K, Figure 31	**NSW Great Artesian Basin Shallow** Surat Shallow • Medium risk	• DPE Biodiversity and Conservation undertake condition monitoring in Macquarie Marshes, Gwydir wetlands
	Vegetation extent and condition Appendix I, Figure 31	**NSW Great Artesian Basin Shallow** Warrego & Central • Low risk	• No proposed monitoring
		NSW MDB Porous Rock • High (Gunnedah-Oxley Basin MDB) , medium (Western Porous Rock) & low risks	• No proposed monitoring, information gained from monitoring in other areas will be transferred.
		NSW MDB Fractured Rock • Medium (Lachlan Fold Belt & Peel Fractured) & low risks	• No proposed monitoring, information gained from monitoring in other areas will be transferred.

Note: Risks in this plan are derived from the risk assessments which form Schedule D to the relevant WRP.

4. Evaluation and reporting

Overall WSP evaluation is a systematic, evidence-based review of its success at protecting, maintaining, and/or improving environmental, social and cultural, and economic outcomes. This includes consideration of whether the water sharing rules were enacted according to the WSP, its operational efficiency and effectiveness, and identification of the factors that enable or act as barriers to achieving the desired outcomes. WSP evaluation seeks to explain why a particular outcome occurred, whether and how well a WSP rule was implemented, what the outcomes were, and what should be done in future in light of the findings[2]. The evaluation of a WRP will be undertaken using the same evaluation framework.

In the context of evaluating environmental outcomes in the Murray–Darling Basin, data from monitoring activities will be analysed to determine whether:

- the water-sharing provisions in the WSP are sufficient to satisfy the WM Act and Basin Plan requirements to protect, enhance and restore water sources, their associated ecosystems, ecological processes and biological diversity, and their water quality
- the approach adopted in this MER Plan provides timely and cost-effective information for adaptive management
- conceptual models used to guide development of the experimental design and survey regime are appropriate
- expected outcomes were achieved, and the contribution of the WSP rules to those outcomes.

4.1. Reporting

Reports on the findings of NSW monitoring activities in the MDB in relation to environmental outcomes will be customised to meet the particular requirements of Basin Plan Schedule 12 (Matters 4, 8, 9, 10, 12, 14, 18 and 19)[3]. Reporting frequency could be annual, five- or ten-yearly, although this doesn't preclude other analysis and reporting based on the most sensible response timescales for groundwater dependent assets. A summary of the various reporting requirements, their frequency and next due dates is provided in Table 5.

Table 5. Timing of various reporting requirements for the Groundwater MER Plan.

Requirement	Matter	Frequency
Basin Plan	Schedule 12, Matter 4: The effectiveness of management of risks to water resources	Annually
Basin Plan	Schedule 12, Matter 8: The achievement of environmental outcomes at an asset scale	Five-yearly
Basin Plan	Schedule 12, Matter 9: The identification of environmental water and the monitoring of its use	Annually
Basin Plan	Schedule 12, Matter 10 The implementation of the environmental management framework (Part 4 of Chapter 10)	Annually
Basin Plan	Schedule 12, Matter 12: Progress towards the water quality targets in chapter 9	Five-yearly

[2] Refer to DPI (2017) *Evaluation of NSW Water Sharing Plans for the Major Regulated Rivers in the Murray–Darling Basin* for a full explanation of the recent NSW WSP evaluation approach, findings and recommendations.

[3] Matters 8, 9, 12 and 19 are core matters requiring monitoring of water resources in order to report on them. The monitoring of these core matters will inform the reporting of other matters such as 4, 10, 14 and 18 which do not require further resources monitoring.

Requirement	Matter	Frequency
Basin Plan	Schedule 12, Matter 14: The implementation of the water quality and salinity management plan, including the extent to which regard is had to the targets in Chapter 9 when making flow management decisions.	Annual
Basin Plan	Schedule 12, Matter 18: The efficiency and effectiveness of the operation of water resource plans, including providing a robust framework under a changing climate	Five-yearly
Basin Plan	Schedule 12, Matter 19: Compliance with water resource plans	Annually

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DPI, 2017d. *NSW Border Rivers Alluvium Water Resource Plan: NSW Border Rivers alluvium resource description.* NSW Department of Primary Industries, Water Resource Management Unit, Sydney.

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Appendix A. Lachlan Alluvium WRP

This appendix of the groundwater WRP MER Plan applies to all groundwater sources located in the Lachlan Alluvium WRP area (see Figure 1 in the resource description report). The Lachlan Alluvium water resource plan: Lachlan Alluvium resource description (DPI, 2017a) provides a detailed description of the plan area including history, land use and topography, environmental assets and river operations and management.

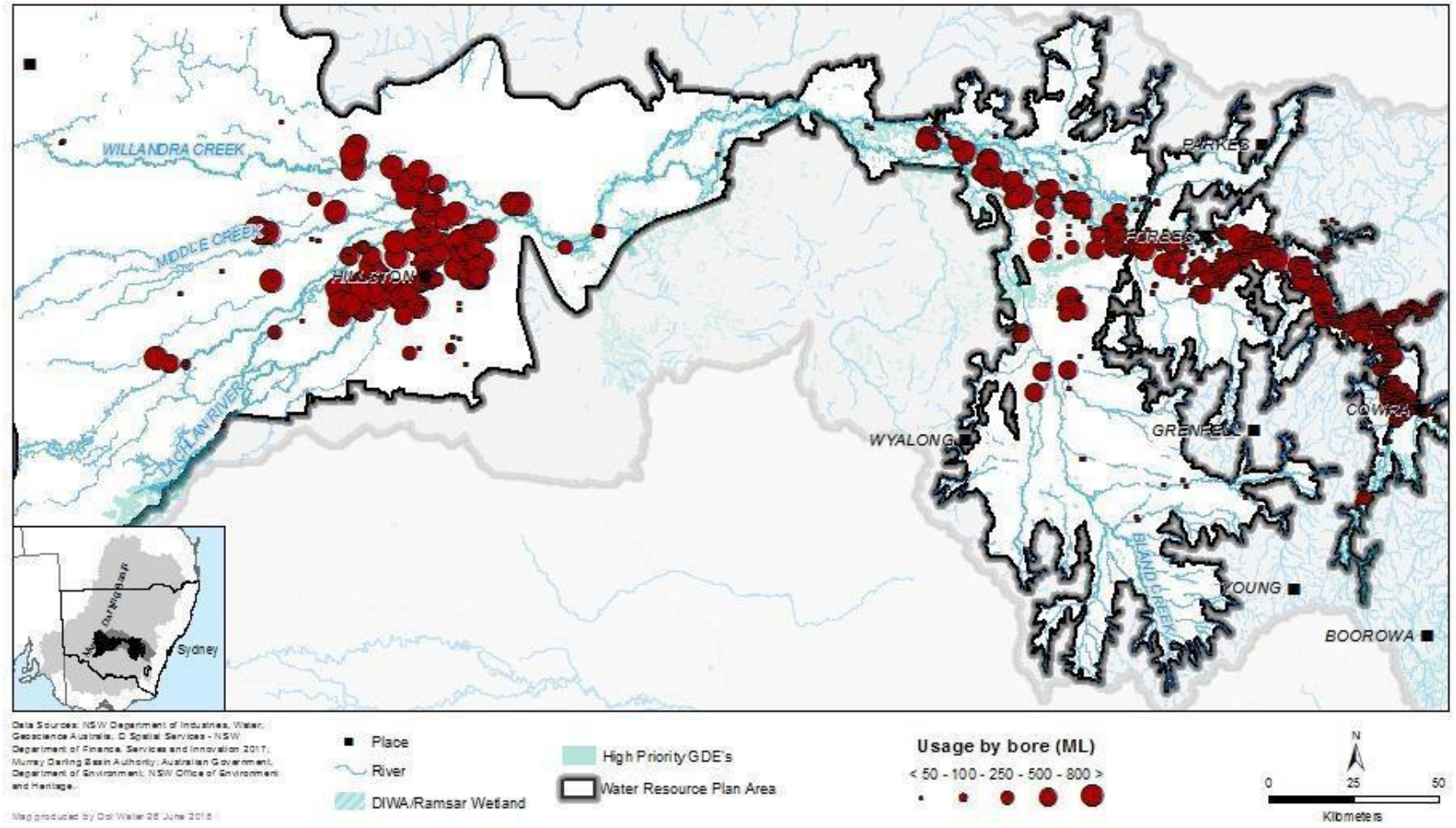

Figure 4. Average metered groundwater extraction in the Lachlan Alluvium WRPA from 2007 to 2016.

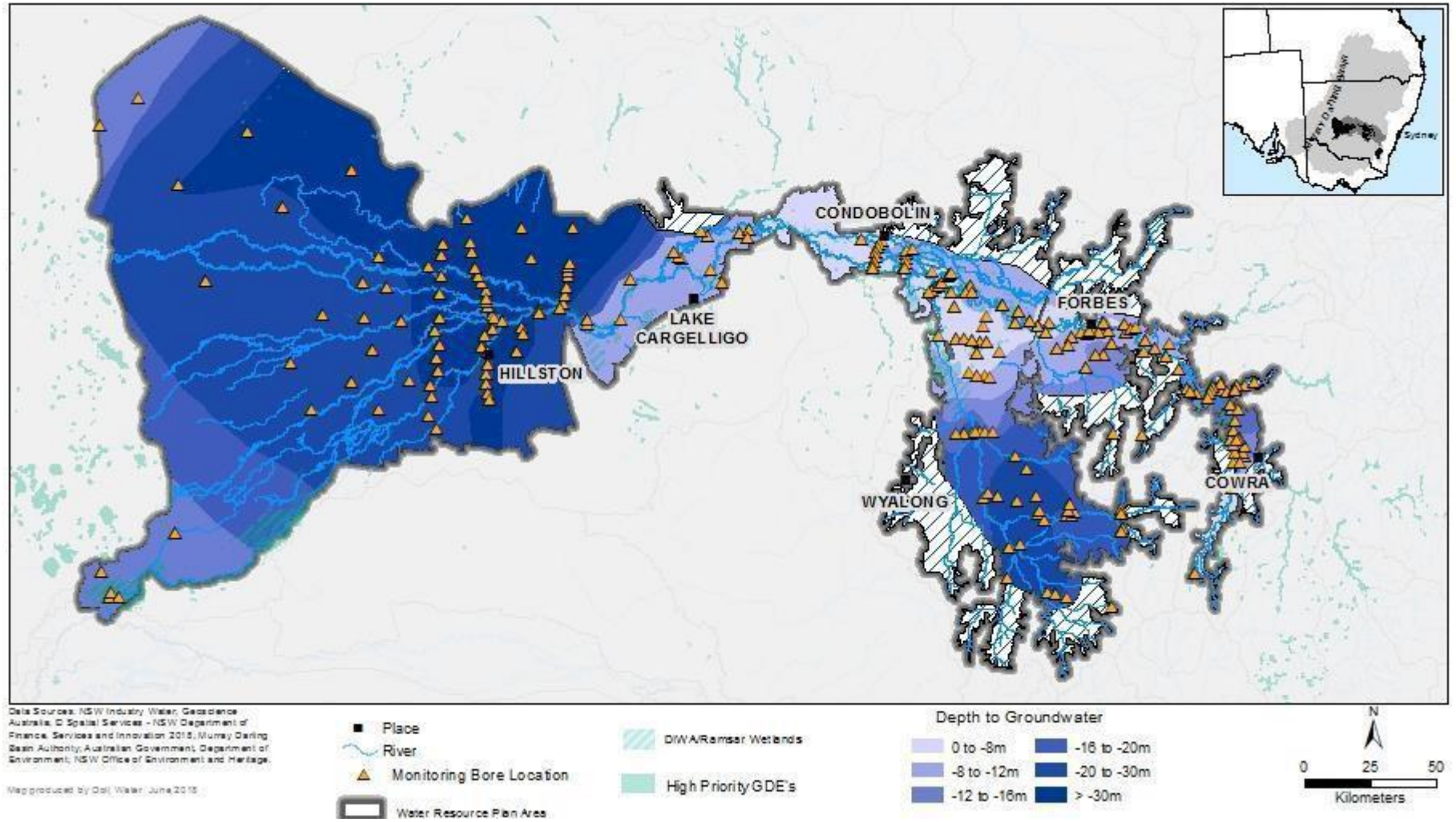

Figure 5. Monitoring bore locations with depth to water table below ground level for 2015/16.

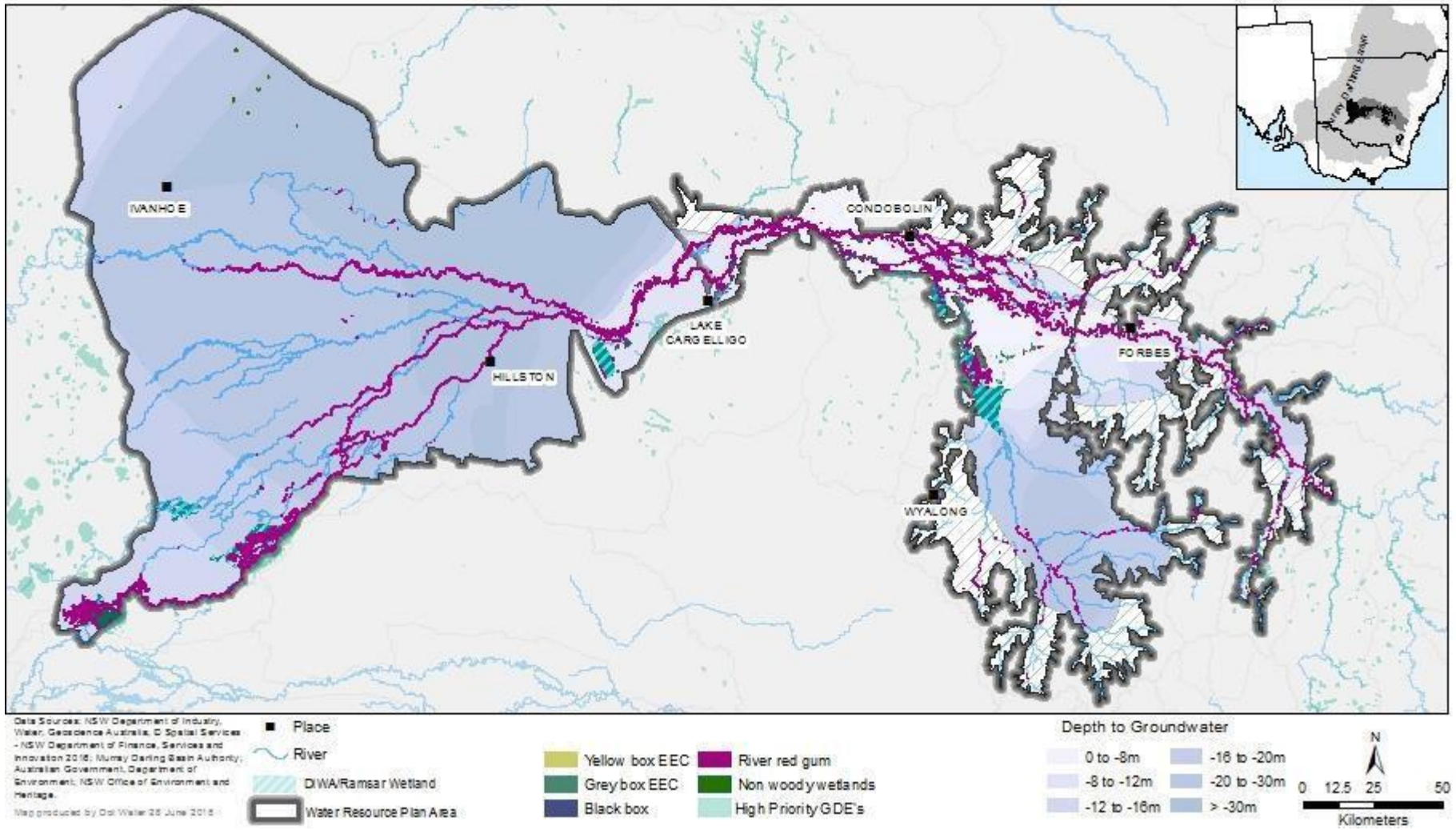

Figure 6. Vegetation GDE performance indicators within the Lachlan Alluvium WRPA.

Appendix B. Gwydir Alluvium WRP

This appendix of the groundwater WRP MER Plan applies to all groundwater sources located in the Gwydir Alluvium WRP area (see Figure 1 in the resource description report). The *Gwydir Alluvium water resource plan: Gwydir Alluvium resource description* (DPI, 2017b) provides a detailed description of the plan area including history, land use and topography, environmental assets and river operations and management.

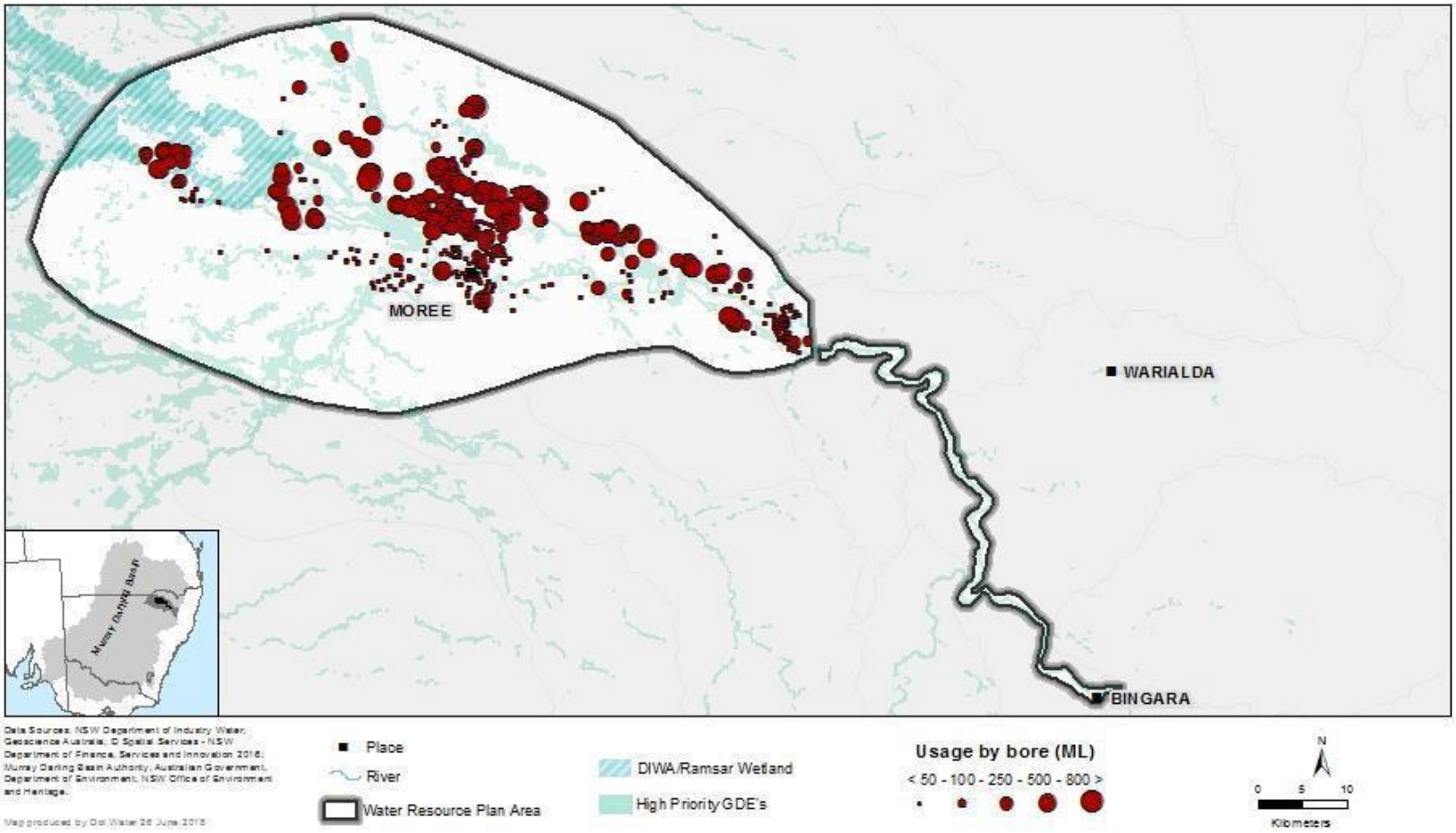

Figure 7. Average metered groundwater extraction in the Gwydir Alluvium WRPA from 2007 to 2016.

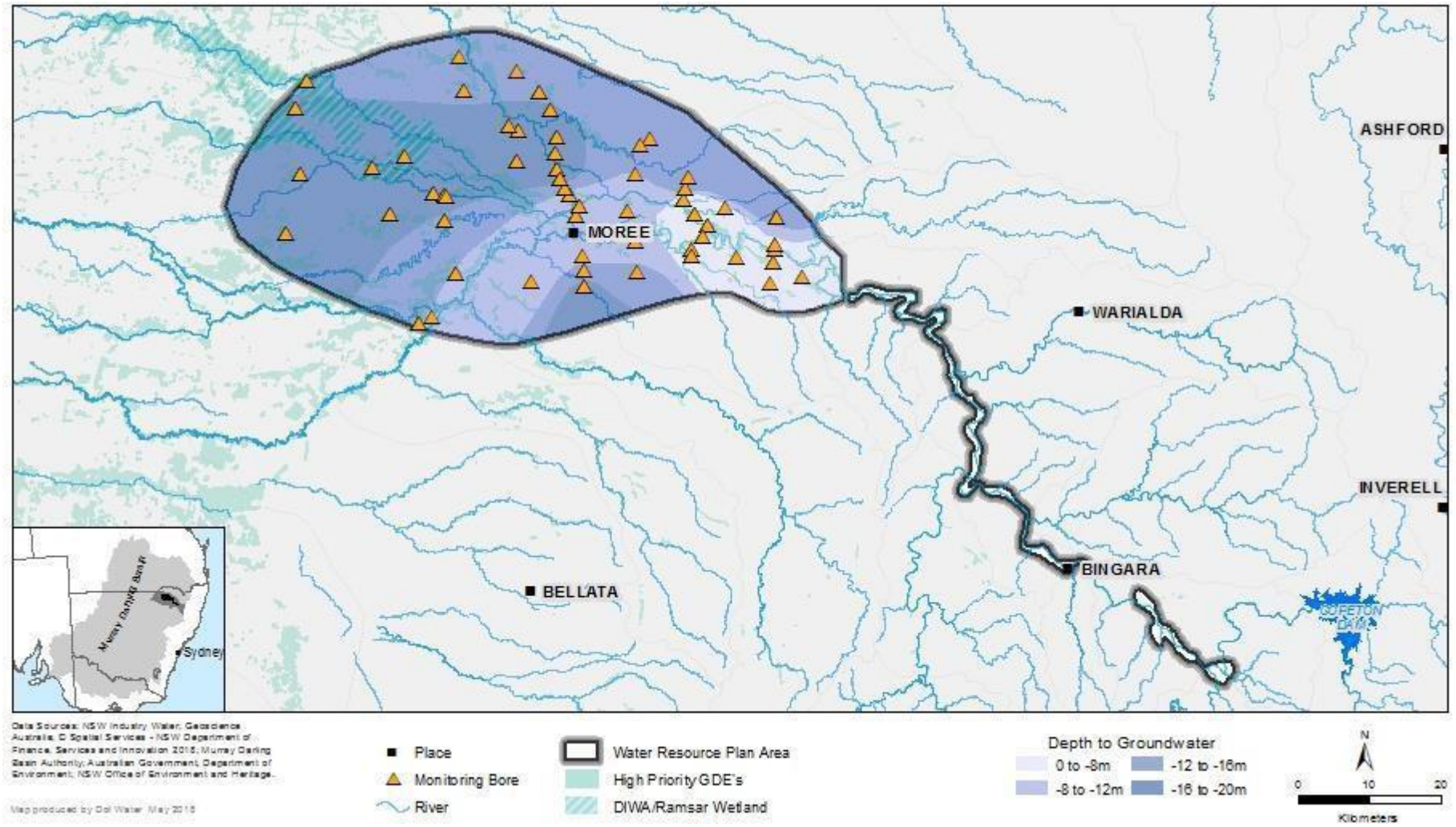

Figure 8. Monitoring bore locations with depth to water table below ground level for 2015/16.

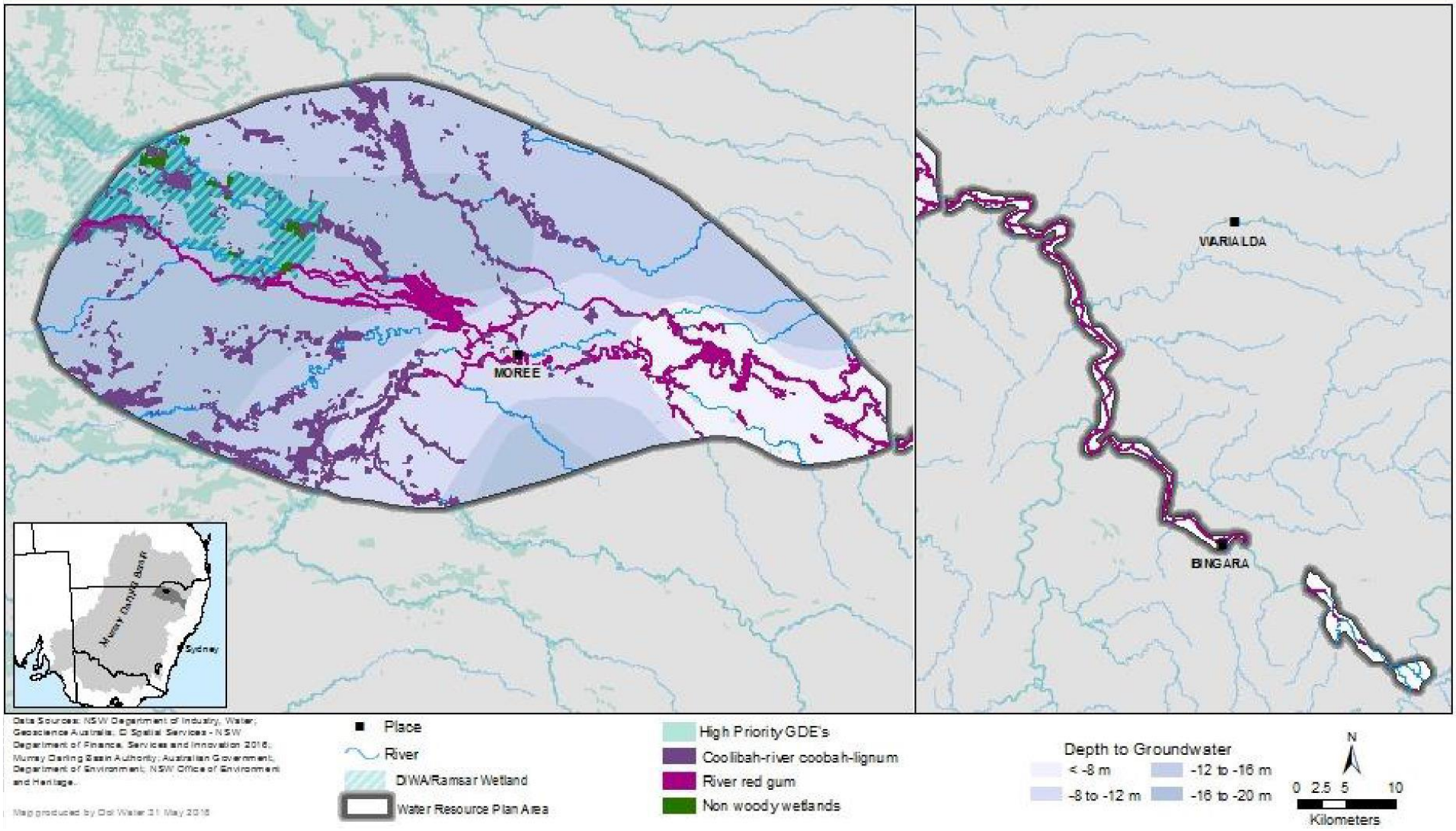

Figure 9. Vegetation GDE performance indicators within the Gwydir Alluvium WRPA.

Appendix C. Macquarie-Castlereagh Alluvium WRP

This appendix of the groundwater WRP MER Plan applies to all groundwater sources located in the Macquarie-Castlereagh Alluvium WRP area (see Figure 1 in the resource description report). The Macquarie-Castlereagh Alluvium water resource plan: Macquarie-Castlereagh Alluvium resource description (DPI, 2017c) provides a detailed description of the plan area including history, land use and topography, environmental assets and river operations and management.

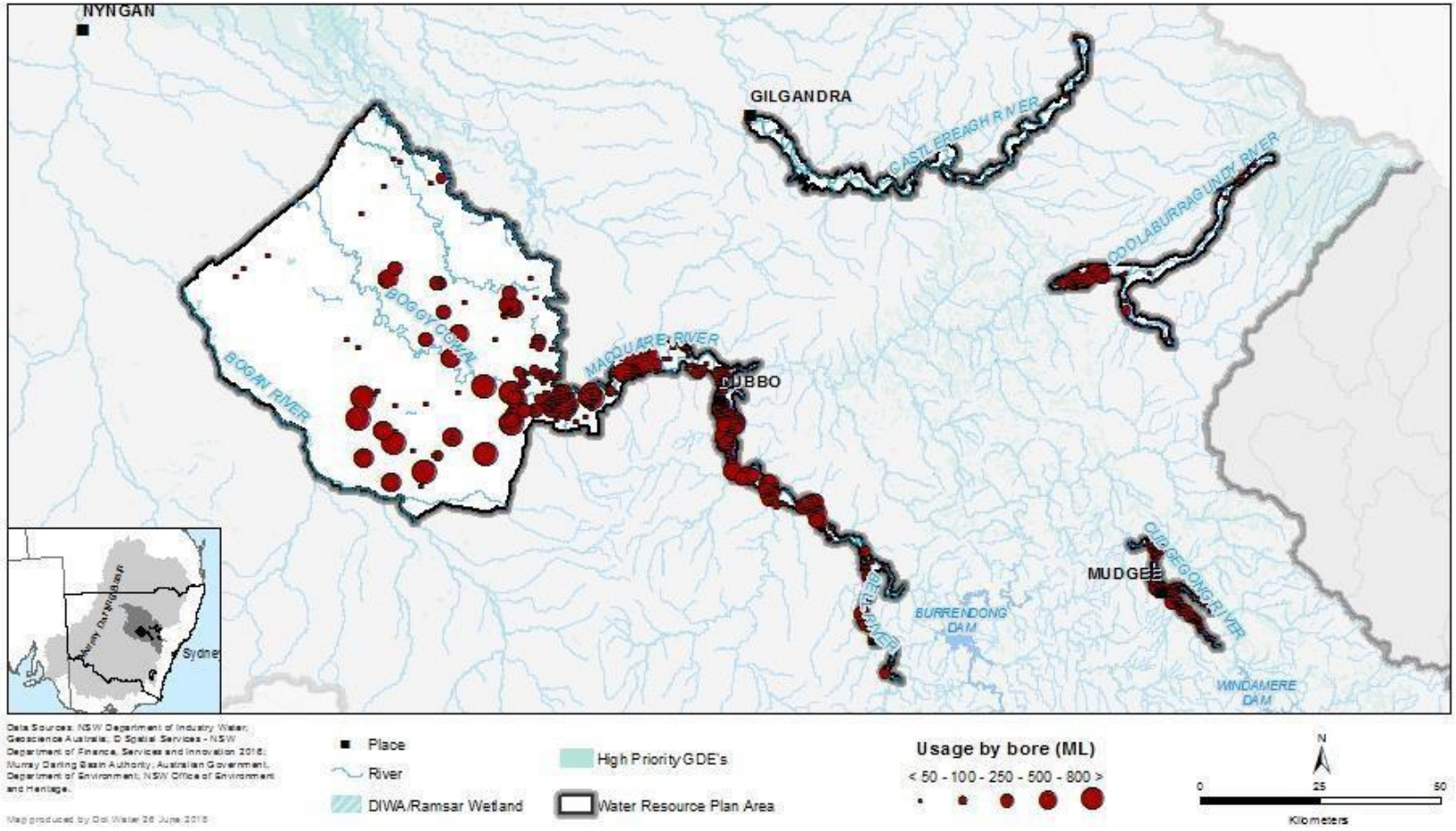

Figure 10. Average metered groundwater extraction in the Macquarie-Castlereagh Alluvium WRPA from 2007 to 2016.

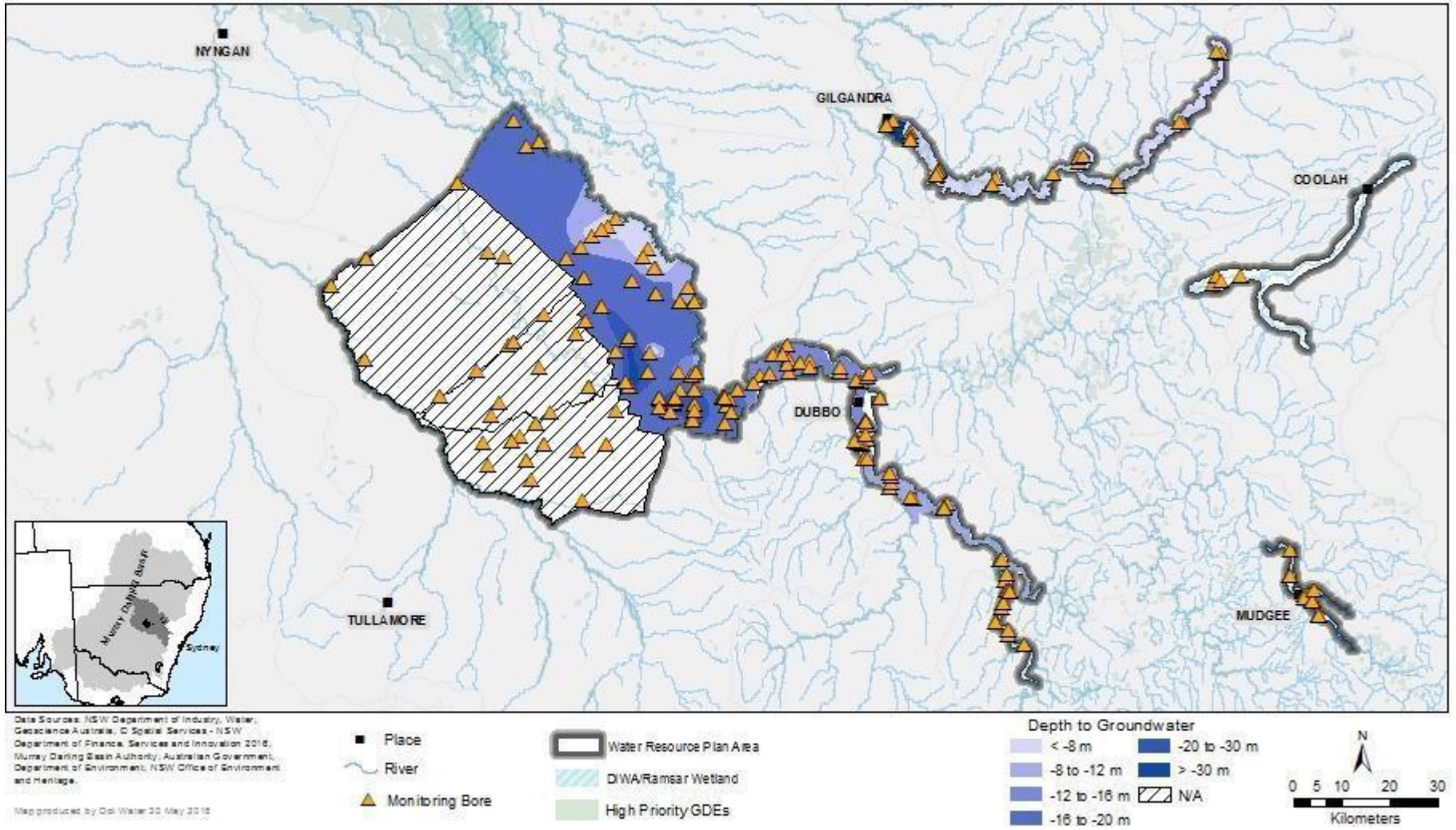

Figure 11. Monitoring bore locations with depth to water table below ground level for 2015/16.

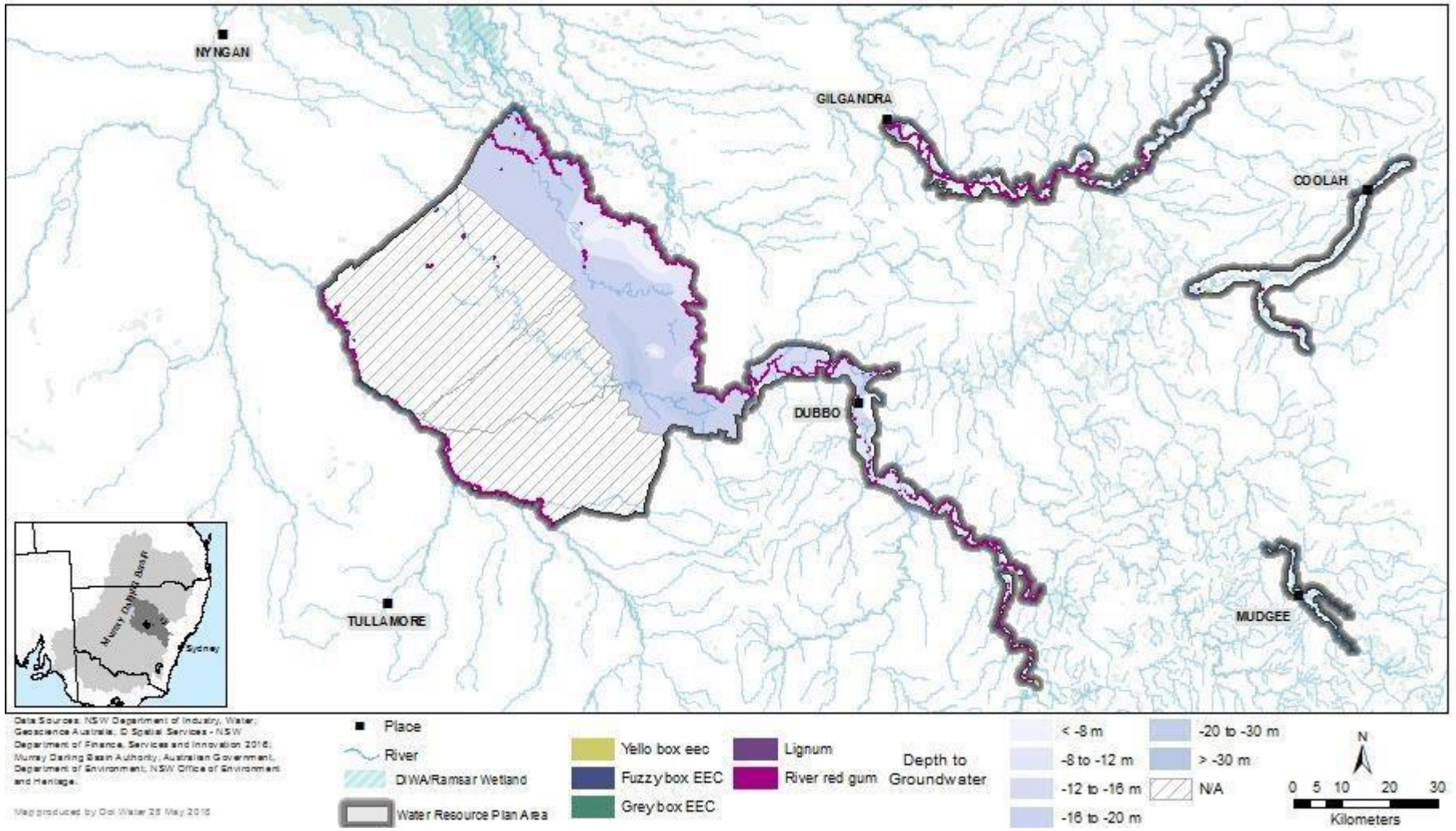

Figure 12. Vegetation GDE performance indicators within the Macquarie-Castlereagh Alluvium WRPA.

Appendix D. NSW Border Rivers Alluvium WRP

This appendix of the groundwater WRP MER Plan applies to all groundwater sources located in the NSW Border Rivers Alluvium WRP area (see Figure 1 in the resource description report). The *NSW Border Rivers Alluvium water resource plan: NSW Border Rivers Alluvium resource description* (DPI, 2017d) provides a detailed description of the plan area including history, land use and topography, environmental assets and river operations and management.

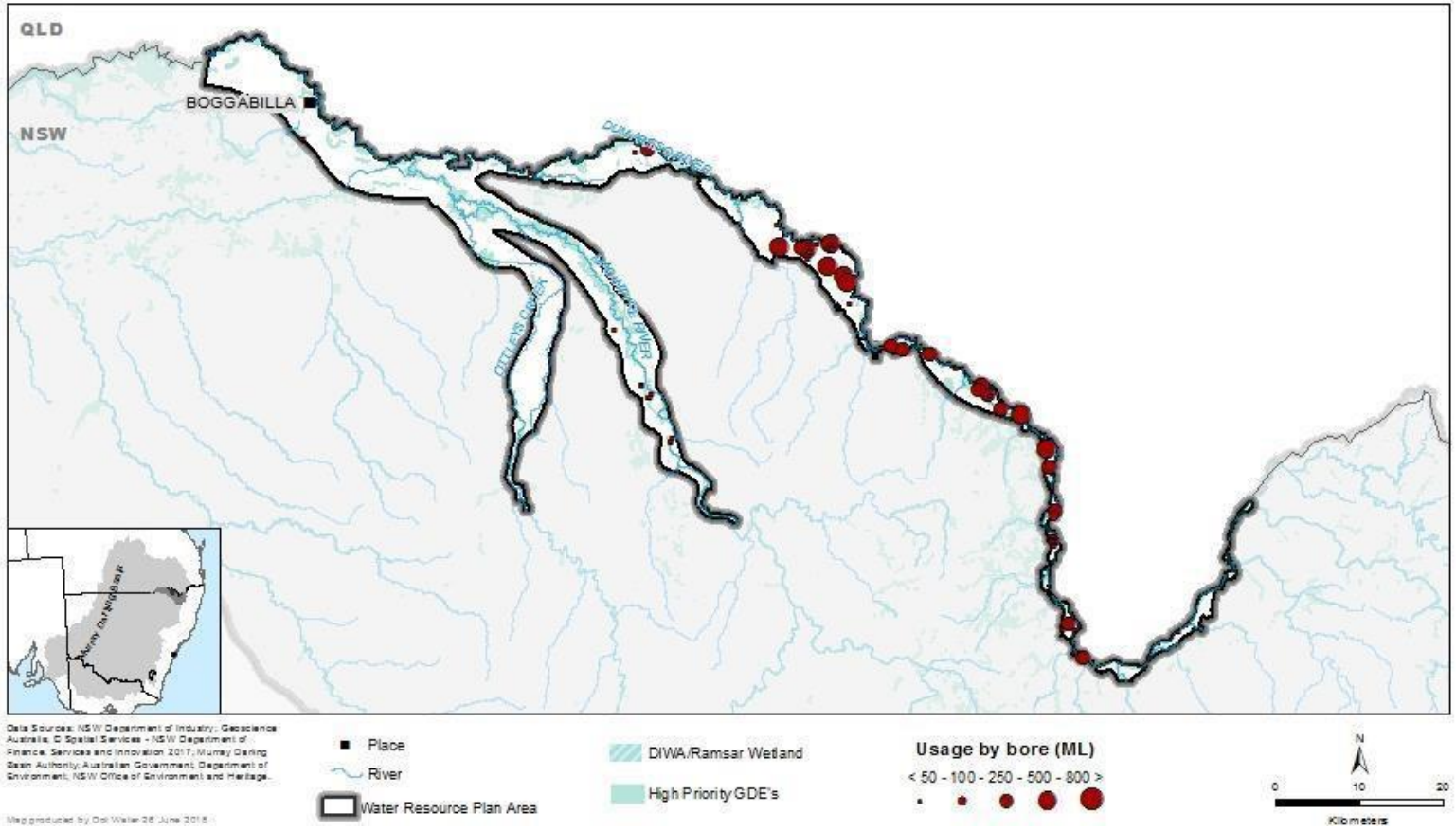

Figure 13. Average metered groundwater extraction in the NSW Border Rivers Alluvium WRPA from 2007 to 2016.

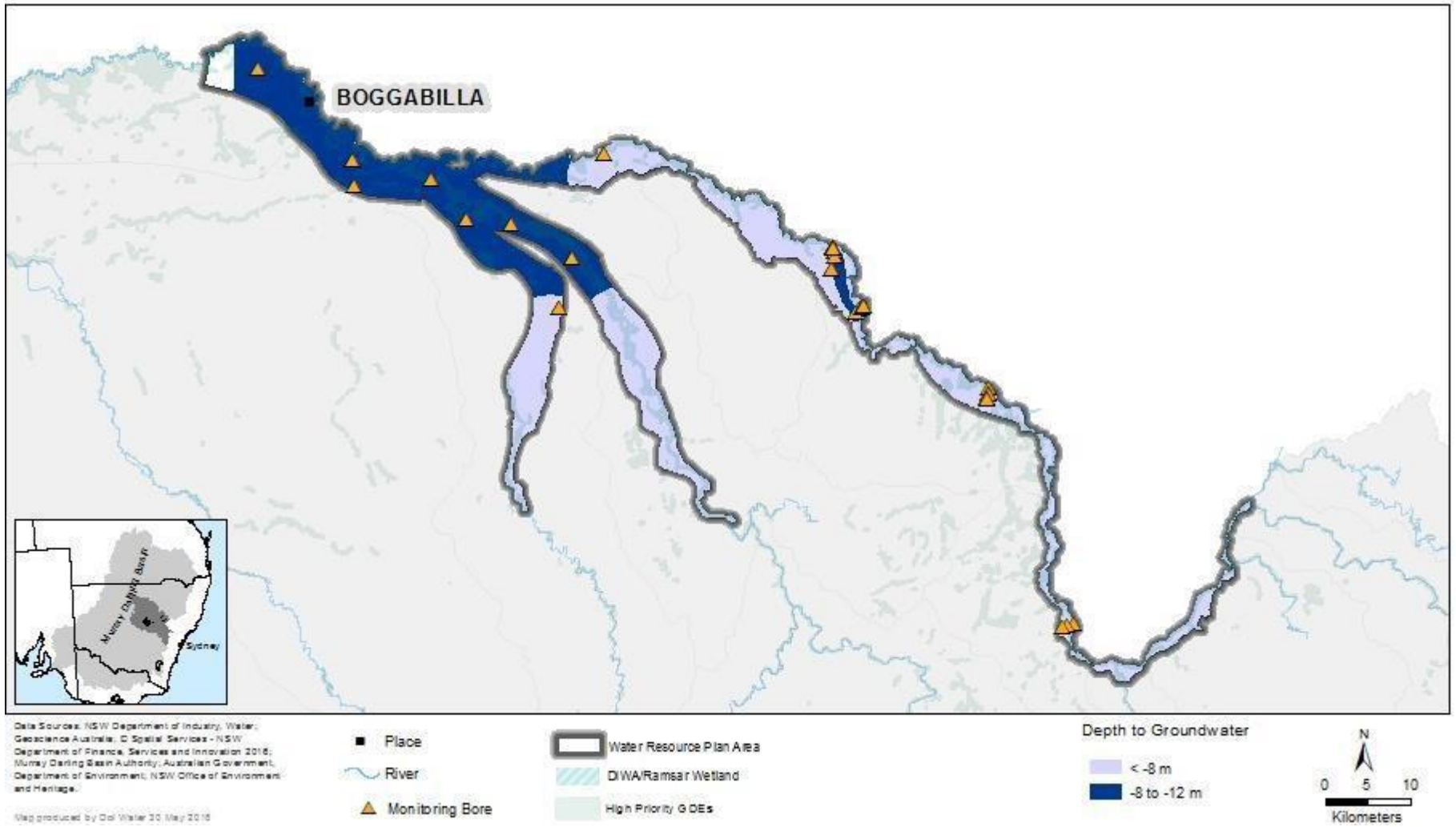

Figure 14. Monitoring bore locations with depth to water table below ground level for 2015/16.

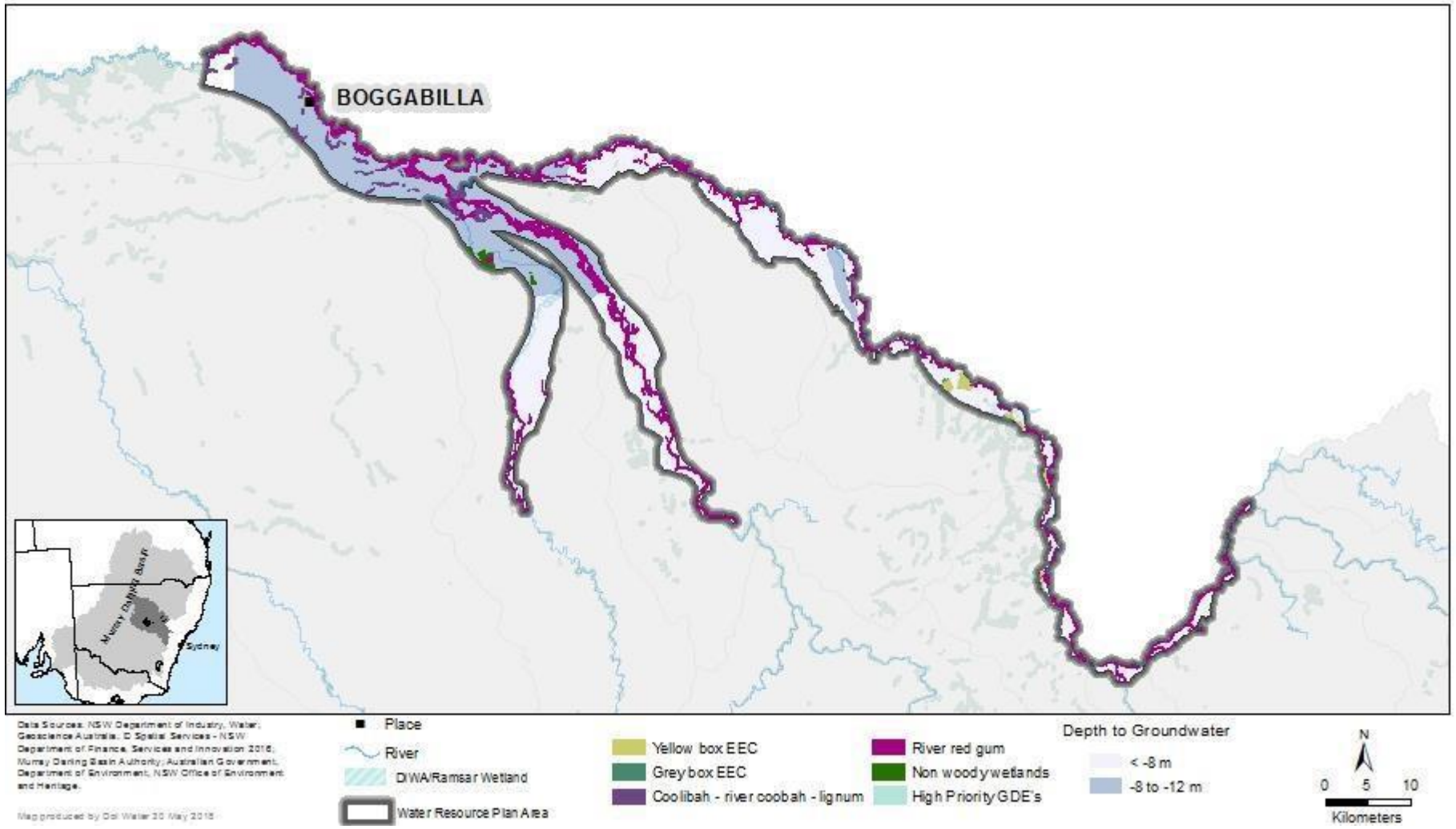

Figure 15. Vegetation GDE performance indicators within the NSW Border Rivers Alluvium WRPA.

Appendix E. Namoi Alluvium WRP

This appendix of the groundwater WRP MER Plan applies to all groundwater sources located in the Namoi Alluvium WRP area (see Figure 1 in the resource description report). The Namoi Alluvium water resource plan: Namoi Alluvium resource description (DPI, 2017e) provides a detailed description of the plan area including history, land use and topography, environmental assets and river operations and management.

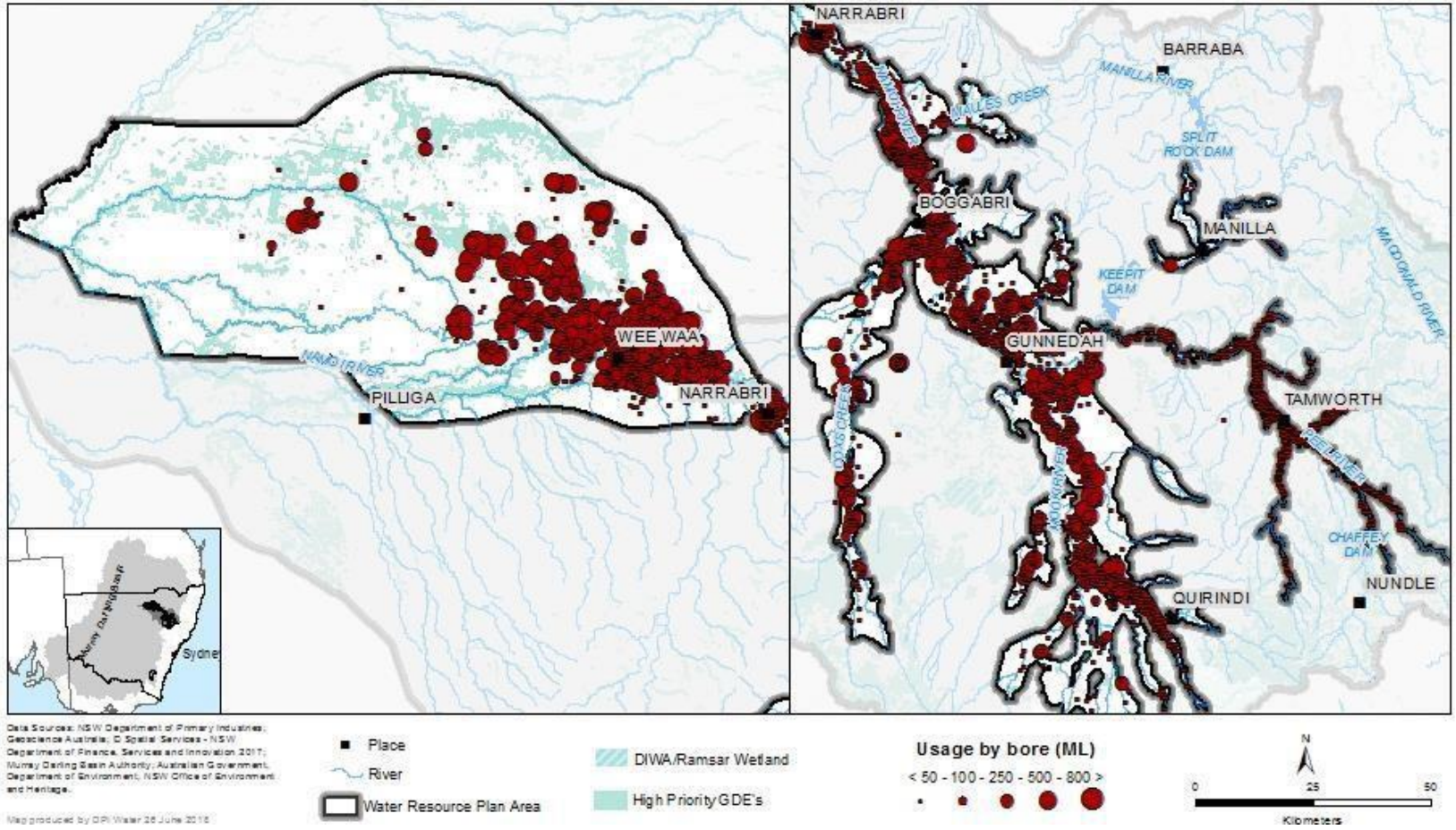

Figure 16. Average metered groundwater extraction in the Namoi Alluvium WRPA from 2007 to 2016.

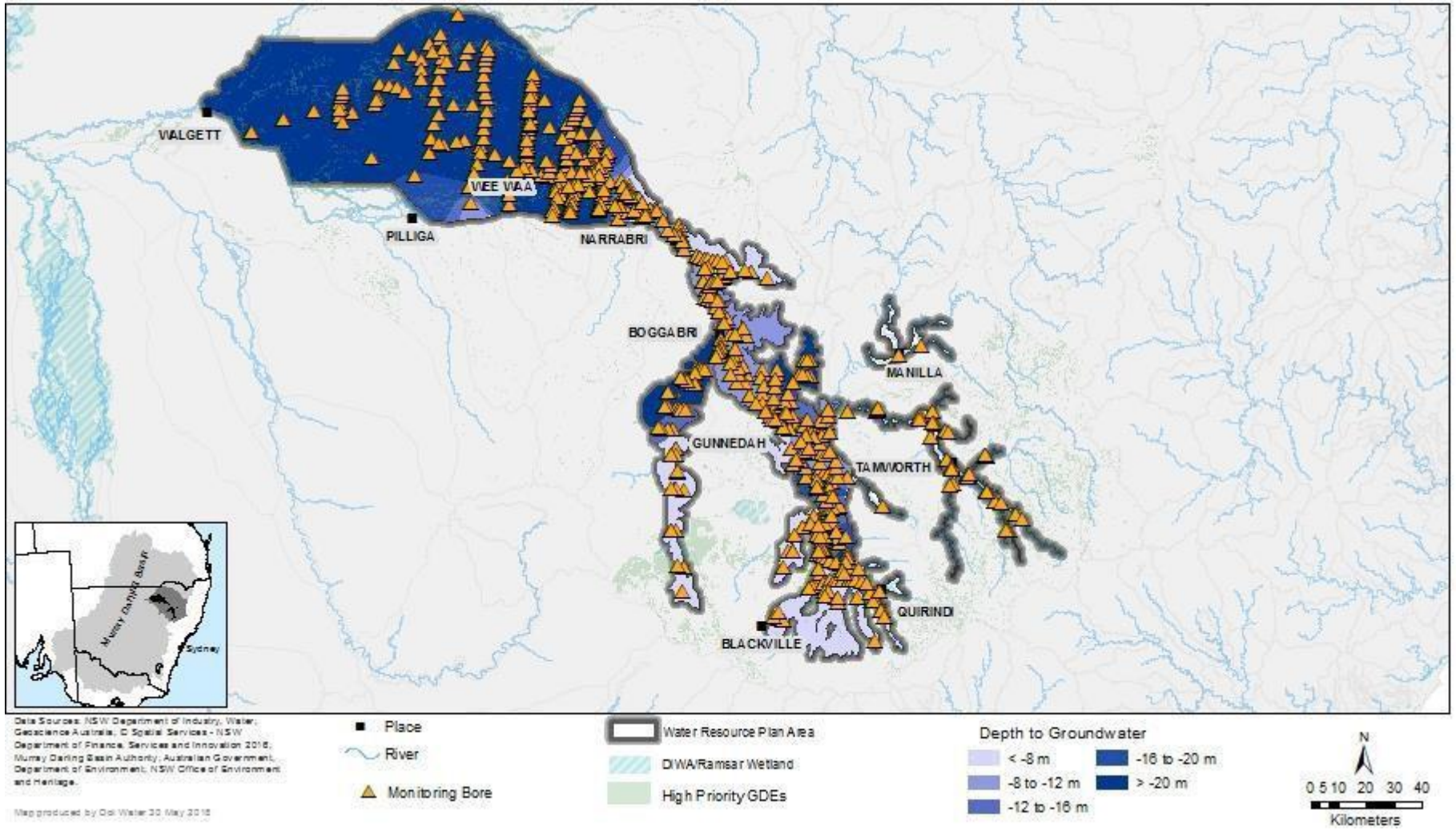

Figure 17. Monitoring bore locations with depth to water table below ground level for 2015/16.

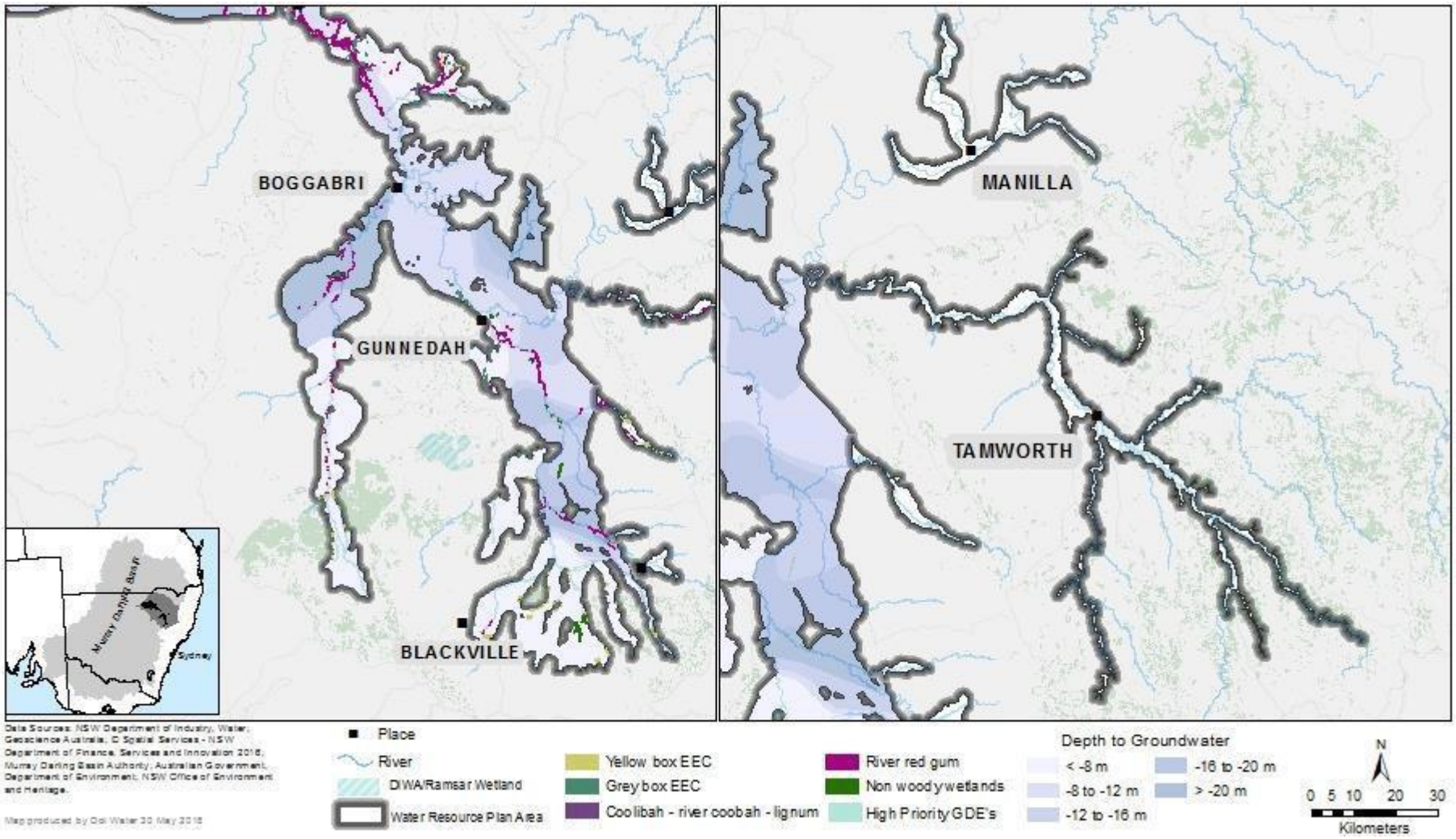

Figure 18. Vegetation GDE performance indicators within the Upper Namoi, Peel and Manilla Alluvial Groundwater Sources.

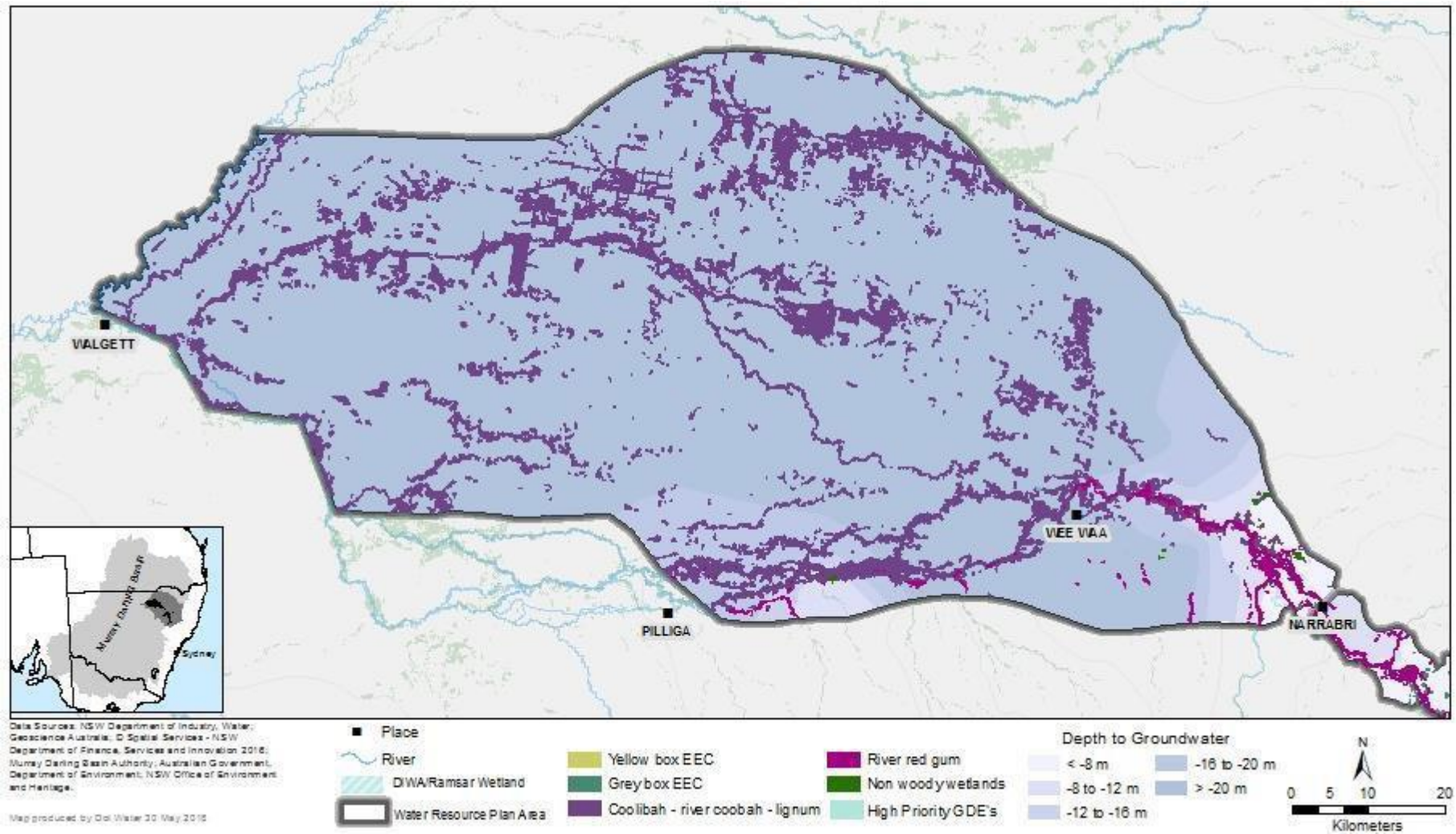

Figure 19. Vegetation GDE performance indicators within the Lower Namoi Alluvial Groundwater Source 2016.

Appendix F. Murray Alluvium WRP

This appendix of the groundwater WRP MER Plan applies to all groundwater sources located in the Murray Alluvium WRP area (see Figure 1 in the resource description report). The *Murray Alluvium water resource plan: Murray Alluvium resource description* (DPI, 2017f) provides a detailed description of the plan area including history, land use and topography, environmental assets and river operations and management.

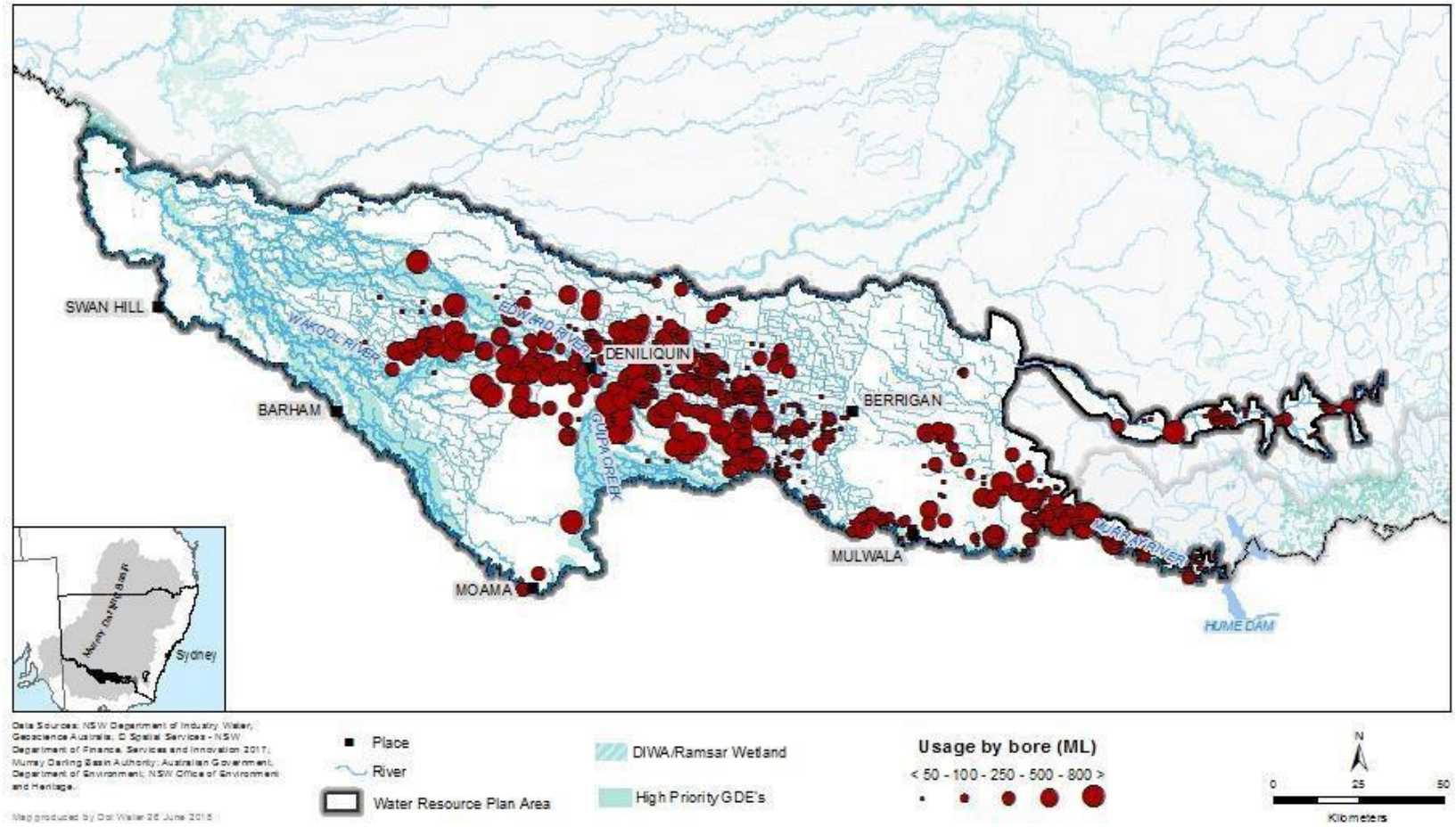

Figure 20. Average metered groundwater extraction in the Murray Alluvium WRPA from 2007 to 2016.

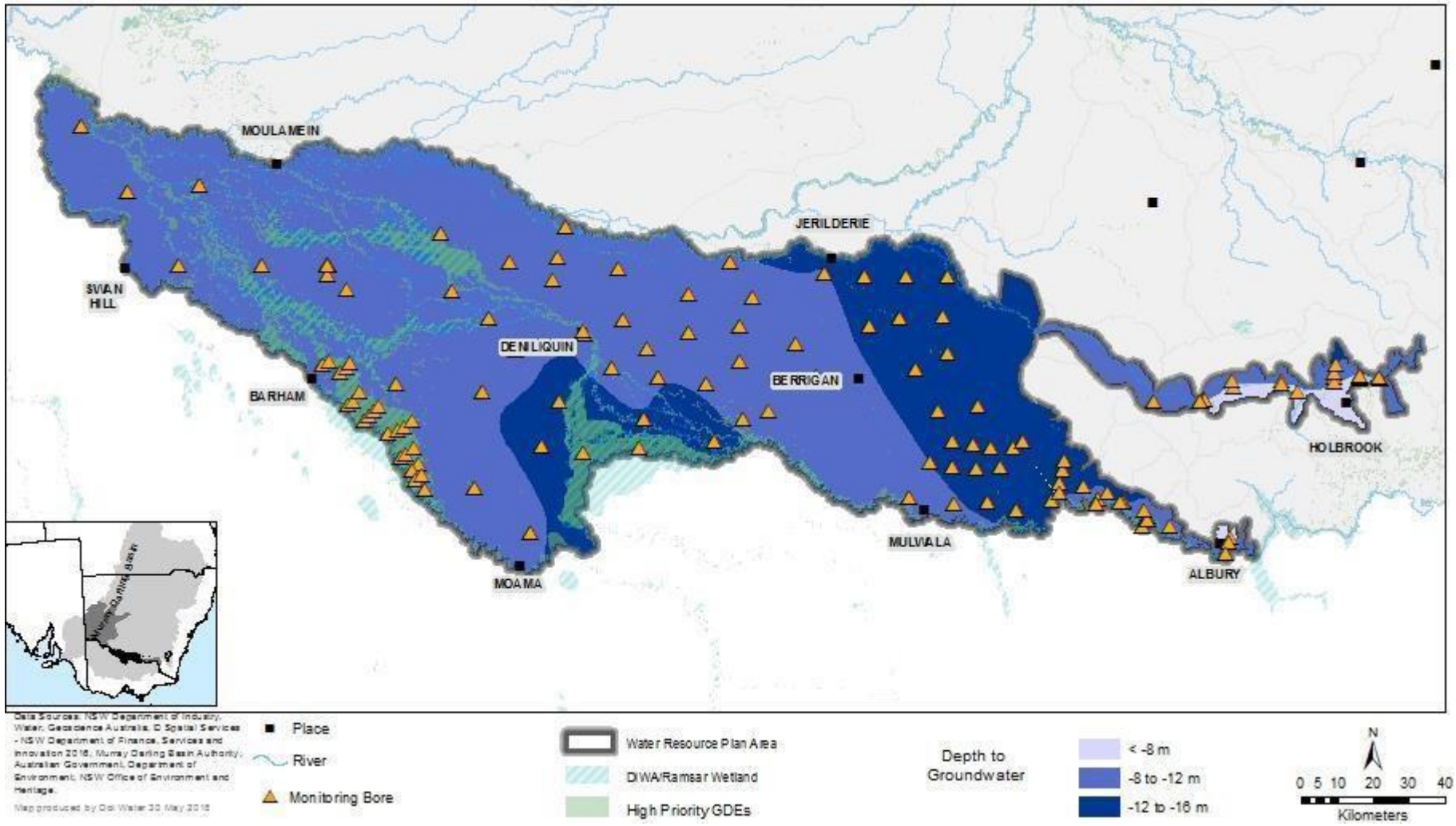

Figure 21. Monitoring bore locations with depth to water table below ground level for 2015/16.

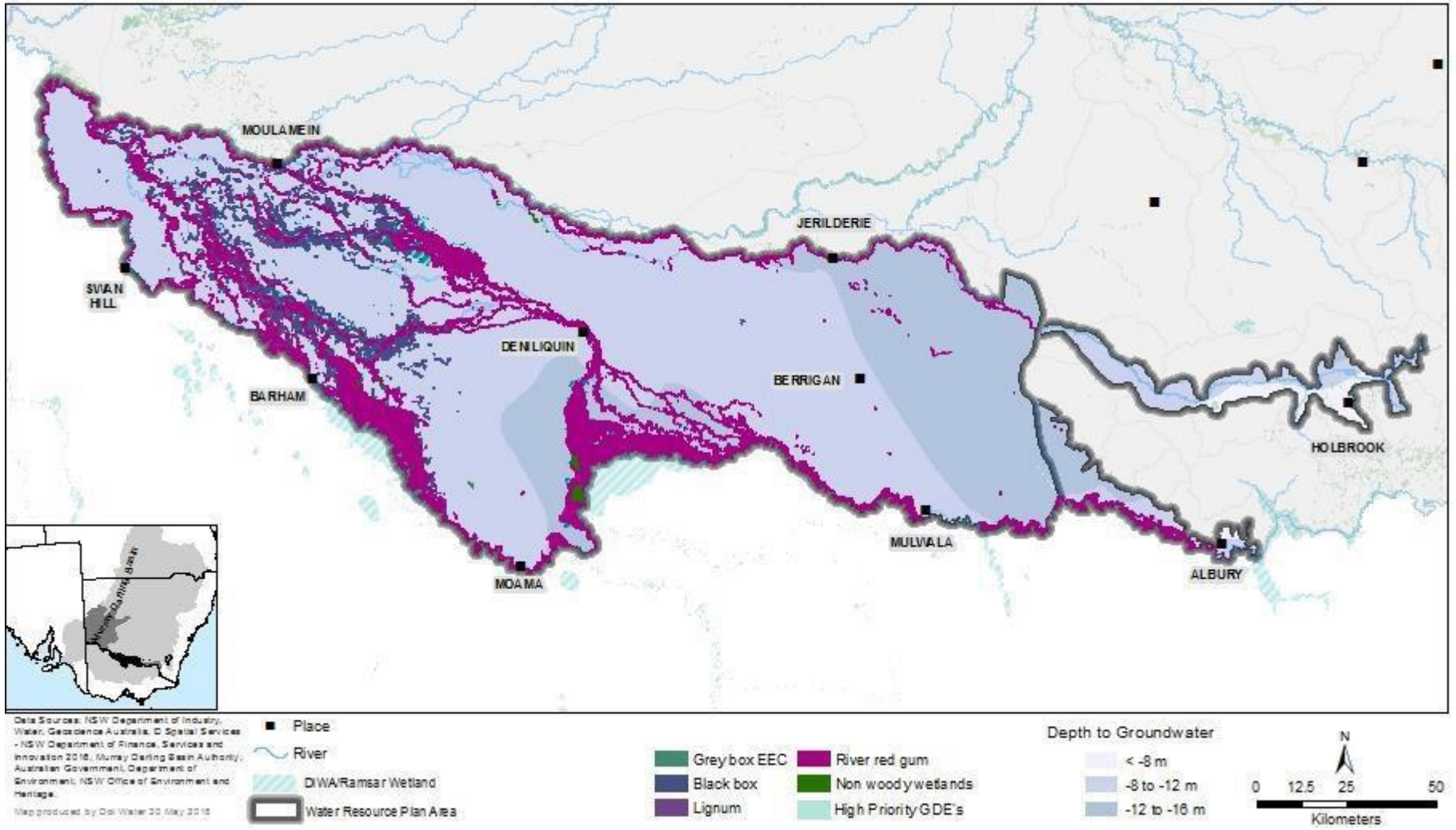

Figure 22. Vegetation GDE performance indicators within the Murray Alluvium WRPA.

Appendix G. Murrumbidgee Alluvium WRP

This appendix of the groundwater WRP MER Plan applies to all groundwater sources located in the Murrumbidgee Alluvium WRP area (see Figure 1 in the resource description report). The *Murrumbidgee Alluvium water resource plan: Murrumbidgee Alluvium resource description* (DPI, 2017g) provides a detailed description of the plan area including history, land use and topography, environmental assets and river operations and management.

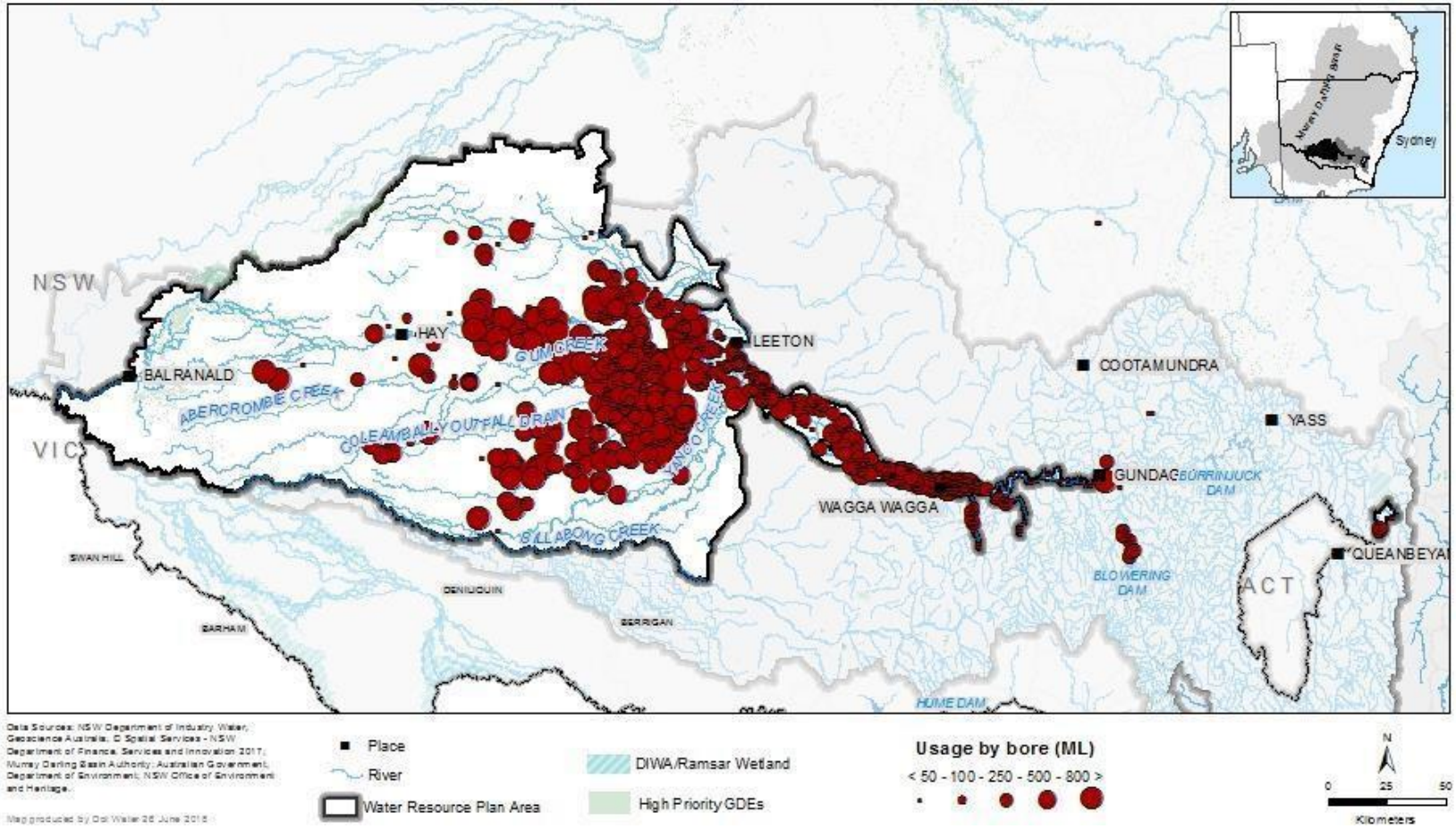

Figure 23. Average metered groundwater extraction in the Murrumbidgee Alluvium WRPA from 2007 to 2016.

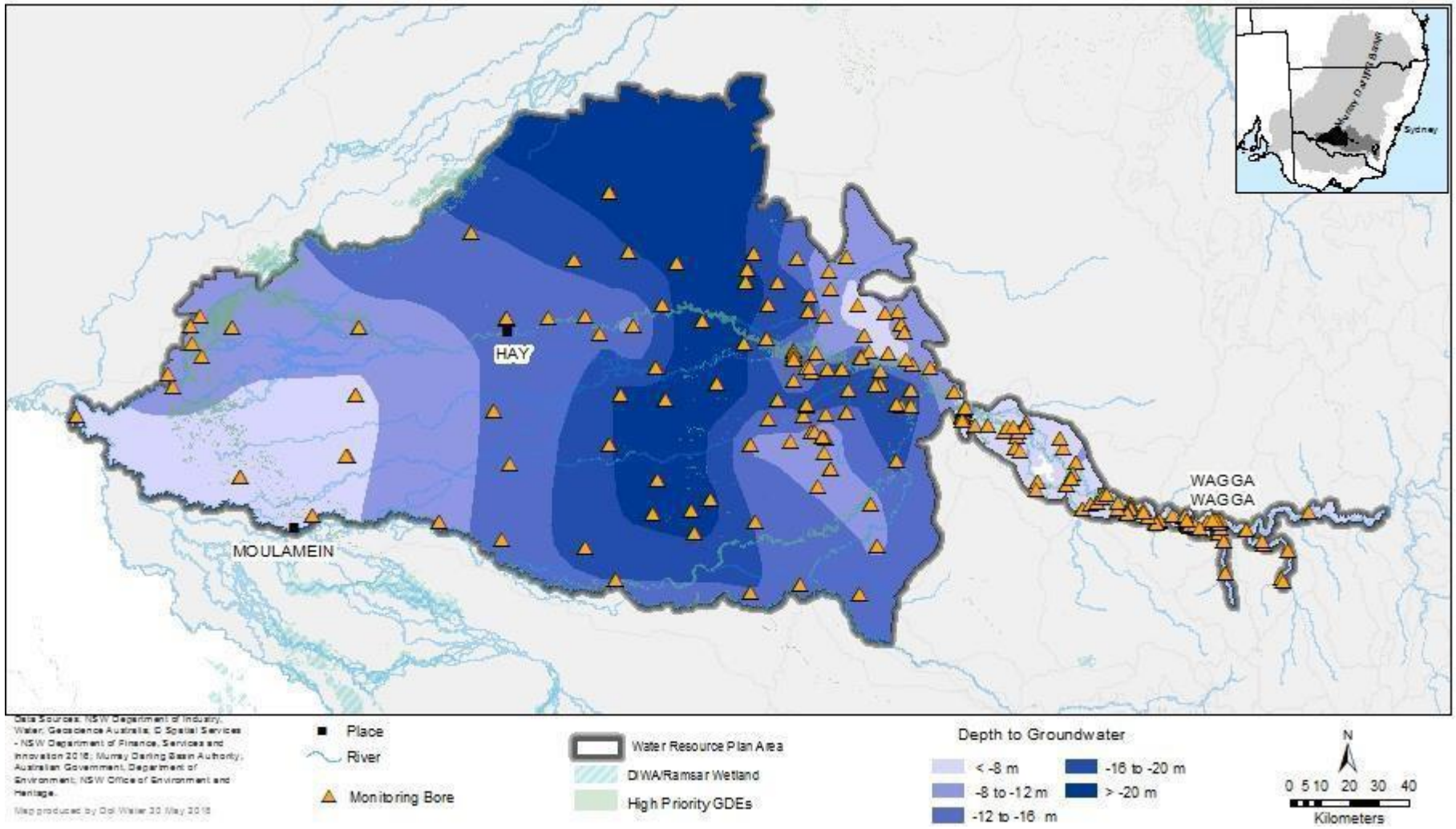

Figure 24. Monitoring bore locations with depth to water table below ground level for 2015/16.

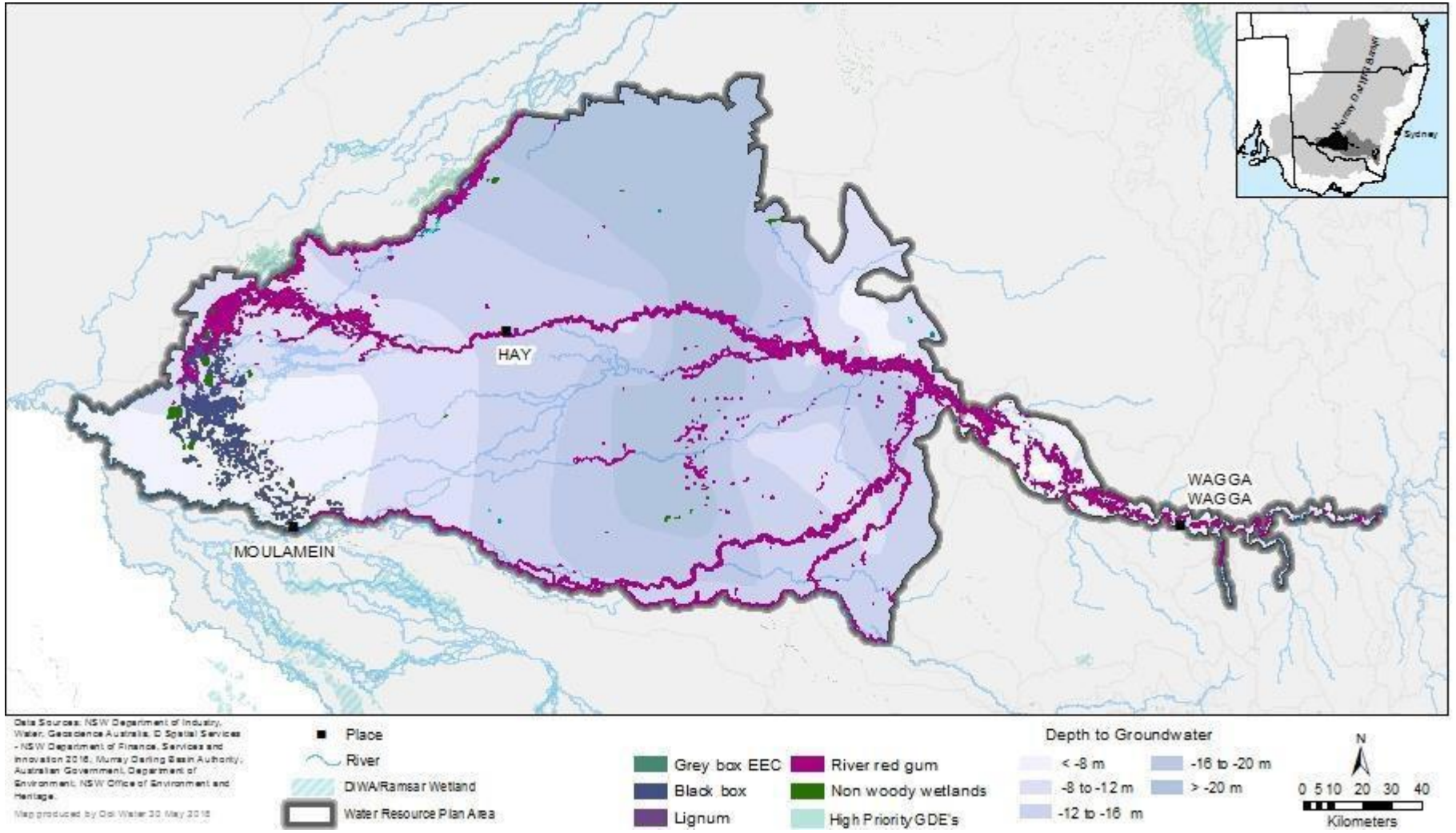

Figure 25. Vegetation GDE performance indicators within the Murrumbidgee Alluvium WRPA.

Appendix H. Darling Alluvium WRP

This appendix of the groundwater WRP MER Plan applies to all groundwater sources located in the Darling Alluvium WRP area (see Figure 1 in the resource description report). The Darling Alluvium water resource plan: Darling Alluvium resource description (DPI, 2017h) provides a detailed description of the plan area including history, land use and topography, environmental assets and river operations and management.

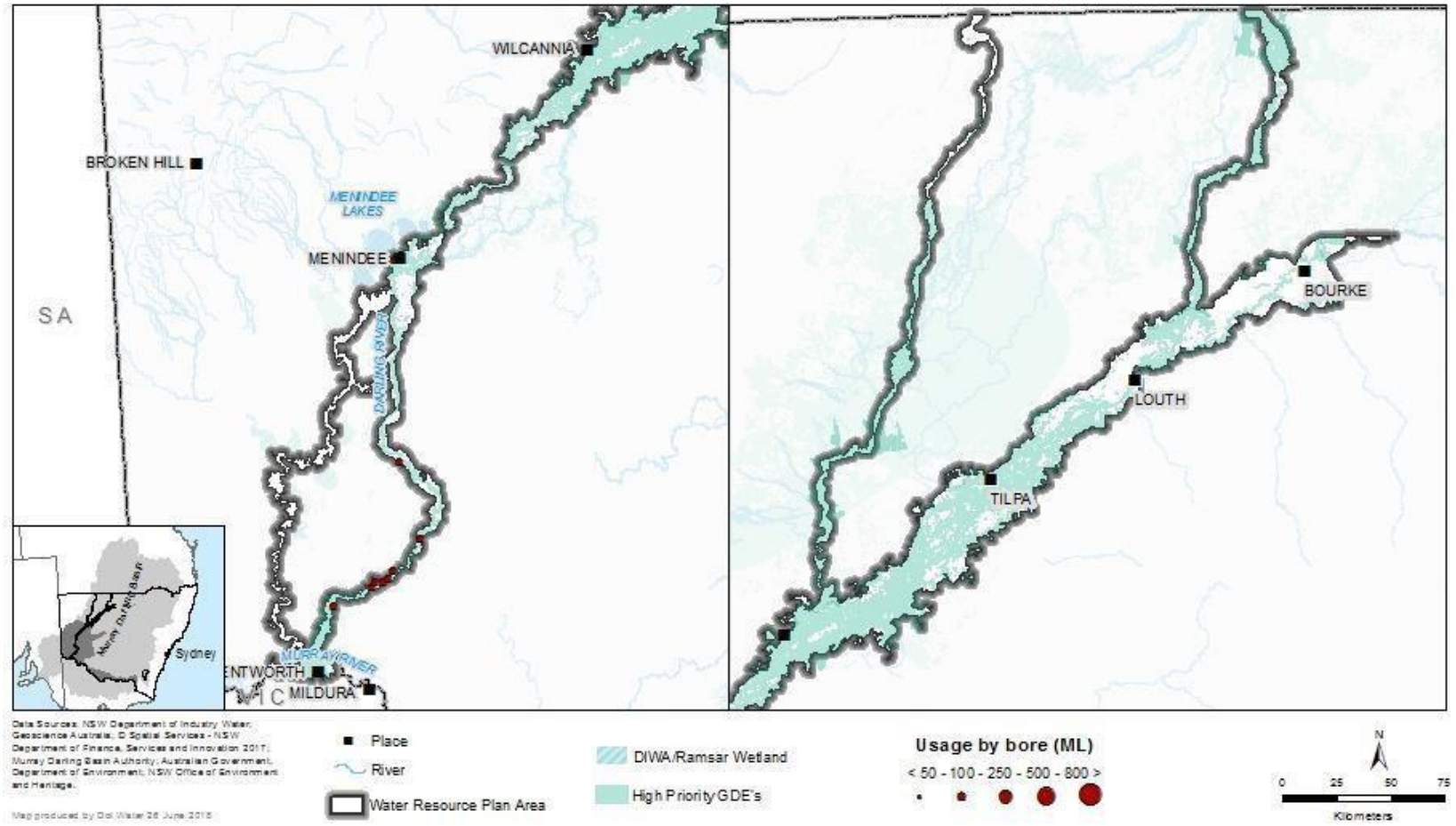

Figure 26. Average metered groundwater extraction in the Darling Alluvium WRPA from 2007 to 2016.

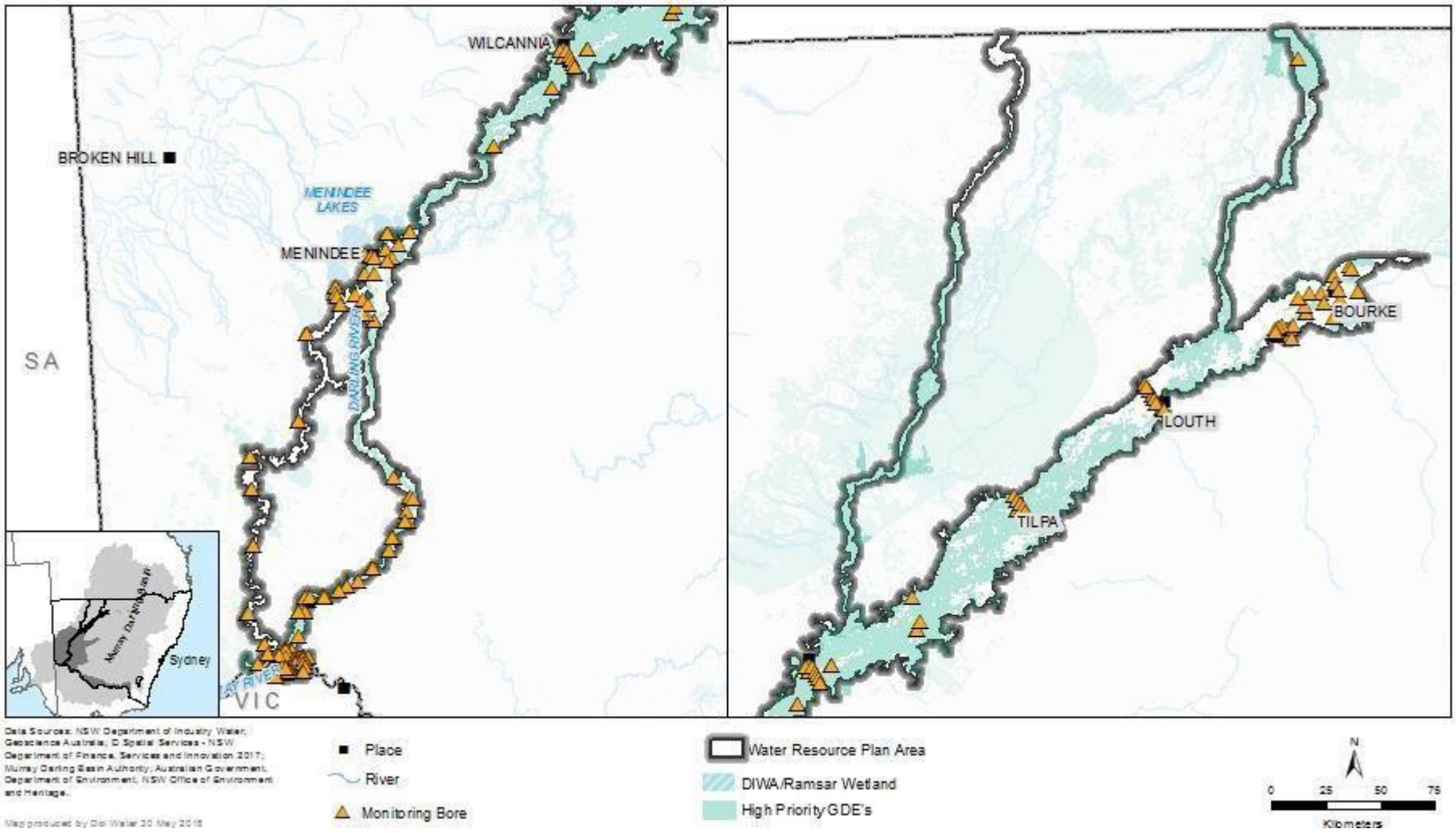

Figure 27. Monitoring bore locations with depth to water table below ground level for 2015/16.

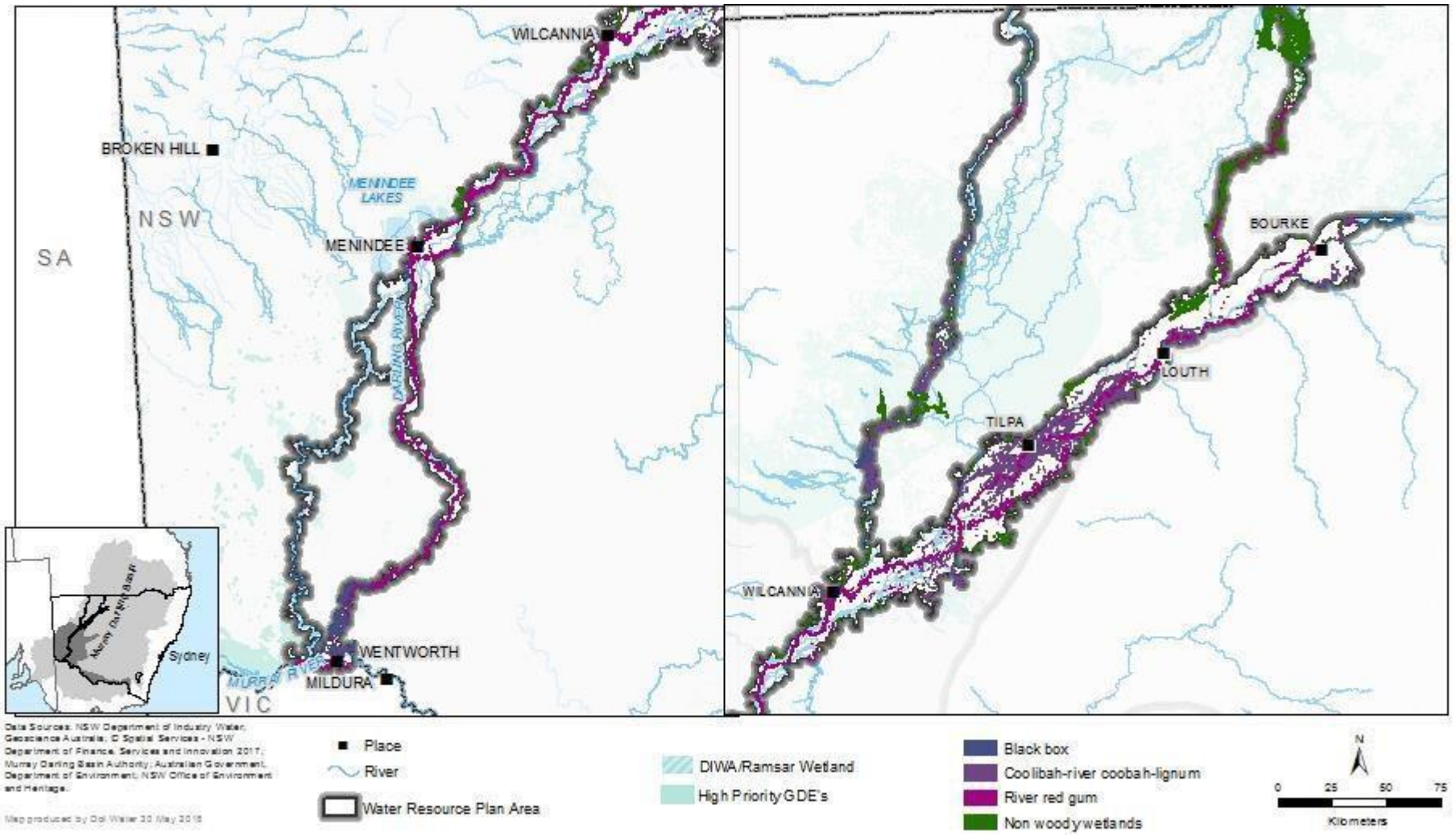

Figure 28. Vegetation GDE performance indicators within the Darling Alluvium WRPA.

Appendix I. NSW Great Artesian Basin Shallow WRP

This appendix of the groundwater WRP MER Plan applies to all groundwater sources located in the NSW Great Artesian Basin Shallow WRP area (see Figure 1 in the resource description report). The *NSW Great Artesian Basin Shallow water resource plan: NSW Great Artesian Basin Shallow resource description* (DPI, 2017i) provides a detailed description of the plan area including history, land use and topography, environmental assets and river operations and management.

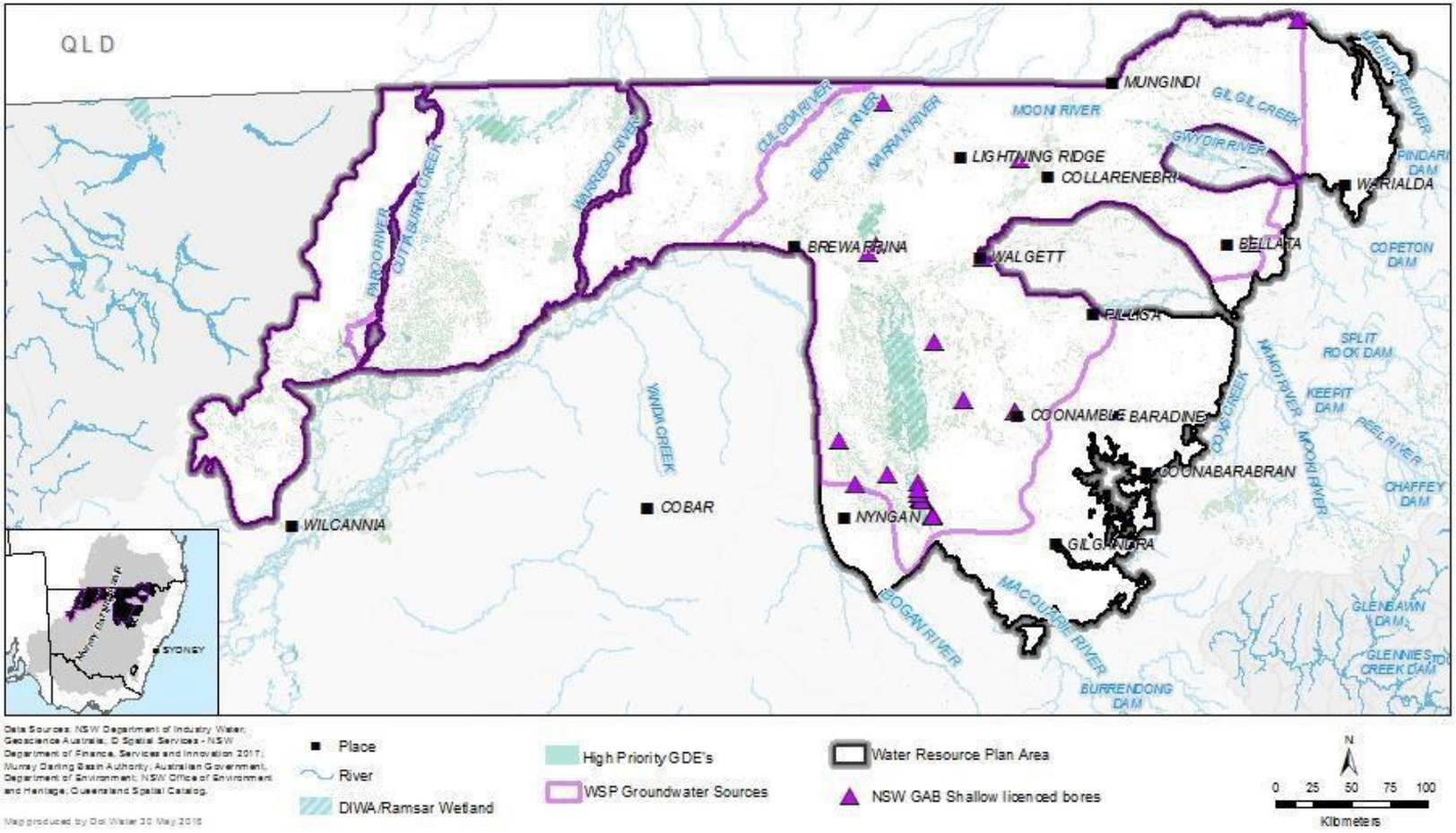

Figure 29. Licenced bores within the NSW Great Artesian Basin Shallow WRPA.

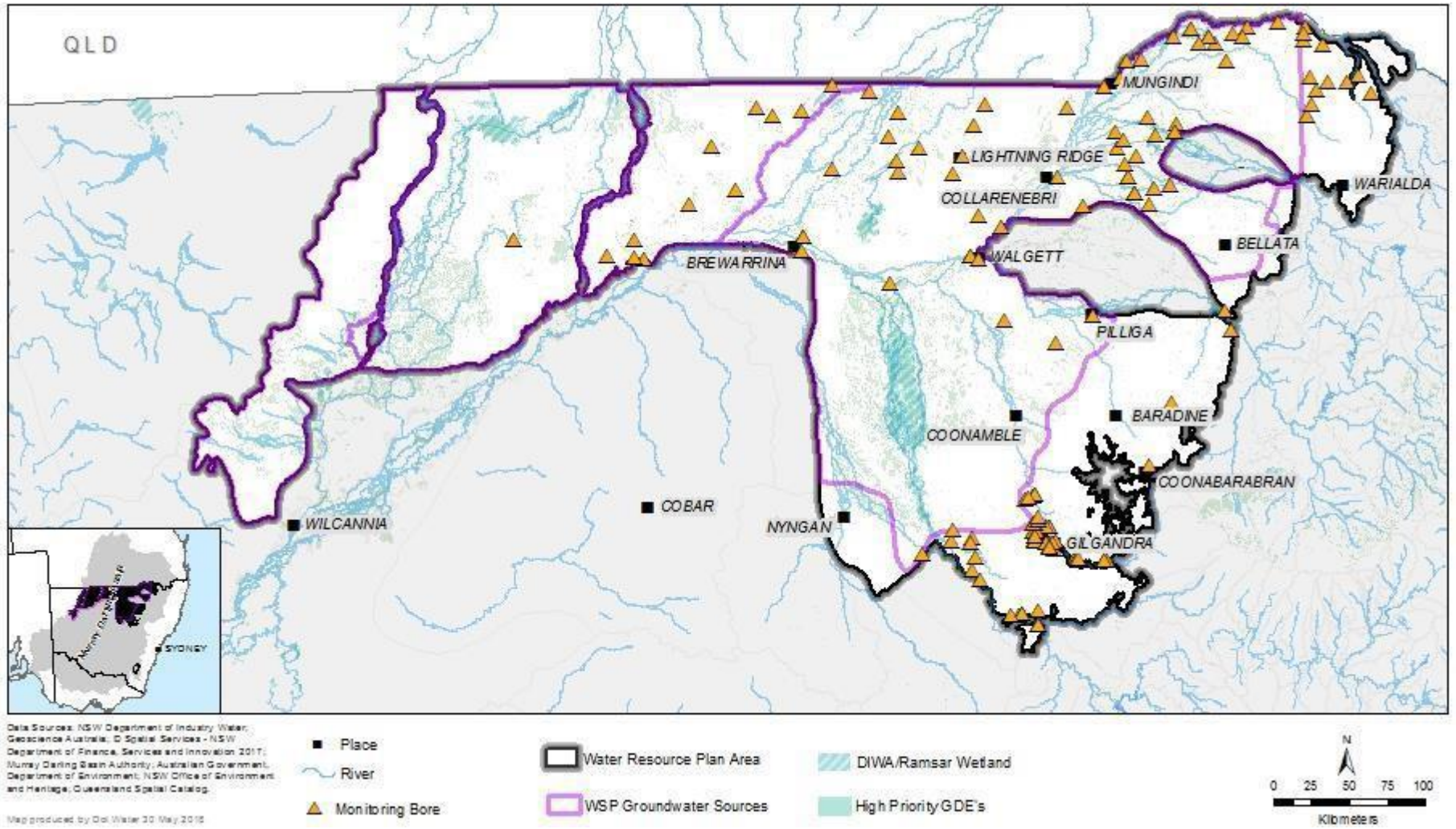

Figure 30. Monitoring bore locations.

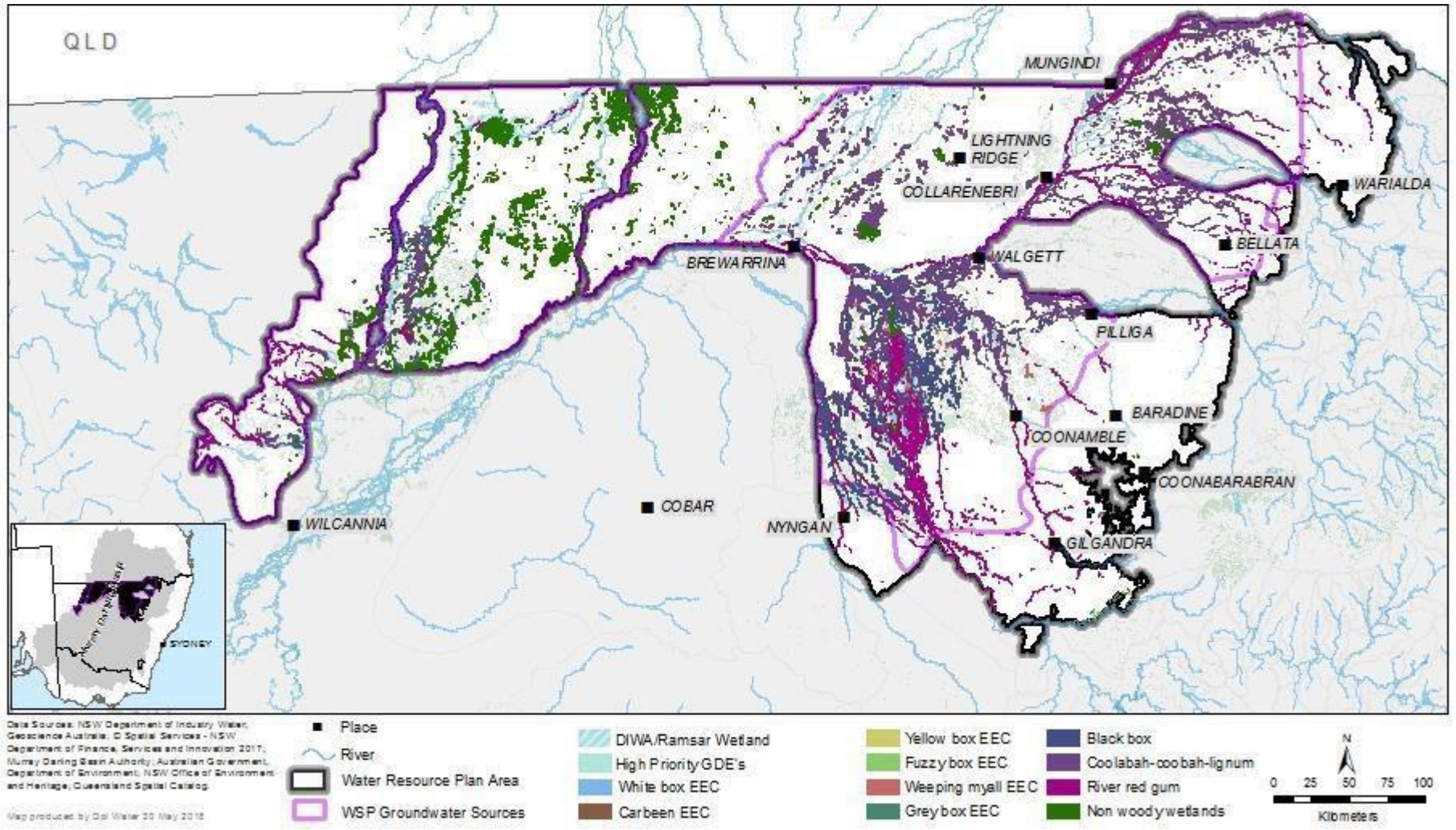

Figure 31. Vegetation GDE performance indicators within the NSW Great Artesian Basin Shallow WRPA.

Appendix J. NSW Murray–Darling Basin Fractured Rock WRP

This appendix of the groundwater WRP MER Plan applies to all groundwater sources located in the NSW Murray–Darling Basin Fractured Rock WRP area (see Figure 1 in the resource description report). The *NSW Murray–Darling Basin Fractured Rock water resource plan: NSW Murray–Darling Basin Fractured Rock resource description* (DPI, draft) provides a detailed description of the plan area including history, land use and topography, environmental assets and river operations and management.

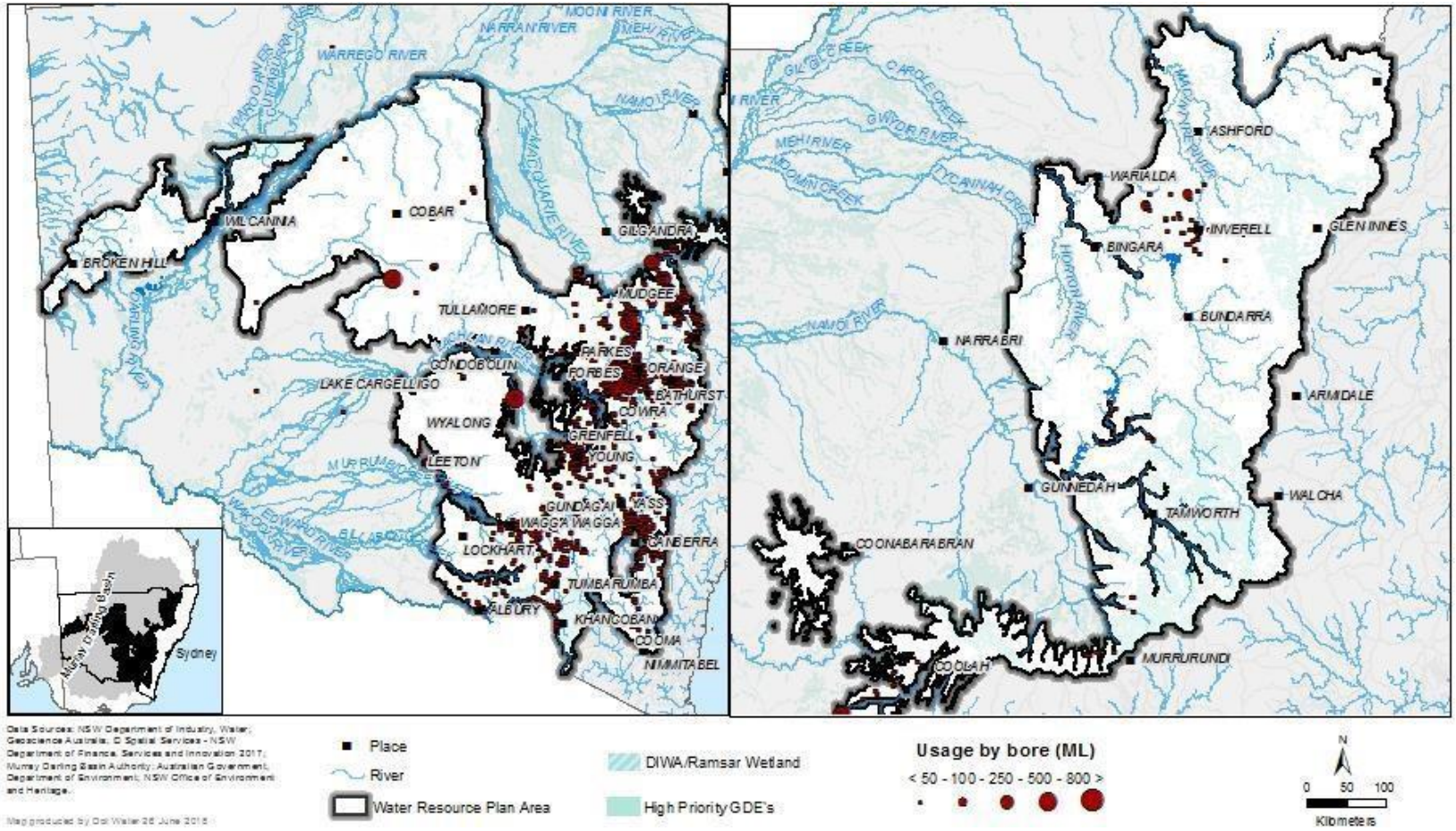

Figure 32. Average metered groundwater extraction in the Murray–Darling Basin Fractured Rock WRPA from 2007 to 2016.

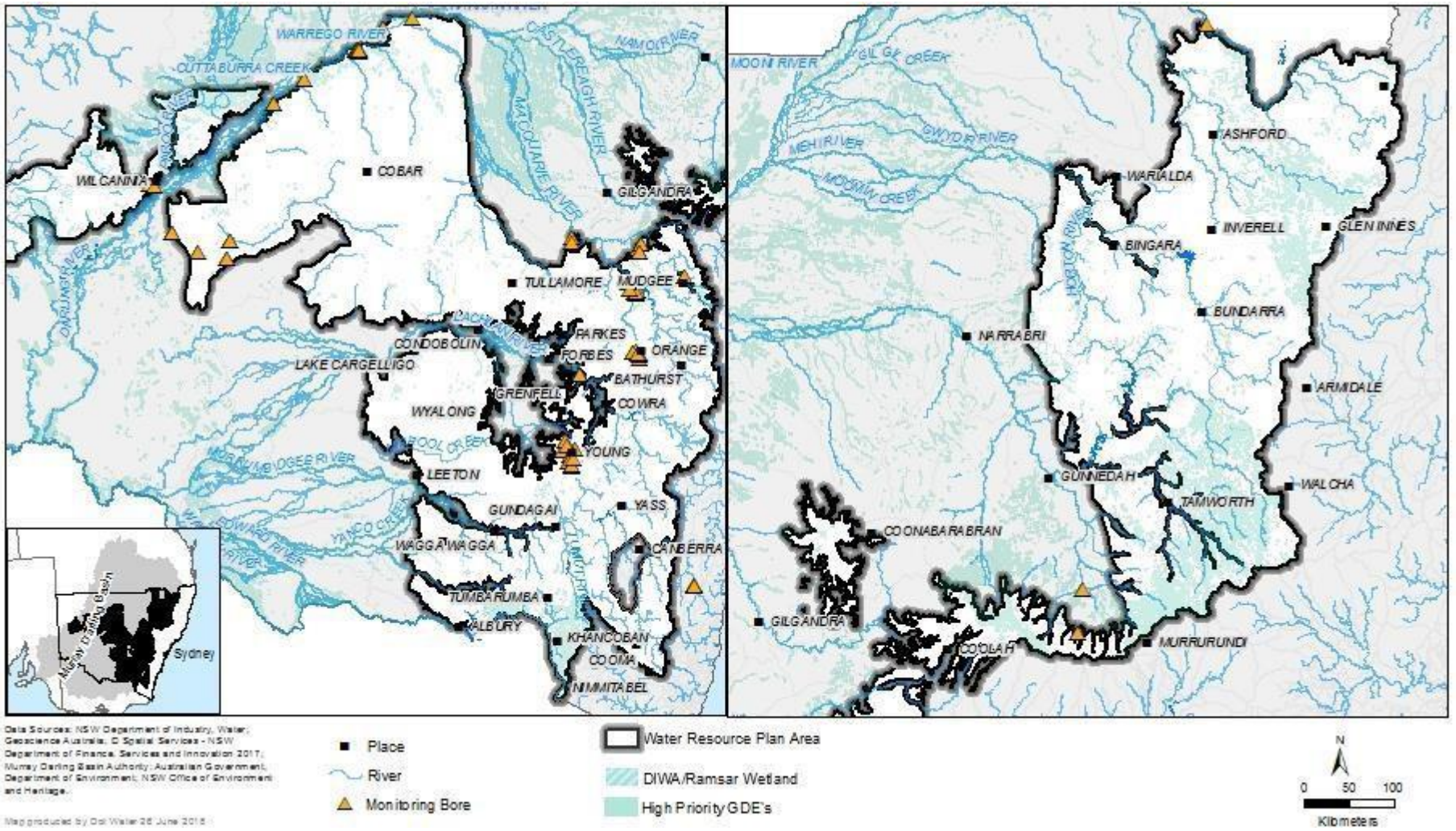

Figure 33. Monitoring bore locations.

Appendix K. NSW Murray–Darling Basin Porous Rock WRP

This appendix of the groundwater WRP MER Plan applies to all groundwater sources located in the NSW Murray–Darling Basin Porous Rock WRP area (see Figure 1 in the resource description report). The *NSW Great Murray–Darling Basin Porous Rock water resource plan: NSW Murray–Darling Basin Porous Rock resource description* (DPI, draft) provides a detailed description of the plan area including history, land use and topography, environmental assets and river operations and management.

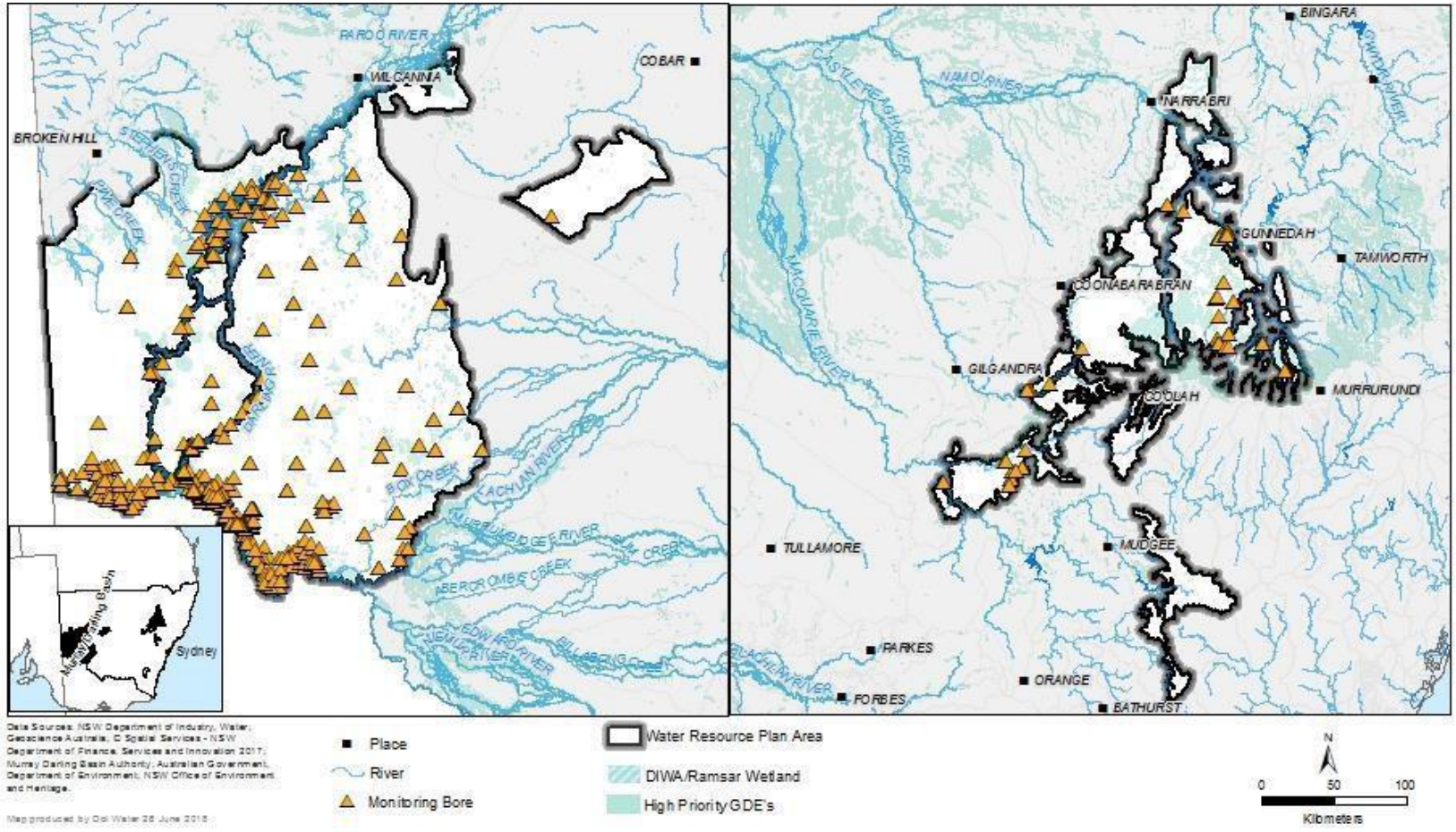

Figure 34. Monitoring bore locations.

Appendix L. Objective alignment between the BWS, LTWP and WSP/WRP

Basin Plan objective	BWS objective	LTWP objective	WRP/WSP objective
5.03 (1)(a), (b) (c) 8.04 (a), (c), (c) 8.05(2)(a), (b) 8.05(3)(a), (b) 8.06 (3)(a), (b) 8.07(2) 8.07 (5) 8.07 (6)	By 2024 improved recruitment of trees within river red gum and black box communities - in the long term achieving a greater range of tree ages By 2024 improved recruitment of trees within the river red gum and black box communities- in the long term achieving a greater range of tree ages	**NV1:** Improve the condition of forest and woodland vegetation communities	**Alluvial WSP**: (a) Protect or enhance the extent and condition of vegetation communities dependent on the presence of groundwater
5.03 (1)(a), (c), (d) 8.04 (a), (c), (d) 8.05(2)(a), (b) 8.05(3)(a), (b) 8.07(2) 8.07 (5) 8.07 (6)	No decline in the condition of river red gum and black box across the Basin	**NV2:** Maintain the extent of forest and woodland vegetation communities	**Alluvial WSP**: (a) Protect or enhance the extent and condition of vegetation communities dependent on the presence of groundwater
5.03 (1)(a), (c), (d) 8.04 (a), (c), (d) 8.05(2)(a), (b) 8.05(3)(a), (b) 8.06 (3)(a), (b) 8.06 (5) 8.07(2) 8.07(4) 8.07 (5) 8.07 (6)	By 2024, improvement in the condition of lignum shrublands	**NV3:** Improve the condition of lignum shrubland	**Alluvial WSP**: (a) Protect or enhance the extent and condition of vegetation communities dependent on the presence of groundwater

Basin Plan objective	BWS objective	LTWP objective	WRP/WSP objective
5.03 (1)(a), (c), (d) 8.04 (a), (c), (d) 8.05(2)(a), (b) 8.05(3)(a), (b) 8.06 (3)(a), (b) 8.06 (5) 8.07(2) 8.07(4) 8.07 (5) 8.07 (6)	Maintain the current extent of extensive lignum shrubland areas within the Basin Closely fringing or occurring within the Lachlan River and Willandra Creek; and common reed and Cumbungi in the Great Cumbung Swamp	**NV4:** Increase the extent of lignum shrubland	**Alluvial WSP**: (a) Protect or enhance the extent and condition of vegetation communities dependent on the presence of groundwater
5.03 (1)(a), (c), (d) 8.04 (a), (c), (d) 8.05(2)(a), (b) 8.05(3)(a), (b) 8.06 (3)(a), (b) 8.06 (5) 8.07(2) 8.07(4) 8.07 (5) 8.07 (6)	Maintain the current extent of non-woody vegetation Closely fringing or occurring within the Lachlan River and Willandra Creek; and common reed and Cumbungi in the Great Cumbung Swamp	**NV5:** Improve condition of non-woody wetland vegetation	**Alluvial WSP**: (a) Protect or enhance the extent and condition of vegetation communities dependent on the presence of groundwater
5.03 (1)(a), (c), (d) 8.04 (a), (c), (d) 8.05(2)(a), (b) 8.05(3)(a), (b) 8.06 (3)(a), (b) 8.06 (5) 8.07(2) 8.07(4) 8.07 (5) 8.07 (6)	Maintain the current extent of non-woody vegetation Closely fringing or occurring within the Lachlan River and Willandra Creek; and common reed and Cumbungi in the Great Cumbung Swamp	**NV6:** Increase the total area of non-woody wetland vegetation	**Alluvial WSP:** (a) Protect or enhance the extent and condition of vegetation communities dependent on the presence of groundwater

Basin Plan objective	BWS objective	LTWP objective	WRP/WSP objective
5.03 (1)(a), (c), (d) 8.04 (a), (c), (d) 8.05(2)(a), (b) 8.05(3)(a), (b) 8.06 (3)(a), (b) 8.06 (5) 8.07(2) 8.07(4) 8.07 (5) 8.07 (6)		**NV7:** Maintain viable non-woody wetland vegetation communities	**Alluvial WSP:** (a) Protect or enhance the extent and condition of vegetation communities dependent on the presence of groundwater
5.03 (1)(a), (c), (d) 8.04 (a), (c), (d) 8.05(2)(a), (b) 8.05(3)(a), (b) 8.06 (3)(a), (b) 8.06 (5) 8.07(2) 8.07(4) 8.07 (5) 8.07 (6)	No specific equivalent BWS objective, but is consistent with achieving several other BWS expected outcomes	**EF7:** Support groundwater conditions to sustain groundwater-dependent biota	**Alluvial WSP**: Protect or enhance the extent and condition of vegetation communities dependent on the presence of groundwater Maintain groundwater salinity (TDS) within ranges that maintain or improve the beneficial use category that supports GDEs Protect the structural integrity of the aquifers from impacts of groundwater extraction

Appendix M. Groundwater alluvial environmental objectives

Broad environmental objectives
Protect, maintain or enhance the ecological condition of this water source and its groundwater dependent ecosystems over the term of this Plan

BWS Theme and Combined LTWP/WSP environmental objectives	Targeted objective performance indicators	Strategies	Water Management Actions and Mechanisms	Relevant management plan(s)
BWS Theme – Native Vegetation **WSP objective** a Protect or enhance the extent and condition of vegetation communities dependent on the presence of groundwater **This objective also supports environmental watering to contribute to the maintenance or enhancement of ecological condition of groundwater dependent ecosystems within the water source. It ensures that WSP strategies do not compromise the EWRs in the LTWP) **LTWP objectives** *NV1, NV2, NV3, NV4,NV5, NV6, NV7, EF7*	1 Change in extent of GDE vegetation communities 2 Change in GDE vegetation community condition Note: the Basin Watering Strategy identifies the following species and communities as significant: * River red gum * Coolibah * Lignum * Black box * non woody wetlands Risk assessment and LTWP also considers * Endangered Ecological Communities within the plan area *Significant wetlands within the Plan area	1 Manage consumptive water extractions in the WRP area to the predefined share of available water. This strategy reserves a share of water for the environment in order to protect groundwater dependent ecosystems	E Reserve all water above the long-term average annual extraction limit (LTAAEL) for the environment as PEW (defined and managed by the listed WSPs). E Available Water Determinations (AWD) adjusts extractive use according to water availability. E Trade limits or prohibitions between ground water plan areas, water sources, and management zones to manage entitlement growth. E Prohibit trade between surface water and groundwater sources.	WSP for the Lachlan Alluvial GW Sources 2020 WSP for the Murray Alluvial GW Sources 2020 WSP for the Macquarie Castlereagh GW Sources 2020 WSP for the Border Rivers Alluvial GW Sources 2029 WSP for the Namoi Alluvial GW Sources 2020 WSP for the Murrumbidgee Alluvial GW Sources 2020 WSP for the Gwydir Alluvial GW Sources 2020 WSP for the Darling Alluvial GW Sources 2020
		2 Manage extraction in local areas to prevent decline in groundwater levels to maintain reliant GDE vegetation	E Extraction limits for individual extractors and associated accounting provisions to manage extraction at the extraction point.	WSP for the Lachlan Alluvial GW Sources 2020 WSP for the Murray Alluvial GW Sources 2020 WSP for the Macquarie Castlereagh GW Sources 2020

BWS Theme and Combined LTWP/WSP environmental objectives	Targeted objective performance indicators	Strategies	Water Management Actions and Mechanisms	Relevant management plan(s)
				WSP for the Border Rivers Alluvial GW Sources 2020 WSP for the Namoi Alluvial GW Sources 2020 WSP for the Murrumbidgee Alluvial GW Sources 2020 WSP for the Gwydir Alluvial GW Sources 2020 WSP for the Darling Alluvial GW Sources 2020
		3 Manage extraction at water supply works to prevent decline in groundwater levels to maintain reliant GDE vegetation	E Specific rules for new bores near GDEs *Access bores - within 200m of GDE	WSP for the Lachlan Alluvial GW Sources 2020 WSP for the Murray Alluvial GW Sources 2020 WSP for the Macquarie Castlereagh GW Sources 2020 WSP for the Border Rivers Alluvial GW Sources 2020 WSP for the Namoi Alluvial GW Sources 2020 WSP for the Murrumbidgee Alluvial GW Sources 2020 WSP for the Gwydir Alluvial GW Sources 2020 WSP for the Darling Alluvial GW Sources 2020
No direct BWS Theme **WSP objective** b Maintain groundwater salinity (TDS) within ranges that maintain or improve the	1 Change in TDS levels as a proportion of baseline levels	1 Groundwater Quality Management Plan provides the management actions for water quality via targets	N Groundwater Quality Management Plan provides the management actions for water quality via targets	WSP for the Lachlan Alluvial GW Sources 2020 WSP for the Murray Alluvial GW Sources 2020 WSP for the Macquarie Castlereagh GW Sources 2020

BWS Theme and Combined LTWP/WSP environmental objectives	Targeted objective performance indicators	Strategies	Water Management Actions and Mechanisms	Relevant management plan(s)
beneficial use category that supports GDEs **LTWP objectives** *EF7*				WSP for the Border Rivers Alluvial GW Sources 2020 WSP for the Namoi Alluvial GW Sources 2020 WSP for the Murrumbidgee Alluvial GW Sources 2020 WSP for the Gwydir Alluvial GW Sources 2020 WSP for the Darling Alluvial GW Sources 2020
No direct BWS Theme **WSP objective** C Protect the structural integrity of the aquifers from impacts of groundwater extraction **LTWP objectives** *EF7*	1 Change in groundwater levels	1 Manage consumptive water extractions in the WRP area to the predefined share of available water. This strategy ensures water availability for all users	E Available Water Determinations (AWD) adjusts extractive use according to water availability. E Trade limits or prohibitions between ground water plan areas, water sources, and management zones to manage entitlement growth. E Prohibit trade between surface water and groundwater sources.	WSP for the Lachlan Alluvial GW Sources 2020 WSP for the Murray Alluvial GW Sources 2020 WSP for the Macquarie Castlereagh GW Sources 2020 WSP for the Border Rivers Alluvial GW Sources 2020 WSP for the Namoi Alluvial GW Sources 2020 WSP for the Murrumbidgee Alluvial GW Sources 2020 WSP for the Gwydir Alluvial GW Sources 2020 WSP for the Darling Alluvial GW Sources 2020