BASIN PLAN IMPLEMENTATION

Risk assessment for the Lachlan Surface Water Resource Plan Area (SW10)

Schedule D

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NOTE: On 21 December 2021, NSW Department of Planning and Environment became the NSW Department of Planning and Environment. Any references to NSW Department of Planning, Industry and Environment in this document, except where made in a historical context, can be taken to refer to Department of Planning and Environment.

Acknowledgments

The maps in this report contain data sourced from:

Murray–Darling Basin Authority

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NSW Spatial Services

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NSW Office of Environment and Heritage: Atlas of NSW Wildlife data

© State of New South Wales through Department of Environment and Heritage (2016), 59-61 Goulburn Street, Sydney 2000

http://www.bionet.nsw.gov.au

NSW Department of Primary Industries—Fisheries: Fish Community Status and Threatened Species data

© State of New South Wales through Department of Industry (2016) 161 Kite Street Orange 2800 www.dpi.nsw.gov.au/fishing/species-protection/threatened-species-distributions-in-nsw

NSW Department of Primary Industries: Fisheries, Fish Barrier database

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Executive summary

The *Basin Plan 2012* (Basin Plan) requires NSW to prepare Water Resource Plans (WRP). The *Risk Assessment for the Lachlan Water Resource Plan Area (SW10)* has been prepared to meet the requirements of the Basin Plan, assessing current and future risks to the condition and continued availability of the water resources. This document will be used to guide the development of the Lachlan WRP.

Part 9, Chapter 10 of the Basin Plan sets out the key requirements for WRP risk assessments:

Chapter 10, Part 9 of the Basin Plan
10.41 Risk identification and assessment methodology
(1) Regard to current and future risks
(2) (a) Risks to meeting environmental watering requirements
(b) Risks arising from matters referred to in subsection 10.20(1) (productive base of groundwater)
(c) Risks arising from potential interception activities
(d) Risks arising from elevated levels of salinity or other types of water quality degradation
(3) (a) Risks identified in Section 4.02
(4) List the identified risks
(5) Assess each risk
(6) Categories of level of risk
(7) Description of the data and methods
(8) Description of uncertainty
10.42 Description of risks
10.43 Strategies for addressing risks
(1) Water resource plan risk mitigation strategies
(2) Strategies take account of Chapter 10 requirements
(3) (a) WRP have regard to strategies listed in section 4.03(3)

The risk assessment framework adopts a cause/threat/impact model that describes the risk pathway of impacts to a receptor. The risk level of an impact is a function of the likelihood of a cause and threat occurring, and the consequence of the impact on the receptor. The risk level is assessed with the current strategies and rules in place, as provided for under the NSW *Water Management Act 2000* and the relevant water sharing plan/s (WSP). The relevant water management actions and mechanisms in place to address particular risks are listed in each chapter.

The Basin Plan requires a water resource plan (WRP) to describe strategies to manage medium or high risks in a manner commensurate with the level of risk. A strategy is commensurate with the level of risk if it results in the level of risk being tolerable. If the risk cannot be addressed to a tolerable level, an explanation should be provided. For example, there may be instances where an identified risk cannot be mitigated due to a range of constraints including, but not limited to infrastructure, third party economic or social impacts, or sustainable diversion limits.

Risk-based management assists water managers to prioritise and plan and direct resources to monitor, mitigate or respond to the factors that pose the highest overall risks. It ensures that strategies (both existing and proposed) are targeted at the appropriate part of the water system. In the context of the NSW risk assessment process, a medium or high risk does not automatically imply that existing WSP rules are inadequate or require change, or that new strategies are required. Rather, the risk assessment can be considered a ‘red flag’ process to provide guidance for where more detailed investigation may be required during the life of the Plan.

Medium and high-risk results that were identified in this risk assessment were reviewed to determine whether they are adequately addressed by existing strategies, or whether modifications or new strategies may be required. Risk treatment options were developed following a systematic approach outlined in Figure 0-1 (Risk Treatment Pathway). Defining

tolerable risk results (i.e. those high or medium results NSW considers are acceptable or adequately managed by existing water resource management strategies) were also part of this approach. Explanations for risk results that the WRP cannot address in a manner commensurate with the level of risk are provided in the Consolidated Risk Table (Table 1).

As strategies are not required for risk results that are low, they have not been further considered in the risk treatment overview.

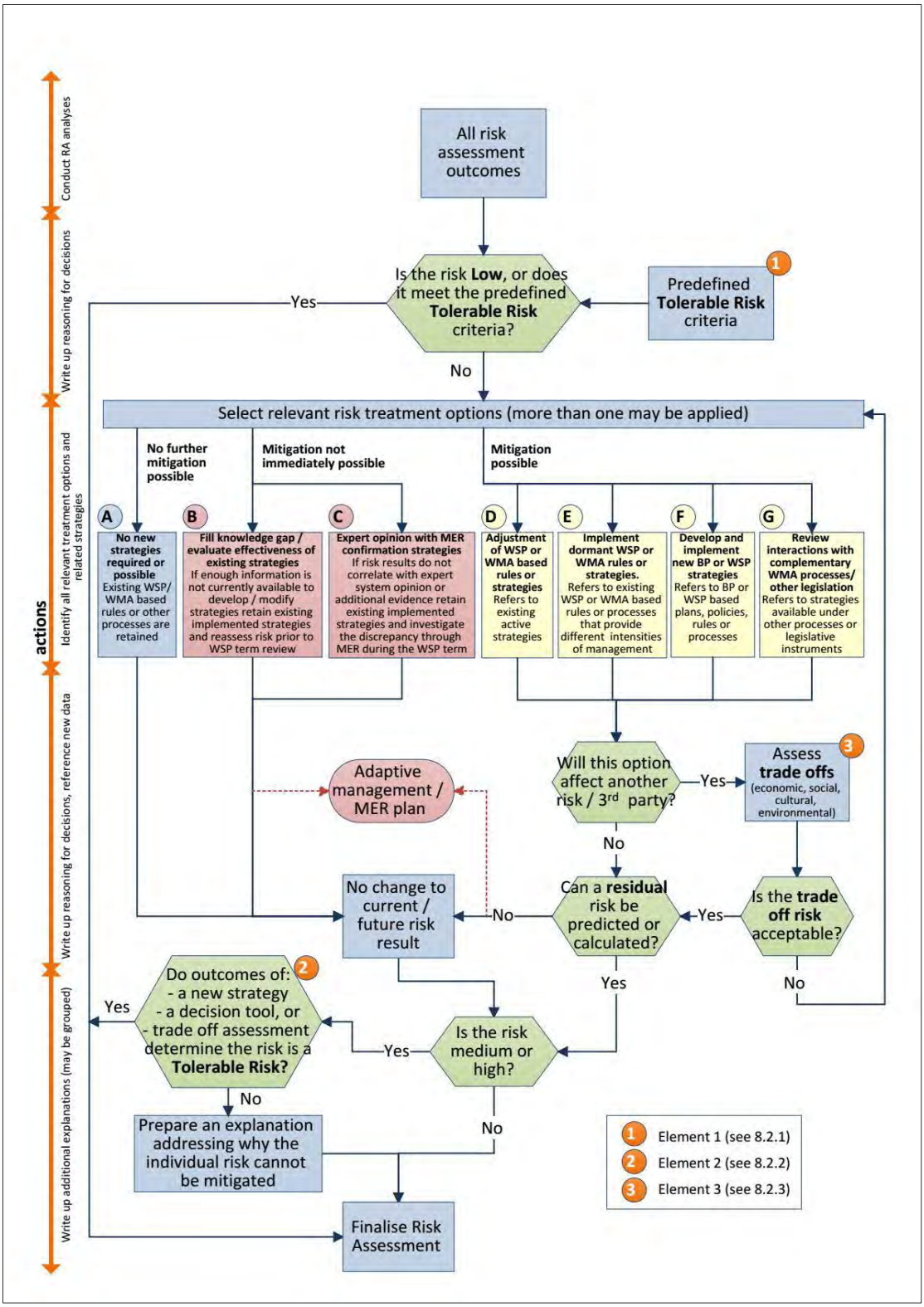

Figure 0-1. Risk treatment pathway.

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Consolidated risk tables

The Consolidated Risk Tables have been developed in conjunction with the MDBA and in response to stakeholder feedback on risk assessment drafts. They present a summary of risk outcomes for each risk assessed in this report and contain contextual information to meet Basin Plan accreditation requirements. They provide a line of sight for each regulated reach or unregulated water source within each WRP area between the following elements which reflect the requirements of the Basin Plan Chapter 10 Part 9 Approaches to addressing risks to water resources:

- **Risk Assessment** including risk identification and the risk calculation basis (current critical mechanisms mitigating risk at the time the risk was assessed, consequence, likelihood, risk outcome and data confidence),
- **Risk Treatment Pathway** including predefined tolerable risk level, risk treatment option, strategies to address all medium and high risk outcomes and new critical mechanisms introduced as a result of WRP development or available to manage risk but not active when risk was assessed,
- **Tolerability Assessment** provided for each medium and high risk result and associated explanations, and
- **Ongoing risk monitoring** provided by indicating where monitoring and evaluation is expected for the water resource plan and associated water sharing, water quality management and long term watering plans.

The Consolidated Risk Tables should be used in conjunction with Table 9-7 and the Consolidated risk maps. This table is an overview of strategy and mechanism relationships and provides line of sight between the strategies used in the Consolidated Risk Tables, associated management plan and other legislative instrument part or section references (including the Basin Plan), and the relevant water sharing plan and water quality management plan objectives. The following table describes the content of the Consolidated Risk Tables; also refer to Appendix H for an overview of the risk assessment process and further explanation of risk assessment drivers and terms.

General information

Each risk has a separate Consolidated table. The title contains the relevant report section, risk title and abbreviation used in tables within this report.

The Consolidated tables are divided into two sections (**Risk assessment** and **Risk treatment pathway**) to clearly show the transition from risk assessment to risk treatment, including which critical water management mechanisms were in place when the risk was assessed, prior to WRP commencement.

The configuration of columns may vary slightly depending on the risk assessed.

SECTION 4.3. RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT AND CAPACITY TO MEET EWRS [E(W)] – REGULATED SYSTEM

River reach or water source within WRP area	Flow or extraction characteristics	Current critical mechanisms (mechanisms active when risk was assessed)	Consequence	Likelihood	Risk rating	Data confidence (consequence / likelihood)	Predefined tolerable risk level	Risk treatment option	Strategies (refer to Table 9-7 for further information)	New critical mechanisms (mechanisms introduced as a result of WRP development or available but not active when risk was assessed)	Tolerable / residual risk rating	Explanation of tolerable risk application OR Explanation of why risk cannot be addressed (refer to Table 9-3)	Monitoring and evaluation
Risk assessment							**Risk treatment pathway**						

Risk assessment

Location information and flow or extraction characteristic

Water sharing plan water management unit within the SDL resource unit.

For each water management unit, risk has been assessed for a variety of flow metrics or other characteristics. These flow metrics or other characteristics are also displayed in the consolidated risk maps.

Information on the calculation basis of the risk outcome

Current critical mechanisms are included here as the risk outcomes were calculated with these water sharing plan or *WMA 2000* based water management controls in place. These key active mechanisms currently address the risk. Mechanisms have been included to provide further detail on the **Strategies to address risk** and are not intended to be a comprehensive list of all relevant mechanisms.

Consequence and likelihood are used to determine the risk outcome via the matrices described in the relevant section of the report. The column entry abbreviations are:

VH Very high (consequence scores only)

H High

M Medium

L Low

VL Very low (consequence scores only)

The likelihood score also includes whether there has been an increase (+), decrease (-) or no change (^{0}) from base case (no development).

Risk rating or outcome (result) and confidence ranking

Risk outcome is a function of consequence and likelihood, the following coding is used.

For further information on data confidence refer to Appendix A

H	High
M	Medium
L	Low

Risk treatment pathway

Information on the application of the Risk treatment pathway

Predefined tolerable risk level or ratings apply to select regulated river locations where NSW cannot address the risk assessed. These results are automatically assigned risk treatment option A as no new strategies are required or possible. The tolerable status is indicated by paler shading of the risk outcome as described in the **Outcomes of Risk treatment** column, and further information is provided in Table 9-3.

Risk treatment option refers to options A-G listed in the Risk Treatment Pathway and summarised below; more than one may apply. See Table 9-1.
A No new strategies required or possible.
B Fill knowledge gap and evaluate effectiveness of existing strategies.
C Knowledge improvement via MER plan is proposed.
D Adjustment of WSPs or WMA based rules.
E Implementation dormant WSP or WMA rules.
F Develop and implement new BP or WSP strategies.
G Review interactions with complementary WMA processes/other legislation.

Strategies to address risk are required by the Basin Plan to be identified for all Medium and High risk outcomes. These are the broad water management and knowledge improvement approaches NSW uses to identify and address risks to water resources. A summary of strategies and their related existing and additional critical mechanisms can be found in Table 9-7.

New critical mechanisms are water sharing plan or WMA 2000 based water management controls that have been developed, modified, substantially changed in implementation status as a result of WRP development, OR are inactive but available if required. Each mechanism has an associated risk treatment option on the Risk Treatment Pathway. Mechanisms have been included to provide further detail on the **Strategies to address risk** and are not intended to be a comprehensive list of all relevant mechanisms.

Outcomes of risk treatment

Tolerable / residual risk rating refers to:
1 Any change to the **Risk rating** after the application of **new critical mechanisms** and recalculation of (residual) risk.
2 The tolerable status of the **Risk rating**. NSW has considered whether risk ratings are acceptable on the basis the risk is adequately managed by the existing and new critical mechanisms. This is in line with the *Basin Plan Water Resource Plan Requirements Position Statement 9B Strategies for addressing risks.* The tolerable status is indicated by paler shading of the risk outcome as below. Explanations are included in the second column of this section. Low risk outcomes have N/A as they do not require a tolerable status. Refer to Table 9-3 for a summary of explanations.

H	High – tolerable
H	High – not tolerable
M	Medium – tolerable
M	Medium – not tolerable

Link to monitoring and management plans

Information regarding the ongoing monitoring, evaluation and reporting for water management plan performance including the water resource plan, water sharing plan, water quality management plan and long-term watering plan (where relevant). Refer to the MER Plan for further information.

SECTION 3.3 RISKS TO ENVIRONMENTAL ASSETS AND FUNCTIONS WITHIN THE LACHLAN SURFACE WRPA DUE TO CONNECTIVITY WITH THE MURRUMBIDGEE WATERCOURSE WRPA									
Water Source Type	**Consequence**	**Likelihood**	**Risk Rating**	**Data confidence (Consequence / Likelihood)**	**Risk treatment option**	**Strategies**	**New Critical Mechanisms**	**Tolerable risk level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and Evaluation**
Regulated	M	L	L	H/H	N/A	None required. Risk is low		N/A	N/A	No MER planned
Unregulated	M	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	No MER planned
Current Critical Mechanisms Environmental flow rules described in WRP Section 4.2										

SECTION 3.3 RISKS OF INSUFFICIENT SURFACE WATER IMPACTING ON PRIORITY GROUNDWATER ASSETS AND FUNCTIONS									
Water Source Type	**Consequence**	**Likelihood**	**Risk Rating**	**Data confidence (Consequence / Likelihood)**	**Risk treatment option**	**Strategies**	**New Critical Mechanisms**	**Tolerable risk level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and Evaluation**
Regulated	M	L	L	H/H	N/A	None required. Risk is low		N/A	N/A	No MER planned
Unregulated	M	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	No MER planned
Current Critical Mechanisms Environmental flow rules described in WRP Section 4.2										

SECTION 4.3. RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT AND CAPACITY TO MEET EWRS [E(W)] – REGULATED SYSTEM													
River reach within WRP area	**Flow or extraction characteristic**	**Current critical mechanisms**	**Consequence**	**Likelihood**	**Risk rating**	**Data confidence (consequence / likelihood)**	**Predefined tolerable risk level**	**Risk treatment option**	**Strategies**	**New critical mechanisms**	**Residual risk rating**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and evaluation**
Lachlan at downstream Wyangala Dam	Zero flow periods	E6 Translucent flow releases from Wyangala Dam as per environmental flow rules in the WSP for the Lachlan Regulated Water Source E8 – Strategic use of Wyangala and Lake Brewster environmental water allowances (EWAs) as described in the WSP for the Lachlan Regulated River Water Source 2016. E9 – Coordinate release of environmental water allowance (EWA) and held environmental water with natural flow events.	M	H-	H	H/H	H	Predefined Tolerable	1 Limit consumptive water extractions in the WRP area to the predefined share of available water. 2 Protect a portion of high flow events with the translucency rule in the Lachlan WRP area. 3 Provide environmental watering events in the regulated river sections of the WRP area. 4 Manage environmental water to meet flow targets specified in the Lachlan LTWP.	None required – risks are tolerable.	N/A	Risk inherent to regulated river reaches. Zero flow periods cannot be scheduled due to dam operational constraints and requirements to deliver water orders and BLR (stock and domestic) replenishment flows. This impact is most pronounced in reaches closest to Wyangala Dam.	No MER planned
Lachlan at downstream Wyangala Dam	Base flow or low flows		M	H+	H	H/H	H	Predefined Tolerable			N/A	Risk inherent to regulated river reaches. Base flows cannot be scheduled due to dam operational constraints and requirements to deliver water orders and BLR (stock and domestic) replenishment flows.	No MER planned
Lachlan at downstream Wyangala Dam	Fresh flows		M	H+	H	H/H	H	Predefined Tolerable			N/A	Water ordering patterns have altered the duration and timing of freshes leading to unnaturally long events in summer due to delivery of irrigation water, and less events in winter due to runoff capture by the dam.	MER planned for WSP objectives
Lachlan at downstream Wyangala Dam	High and infrequent flows – bank full 1.5 years ARI		M	H-	H	H/H	H	Predefined Tolerable			N/A	The Boorowa River, Crowther Creek, Belubula River and Mandagery Creek enter the Lachlan River downstream of Wyangala Dam. These tributaries reduce the likelihood scores for 1.5 year ARI, 2.5 year ARI and 5 year ARI events to 'low' by Jemmalong Weir (see next section of this table). The length of river where 1.5 - 5 year ARI events are impacted by water resource development to the degree indicated by analysis of data from immediately below Wyangala dam (gauging station 412067) is relatively short. Hence the risk is considered tolerable	MER planned for WSP objectives
Lachlan at downstream Wyangala Dam	High and infrequent flows – over bank 2.5 years ARI		M	H-	H	H/H	H	Predefined Tolerable			N/A		MER planned for WSP objectives
Lachlan at downstream Wyangala Dam	High and infrequent flows – over bank 5.0 years ARI		M	M-	M	H/H	M	Predefined Tolerable			N/A		MER planned for WSP objectives

SECTION 4.3. RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT AND CAPACITY TO MEET EWRS [E(W)] – REGULATED SYSTEM

River reach within WRP area	Flow or extraction characteristic	Current critical mechanisms	Consequence	Likelihood	Risk rating	Data confidence (consequence / likelihood)	Predefined tolerable risk level	Risk treatment option	Strategies	New critical mechanisms	Residual risk rating	Explanation of tolerable risk application OR Explanation of why risk cannot be addressed	Monitoring and evaluation
Lachlan at Jemmalong Weir	Zero flow periods	E6 Translucent flow releases from Wyangala Dam as per environmental flow rules in the WSP for the Lachlan Regulated Water Source E8 – Strategic use of Wyangala and Lake Brewster environmental water allowances (EWAs) as described in the WSP for the Lachlan Regulated River Water Source 2016. E9 – Coordinate release of environmental water allowance (EWA) and held environmental water with natural flow events.	VH	H-	H	H/H	H	Predefined Tolerable	1 Limit consumptive water extractions in the WRP area to the predefined share of available water. 2 Protect a portion of high flow events with the translucency rule in the Lachlan WRP area. 3 Provide environmental watering events in the regulated river sections of the WRP area. 4 Manage environmental water to meet flow targets specified in the Lachlan LTWP.	None required – risks are tolerable.	N/A	Risk inherent to regulated river reaches. Zero flow periods cannot be scheduled due to dam operational constraints and requirements to deliver water orders and BLR (stock and domestic) replenishment flows.	No MER planned
Lachlan at Jemmalong Weir	Base flow or low flows		VH	H+	H	H/H	H	Predefined Tolerable			N/A	Risk inherent to regulated river reaches. Base flows cannot be scheduled due to dam operational constraints and requirements to deliver water orders and BLR (stock and domestic) replenishment flows.	No MER planned
Lachlan at Jemmalong Weir	Fresh flows		VH	H+	H	H/H	H	Predefined Tolerable			N/A	Water ordering patterns have altered the duration and timing of freshes leading to unnaturally long events in summer due to delivery of irrigation water, and less events in winter due to runoff capture by the dam.	MER planned for WSP objectives
Lachlan at Jemmalong Weir	High and infrequent flows – bank full 1.5 years ARI		VH	L-	M	H/H	M	Predefined Tolerable			N/A	The Boorowa River, Crowther Creek, Belubula River and Mandagery Creek enter the Lachlan River downstream of Wyangala Dam and upstream of Jemmalong Weir. These tributaries reduce the likelihood scores for 1.5 year ARI, 2.5 year ARI and 5 year ARI events in the Lachlan River to 'low' by Jemmalong Weir. This medium risk result is driven by a low likelihood and a very high ecological consequence. The risk is tolerable because of the low likelihood.	MER planned for WSP objectives
Lachlan at Jemmalong Weir	High and infrequent flows – over bank 2.5 years ARI		VH	L-	M	H/H	M	Predefined Tolerable			N/A		MER planned for WSP objectives
Lachlan at Jemmalong Weir	High and infrequent flows – over bank 5.0 years ARI		VH	L-	M	H/H	M	Predefined Tolerable			N/A		MER planned for WSP objectives
Lachlan at Willandra Weir	Zero flow periods	E6 Translucent flow releases from Wyangala Dam as per environmental flow rules in the WSP for the Lachlan Regulated Water Source E8 – Strategic use of Wyangala and Lake Brewster	VH	H+	H	H/H	H	Predefined Tolerable	1 Limit consumptive water extractions in the WRP area to the predefined share of available water. 2 Protect a portion of high flow events with the translucency rule in the Lachlan WRP area. 3 Provide environmental	None required – risks are tolerable.	N/A	Risk inherent to regulated river reaches. Zero flow periods cannot be scheduled due to dam operational constraints and requirements to deliver water orders and BLR (stock and domestic) replenishment flows.	No MER planned

SECTION 4.3. RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT AND CAPACITY TO MEET EWRS [E(W)] – REGULATED SYSTEM												
River reach within WRP area	**Flow or extraction characteristic**	**Current critical mechanisms**	**Consequence**	**Likelihood**	**Risk rating**	**Data confidence (consequence / likelihood)**	**Predefined tolerable risk level**	**Risk treatment option**	**Strategies**	**New critical mechanisms**	**Residual risk rating**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and evaluation**
Lachlan at Willandra Weir	Base flow or low flows	environmental water allowances (EWAs) as described in the WSP for the Lachlan Regulated River Water Source 2016. E9 – Coordinate release of environmental water allowance (EWA) and held environmental water with natural flow events.	VH	H+	H	H/H	H	Predefined Tolerable	watering events in the regulated river sections of the WRP area. 4 Manage environmental water to meet flow targets specified in the Lachlan LTWP.		N/A	Risk inherent to regulated river reaches. Base flows cannot be scheduled due to dam operational constraints and requirements to deliver water orders and BLR (stock and domestic) replenishment flows.	No MER planned
Lachlan at Willandra Weir	Fresh flows		VH	H+	H	H/H	H	Predefined Tolerable			N/A	Water ordering patterns have altered the duration and timing of freshes leading to unnaturally long events in summer due to delivery of irrigation water, and less events in winter due to runoff capture by the dam.	MER planned for WSP objectives
Lachlan at Willandra Weir	High and infrequent flows – bank full 1.5 years ARI		VH	L-	M	H/H	M	Predefined Tolerable			N/A	The Boorowa River, Crowther Creek, Belubula River and Mandagery Creek which enter the Lachlan River upstream of Jemmalong Weir. These tributaries combined with additional residual catchment inflows downstream of Jemmalong Weir during wet years reduce the likelihood scores for 1.5 year ARI, 2.5 year ARI and 5 year ARI events in the Lachlan River to 'low' from Jemmalong Weir downstream to Booligal Weir. This medium risk result is driven by a low likelihood and a very high ecological consequence. The risk is tolerable because of the low likelihood.	MER planned for WSP objectives
Lachlan at Willandra Weir	High and infrequent flows – over bank 2.5 years ARI		VH	L-	M	H/H	M	Predefined Tolerable			N/A		MER planned for WSP objectives
Lachlan at Willandra Weir	High and infrequent flows – over bank 5.0 years ARI		VH	L-	M	H/H	M	Predefined Tolerable			N/A		MER planned for WSP objectives
Lachlan at Booligal Weir	Zero flow periods	E8 – Strategic use of Wyangala and Lake Brewster environmental water allowances (EWAs) as described in the WSP for the Lachlan Regulated River Water Source 2016. E9 – Coordinate release of environmental water allowance (EWA) and held environmental water with natural flow events. E5 Protection of PEW through compliance of LTAAEL E6 Translucent flow releases from Wyangala Dam as per	H	H-	H	H/H	H	Predefined Tolerable	1 Limit consumptive water extractions in the WRP area to the predefined share of available water. 2 Protect a portion of high flow events with the translucency rule in the Lachlan WRP area. 3 Provide environmental watering events in the regulated river sections of the WRP area. 4 Manage environmental water to meet flow targets specified in the Lachlan LTWP.	None required – risks are tolerable.	N/A	Risk inherent to regulated river reaches. Zero flow periods cannot be scheduled due to dam operational constraints and requirements to deliver water orders and BLR (stock and domestic) replenishment flows.	MER planned for WSP objectives
Lachlan at Booligal Weir	Base flow or low flows		H	H+	H	H/H	H	Predefined Tolerable			N/A	Risk inherent to regulated river reaches. Base flows cannot be scheduled due to dam operational constraints and requirements to deliver water orders and BLR (stock and domestic) replenishment flows.	MER planned for WSP objectives
Lachlan at Booligal Weir	Fresh flows		H	H-	H	H/H	H	Predefined Tolerable			N/A	Water ordering patterns have altered the duration and timing of freshes leading to unnaturally long events in summer due to delivery of irrigation water, and less events in winter due to runoff capture by the dam.	MER planned for WSP objectives

SECTION 4.3. RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT AND CAPACITY TO MEET EWRS [E(W)] – REGULATED SYSTEM												
River reach within WRP area	**Flow or extraction characteristic**	**Current critical mechanisms**	**Consequence**	**Likelihood**	**Risk rating**	**Data confidence (consequence / likelihood)**	**Predefined tolerable risk level**	**Risk treatment option**	**Strategies**	**New critical mechanisms**	**Residual risk rating**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and evaluation**
Lachlan at Booligal Weir	High and infrequent flows – bank full 1.5 years ARI	environmental flow rules in the WSP for the Lachlan Regulated River Water Source 2016	H	L-	L	H/H	L	Predefined Tolerable			N/A	The Boorowa River, Crowther Creek, Belubula River and Mandagery Creek which enter the Lachlan River upstream of Jemmalong Weir. These tributaries combined with additional residual catchment inflows downstream of Jemmalong Weir during wet years reduce the likelihood scores for 1.5 year ARI, 2.5 year ARI and 5 year ARI events in the Lachlan River to 'low' from Jemmalong Weir downstream to Booligal Weir. These high and medium risk results are driven by a low likelihood and a very high ecological consequence. The risk is tolerable because of the low likelihood.	MER planned for WSP objectives
Lachlan at Booligal Weir	High and infrequent flows – over bank 2.5 years ARI		H	L-	L	H/H	L	Predefined Tolerable			N/A		MER planned for WSP objectives
Lachlan at Booligal Weir	High and infrequent flows – over bank 5.0 years ARI		H	L-	L	H/H	L	Predefined Tolerable			N/A		No MER planned
Willandra Creek flow node	Zero flow periods	E8 – Strategic use of Wyangala and Lake Brewster environmental water allowances (EWAs) as described in the WSP for the Lachlan Regulated River Water Source 2016. E9 – Coordinate release of environmental water allowance (EWA) and held environmental water with natural flow events. E5 Protection of PEW through compliance of LTAAEL E6 Translucent flow releases from Wyangala Dam as per environmental flow rules in the WSP for the Lachlan Regulated Water Source	H	L0	L	H/H	L	N/A	1 Limit consumptive water extractions in the WRP area to the predefined share of available water. 2 Protect a portion of high flow events in the lower Lachlan WRP area. 3 Provide environmental watering events in the regulated river and downstream unregulated river sections of the WRP area. 4 Manage environmental water to meet flow targets specified in the Lachlan LTWP.	None required – risks are tolerable.	N/A	Risk inherent to regulated river reaches. Zero flow periods cannot be scheduled due to dam operational constraints and requirements to deliver water orders and BLR (stock and domestic) replenishment flows.	No MER planned
Willandra Creek flow node	Base flow or low flows		H	H+	H	H/H	H	Predefined Tolerable			N/A	Risk inherent to regulated river reaches. Base flows cannot be scheduled due to dam operational constraints and requirements to deliver water orders and BLR (stock and domestic) replenishment flows.	MER planned for WSP objectives
Willandra Creek flow node	Fresh flows		H	H+	H	H/H	H	Predefined Tolerable			N/A	Water ordering patterns have altered the duration and timing of freshes leading to unnaturally long events in summer due to delivery of irrigation water, and less events in winter due to runoff capture by the dam.	MER planned for WSP objectives
Willandra Creek flow node	High and infrequent flows – bank full 1.5 years ARI		H	M-	M	H/H	M	Predefined Tolerable			N/A	The Boorowa River, Crowther Creek, Belubula River and Mandagery Creek which enter the Lachlan River upstream of Jemmalong Weir. These tributaries combined with additional residual catchment inflows downstream of Jemmalong Weir during wet years reduce the likelihood scores for 1.5 year ARI, 2.5 year ARI and 5 year ARI events in the Lachlan River to 'low' from Jemmalong Weir downstream to Booligal Weir. These high and medium risk results are driven by a low likelihood and a very high ecological consequence. The risk is tolerable because of the low likelihood.	MER planned for WSP objectives

SECTION 4.3. RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT AND CAPACITY TO MEET EWRS [E(W)] – REGULATED SYSTEM

River reach within WRP area	Flow or extraction characteristic	Current critical mechanisms	Consequence	Likelihood	Risk rating	Data confidence (consequence / likelihood)	Predefined tolerable risk level	Risk treatment option	Strategies	New critical mechanisms	Residual risk rating	Explanation of tolerable risk application OR Explanation of why risk cannot be addressed	Monitoring and evaluation
Willandra Creek flow node	High and infrequent flows – over bank 2.5 years ARI		H	M-	M	H/H	M	Predefined Tolerable			N/A	The Boorowa River, Crowther Creek, Belubula River and Mandagery Creek which enter the Lachlan River upstream of Jemmalong Weir. These tributaries combined with additional residual catchment inflows downstream of Jemmalong Weir during wet years reduce the likelihood scores for 1.5 year ARI, 2.5 year ARI and 5 year ARI events in the Lachlan River to 'low' from Jemmalong Weir downstream to Booligal Weir. These high and medium risk results are driven by a low likelihood and a very high ecological consequence. The risk is tolerable because of the low likelihood.	MER planned for WSP objectives
Willandra Creek flow node	High and infrequent flows – over bank 5.0 years ARI		H	M-	M	H/H	M	Predefined Tolerable			N/A	The Boorowa River, Crowther Creek, Belubula River and Mandagery Creek which enter the Lachlan River upstream of Jemmalong Weir. These tributaries combined with additional residual catchment inflows downstream of Jemmalong Weir during wet years reduce the likelihood scores for 1.5 year ARI, 2.5 year ARI and 5 year ARI events in the Lachlan River to 'low' from Jemmalong Weir downstream to Booligal Weir. These high and medium risk results are driven by a low likelihood and a very high ecological consequence. The risk is tolerable because of the low likelihood.	MER planned for WSP objectives
Belubula River at Carcoar	Zero flow periods	E7 rules governing uncontrolled flow access for general and high security entitlement holders as per the WSP for the Belubula River Regulated Water Source E5 Protection of PEW through compliance of LTAAEL	H	M-	M	H/H	M	Predefined Tolerable	1 Limit consumptive water extractions in the WRP area to the predefined share of available water. 2 Protect a portion of tributary fresh flow events in the Belubula Water Source within the Lachlan WRP area by regulating access to uncontrolled flows. 3. Protect the first fresh of uncontrolled flows in the Belubula River from October to April. 4 Manage environmental water to meet flow targets specified in the Lachlan LTWP. 5 Protect low flow habitats from accelerated rates of drying..	None required – risk is tolerable.	N/A	Risk inherent to regulated river reaches. Zero flow periods cannot be scheduled due to dam operational constraints and requirements to deliver water orders and BLR (stock and domestic) replenishment flows.	MER planned for WSP objectives
Belubula River at Carcoar	Base flow or low flows		H	H-	H	H/H	H	Predefined Tolerable		None required – risk is tolerable	N/A	Risk inherent to regulated river reaches. Base flows cannot be scheduled due to dam operational constraints and requirements to deliver water orders and BLR (stock and domestic) replenishment flows.	MER planned for WSP objectives
Belubula River at Carcoar	Fresh flows		H	H+	H	H/H	H	Predefined Tolerable		N2 – Protect the 'first fresh' of uncontrolled flows in the Belubula River by restricting access by entitlement holders as specified in WSP	N/A	Water ordering patterns have altered the duration and timing of freshes leading to unnaturally long events in summer due to delivery of irrigation water, and less events in winter due to runoff capture by the dam. Freshes from uncontrolled tributary flows have access limits specified in the WSP (see column to left called 'current mechanisms') and there is a new 'first fresh' protection rule proposed.	MER planned for WSP objectives

SECTION 4.3. RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT AND CAPACITY TO MEET EWRS [E(W)] – REGULATED SYSTEM												
River reach within WRP area	**Flow or extraction characteristic**	**Current critical mechanisms**	**Consequence**	**Likelihood**	**Risk rating**	**Data confidence (consequence / likelihood)**	**Predefined tolerable risk level**	**Risk treatment option**	**Strategies**	**New critical mechanisms**	**Residual risk rating**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and evaluation**
Belubula River at Carcoar	High and infrequent flows – bank full 1.5 years ARI		H	H-	H	H/H	H	Predefined Tolerable		None required – risk is tolerable	N/A	The proximity of the Belubula River at Carcoar gauging station (412077) to Carcoar dam with no unregulated tributaries shows the maximum hydrological effect of Carcoar Dam. Impacts on fresh and flood magnitude flows attenuate downstream due to the large catchment areas of unregulated tributaries entering the Belubula River below Carcoar Dam. Downstream (by Canowindra, 412195), there is a limited capacity to influence high flow events due to the magnitude of 1.5 year and greater flood flow rates relative to the volume of water entitlement, installed pump capacities and irrigator off-stream water storage volumes.	MER planned for WSP objectives
Belubula River at Carcoar	High and infrequent flows – over bank 2.5 years ARI		H	H-	H	H/H	H	Predefined Tolerable		None required – risk is tolerable	N/A	The proximity of the Belubula River at Carcoar gauging station (412077) to Carcoar dam with no unregulated tributaries shows the maximum hydrological effect of Carcoar Dam. Impacts on fresh and flood magnitude flows attenuate downstream due to the large catchment areas of unregulated tributaries entering the Belubula River below Carcoar Dam. Downstream (by Canowindra, 412195), there is a limited capacity to influence high flow events due to the magnitude of 1.5 year and greater flood flow rates relative to the volume of water entitlement, installed pump capacities and irrigator off-stream water storage volumes.	MER planned for WSP objectives
Belubula River at Carcoar	High and infrequent flows – over bank 5.0 years ARI		H	H+-	H	H/H	H	Predefined Tolerable		None required – risk is tolerable.	N/A	The proximity of the Belubula River at Carcoar gauging station (412077) to Carcoar dam with no unregulated tributaries shows the maximum hydrological effect of Carcoar Dam. Impacts on fresh and flood magnitude flows attenuate downstream due to the large catchment areas of unregulated tributaries entering the Belubula River below Carcoar Dam. Downstream (by Canowindra, 412195), there is a limited capacity to influence high flow events due to the magnitude of 1.5 year and greater flood flow rates relative to the volume of water entitlement, installed pump capacities and irrigator off-stream water storage volumes.	MER planned for WSP objectives
Belubula River at Helensholme	Zero flow periods	E7 rules governing uncontrolled flow access for general and high security entitlement holders as per the WSP for the Belubula River Regulated Water Source E5 Protection of PEW through compliance of LTAAEL	H	H+	H	H/H	H	Predefined Tolerable	1 Limit consumptive water extractions in the WRP area to the predefined share of available water. 2 Protect a portion of tributary fresh flow events in the Belubula Water Source within the Lachlan WRP area by regulating access to uncontrolled flows. 3. Protect the first fresh of uncontrolled flows in the Belubula River from October to April. 4 Manage environmental water to meet flow targets specified in the Lachlan LTWP. 5 Protect low flow habitats from accelerated rates of drying.	None required – risk is tolerable.	N/A	Risk inherent to regulated river reaches. Zero flow periods cannot be scheduled due to dam operational constraints and requirements to deliver water orders and BLR (stock and domestic) replenishment flows.	No MER planned
Belubula River at Helensholme	Base flow or low flows		H	M+	M	H/H	M	Predefined Tolerable		None required – risk is tolerable	N/A	Risk inherent to regulated river reaches. Base flows cannot be scheduled due to dam operational constraints and requirements to deliver water orders and BLR (stock and domestic) replenishment flows.	MER planned for WSP objectives
Belubula River at Helensholme	Fresh flows		H	M+	M	H/H	M	Predefined Tolerable		N2 – Protect the 'first fresh' of uncontrolled flows in the Belubula River by restricting access by entitlement holders as specified in WSP	N/A	Water ordering patterns have altered the duration and timing of freshes leading to unnaturally long events in summer due to delivery of irrigation water, and less events in winter due to runoff capture by the dam. Freshes from uncontrolled tributary flows have access limits specified in the WSP (see column to left called 'current mechanisms') and there is a new 'first fresh' protection rule proposed.	MER planned for WSP objectives

SECTION 4.3. RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT AND CAPACITY TO MEET EWRS [E(W)] – REGULATED SYSTEM

River reach within WRP area	Flow or extraction characteristic	Current critical mechanisms	Consequence	Likelihood	Risk rating	Data confidence (consequence / likelihood)	Predefined tolerable risk level	Risk treatment option	Strategies	New critical mechanisms	Residual risk rating	Explanation of tolerable risk application OR Explanation of why risk cannot be addressed	Monitoring and evaluation
Belubula River at Helensholme	High and infrequent flows – bank full 1.5 years ARI		H	L-	L	H/H	L	N/A		None required – risk is low	N/A	Impacts on fresh and flood magnitude flows attenuate downstream from Carcoar Dam due to the large catchment areas of unregulated tributaries entering the Belubula River below Carcoar Dam. Downstream by Canowindra (412195), there is a limited capacity to influence high flow events due to the magnitude of 1.5 year and greater flood flow rates relative to the volume of water entitlement, installed pump capacities and irrigator off-stream water storage volumes.	MER planned for WSP objectives
Belubula River at Helensholme	High and infrequent flows – over bank 2.5 years ARI		H	L-	L	H/H	L	N/A		None required – risk is low	N/A	Impacts on fresh and flood magnitude flows attenuate downstream from Carcoar Dam due to the large catchment areas of unregulated tributaries entering the Belubula River below Carcoar Dam. Downstream by Canowindra (412195), there is a limited capacity to influence high flow events due to the magnitude of 1.5 year and greater flood flow rates relative to the volume of water entitlement, installed pump capacities and irrigator off-stream water storage volumes.	MER planned for WSP objectives
Belubula River at Helensholme	High and infrequent flows – over bank 5.0 years ARI		H	L-	L	H/H	L	N/A		None required – risk is low	N/A	Impacts on fresh and flood magnitude flows attenuate downstream from Carcoar Dam due to the large catchment areas of unregulated tributaries entering the Belubula River below Carcoar Dam. Downstream by Canowindra (412195), there is a limited capacity to influence high flow events due to the magnitude of 1.5 year and greater flood flow rates relative to the volume of water entitlement, installed pump capacities and irrigator off-stream water storage volumes.	MER planned for WSP objectives

Current Critical Mechanisms:
E1 Reserve all water above the long-term average annual extraction limit (LTAAEL) for the environment as PEW (defined and managed by the listed WSPs).

SECTION 4.3. RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT AND CAPACITY TO MEET EWRS [E(W)] – UNREGULATED SYSTEM											
Water source within WRP area	**Flow or extraction characteristic**	**Current critical mechanisms**	**Consequence**	**Likelihood**	**Risk rating**	**Data confidence (consequence / likelihood)**	**Risk treatment option**	**Strategies**	**New critical mechanisms**	**Tolerable risk level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and evaluation**
Abercrombie River above Wyangala† (6th Yr CtP)	Zero flow periods	E4 – Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage entitlement growth. E11 – Cease / commence to pump rules for streams. E12 – Cease / commence to pump rules for in-stream and off-river pools.	H	L+	L	H/M	A E	1 Limit consumptive water extractions in the WRP area to the predefined share of available water. 5 Protect low flow habitats from accelerated rates of drying. 6 Protect pools in streams, wetlands, lagoons and floodplains within the WRP area during dry periods. 18 Improve knowledge used to assess risk in unregulated sections of the WRP area. 19 Improve knowledge of effectiveness of existing strategies.	None required – risks are low	N/A		
Abercrombie River above Wyangala† (6th Yr CtP)	Base flow or low flows		H	L-	L	H/M	A E		None required – risks are low	N/A		
Abercrombie River above Wyangala† (6th Yr CtP)	Fresh flows		H	L-	L	H/M	A E		None required – risks are low	N/A		
Abercrombie River above Wyangala† (6th Yr CtP)	High and infrequent flows – bank full 1.5 years ARI		H	L0	L	H/M	A E		None required – risks are low	N/A		
Abercrombie River above Wyangala† (6th Yr CtP)	High and infrequent flows – over bank 2.5 years ARI		H	L0	L	H/M	A E		None required – risks are low	N/A		
Abercrombie River above Wyangala† (6th Yr CtP)	High and infrequent flows – over bank 5.0 years ARI		H	L0	L	H/M	A E		None required – risks are low	N/A		
Belubula River above Carcoar Dam	Zero flow periods	E4 – Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage entitlement growth. E11 – Cease / commence to pump rules for streams. E12 – Cease / commence to pump rules for in-stream and off-river pools.	L	H+	M	H/M	B C	1 Limit consumptive water extractions in the WRP area to the predefined share of available water. 5 Protect low flow habitats from accelerated rates of drying. 6 Protect pools in streams, wetlands, lagoons and floodplains within the WRP area during dry periods. 18 Improve knowledge used to assess risk in unregulated sections of the WRP area. 19 Improve knowledge of effectiveness of existing strategies.	N5 – Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies	M	Tolerable – Recommend monitoring of WAL activation (likelihood is low as assets / values are above WAL locations)	MER planned for WSP objectives MER for N5
Belubula River above Carcoar Dam	Base flow or low flows		L	H-	M	H/M	B C		N5 – Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies	M	Tolerable – Recommend monitoring of WAL activation (likelihood is low as assets / values are above WAL locations)	MER planned for WSP objectives MER for N5
Belubula River above Carcoar Dam	Fresh flows		L	L-	L	H/M	A		None required – risks are low	N/A		
Belubula River above Carcoar Dam	High and infrequent flows – bank full 1.5 years ARI		L	L0	L	H/M	A		None required – risks are low	N/A		
Belubula River above Carcoar Dam	High and infrequent flows – over bank 2.5 years ARI		L	L0	L	H/M	A		None required – risks are low	N/A		
Belubula River above Carcoar Dam	High and infrequent flows – over bank 5.0 years ARI		L	L0	L	H/M	A		None required – risks are low	N/A		

SECTION 4.3. RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT AND CAPACITY TO MEET EWRS [E(W)] – UNREGULATED SYSTEM											
Water source within WRP area	**Flow or extraction characteristic**	**Current critical mechanisms**	**Consequence**	**Likelihood**	**Risk rating**	**Data confidence (consequence / likelihood)**	**Risk treatment option**	**Strategies**	**New critical mechanisms**	**Tolerable risk level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and evaluation**
Belubula Tributaries below Carcoar Dam	Zero flow periods	E4 – Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage entitlement growth. E11 – Cease / commence to pump rules for streams. E12 – Cease / commence to pump rules for in-stream and off-river pools.	M	H+	H	H/L	B C	1 Limit consumptive water extractions in the WRP area to the predefined share of available water. 5 Protect low flow habitats from accelerated rates of drying. 6 Protect pools in streams, wetlands, lagoons and floodplains within the WRP area during dry periods. 18 Improve knowledge used to assess risk in unregulated sections of the WRP area. 19 Improve knowledge of effectiveness of existing strategies.	N5 - Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies N6 - Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies	H	Not tolerable – Recommend strategy review during WRP development (active gauge is available)	MER planned for WSP objectives MER for N5 and N6
Belubula Tributaries below Carcoar Dam	Base flow or low flows		M	H-	H	H/L	B C		N5 - Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies N6 - Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies	H	Not tolerable – Recommend strategy review during WRP development (active gauge is available)	MER planned for WSP objectives MER for N5 and N6
Belubula Tributaries below Carcoar Dam	Fresh flows		M	H-	H	H/L	B C		N5 - Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies N6 - Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies	H	Not tolerable – Recommend strategy review during WRP development (active gauge is available)	MER planned for WSP objectives MER for N5 and N6
Belubula Tributaries below Carcoar Dam	High and infrequent flows – bank full 1.5 years ARI		M	L0	L	H/L	A		None required – risks are low	N/A		
Belubula Tributaries below Carcoar Dam	High and infrequent flows – over bank 2.5 years ARI		M	L0	L	H/L	A		None required – risks are low	N/A		
Belubula Tributaries below Carcoar Dam	High and infrequent flows – over bank 5.0 years ARI		M	L0	L	H/L	A		None required – risks are low	N/A		
Bogandillon and Manna Creeks	Zero flow periods	E4 – Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage entitlement growth. E11 – Cease / commence to pump rules for streams. E12 – Cease / commence to pump rules for in-stream and off-river pools.	M	L+	L	H/L	A	1 Limit consumptive water extractions in the WRP area to the predefined share of available water. 5 Protect low flow habitats from accelerated rates of drying. 6 Protect pools in streams, wetlands, lagoons and floodplains within the WRP area during dry periods. 18 Improve knowledge used to assess risk in unregulated sections of the WRP area. 19 Improve knowledge of effectiveness of existing strategies.	None required – risks are low	N/A		
Bogandillon and Manna Creeks	Base flow or low flows		M	H-	H	H/L	B C		N5 – Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies	H	Tolerable – Recommend frequent monitoring of WAL activation (impact is likely to occur with growth in use)	MER planned for WSP objectives MER for N5
Bogandillon and Manna Creeks	Fresh flows		M	L-	L	H/L	A		None required – risks are low	N/A		
Bogandillon and Manna Creeks	High and infrequent flows – bank full 1.5 years ARI		M	L0	L	H/L	A		None required – risks are low	N/A		

SECTION 4.3. RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT AND CAPACITY TO MEET EWRS [E(W)] – UNREGULATED SYSTEM											
Water source within WRP area	**Flow or extraction characteristic**	**Current critical mechanisms**	**Consequence**	**Likelihood**	**Risk rating**	**Data confidence (consequence / likelihood)**	**Risk treatment option**	**Strategies**	**New critical mechanisms**	**Tolerable risk level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and evaluation**
Bogandillon and Manna Creeks	High and infrequent flows – over bank 2.5 years ARI		M	L0	L	H/L	A		None required – risks are low	N/A		
Bogandillon and Manna Creeks	High and infrequent flows – over bank 5.0 years ARI		M	L0	L	H/L	A		None required – risks are low	N/A		
Boorowa River and Hovells Creek	Zero flow periods	E4 – Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage entitlement growth. E11 – Cease / commence to pump rules for streams. E12 – Cease / commence to pump rules for in-stream and off-river pools. E14 – Restrict construction of in-river dams on 3rd order or higher streams.	M	H+	H	H/M	B C	1 Limit consumptive water extractions in the WRP area to the predefined share of available water. 5 Protect low flow habitats from accelerated rates of drying. 6 Protect pools in streams, wetlands, lagoons and floodplains within the WRP area during dry periods. 18 Improve knowledge used to assess risk in unregulated sections of the WRP area. 19 Improve knowledge of effectiveness of existing strategies.	N5 - Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies N6 - Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies	H	Not tolerable – Recommend strategy review during WRP development (active gauge is available)	MER planned for WSP objectives MER for N5 and N6
Boorowa River and Hovells Creek	Base flow or low flows		M	H-	H	H/M	B C			H	Not tolerable – Recommend strategy review during WRP development (active gauge is available)	MER planned for WSP objectives MER for N5 and N6
Boorowa River and Hovells Creek	Fresh flows		M	L-	L	H/M	A		None required – risks are low	N/A		
Boorowa River and Hovells Creek	High and infrequent flows – bank full 1.5 years ARI		M	L0	L	H/M	A		None required – risks are low	N/A		
Boorowa River and Hovells Creek	High and infrequent flows – over bank 2.5 years ARI		M	L0	L	H/M	A		None required – risks are low	N/A		
Boorowa River and Hovells Creek	High and infrequent flows – over bank 5.0 years ARI		M	L0	L	H/M	A		None required – risks are low	N/A		
Burrangong Creek	Zero flow periods	E4 – Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage entitlement growth. E11 – Cease / commence to pump rules for streams. E12 – Cease / commence to pump rules for in-stream and off-river pools.	L	H+	M	H/L	B C	1 Limit consumptive water extractions in the WRP area to the predefined share of available water. 5 Protect low flow habitats from accelerated rates of drying. 6 Protect pools in streams, wetlands, lagoons and floodplains within the WRP area during dry periods. 18 Improve knowledge used to assess risk in unregulated sections of the WRP area. 19 Improve knowledge of effectiveness of existing strategies.	N5 – Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies N6 – Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies	M	Tolerable – Recommend frequent monitoring of WAL activation (impact is likely to occur with growth in use)	MER planned for WSP objectives MER for N5 and N6
Burrangong Creek	Base flow or low flows		L	H-	M	H/L	B C		N5 – Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies N6 – Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies	M	Not tolerable – Recommend strategy review during WRP development (active gauge is not available)	MER planned for WSP objectives MER for N5 and N6
Burrangong Creek	Fresh flows		L	L-	L	H/L	A		None required – risks are low	N/A		

SECTION 4.3. RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT AND CAPACITY TO MEET EWRS [E(W)] – UNREGULATED SYSTEM											
Water source within WRP area	**Flow or extraction characteristic**	**Current critical mechanisms**	**Consequence**	**Likelihood**	**Risk rating**	**Data confidence (consequence / likelihood)**	**Risk treatment option**	**Strategies**	**New critical mechanisms**	**Tolerable risk level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and evaluation**
Burrangong Creek	High and infrequent flows – bank full 1.5 years ARI		L	L-	L	H/L	A		None required – risks are low	N/A		
Burrangong Creek	High and infrequent flows – over bank 2.5 years ARI		L	L-	L	H/L	A		None required – risks are low	N/A		
Burrangong Creek	High and infrequent flows – over bank 5.0 years ARI		L	L0	L	H/L	A		None required – risks are low	N/A		
Crookwell River† (6th Yr CtP)	Zero flow periods	E4 – Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage entitlement growth. E11 – Cease / commence to pump rules for streams. E12 – Cease / commence to pump rules for in-stream and off-river pools. E14 – Restrict construction of in-river dams on 3rd order or higher streams.	H	L0	L	H/H	A	1 Limit consumptive water extractions in the WRP area to the predefined share of available water. 5 Protect low flow habitats from accelerated rates of drying. 6 Protect pools in streams, wetlands, lagoons and floodplains within the WRP area during dry periods. 18 Improve knowledge used to assess risk in unregulated sections of the WRP area. 19 Improve knowledge of effectiveness of existing strategies.	None required – risks are low	N/A		
Crookwell River† (6th Yr CtP)	Base flow or low flows		H	H-	H	H/H	B C E		N5 - Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies N6 - Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies	H	Not tolerable – Recommend strategy review during WRP development (active gauge is available)	MER planned for WSP objectives MER for N5 and N6
Crookwell River† (6th Yr CtP)	Fresh flows		H	L-	L	H/H	A		None required – risks are low	N/A		
Crookwell River† (6th Yr CtP)	High and infrequent flows – bank full 1.5 years ARI		H	L-	L	H/H	A		None required – risks are low	N/A		
Crookwell River† (6th Yr CtP)	High and infrequent flows – over bank 2.5 years ARI		H	L0	L	H/H	A		None required – risks are low	N/A		
Crookwell River† (6th Yr CtP)	High and infrequent flows – over bank 5.0 years ARI		H	L0	L	H/H	A		None required – risks are low	N/A		
Crowther Creek	Zero flow periods	E4 – Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage entitlement growth. E11 – Cease / commence to pump rules for streams. E12 – Cease / commence to pump rules for in-stream and off-river pools.	M	M+	M	H/M	B C	1 Limit consumptive water extractions in the WRP area to the predefined share of available water. 5 Protect low flow habitats from accelerated rates of drying. 6 Protect pools in streams, wetlands, lagoons and floodplains within the WRP area during dry periods. 18 Improve knowledge used to assess risk in unregulated sections of the WRP area. 19 Improve knowledge of effectiveness of existing strategies.	N5 – Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies N6 – Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies	M	Tolerable – Recommend frequent monitoring of WAL activation (impact is likely to occur with growth in use)	MER planned for WSP objectives MER for N5 and N6
Crowther Creek	Base flow or low flows		M	H-	H	H/M	B C		N5 – Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies N6 - Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies	H	Tolerable – Recommend frequent monitoring of WAL activation (impact is likely to occur with growth in use)	MER planned for WSP objectives MER for N5 and N6
Crowther Creek	Fresh flows		M	L-	L	H/M	A		None required – risks are low	N/A		
Crowther Creek	High and infrequent flows – bank full 1.5 years ARI		M	L0	L	H/M	A		None required – risks are low	N/A		

SECTION 4.3. RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT AND CAPACITY TO MEET EWRS [E(W)] – UNREGULATED SYSTEM												
Water source within WRP area	**Flow or extraction characteristic**	**Current critical mechanisms**	**Consequence**	**Likelihood**	**Risk rating**	**Data confidence (consequence / likelihood)**	**Risk treatment option**	**Strategies**	**New critical mechanisms**	**Tolerable risk level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and evaluation**
Crowther Creek	High and infrequent flows – over bank 2.5 years ARI		M	L0	L	H/M	A		None required – risks are low	N/A		
Crowther Creek	High and infrequent flows – over bank 5.0 years ARI		M	L0	L	H/M	A		None required – risks are low	N/A		
Goobang and Billabong Creeks	Zero flow periods	E4 – Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage entitlement growth. E12 – Cease / commence to pump rules for in-stream and off-river pools. E14 – Restrict construction of in-river dams on 3rd order or higher streams.	M	H+	H	C	B C	1 Limit consumptive water extractions in the WRP area to the predefined share of available water. 5 Protect low flow habitats from accelerated rates of drying. 6 Protect pools in streams, wetlands, lagoons and floodplains within the WRP area during dry periods. 18 Improve knowledge used to assess risk in unregulated sections of the WRP area. 19 Improve knowledge of effectiveness of existing strategies.	N5 – Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies N6 – Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies	H	Tolerable – Recommend frequent monitoring of WAL activation (impact is likely to occur with growth in use)	MER planned for WSP objectives MER for N5 and N6
Goobang and Billabong Creeks	Base flow or low flows		M	H-	H	H/H	B C		N5 – Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies N6 – Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies	H	Tolerable – Recommend frequent monitoring of WAL activation (impact is likely to occur with growth in use)	MER planned for WSP objectives MER for N5 and N6
Goobang and Billabong Creeks	Fresh flows		M	L-	L	H/H	A		None required – risks are low	N/A		
Goobang and Billabong Creeks	High and infrequent flows – bank full 1.5 years ARI		M	L-	L	H/H	A		None required – risks are low	N/A		
Goobang and Billabong Creeks	High and infrequent flows – over bank 2.5 years ARI		M	L0	L	H/H	A		None required – risks are low	N/A		
Goobang and Billabong Creeks	High and infrequent flows – over bank 5.0 years ARI		M	L0	L	H/H	A		None required – risks are low	N/A		
Goonigal and Kangarooby Creeks	Zero flow periods	E4 – Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage entitlement growth. E11 – Cease / commence to pump rules for streams. E12 – Cease / commence to pump rules for in-stream and off-river pools.	L	M+	L	H/L	A	1 Limit consumptive water extractions in the WRP area to the predefined share of available water. 5 Protect low flow habitats from accelerated rates of drying. 6 Protect pools in streams, wetlands, lagoons and floodplains within the WRP area during dry periods. 18 Improve knowledge used to assess risk in unregulated sections of the WRP area.	None required – risks are low	N/A		
Goonigal and Kangarooby Creeks	Base flow or low flows		L	H-	M	H/L	B C		N5 – Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies N6 – Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies	M	Tolerable – Recommend frequent monitoring of WAL activation (impact is likely to occur with growth in use)	MER planned for WSP objectives MER for N5 and N6

SECTION 4.3. RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT AND CAPACITY TO MEET EWRS [E(W)] – UNREGULATED SYSTEM												
Water source within WRP area	**Flow or extraction characteristic**	**Current critical mechanisms**	**Consequence**	**Likelihood**	**Risk rating**	**Data confidence (consequence / likelihood)**	**Risk treatment option**	**Strategies**	**New critical mechanisms**	**Tolerable risk level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and evaluation**
Goonigal and Kangarooby Creeks	Fresh flows		L	H-	M	H/L	B C	19 Improve knowledge of effectiveness of existing strategies.	N5 – Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies N6 –Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies	M	Tolerable – Recommend frequent monitoring of WAL activation (impact is likely to occur with growth in use)	MER planned for WSP objectives MER for N5 and N6
Goonigal and Kangarooby Creeks	High and infrequent flows – bank full 1.5 years ARI		L	L0	L	H/L	A		None required – risks are low	N/A		
Goonigal and Kangarooby Creeks	High and infrequent flows – over bank 2.5 years ARI		L	L0	L	H/L	A		None required – risks are low	N/A		
Goonigal and Kangarooby Creeks	High and infrequent flows – over bank 5.0 years ARI		L	L0	L	H/L	A		None required – risks are low	N/A		
Gunningbland and Yarrabandai	Zero flow periods		L	L+	L	H/L	A		None required – risks are low	N/A		
Gunningbland and Yarrabandai	Base flow or low flows	E4 – Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage entitlement growth. E12 – Cease / commence to pump rules for in-stream and off-river pools. E14 – Restrict construction of in-river dams on 3rd order or higher streams.	L	L-	L	H/L	A	1 Limit consumptive water extractions in the WRP area to the predefined share of available water. 5 Protect low flow habitats from accelerated rates of drying. 6 Protect pools in streams, wetlands, lagoons and floodplains within the WRP area during dry periods. 18 Improve knowledge used to assess risk in unregulated sections of the WRP area. 19 Improve knowledge of effectiveness of existing strategies.	None required – risks are low	N/A		
Gunningbland and Yarrabandai	Fresh flows		L	L-	L	H/L	A		None required – risks are low	N/A		
Gunningbland and Yarrabandai	High and infrequent flows – bank full 1.5 years ARI		L	L0	L	H/L	A		None required – risks are low	N/A		
Gunningbland and Yarrabandai	High and infrequent flows – over bank 2.5 years ARI		L	L0	L	H/L	A		None required – risks are low	N/A		
Gunningbland and Yarrabandai	High and infrequent flows – over bank 5.0 years ARI		L	L0	L	H/L	A		None required – risks are low	N/A		
Humbug Creek	Zero flow periods	E4 – Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage entitlement growth. E12 – Cease / commence to pump rules for in-stream and off-river pools. E14 – Restrict construction of in-river dams on 3rd order or higher streams.	L	L+	L	H/L	A	1 Limit consumptive water extractions in the WRP area to the predefined share of available water. 5 Protect low flow habitats from accelerated rates of drying. 6 Protect pools in streams, wetlands, lagoons and floodplains within the WRP area during dry periods. 18 Improve knowledge used to assess risk in unregulated sections of the WRP area.	None required – risks are low	N/A		
Humbug Creek	Base flow or low flows		L	L-	L	H/L	A		None required – risks are low	N/A		
Humbug Creek	Fresh flows		L	L-	L	H/L	A		None required – risks are low	N/A		

SECTION 4.3. RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT AND CAPACITY TO MEET EWRS [E(W)] – UNREGULATED SYSTEM

Water source within WRP area	Flow or extraction characteristic	Current critical mechanisms	Consequence	Likelihood	Risk rating	Data confidence (consequence / likelihood)	Risk treatment option	Strategies	New critical mechanisms	Tolerable risk level	Explanation of tolerable risk application OR Explanation of why risk cannot be addressed	Monitoring and evaluation
Humbug Creek	High and infrequent flows – bank full 1.5 years ARI		L	L0	L	H/L	A	19 Improve knowledge of effectiveness of existing strategies.		N/A		
Humbug Creek	High and infrequent flows – over bank 2.5 years ARI		L	L0	L	H/L	A			N/A		
Humbug Creek	High and infrequent flows – over bank 5.0 years ARI		L	L0	L	H/L	A			N/A		
Lachlan River above Reids Flat† (6th Yr CtP)	Zero flow periods	E4 – Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage entitlement growth. E11 – Cease / commence to pump rules for streams. E12 – Cease / commence to pump rules for in-stream and off-river pools.	VH	LO	M	H/H	B C E	1 Limit consumptive water extractions in the WRP area to the predefined share of available water. 5 Protect low flow habitats from accelerated rates of drying. 6 Protect pools in streams, wetlands, lagoons and floodplains within the WRP area during dry periods. 18 Improve knowledge used to assess risk in unregulated sections of the WRP area. 19 Improve knowledge of effectiveness of existing strategies.	N5 – Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies N6 – Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies	M	Tolerable – Recommend monitoring of WAL activation (likelihood is low but water source contains very high value assets and/or values)	MER planned for WSP objectives MER for N5 and N6
Lachlan River above Reids Flat† (6th Yr CtP)	Base flow or low flows		VH	M-	H	H/H	B C E		N5 – Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies N6 – Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies	H	Not Tolerable – Recommend strategy review during WRP development (active gauge is available)	MER planned for WSP objectives MER for N5 and N6
Lachlan River above Reids Flat† (6th Yr CtP)	Fresh flows		VH	L-	M	H/H	B C E		N5 – Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies N6 – Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies	M	Tolerable – Recommend monitoring of WAL activation (likelihood is low but water source contains very high value assets and/or values)	MER planned for WSP objectives MER for N5 and N6
Lachlan River above Reids Flat† (6th Yr CtP)	High and infrequent flows – bank full 1.5 years ARI		VH	L0	M	H/H	A B		N5 – Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies N6 – Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies	M	Tolerable – Recommend monitoring of WAL activation (likelihood is low but water source contains very high value assets and/or values)	MER planned for WSP objectives MER for N5 and N6
Lachlan River above Reids Flat† (6th Yr CtP)	High and infrequent flows – over bank 2.5 years ARI		VH	L0	M	H/M	A B		N5 – Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies N6 – Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies	M	Tolerable – Recommend monitoring of WAL activation (likelihood is low but water source contains very high value assets and/or values)	MER planned for WSP objectives MER for N5 and N6
Lachlan River above Reids Flat† (6th Yr CtP)	High and infrequent flows – over bank 5.0 years ARI		VH	L0	M	H/M	A B		N5 – Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies N6 – Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies	M	Tolerable – Recommend monitoring of WAL activation (likelihood is low but water source contains very high value assets and/or values)	MER planned for WSP objectives MER for N5 and N6

SECTION 4.3. RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT AND CAPACITY TO MEET EWRS [E(W)] – UNREGULATED SYSTEM												
Water source within WRP area	**Flow or extraction characteristic**	**Current critical mechanisms**	**Consequence**	**Likelihood**	**Risk rating**	**Data confidence (consequence / likelihood)**	**Risk treatment option**	**Strategies**	**New critical mechanisms**	**Tolerable risk level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and evaluation**
Lake Forbes and Back Yamma Creek	Zero flow periods	E4 – Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage entitlement growth. E11 – Cease / commence to pump rules for streams. E12 – Cease / commence to pump rules for in-stream and off-river pools. E14 – Restrict construction of in-river dams on 3rd order or higher streams.	L	L+	L	H/M	A	1 Limit consumptive water extractions in the WRP area to the predefined share of available water. 5 Protect low flow habitats from accelerated rates of drying. 6 Protect pools in streams, wetlands, lagoons and floodplains within the WRP area during dry periods. 18 Improve knowledge used to assess risk in unregulated sections of the WRP area. 19 Improve knowledge of effectiveness of existing strategies.	None required – risks are low	N/A		
Lake Forbes and Back Yamma Creek	Base flow or low flows		L	L-	L	H/L	A		None required – risks are low	N/A		
Lake Forbes and Back Yamma Creek	Fresh flows		L	L0	L	H/L	A		None required – risks are low	N/A		
Lake Forbes and Back Yamma Creek	High and infrequent flows – bank full 1.5 years ARI		L	L0	L	H/L	A		None required – risks are low	N/A		
Lake Forbes and Back Yamma Creek	High and infrequent flows – over bank 2.5 years ARI		L	L0	L	H/L	A		None required – risks are low	N/A		
Lake Forbes and Back Yamma Creek	High and infrequent flows – over bank 5.0 years ARI		L	L0	L	H/L	A		None required – risks are low	N/A		
Mandagery Creek (CtP implemented)	Zero flow periods	E4 – Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage entitlement growth. E11 – Cease / commence to pump rules for streams. E12 - Cease / commence to pump rules for in-stream and off-river pools. E14 - Restrict construction of in-river dams on 3rd order or higher streams.	H	L+	L	H/M	A	1 Limit consumptive water extractions in the WRP area to the predefined share of available water. 5 Protect low flow habitats from accelerated rates of drying. 6 Protect pools in streams, wetlands, lagoons and floodplains within the WRP area during dry periods. 18 Improve knowledge used to assess risk in unregulated sections of the WRP area. 19 Improve knowledge of effectiveness of existing strategies.	None required – risk is low	N/A		
Mandagery Creek (CtP implemented)	Base flow or low flows		H	H-	H	H/M	B C E		N5 – Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies N6 – Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies	H	Not tolerable – Recommend strategy review during WRP development (active gauge is available)	MER planned for WSP objectives MER for N5 and N6
Mandagery Creek (CtP implemented)	Fresh flows		H	M-	M	H/M	B C E			M		
Mandagery Creek (CtP implemented)	High and infrequent flows – bank full 1.5 years ARI		H	L-	L	H/M	A		None required – risks are low	N/A		
Mandagery Creek (CtP implemented)	High and infrequent flows – over bank 2.5 years ARI		H	L-	L	H/M	A		None required – risks are low	N/A		
Mandagery Creek (CtP implemented)	High and infrequent flows – over bank 5.0 years ARI		H	L0	L	H/M	A		None required – risks are low	N/A		

SECTION 4.3. RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT AND CAPACITY TO MEET EWRS [E(W)] – UNREGULATED SYSTEM											
Water source within WRP area	**Flow or extraction characteristic**	**Current critical mechanisms**	**Consequence**	**Likelihood**	**Risk rating**	**Data confidence (consequence / likelihood)**	**Risk treatment option**	**Strategies**	**New critical mechanisms**	**Tolerable risk level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and evaluation**
Mid Lachlan Unregulated†	Zero flow periods	E4 – Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage entitlement growth. E11 – Cease / commence to pump rules for streams. E12 – Cease / commence to pump rules for in-stream and off-river pools. E8 – Strategic use of Wyangala and Lake Brewster environmental water allowances (EWAs) as described in the WSP. E9 – Coordinate release of environmental water allowance (EWA) and held environmental water with natural flow events. E5 – Protection of PEW through compliance of LTAAEL E6 Translucent flow releases from Wyangala Dam as per environmental flow rules in the WSP for the Lachlan Regulated River Water Source 2016	H	L+	L	H/L	A	1 Limit consumptive water extractions in the WRP area to the predefined share of available water. 5 Protect low flow habitats from accelerated rates of drying. 6 Protect pools in streams, wetlands, lagoons and floodplains within the WRP area during dry periods. 18 Improve knowledge used to assess risk in unregulated sections of the WRP area. 19 Improve knowledge of effectiveness of existing strategies.	None required – risks are low	N/A		
Mid Lachlan Unregulated†	Base flow or low flows		H	M-	M	H/L	B C E		N5 – Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies N6 – Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies	M	Not tolerable – Recommend strategy review during WRP development (active gauge is available)	MER planned for WSP objectives MER for N5 and N6
Mid Lachlan Unregulated†	Fresh flows		H	L-*	L	H/L	A		None required – risks are low	N/A		
Mid Lachlan Unregulated†	High and infrequent flows – bank full 1.5 years ARI		H	L-	L	H/L	A		None required – risks are low	N/A		
Mid Lachlan Unregulated†	High and infrequent flows – over bank 2.5 years ARI		H	L-	L	H/L	A		None required – risks are low	N/A		
Mid Lachlan Unregulated†	High and infrequent flows – over bank 5.0 years ARI		H	L-	L	H/L	A		None required – risks are low	N/A		
Mount Hope Area	Zero flow periods	E4 – Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage entitlement growth. E11 – Cease / commence to pump rules for streams. E12 – Cease / commence to pump rules for in-stream and off-river pools.	L	L+	L	H/L	A	1 Limit consumptive water extractions in the WRP area to the predefined share of available water. 5 Protect low flow habitats from accelerated rates of drying. 6 Protect pools in streams, wetlands, lagoons and floodplains within the WRP area during dry periods. 18 Improve knowledge used to assess risk in unregulated sections of the WRP area. 19 Improve knowledge of effectiveness of existing strategies.	None required – risks are low	N/A		
Mount Hope Area	Base flow or low flows		L	L-	L	H/L	A		None required – risks are low	N/A		
Mount Hope Area	Fresh flows		L	L-	L	H/L	A		None required – risks are low	N/A		
Mount Hope Area	High and infrequent flows – bank full 1.5 years ARI		L	L0	L	H/L	A		None required – risks are low	N/A		
Mount Hope Area	High and infrequent flows – over bank 2.5 years ARI		L	L0	L	H/L	A		None required – risks are low	N/A		
Mount Hope Area	High and infrequent flows – over bank 5.0 years ARI		L	L0	L	H/L	A		None required – risks are low	N/A		

SECTION 4.3. RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT AND CAPACITY TO MEET EWRS [E(W)] – UNREGULATED SYSTEM											
Water source within WRP area	**Flow or extraction characteristic**	**Current critical mechanisms**	**Consequence**	**Likelihood**	**Risk rating**	**Data confidence (consequence / likelihood)**	**Risk treatment option**	**Strategies**	**New critical mechanisms**	**Tolerable risk level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and evaluation**
Naradhan Area	Zero flow periods	E4 – Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage entitlement growth. E11 – Cease / commence to pump rules for streams. E12 – Cease / commence to pump rules for in-stream and off-river pools.	L	L+	L	H/L	A	1 Limit consumptive water extractions in the WRP area to the predefined share of available water. 5 Protect low flow habitats from accelerated rates of drying. 6 Protect pools in streams, wetlands, lagoons and floodplains within the WRP area during dry periods. 18 Improve knowledge used to assess risk in unregulated sections of the WRP area. 19 Improve knowledge of effectiveness of existing strategies..	None required – risks are low	N/A		
Naradhan Area	Base flow or low flows		L	L-	L	H/L	A		None required – risks are low	N/A		
Naradhan Area	Fresh flows		L	L-	L	H/L	A		None required – risks are low	N/A		
Naradhan Area	High and infrequent flows – bank full 1.5 years ARI		L	L0	L	H/L	A		None required – risks are low	N/A		
Naradhan Area	High and infrequent flows – over bank 2.5 years ARI		L	L0	L	H/L	A		None required – risks are low	N/A		
Naradhan Area	High and infrequent flows – over bank 5.0 years ARI		L	L0	L	H/L	A		None required – risks are low	N/A		
Ooma Creek and Tributaries	Zero flow periods	E4 – Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage entitlement growth. E11 – Cease / commence to pump rules for streams. E12 – Cease / commence to pump rules for in-stream and off-river pools.	L	L+	L	H/L	A	1 Limit consumptive water extractions in the WRP area to the predefined share of available water. 5 Protect low flow habitats from accelerated rates of drying. 6 Protect pools in streams, wetlands, lagoons and floodplains within the WRP area during dry periods. 18 Improve knowledge used to assess risk in unregulated sections of the WRP area. 19 Improve knowledge of effectiveness of existing strategies.	None required – risks are low	N/A		MER planned for WSP objectives MER for N5
Ooma Creek and Tributaries	Base flow or low flows		L	H-	M	H/L	B C		N5 – Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies	M	Tolerable – Recommend monitoring of WAL activation (likelihood is low as assets / values are above WAL locations)	MER planned for WSP objectives MER for N5
Ooma Creek and Tributaries	Fresh flows		L	L-	L	H/L	A		None required – risks are low	N/A		
Ooma Creek and Tributaries	High and infrequent flows – bank full 1.5 years ARI		L	L-	L	H/L	A		None required – risks are low	N/A		
Ooma Creek and Tributaries	High and infrequent flows – over bank 2.5 years ARI		L	L0	L	H/L	A		None required – risks are low	N/A		
Ooma Creek and Tributaries	High and infrequent flows – over bank 5.0 years ARI		L	L0	L	H/L	A		None required – risks are low	N/A		

SECTION 4.3. RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT AND CAPACITY TO MEET EWRS [E(W)] – UNREGULATED SYSTEM											
Water source within WRP area	**Flow or extraction characteristic**	**Current critical mechanisms**	**Consequence**	**Likelihood**	**Risk rating**	**Data confidence (consequence / likelihood)**	**Risk treatment option**	**Strategies**	**New critical mechanisms**	**Tolerable risk level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and evaluation**
Tyagong Creek	Zero flow periods	E4 – Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage entitlement growth. E11 – Cease / commence to pump rules for streams. E12 – Cease / commence to pump rules for in-stream and off-river pools.	L	M+	L	H/L	A	1 Limit consumptive water extractions in the WRP area to the predefined share of available water. 5 Protect low flow habitats from accelerated rates of drying. 6 Protect pools in streams, wetlands, lagoons and floodplains within the WRP area during dry periods. 18 Improve knowledge used to assess risk in unregulated sections of the WRP area. 19 Improve knowledge of effectiveness of existing strategies.	None required – risks are low	N/A		MER planned for WSP objectives MER for N5
Tyagong Creek	Base flow or low flows		L	H-	M	H/L	B C		N5 – Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies N6 – Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies	M	Tolerable – Recommend monitoring of WAL activation (likelihood is low as assets / values are above WAL locations)	MER planned for WSP objectives MER for N5 and N6
Tyagong Creek	Fresh flows		L	L-	L	H/L	A		None required – risks are low	N/A		MER planned for WSP objectives MER for N5
Tyagong Creek	High and infrequent flows – bank full 1.5 years ARI		L	L0	L	H/L	A		None required – risks are low	N/A		
Tyagong Creek	High and infrequent flows – over bank 2.5 years ARI		L	L0	L	H/L	A		None required – risks are low	N/A		
Tyagong Creek	High and infrequent flows – over bank 5.0 years ARI		L	L0	L	H/L	A		None required – risks are low	N/A		
Unregulated Effluent Creeks	Zero flow periods	E4 – Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage entitlement growth. E11 – Cease / commence to pump rules for streams. E12 – Cease / commence to pump rules for in-stream and off-river pools. E8 – Strategic use of Wyangala and Lake Brewster environmental water allowances (EWAs) as described in the WSP. E9 – Coordinate release of environmental water allowance (EWA) and held environmental water with	M	L0	L	H/L	A	1 Limit consumptive water extractions in the WRP area to the predefined share of available water. 5 Protect low flow habitats from accelerated rates of drying. 6 Protect pools in streams, wetlands, lagoons and floodplains within the WRP area during dry periods. 18 Improve knowledge used to assess risk in unregulated sections of the WRP area. 19 Improve knowledge of effectiveness of existing strategies.	None required – risks are low	N/A		
Unregulated Effluent Creeks	Base flow or low flows		M	H+	H	H/L	B C E		N5 – Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies N6 – Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies	H	Not tolerable – Recommend strategy review during WRP development (active gauge is available)	MER planned for WSP objectives MER for N5 and N6
Unregulated Effluent Creeks	Fresh flows		M	M+*	M	H/L	B C		N5 – Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies N6 – Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies	M	Not tolerable – Recommend strategy review during WRP development (active gauge is available)	MER planned for WSP objectives MER for N5 and N6

SECTION 4.3. RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT AND CAPACITY TO MEET EWRS [E(W)] – UNREGULATED SYSTEM												
Water source within WRP area	**Flow or extraction characteristic**	**Current critical mechanisms**	**Consequence**	**Likelihood**	**Risk rating**	**Data confidence (consequence / likelihood)**	**Risk treatment option**	**Strategies**	**New critical mechanisms**	**Tolerable risk level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and evaluation**
Unregulated Effluent Creeks	High and infrequent flows – bank full 1.5 years ARI	natural flow events. E5 Protection of PEW through compliance of LTAAEL E6 Translucent flow releases from Wyangala Dam as per environmental flow rules in the WSP for the Lachlan Regulated Water Source	M	M-	M	H/L	B C		N5 – Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies N6 – Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies	M	Not tolerable – Recommend strategy review during WRP development (active gauge is available)	MER planned for WSP objectives MER for N5 and N6
Unregulated Effluent Creeks	High and infrequent flows – over bank 2.5 years ARI		M	M-	M	H/L	B C		N5 – Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies N6 – Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies	M	Not tolerable – Recommend strategy review during WRP development (active gauge is available)	MER planned for WSP objectives MER for N5 and N6
Unregulated Effluent Creeks	High and infrequent flows – over bank 5.0 years ARI		M	M-	M	H/L	B C		N5 – Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies N6 – Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies	M	Not tolerable – Recommend strategy review during WRP development (active gauge is available)	MER planned for WSP objectives MER for N5 and N6
Waugoola Creek	Zero flow periods	E4 – Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage entitlement growth. E11 – Cease / commence to pump rules for streams. E12 – Cease / commence to pump rules for in-stream and off-river pools.	M	H+	H	H/H	B C	1 Limit consumptive water extractions in the WRP area to the predefined share of available water. 5 Protect low flow habitats from accelerated rates of drying. 6 Protect pools in streams, wetlands, lagoons and floodplains within the WRP area during dry periods. 18 Improve knowledge used to assess risk in unregulated sections of the WRP area. 19 Improve knowledge of effectiveness of existing strategies.	N5 – Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies N6 – Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies	H	Tolerable – Recommend frequent monitoring of WAL activation (impact is likely to occur with growth in use)	MER planned for WSP objectives MER for N5 and N6
Waugoola Creek	Base flow or low flows		M	H-	H	H/H	B C		N5 – Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies N6 – Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies	H	Tolerable – Recommend frequent monitoring of WAL activation (impact is likely to occur with growth in use)	MER planned for WSP objectives MER for N5 and N6
Waugoola Creek	Fresh flows		M	L-	L	H/H	A		None required – risks are low	N/A		
Waugoola Creek	High and infrequent flows – bank full 1.5 years ARI		M	L0	L	H/H	A		None required – risks are low	N/A		
Waugoola Creek	High and infrequent flows – over bank 2.5 years ARI		M	L0	L	H/H	A		None required – risks are low	N/A		
Waugoola Creek	High and infrequent flows – over bank 5.0 years ARI		M	L0	L	H/H	A		None required – risks are low	N/A		
Western Bland Creek	Zero flow periods	E4 – Trade limits or prohibitions between surface water plan areas, water sources, and management	M	L+	L	H/L	A	1 Limit consumptive water extractions in the WRP area to the predefined share of available water. 5 Protect low flow habitats from	None required – risks are low	N/A		

SECTION 4.3. RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT AND CAPACITY TO MEET EWRS [E(W)] – UNREGULATED SYSTEM												
Water source within WRP area	**Flow or extraction characteristic**	**Current critical mechanisms**	**Consequence**	**Likelihood**	**Risk rating**	**Data confidence (consequence / likelihood)**	**Risk treatment option**	**Strategies**	**New critical mechanisms**	**Tolerable risk level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and evaluation**
Western Bland Creek	Base flow or low flows	zones to manage entitlement growth. E11 – Cease / commence to pump rules for streams. E12 – Cease / commence to pump rules for in-stream and off-river pools. E14 – Restrict construction of in-river dams on 3rd order or higher streams.	M	H-	H	H/L	B C	accelerated rates of drying. 6 Protect pools in streams, wetlands, lagoons and floodplains within the WRP area during dry periods. 18 Improve knowledge used to assess risk in unregulated sections of the WRP area. 19 Improve knowledge of effectiveness of existing strategies.	N5 – Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies N6 – Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies	H	Not tolerable – Recommend strategy review during WRP development (active gauge is not available)	MER planned for WSP objectives MER for N5 and N6
Western Bland Creek	Fresh flows		M	L-	L	H/L	A		None required – risks are low	N/A		
Western Bland Creek	High and infrequent flows – bank full 1.5 years ARI		M	L0	L	H/L	A		None required – risks are low	N/A		
Western Bland Creek	High and infrequent flows – over bank 2.5 years ARI		M	L0	L	H/L	A		None required – risks are low	N/A		
Western Bland Creek	High and infrequent flows – over bank 5.0 years ARI		M	L0	L	H/L	A		None required – risks are low	N/A		
Current Critical Mechanisms: E1 Reserve all water above the long-term average annual extraction limit (LTAAEL) for the environment as PEW (defined and managed by the listed WSPs).												

SECTION 4.4 RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT FROM EXTRACTION UNDER BLR [E(BLR)] - REGULATED WATER SOURCES ONLY

Water source within WRP Area	Flow or Extraction Characteristic	Consequence	Likelihood	Risk Rating	Data confidence (Consequence / Likelihood)	Risk treatment option	Strategy	New Critical Mechanisms	Tolerable Risk Level	Explanation of Tolerable Risk Application OR Explanation (required if risk is above tolerable level)	Monitoring and Evaluation
Regulated river	BLR (D&S) extraction	M-VH	Nil	Nil	H/H	N/A	None required. Risk is nil.		N/A	N/A	

Current Critical Mechanisms:
E1 Reserve all water above the long-term average annual extraction limit (LTAAEL) for the environment as PEW (defined and managed by the listed WSPs).
E2 Available Water Determinations (AWD) adjust extractive use according to water availability.

SECTION 4.4. RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT FROM EXTRACTION UNDER BLR [E(BLR)] – UNREGULATED WATER SOURCES ONLY

Water source within WRP area	Flow or extraction characteristic	Consequence	Likelihood	Risk rating	Data confidence (consequence / likelihood)	Risk treatment option	Strategies	New critical mechanisms	Tolerable risk level	Explanation of tolerable risk application OR Explanation (required if risk is above tolerable level)	Monitoring and evaluation
Abercrombie River above Wyangala	BLR (D&S) extraction	L	M	L	H/L	N/A	None required. Risk is low.		N/A	N/A	
Belubula River above Carcoar Dam	BLR (D&S) extraction	L	L	L	H/L	N/A	None required. Risk is low.		N/A	N/A	
Belubula Tributaries below Carcoar Dam	BLR (D&S) extraction	M	L	L	H/L	N/A	None required. Risk is low.		N/A	N/A	
Bogandillon and Manna Creeks	BLR (D&S) extraction	M	L	L	H/L	N/A	None required. Risk is low.		N/A	N/A	
Boorowa River and Hovells Creek	BLR (D&S) extraction	M	L	L	H/L	N/A	None required. Risk is low.		N/A	N/A	
Burrangong Creek	BLR (D&S) extraction	L	L	L	H/L	N/A	None required. Risk is low.		N/A	N/A	
Crookwell River	BLR (D&S) extraction	H	L	L	H/L	N/A	None required. Risk is low.		N/A	N/A	
Crowther Creek	BLR (D&S) extraction	M	L	L	H/L	N/A	None required. Risk is low.		N/A	N/A	
Goobang and Billabong Creeks	BLR (D&S) extraction	M	L	L	H/L	N/A	None required. Risk is low.		N/A	N/A	
Goonigal and Kangarooby Creeks	BLR (D&S) extraction	L	L	L	H/L	N/A	None required. Risk is low.		N/A	N/A	

SECTION 4.4. RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT FROM EXTRACTION UNDER BLR [E(BLR)] – UNREGULATED WATER SOURCES ONLY

Water source within WRP area	Flow or extraction characteristic	Consequence	Likelihood	Risk rating	Data confidence (consequence / likelihood)	Risk treatment option	Strategies	New critical mechanisms	Tolerable risk level	Explanation of tolerable risk application OR Explanation (required if risk is above tolerable level)	Monitoring and evaluation
Gunningbland and Yarrabandai	BLR (D&S) extraction	L	L	L	H/L	N/A	None required. Risk is low.		N/A	N/A	
Humbug Creek	BLR (D&S) extraction	L	H	M	H/L	F	16 Protect the environment from changes in flow attributable to growth in BLR extractive use.	N1 – Sustainable diversion limits	M	See below.	MER planned for WSP objectives
Lachlan River above Reids Flat	BLR (D&S) extraction	VH	L	M	H/L	N/A	16 Protect the environment from changes in flow attributable to growth in BLR extractive use.	N1 – Sustainable diversion limits	M	See below.	
Lake Forbes and Back Yamma Creek	BLR (D&S) extraction	L	L	L	H/L	N/A	None required. Risk is low.		N/A	N/A	
Mandagery Creek	BLR (D&S) extraction	H	L	L	H/L	N/A	None required. Risk is low.		N/A	N/A	
Mid Lachlan Unregulated	BLR (D&S) extraction	H	L	M	H/L	F	16 Protect the environment from changes in flow attributable to growth in BLR extractive use.	N1 – Sustainable diversion limits	M	See below.	MER planned for WSP objectives
Mount Hope Area	BLR (D&S) extraction	L	H	M	H/L	F	16 Protect the environment from changes in flow attributable to growth in BLR extractive use.	N1 – Sustainable diversion limits	M	See below.	
Naradhan Area	BLR (D&S) extraction	L	L	L	H/L	N/A	None required. Risk is low.		N/A	N/A	
Ooma Creek and Tributaries	BLR (D&S) extraction	L	L	L	H/L	N/A	None required. Risk is low.		N/A	N/A	
Tyagong Creek	BLR (D&S) extraction	L	L	L	H/L	N/A	None required. Risk is low.		N/A	N/A	
Unreg Effluent Creeks	BLR (D&S) extraction	M	L	L	H/L	N/A	None required. Risk is low.		N/A	N/A	
Waugoola Creek	BLR (D&S) extraction	M	L	L	H/L	N/A	None required. Risk is low.		N/A	N/A	
Western Bland Creek	BLR (D&S) extraction	M	L	L	H/L	N/A	None required. Risk is low.		N/A	N/A	

Current critical mechanisms:
E1 Reserve all water above the long-term average annual extraction limit (LTAAEL) for the environment as PEW (defined and managed by the listed WSPs).
E2 Available Water Determinations (AWD) adjust extractive use according to water availability.

Explanation of tolerable risk application:
Domestic and stock rights are established and controlled under the WMA 2000. Take from surface waters for this purpose does not require either a water access licence or a work approval. Generally domestic and stock rights estimations are a small component of the consumptive demand on a water source. WSPs recognise and prioritise these rights in the management of long term extraction limits by including estimations in calculations and reducing licensed water use if corrective action is required. Risk to the environment from growth in domestic and stock rights is generally tolerable because it is managed within long term extraction limits and the SDL.
In some circumstances, where demand is stronger or when water shortages occur, domestic and stock rights can be restricted by the Minister either temporarily, or through the establishment of a mandatory guideline. Domestic and stock rights may also be limited by the Minister where high hydrologic stress on a water source may result from increased demand due to property subdivision. Risk to other users and the environment from growth in domestic and stock rights in these circumstances is tolerable because there are mechanisms available to manage demand if required.
N/A no data available or not applicable

SECTION 4.5.1. RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT FROM INTERCEPTION ACTIVITIES [E(I-FD)]

Risk	Water source type	Location, reach or extraction type within WRP area	Flow or extraction characteristic	Consequence	Likelihood	Risk rating	Data confidence (consequence / likelihood)	Risk treatment option	Strategies	New critical mechanisms	Tolerable risk level	Explanation of tolerable risk application OR Explanation of why risk cannot be addressed	Monitoring and evaluation
Risk to water available for the environment from farm dam interception E(I-FD)	Regulated	Booligal Wetlands	–	Minor	Possible	L	M/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for the environment from farm dam interception E(I-FD)	Regulated	Great Cumbung Swamp	–	Minor	Possible	L	M/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for the environment from farm dam interception E(I-FD)	Regulated	Regulated water sources	High flows	M-VH	VL	L	H/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for the environment from farm dam interception E(I-FD)	Unregulated	Abercrombie River @ Abercrombie	Variation Annual Index CV	H	L	L	M/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for the environment from farm dam interception E(I-FD)	Unregulated	Abercrombie River @ Abercrombie	Low Flow Index Q90	H	L	L	M/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for the environment from farm dam interception E(I-FD)	Unregulated	Abercrombie River @ Abercrombie	High Flow Index Q10	H	L	L	M/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for the environment from farm dam interception E(I-FD)	Unregulated	Abercrombie River @ Hadley No.2	Variation Annual Index CV	M	L	L	M/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for the environment from farm dam interception E(I-FD)	Unregulated	Abercrombie River @ Hadley No.2	Low Flow Index Q90	M	L	L	M/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for the environment from farm dam interception E(I-FD)	Unregulated	Abercrombie River @ Hadley No.2	High Flow Index Q10	M	L	L	M/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for the environment from farm dam interception E(I-FD)	Regulated	Belubula River @ the Needles+	Variation Annual Index CV	L	L	L	M/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for the environment from farm dam interception E(I-FD)	Regulated	Belubula River @ the Needles+	Low Flow Index Q90	L	H	M	M/M	N/A	None required. Risk is tolerable		M	The taking of water from farm dams is regulated by the Harvestable Rights Policy. Any take above that allowed under the policy must be licensed..	Ongoing monitoring of potential growth in number of farm dams within medium and high risk water sources
Risk to water available for the environment from farm dam interception E(I-FD)	Regulated	Belubula River @ the Needles+	High Flow Index Q10	L	L	L	M/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for the environment from farm dam interception E(I-FD)	Unregulated	Bland Creek @ Morangarell	Variation Annual Index CV	L	L	L	M/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for the environment from farm dam interception E(I-FD)	Unregulated	Bland Creek @ Morangarell	Low Flow Index Q90	L	L	L	M/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for the environment from farm dam interception E(I-FD)	Unregulated	Bland Creek @ Morangarell	High Flow Index Q10	L	L	L	M/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for the environment from farm dam interception E(I-FD)	Unregulated	Boorowa River @ Prossers Crossing	Variation Annual Index CV	M	L	L	M/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for the environment from farm dam interception E(I-FD)	Unregulated	Boorowa River @ Prossers Crossing	Low Flow Index Q90	M	L	L	M/M	N/A	None required. Risk is low		N/A	N/A	

SECTION 4.5.1. RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT FROM INTERCEPTION ACTIVITIES [E(I-FD)]

Risk	Water source type	Location, reach or extraction type within WRP area	Flow or extraction characteristic	Consequence	Likelihood	Risk rating	Data confidence (consequence / likelihood)	Risk treatment option	Strategies	New critical mechanisms	Tolerable risk level	Explanation of tolerable risk application OR Explanation of why risk cannot be addressed	Monitoring and evaluation
Risk to water available for the environment from farm dam interception E(I-FD)	Unregulated	Boorowa River @ Prossers Crossing	High Flow Index Q10	M	L	L	M/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for the environment from farm dam interception E(I-FD)	Unregulated	Coombing Creek @ Near Neville	Variation Annual Index CV	VL	L	L	M/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for the environment from farm dam interception E(I-FD)	Unregulated	Coombing Creek @ Near Neville	Low Flow Index Q90	VL	L	L	M/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for the environment from farm dam interception E(I-FD)	Unregulated	Coombing Creek @ Near Neville	High Flow Index Q10	VL	L	L	M/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for the environment from farm dam interception E(I-FD)	Unregulated	Crookwell River @ Narrawa North	Variation Annual Index CV	L	L	L	M/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for the environment from farm dam interception E(I-FD)	Unregulated	Crookwell River @ Narrawa North	Low Flow Index Q90	L	M	L	M/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for the environment from farm dam interception E(I-FD)	Unregulated	Crookwell River @ Narrawa North	High Flow Index Q10	L	L	L	M/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for the environment from farm dam interception E(I-FD)	Unregulated	Flyers Creek @ Beneree	Variation Annual Index CV	VL	L	L	M/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for the environment from farm dam interception E(I-FD)	Unregulated	Flyers Creek @ Beneree	Low Flow Index Q90	VL	M	L	M/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for the environment from farm dam interception E(I-FD)	Unregulated	Flyers Creek @ Beneree	High Flow Index Q10	VL	L	L	M/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for the environment from farm dam interception E(I-FD)	Unregulated	Lachlan River @ Gunning	Variation Annual Index CV	L	L	L	M/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for the environment from farm dam interception E(I-FD)	Unregulated	Lachlan River @ Gunning[+]	Low Flow Index Q90	L	M	L	M/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for the environment from farm dam interception E(I-FD)	Unregulated	Lachlan River @ Gunning	High Flow Index Q10	L	L	L	M/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for the environment from farm dam interception E(I-FD)	Unregulated	Lachlan River @ Narrawa	Variation Annual Index CV	L	L	L	M/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for the environment from farm dam interception E(I-FD)	Unregulated	Lachlan River @ Narrawa	Low Flow Index Q90	L	L	L	M/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for the environment from farm dam interception E(I-FD)	Unregulated	Lachlan River @ Narrawa	High Flow Index Q10	L	L	L	M/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for the environment from farm dam interception E(I-FD)	Unregulated	Mandagery Creek @ u/s Eugowra (Smithfield)	Variation Annual Index CV	L	L	L	M/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for the environment from farm dam interception E(I-FD)	Unregulated	Mandagery Creek @ u/s Eugowra (Smithfield)	Low Flow Index Q90	L	L	L	M/M	N/A	None required. Risk is low		N/A	N/A	

SECTION 4.5.1. RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT FROM INTERCEPTION ACTIVITIES [E(I-FD)]

Risk	Water source type	Location, reach or extraction type within WRP area	Flow or extraction characteristic	Consequence	Likelihood	Risk rating	Data confidence (consequence / likelihood)	Risk treatment option	Strategies	New critical mechanisms	Tolerable risk level	Explanation of tolerable risk application OR Explanation of why risk cannot be addressed	Monitoring and evaluation
Risk to water available for the environment from farm dam interception E(I-FD)	Unregulated	Mandagery Creek @ u/s Eugowra (Smithfield)	High Flow Index Q10	L	L	L	M/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for the environment from farm dam interception E(I-FD)	Unregulated	Pudmans Creek @ Kennys Creek Rd	Variation Annual Index CV	L	L	L	M/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for the environment from farm dam interception E(I-FD)	Unregulated	Pudmans Creek @ Kennys Creek Rd	Low Flow Index Q90	L	L	L	M/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for the environment from farm dam interception E(I-FD)	Unregulated	Pudmans Creek @ Kennys Creek Rd	High Flow Index Q10	L	L	L	M/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for the environment from farm dam interception E(I-FD)	Unregulated	Rocky Bridge Creek @ Near Neville	Variation Annual Index CV	L	L	L	M/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for the environment from farm dam interception E(I-FD)	Unregulated	Rocky Bridge Creek @ Near Neville	Low Flow Index Q90	L	L	L	M/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for the environment from farm dam interception E(I-FD)	Unregulated	Rocky Bridge Creek @ Near Neville	High Flow Index Q10	L	L	L	M/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for the environment from farm dam interception E(I-FD)	Unregulated	Tuena Creek @ Tuena	Variation Annual Index CV	L	L	L	M/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for the environment from farm dam interception E(I-FD)	Unregulated	Tuena Creek @ Tuena	Low Flow Index Q90	L	L	L	M/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for the environment from farm dam interception E(I-FD)	Unregulated	Tuena Creek @ Tuena	High Flow Index Q10	L	L	L	M/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for the environment from farm dam interception E(I-FD)	Unregulated	Wattle Creek @ Dudauman	Variation Annual Index CV	L	L	L	M/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for the environment from farm dam interception E(I-FD)	Unregulated	Wattle Creek @ Dudauman	Low Flow Index Q90	L	L	L	M/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for the environment from farm dam interception E(I-FD)	Unregulated	Wattle Creek @ Dudauman	High Flow Index Q10	L	L	L	M/M	N/A	None required. Risk is low		N/A	N/A	

Current critical mechanisms – E(I-FD)
E16 Require farm dams with a capacity above the maximum harvestable right dam capacity (MHRDC) to be licensed and comply with extraction limits as described in Strategy 1 (E1 Reserve all water above the long-term average annual extraction limit (LTAAEL) for the environment as PEW (defined and managed by the listed WSPs) & E2 Available Water Determinations (AWD) adjust extractive use according to water availability)

New Strategy: With the exception of Belubula River at the Needles which is a regulated river, no new strategies are required as risks are low. Refer to MER.

N/A no data available or not applicable

Explanation of tolerable risk application:
Domestic and stock rights are established and controlled under the WMA 2000. Take from surface waters for this purpose does not require either a water access licence or a work approval provided farm dam capacity is within the maximum harvestable right capacity. WSPs recognise and prioritise these rights in the management of long term extraction limits by including estimations in calculations and reducing licensed water use if corrective action is required. Risk to the environment from growth in domestic and stock rights is generally tolerable because it is managed within long term extraction limits and the SDL.
In some circumstances, where demand is stronger or when water shortages occur, domestic and stock rights can be restricted by the Minister either temporarily, or through the establishment of a mandatory guideline. Domestic and stock rights may also be limited by the Minister where high hydrologic stress on a water source may result from increased demand due to property subdivision. Risk to other users and the environment from growth in domestic and stock rights in these circumstances is tolerable because there are mechanisms available to manage demand if required.

SECTION 4.5.2 RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT FROM INTERCEPTION ACTIVITIES [E(I-PF)]

Risk	Water Source Type	Consequence	Likelihood	Risk Rating	Data confidence (Consequence / Likelihood)	Risk treatment option	Strategies	New Critical Mechanisms	Tolerable risk level	Explanation of tolerable risk application OR Explanation of why risk cannot be addressed	Monitoring and Evaluation
Risk to water available for the environment from plantation forestry E(I-PF)	Regulated	M-VH	Nil	Nil	H/M	N/A	None required. Risk is nil		N/A	N/A	
	Unregulated	L_VH	Nil	Nil	H/M	N/A	None required. Risk is nil		N/A	N/A	

Current Critical Mechanisms - E(I-PF)
E17 Plantation forestry interception is considered low risk therefore no mechanisms have been implemented under the WM Act.
E18 Ongoing risk monitoring to determine impact of future expansion of forest plantations at local and regional scales

SECTION 4.5.3 RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT FROM INTERCEPTION ACTIVITIES [E(I-M)]

Risk	Water Source Type	Risk Rating	Data confidence (Consequence / Likelihood)	Risk treatment option	Strategies	New Critical Mechanisms	Tolerable risk level	Explanation of tolerable risk application OR Explanation of why risk cannot be addressed	Monitoring and Evaluation
Reduced water quantity available for the environment caused by mining E(I-M)	Regulated	Nil	M/M	N/A	None required. Risk is nil		N/A	N/A	
	Unregulated	Nil	M/M	N/A	None required. Risk is nil		N/A	N/A	
Poor water quality for the environment caused by mining E(I-M)	Regulated	L	M/M	N/A	None required. Risk is low		N/A	N/A	
	Unregulated	L	M/M	N/A	None required. Risk is low		N/A	N/A	
Damage to structural integrity caused by mining E(I-M)	Regulated	L	M/M	N/A	None required. Risk is low		N/A	N/A	
	Unregulated	L	M/M	N/A	None required. Risk is low		N/A	N/A	

Current Critical Mechanisms - E(I-M)
Impacts of mining and coal seam gas activities are assessed under the *Environmental Planning and Assessment Act 1979*.
Water access licences must be obtained under the *NSW Water Management Act 2000*. Licences must be obtained via the market. As such, mining activities cannot increase water use and reduce water available for the environment.
Protection of the Environment Operations Act 1997 and the *Protection of the Environment Operations Act 1997* (POEO Act) the Environment Protection Authority (EPA) uses environment protection licences to regulate the activities to avoid and minimise harm caused by water pollution.

SECTION 4.5.4 RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT FROM INTERCEPTION ACTIVITIES [E(I-FH)]

Risk	Water Source Type	Consequence	Likelihood	Risk Rating	Data confidence (Consequence / Likelihood)	Risk treatment option	Strategies	New Critical Mechanisms	Tolerable risk level	Explanation of tolerable risk application OR Explanation of why risk cannot be addressed	Monitoring and Evaluation
Risk to water available for the environment from floodplain harvesting E(I-FH)	Regulated	VH	Nil	Nil	H/M	N/A	None required – risk is Nil		N/A	See section 5.4 of the water resource plan for current management actions and mechanisms	

Current Critical Mechanisms - E(I-FH)
The Floodplain Harvesting Policy and Healthy Floodplains Projects are converting this form of take into a licensable right. No historical floodplain harvesting has been identified in the Lachlan WRPA there is no need to apply the Floodplain Harvesting Policy and issue licenses under the Healthy Floodplains Project. See section 5.4 of the water resource plan for current management actions and mechanisms.

SECTION 4.6. RISKS OF INSUFFICIENT WATER FOR THE ENVIRONMENT DUE TO CLIMATE CHANGE [E(CC)]

Risk	Location, reach or extraction type within WRP area	Climate change scenario (MDBSY)	Current critical mechanisms	Consequence	Likelihood	Risk rating	Data confidence (consequence /	Risk treatment option	Strategies	New critical mechanisms	Tolerable risk level	Explanation of tolerable risk application OR Explanation of why risk cannot be addressed	Monitoring and evaluation
Regulated environmental assets													
Risk of insufficient water available for other uses due to climate change E(CC)	Booligal Wetlands	Wet climate change scenario	E1 – Reserve all water above the long-term average annual extraction limit (LTAAEL) for the environment as PEW (defined and managed by the listed WSPs). E2 – Available Water Determinations (AWD) adjust extractive use according to water availability.	Negligible	Unlikely	L	M/M	N/A	None required. Risk is low.		N/A		
Risk of insufficient water available for other uses due to climate change E(CC)	Great Cumbung Swamp	Wet climate change scenario		Negligible	Unlikely	L	M/M	N/A	None required. Risk is low.		N/A		
Risk of insufficient water available for other uses due to climate change E(CC)	Booligal Wetlands	Median climate change scenario		Moderate	Possible	M	M/M	F	15 Protect the environment and water users from changes in flow attributable to climate change.	N1 – Sustainable Diversion Limits	M	An individual licence holder's annual access to water is governed by their entitlement and climatic availability. The volume of water available to meet all competing environmental and extractive needs varies on a yearly and daily basis, depending on the weather, river flows and aquifer characteristics	
Risk of insufficient water available for other uses due to climate change E(CC)	Great Cumbung Swamp	Median climate change scenario		Moderate	Possible	M	M/M	F			M		
Risk of insufficient water available for other uses due to climate change E(CC)	Booligal Wetlands	Dry climate change scenario		Severe	Likely	H	M/M	F			H		
Risk of insufficient water available for other uses due to climate change E(CC)	Great Cumbung Swamp	Dry climate change scenario		Severe	Likely	H	M/M	F			H		
Regulated rivers													
Risk of insufficient water available for other uses due to climate change E(CC)	Lachlan @ Wyangala Dam	Dry climate change scenario	E1 - Reserve all water above the long-term average annual extraction limit (LTAAEL) for the environment as PEW	Medium	Medium	Medium	H/M	B C F	15 Protect the environment and water users from changes in flow attributable to climate change.	N1 Sustainable Diversion Limits N5 - Projects resulting from application of risk	M	An individual licence holder's annual access to water is governed by their entitlement and climatic	MER planned for WSP objectives MER for N5 and N6
Risk of insufficient water available for other uses due to climate change E(CC)	Lachlan @ Jemalong Weir	Dry climate change scenario		Very high	Medium	High	H/M	B C F			H		

Risk of insufficient water available for other uses due to climate change E(CC)	Lachlan @ Willandra Weir	Dry climate change scenario	(defined and managed by the listed WSPs). E2 - Available Water Determinations (AWD) adjust extractive use according to water availability.	Very high	Medium	High	H/M	B C F		treatment option C Expert opinion with MER confirmation strategies N6 - Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies	H	availability. The volume of water available to meet all competing environmental and extractive needs varies on a yearly and daily basis, depending on the weather, river flows and aquifer characteristics.	
Risk of insufficient water available for other uses due to climate change E(CC)	Lachlan @ Booligal Weir	Dry climate change scenario		High	Medium	Medium	H/M	B C F			M		
Risk of insufficient water available for other uses due to climate change E(CC)	Willandra Creek flow node	Dry climate change scenario		High	Medium	Medium	H/M	B C F			M		
Risk of insufficient water available for other uses due to climate change E(CC)	Belubula River @ Carcoar	Dry climate change scenario		High	Medium	Medium	H/M	B C F			M		
Risk of insufficient water available for other uses due to climate change E(CC)	Belubula River @ Helensholme	Dry climate change scenario		High	Medium	Medium	H/M	B C F			M		
Unregulated water sources													
Risk of insufficient water available for other uses due to climate change E(CC)	Abercrombie R above Wyangala	Dry climate change scenario	E1 - Reserve all water above the long-term average annual extraction limit (LTAAEL) for the environment as PEW (defined and managed by the listed WSPs). E2 - Available Water Determinations (AWD) adjust extractive use according to water availability.	High	Medium	Medium	H/M	B C F	15 Protect the environment and water users from changes in flow attributable to climate change.	N1 Sustainable Diversion Limits N5 - Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies N6 - Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies	M	An individual licence holder's annual access to water is governed by their entitlement and climatic availability. The volume of water available to meet all competing environmental and extractive needs varies on a yearly and daily basis, depending on the weather, river flows and aquifer characteristics.	MER planned for WSP objectives MER for N5 and N6
Risk of insufficient water available for other uses due to climate change E(CC)	Belubula R above Carcoar Dam	Dry climate change scenario		Low	Medium	Low	H/M	N/A	None required. Risk is low.	N/A			N/A
Risk of insufficient water available for other uses due to climate change E(CC)	Belubula Tributaries below Carcoar Dam	Dry climate change scenario		Medium	Medium	Medium	H/M	B C F	15 Protect the environment and water users from changes in flow attributable to climate change.	N1 Sustainable Diversion Limits N5 - Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies N6 - Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies	M	An individual licence holder's annual access to water is governed by their entitlement and climatic availability. The volume of water available to meet all competing environmental and extractive needs varies on a yearly and daily basis, depending on the weather, river flows and aquifer characteristics.	MER planned for WSP objectives MER for N5 and N6
Risk of insufficient water available for other uses due to climate change E(CC)	Bogandillon and Manna Creeks	Dry climate change scenario		Medium	Medium	Medium	H/M	B C F			M		
Risk of insufficient water available for other uses due to climate change E(CC)	Boorowa River and Hovells Creek	Dry climate change scenario		Medium	Medium	Medium	H/M	B C F			M		

Risk of insufficient water available for other uses due to climate change E(CC)	Burrangong Creek	Dry climate change scenario		Low	Medium	Low	H/M	N/A	None required. Risk is low.		N/A	N/A	
Risk of insufficient water available for other uses due to climate change E(CC)	Crookwell River	Dry climate change scenario		High	Medium	Medium	H/M	B C F	15 Protect the environment and water users from changes in flow attributable to climate change.	N1 Sustainable Diversion Limits N5 - Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies N6 - Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies	M	An individual licence holder's annual access to water is governed by their entitlement and climatic availability. The volume of water available to meet all competing environmental and extractive needs varies on a yearly and daily basis, depending on the weather, river flows and aquifer characteristics.	MER planned for WSP objectives MER for N5 and N6
Risk of insufficient water available for other uses due to climate change E(CC)	Crowther Creek	Dry climate change scenario		Medium	Medium	Medium	H/M	B C F			M		
Risk of insufficient water available for other uses due to climate change E(CC)	Goobang and Billabong Creeks	Dry climate change scenario		Medium	Medium	Medium	H/M	B C F			M		
Risk of insufficient water available for other uses due to climate change E(CC)	Goonigal and Kangarooby Creeks	Dry climate change scenario		Low	Medium	Low	H/M	N/A	None required. Risk is low.		N/A	N/A	N/A
Risk of insufficient water available for other uses due to climate change E(CC)	Gunningbland and Yarrabandai	Dry climate change scenario		Low	Medium	Low	H/M	N/A	None required. Risk is low.		N/A	N/A	N/A
Risk of insufficient water available for other uses due to climate change E(CC)	Humbug Creek	Dry climate change scenario		Low	Medium	Low	H/M	N/A	None required. Risk is low.		N/A	N/A	N/A
Risk of insufficient water available for other uses due to climate change E(CC)	Lachlan River above Reids Flat	Dry climate change scenario		Very high	Medium	High	H/M	B C F	15 Protect the environment and water users from changes in flow attributable to climate change.	N1 Sustainable Diversion Limits N5 - Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies N6 - Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies	H	An individual licence holder's annual access to water is governed by their entitlement and climatic availability. The volume of water available to meet all competing environmental and extractive needs varies on a yearly and daily basis, depending on the weather, river flows and aquifer characteristics.	MER planned for WSP objectives MER for N5 and N6
Risk of insufficient water available for other uses due to climate change E(CC)	Lake Forbes and Back Yamma Creek	Dry climate change scenario		Low	Medium	Low	H/M	N/A	None required. Risk is low.		N/A	N/A	N/A
Risk of insufficient water available for other uses due to climate change E(CC)	Mandagery Creek	Dry climate change scenario		High	Medium	Medium	H/M	B C F	15 Protect the environment and water users from changes in flow attributable to climate change.	N1 Sustainable Diversion Limits N5 - Projects resulting from application of risk treatment option C Expert opinion with	M	An individual licence holder's annual access to water is governed by their entitlement and climatic availability.	MER planned for WSP objectives MER for N5 and N6
Risk of insufficient water available for other uses due to climate change E(CC)	Mid Lachlan Unreg	Dry climate change scenario		High	Medium	Medium	H/M	B C F			M		

										MER confirmation strategies N6 - Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies		The volume of water available to meet all competing environmental and extractive needs varies on a yearly and daily basis, depending on the weather, river flows and aquifer characteristics.	
Risk of insufficient water available for other uses due to climate change E(CC)	Mount Hope Area	Dry climate change scenario		Low	Medium	Low	H/M	N/A	None required. Risk is low.		N/A	N/A	N/A
Risk of insufficient water available for other uses due to climate change E(CC)	Naradhan Area	Dry climate change scenario		Low	Medium	Low	H/M	N/A	None required. Risk is low.		N/A	N/A	N/A
Risk of insufficient water available for other uses due to climate change E(CC)	Ooma Creek and Tributaries	Dry climate change scenario		Low	Medium	Low	H/M	N/A	None required. Risk is low.		N/A	N/A	N/A
Risk of insufficient water available for other uses due to climate change E(CC)	Tyagong Creek	Dry climate change scenario		Low	Medium	Low	H/M	N/A	None required. Risk is low.		N/A	N/A	N/A
Risk of insufficient water available for other uses due to climate change E(CC)	Unreg Effluent Creeks	Dry climate change scenario		Medium	Medium	Medium	H/M	B C F	15 Protect the environment and water users from changes in flow attributable to climate change.	N1 Sustainable Diversion Limits N5 - Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies N6 - Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies	M	An individual licence holder's annual access to water is governed by their entitlement and climatic availability. The volume of water available to meet all competing environmental and extractive needs varies on a yearly and daily basis, depending on the weather, river flows and aquifer characteristics.	MER planned for WSP objectives MER for N5 and N6
Risk of insufficient water available for other uses due to climate change E(CC)	Waugoola Creek	Dry climate change scenario		Medium	Medium	Medium	H/M	B C F			M		
Risk of insufficient water available for other uses due to climate change E(CC)	Western Bland Creek	Dry climate change scenario		Medium	Medium	Medium	H/M	B C F			M		

SECTION 5 RISKS TO ENVIRONMENTAL ASSETS AND FUNCTIONS FROM PEST PLANTS AND ANIMALS										
Water Source Type	**Consequence**	**Likelihood**	**Risk Rating**	**Data confidence (Consequence / Likelihood)**	**Risk treatment option**	**Strategies**	**New Critical Mechanisms**	**Tolerable risk level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and Evaluation**
Lachlan WRP area water sources	M	M	M	M/M	A	No new strategies required		M	Risk is tolerable. Other legislative processes mitigate risk	No MER planned
Current Critical Mechanisms Biosecurity Act 2015 Biodiversity Conservation Act 2016 Environmental flow rules described in WRP Section 4.2										

SECTION 6.3, 6.4, 6.5., 6.6 RISKS TO THE HEALTH OF WATER-DEPENDENT ECOSYSTEMS FROM POOR WATER QUALITY [E(WQ-CWP)], [E(WQ-WWP)], [E(WQ-S)], [E(WQ-PT)]														
Risk code	**Water source type**	**Location, reach or extraction type within WRP area**	**Water quality characteristic**	**Current critical mechanisms**	**Consequence**	**Likelihood**	**Risk rating**	**Data confidence (consequence / likelihood)**	**Risk treatment option**	**Strategies**	**New critical mechanisms**	**Tolerable risk level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and Evaluation**
										The primary strategy for addressing risks associated with water quality is the implementation of the Water Quality Management Plan for Lachlan WRPA. Additional actions and mechanisms relevant to the WRP are listed below.				**WQ 1, 2, 3, 4, 5, 6, 7**
E(WQ)	Unregulated	412027 Lachlan River at Reids Flat	Turbidity	E4 – Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage entitlement growth. E11 – Cease / commence to pump rules for streams. E12 – Cease / commence to pump rules for in-stream and off-river pools. E13 – Authorised in-river dam construction, operation, and passing flow requirements as specified on the dam approval. E14 – Restrict construction of in-river dams on 3rd order or higher streams.	VH	L	M	M/H	F	Refer to WQM Plan		Refer to WQM Plan.		
E(WQ)	Unregulated	412027 Lachlan River at Reids Flat	Total Phosphorus	E4 – Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage entitlement growth. E11 – Cease / commence to pump rules for streams. E12 – Cease / commence to pump rules for in-stream and off-river pools. E13 – Authorised in-river dam construction, operation, and passing flow requirements as specified on the dam approval. E14 – Restrict construction of in-river dams on 3rd order or higher streams.	VH	L	M	M/H	F	Refer to WQM Plan		Refer to WQM Plan.		
E(WQ)	Unregulated	412027 Lachlan River at Reids Flat	Total Nitrogen	E4 – Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage entitlement growth. E11 – Cease / commence to pump rules for streams. E12 – Cease / commence to pump rules for in-stream and off-river pools. E13 – Authorised in-river dam construction, operation, and passing flow requirements as specified on the dam approval. E14 – Restrict construction of in-river dams on 3rd order or higher streams.	VH	M	H	M/H	F	Refer to WQM Plan		Refer to WQM Plan.		
E(WQ)	Unregulated	412027 Lachlan River at Reids Flat	pH	E4 – Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage entitlement growth. E11 – Cease / commence to pump rules for streams. E12 – Cease / commence to pump rules for in-stream and off-river pools. E13 – Authorised in-river dam construction, operation, and passing flow requirements as specified on the dam approval. E14 – Restrict construction of in-river dams on 3rd order or higher streams.	VH	L	M	M/H	F	Refer to WQM Plan		Refer to WQM Plan.		
E(WQ)	Unregulated	412027 Lachlan River at Reids Flat	Dissolved Oxygen	E4 – Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage entitlement growth. E11 – Cease / commence to pump rules for streams. E12 – Cease / commence to pump rules for in-stream and off-river pools. E13 – Authorised in-river dam construction, operation, and passing flow requirements as specified on the dam approval. E14 – Restrict construction of in-river dams on 3rd order or higher streams.	VH	M	H	M/H	F	Refer to WQM Plan		Refer to WQM Plan.		

SECTION 6.3, 6.4, 6.5., 6.6 RISKS TO THE HEALTH OF WATER-DEPENDENT ECOSYSTEMS FROM POOR WATER QUALITY [E(WQ-CWP)], [E(WQ-WWP)], [E(WQ-S)], [E(WQ-PT)]														
Risk code	**Water source type**	**Location, reach or extraction type within WRP area**	**Water quality characteristic**	**Current critical mechanisms**	**Consequence**	**Likelihood**	**Risk rating**	**Data confidence (consequence / likelihood)**	**Risk treatment option**	**Strategies**	**New critical mechanisms**	**Tolerable risk level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and Evaluation**
										The primary strategy for addressing risks associated with water quality is the implementation of the Water Quality Management Plan for Lachlan WRPA. Additional actions and mechanisms relevant to the WRP are listed below.				**WQ 1, 2, 3, 4, 5, 6, 7**
E(WQ)	Unregulated	41210123 Abercrombie River at Camping Area	Turbidity	E4 – Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage entitlement growth. E11 – Cease / commence to pump rules for streams. E12 – Cease / commence to pump rules for in-stream and off-river pools. E13 – Authorised in-river dam construction, operation, and passing flow requirements as specified on the dam approval. E14 – Restrict construction of in-river dams on 3rd order or higher streams.	H	L	L	M/H	F	Refer to WQM Plan		Refer to WQM Plan.		
E(WQ)	Unregulated	41210123 Abercrombie River at Camping Area	Total Phosphorus	E4 – Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage entitlement growth. E11 – Cease / commence to pump rules for streams. E12 – Cease / commence to pump rules for in-stream and off-river pools. E13 – Authorised in-river dam construction, operation, and passing flow requirements as specified on the dam approval. E14 – Restrict construction of in-river dams on 3rd order or higher streams.	H	L	L	M/H	F	Refer to WQM Plan		Refer to WQM Plan.		
E(WQ)	Unregulated	41210123 Abercrombie River at Camping Area	Total Nitrogen	E4 – Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage entitlement growth. E11 – Cease / commence to pump rules for streams. E12 – Cease / commence to pump rules for in-stream and off-river pools. E13 – Authorised in-river dam construction, operation, and passing flow requirements as specified on the dam approval. E14 – Restrict construction of in-river dams on 3rd order or higher streams.	H	L	L	M/H	F	Refer to WQM Plan		Refer to WQM Plan.		
E(WQ)	Unregulated	41210123 Abercrombie River at Camping Area	pH	E4 – Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage entitlement growth. E11 – Cease / commence to pump rules for streams. E12 – Cease / commence to pump rules for in-stream and off-river pools. E13 – Authorised in-river dam construction, operation, and passing flow requirements as specified on the dam approval. E14 – Restrict construction of in-river dams on 3rd order or higher streams.	H	L	L	M/H	F	Refer to WQM Plan		Refer to WQM Plan.		
E(WQ)	Unregulated	41210123 Abercrombie River at Camping Area	Dissolved Oxygen	E4 – Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage entitlement growth. E11 – Cease / commence to pump rules for streams. E12 – Cease / commence to pump rules for in-stream and off-river pools. E13 – Authorised in-river dam construction, operation, and passing flow requirements as specified on the dam approval. E14 – Restrict construction of in-river dams on 3rd order or higher streams.	H	L	L	M/H	F	Refer to WQM Plan		Refer to WQM Plan.		

SECTION 6.3, 6.4, 6.5., 6.6 RISKS TO THE HEALTH OF WATER-DEPENDENT ECOSYSTEMS FROM POOR WATER QUALITY [E(WQ-CWP)], [E(WQ-WWP)], [E(WQ-S)], [E(WQ-PT)]														
Risk code	**Water source type**	**Location, reach or extraction type within WRP area**	**Water quality characteristic**	**Current critical mechanisms**	**Consequence**	**Likelihood**	**Risk rating**	**Data confidence (consequence / likelihood)**	**Risk treatment option**	**Strategies**	**New critical mechanisms**	**Tolerable risk level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and Evaluation**
										The primary strategy for addressing risks associated with water quality is the implementation of the Water Quality Management Plan for Lachlan WRPA. Additional actions and mechanisms relevant to the WRP are listed below.				**WQ 1, 2, 3, 4, 5, 6, 7**
E(WQ)	Unregulated	412029 Boorowa River at Prossers Crossing	Turbidity	E4 – Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage entitlement growth. E11 – Cease / commence to pump rules for streams. E12 – Cease / commence to pump rules for in-stream and off-river pools. E13 – Authorised in-river dam construction, operation, and passing flow requirements as specified on the dam approval. E14 – Restrict construction of in-river dams on 3rd order or higher streams.	H	L	L	M/H	F	Refer to WQM Plan		Refer to WQM Plan.		
E(WQ)	Unregulated	412029 Boorowa River at Prossers Crossing	Total Phosphorus	E4 – Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage entitlement growth. E11 – Cease / commence to pump rules for streams. E12 – Cease / commence to pump rules for in-stream and off-river pools. E13 – Authorised in-river dam construction, operation, and passing flow requirements as specified on the dam approval. E14 – Restrict construction of in-river dams on 3rd order or higher streams.	H	H	H	M/H	F	Refer to WQM Plan		Refer to WQM Plan.		
E(WQ)	Unregulated	412029 Boorowa River at Prossers Crossing	Total Nitrogen	E4 – Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage entitlement growth. E11 – Cease / commence to pump rules for streams. E12 – Cease / commence to pump rules for in-stream and off-river pools. E13 – Authorised in-river dam construction, operation, and passing flow requirements as specified on the dam approval. E14 – Restrict construction of in-river dams on 3rd order or higher streams.	H	H	H	M/H	F	Refer to WQM Plan		Refer to WQM Plan.		
E(WQ)	Unregulated	412029 Boorowa River at Prossers Crossing	pH	E4 – Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage entitlement growth. E11 – Cease / commence to pump rules for streams. E12 – Cease / commence to pump rules for in-stream and off-river pools. E13 – Authorised in-river dam construction, operation, and passing flow requirements as specified on the dam approval. E14 – Restrict construction of in-river dams on 3rd order or higher streams.	H	L	L	M/H	F	Refer to WQM Plan		Refer to WQM Plan.		
E(WQ)	Unregulated	412029 Boorowa River at Prossers Crossing	Dissolved Oxygen	E11 – Cease / commence to pump rules for streams. E12 – Cease / commence to pump rules for in-stream and off-river pools. E13 – Authorised in-river dam construction, operation, and passing flow requirements as specified on the dam approval. E14 – Restrict construction of in-river dams on 3rd order or higher streams.	H	M	M	M/H	F	Refer to WQM Plan		Refer to WQM Plan.		

SECTION 6.3, 6.4, 6.5., 6.6 RISKS TO THE HEALTH OF WATER-DEPENDENT ECOSYSTEMS FROM POOR WATER QUALITY [E(WQ-CWP)], [E(WQ-WWP)], [E(WQ-S)], [E(WQ-PT)]														
Risk code	**Water source type**	**Location, reach or extraction type within WRP area**	**Water quality characteristic**	**Current critical mechanisms**	**Consequence**	**Likelihood**	**Risk rating**	**Data confidence (consequence / likelihood)**	**Risk treatment option**	**Strategies**	**New critical mechanisms**	**Tolerable risk level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and Evaluation**
										The primary strategy for addressing risks associated with water quality is the implementation of the Water Quality Management Plan for Lachlan WRPA. Additional actions and mechanisms relevant to the WRP are listed below.				**WQ 1, 2, 3, 4, 5, 6, 7**
E(WQ)	Regulated	412009 Belubula River at Canowindra	Turbidity	E7 – Rules governing uncontrolled flow access for general and high security entitlement holders as per the WSP for the Belubula River Regulated Water Source 2012 E10 – Rates of change to storage release protocol.	H	L	L	M/H	F	Refer to WQM Plan		Refer to WQM Plan.		MER planned for WSP objectives and WQ 1, 2, 4, 5
E(WQ)	Regulated	412009 Belubula River at Canowindra	Total Phosphorus	E7 – Rules governing uncontrolled flow access for general and high security entitlement holders as per the WSP for the Belubula River Regulated Water Source 2012 E10 – Rates of change to storage release protocol.	H	H	H	M/H	F	Refer to WQM Plan	N2 Proposed first fresh protection rule in the WSP for the Belubula Regulated River Water Source 2012	Refer to WQM Plan.		MER planned for WSP objectives and WQ 1, 2, 4, 5
E(WQ)	Regulated	412009 Belubula River at Canowindra	Total Nitrogen	E7 – Rules governing uncontrolled flow access for general and high security entitlement holders as per the WSP for the Belubula River Regulated Water Source 2012 E10 – Rates of change to storage release protocol.	H	M	M	M/H	F	Refer to WQM Plan	N2 Proposed first fresh protection rule in the WSP for the Belubula Regulated River Water Source 2012	Refer to WQM Plan.		MER planned for WSP objectives and WQ 1, 2, 4, 5
E(WQ)	Regulated	412009 Belubula River at Canowindra	pH	E7 – Rules governing uncontrolled flow access for general and high security entitlement holders as per the WSP for the Belubula River Regulated Water Source 2012 E10 – Rates of change to storage release protocol.	H	M	M	M/H	F	Refer to WQM Plan	N2 Proposed first fresh protection rule in the WSP for the Belubula Regulated River Water Source 2012	Refer to WQM Plan.		
E(WQ)	Regulated	412009 Belubula River at Canowindra	Dissolved Oxygen	E7 – Rules governing uncontrolled flow access for general and high security entitlement holders as per the WSP for the Belubula River Regulated Water Source 2012 E10 – Rates of change to storage release protocol.	H	L	L	M/H	F	Refer to WQM Plan		Refer to WQM Plan.		MER planned for WSP objectives and WQ 1, 2, 4, 5

SECTION 6.3, 6.4, 6.5., 6.6 RISKS TO THE HEALTH OF WATER-DEPENDENT ECOSYSTEMS FROM POOR WATER QUALITY [E(WQ-CWP)], [E(WQ-WWP)], [E(WQ-S)], [E(WQ-PT)]														
Risk code	**Water source type**	**Location, reach or extraction type within WRP area**	**Water quality characteristic**	**Current critical mechanisms**	**Consequence**	**Likelihood**	**Risk rating**	**Data confidence (consequence / likelihood)**	**Risk treatment option**	**Strategies**	**New critical mechanisms**	**Tolerable risk level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and Evaluation**
										The primary strategy for addressing risks associated with water quality is the implementation of the Water Quality Management Plan for Lachlan WRPA. Additional actions and mechanisms relevant to the WRP are listed below.				**WQ 1, 2, 3, 4, 5, 6, 7**
E(WQ-CWP)	Regulated	412009 Belubula River at Canowindra	Temperature	E7 – Rules governing uncontrolled flow access for general and high security entitlement holders as per the WSP for the Belubula River Regulated Water Source 2012 E10 – Rates of change to storage release protocol. E15 – Improve dam infrastructure and its management so that water releases are more closely matched to ambient river temperatures.	M	M	M	M/H	F	Refer to WQM Plan	N2 Proposed first fresh protection rule in the Belubula Regulated River Water Source 2012	Refer to WQM Plan.		MER planned for WSP objectives and WQ 1, 6
E(WQ)	Regulated	412004 Lachlan River at Forbes (Cotton's Weir)	Turbidity	E6 – Translucent flow releases from Wyangala Dam as per environmental flow rules in the WSP for the Lachlan Regulated River Water Source 2016 E8 – Strategic use of the Wyangala and Brewster environmental water allowances (EWAs) and the water quality allowance (WQA) as described in the WSP. E10 – Rates of change to storage release protocol. E9 – Coordinate release of environmental water allowances (EWAs) and held environmental water with natural flow events when appropriate.	H	H	H	M/H	F	Refer to WQM Plan	N3 Strategic use of environmental water allowance (EWA) (and relevant held environmental water licences) as guided by the LTWP.	Refer to WQM Plan.		MER planned for WSP objectives and WQ 1, 2, 4, 5
E(WQ)	Regulated	412004 Lachlan River at Forbes (Cotton's Weir)	Total Phosphorus	E6 – Translucent flow releases from Wyangala Dam as per environmental flow rules in the WSP for the Lachlan Regulated River Water Source 2016 E8 – Strategic use of the Wyangala and Brewster environmental water allowances (EWAs) and the water quality allowance (WQA) as described in the WSP. E10 – Rates of change to storage release protocol. E9 – Coordinate release of environmental water allowances (EWAs) and held environmental water with natural flow events when appropriate.	H	H	H	M/H	F	Refer to WQM Plan	N3 Strategic use of environmental water allowance (EWA) (and relevant held environmental water licences) as guided by the LTWP.	Refer to WQM Plan.		MER planned for WSP objectives and WQ 1, 2, 4, 5
E(WQ)	Regulated	412004 Lachlan River at Forbes (Cotton's Weir)	Total Nitrogen	E6 – Translucent flow releases from Wyangala Dam as per environmental flow rules in the WSP for the Lachlan Regulated Water Source 2016 E8 – Strategic use of the Wyangala and Brewster environmental water allowances (EWAs) and the water quality allowance (WQA) as described in the WSP. E10 – Rates of change to storage release protocol.	H	M	M	M/H	F	Refer to WQM Plan	N3 Strategic use of environmental water allowance (EWA) (and relevant held environmental water licences) as guided by the LTWP.	Refer to WQM Plan.		MER planned for WSP objectives and WQ 1, 2, 4, 5

SECTION 6.3, 6.4, 6.5., 6.6 RISKS TO THE HEALTH OF WATER-DEPENDENT ECOSYSTEMS FROM POOR WATER QUALITY [E(WQ-CWP)], [E(WQ-WWP)], [E(WQ-S)], [E(WQ-PT)]														
Risk code	**Water source type**	**Location, reach or extraction type within WRP area**	**Water quality characteristic**	**Current critical mechanisms**	**Consequence**	**Likelihood**	**Risk rating**	**Data confidence (consequence / likelihood)**	**Risk treatment option**	**Strategies**	**New critical mechanisms**	**Tolerable risk level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and Evaluation**
										The primary strategy for addressing risks associated with water quality is the implementation of the Water Quality Management Plan for Lachlan WRPA. Additional actions and mechanisms relevant to the WRP are listed below.				**WQ 1, 2, 3, 4, 5, 6, 7**
				E9 – Coordinate release of environmental water allowances (EWAs), and held environmental water with natural flow events when appropriate.										
E(WQ)	Regulated	412004 Lachlan River at Forbes (Cotton's Weir)	pH	E6 – Translucent flow releases from Wyangala Dam as per environmental flow rules in the WSP for the Lachlan Regulated River Water Source 2016 E8 – Strategic use of the Wyangala and Brewster environmental water allowances (EWAs) and the water quality allowance (WQA) as described in the WSP. E10 – Rates of change to storage release protocol. E9 – Coordinate release of environmental water allowances (EWAs),) and held environmental water with natural flow events when appropriate.	H	L	L	M/H	F	Refer to WQM Plan		Refer to WQM Plan.		MER planned for WSP objectives and WQ 1, 2, 4, 5
E(WQ)	Regulated	412004 Lachlan River at Forbes (Cotton's Weir)	Dissolved Oxygen	E6 – Translucent flow releases from Wyangala Dam as per environmental flow rules in the WSP for the Lachlan Regulated Water Source 2016 E8 – Strategic use of the Wyangala and Brewster environmental water allowances (EWAs) and the water quality allowance (WQA) as described in the WSP. E10 – Rates of change to storage release protocol. E9 – Coordinate release of environmental water allowances (EWAs),) and held environmental water with natural flow events when appropriate.	H	H	H	M/H	F	Refer to WQM Plan	N3 Strategic use of environmental water allowance (EWA) (and relevant held environmental water licences) as guided by the LTWP.	Refer to WQM Plan.		MER planned for WSP objectives and WQ 1, 2, 4, 5
E(WQ)	Regulated	412006 Lachlan River at Condobolin Bridge	Turbidity	E6 – Translucent flow releases from Wyangala Dam as per environmental flow rules in the WSP for the Lachlan Regulated River Water Source 2016 E8 – Strategic use of the Wyangala and Brewster environmental water allowances (EWAs) and the water quality allowance (WQA) as described in the WSP. E10 – Rates of change to storage release protocol. E9 – Coordinate release of environmental water allowances (EWAs) and held environmental water with natural flow events when appropriate.	H	H	H	M/H	F	Refer to WQM Plan	N3 Strategic use of environmental water allowance (EWA) (and relevant held environmental water licences) as guided by the LTWP.	Refer to WQM Plan.		MER planned for WSP objectives and WQ 1, 2, 4, 5
E(WQ)	Regulated	412006 Lachlan River at Condobolin Bridge	Total Phosphorus	E6 – Translucent flow releases from Wyangala Dam as per environmental flow rules in the WSP for the Lachlan Regulated Water Source 2016 E8 – Strategic use of the Wyangala and Brewster environmental water allowances (EWAs) and the water quality allowance (WQA) as described in the WSP.	H	H	H	M/H	F	Refer to WQM Plan	N3 Strategic use of environmental water allowance (EWA) (and relevant held environmental water licences) as guided by the LTWP.	Refer to WQM Plan.		MER planned for WSP objectives and WQ 1, 2, 4, 5

SECTION 6.3, 6.4, 6.5., 6.6 RISKS TO THE HEALTH OF WATER-DEPENDENT ECOSYSTEMS FROM POOR WATER QUALITY [E(WQ-CWP)], [E(WQ-WWP)], [E(WQ-S)], [E(WQ-PT)]														
Risk code	**Water source type**	**Location, reach or extraction type within WRP area**	**Water quality characteristic**	**Current critical mechanisms**	**Consequence**	**Likelihood**	**Risk rating**	**Data confidence (consequence / likelihood)**	**Risk treatment option**	**Strategies**	**New critical mechanisms**	**Tolerable risk level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and Evaluation**
										The primary strategy for addressing risks associated with water quality is the implementation of the Water Quality Management Plan for Lachlan WRPA. Additional actions and mechanisms relevant to the WRP are listed below.				**WQ 1, 2, 3, 4, 5, 6, 7**
				E10 – Rates of change to storage release protocol. E9 – Coordinate release of environmental water allowances (EWAs), and held environmental water with natural flow events when appropriate.										
E(WQ)	Regulated	412006 Lachlan River at Condobolin Bridge	Total Nitrogen	E6 – Translucent flow releases from Wyangala Dam as per environmental flow rules in the WSP for the Lachlan Regulated River Water Source 2016 E8 – Strategic use of the Wyangala and Brewster environmental water allowances (EWAs) and the water quality allowance (WQA) as described in the WSP. E10 – Rates of change to storage release protocol. E9 – Coordinate release of environmental water allowances (EWAs) and held environmental water with natural flow events when appropriate.	H	M	M	M/H	F	Refer to WQM Plan	N3 Strategic use of environmental water allowance (EWA) (and relevant held environmental water licences) as guided by the LTWP.	Refer to WQM Plan.		MER planned for WSP objectives and WQ 1, 2, 4, 5
E(WQ)	Regulated	412006 Lachlan River at Condobolin Bridge	pH	E6 – Translucent flow releases from Wyangala Dam as per environmental flow rules in the WSP for the Lachlan Regulated River Water Source 2016 E8 – Strategic use of the Wyangala and Brewster environmental water allowances (EWAs) and the water quality allowance (WQA) as described in the WSP. E10 – Rates of change to storage release protocol. E9 – Coordinate release of environmental water allowances (EWAs) and held environmental water with natural flow events when appropriate.	H	M	M	M/H	F	Refer to WQM Plan	N3 Strategic use of environmental water allowance (EWA) (and relevant held environmental water licences) as guided by the LTWP.	Refer to WQM Plan.		MER planned for WSP objectives and WQ 1, 2, 4, 5
E(WQ)	Regulated	412006 Lachlan River at Condobolin Bridge	Dissolved Oxygen	E6 – Translucent flow releases from Wyangala Dam as per environmental flow rules in the WSP for the Lachlan Regulated River Water Source 2016 E8 – Strategic use of the Wyangala and Brewster environmental water allowances (EWAs) and the water quality allowance (WQA) as described in the WSP. E10 – Rates of change to storage release protocol. E9 – Coordinate release of environmental water allowances (EWAs) and held environmental water with natural flow events when appropriate.	H	M	M	M/H	F	Refer to WQM Plan	N3 Strategic use of environmental water allowance (EWA) (and relevant held environmental water licences) as guided by the LTWP.	Refer to WQM Plan.		MER planned for WSP objectives and WQ 1, 2, 4, 5

SECTION 6.3, 6.4, 6.5., 6.6 RISKS TO THE HEALTH OF WATER-DEPENDENT ECOSYSTEMS FROM POOR WATER QUALITY [E(WQ-CWP)], [E(WQ-WWP)], [E(WQ-S)], [E(WQ-PT)]														
Risk code	**Water source type**	**Location, reach or extraction type within WRP area**	**Water quality characteristic**	**Current critical mechanisms**	**Consequence**	**Likelihood**	**Risk rating**	**Data confidence (consequence / likelihood)**	**Risk treatment option**	**Strategies**	**New critical mechanisms**	**Tolerable risk level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and Evaluation**
										The primary strategy for addressing risks associated with water quality is the implementation of the Water Quality Management Plan for Lachlan WRPA. Additional actions and mechanisms relevant to the WRP are listed below.				**WQ 1, 2, 3, 4, 5, 6, 7**
E(WQ)	Regulated	412011 Lachlan River at Lake Cargelligo Weir	Turbidity	E6 – Translucent flow releases from Wyangala Dam as per environmental flow rules in the WSP for the Lachlan Regulated River Water Source 2016 E8 – Strategic use of the Wyangala and Brewster environmental water allowances (EWAs) and the water quality allowance (WQA) as described in the WSP. E10 – Rates of change to storage release protocol. E9 – Coordinate release of environmental water allowances (EWAs) and held environmental water with natural flow events when appropriate.	H	M	M	M/H	F	Refer to WQM Plan	N3 Strategic use of environmental water allowance (EWA) (and relevant held environmental water licences) as guided by the LTWP.	Refer to WQM Plan.		MER planned for WSP objectives and WQ 1, 2, 4, 5
E(WQ)	Regulated	412011 Lachlan River at Lake Cargelligo Weir	Total Phosphorus	E6 – Translucent flow releases from Wyangala Dam as per environmental flow rules in the WSP for the Lachlan Regulated River Water Source 2016 E8 – Strategic use of the Wyangala and Brewster environmental water allowances (EWAs) and the water quality allowance (WQA) as described in the WSP. E10 – Rates of change to storage release protocol. E9 – Coordinate release of environmental water allowances (EWAs) and held environmental water with natural flow events when appropriate.	H	M	M	M/H	F	Refer to WQM Plan	N3 Strategic use of environmental water allowance (EWA) (and relevant held environmental water licences) as guided by the LTWP.	Refer to WQM Plan.		WQ 1, 2, 4, 5
E(WQ)	Regulated	412011 Lachlan River at Lake Cargelligo Weir	Total Nitrogen	E6 – Translucent flow releases from Wyangala Dam as per environmental flow rules in the WSP for the Lachlan Regulated River Water Source 2016 E8 – Strategic use of the Wyangala and Brewster environmental water allowances (EWAs) and the water quality allowance (WQA) as described in the WSP. E10 – Rates of change to storage release protocol. E9 – Coordinate release of environmental water allowances (EWAs) and held environmental water with natural flow events when appropriate.	H	M	M	M/H	F	Refer to WQM Plan	N3 Strategic use of environmental water allowance (EWA) (and relevant held environmental water licences) as guided by the LTWP.	Refer to WQM Plan.		WQ 1, 2, 4, 5
E(WQ)	Regulated	412011 Lachlan River at Lake Cargelligo Weir	pH	E6 – Translucent flow releases from Wyangala Dam as per environmental flow rules in the WSP for the Lachlan Regulated River Water Source 2016 E8 – Strategic use of the Wyangala and Brewster environmental water allowances (EWAs) and the water quality allowance (WQA) as described in the WSP. E10 – Rates of change to storage release protocol.	H	M	M	M/H	F	Refer to WQM Plan	N3 Strategic use of environmental water allowance (EWA) (and relevant held environmental water licences) as guided by the LTWP.	Refer to WQM Plan.		WQ 1, 2, 4, 5

SECTION 6.3, 6.4, 6.5., 6.6 RISKS TO THE HEALTH OF WATER-DEPENDENT ECOSYSTEMS FROM POOR WATER QUALITY [E(WQ-CWP)], [E(WQ-WWP)], [E(WQ-S)], [E(WQ-PT)]														
Risk code	**Water source type**	**Location, reach or extraction type within WRP area**	**Water quality characteristic**	**Current critical mechanisms**	**Consequence**	**Likelihood**	**Risk rating**	**Data confidence (consequence / likelihood)**	**Risk treatment option**	**Strategies**	**New critical mechanisms**	**Tolerable risk level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and Evaluation**
										The primary strategy for addressing risks associated with water quality is the implementation of the Water Quality Management Plan for Lachlan WRPA. Additional actions and mechanisms relevant to the WRP are listed below.				**WQ 1, 2, 3, 4, 5, 6, 7**
				E9 – Coordinate release of environmental water allowances (EWAs) and held environmental water with natural flow events when appropriate.										
E(WQ)	Regulated	412011 Lachlan River at Lake Cargelligo Weir	Dissolved Oxygen	E6 – Translucent flow releases from Wyangala Dam as per environmental flow rules in the WSP for the Lachlan Regulated River Water Source 2016 E8 – Strategic use of the Wyangala and Brewster environmental water allowances (EWAs) and the water quality allowance (WQA) as described in the WSP. E10 – Rates of change to storage release protocol. E9 – Coordinate release of environmental water allowances (EWAs) and held environmental water with natural flow events when appropriate.	H	M	M	M/H	F	Refer to WQM Plan	N3 Strategic use of environmental water allowance (EWA) (and relevant held environmental water licences) as guided by the LTWP.	Refer to WQM Plan.		MER planned for WSP objectives and WQ 1, 2, 4, 5
E(WQ)	Regulated	412039 Lachlan River at Hillston Weir	Turbidity	E6 – Translucent flow releases from Wyangala Dam as per environmental flow rules in the WSP for the Lachlan Regulated River Water Source 2016 E8 – Strategic use of the Wyangala and Brewster environmental water allowances (EWAs) and the water quality allowance (WQA) as described in the WSP. E10 – Rates of change to storage release protocol. E9 – Coordinate release of environmental water allowances (EWAs) and held environmental water with natural flow events when appropriate.	VH	M	H	M/H	F	Refer to WQM Plan	N3 Strategic use of environmental water allowance (EWA) (and relevant held environmental water licences) as guided by the LTWP.	Refer to WQM Plan.		MER planned for WSP objectives and WQ 1, 2, 4, 5
E(WQ)	Regulated	412039 Lachlan River at Hillston Weir	Total Phosphorus	E6 – Translucent flow releases from Wyangala Dam as per environmental flow rules in the WSP for the Lachlan Regulated River Water Source 2016 E8 – Strategic use of the Wyangala and Brewster environmental water allowances (EWAs) and the water quality allowance (WQA) as described in the WSP. E10 – Rates of change to storage release protocol. E9 – Coordinate release of environmental water allowances (EWAs) and held environmental water with natural flow events when appropriate.	VH	H	H	M/H	F	Refer to WQM Plan	N3 Strategic use of environmental water allowance (EWA) (and relevant held environmental water licences) as guided by the LTWP.	Refer to WQM Plan.		WQ 1, 2, 4, 5
E(WQ)	Regulated	412039 Lachlan River at Hillston Weir	Total Nitrogen	E6 – Translucent flow releases from Wyangala Dam as per environmental flow rules in the WSP for the Lachlan Regulated River Water Source 2016 E8 – Strategic use of the Wyangala and Brewster environmental water allowances (EWAs) and the water quality allowance (WQA) as described in the WSP.	VH	H	H	M/H	F	Refer to WQM Plan	N3 Strategic use of environmental water allowance (EWA) (and relevant held environmental water licences) as guided by the LTWP.	Refer to WQM Plan.		WQ 1, 2, 4, 5

SECTION 6.3, 6.4, 6.5., 6.6 RISKS TO THE HEALTH OF WATER-DEPENDENT ECOSYSTEMS FROM POOR WATER QUALITY [E(WQ-CWP)], [E(WQ-WWP)], [E(WQ-S)], [E(WQ-PT)]														
Risk code	**Water source type**	**Location, reach or extraction type within WRP area**	**Water quality characteristic**	**Current critical mechanisms**	**Consequence**	**Likelihood**	**Risk rating**	**Data confidence (consequence / likelihood)**	**Risk treatment option**	**Strategies**	**New critical mechanisms**	**Tolerable risk level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and Evaluation**
										The primary strategy for addressing risks associated with water quality is the implementation of the Water Quality Management Plan for Lachlan WRPA. Additional actions and mechanisms relevant to the WRP are listed below.				**WQ 1, 2, 3, 4, 5, 6, 7**
				E10 – Rates of change to storage release protocol. E9 – Coordinate release of environmental water allowances (EWAs) and held environmental water with natural flow events when appropriate.										
E(WQ)	Regulated	412039 Lachlan River at Hillston Weir	pH	E6 – Translucent flow releases from Wyangala Dam as per environmental flow rules in the WSP for the Lachlan Regulated River Water Source 2016 E8 – Strategic use of the Wyangala and Brewster environmental water allowances (EWAs) and the water quality allowance (WQA) as described in the WSP. E10 – Rates of change to storage release protocol. E9 – Coordinate release of environmental water allowances (EWAs) and held environmental water with natural flow events when appropriate.	VH	L	M	M/H	F	Refer to WQM Plan	N3 Strategic use of environmental water allowance (EWA) (and relevant held environmental water licences) as guided by the LTWP.	Refer to WQM Plan.		WQ 1, 2, 4, 5
E(WQ)	Regulated	412039 Lachlan River at Hillston Weir	Dissolved Oxygen	E6 – Translucent flow releases from Wyangala Dam as per environmental flow rules in the WSP for the Lachlan Regulated River Water Source 2016 E8 – Strategic use of the Wyangala and Brewster environmental water allowances (EWAs) and the water quality allowance (WQA) as described in the WSP. E10 – Rates of change to storage release protocol. E9 – Coordinate release of environmental water allowances (EWAs), and held environmental water with natural flow events when appropriate.	VH	M	H	M/H	F	Refer to WQM Plan	N3 Strategic use of environmental water allowance (EWA) (and relevant held environmental water licences) as guided by the LTWP.	Refer to WQM Plan.		MER planned for WSP objectives and WQ 1, 2, 4, 5
E(WQ)	Regulated	412005 Lachlan River at Booligal	Turbidity	E6 – Translucent flow releases from Wyangala Dam as per environmental flow rules in the WSP for the Lachlan Regulated River Water Source 2016 E8 – Strategic use of the Wyangala and Brewster environmental water allowances (EWAs) and the water quality allowance (WQA) as described in the WSP. E10 – Rates of change to storage release protocol. E9 – Coordinate release of environmental water allowances (EWAs), and held environmental water with natural flow events when appropriate.	H	H	H	M/H	F	Refer to WQM Plan	N3 Strategic use of environmental water allowance (EWA) (and relevant held environmental water licences) as guided by the LTWP.	Refer to WQM Plan.		
E(WQ)	Regulated	412005 Lachlan River at Booligal	Total Phosphorus	E6 – Translucent flow releases from Wyangala Dam as per environmental flow rules in the WSP for the Lachlan Regulated River Water Source 2016	H	H	H	M/H	F	Refer to WQM Plan		Refer to WQM Plan.		

SECTION 6.3, 6.4, 6.5., 6.6 RISKS TO THE HEALTH OF WATER-DEPENDENT ECOSYSTEMS FROM POOR WATER QUALITY [E(WQ-CWP)], [E(WQ-WWP)], [E(WQ-S)], [E(WQ-PT)]														
Risk code	**Water source type**	**Location, reach or extraction type within WRP area**	**Water quality characteristic**	**Current critical mechanisms**	**Consequence**	**Likelihood**	**Risk rating**	**Data confidence (consequence / likelihood)**	**Risk treatment option**	**Strategies**	**New critical mechanisms**	**Tolerable risk level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and Evaluation**
										The primary strategy for addressing risks associated with water quality is the implementation of the Water Quality Management Plan for Lachlan WRPA. Additional actions and mechanisms relevant to the WRP are listed below.				**WQ 1, 2, 3, 4, 5, 6, 7**
				E8 – Strategic use of the Wyangala and Brewster environmental water allowances (EWAs) and the water quality allowance (WQA) as described in the WSP. E10 – Rates of change to storage release protocol. E9 – Coordinate release of environmental water allowances (EWAs) and held environmental water with natural flow events when appropriate.			H						
E(WQ)	Regulated	412005 Lachlan River at Booligal	Total Nitrogen	E6 – Translucent flow releases from Wyangala Dam as per environmental flow rules in the WSP for the Lachlan Regulated River Water Source 2016 E8 – Strategic use of the Wyangala and Brewster environmental water allowances (EWAs) and the water quality allowance (WQA) as described in the WSP. E10 – Rates of change to storage release protocol. E9 – Coordinate release of environmental water allowances (EWAs) and held environmental water with natural flow events when appropriate.	H	H		M/H	F	Refer to WQM Plan		Refer to WQM Plan.		
E(WQ)	Regulated	412005 Lachlan River at Booligal	pH	E6 – Translucent flow releases from Wyangala Dam as per environmental flow rules in the WSP for the Lachlan Regulated River Water Source 2016 E8 – Strategic use of the Wyangala and Brewster environmental water allowances (EWAs) and the water quality allowance (WQA) as described in the WSP. E10 – Rates of change to storage release protocol. E9 – Coordinate release of environmental water allowances (EWAs) and held environmental water with natural flow events when appropriate.	H	L	L	M/H	F	Refer to WQM Plan		Refer to WQM Plan.		
E(WQ)	Regulated	412005 Lachlan River at Booligal	Dissolved Oxygen	E6 – Translucent flow releases from Wyangala Dam as per environmental flow rules in the WSP for the Lachlan Regulated River Water Source 2016 E8 – Strategic use of the Wyangala and Brewster environmental water allowances (EWAs) and the water quality allowance (WQA) as described in the WSP. E10 – Rates of change to storage release protocol. E9 – Coordinate release of environmental water allowances (EWAs) and held environmental water with natural flow events when appropriate.	H	M	M	M/H	F	Refer to WQM Plan		Refer to WQM Plan.		

SECTION 6.3, 6.4, 6.5., 6.6 RISKS TO THE HEALTH OF WATER-DEPENDENT ECOSYSTEMS FROM POOR WATER QUALITY [E(WQ-CWP)], [E(WQ-WWP)], [E(WQ-S)], [E(WQ-PT)]														
Risk code	**Water source type**	**Location, reach or extraction type within WRP area**	**Water quality characteristic**	**Current critical mechanisms**	**Consequence**	**Likelihood**	**Risk rating**	**Data confidence (consequence / likelihood)**	**Risk treatment option**	**Strategies**	**New critical mechanisms**	**Tolerable risk level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and Evaluation**
										The primary strategy for addressing risks associated with water quality is the implementation of the Water Quality Management Plan for Lachlan WRPA. Additional actions and mechanisms relevant to the WRP are listed below.				**WQ 1, 2, 3, 4, 5, 6, 7**
E(WQ)	Regulated	412045 Lachlan River at Corrong	Turbidity	E6 – Translucent flow releases from Wyangala Dam as per environmental flow rules in the WSP for the Lachlan Regulated River Water Source 2016 E8 – Strategic use of the Wyangala and Brewster environmental water allowances (EWAs) and the water quality allowance (WQA) as described in the WSP. E10 – Rates of change to storage release protocol. E9 – Coordinate release of environmental water allowances (EWAs) and held environmental water with natural flow events when appropriate.	L	H	M	M/H	F	Refer to WQM Plan		Refer to WQM Plan.		MER planned for WSP objectives and WQ 1, 2, 4, 5
E(WQ)	Regulated	412045 Lachlan River at Corrong	Total Phosphorus	E6 – Translucent flow releases from Wyangala Dam as per environmental flow rules in the WSP for the Lachlan Regulated River Water Source 2016 E8 – Strategic use of the Wyangala and Brewster environmental water allowances (EWAs) and the water quality allowance (WQA) as described in the WSP. E10 – Rates of change to storage release protocol. E9 – Coordinate release of environmental water allowances (EWAs) and held environmental water with natural flow events when appropriate.	L	H	M	M/H	F	Refer to WQM Plan		Refer to WQM Plan.		MER planned for WSP objectives and WQ 1, 2, 4, 5
E(WQ)	Regulated	412045 Lachlan River at Corrong	Total Nitrogen	E6 – Translucent flow releases from Wyangala Dam as per environmental flow rules in the WSP for the Lachlan Regulated River Water Source 2016 E8 – Strategic use of the Wyangala and Brewster environmental water allowances (EWAs) and the water quality allowance (WQA) as described in the WSP. E10 – Rates of change to storage release protocol. E9 – Coordinate release of environmental water allowances (EWAs) and held environmental water with natural flow events when appropriate.	L	H	M	M/H	F	Refer to WQM Plan		Refer to WQM Plan.		MER planned for WSP objectives and WQ 1, 2, 4, 5
E(WQ)	Regulated	412045 Lachlan River at Corrong	pH	E6 – Translucent flow releases from Wyangala Dam as per environmental flow rules in the WSP for the Lachlan Regulated River Water Source 2016 E8 – Strategic use of the Wyangala and Brewster environmental water allowances (EWAs) and the water quality allowance (WQA) as described in the WSP. E10 – Rates of change to storage release protocol.	L	L	L	M/H	F	Refer to WQM Plan		Refer to WQM Plan.		MER planned for WSP objectives and WQ 1, 2, 4, 5

SECTION 6.3, 6.4, 6.5., 6.6 RISKS TO THE HEALTH OF WATER-DEPENDENT ECOSYSTEMS FROM POOR WATER QUALITY [E(WQ-CWP)], [E(WQ-WWP)], [E(WQ-S)], [E(WQ-PT)]														
Risk code	**Water source type**	**Location, reach or extraction type within WRP area**	**Water quality characteristic**	**Current critical mechanisms**	**Consequence**	**Likelihood**	**Risk rating**	**Data confidence (consequence / likelihood)**	**Risk treatment option**	**Strategies**	**New critical mechanisms**	**Tolerable risk level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and Evaluation**
										The primary strategy for addressing risks associated with water quality is the implementation of the Water Quality Management Plan for Lachlan WRPA. Additional actions and mechanisms relevant to the WRP are listed below.				**WQ 1, 2, 3, 4, 5, 6, 7**
				E9 – Coordinate release of environmental water allowances (EWAs) and held environmental water with natural flow events when appropriate.			L					Refer to WQM Plan.		
E(WQ)	Regulated	412045 Lachlan River at Corrong	Dissolved Oxygen	E6 – Translucent flow releases from Wyangala Dam as per environmental flow rules in the WSP for the Lachlan Regulated River Water Source 2016 E8 – Strategic use of the Wyangala and Brewster environmental water allowances (EWAs) and the water quality allowance (WQA) as described in the WSP. E10 – Rates of change to storage release protocol. E9 – Coordinate release of environmental water allowances (EWAs) and held environmental water with natural flow events when appropriate.	L	L		M/H	F	Refer to WQM Plan				MER planned for WSP objectives and WQ 1, 2, 4, 5
E(WQ-CWP)	Regulated	200 km downstream of Wyangala Dam (includes Lachlan at downstream Wyangala Dam and Lachlan at Cowra)	Cold Water Pollution	E8 – Strategic use of the Wyangala and Brewster environmental water allowances (EWAs) and the water quality allowance (WQA) as described in the WSP. E15 – Improve dam infrastructure and its management so that water releases are more closely matched to ambient river temperatures.	H	H	H	M/M	F	Refer to WQM Plan **2.** Protect a portion of high flow events in the Lachlan and Belubula WSP areas in the Lachlan WRP area.	**N3** Strategic use of environmental water (EWAs) (and relevant held environmental water licences) as guided by the LTWP..	Refer to WQM Plan.		MER planned for WSP objectives and WQ 1, 2, 4, 5
E(WQ-CWP)	Regulated	100 km downstream of Carcoar Dam (includes Belubula River at Carcoar and Belubula at the Needles)		**E15** Improve dam infrastructure and its management so that water releases are more closely matched to ambient river temperatures	M	M	M	M/M	F	Refer to WQM Plan **2.** Protect a portion of high flow events in the Lachlan and Belubula WSP areas in the Lachlan WRP area.	**N2** Proposed first fresh protection rule in the WSP for the Belubula Regulated River Water Source 2016	Refer to WQM Plan.		MER planned for WSP objectives and WQ 1, 2, 4, 5
E(WQ-WWP)	Regulated	Immediately downstream of Carcoar Dam	Warm Water Pollution	**E15** Improve dam infrastructure and its management so that water releases are more closely matched to ambient river temperatures	M	L	L	M/M	N/A	None required - Risk is Low				
E(WQ-WWP)	Regulated	Immediately downstream of Wyangala Dam,		E8 – Strategic use of the Wyangala and Brewster environmental water allowances (EWAs) and the water quality allowance (WQA) as described in the WSP. E15 – Improve dam infrastructure and its management so that water releases are more closely matched to ambient river temperatures.	H	M	M	M/M	F	Refer to WQM Plan **2.** Protect a portion of high flow events in the Lachlan and Belubula WSP areas in the Lachlan WRP area.	**N3** Strategic use of environmental water (EWAs) (and relevant held environmental water licences) as guided by the LTWP.	Refer to WQM Plan.		MER planned for WSP objectives and WQ 1, 2, 4, 5

SECTION 6.3, 6.4, 6.5., 6.6 RISKS TO THE HEALTH OF WATER-DEPENDENT ECOSYSTEMS FROM POOR WATER QUALITY [E(WQ-CWP)], [E(WQ-WWP)], [E(WQ-S)], [E(WQ-PT)]														
Risk code	**Water source type**	**Location, reach or extraction type within WRP area**	**Water quality characteristic**	**Current critical mechanisms**	**Consequence**	**Likelihood**	**Risk rating**	**Data confidence (consequence / likelihood)**	**Risk treatment option**	**Strategies**	**New critical mechanisms**	**Tolerable risk level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and Evaluation**
										The primary strategy for addressing risks associated with water quality is the implementation of the Water Quality Management Plan for Lachlan WRPA. Additional actions and mechanisms relevant to the WRP are listed below.				**WQ 1, 2, 3, 4, 5, 6, 7**
E(WQ-PT)	Regulated & Unregulated	-	Pathogens and toxicants	Protection of the Environment Operations Act 1997 Local Government Act 1993 Local Government (General) Regulation 2005	VH	L	M	H/M	A	No new strategies required	NA	M	Risk is tolerable. Other legislative processes mitigate risk	NA
E(WQ-S)	Regulated	412004 Lachlan River at Forbes (Cotton's Weir)	Salinity	E6 – Translucent flow releases from Wyangala Dam as per environmental flow rules in the WSP for the Lachlan Regulated River Water Source 2016 E8 – Strategic use of the Wyangala and Brewster environmental water allowances (EWAs) and the water quality allowance (WQA) as described in the WSP. E10 – Rates of change to storage release protocol. E9 – Coordinate release of environmental water allowances (EWAs) and held environmental water with natural flow events when appropriate.	H	M	M	M/H	F	Refer to WQM Plan.		Refer to WQM Plan.		MER planned for WSP objectives and WQ 1, 2

SECTION 7.4. RISKS TO OTHER WATER USERS DUE TO UNSUITABLE WATER QUALITY [O(WQ-BGA)]															
Risk code	**Risk**	**Water source type**	**Location, reach or extraction type within WRP area**	**Water quality characteristic**	**Current critical mechanisms**	**Consequence**	**Likelihood**	**Risk rating**	**Data confidence (consequence / likelihood)**	**Risk treatment option**	**Strategies**	**New critical mechanisms**	**Tolerable risk level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and evaluation**
											The primary strategy for addressing risks associated with water quality is the implementation of the Water Quality Management Plan for Lachlan WRPA. Additional actions and mechanisms relevant to the WRP are listed below.				**WQ 1, 2, 3, 4, 5, 6, 7**
O(WQ-BGA)	Risks to recreational water quality	Reservoir	Carcoar Dam	Recreational Water Quality (BGA)	Refer to WQM Plan	L	M	L	H/M	F	Refer to WQM Plan		Refer to WQM Plan.		
O(WQ-BGA)	Risks to recreational water quality	Regulated	Belubula River downstream Carcoar Dam	Recreational Water Quality (BGA)	Refer to WQM Plan	L	L	L	H/M	F	Refer to WQM Plan		Refer to WQM Plan.		
O(WQ-BGA)	Risks to recreational water quality	Reservoir	Water Supply Reservoir, Cadia Gold Mine	Recreational Water Quality (BGA)	Refer to WQM Plan	L	H	M	H/M	F	Refer to WQM Plan		Refer to WQM Plan.		
O(WQ-BGA)	Risks to recreational water quality	Reservoir	Wyangala Dam	Recreational Water Quality (BGA)	Refer to WQM Plan	L	M	L	H/M	F	Refer to WQM Plan		Refer to WQM Plan.		
O(WQ-BGA)	Risks to recreational water quality	Regulated	Lachlan River downstream Wyangala Dam	Recreational Water Quality (BGA)	Refer to WQM Plan	L	L	L	H/M	F	Refer to WQM Plan		Refer to WQM Plan.		
O(WQ-BGA)	Risks to recreational water quality	Regulated	Lachlan River at Cowra	Recreational Water Quality (BGA)	Refer to WQM Plan	L	L	L	H/M	F	Refer to WQM Plan		Refer to WQM Plan.		
O(WQ-BGA)	Risks to recreational water quality	Regulated	Lachlan River at Forbes (Cottons Weir)	Recreational Water Quality (BGA)	Refer to WQM Plan	L	L	L	H/M	F	Refer to WQM Plan		Refer to WQM Plan.		
O(WQ-BGA)	Risks to recreational water quality	Lake	Lake Forbes	Recreational Water Quality (BGA)	Refer to WQM Plan	L	H	M	H/M	F	Refer to WQM Plan		Refer to WQM Plan.		
O(WQ-BGA)	Risks to recreational water quality	Regulated	Lachlan River at Condobolin	Recreational Water Quality (BGA)	Refer to WQM Plan	L	L	L	H/M	F	Refer to WQM Plan		Refer to WQM Plan.		
O(WQ-BGA)	Risks to recreational water quality	Lake	Gum Bend Lake	Recreational Water Quality (BGA)	Refer to WQM Plan	L	H	M	H/M	F	Refer to WQM Plan		Refer to WQM Plan.		
O(WQ-BGA)	Risks to recreational water quality	Reservoir	Lachlan River at Lake Cargelligo Weir	Recreational Water Quality (BGA)	Refer to WQM Plan	L	L	L	H/M	F	Refer to WQM Plan		Refer to WQM Plan.		

SECTION 7.4. RISKS TO OTHER WATER USERS DUE TO UNSUITABLE WATER QUALITY [O(WQ-BGA)]															
Risk code	**Risk**	**Water source type**	**Location, reach or extraction type within WRP area**	**Water quality characteristic**	**Current critical mechanisms**	**Consequence**	**Likelihood**	**Risk rating**	**Data confidence (consequence / likelihood)**	**Risk treatment option**	**Strategies**	**New critical mechanisms**	**Tolerable risk level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and evaluation**
											The primary strategy for addressing risks associated with water quality is the implementation of the Water Quality Management Plan for Lachlan WRPA. Additional actions and mechanisms relevant to the WRP are listed below.				**WQ 1, 2, 3, 4, 5, 6, 7**
O(WQ-BGA)	Risks to recreational water quality	Reservoir	Lake Cargelligo	Recreational Water Quality (BGA)	Refer to WQM Plan	L	H	M	H/M	F	Refer to WQM Plan		Refer to WQM Plan.		
O(WQ-BGA)	Risks to recreational water quality	Lake	Curlew Water	Recreational Water Quality (BGA)	Refer to WQM Plan	L	L	L	H/M	F	Refer to WQM Plan		Refer to WQM Plan.		
O(WQ-BGA)	Risks to recreational water quality	Regulated	Lake Creek at Lake Cargelligo outlet	Recreational Water Quality (BGA)	Refer to WQM Plan	L	L	L	H/M	F	Refer to WQM Plan		Refer to WQM Plan.		
O(WQ-BGA)	Risks to recreational water quality	Regulated	Lachlan River at Willandra Weir	Recreational Water Quality (BGA)	Refer to WQM Plan	L	L	L	H/M	F	Refer to WQM Plan		Refer to WQM Plan.		
O(WQ-BGA)	Risks to recreational water quality	Regulated	Lachlan River at Lake Brewster Weir	Recreational Water Quality (BGA)	Refer to WQM Plan	L	L	L	H/M	F	Refer to WQM Plan		Refer to WQM Plan.		
O(WQ-BGA)	Risks to recreational water quality	Reservoir	Lake Brewster	Recreational Water Quality (BGA)	Refer to WQM Plan	L	H	M	H/M	F	Refer to WQM Plan		Refer to WQM Plan.		
O(WQ-BGA)	Risks to recreational water quality	Regulated	Lachlan River at Hillston	Recreational Water Quality (BGA)	Refer to WQM Plan	L	M	L	H/M	F	Refer to WQM Plan		Refer to WQM Plan.		
O(WQ-BGA)	Risks to recreational water quality	Regulated	Lachlan River at Booligal	Recreational Water Quality (BGA)	Refer to WQM Plan	L	L	L	H/M	F	Refer to WQM Plan		Refer to WQM Plan.		
O(WQ-BGA)	Risks to recreational water quality	Regulated	Lachlan River at Corrong	Recreational Water Quality (BGA)	Refer to WQM Plan	L	M	L	H/M	F	Refer to WQM Plan		Refer to WQM Plan.		

SECTION 8.2.1 RISKS TO WATER AVAILABLE FOR OTHER USES DUE TO INTERCEPTION ACTIVITY [O(I-FD)] – REGULATED WATER SOURCE												
Risk	**Water source type**	**Location, reach or extraction type within WRP area**	**Consequence**	**Likelihood**	**Risk rating**	**Data confidence (consequence / likelihood)**	**Risk treatment option**	**Strategies**	**New critical mechanisms**	**Tolerable risk level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and evaluation**
Risk to water available for other uses due to farm dam interception (regulated rivers) O(I-FD)	Regulated	Lachlan High Security	Negligible	Possible	L	M/H	N/A	None required. Risk is low.		N/A	N/A	
Risk to water available for other uses due to farm dam interception (regulated rivers) O(I-FD)	Regulated	Lachlan General Security Water	Minor	Possible	L	M/H	N/A	None required. Risk is low.		N/A	N/A	
Risk to water available for other uses due to farm dam interception (regulated rivers) O(I-FD)	Regulated	Lachlan Supplementary/Uncontrolled Flow	Negligible	Possible	L	M/H	N/A	None required. Risk is low.		N/A	N/A	
Risk to water available for other uses due to farm dam interception (regulated rivers) O(I-FD)	Regulated	Belubula High Security	Negligible	Possible	L	M/H	N/A	None required. Risk is low.		N/A	N/A	
Risk to water available for other uses due to farm dam interception (regulated rivers) O(I-FD)	Regulated	Belubula General Security Water	Minor	Possible	L	M/H	N/A	None required. Risk is low.		N/A	N/A	
Risk to water available for other uses due to farm dam interception (regulated rivers) O(I-FD)	Regulated	Belubula Supplementary/Uncontrolled Flow	Negligible	Possible	L	M/H	N/A	None required. Risk is low.		N/A	N/A	
Current critical mechanisms – O(I-FD) E16 Require farm dams with a capacity above the maximum harvestable right dam capacity (MHRDC) to be licensed and comply with extraction limits as described in Strategy 1 (E1 Reserve all water above the long-term average annual extraction limit (LTAAEL) for the environment as PEW (defined and managed by the listed WSPs) & E2 Available Water Determinations (AWD) adjust extractive use according to water availability) N/A no data available or not applicable												

SECTION 8.2.1 RISKS TO WATER AVAILABLE FOR OTHER USES FROM INTERCEPTION ACTIVITIES [O(I-FD)] – UNREGULATED WATER SOURCES												
Risk	**Water Source Type**	**Location, Reach, or Extraction Type within WRP Area**	**Flow or Extraction Characteristic**	**Consequence**	**Likelihood**	**Risk Rating**	**Data confidence (Consequence / Likelihood)**	**Risk treatment option**	**Strategies**	**New Critical Mechanisms**	**Tolerable risk level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and Evaluation**
Risk to water available for other uses from farm dam interception O(I-FD)	Unregulated	Abercrombie River @ Abercrombie	Variation Annual Index CV	High	Low	Low	H/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for other uses from farm dam interception O(I-FD)	Unregulated		Low Flow Index Q90	High	Low	Low	H/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for other uses from farm dam interception O(I-FD)	Unregulated		High Flow Index Q10	High	Low	Low	H/M	N/A	None required. Risk is low		N/A	N/A	

SECTION 8.2.1 RISKS TO WATER AVAILABLE FOR OTHER USES FROM INTERCEPTION ACTIVITIES [O(I-FD)] – UNREGULATED WATER SOURCES

Risk	Water Source Type	Location, Reach, or Extraction Type within WRP Area	Flow or Extraction Characteristic	Consequence	Likelihood	Risk Rating	Data confidence (Consequence / Likelihood)	Risk treatment option	Strategies	New Critical Mechanisms	Tolerable risk level	Explanation of tolerable risk application OR Explanation of why risk cannot be addressed	Monitoring and Evaluation
Risk to water available for other uses from farm dam interception O(I-FD)	Unregulated	Abercrombie River @ Hadley No.2	Variation Annual Index CV	Medium	Low	Low	H/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for other uses from farm dam interception O(I-FD)	Unregulated		Low Flow Index Q90	Medium	Low	Low	H/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for other uses from farm dam interception O(I-FD)	Unregulated		High Flow Index Q10	Medium	Low	Low	H/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for other uses from farm dam interception O(I-FD)	Unregulated	Belubula River @ the Needles+	Variation Annual Index CV	Medium	Low	Low	H/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for other uses from farm dam interception O(I-FD)	Unregulated		Low Flow Index Q90	Medium	High	High	H/M	A	14 Protect other water users from changes in flow attributable to growth in BLR extractive use.	N1 Sustainable diversion limits	M	The taking of water from farm dams is regulated by the Harvestable Rights Policy. Any take above that allowed under the policy must be licensed.	Ongoing monitoring of potential growth in number of farm dams within medium and high risk water sources
Risk to water available for other uses from farm dam interception O(I-FD)	Unregulated		High Flow Index Q10	Medium	Low	Low	H/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for other uses from farm dam interception O(I-FD)	Unregulated	Bland Creek @ Morangarell	Variation Annual Index CV	Low	Low	Low	H/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for other uses from farm dam interception O(I-FD)	Unregulated		Low Flow Index Q90	Low	Low	Low	H/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for other uses from farm dam interception O(I-FD)	Unregulated		High Flow Index Q10	Low	Low	Low	H/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for other uses from farm dam interception O(I-FD)	Unregulated	Boorowa River @ Prossers Crossing	Variation Annual Index CV	Low	Low	Low	H/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for other uses from farm dam interception O(I-FD)	Unregulated		Low Flow Index Q90	Low	Low	Low	H/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for other uses from farm dam interception O(I-FD)	Unregulated		High Flow Index Q10	Low	Low	Low	H/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for other uses from farm dam interception O(I-FD)	Unregulated	Coombing Creek @ Near Neville	Variation Annual Index CV	Very low	Low	Low	H/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for other uses from farm dam interception O(I-FD)	Unregulated		Low Flow Index Q90	Very low	Low	Low	H/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for other uses from farm dam interception O(I-FD)	Unregulated		High Flow Index Q10	Very low	Low	Low	H/M	N/A	None required. Risk is low		N/A	N/A	

SECTION 8.2.1 RISKS TO WATER AVAILABLE FOR OTHER USES FROM INTERCEPTION ACTIVITIES [O(I-FD)] – UNREGULATED WATER SOURCES

Risk	Water Source Type	Location, Reach, or Extraction Type within WRP Area	Flow or Extraction Characteristic	Consequence	Likelihood	Risk Rating	Data confidence (Consequence / Likelihood)	Risk treatment option	Strategies	New Critical Mechanisms	Tolerable risk level	Explanation of tolerable risk application OR Explanation of why risk cannot be addressed	Monitoring and Evaluation
Risk to water available for other uses from farm dam interception O(I-FD)	Unregulated	Crookwell River @ Narrawa North	Variation Annual Index CV	Medium	Low	Low	H/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for other uses from farm dam interception O(I-FD)	Unregulated		Low Flow Index Q90	Medium	Medium	Medium	H/M	A	14 Protect other water users from changes in flow attributable to growth in BLR extractive use.	N1 Sustainable diversion limits	M	The taking of water from farm dams is regulated by the Harvestable Rights Policy. Any take above that allowed under the policy must be licensed.	Ongoing monitoring of potential growth in number of farm dams within medium and high risk water sources
Risk to water available for other uses from farm dam interception O(I-FD)	Unregulated		High Flow Index Q10	Medium	Low	Low	H/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for other uses from farm dam interception O(I-FD)	Unregulated	Flyers Creek @ Beneree	Variation Annual Index CV	Very low	Low	Low	H/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for other uses from farm dam interception O(I-FD)	Unregulated		Low Flow Index Q90	Very low	Medium	Low	H/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for other uses from farm dam interception O(I-FD)	Unregulated		High Flow Index Q10	Very low	Low	Low	H/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for other uses from farm dam interception O(I-FD)	Unregulated	Lachlan River @ Gunning	Variation Annual Index CV	Very low	Low	Low	H/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for other uses from farm dam interception O(I-FD)	Unregulated		Low Flow Index Q90	Very low	Medium	Low	H/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for other uses from farm dam interception O(I-FD)	Unregulated		High Flow Index Q10	Very low	Low	Low	H/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for other uses from farm dam interception O(I-FD)	Unregulated	Lachlan River @ Narrawa	Variation Annual Index CV	Low	Low	Low	H/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for other uses from farm dam interception O(I-FD)	Unregulated		Low Flow Index Q90	Low	Low	Low	H/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for other uses from farm dam interception O(I-FD)	Unregulated		High Flow Index Q10	Low	Low	Low	H/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for other uses from farm dam interception O(I-FD)	Unregulated	Mandagery Creek @ u/s Eugowra	Variation Annual Index CV	Low	Low	Low	H/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for other uses from farm dam interception O(I-FD)	Unregulated		Low Flow Index Q90	Low	Low	Low	H/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for other uses from farm dam interception O(I-FD)	Unregulated		High Flow Index Q10	Low	Low	Low	H/M	N/A	None required. Risk is low		N/A	N/A	

SECTION 8.2.1 RISKS TO WATER AVAILABLE FOR OTHER USES FROM INTERCEPTION ACTIVITIES [O(I-FD)] – UNREGULATED WATER SOURCES												
Risk	**Water Source Type**	**Location, Reach, or Extraction Type within WRP Area**	**Flow or Extraction Characteristic**	**Consequence**	**Likelihood**	**Risk Rating**	**Data confidence (Consequence / Likelihood)**	**Risk treatment option**	**Strategies**	**New Critical Mechanisms**	**Tolerable risk level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and Evaluation**
Risk to water available for other uses from farm dam interception O(I-FD)	Unregulated	Pudmans Creek @ Kennys Creek Rd	Variation Annual Index CV	Low	Low	Low	H/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for other uses from farm dam interception O(I-FD)	Unregulated		Low Flow Index Q90	Low	Low	Low	H/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for other uses from farm dam interception O(I-FD)	Unregulated		High Flow Index Q10	Low	Low	Low	H/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for other uses from farm dam interception O(I-FD)	Unregulated	Rocky Bridge @ Near Neville	Variation Annual Index CV	Low	Low	Low	H/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for other uses from farm dam interception O(I-FD)	Unregulated		Low Flow Index Q90	Low	Low	Low	H/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for other uses from farm dam interception O(I-FD)	Unregulated		High Flow Index Q10	Low	Low	Low	H/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for other uses from farm dam interception O(I-FD)	Unregulated	Tuena Creek @ Tuena	Variation Annual Index CV	Medium	Low	Low	H/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for other uses from farm dam interception O(I-FD)	Unregulated		Low Flow Index Q90	Medium	Low	Low	H/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for other uses from farm dam interception O(I-FD)	Unregulated		High Flow Index Q10	Medium	Low	Low	H/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for other uses from farm dam interception O(I-FD)	Unregulated	Wattle Creek @ Dudauman	Variation Annual Index CV	Low	Low	Low	H/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for other uses from farm dam interception O(I-FD)	Unregulated		Low Flow Index Q90	Low	Low	Low	H/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for other uses from farm dam interception O(I-FD)	Unregulated		High Flow Index Q10	Low	Low	Low	H/M	N/A	None required. Risk is low		N/A	N/A	
Current Critical Mechanisms - O(I-FD) E16 Require farm dams with a capacity above the maximum harvestable right dam capacity (MHRDC) to be licensed and comply with extraction limits as described in Strategy 1 (E1 Reserve all water above the long-term average annual extraction limit (LTAAEL) for the environment as PEW (defined and managed by the listed WSPs) & E2 Available Water Determinations (AWD) adjust extractive use according to water availability)													
New Strategy: None required. Risks are low. Refer to MER. N/A no data available or not applicable													

SECTION 8.2.2 RISKS TO WATER AVAILABLE FOR OTHER USES FROM INTERCEPTION ACTIVITIES [O(I-PF)]

Risk	Water Source Type	Consequence	Likelihood	Risk Rating	Data confidence (Consequence / Likelihood)	Risk treatment option	Strategies	New Critical Mechanisms	Tolerable risk level	Explanation of tolerable risk application OR Explanation of why risk cannot be addressed	Monitoring and Evaluation
Risk to water available for other uses from plantation forestry O(I-PF)	Regulated	M-VH	Nil	Nil	L/M	N/A	None required. Risk is nil		N/A	N/A	
	Unregulated	L-VH	Nil	Nil	H/M	N/A	None required. Risk is nil		N/A	N/A	

Current Critical Mechanisms - E(I-PF)
E17 Plantation forestry interception is considered low risk therefore no mechanisms have been implemented under the WM Act.
E18 Ongoing risk monitoring to determine impact of future expansion of forest plantations at local and regional scales

SECTION 8.2.3 RISKS TO WATER AVAILABLE FOR OTHER USES FROM INTERCEPTION ACTIVITIES [E(I-M)]

Risk	Water Source Type	Risk Rating	Data confidence (Consequence / Likelihood)	Risk treatment option	Strategies	New Critical Mechanisms	Tolerable risk level	Explanation of tolerable risk application OR Explanation of why risk cannot be addressed	Monitoring and Evaluation
Reduced water quantity available for other uses caused by mining E(I-M)	Regulated	Nil	M/M	N/A	None required. Risk is nil		N/A	N/A	
	Unregulated	Nil	M/M	N/A	None required. Risk is nil		N/A	N/A	
Poor water quality for the other uses caused by mining O(I-M)	Regulated	L	M/M	N/A	None required. Risk is low		N/A	N/A	
	Unregulated	L	M/M	N/A	None required. Risk is low		N/A	N/A	
Damage to structural integrity caused by mining O(I-M)	Regulated	L	M/M	N/A	None required. Risk is low		N/A	N/A	
	Unregulated	L	M/M	N/A	None required. Risk is low		N/A	N/A	

Current Critical Mechanisms - E(I-M)
Impacts of mining and coal seam gas activities are assessed under the *Environmental Planning and Assessment Act 1979*.
Water access licences must be obtained under the *NSW Water Management Act 2000*. Licences must be obtained via the market. As such, mining activities cannot increase water use and reduce water available for the environment.
Protection of the Environment Operations Act 1997 and the *Protection of the Environment Operations Act 1997* (POEO Act) the Environment Protection Authority (EPA) uses environment protection licences to regulate the activities to avoid and minimise harm caused by water pollution.

SECTION 8.2.4 RISKS TO WATER AVAILABLE FOR OTHER USES FROM INTERCEPTION ACTIVITIES [O(I-FH)]

Risk	Water Source Type	Consequence	Likelihood	Risk Rating	Data confidence (Consequence / Likelihood)	Risk treatment option	Strategies	New Critical Mechanisms	Tolerable risk level	Explanation of tolerable risk application OR Explanation of why risk cannot be addressed	Monitoring and Evaluation
Risk to water available for other uses from floodplain harvesting O(I-FH)	Regulated	H	Nil	Nil	H/M	N/A	None required – Risk is Nil		N/A	NA	-
Risk to water available for other uses from floodplain harvesting O(I-FH)	Unregulated	L-M	Nil	Nil	H/M	N/A	None required – Risk is Nil		NA	NA	-

Current Critical Mechanisms - E(I-FH)
the Floodplain Harvesting Policy and Healthy Floodplains Projects are converting this form of take into a licensable right. This form of take will be managed under the Floodplain licencing framework.

SECTION 8.3. RISKS TO WATER AVAILABLE FOR OTHER WATER USERS DUE TO CLIMATE CHANGE [O(CC)]

Risk	Location, reach or extraction type within WRP area	Climate change scenario (MDBSY)	Current critical mechanisms	Consequence	Likelihood	Risk rating	Data confidence (consequence / likelihood)	Risk treatment option	Strategies	New critical mechanisms	Tolerable risk level	Explanation of tolerable risk application OR Explanation of why risk cannot be addressed	Monitoring and evaluation
Risk to water available for other uses due to climate change O(CC)	Lachlan High Security	Wet climate change scenario	E2 Available Water Determinations (AWD) adjust extractive use according to water availability.	Negligible	Unlikely	L	M/M	N/A	None required. Risk is low.		N/A		
Risk to water available for other uses due to climate change O(CC)	Belubula High Security	Wet climate change scenario		Negligible	Unlikely	L	M/M	N/A	None required. Risk is low.		N/A		
Risk to water available for other uses due to climate change O(CC)	Lachlan General Security Water	Wet climate change scenario		Negligible	Unlikely	L	M/M	N/A	None required. Risk is low.		N/A		
Risk to water available for other uses due to climate change O(CC)	Belubula General Security Water	Wet climate change scenario		Negligible	Unlikely	L	M/M	N/A	None required. Risk is low.		N/A		
Risk to water available for other uses due to climate change O(CC)	Lachlan High Security	Median climate change scenario		Negligible	Possible	L	M/M	N/A	None required. Risk is low.		N/A		
Risk to water available for other uses due to climate change O(CC)	Belubula High Security	Median climate change scenario		Negligible	Possible	L	M/M	N/A	None required. Risk is low.		N/A		

SECTION 8.3. RISKS TO WATER AVAILABLE FOR OTHER WATER USERS DUE TO CLIMATE CHANGE [O(CC)]													
Risk	**Location, reach or extraction type within WRP area**	**Climate change scenario (MDBSY)**	**Current critical mechanisms**	**Consequence**	**Likelihood**	**Risk rating**	**Data confidence (consequence / likelihood)**	**Risk treatment option**	**Strategies**	**New critical mechanisms**	**Tolerable risk level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and evaluation**
Risk to water available for other uses due to climate change O(CC)	Lachlan General Security Water	Median climate change scenario		Moderate	Possible	M	M/M	F	15 Protect the environment and water users from changes in flow attributable to climate change.	N1 – Sustainable Diversion Limits	M	An individual licence holder's annual access to water is governed by their entitlement and climatic availability. The volume of water available to meet all competing environmental and extractive needs varies on a yearly and daily basis, depending on the weather, river flows and aquifer characteristics	
Risk to water available for other uses due to climate change O(CC)	Belubula General Security Water	Median climate change scenario		Moderate	Possible	M	M/M	F	15 Protect the environment and water users from changes in flow attributable to climate change.	N1 – Sustainable Diversion Limits	M		
Risk to water available for other uses due to climate change O(CC)	Lachlan High Security	Dry climate change scenario		Negligible	Possible	M	M/M	F	15 Protect the environment and water users from changes in flow attributable to climate change.	N1 – Sustainable Diversion Limits	M	An individual licence holder's annual access to water is governed by their entitlement and climatic availability. The volume of water available to meet all competing environmental and extractive needs varies on a yearly and daily basis, depending on the weather, river flows and aquifer characteristics	
Risk to water available for other uses due to climate change O(CC)	Belubula High Security	Dry climate change scenario		Negligible	Possible	M	M/M	F	15 Protect the environment and water users from changes in flow attributable to climate change.	N1 – Sustainable Diversion Limits	M		
Risk to water available for other uses due to climate change O(CC)	Lachlan General Security Water	Dry climate change scenario		Major	Likely	H	M/M	F	15 Protect the environment and water users from changes in flow attributable to climate change.	N1 – Sustainable Diversion Limits	H	An individual licence holder's annual access to water is governed by their entitlement and climatic availability. The volume of water available to meet all competing environmental and extractive needs varies on a yearly and daily basis, depending on the weather, river flows and aquifer characteristics	
Risk to water available for other uses due to climate change O(CC)	Belubula General Security Water	Dry climate change scenario		Major	Likely	H	M/M	F	15 Protect the environment and water users from changes in flow attributable to climate change.	N1 – Sustainable Diversion Limits	H		

SECTION 8.3 RISKS TO WATER AVAILABLE FOR OTHER USES DUE TO CLIMATE CHANGE [O(CC)] – UNREGULATED WATER SOURCES													
Risk	**Location, Reach, or Extraction Type within WRP Area**	**Climate Change Scenario (MDBSY)**	**Current Critical Mechanisms**	**Consequence**	**Likelihood**	**Risk Rating**	**Data confidence (Consequence / Likelihood)**	**Risk treatment option**	**Strategy**	**New Critical Mechanisms**	**Tolerable Risk Level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and Evaluation**
Risk to water available for other uses due to climate change O(CC)	Abercrombie R above Wyangala	Dry climate change scenario	E1 - Reserve all water above the long-term average annual extraction limit (LTAAEL) for the	L	M	L	H/M	N/A	None required. Risk is low.		N/A	N/A	

SECTION 8.3 RISKS TO WATER AVAILABLE FOR OTHER USES DUE TO CLIMATE CHANGE [O(CC)] – UNREGULATED WATER SOURCES												
Risk	**Location, Reach, or Extraction Type within WRP Area**	**Climate Change Scenario (MDBSY)**	**Current Critical Mechanisms**	**Consequence**	**Likelihood**	**Risk Rating**	**Data confidence (Consequence / Likelihood)**	**Risk treatment option**	**Strategy**	**New Critical Mechanisms**	**Tolerable Risk Level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and Evaluation**
Risk to water available for other uses due to climate change O(CC)	Belubula R above Carcoar Dam	Dry climate change scenario	environment as PEW (defined and managed by the listed WSPs). E2 - Available Water Determinations (AWD) adjust extractive use according to water availability.	L	M	L	H/M	N/A	None required. Risk is low.		N/A	N/A	
Risk to water available for other uses due to climate change O(CC)	Belubula Tributaries below Carcoar Dam	Dry climate change scenario		L	M	L	H/M	N/A	None required. Risk is low.		N/A	N/A	
Risk to water available for other uses due to climate change O(CC)	Bogandillon and Manna Creeks	Dry climate change scenario		L	M	L	H/M	N/A	None required. Risk is low.		N/A	N/A	
Risk to water available for other uses due to climate change O(CC)	Boorowa River and Hovells Creek	Dry climate change scenario		L	M	L	H/M	N/A	None required. Risk is low.		N/A	N/A	
Risk to water available for other uses due to climate change O(CC)	Burrangong Creek	Dry climate change scenario		M	M	M	H/M	F	15 Protect the environment and water users from changes in flow attributable to climate change.	N1 Sustainable Diversion Limits	M	An individual licence holder's annual access to water is governed by their entitlement and climatic availability. The volume of water available to meet all competing environmental and extractive needs varies on a yearly and daily basis, depending on the weather, river flows and aquifer characteristics.	
Risk to water available for other uses due to climate change O(CC)	Crookwell River	Dry climate change scenario		L	M	L	H/M	N/A	None required. Risk is low.		N/A	N/A	
Risk to water available for other uses due to climate change O(CC)	Crowther Creek	Dry climate change scenario		L	M	L	H/M	N/A	None required. Risk is low.		N/A	N/A	
Risk to water available for other uses due to climate change O(CC)	Goobang and Billabong Creeks	Dry climate change scenario		L	M	L	H/M	N/A	None required. Risk is low.		N/A	N/A	
Risk to water available for other uses due to climate change O(CC)	Goonigal and Kangarooby Creeks	Dry climate change scenario		L	M	L	H/M	N/A	None required. Risk is low.		N/A	N/A	
Risk to water available for other uses due to climate change O(CC)	Gunningbland and Yarrabandai	Dry climate change scenario		L	M	L	H/M	N/A	None required. Risk is low.		N/A	N/A	

SECTION 8.3 RISKS TO WATER AVAILABLE FOR OTHER USES DUE TO CLIMATE CHANGE [O(CC)] – UNREGULATED WATER SOURCES													
Risk	**Location, Reach, or Extraction Type within WRP Area**	**Climate Change Scenario (MDBSY)**	**Current Critical Mechanisms**	**Consequence**	**Likelihood**	**Risk Rating**	**Data confidence (Consequence / Likelihood)**	**Risk treatment option**	**Strategy**	**New Critical Mechanisms**	**Tolerable Risk Level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and Evaluation**
Risk to water available for other uses due to climate change O(CC)	Humbug Creek	Dry climate change scenario		L	M	L	H/M	F	15 Protect the environment and water users from changes in flow attributable to climate change.	N1 Sustainable Diversion Limits	M	An individual licence holder's annual access to water is governed by their entitlement and climatic availability. The volume of water available to meet all competing environmental and extractive needs varies on a yearly and daily basis, depending on the weather, river flows and aquifer characteristics.	
Risk to water available for other uses due to climate change O(CC)	Lachlan River above Reids Flat	Dry climate change scenario		L	M	L	H/M	N/A	None required. Risk is low.		N/A	N/A	
Risk to water available for other uses due to climate change O(CC)	Lake Forbes and Back Yamma Creek	Dry climate change scenario		L	M	L	H/M	N/A	None required. Risk is low.		N/A	N/A	
Risk to water available for other uses due to climate change O(CC)	Mandagery Creek	Dry climate change scenario		M	M	M	H/M	F	15 Protect the environment and water users from changes in flow attributable to climate change.	N1 Sustainable Diversion Limits	M	An individual licence holder's annual access to water is governed by their entitlement and climatic availability. The volume of water available to meet all competing environmental and extractive needs varies on a yearly and daily basis, depending on the weather, river flows and aquifer characteristics.	
Risk to water available for other uses due to climate change O(CC)	Mid Lachlan Unreg	Dry climate change scenario		L	M	L	H/M	N/A	None required. Risk is low.		N/A	N/A	
Risk to water available for other uses due to climate change O(CC)	Mount Hope Area	Dry climate change scenario		L	M	L	H/M	N/A	None required. Risk is low.		N/A	N/A	
Risk to water available for other uses due to climate change O(CC)	Naradhan Area	Dry climate change scenario		L	M	L	H/M	N/A	None required. Risk is low.		N/A	N/A	
Risk to water available for other uses due to climate change O(CC)	Ooma Creek and Tributaries	Dry climate change scenario		L	M	L	H/M	N/A	None required. Risk is low.		N/A	N/A	
Risk to water available for other uses due to climate change O(CC)	Tyagong Creek	Dry climate change scenario		L	M	L	H/M	N/A	None required. Risk is low.		N/A	N/A	

SECTION 8.3 RISKS TO WATER AVAILABLE FOR OTHER USES DUE TO CLIMATE CHANGE [O(CC)] – UNREGULATED WATER SOURCES													
Risk	**Location, Reach, or Extraction Type within WRP Area**	**Climate Change Scenario (MDBSY)**	**Current Critical Mechanisms**	**Consequence**	**Likelihood**	**Risk Rating**	**Data confidence (Consequence / Likelihood)**	**Risk treatment option**	**Strategy**	**New Critical Mechanisms**	**Tolerable Risk Level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and Evaluation**
Risk to water available for other uses due to climate change O(CC)	Unreg Effluent Creeks	Dry climate change scenario		L	M	L	H/M	N/A	None required. Risk is low.		N/A	N/A	
Risk to water available for other uses due to climate change O(CC)	Waugoola Creek	Dry climate change scenario		L	M	L	H/M	N/A	None required. Risk is low.		N/A	N/A	
Risk to water available for other uses due to climate change O(CC)	Western Bland Creek	Dry climate change scenario		M	M	M	H/M	F	15 Protect the environment and water users from changes in flow attributable to climate change.	N1 Sustainable Diversion Limits	M	An individual licence holder's annual access to water is governed by their entitlement and climatic availability. The volume of water available to meet all competing environmental and extractive needs varies on a yearly and daily basis, depending on the weather, river flows and aquifer characteristics.	

SECTION 8.4 RISKS TO WATER AVAILABLE FOR OTHER USES DUE TO GROWTH IN BLR [O(BLR)] - REGULATED WATER SOURCE											
Water Source Type	**Flow or Extraction Characteristic**	**Current Critical Mechanisms**	**Consequence**	**Likelihood**	**Risk Rating**	**Data confidence (Consequence / Likelihood)**	**Risk treatment option**	**Strategy**	**New Critical Mechanisms**	**Tolerable Risk Level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and Evaluation**
Regulated river	BLR (D&S) extraction	E19 - Minister may restrict BLR access through the establishment of mandatory guidelines. E20 - Minister may temporarily restrict access under the WMA s. 324 when there are water shortages.	H	Nil	Nil			Risk is Nil – none required				

SECTION 8.4. RISKS TO WATER AVAILABLE FOR OTHER WATER USERS DUE TO GROWTH IN BLR [O(BLR)] UNREGULATED WATER SOURCE												
Water source type	**Location, reach or extraction type within WRP area**	**Current critical mechanisms**	**Consequence**	**Likelihood**	**Risk rating**	**Data confidence (consequence / likelihood)**	**Risk treatment option**	**Strategies**	**New critical mechanisms**	**Tolerable risk level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and evaluation**
Unregulated	Abercrombie River above Wyangala	E19 Minister may restrict BLR access through the establishment of mandatory guidelines under the WMA s. 52(2) and S. 336B E20 - Minister may temporarily restrict access under the WMA s. 324 when there are water shortages.	L	M	L	M/M	N/A	None required. Risk is low.		N/A		
Unregulated	Belubula River above Carcoar Dam		L	L	L	M/M	N/A	None required. Risk is low.		N/A		
Unregulated	Belubula Tributaries below Carcoar Dam		M	L	L	M/M	N/A	None required. Risk is low.		N/A		
Unregulated	Bogandillon and Manna Creeks		L	L	L	N/A	N/A	None required. Risk is low.		N/A		
Unregulated	Boorowa River and Hovells Creek		L	L	L	M/M	N/A	None required. Risk is low.		N/A		
Unregulated	Burrangong Creek		L	L	L	M/M	N/A	None required. Risk is low.		N/A		
Unregulated	Crookwell River		L	L	L	M/M	N/A	None required. Risk is low.		N/A		
Unregulated	Crowther Creek		L	L	L	M/M	N/A	None required. Risk is low.		N/A		
Unregulated	Goobang and Billabong Creeks		L	L	L	M/M	N/A	None required. Risk is low.		N/A		
Unregulated	Goonigal and Kangarooby Creeks		L	L	L	N/A	N/A	None required. Risk is low.		N/A		
Unregulated	Gunningbland and Yarrabandai		L	L	L	M/M	N/A	None required. Risk is low.		N/A		
Unregulated	Humbug Creek	E19 Minister may restrict BLR access through the establishment of mandatory guidelines under the WMA s. 52(2) and S. 336B E20 - Minister may temporarily restrict access under the WMA s. 324 when there are water shortages.	L	H	M	M/M	D	17 Protect licenced water users from changes in flow attributable to growth in BLR extractive use.	E19 Minister may restrict BLR access through the establishment of mandatory guidelines under the WMA s. 52(2) and S. 336B.	M	Risk to other users from growth in domestic and stock rights in these circumstances is tolerable because there are mechanisms available to manage demand if required.	
Unregulated	Lachlan River above Reids Flat		L	L	L	M/M	N/A	None required. Risk is low.		N/A		
Unregulated	Lake Forbes and Back Yamma Creek		L	L	L	M/M	N/A	None required. Risk is low.		N/A		

SECTION 8.4. RISKS TO WATER AVAILABLE FOR OTHER WATER USERS DUE TO GROWTH IN BLR [O(BLR)] UNREGULATED WATER SOURCE												
Water source type	**Location, reach or extraction type within WRP area**	**Current critical mechanisms**	**Consequence**	**Likelihood**	**Risk rating**	**Data confidence (consequence / likelihood)**	**Risk treatment option**	**Strategies**	**New critical mechanisms**	**Tolerable risk level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and evaluation**
Unregulated	Mandagery Creek		M	L	L	M/M	N/A	None required. Risk is low.		N/A		
Unregulated	Mid Lachlan unregulated		H	L	M	M/M	D	17 Protect licenced water users from changes in flow attributable to growth in BLR extractive use.	E19 Minister may restrict BLR access through the establishment of mandatory guidelines under the WMA s. 52(2) and S. 336B.	M	Risk to other users from growth in domestic and stock rights in these circumstances is tolerable because there are mechanisms available to manage demand if required.	
Unregulated	Mount Hope Area		L	H	M	M/M	N/A	17 Protect licenced water users from changes in flow attributable to growth in BLR extractive use.	E19 Minister may restrict BLR access through the establishment of mandatory guidelines under the WMA s. 52(2) and S. 336B.	M	Risk to other users from growth in domestic and stock rights in these circumstances is tolerable because there are mechanisms available to manage demand if required.	
Unregulated	Naradhan Area		L	L	L	M/M	N/A	None required. Risk is low.		N/A		
Unregulated	Ooma Creek and Tributaries		L	L	L	M/M	N/A	None required. Risk is low.		N/A		
Unregulated	Tyagong Creek		L	L	L	M/M	N/A	None required. Risk is low.		N/A		
Unregulated	Unreg Effluent Creeks		L	L	L	M/M	N/A	None required. Risk is low.		N/A		
Unregulated	Waugoola Creek		L	L	L	M/M	N/A	None required. Risk is low.		N/A		

Current critical mechanisms – O(BLR):
E1 Reserve all water above the long-term average annual extraction limit (LTAAEL) for the environment as PEW (defined and managed by the listed WSPs).
E2 Available Water Determinations (AWD) adjust extractive use according to water availability.
E19 Minister may restrict BLR access through the establishment of mandatory guidelines under the WMA s. 52(2) and S. 336B.
E20 Minister may temporarily restrict access under the WMA s. 324 when there are water shortages.
N/A no data available or not applicable

Consolidated risk maps

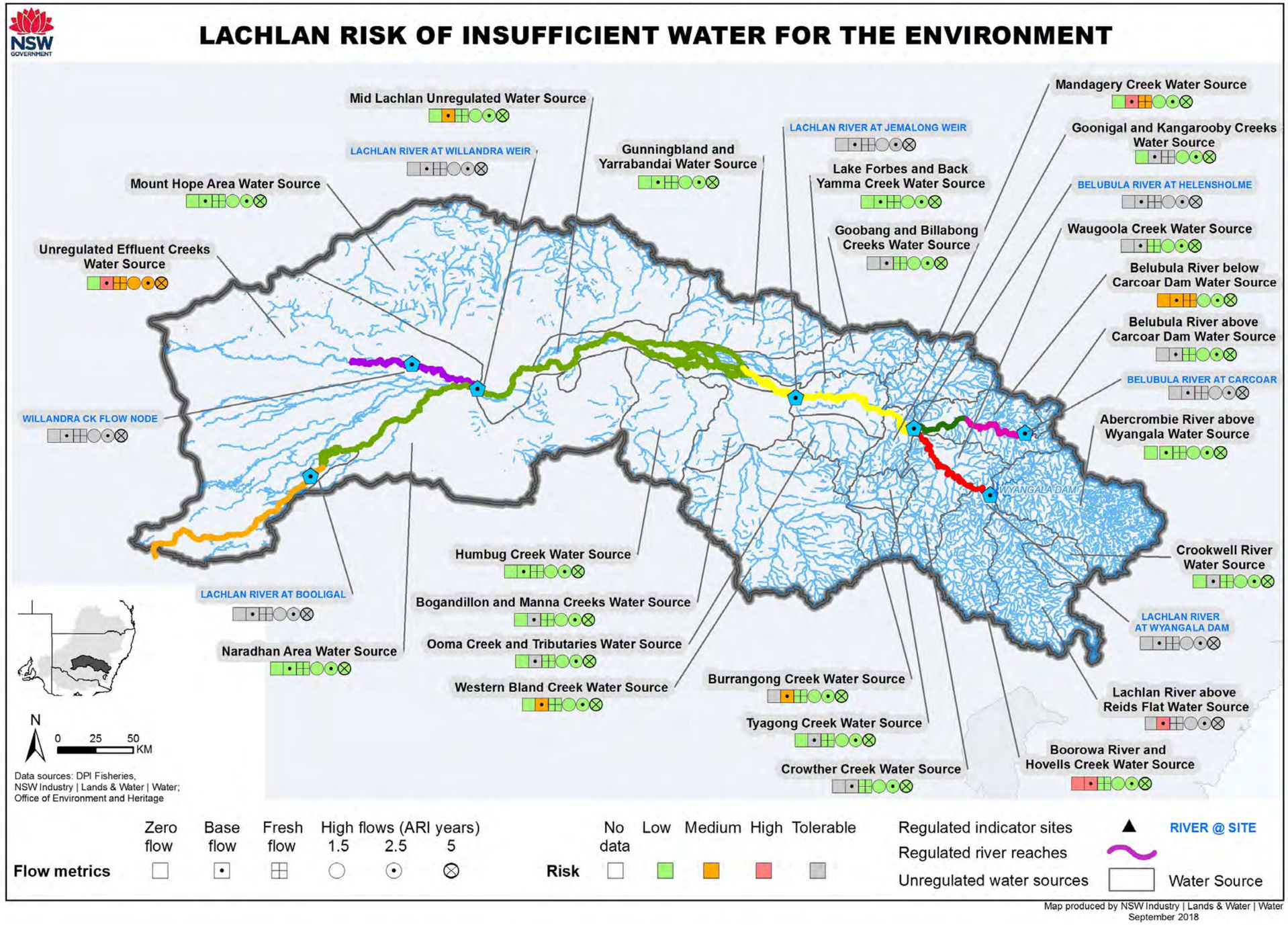


Figure 0-2. Consolidated risk map – insufficient water for the environment

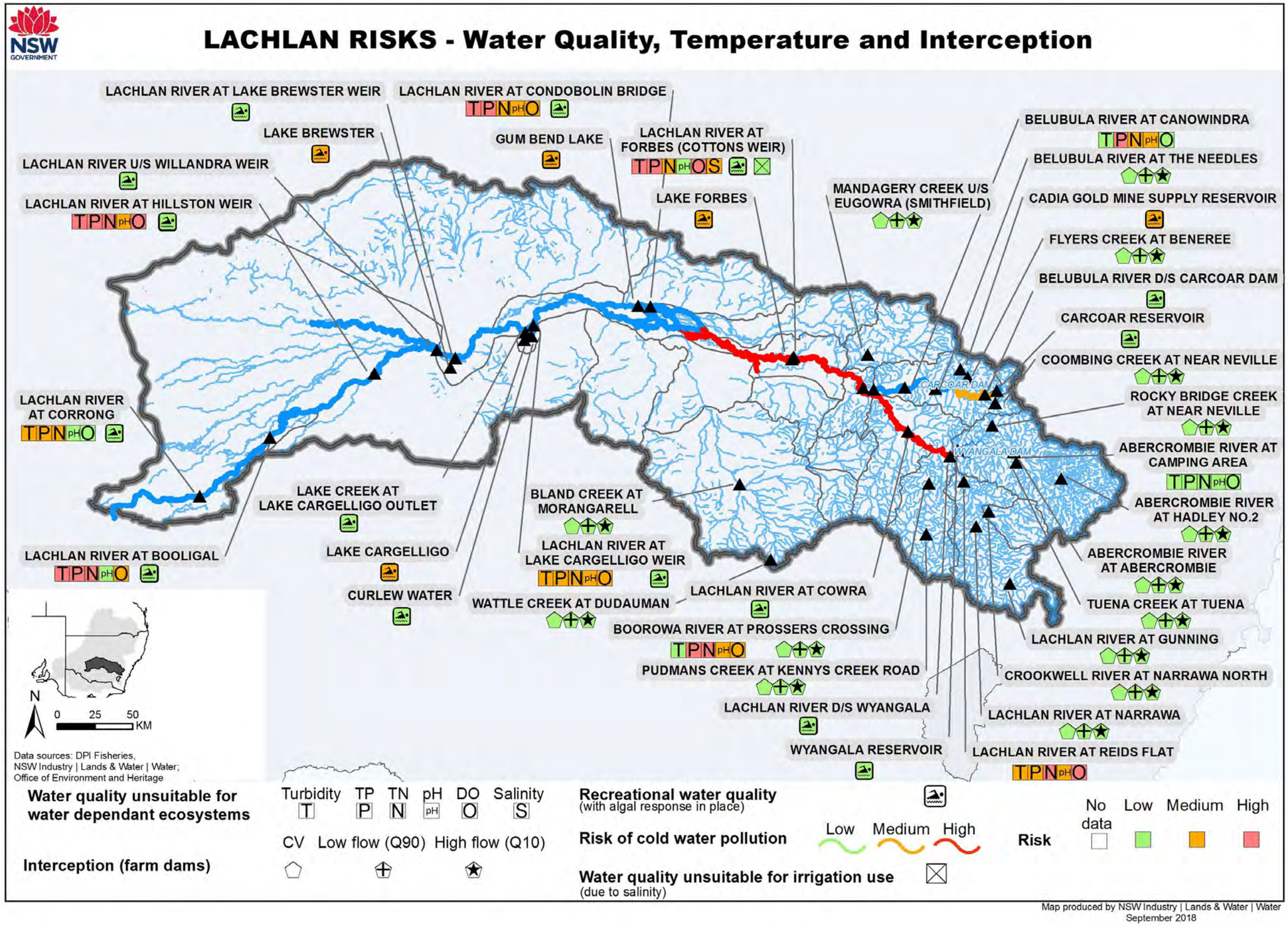


Figure 0-3. Consolidated risk map – water quality, temperature and interception

Abbreviations

Abbreviation	Description
ARI	Average recurrence interval
AWD	Available water determination
BLR	basic landholder rights
COAG	Council of Australian Governments
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CWP	Cold water pollution
CSG	Coal seam gas
DPI Water	Department of Primary Industries Water (now part of NSW Department of Planning and Environment)
EWA	Environmental water allowance (replacing environmental contingency allowance ECA)
EWR	Environmental watering requirements
HEVAE	High ecological value aquatic ecosystems
LLS	Local Land Services
LTWP	Long-term water plan
MDB	Murray–Darling Basin
MDBSY Project	Murray–Darling Basin Sustainable Yield Project
MDBA	Murray–Darling Basin Authority
NOW	NSW Office of Water (now part of NSW Department of Planning and Environment)
OEH	NSW Office of Environment and Heritage
NRC	Natural Resources Commission
NRM	Natural resource management
NWI	National Water Initiative
SDL	Sustainable diversion limit
WM Act	*Water Management Act 2000*
WRP	Water resource plan
WRPA	Water resource plan area
WSP	Water sharing plan
WQM Plan	Water quality management plan
E(W)	Risks to water available for the environment due to river regulation and licensed extraction
E(BLR)	Risks to water available for the environment from extraction by basic landholder rights
E(I-FD)	Risk to water available for the environment from interception activities (farm dams)
E(I-PF)	Risk to water available for the environment from interception activities (plantation forestry)
E(CC)	Risk to water available for the environment due to climate change
E(WQ-CWP)	Risk to the health of water-dependent ecosystems from poor water quality (cold water pollution)
E(WQ-WWP)	Risk to the health of water-dependent ecosystems from poor water quality (warm water pollution)
E(WQ)	Risk to the health of water-dependent ecosystems from poor water quality (TP, TN, pH, Turbidity, DO)
E(WQ-S)	Risk to the health of water-dependent ecosystems from poor water quality (instream salinity)
O(WQ-BGA)	Risks to recreational water quality and human health from blue-green algae
O(I-FD)	Risk to water available for other uses from interception activities (farm dams) (regulated rivers)
O(I-PF)	Risk to water available for other uses from interception activities (plantation forestry) (regulated rivers)
O(CC)	Risk to water available for other uses from climate change (regulated rivers)
O(BLR)	Risk to water available for other uses from growth in BLR (unregulated rivers)
WWP	Warm water pollution

1 Introduction

1.1 Background

The Basin Plan is an adaptive management framework that has been developed by the Murray–Darling Basin Authority (MDBA) to provide a coordinated approach to managing water resources across the four member states and territory in the Murray–Darling Basin (MDB).

A risk assessment is a key step in the development of a water resource plan (WRP) for each valley and groundwater source in the MDB. Chapter 4, Part 2 of the Basin Plan (Risks and strategies to address risks) sets out matters that must be considered in terms of risk and management strategies in WRPs. Chapter 10, Part 9 (Approaches to addressing risk to water resources) outlines how Basin States must undertake risk assessments as well as the MDBA's associated accreditation requirements.

The Basin Plan requires that a WRP must be prepared having regard to current or future risks to the condition and continued availability of water resources of a water resource plan area. This risk assessment will form Schedule D of the WRP.

Figure 1-1. Components of the WRP

Figure 1-1. Components of the WRP illustrates the relationship of the risk assessment document with the other elements of the WRP.

1.2 Document map

This risk assessment identifies and addresses risks to water resources to meet the requirements of Chapter 10, Part 9. Table 1-1 summarises where the Basin Plan requirements are addressed in this risk assessment.

The document is organised according to receptors, such that the risks to the environment (Sections 4 and 5) and risks to other water-dependent values and users (Sections 6 and 7) are assessed together.

These sections address risk to the condition or continued availability of Basin water resources and the consequences of the materialisation of these risks as identified in Chapter 4.02 of the Basin Plan; namely, that water quality or quantity is insufficient to meet consumptive, economic, environmental, and public benefit (social, cultural, Indigenous) uses and values.

Risks are analysed in Sections 4 to 7 of this report. Five basic steps are described for each risk (10.41(5)). These are:

- The risk pathway, with a summary of how the cause and threat may arise (10.41(2), (3); 10.42(b))
- Identification of likelihood and consequence metrics, and description of how low, medium and high categories were defined for each metric (10.41(5); 10.42(a))
- Summary of the data and method used to fulfil each likelihood and consequence metric (10.41(7))
- Identification and discussion of strategies that are in place to address risks (10.43)
- Combination of likelihood and consequence ratings to derive an overall risk rating (10.41(5),(6)).

  Note that where a risk result is highlighted as medium or high, it does not necessarily imply that existing management actions and mechanisms require change or are inadequate. In many circumstances these risks will already have a level of management in place that is commensurate with the risk result.

Strategies for addressing risks as having a medium or higher level of risk (10.43(1)) are discussed in Section 9.

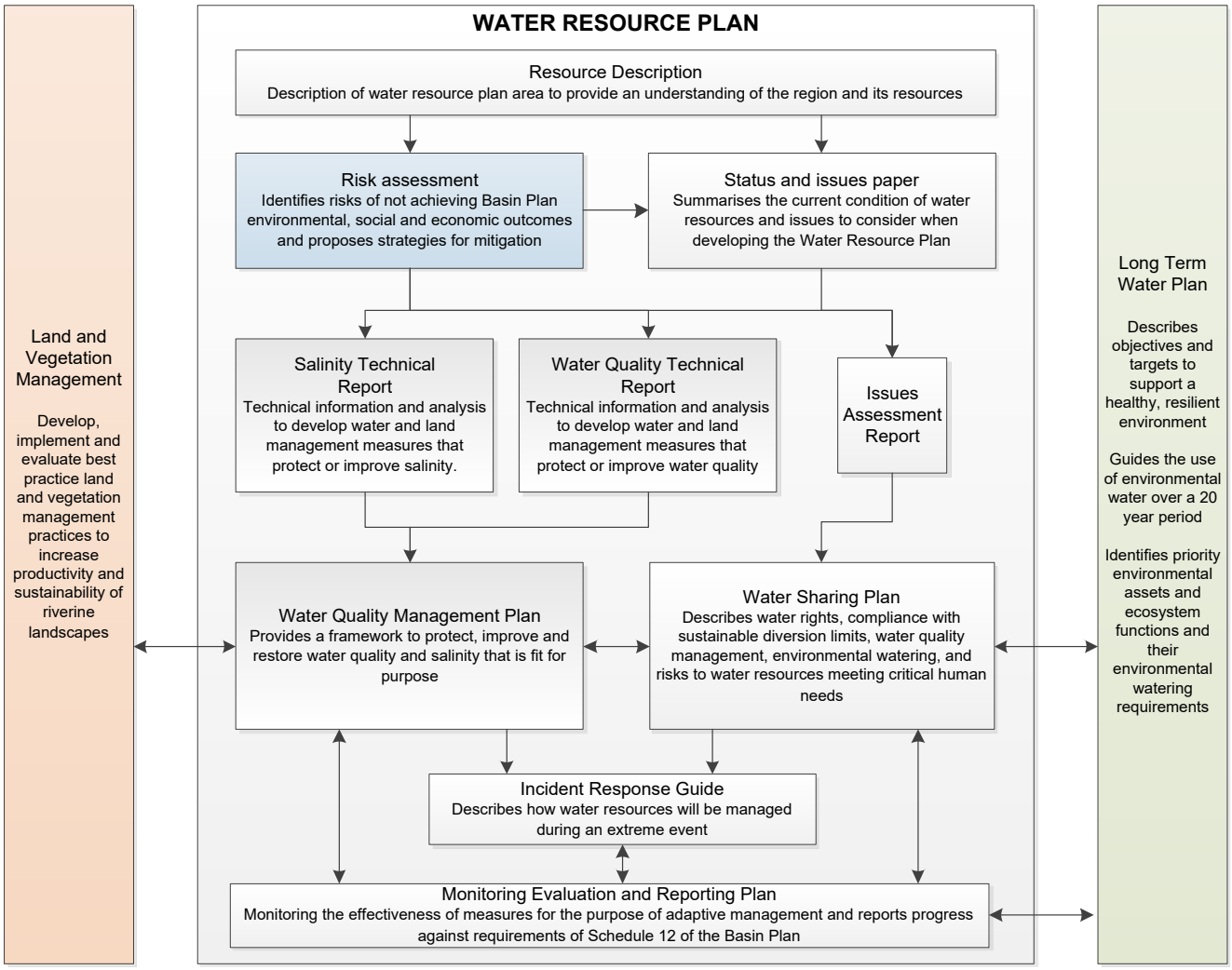


Figure 1-1. Components of the WRP

Table 1-1. Basin Plan requirements and where each is addressed in this risk assessment document

Basin Plan requirement		Location in Risk Assessment		Location in WRP
Chapter 10, Part 9		Section 1	Introduction	
10.41(1)	Having regard to current and future risks	Section 2	NSW risk assessment framework overview	3
		2.1	Introduction	
10.41(7)	Describe the data and methods used	2.2	Risk assessment framework	3.1
		2.3	Risk assessment scope	
10.41(8)	Describe the uncertainties	2.4	Limitations and uncertainties	3.2
		Section 3	Overview of the WRP area	
10.02	Identification of the water resource plan area and water resources	3.1	Identification of the water resource plan area	2 2.1 2.2
10.03	Identification of SDL resource units and water resources			
		3.2	Characterisation of the WRPA	
10.05 10.19 10.41(1), 10.41(2)(b), 10.20(1)(b) 10.23(1)(b)	Regard to other water resources Groundwater and surface water connections Risks arising from structural damage to an aquifer and the hydraulic relationships between groundwater and surface water systems	3.3	Connectivity within and between WRPAs	2.2 3 5.7
10.41(3)(a), 4.02(1)(a)	Insufficient water available for the environment	Section 4	Risk of insufficient water for the environment	3.2
10.41(1)	Regard to current and future risks	4.1	Background	3.1
Schedule 8, Schedule 9	Criteria for identifying an environmental asset and an ecosystem function	4.2	Assigning a consequence rating (HEVAE)	3.1
10.41(1), 10.41(2)(a), 10.41(5),(6)	Risks to water available for the environment and capacity to meet environmental watering requirements	4.3	Risks to water available for the environment due to river regulation and licensed extraction	3 3.1 3.2
10.41(1), 10.41(2)(a), 10.41(5),(6)	Risks to water available for the environment	4.4	Risks to water available for the environment from extraction by basic landholder rights	3 3.1 3.2
10.41(1), 10.41(2)(c), 10.23, 10.41(5),(6)		4.5	Risk to water available for the environment from interception activities (farm dams, plantation forestry, mining, floodplain harvesting)	
10.41(1) , 10.41(5),(6)		4.6	Risk to water available for the environment due to climate change	
10.41(3)	Risk to environmental assets and functions from pest plants and animal	Section 5	Risk to environmental assets and functions from pest plants and animal	3 3.1 3.2

Basin Plan requirement		Location in Risk Assessment		Location in WRP
10.41(3)(a), 4.02(1)(c)	Poor health of water-dependent ecosystems	Section 6	Risks to health of water-dependent ecosystems from poor water quality	3 3.1 3.2 6
10.41(1)	Regard to current and future risks	6.1	Background	3 3.1 3.2
Schedule 8, Schedule 9	Criteria for identifying an environmental asset and an ecosystem function	6.3.1, 6.4.1, 6.5.1, 6.6.1	Assigning a consequence rating (HEVAE)	3.1
10.41(1), 10.41(1)(d) , 10.41(5),(6)	Risks arising from elevated levels of salinity or other types of water quality degradation	6.3	Risks due to water temperature outside natural ranges	3 3.1 3.2 6
		6.4	Risks due to turbidity, TP, TN, pH, turbidity and DO	
		6.5	Risks due to elevated levels of instream salinity	
		6.6	Risks due to pathogens and toxicants	
10.41(3)(a), 4.02(1)(b), 4.02(2)(a)(b)	Risks identified in section 4.02 Risk arising from water being of a quality unsuitable for use Water is not suitable for consumptive and other economic uses of Basin water resources Water is not suitable to maintain social, cultural, Indigenous and other public benefit values	Section 7	Risk to other water uses due to unsuitable water quality	3 3.1 3.2 6
10.41(1), 10.41(2)(d) , 10.41(5),(6)	Risks arising from elevated levels of salinity or other types of water quality degradation	7.3	Risks to irrigation water from elevated instream salinity	3 3.1 3.2 6
		7.4	Risks to water used for recreational purposes	
		7.5	Risks to water used for human consumption	
		7.6	Other values	
10.41(3)(a), 4.02(1)(b), 4.02(2)(a)(b)	Risks identified in section 4.02 Insufficient water available for consumptive and other economic uses of Basin water resources Insufficient water available to maintain social, cultural, Indigenous and other public benefit values	Section 8	Risk to water available for other uses	3 3.1 3.2 3.3
10.41(1), 10.41(2)(c), 10.23, 10.41(5),(6)	Risks arising from potential interception activities	8.1	Risks to other water users from interception activities	3 3.1 3.2 3.3
10.41(1), 10.41(5),(6)	Future risks	8.2	Risk to other water users due to climate change	3 3.1 3.2 3.3
		8.3	Risk to other water users due to growth in BLR	

Basin Plan requirement		Location in Risk Assessment		Location in WRP
		8.4	Other values	
10.41(1), 10.42 10.43	Lists the risks identified Strategies for addressing risks as having a medium or higher level of risk	Section 9	Summary of risks, tolerable discussion, revised risk tables identifying tolerable	3 3.1 3.2 3.3
		Executive Summary	Consolidated Risk Tables	
10.41(7)(8)	Description of the data and methods Description of uncertainty	Appendix A		3.1

2 NSW Basin Plan risk assessment framework overview

2.1 Introduction

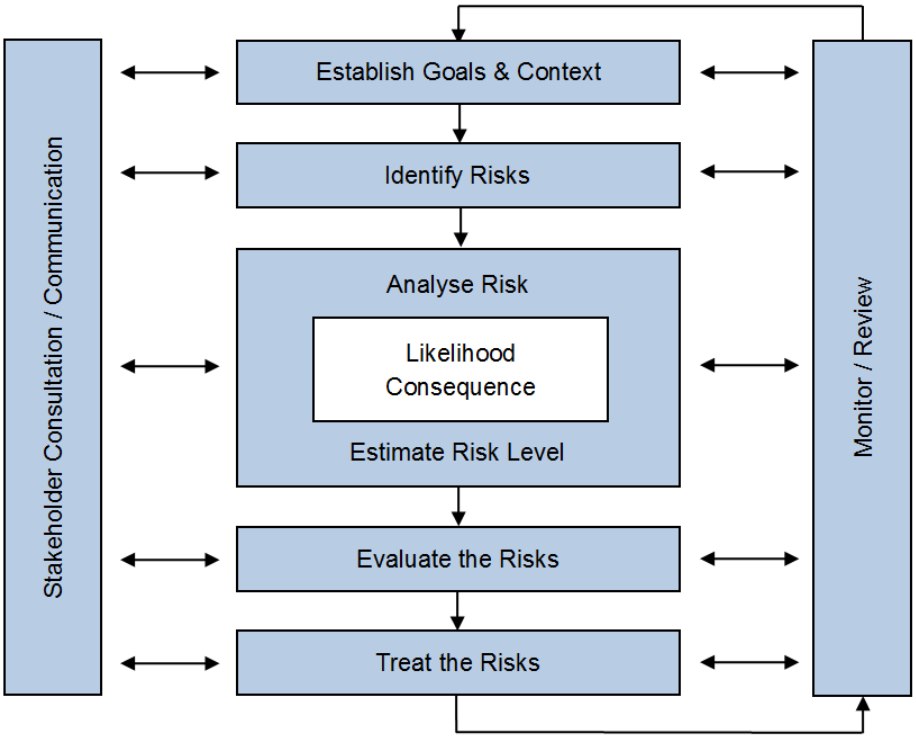
Risk-based management is not a new concept in water resource planning in NSW. Considerable work has been undertaken by State governments and under Commonwealth-level intergovernmental initiatives to design and implement risk-based water planning. The *National Water Initiative* (NWI) *Policy Guidelines for Water Planning and Management* (NWI 2010) endorsed by the Council of Australian Governments (COAG), adopts a risk-management approach.

Risk-based management assists water managers in prioritising and directing time and effort to monitor, mitigate or respond to the factors that pose the highest overall risks. It ensures that management is targeted at the appropriate part of the water system.

NSW has been implementing risk-based water planning processes since implementing water reform in the late 1990s. These approaches have included the initial Stressed Rivers and Aquifer Risk Assessments in 1998 (DLWC 1998a and b). The macro-water planning process adopted in 2004 to complete water sharing plans across the State also used a risk-based approach (NOW 2011 and 2015; Raine et al. 2012).

2.2 The risk assessment framework

Risk assessments for each NSW WRP follow the process illustrated in Figure 2-1.. This process is consistent with the NWI *Policy Guidelines for Water Planning and Management* and NSW's Basin Plan obligations.



Source: AS/NZS ISO 31000:2009 (Standards Australia 2009)

Figure 2-1. The NSW Basin Plan risk assessment framework

The risk assessment framework adopts a cause/threat/impact model that describes the pathway for impacts to a receptor. Adopting the cause/threat/impact pathway approach provides a systematic way to identify the full range of factors that may lead to an impact, while also being consistent with the internationally recognised risk standard which considers both likelihood and consequence.

Causes have the potential to induce a threat to various extents, depending upon the characteristics of the water resource. Receptors are considered in an intergenerational context, that is, current and future uses and users, as required under subsection 10.41(1).

The causes, threats and impacts considered in this assessment are summarised in Table 2-1.

Table 2-1. Summary of causes, threats and impacts considered in this risk assessment

Cause	Threat	Impact
• River regulation • Licensed surface water extraction (regulated and unregulated) • Growth in extraction under basic landholder rights • Interception activities (including farm dams and plantation forestry) • Change in runoff and rainfall from climate change • Land management practices and natural landscape system processes	• Alteration to ecologically significant flow regime components (zero flow periods, base flows, fresh flows, high flows) • Reduced surface water availability • Reduced runoff into surface water sources • Poor instream water quality (temperature depression, suspended matter, nutrients, dissolved oxygen, pH)	• Change to instream environmental assets and ecosystem functions • Human health and recreational use • Reduced water availability for other uses

The risk level of an impact is a function of the *likelihood* of a cause and threat occurring, and the *consequence* of the impact on the receptor. For this risk assessment, the following definitions have been adopted:

- Likelihood: the probability that a cause will result in a threat. It is not an indication of the size of the threat, but rather conveys the probability that the threat will be significant.
- Consequence: the loss of value for an impacted receptor.

An example of how the cause/threat/impact model and likelihood/consequence standard have been combined is illustrated in Figure 2-2. for risks arising from river regulation and surface water extraction.

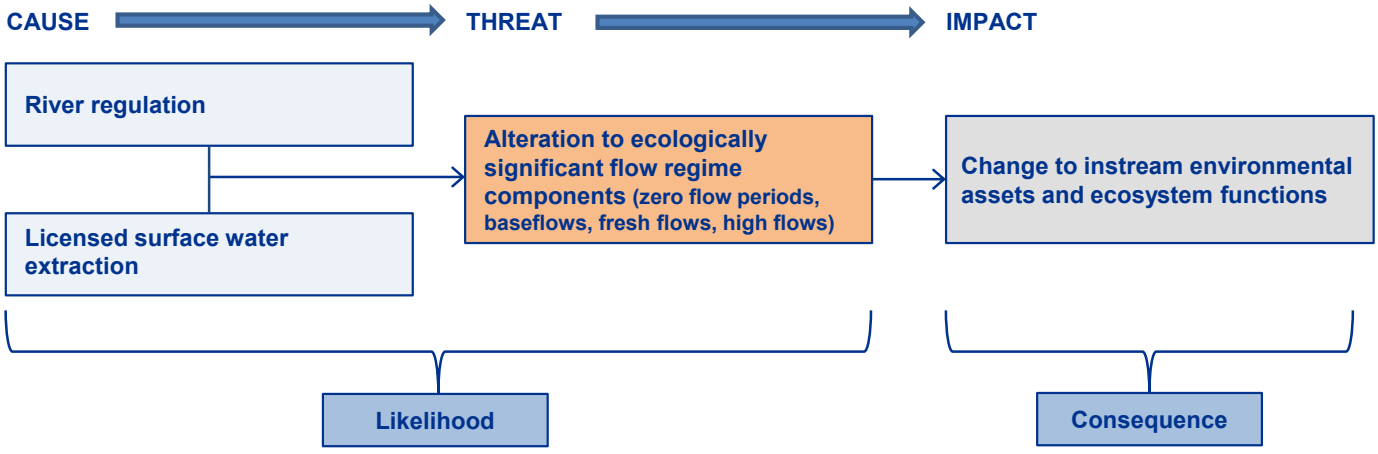


Figure 2-2. Example of an impact pathway for identifying risks to the environment associated with river regulation and licensed extraction

Risk levels are calculated using the standard risk assessment matrix used under the macro-planning approach (Table 2-2). Specific risk matrices for each risk are provided within this document.

Table 2-2. The risk assessment matrix

Risk level		Likelihood		
		1	2	3
Consequence	1	Low	Low	Medium
	2	Low	Medium	High
	3	Medium	High	High

A consolidated risk table has been developed for each water resource plan area (WRPA) to capture the risk assessment process. Key elements of the register include identification of the risk causes, threats and impacts, consequence and likelihood metrics, existing water management actions and mechanisms, and risk outcomes. The consolidated table will also be used to assist in ongoing monitoring and evaluation.

An outline of the process and definitions used in this risk assessment is provided in Appendix H.

2.3 Risk assessment scope

The Basin Plan sets out the risks to be included in a risk assessment. Based on these requirements, the criteria adopted for including cause/threat/impact combinations in this assessment are that:

- The risk directly relates to a change in the water resource, which may be change the quantity or quality of the resource.
- Risks for which the cause or threat would be mitigated through the use of NSW water management tools, such as rules within a water sharing plan.

Risks identified in the Basin Plan that do not have an apparent cause/threat/impact pathway in a water resource context have not been qualitatively assessed; rather, where appropriate commentary is provided to document a clear rationale. Alternatively, reference is made to other supporting documents.

Establishing the timeframe for the risk assessment determines the point from which the potential for impact will be assessed. As required by the Basin Plan, this risk assessment identifies and assesses current and future risks. The following definitions have been adopted:

- Current risk: the risk that exists prior to the commencement of the WRP and prior to the application of any new or altered water management actions and mechanisms and strategies. Current risk has been assessed with the existing water sharing plan (WSP) rules based on the *Water Management Act 2000* (WMA) set in place
- Future risk: these risks may affect the condition or continued availability of water resources during or subsequent to the 10 year term of relevant WSPs. Future risk is also assessed with the existing WSP or WMA-based strategy set in place. Future risks that have been assessed include risk to the environment and to licensed water users from growth in water use by basic landholder rights (both domestic and stock and farm dam interception), interception activities (including plantation forestry and farm dams) and climate change.

As noted above, many water management actions and mechanisms are already in place, which may adequately address risk. The purpose of this risk assessment is therefore to review the risks and associated management measures for current and future effectiveness, and to verify

whether the level of risk is matched by the level of water resource management. This purpose is underpinned in the WRPs through the inclusion of monitoring, review and adaptive management processes to confirm that the risk levels derived are appropriate, and the management of the risks is effective and commensurate with the level of risk.

Scale is important to the interpretation of risk results, as even within a water source or along a particular reach, risks for specific receptors will vary depending upon factors such as the level of development and use.

Generally, this risk framework has been applied at the finest scale at which data was available for. In the unregulated system, a water source scale was adopted to match current WSP boundaries. A reach scale for regulated rivers within the Lachlan surface water sustainable diversion limit (SDL) resource unit was used to match MDBA gauge sites for hydrological modelling.

The qualitative risk values assigned to cause/threat/impacts should therefore be considered in this context. As much as possible, strategies identified to manage medium and high risks take into consideration any local-scale characteristics which may have some bearing on the assessed risks.

2.4 Limitations and uncertainties

A ‘best available information’ approach was used to undertake this risk assessment. As much as practically possible, the most current data available were used to assess risks. Where relevant data has been made available after the completion of the analyses and time constraints preclude its inclusion in this risk assessment, it will be considered in any future risk assessments. Similarly, any new or additional data will be integrated into future risk assessments after the WRP commences, where appropriate.

A description of the data sources used to quantify likelihood and consequence metrics is provided in Appendix A to meet subsection 10.41(7). Appendix A also discusses the uncertainties in risk and the confidence level of the metrics used, to meet subsection 10.41(8).

Confidence in the data used is rated according to the criteria in Table 2-3.

Table 2-3. Criteria used for rating confidence in data

Low	Moderate	High
• Insufficient data/information available for assessment • Data not applicable to the scale of the assessment • Data/information based on estimates using methods/analytical models with a high degree of uncertainty • Estimated data not based on any reliable measurements • Anecdotal evidence only	• Limited available data/information but applicable to the scale of the assessment • Limited data based on reliable measurements • Data/information based on estimates using methods/numerical models with moderate levels of certainty • Limited documented evidence	• Sufficient data/ information available for assessment • Reliable data available for the scale of assessment • Data based on reliable measurements • Data/information based on estimates using methods/numerical models with a high degree of certainty • Documented evidence available

Constraints around data availability and the scale of the risk assessment mean that uncertainty can be introduced within each step of the risk assessment. The reliability of the risk outcomes is influenced by:

- Risk metrics that do not accurately capture the impact pathway
- The way metric categories are defined (i.e. low, medium, high)
- Lack of applicable data to analyse metrics
- Use of data that is 'best available' but is not strictly suitable.

The reliability of the risk outcomes therefore needs to recognise limitations in the framework, as well as data unavailability or mismatches. Consideration is given to confidence in data when developing strategies for medium or high level risks; for example, strategies might be based on fill knowledge gaps or evaluating the effectiveness of water management actions and mechanisms where there is insufficient or limited data available and the confidence in the data used is low.

3 Overview of the Lachlan Water Resource Plan Area (SW10)

3.1 Identification of the Lachlan Water Resource Plan Area

For the purpose of section 10.02 of the Basin Plan, this Risk Assessment applies to the water resource plan area (WRPA) and the water resources identified in section 3.05 of the Basin Plan as the Lachlan WRPA.

For the purpose of section 10.03 of the Basin Plan, the following are identified:

- the SDL resource unit in the Lachlan WRPA is that described in section 6.02 and Schedule 2 to the Basin Plan within the Lachlan WRPA, (being the Lachlan surface water SDL resource unit SS16) and
- the water resources within that SDL resource unit are those described in section 6.02 and Schedule 2 to the Basin Plan within the Lachlan WRPA.

3.2 Characterisation of the Lachlan Water Resource Plan Area

The Lachlan WRPA (Murray–Darling Basin reference number SW10), is bounded by the Murrumbidgee catchment to the south, the Barwon River to the west (a tributary of the Darling), the slopes of the Great Dividing Range to the east and the Border Rivers region to the north (Figure 3-1.).

The Lachlan River originates in the Great Dividing Range near the township of Gunning, and flows 1,400 km across western NSW to its junction with the Murrumbidgee River near Oxley. Under normal conditions the Lachlan River is a terminal system with little water flowing past the Great Cumbung Swamp. Only in large flood events does water flow through into the Murrumbidgee River (Green et al. 2011). The lowland region is characterised by an extensive floodplain environment in the western part of the catchment and is generally less than 200m in elevation, featuring important wetlands and distributary streams (Green et al. 2011). The Lachlan River catchment is made up of several main tributaries including the Abercrombie River, the Boorowa River, the Belubula Regulated River, the Crookwell River and Western Bland Creek. The Lachlan River, for the main part, is regulated but diverges into a number of unregulated distributary creeks at the downstream end of the catchment.

Downstream of Forbes, the Lachlan River has several regulated anabranches including Island, Wallamundry, Wallaroi, Nerathong, Bumbuggan and Goobang Creeks before these recombine again in the central reaches of the Lachlan River. Significant features of the Lower Lachlan River include Willandra Creek, the Booligal Wetlands, Merrowie Creek Wetlands and the Great Cumbungi Swamp (Figure 3-1.). In the central to lower reaches, two natural lakes (Lake Brewster and Lake Cargelligo) have been modified for use as regulated river storages (Green et al. 2011).

The catchment has a temperate climate. Average rainfall ranges from 1,100 mm per year in the eastern part of the catchment to just 200 mm in the far west. This represents a range of about 0.5-2 times the catchment average of 600 mm. In the more moderate middle parts of the catchment average annual rainfall is between 400 mm and 600 mm per year. Monthly rainfall is generally uniform throughout the year with slightly higher falls in January and October (Green et al. 2011).

- The Lachlan WRPA is comprised of regulated and unregulated rivers. Under the NSW *Water Management Act 2000*, a regulated river is a gazetted river where downstream flows are regulated by a major State-owned storage or dam to supply water. The Lachlan and Belubula Regulated River Water Sources extend from Wyangala and Carcoar Dams along the Lachlan and Belubula Rivers as well as anabranches and distributary channels shown in Figure 3-1. Figure 3-3. shows the spatial distribution of water access licence entitlements in the Lachlan Regulated River Water Source. For the purpose of this risk assessment in the Lachlan WRPA, the Lachlan regulated river was divided into reaches based upon hydrologic modelling at specific hydrologic indicator sites (see Figure 4-2).
- With the exception of the Belubula, the remaining rivers in the Lachlan WRPA are not gazetted as regulated rivers and fall under the category of unregulated rivers. The unregulated rivers were embargoed in the mid-1990s and their ecological water requirements progressively protected with the introduction of water sharing plans. The Lachlan unregulated river water sources comprise all of the streams upstream of Wyangala and Carcoar Dams, and all of the tributaries entering the Lachlan and Belubula Rivers downstream of Wyangala and Carcoar Dams. The unregulated river water sources in the Lachlan WRPA can be divided into three main sub areas (Figure 3-2.). There are 23 unregulated water sources in the Lachlan WRPA. Figure 3-4. shows the unregulated water sources in the Lachlan WRPA and the spatial distribution of licence entitlements.

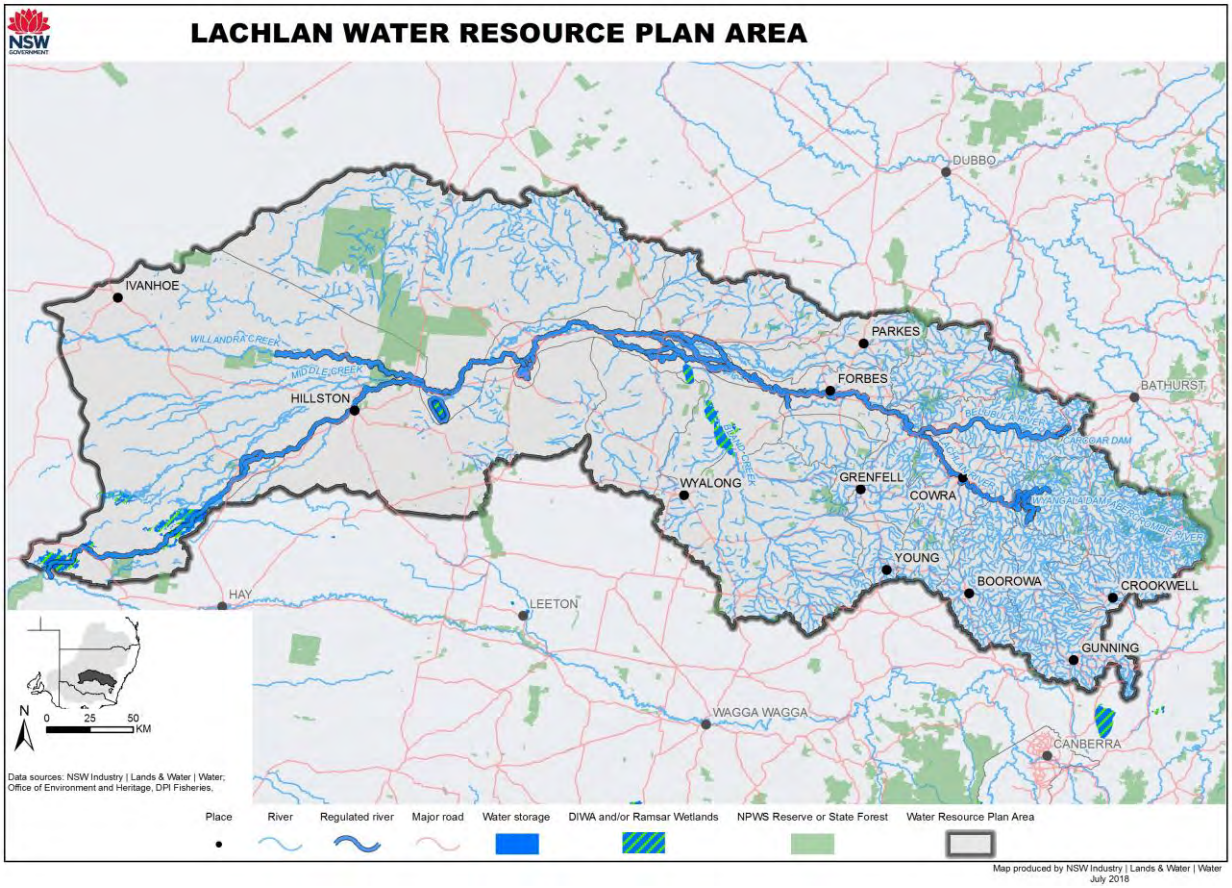


Figure 3-1. The Lachlan WRPA (SW10)

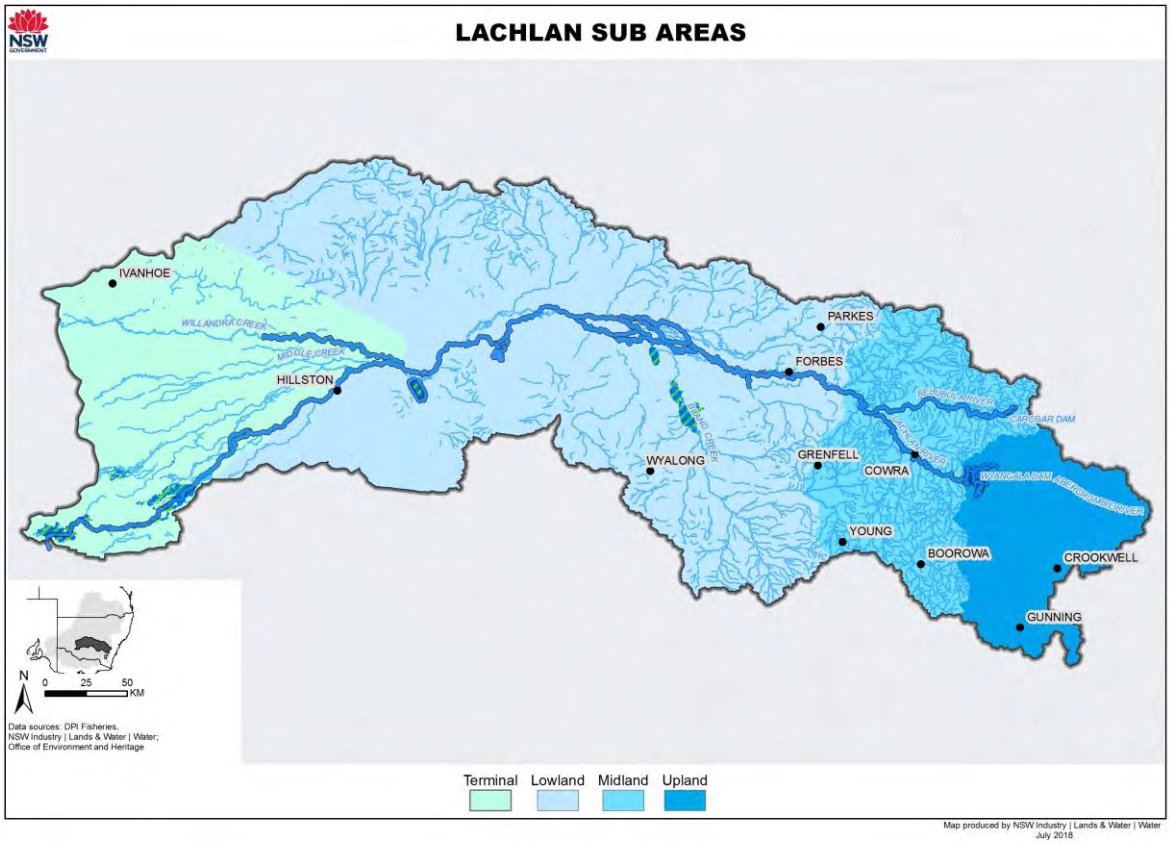


Figure 3-2. Sub areas of the Lachlan WRPA (SW10) (upland, midland and lowland)

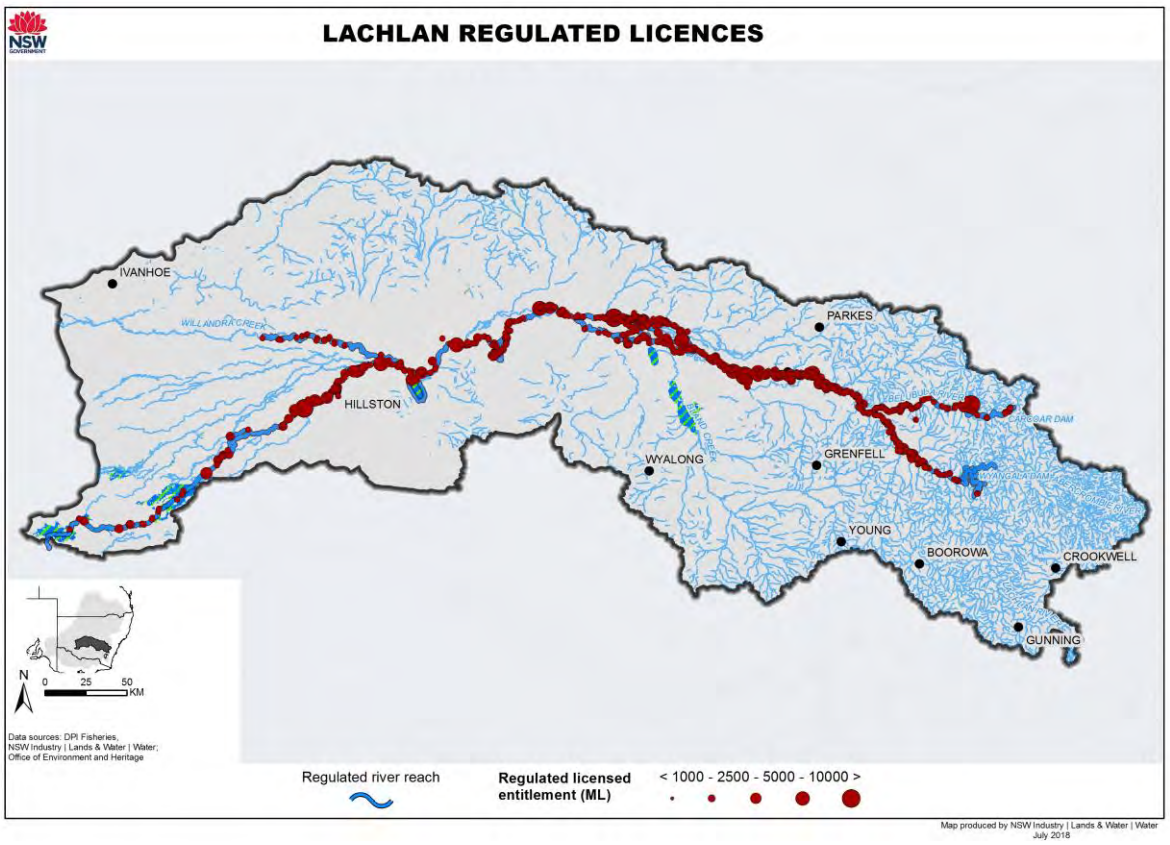


Figure 3-3. Regulated river entitlement in the Lachlan WRPA (SW10)

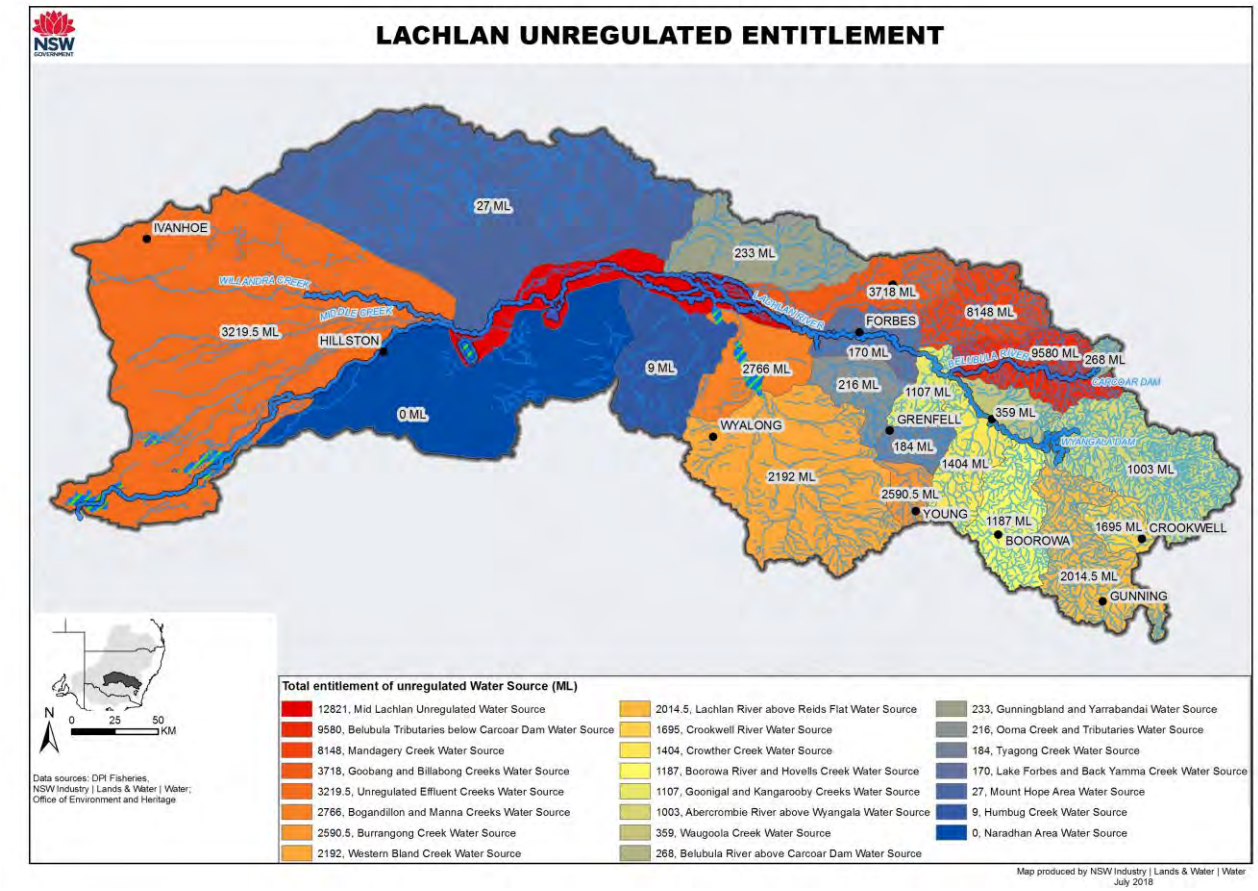


Figure 3-4. Unregulated water sources and entitlement in the Lachlan WRPA (SW10)

3.3 Connectivity

The Lachlan WRPA contains a single SDL resource unit, Lachlan SS16. Within this resource unit, the two WSPs within the Lachlan WRPA recognise and manage the hydrological connection between regulated and unregulated surface water sources. Water management actions and mechanisms that are included in the *Water Sharing Plan for the Lachlan Regulated River Water Source 2016*, *Water Sharing Plan for the Belubula Regulated River Water Source 2012* and the *Water Sharing Plan for the Lachlan Unregulated River Water Sources 2012* to manage hydrological connections within the WRP area are discussed below.

Connectivity of the Lachlan WRPA with adjacent WRPAs, including downstream surface waters and groundwater aquifers, is discussed in Section 3.3.2.

3.3.1 Connectivity between unregulated and regulated water sources within the Lachlan WRPA

The connectivity between the Lachlan unregulated water sources and the regulated water source is managed by a suite of rules within the three WSPs. Unregulated water sources are situated both upstream and downstream of the Lachlan Regulated River Water Source and rules are applied to manage both connectivity situations.

In order to protect a portion of very low flows for the benefit of the environment, the *Water Sharing Plan for the Lachlan Unregulated River Water Sources 2012* provides cease to pump rules for several water sources with high environmental values. Cease to pump rules specify a flow requirement to benefit important environmental attributes such as Macquarie perch in the Lachlan WRPA and provides for connectivity between water sources, including into the

regulated river. Cease to pump rules ensure that very low flows are protected by requiring water users to stop taking water when flow declines below a set level.

The *Water Sharing Plan for the Lachlan Regulated River Water Source 2016* establishes provisions for environmental water. These provisions include rules that allow for the release of a portion of natural inflows to Wyangala dam as 'translucent flows' with the objective of achieving a range of environmental purposes, and to improve connectivity between the regulated and unregulated effluent streams water source in the downstream terminal reaches of the Lachlan WRPA (Figure 3-2.).

An environmental water allowance (EWA) also specifies a volume of water to be set aside in Wyangala Dam to deliver water for environmental purposes, including connectivity between the regulated river, the unregulated effluent creeks and mid-Lachlan unregulated water sources in the middle and lower sections of the Lachlan valley.

Lastly, the Plan reserves water above the Plan limit which provides water for environmental benefits and supports connectivity between the regulated rivers and unregulated rivers in the Lachlan valley.

3.3.2 Connectivity with other WRPAs

3.3.2.1 Surface water to surface water

For the purposes of section 10.05 of the Basin Plan, the Lachlan WRPA (SW10) is considered to have limited (floods only) hydrological connection to surface water resource units within the Murrumbidgee WRPA (SW09). The Basin-wide Watering Strategy has an expectation that connectivity between the Lachlan River and its floodplains is improved by 10-20% in the Lachlan WRPA. Adjacent resource units are summarised in Table 3-2.

Any potential risks to the Murrumbidgee WRPA (SW09) from water management related activities in the Lachlan Surface Water Resource Plan area are considered in the Murrumbidgee WRPA (SW09) Risk Assessment. Given the connectivity only occurs during large floods which cannot be managed, any risks are minimal and cannot be managed.

The following is a qualitative assessment based on Department of Planning and Environment ecohydrology specialist expert opinion. There are potential risks to environmental assets and functions in the Lachlan Surface WRP from the Murrumbidgee Watercourse WRPA (SW09). These risks include movement of invasive species causing changes in water quality and impacts on native water-dependent biota and ecosystems. The likelihood of new invasive species becoming established in the Lachlan Surface WRP area was ‘low’ given the impacts of existing invasive species, and the consequence score was ‘medium’. Using the risk matrix Table 4-10, the overall risk rating was ‘**low**’ (Table 3-1)

Table 3-1 Risk to environmental assets and functions within the Lachlan Surface WRPA due to connectivity with Murrumbidgee Watercourse WRPA

	Consequence	Likelihood	Overall risk rating
Regulated river water source	Medium	Low	Low
Unregulated river water sources	Medium	Low	Low

3.3.2.2 Surface water to groundwater

For the purposes of section 10.05 of the Basin Plan, the Lachlan WRPA (SW10) is considered to have the significant hydrologic connection to the following resources:

- Upper Lachlan Alluvium (GS44)
- Lower Lachlan Alluvium (GS25)

- Belubula Alluvium (GS12)
- Lachlan Fold Belt MDB (GS20)
- Orange Basalt (GS39
- Young Granite (GS51).

Lachlan Alluvium WRP

The Belubula Alluvium is considered to be highly connected to the regulated Belubula River. Groundwater monitoring data shows water levels respond quickly to changes in the river levels. This high level of hydrologic connection is recognised and managed in the *Water Sharing Plan for the Lachlan Alluvial Groundwater Sources 2020* by linking annual available water determinations (AWDs) for aquifer access licences to AWDs for regulated river surface water access licences. Linking extraction of groundwater to surface water availability according to the level of connectivity, limits to acceptable levels, any potential impacts from groundwater extraction on surface waters, surface water users, and the environment.

The Lower and Upper Lachlan Alluviums are considered to be less highly connected to overlying surface waters. For the Upper Lachlan Alluvium, the Lachlan River varies between losing and gaining conditions along its length depending on geology, topography, local conditions and prevailing long-term climatic conditions. Although the Lachlan River is considered to be hydrologically connected to the Upper Lachlan Alluvium, groundwater pumping impacts at the river are subdued and / or delayed due to the depth and width of the alluvium. The greater depth to the regional water table in the Lower Lachlan Alluvium results in the hydraulic disconnection of the alluvium from the Lachlan River and its tributaries for much of their reaches. That is, whilst the Lachlan River would lose water into the underlying alluvium, the rate of loss is not influenced by groundwater pumping. Surface WSP rules that protect environmental water also protect recharge from the river into the Lower Lachlan Alluvium.

Both the Lower and Upper Alluviums are managed independently from the river. Distance criteria for bores are used to manage the location at which water is extracted by new bores to minimise localised impacts. Available water determinations are used to control growth in extractions above the LTAAEL / SDL. The level of impact on the hydraulic relationships and properties between these groundwater systems and connected surface water systems was considered in setting the LTAAELs and SDLs for these SDL resource units. The level of connectivity between surface and groundwater resources including the lag times for groundwater pumping impacts was considered and acknowledged in setting these limits. The management of extraction to these limits will ensure these hydraulic relationships are maintained to the acceptable level of impacts determined during those assessments.

Murrumbidgee Alluvium WRP

A small area of the southern boundary of the Lachlan surface WRP area overlies a small area of the northern boundary of the Lower Murrumbidgee Shallow Alluvium. These resource units are not considered to have significant hydrologic connection in the area of overlap.

NSW MDB Fractured Rock WRP

The Lachlan Fold Belt MDB, Orange Basalt and Young Granite are fractured rock resources that outcrop in areas of high elevation and rainfall and are expected to discharge to the surface providing some baseflow to unregulated streams in the upper Lachlan catchment. The low permeability of fractured rock resources limits the potential for groundwater extraction to impact overlying resources hence these resources are managed separately from surface waters. For unregulated gaining streams groundwater is not considered to be a major contributor to surface water flows in comparison to other inputs such as rainfall.

The Kanmantoo Fold Belt is considered to have insignificant levels of hydrologic connection with overlying surface waters as it has low elevation, low rainfall and low levels of extraction.

Potential impacts of surface water extraction on groundwater derived baseflows, hydraulic connectivity and the groundwater resources are managed by PEW rules in the appropriate surface WSPs. Protection of low flows by appropriate access rules limits any impacts to

groundwater resources to acceptable limits. The level of impact on the hydraulic relationships and properties between these groundwater systems and connected surface water systems was also considered in setting the SDLs for these SDL resource units. The management of extraction to these limits will ensure these hydraulic relationships are maintained to the acceptable level of impacts determined during that assessment.

Any potential risks to surface water (including risks to the environment and risks to other users) as a result of ground water extraction are considered in the risk assessments for the Lachlan Alluvium, Murrumbidgee Alluvium and NSW MDB Fractured Rock WRPs (NSW Department of Industry, 2019a, b, c)..

Table 3-2 Adjacent SDL resource units

SDLRU	Adjacent SDLRU	Adjacent WRP / non Basin WSP
Lachlan SS16	SS15 Murrumbidgee	SW09 Murrumbidgee WRP
	SS18 Lower Darling	SW08 NSW Murray and Lower Darling WRP
	GS12 Belubula Alluvium	GW10 Lachlan Alluvium WRP
	GS25 Lower Lachlan Alluvium	GW10 Lachlan Alluvium WRP
	GS44 Upper Lachlan Alluvium	GW10 Lachlan Alluvium WRP
	GS28a Lower Murrumbidgee Shallow Alluvium	GW09 Murrumbidgee Alluvium WRP
	GS39 Orange Basalt	GW11 NSW Murray-Darling Basin Fractured Rock WRP
	GS51 Young Granite	GW11 NSW Murray-Darling Basin Fractured Rock WRP
	GS19 Kanmantoo Fold Belt	GW11 NSW Murray-Darling Basin Fractured Rock WRP
	GS20 Lachlan Fold Belt MDB	GW11 NSW Murray-Darling Basin Fractured Rock WRP

4 Risk of insufficient water available for the environment

4.1 Background

The Basin Plan establishes objectives in relation to environmental outcomes (Chapter 5.03). These include protecting and restoring water-dependent ecosystems and functions, and ensuring they are resilient to risks and threats.

Environmental assets of the Basin include the rivers, lakes, billabongs, wetlands, groundwater systems, floodplains and their flood-dependent forests, and include water-dependent ecosystems, ecosystem services and sites with ecological significance (MDBA 2010). Schedule 8 of the Basin Plan lists the criteria for identifying an environmental asset.

Ecosystem functions are the key physical, chemical and biological processes that support the Basin's environmental assets, and include the transport of nutrients, organic matter and sediment in rivers, wetting and drying cycles, and provision for migration and re-colonisation by plants and animals along rivers and across floodplains (MDBA 2010). Schedule 9 of the Basin Plan lists the criteria for identifying an ecosystem function.

There are a number of causes and threats that will impact the availability of water for the environment which may in turn potentially impact instream ecological functions and assets. In the NSW MDB, these risks include:

- River regulation and licensed surface water extraction altering the timing, duration and frequency of flow components
- Growth in extraction of water required by basic landholder rights
- Interception activities (farm dams, commercial plantations, mining and floodplain harvesting)
- Climate change.

These impacts could all lead to the alteration of instream ecological functions and assets. The risk pathways for considering potential impacts of insufficient water for the environment are summarised in Figure 4-1 The risks are analysed and discussed in the following sections.

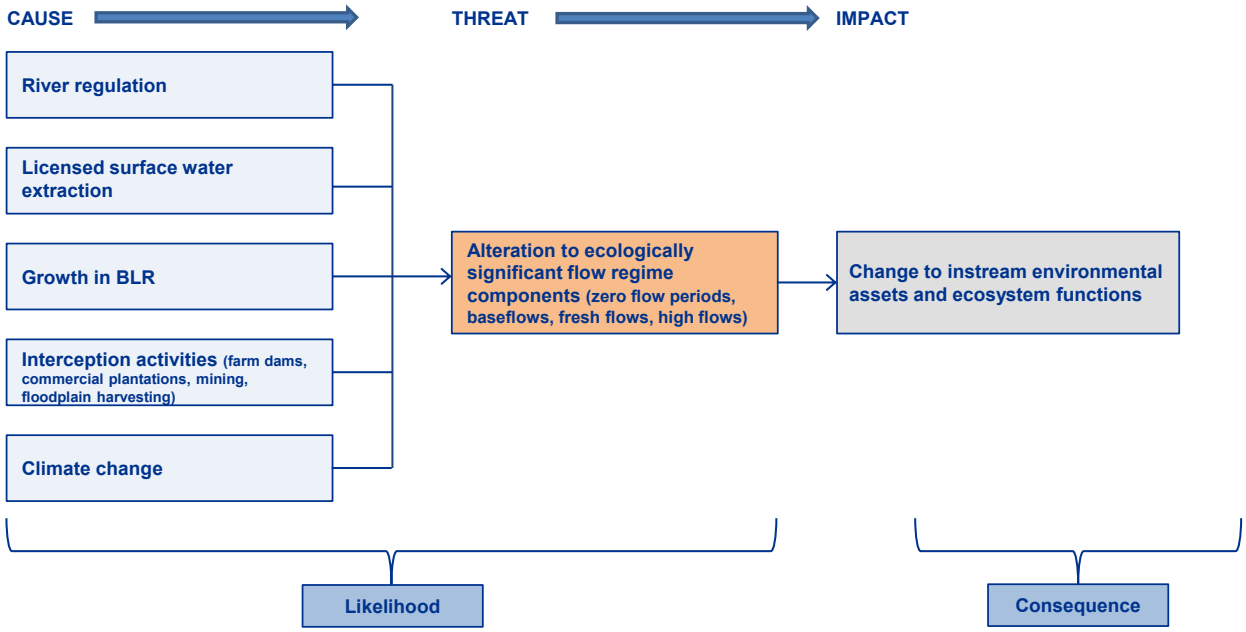


Figure 4-1. Risk pathways for risks of insufficient water for the environment and capacity to meet environmental watering requirements

4.2 Assigning a consequence rating

The consequence of impacts to ecological functions and assets was determined using the High Ecological Value Aquatic Ecosystems (HEVAE) score and the extraction pressure within an unregulated water source or regulated river reach. These two metrics describe the ecological value and their sensitivity to impacts.

HEVAE scores were derived from the National Aquatic Ecosystems Toolkit Module 3, guidelines developed by the Aquatic Ecosystems Task Group for the Department of Sustainability, Environment, Water Population and Communities (2012). HEVAE values were assigned at a reach scale. A decision tree was then used to assign a consequence rating at a reach scale for regulated rivers and a water source scale for unregulated rivers.

A consequence score is assigned at a reach scale for regulated rivers. The regulated river was broken into reaches that were represented by MDBA hydrologic indicator sites used for modelling (MDBA 2010) (Figure 4-2). These sites correspond to selected streamflow gauging stations. The reaches represented by the hydrologic indicator sites were selected by identifying where significant tributaries or distributaries upstream and downstream of the site change the hydrology significantly. This process was used to determine the reach extents for each hydrologic indicator site in the regulated river system.

A consequence score is assigned at a water source scale for unregulated rivers. Single reach Integrated Quantity and Quality Models (IQQM) were developed at a water source scale for unregulated rivers. Where appropriate, unregulated flow gauges were also used for single reach models in adjacent water sources if a suitable gauge was not available. For the mid-Lachlan unregulated distributaries and the lower Lachlan unregulated effluent creeks, a combination of regulated and unregulated flow information were used to model flow sequences for these complex unregulated systems.

To ensure the HEVAE outcomes developed by the NSW Department of Planning and Environment (Healey et al. 2012; Healey et al. 2018) could be useful spatially and reported consistently across a WRPA and water sources, available data was attached to the River Styles® spatial layer. The River Styles® mapping has been undertaken across all catchments in NSW to third or fourth order streams and greater. It is the primary spatial layer to which the HEVAE data are applied, enabling instream value to be represented on a spatial scale.

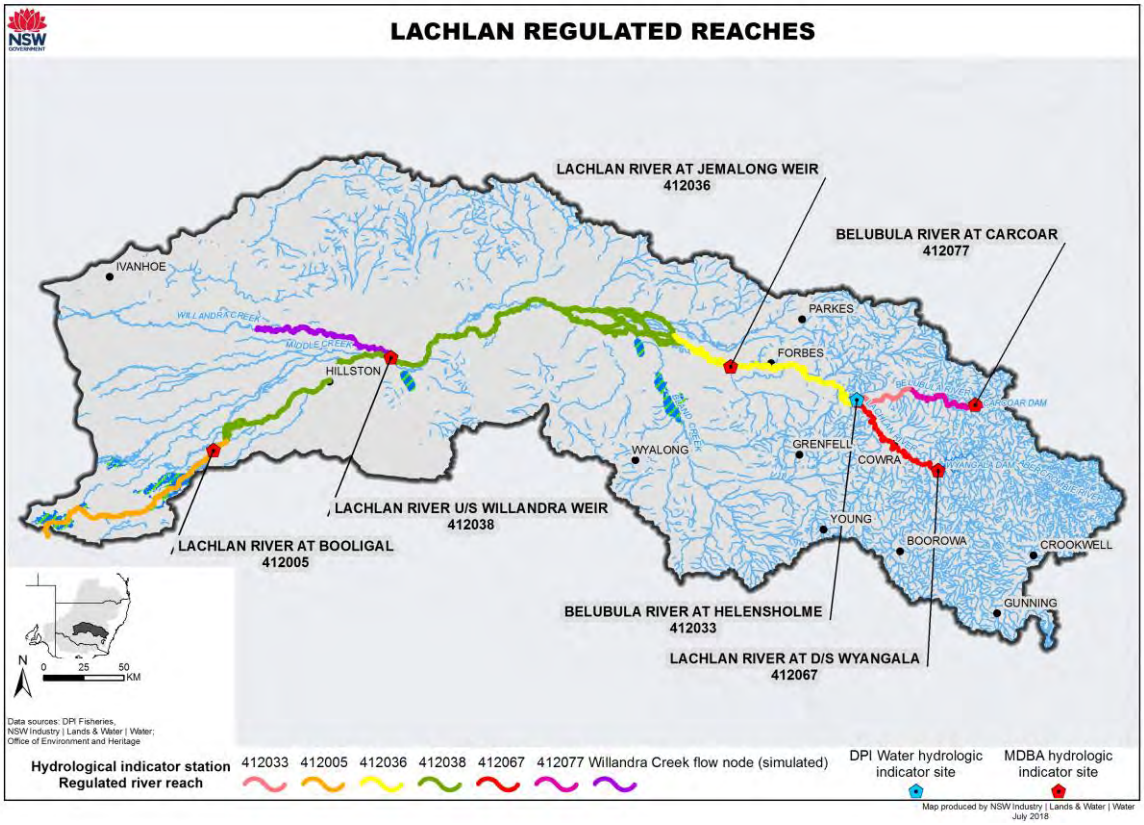


Figure 4-2. MDBA hydrologic indicator sites and representative regulated reaches for the Lachlan WRPA

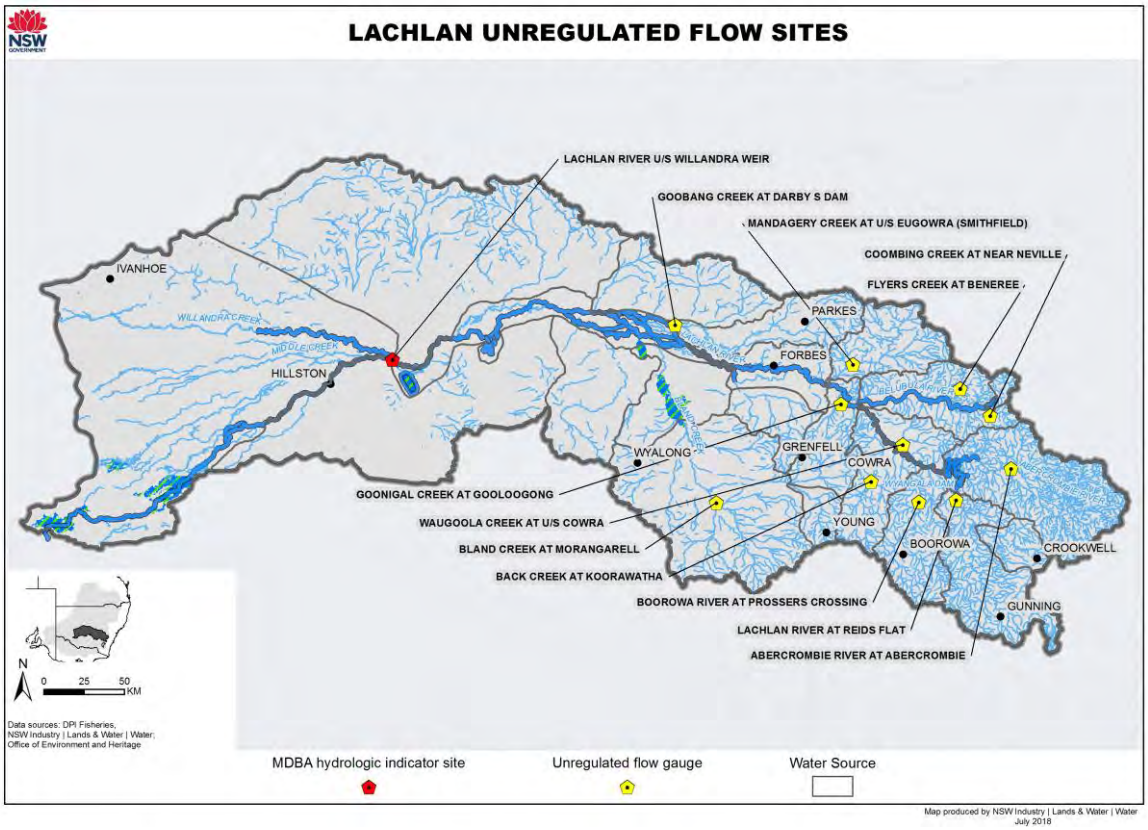


Figure 4-3. Location of unregulated flow gauges and the MDBA hydrologic indicator site used for generating flow sequences in unregulated rivers in the Lachlan WRPA

4.2.1 HEVAE

Ecological scoring was derived from the National Aquatic Ecosystems Toolkit Module 3 (Guidelines for Identifying HEVAE, Aquatic Ecosystems Task Group 2012). For the purposes of the toolkit, HEVAE are aquatic ecosystems that are considered to be of high ecological value as determined by a consistent and objective process such as that provided by Module 3. A standardised HEVAE method was applied to every MDB WRPA. Detailed methodology is provided in Healey et al. (2018).

The criteria used in the HEVAE framework aligns to criteria listed in Schedules 8 and 9 of the Basin Plan for identifying ecological assets and ecosystem functions. The alignment of the two sets of criteria is provided in 0. The assigning of HEVAE scoring was developed using the same data and mobility weightings used by the Office of Environment and Heritage (OEH) to identify environmental assets and functions for the Long Term Water Plan (LTWP).

The HEVAE framework consists of five key criteria that can be used at a range of scales; diversity, distinctiveness, naturalness, vital habitat and representativeness. It should be noted that NSW does not currently use the key criteria of “representativeness” due to insufficient data availability.

HEVAE criteria are applicable at the regional level and meet NSW jurisdictional needs (Aquatic Ecosystems Task Group 2012). Each of the four criteria had a number of associated attributes (Figure 4-3); a score between 0 and 1.0 was assigned to each attribute based on the data type and source. A weighting was applied to each metric to give an overall criteria score. The four criteria were then combined into a final score between 0 and 1.0 to give an overall instream value score (i.e. a HEVAE score).

Natural variation in attribute scores can occur and may cause or influence clumping in data sets. To reduce this clumping effect, data-rich outcomes were standardised (Macgregor et al. 2011; Bennett et al. 2002) to enable each assessed attribute to be scored against the same scale (Macgregor et al. 2011).

Weightings were applied to the attributes to reflect the purpose of the assessment and the views of stakeholders (Bennett et al. 2002). Applying a weighting process also allowed the final scoring to reflect the importance of the factors used in this assessment (Macgregor et al. 2011) and to assist with identifying attributes that have a greater contribution to the assessment (Hughey 2013).

During the development of macro WSPs in NSW, specific weightings were linked to the flow sensitivity (Figure 4-1) of in-stream dependent threatened species, populations and communities (NOW 2011; DIPNR, 2005). These weightings were agreed upon through discussions with participating NSW agencies who considered that the legislative requirements of threatened factors provide an objective approach to water planning needs (NOW 2011). These same flow sensitivity weightings were applied in the HEVAE scoring. Evidence was collated to support the weightings associated with attributes. For example, if a threatened species population or endangered ecological community had alteration to natural flow listed as a key threat, it receives a flow sensitivity weighting of 4.

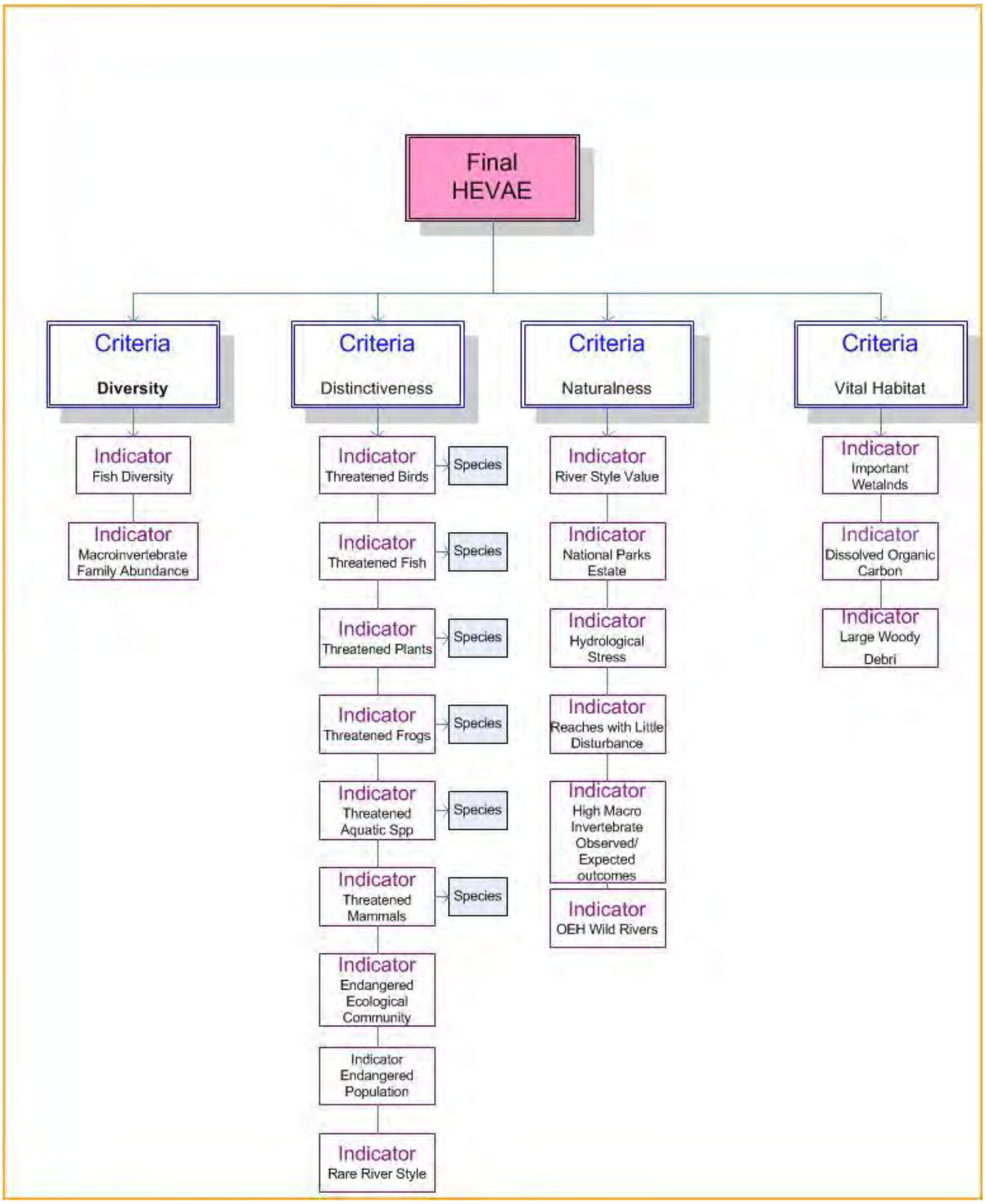


Figure 4-4. The four HEVAE criteria and associated attributes used in assessing HEVAE in NSW

Table 4-1. Examples of flow sensitivity weightings used in the HEVAE process

Score/ weighting	Definition	Examples
4	Highly sensitive to extraction and/or flow, with specific flow requirements - less able to move to alternative refuge	Fish; stream breeding threatened frogs; threatened listings where alteration to flow is listed as a key threat, Ramsar wetlands
3	Moderately sensitive to extraction and/or flow - some ability to adjust to flow changes or relocate	Macroinvertebrates, some threatened frogs; frogs, turtles, wet flora; threatened listings where alteration to flow is listed as a key threat, but profile details indicate moderate influence
2	Slightly sensitive to extraction and/or flow - can generally survive across a wider range of flow conditions, or can move elsewhere to seek refuge	Wading/water birds; threatened listings where alteration to flow considered as a potential threat, but profile details indicate lesser influence
1	Low sensitivity to extraction and/or flow - secondary relationship to flow and extraction	Riparian and some floodplain vegetation; birds that nest in riparian trees; threatened listings where alteration to flow may not be considered to be a threat, but profile details indicate lesser influence, geomorphology
Reference: Healey et al. (2018).		

4.2.2 Consequence decision tree

To determine the impact on instream ecological functions and assets, consideration has to be given to where and how much extraction pressure (individual licence entitlement) has occurred and whether this had the potential to influence the HEVAE score.

A decision tree was used which prioritised Ramsar habitat, converting high and very high HEVAE scores into high and very high consequence ranks. Non-Ramsar high and very high value reaches were ranked according to whether they were upstream or downstream of extraction, and whether freshwater-dependent fauna and flora occurred in the assessment area.

Medium HEVAE scores either retained their rank or were downgraded to a low or very low consequence using a similar rationale as the high and very high HEVAE scores described above. That is, if freshwater-dependent fauna and flora occurred in the assessment area, the HEVAE score remained medium. If there were no freshwater-dependent fauna and flora in the assessment area the consequence score became either low or very low, depending on whether the assessment area had cumulatively more medium and low HEVAE reaches, or mostly very low HEVAE reaches.

Freshwater-dependent fauna and flora records used in the decision tree process were site-based data (recorded data), obtained from agency databases and with a high level of confidence. Predicted and known records (see Healey et al. 2018) used in the HEVAE model were not considered when progressing through the decision tree, as the confidence in those data was not as high. In the event that there were no site-based records, the consequence rank was lowered to the next category. That is, if a high HEVAE score had records only based upon predicted or known data, the consequence category became medium.

Each bifurcation in the decision tree was annotated to allow each score to be tracked through the decision tree during the assessment. The decision tree and the rationale for each bifurcation are provided in Appendix C.

4.2.3 Consequence score

4.2.3.1 Regulated river water source

Key aquatic ecological assets in the Lachlan WRPA include:

- 471,011 ha of wetlands on the lower Lachlan River floodplains, with nine wetlands listed within the Directory of Important Wetlands In Australia as having particular values for water bird and migratory bird habitat (Booligal Wetlands and Great Cumbung Swamp)
- River reaches with high fish diversity
- Native and threatened fish species including the eel-tailed catfish, silver perch, Macquarie perch, golden perch, big-headed gudgeon, olive perchlet, southern pygmy perch, Murray cod, western carp gudgeon, Murray crayfish
- Habitat for threatened frog species such as Booroolong frog, yellow spotted tree frog, southern bell frog and stuttering frog
- Habitat for threatened bird species including magpie goose, Australasian bittern, brolga, black-necked stork, Australian painted snipe, black-tailed godwit, blue-billed duck, eastern osprey, freckled duck and curlew sandpiper
- Habitat for two threatened bat species including the southern myotis and the greater broad-nosed bat
- Habitat for threatened plant species including spike rush, dense cord rush, Austral pillwort, Klaphake's sedge, winged peppercress and Menindee nightshade
- Areas of river red gum woodland, black box woodland and lignum
- Habitat supporting the Lowland Catchment of the Lachlan River Endangered Ecological Community
- Off-river billabongs and wetlands located throughout the catchment
- In-stream pools and low flow refuges that support local and migratory species.

Consequence scoring shows that most of the Lachlan regulated river has high to very high consequences (Figure 4-5; Figure 4-2) due to a number of factors including high fish diversity, presence of threatened fish species and large tracts of riparian vegetation and relatively undisturbed river reaches contributing to the provision of habitat and primary production. There is also the presence of endangered ecological communities, the most widespread of these being the Lowland Darling River Aquatic EEC and the Coolabah-Black box Woodland EEC.

Table 4-2. Consequence results for the Lachlan regulated water source in the Lachlan WRPA

Regulated river reach	Consequence rating (HEVAE consequence score)
Lachlan @ Wyangala Dam	Medium
Lachlan @ Jemalong Weir	Very high
Lachlan @ Willandra Weir	Very high
Lachlan @ Booligal Weir	High
Willandra Creek flow node	High
Belubula River @ Carcoar	High
Belubula River @ Helensholme	High
Reference: Healey et al. (2018).	

Fish data from the MDB Sustainable Rivers Audit (Davies et al. 2012) and other sources were analysed by DPI Fisheries to assess the distribution of threatened fish species and to identify areas of relative high fish biodiversity within the Lachlan WRPA. These data are included in the HEVAE assessment; results are provided in Appendix D.

4.2.3.2 Unregulated water sources

Unregulated rivers in the Lachlan WRPA have very high or high consequence scores (Figure 4-3) in the following water sources:

- In the upland and midland zones, the Abercrombie River above Wyangala Dam, the Crookwell River, the Lachlan River above Reids Flat and Mandagery Creek have high ecological values due to the occurrence of threatened fish and frog species, including Macquarie perch, silver perch, Murray crayfish and the southern bell frog
- In the lowland and terminal zones, the mid-Lachlan unregulated water source and the unregulated effluent creeks water source have high and medium consequence scores due to the presence of Murray cod, Menindee nightshade and the southern bell frog.

Table 4-3. Consequence results for the Lachlan unregulated water sources in the Lachlan WRPA

Unregulated water source	Consequence rating (HEVAE consequence score)
Abercrombie R above Wyangala	High
Belubula R above Carcoar Dam	Low
Belubula Tributaries below Carcoar Dam	Medium
Bogandillon and Manna Creeks	Medium
Boorowa River and Hovells Creek	Medium
Burrangong Creek	Low
Crookwell River	High
Crowther Creek	Medium
Goobang and Billabong Creeks	Medium
Goonigal and Kangarooby Creeks	Low
Gunningbland and Yarrabandai	Low
Humbug Creek	Low
Lachlan River above Reids Flat	Very high
Lake Forbes and Back Yamma Creek	Low
Mandagery Creek	High
Mid Lachlan Unreg	High
Mount Hope Area	Low
Naradhan Area	Low
Ooma Creek and Tributaries	Low
Tyagong Creek	Low
Unreg Effluent Creeks	Medium
Waugoola Creek	Medium
Western Bland Creek	Medium
Reference: Healey et al. (2018).	

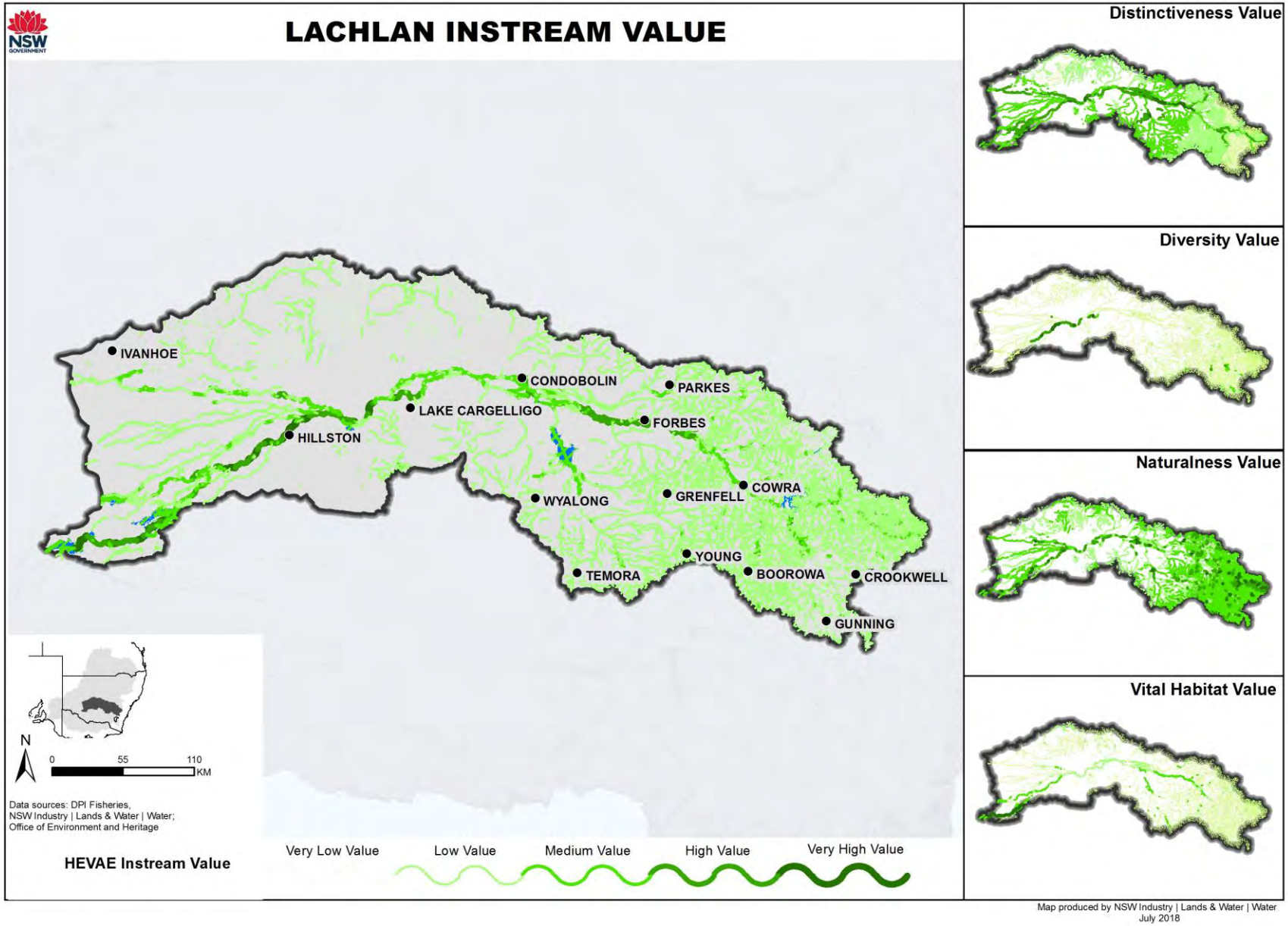


Figure 4-5. HEVAE scoring of instream values in the Lachlan WRPA

4.3 Risks to water available for the environment and capacity to meet environmental water requirements [E(W)]

The regulation of river flows can impact on ecosystem functions and environmental assets through changes in the magnitude, frequency, duration and timing/seasonality of river flows, potentially leading to a loss or degradation of instream ecological values. In regulated systems, risks to the riverine environment can be due to insufficient water, particularly at the bottom end of a catchment, or too much water in circumstances where base flows or natural dry periods no longer occur. The channel and floodplain are functionally and ecologically inseparable with the hydrological connections between the main river channel and its floodplain controlled by the pattern of flow in the river. The regulation of flow, and extraction of water, may alter a river's hydrology to the extent that it cannot maintain its key ecosystem functions.

The extraction of unregulated flow can impact on ecosystem functions by reducing the magnitude of river flows and increasing the frequency and duration of zero flows. In some unregulated reaches, such as reaches downstream of regulated rivers or non-regulating dams, higher flows such as freshes can also be reduced.

The impact pathway is shown in Figure 4-6 and demonstrates that the threat of flow alteration is driven by licensed surface water extraction and river regulation. The likelihood is described as the extent of change to key flow components, while the consequence is assessed by considering the ecological assets and functions that would be impacted.

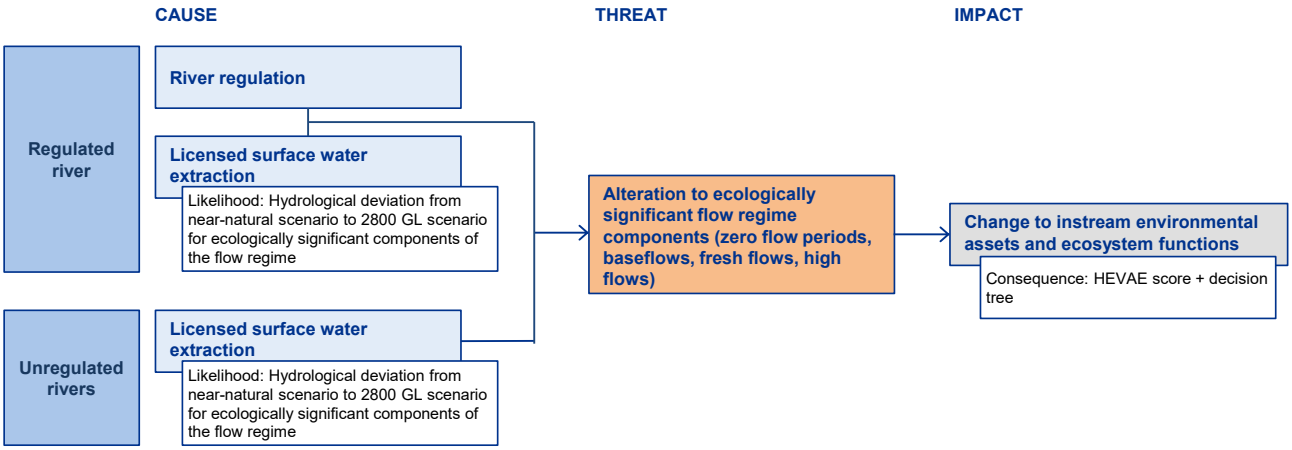


Figure 4-6. Impact pathway showing impact of river regulation and licensed extraction on water available for the environment

4.3.1 Determining the likelihood rating

Stream flow varies in response to climate, season, landform and land use. Stream flow supports key environmental assets and underpins ecosystem functions within the riverine environment.

This risk assessment process has identified key features of flow regimes which have impacts on key ecosystem functions and assets identified by the MDBA (2010) and Alluvium (2010). These key flow components and their features are summarised below (Table 4-4).

Table 4-4. Key features of flow regimes that impact on ecosystem functions and environmental assets

Flow regime component	Key feature
Cease to flow events for pools and refugia (Z)	Pools can provide important refugia for a range of taxa during periods of no flow. Continued extraction of water from pools can lead to greater competition for resources by aquatic biota, as well as changes to water quality.
Base flows (BF)	Base flows (low flows) are those flows that are confined to the low flow part of the channel. They persist after rain has stopped as a result of connection to groundwater aquifers. Protection of low flows protects longitudinal connectivity, as well as important flowing water habitat types (riffles and pools) that support specialist feeding groups including macroinvertebrate communities and fish. Base flows are important to fish communities because they: • Provide a diversity of habitats for sheltering, feeding and spawning. • Establish connectivity and enable longitudinal movement of fish between pools. Large bodied fish may not move during base flows due to inadequate water depth within riffles, but small bodied fish may move if conditions are suitable. • Constantly exchange and refresh water in pools and therefore maintaining reasonable water quality.
Freshes (F)	Freshes are larger flows that inundate the sides of the banks and any in-channel bars and benches that may be present. These are often caused by a rain event leading to increased inflows to the river that travel as a pulsed flow down the system. Freshes are required to support instream processes and biota in the same way as bank full and over bank flows, in terms of flow magnitude, duration, timing and frequency. Freshes are a distinct event.
Large and infrequent flows (BKF and OB)	Large flow events occur on an average recurrence interval (ARI) of greater than a year. These flow events are distinct from base flows and freshes because they can generate bank full and over bank flows. Bank full flows are regarded as important for maintaining river geomorphology, and are often termed the “channel forming” flows, as they help define and maintain channel dimensions such as width, depth and slope, and in-channel habitats such as benches and bars. High flows and freshes also act as a natural disturbance in river systems, helping to remove vegetation, aquatic plants and organic matter and resetting successional processes. Over bank flows deliver water, sediment and dissolved material, including plant nutrients, to the floodplain and provide temporary access to floodplain aquatic habitats. Water returning from the floodplain to the channel may carry carbon in the form of dissolved carbon and organic detritus, micro-organisms and small plankton animals. All are generated by the productive floodplain ecosystem and supported by inputs of water from the channel.
Reference: MDBA 2010, MDBA 2012; Alluvium 2010, Chessman et al. 2006a	

Risks to the capacity of not meeting environmental watering requirements of ecosystem functions and environmental assets are described by the extent of hydrological deviation of key flow regimes. All hydrological modelling was undertaken using IQQM software. IQQM is the principle modelling platform used in NSW and Queensland, and was also used by the MDBA (MDBA 2012).

The hydrological alteration metrics used to assign a likelihood rating of impacting on the ecological assets and functions are the same as those used to prioritise flows for key ecological processes in the Basin Plan (MDBA 2012).

Hydrological alteration metrics were chosen to reflect the key ecological features of flow regimes described in Table 4-4. These metrics indicate change to the following flow components:

- Zero flow periods (or cease to flow events) (Z)

- Base flows (BF)
- Freshes (F)
- High flows 1.5 year average recurrence interval (ARI) (BK1.5)
- High flows 2.5 year ARI (OB2.5)
- High flows 5.0 year ARI (OB5).

Differences in channel morphology along a river may mean that a high flow event could result in over bank flows on one reach but not others. The ARI events used in this risk assessment are therefore considered to be broadly indicative of a river section's likelihood. The specific ARI that might be needed, for instance, to inundate a particular wetland, will be addressed in the Long Term Water Plan (LTWP).

Under the Basin Plan, environmental watering requirements (EWRs) are those needed to achieve ecological objectives for priority environmental assets (PEAs) and priority ecosystem functions (PEFs). EWRs are identified for PEAs and PEFs in the Lachlan WRPA in the LTWP developed by OEH (2018; Table 6) and are based on seven flow components. Within each flow component, flow types have been assigned based on the magnitude, timing, duration and frequency of flow required to support environmental assets and ecosystem functions.

This risk assessment was completed prior to EWRs being developed for the Lachlan WRPA; therefore the ideal timing of EWR was not an explicit consideration in the likelihood calculations discussed below. However, the likelihood assessment does identify the change in frequency, magnitude or duration of certain flow components, regardless of the seasonality. Therefore any changes to hydrology during the ideal LTWP timing periods have been identified.

The alignment between the EWRs identified in the LTWP and the flow components used in this risk assessment is provided in Table 4-5 below. This table demonstrates how regard was had to the EWRs for PEAs and PEFs in the preparation of the likelihood component of this risk assessment. As discussed in Section 4.2 above, there is also alignment between Schedules 8 and 9 of the Basin Plan and the assets and functions identified in the LTWP. Therefore the risks to the capacity to meet EWRs in the Lachlan WRPA can be assessed and consideration given to strategies to manage these risks as required by Chapter 10 of the Basin Plan (see Section 8 of this report).

Table 4-5. Alignment of EWRs of the LTWP and flow components assessed in the Lachlan WRPA risk assessment

Long Term Water Plan (OEH)[1]						Lachlan WRPA risk assessment (NSW Department of Planning and Environment)	
Flow component[1]	EWR reference	Maximum inter-flow period	Ideal EWR			Flow component assessed (section 4.3)	How this risk assessment considers the EWR
			Timing	Duration	Frequency		
Cease-to-flow	CF1	No greater than modelled natural	In line with modelled natural low flow season	In line with natural, unless key refuges endangered, or as described in planning unit specific EWR tables	In line with modelled natural	Zero flow (Z)	Metrics used to calculate likelihood for the zero flow component identifies changes in timing, duration and ideal frequency

Long Term Water Plan (OEH)[1]						Lachlan WRPA risk assessment (NSW Department of Planning and Environment)	
Flow component[1]	EWR reference	Maximum inter-flow period	Ideal EWR			Flow component assessed (section 4.3)	How this risk assessment considers the EWR
			Timing	Duration	Frequency		
Very-low flow	VF1	1 year	Any time	In line with modelled natural	In line with modelled natural	Base flow (BF)	Metrics used to calculate likelihood of base flow components included identifying low flows during 'wet' and 'dry' seasons. The dry season calculation is equivalent to very low flows (approximately 90–95%ile)

Long Term Water Plan (OEH)[1]						Lachlan WRPA risk assessment (NSW Department of Planning and Environment)	
Flow component[1]	EWR reference	Maximum inter-flow period	Ideal EWR			Flow component assessed (section 4.3)	How this risk assessment considers the EWR
			Timing	Duration	Frequency		
”Base flow”[2]	BF1	1 year	Any time	Maintain refuge habitat quantity and quality, and support connectivity	In line with modelled natural	Base flow (BF)	Metrics used to calculate likelihood of base flow components included identifying low flows during ‘wet’ and ‘dry’ seasons. Likelihoods were generally calculated on flows between the 80–95%ile, depending on which percentile most accurately described low flows in the water source.
“Base flow”[2]	BF2	2 years	September to March	In line with modelled natural	5–10 in a 10-year period (1:1–2)	Fresh (F)	Metrics used to calculate likelihood of fresh flow components included identifying 20%ile flows during ‘wet’ and ‘dry’ seasons and would capture alterations to the BF2 flows.
Small fresh	SF1	1 year	October to April (but can occur anytime) (Ideally 2–3 weeks after LF2)	10 days minimum	Annual (1:1)	Fresh/ARI 1.5 (F, BKF1.5)	Metrics used to calculate likelihood of fresh flow (20%ile during wet/dry periods) and ARI 1.5 would capture most of the SF1 flows.

Long Term Water Plan (OEH)[1]						Lachlan WRPA risk assessment (NSW Department of Planning and Environment)	
Flow component[1]	EWR reference	Maximum inter-flow period	Ideal EWR			Flow component assessed (section 4.3)	How this risk assessment considers the EWR
			Timing	Duration	Frequency		
Small fresh	SF2	2 years	September to April	14 days minimum	5–10 in a 10-year period (1:1–2)	ARI 1.5 (BKF1.5)	Metrics used to calculate likelihood of ARI 1.5 flow component identifies changes to SF2.
Large fresh	LF1	2 years	July to September (but can occur anytime)	5 days minimum	5–10 in a 10-year period (1:1–2)	ARI 1.5 (BKF1.5)	Metrics used to calculate likelihood of ARI 1.5 flow component identifies changes to LF1.
Large Fresh	LF2	4 years	October to April (Ideally 2–3 weeks before SF1)	5 days minimum	3–5 in a 10-year period (1:2–3)	ARI 2.5 (BKF2.5)	Metrics used to calculate likelihood of ARI 2.5 flow component identifies changes to LF2.
Bankfull	BK1	N/A	August to February (but can occur anytime)	In line with natural	8–10 years in 10	ARI 1.5 (BKF1.5) ARI 2.5 (BKF2.5)	Metrics used to calculate likelihood of ARI 1.5 and 2.5 flow component identifies changes to BK1.
Small wetland inundation	WL1	18 months	Any time	In line with natural	8-10 years in 10	Fresh/ARI 1.5 (F, BKF1.5)	Metrics used to calculate likelihood of fresh flow (20%ile during wet/dry periods) and ARI 1.5 would capture most of the WL1 flows.
Small wetland inundation	WL2	18 months	September to March (but can occur anytime)	10 days minimum, 2–8 months of habitat inundation	7–8 years in 10	Fresh/ARI 1.5 (F, BKF1.5)	Metrics used to calculate likelihood of fresh flow (20%ile during wet/dry periods) and ARI 1.5 would capture most of the WL2 flows.
Large wetland inundation	WL3	3 years	October to April	2–6 months of habitat inundation	5–7 years in 10	ARI 1.5 / ARI 2.5 (OB1.5 / OB2.5)	Metrics used to calculate likelihood of ARI 1.5 and ARI 2.5 flow component identifies changes to WL3 flows

Long Term Water Plan (OEH)[1]						Lachlan WRPA risk assessment (NSW Department of Planning and Environment)	
Flow component[1]	EWR reference	Maximum inter-flow period	Ideal EWR			Flow component assessed (section 4.3)	How this risk assessment considers the EWR
			Timing	Duration	Frequency		
Large wetland inundation	WL4	5 years	August to February (but can occur any time)	5 days minimum, 2–3 months of habitat inundation	3–5 years in 10	ARI 2.5 / ARI 5.0 (OB2.5 / OB5.0)	Metrics used to calculate likelihood of ARI 2.5 and ARI 5.0 flow component identifies changes to WL4 flows
Small over bank	OB1	2 years	September to March (but can occur any time)	2–8 months of habitat inundation	7–8 years in 10	ARI 1.5 (BKF 1.5)	Metrics used to calculate likelihood of ARI 1.5 flow component identifies changes to OB1.
Small over bank	OB2	3 years	October to April	10 days minimum, 2–6 months of habitat inundation	4–7 years in 10	ARI 2.5 (OB2.5)	Metrics used to calculate likelihood of ARI 2.5 flow component identifies changes to OB2.
Over bank	OB3	4 years	August to February (but can occur any time)	days minimum, 2–3 months of habitat inundation	3–5 years in 10	ARI 2.5 (OB2.5)	Metrics used to calculate likelihood of ARI 2.5 flow component identifies changes to OB3.
Over bank	OB4	5 years	September to May (but can occur any time)	3–8 months of habitat inundation	2–3 years in 10	ARI 5 (OB5)	Metrics used to calculate likelihood of ARI 5 flow component identifies changes to OB4.
Over bank	OB5	10 years	Any time	1–6 months of habitat inundation	1 year in 10	ARI 5 (OB5)	Metrics used to calculate likelihood of ARI 5 flow component identifies changes to OB5.

1 Table 6, OEH 2018. Note that LTWP flow components do not provide definitions of percentiles or frequencies

2 ”Base flow” in the LTWP is not defined as a flow percentile or flow component, but rather a “base” flow required to provide minimum depth and connectivity requirements to support migratory fish.

4.3.1.1 Regulated river water source

The MDBA modelled a 2,800 gigalitre (GL) reduction target across the Basin (MDBA 2012). Flow sequences were generated by the MDBA using NSW Department of Planning and Environment IQQM models. This modelling scenario modelled a 2800 GL/year reduction in consumptive water use across the Basin; this included 450 GL/yr recovery from the northern Basin. While an eventual Basin Plan recovery target was 2,750 GL, the 2,800 GL scenario is considered relevant as the change in the Condamine-Balonne valley had little impact on the environmental flow indicators downstream (MDBA 2012).

The results published by the MDBA (MDBA 2012) are the percentage change of the 2,800 GL target scenario from a near-natural condition scenario. The latter is a modelled scenario approximating river flows without any dams, weirs or extraction (MDBA 2012).

Likelihood category definitions are defined based on the extent of deviation from the near-natural condition (Table 4-6). Flow deviation can be positive (e.g. 125%), which means more water is available for that particular flow component under the 2,800 GL scenario than the near-natural condition; conversely a negative deviation (e.g. 75%) means less water for that particular flow component.

Table 4-6. Likelihood metrics for risk of insufficient water available for the environment and risk to EWRs in the regulated Lachlan River

Likelihood metric	Metric category	Metric category definition
Flow Deviation (2800 GL target scenario compared to near-natural condition scenario) (MDBA 2012)	Low	< 20% departure from near-natural condition (+/-)
	Medium	20–50% departure from near-natural condition (+/-)
	High	> 50% departure from near-natural condition (+/-)
Reference: Alluvium 2010; Van Laarhoven & van der Wielen 2009		

The following hydrologic indicator sites were used to calculate likelihood results in the assessment of risk for the Lachlan regulated river (Table 4-7).

Table 4-7. Likelihood results for the Lachlan and Belubula regulated rivers

Regulated river reach	Likelihood rating					
	Zero flow periods	Base flow or low flows	Fresh flows	High and infrequent flows		
				OB 1.5 ARI	OB 2.5 ARI	OB 5.0 ARI
Lachlan @ Wyangala Dam	H-	H+	H+	H-	H-	M-
Lachlan @ Jemalong Weir	H-	H+	H+	L-	L-	L-
Lachlan @ Willandra Weir	H+	H+	H+	L-	L-	L-
Lachlan @ Booligal Weir	H-	H+	H-	L-	L-	L-
Willandra Creek flow node	L0	H+	H+	M-	M-	M-
Belubula River @ Carcoar	M-	H-	H+	H-	H-	H-
Belubula River @ Helensholme	H+	M+	M+	L-	L-	L-
Key: L = low; M = medium; H = high; N/A = no hydrological data available + increase from near-natural condition; – decrease from near natural condition; 0 no change from near-natural condition Reference: MDBA 2012						

4.3.1.2 Unregulated water sources

For the majority of unregulated water sources, single reach IQQM models were used to derive flow sequences. Extraction at full development of unregulated entitlement was assumed to simulate flow sequences to compare against the near-natural condition scenario (as defined above). Where appropriate, unregulated flow gauges were also used for single reach models in adjacent water sources if a suitable gauge was not available. Similar to regulated systems, likelihood category definitions are defined based on the extent of deviation from the near-natural condition (Table 4-8).

Table 4-8. Likelihood metrics for risk of insufficient water available for the environment and risk to EWRs in unregulated water sources in the Lachlan WRPA

Likelihood metric	Metric category	Metric category definition
Flow Deviation (full development of unregulated entitlement compared to near-natural condition scenario)	Low	< 20% departure from near-natural condition (+/-)
	Medium	20-50% departure from near-natural condition (+/-)
	High	> 50% departure from near-natural condition (+/-)
Reference: Alluvium 2010; VanLaarhoven & van der Wielen 2009		

The likelihood results for the unregulated Lachlan water source are shown in Table 4-9.

Table 4-9. Likelihood results for unregulated water sources in the Lachlan WRPA

Unregulated water source	Likelihood rating					
	Zero flow periods	Base flow or low flows	Fresh flows	High and infrequent flows		
				OB 1.5 ARI	OB 2.5 ARI	OB 5.0 ARI
Abercrombie R above Wyangala **	L^{+}	L^{-}	L^{-}	L^{0}	L^{0}	L^{0}
Belubula R above Carcoar Dam	H^{+}	H^{-}	L^{-}	L^{0}	L^{0}	L^{0}
Belubula Tributaries below Carcoar Dam	H^{+}	H^{-}	H^{-}	L^{0}	L^{0}	L^{0}
Bogandillon and Manna Creeks	L^{+}	H^{-}	L^{-}	L^{0}	L^{0}	L^{0}
Boorowa River and Hovells Creek	H^{+}	H^{-}	L^{-}	L^{0}	L^{0}	L^{0}
Burrangong Creek	H^{+}	H^{-}	L^{-}	L^{-}	L^{-}	L^{0}
Crookwell River **	L^{0}	H^{-}	L^{-}	L^{-}	L^{0}	L^{0}
Crowther Creek	M^{+}	H^{-}	L^{-}	L^{0}	L^{0}	L^{0}
Goobang and Billabong Creeks	H^{+}	H^{-}	L^{-}	L^{-}	L^{0}	L^{0}
Goonigal and Kangarooby Creeks	M^{+}	H^{-}	H^{-}	L^{0}	L^{0}	L^{0}
Gunningbland and Yarrabandai	L^{+}	L^{-}	L^{-}	L^{0}	L^{0}	L^{0}
Humbug Creek	L^{+}	L^{-}	L^{-}	L^{0}	L^{0}	L^{0}

Unregulated water source	Likelihood rating					
	Zero flow periods	Base flow or low flows	Fresh flows	High and infrequent flows		
				OB 1.5 ARI	OB 2.5 ARI	OB 5.0 ARI
Lachlan River above Reids Flat **	L^0	M^-	L^-	L^0	L^0	L^0
Lake Forbes and Back Yamma Creek	L^+	L^-	L^0	L^0	L^0	L^0
Mandagery Creek **	L^+	H^-	M^-	L^-	L^-	L^0
Mid Lachlan unreg	L^+	M^-	L^{-*}	L^-	L^-	L-
Mount Hope area	L^+	L^-	L^-	L^0	L^0	L^0
Naradhan area	L^+	L^-	L^-	L^0	L^0	L^0
Ooma Creek and tributaries	L^+	H^-	L^-	L^-	L^0	L^0
Tyagong Creek	M^+	H^-	L^-	L^0	L^0	L^0
Unreg Effluent Creeks	L^0	H^+	M^{+*}	M^-	M^-	M^-
Waugoola Creek	H^+	H^-	L^-	L^0	L^0	L^0
Western Bland Creek	L^+	H^-	L^-	L^0	L^0	L^0
Key: L = low; M = medium; H = high; N/A = no data available $^+$ increase from near-natural condition; $^-$ decrease from near-natural condition; ^{0} no change from near-natural condition ** A Cease to Pump (CtP) was included in the modelling scenario.						
Reference: MDBA 2012						

4.3.2 Existing water management actions and mechanisms

The *Water Management Act 2000* requires that the sharing of water must protect the water source and its dependent ecosystems, and that water sharing plans establish specific rules that protect water for the environment. There are a range of existing management actions and mechanisms that are in place to protect environmental requirements in the Lachlan valley. These mechanisms are provided for under the *Water Management Act 2000* and through specific rules within the regulated and unregulated water sharing plans.

The *Water Sharing Plan for the Lachlan Regulated River Water Source 2016* and the *Water Sharing Plan for the Belubula Regulated River Water Source 2012* have the following actions and mechanisms to provide water for the environment:

- Reserve all water above the long term average annual extraction limit for planned environmental water
- Release of translucent flows from Wyangala Dam as specified in the *Water Sharing Plan for the Lachlan Regulated River Water Source 2016*
- Release of Wyangala Dam and Lake Brewster Environmental Water Allowances as specified in the *Water Sharing Plan for the Lachlan Regulated River Water Source 2016*
- Release of a Water Quality Allowance as specified in the *Water Sharing Plan for the Lachlan Regulated River Water Source 2016*
- Maintenance of a visible flow in the Lachlan River at Geramy
- Delivery of domestic and stock replenishment flows that provide social and environmental benefits Allowance as specified in the *Water Sharing Plan for the Lachlan Regulated River Water Source 2016*

- Restricted access to uncontrolled flows as specified in *the Water Sharing Plan for the Belubula Regulated River Water Source 2012*
- Restricted access to 'first fresh' events as specified in the *Water Sharing Plan for the Belubula Regulated River Water Source 2012*
- Ministerial discretion around rules relating to the rates of change to releases from water storages to minimise environmental and geomorphological impacts.

The *Water Sharing Plan for the Lachlan Unregulated River Water Sources 2012* has the following actions and mechanisms to provide water for the environment:

- Reserve all water above the long term average annual extraction limit for planned environmental water.
- Cease to pump rules, commence to pump rules and flow rates/levels provide protection during dry times. Aquifer access licences that extract groundwater that is highly connected to the unregulated surface water may also have a cease to pump rule applied
- Rules for granting and amending water supply works approvals are established for groundwater sources to provide protection for environmental assets. This provides protection for base flows and key assets such as groundwater-dependent ecosystems (GDEs). These rules stipulate buffer distances from which new bores can be placed from specific features such as GDEs, neighbouring bores and contaminated sites, as well as rules for existing bores
- Restrictions on trade to protect areas of high ecological value
- Restrictions on in-river and off-river pools when the volume of that water is less than the full capacity of the pool.

The 2,800 GL scenario modelling (MDBA 2012) included a water recovery volume in the Lachlan of 48 GL/yr (average long term use). This volume represents the volume of water already recovered in the Lachlan.

4.3.3 Risk outcomes

The risk matrix used to determine the risk to environmental water for ecological functions and assets due to licensed surface water extraction and river regulation (in the regulated water source only) is provided in Table 4-10.

Table 4-10. Risk matrix to determine risk outcomes of insufficient water for the environment and capacity to meet EWRs

		Likelihood (of hydrological alternation)		
		Low	Medium	High
Consequence (HEVAE consequence score)	Very low	Low	Low	Low
	Low	Low	Low	Medium
	Medium	Low	Medium	High
	High	Low	Medium	High
	Very high	Medium	High	High

4.3.3.1 Regulated river water source

Combining the risk consequence and likelihood ratings (Table 4-2 and Table 4-7) for the Lachlan regulated river results in the overall risk levels to ecological assets and functions as shown in Table 4-11. Overall, there were high and medium risks across all flow components (i.e. zero flow, base flows, fresh flows and each ARI).

The flow regimes of the Lachlan and Belubula Rivers have been substantially altered by the construction of Wyangala and Carcoar Dams and the various weirs and structures that control the delivery of water along the regulated trunk streams, distributary and anabranch channels.

The combination of very high and high values of consequence, along with significant flow alterations (likelihood), were a contributing factor in influencing the high and medium risk categories throughout the regulated river. In particular, the regulated river downstream of Wyangala Dam had very high consequence coupled with high likelihood metrics for each of the flow components.

Regulation of the river system has caused significant reduction in moderate to high flows in the lower Lachlan River. It has also contributed to an increase in the average period between large flows (5 year ARI), and a reduction in the average volume of large flows. Regulation effects on large flows along the lower Belubula River are smaller as numerous unregulated tributaries enter the Belubula River below Carcoar Dam.

4.3.3.2 Unregulated water sources

Combining the risk consequence and likelihood ratings (Table 4-3 and Table 4-9) for the Lachlan unregulated water sources results in the overall risk levels to ecological assets and functions as shown in Table 4-12. Overall, risks to unregulated water sources were largely restricted to the zero flow, base flow and fresh flow components. Of the 23 unregulated water sources within the Lachlan, four demonstrated a medium risk to an increase in zero flow periods, while a further four water sources had a high risk. There were six unregulated water sources with a medium risk to the reduction in base flows and eleven water sources returning a high risk.

Few water sources had high risks associated with freshes and larger ARI flow components. These were the Belubula River tributaries below Carcoar Dam and the mid-Lachlan unregulated tributaries water sources.

Table 4-11. Risk of insufficient water for the environment and capacity to meet EWRs in the regulated Lachlan River [E(W)]

Regulated river reach	Consequence	Likelihood						Overall risk rating – E(W)					
		Zero flow periods	Base flow or low flows	Fresh flows	High and infrequent flows			Zero flow periods	Base flow or low flows	Fresh flows	High and infrequent flows		
					OB 1.5 ARI	OB 2.5 ARI	OB 5.0 ARI				OB 1.5 ARI	OB 2.5 ARI	OB 5.0 ARI
Lachlan @ Wyangala Dam	M	H-	H+	H+	H-	H-	M-	H	H	H	H	H	M
Lachlan @ Jemalong Weir	VH	H-	H+	H+	L-	L-	L-	H	H	H	M	M	M
Lachlan @ Willandra Weir	VH	H+	H+	H+	L-	L-	L-	H	H	H	M	M	M
Lachlan @ Booligal Weir	H	H-	H+	H-	L-	L-	L-	H	H	H	L	L	L
Willandra Creek flow node	H	L0	H+	H+	M-	M-	M-	L	H	H	M	M	M
Belubula River @ Carcoar	H	M-	H-	H+	H-	H-	H-	M	H	H	H	H	H
Belubula River @ Helensholme	H	H+	M+	M+	L-	L-	L-	H	M	M	L	L	L

Key: L = Low; M = Medium; H = High; N/A = no hydrological data available

$^{+}$ increase from near natural condition ; $^{-}$ decrease from near-natural condition; ^{0} no change from near-natural condition

Table 4-12. Risk of insufficient water for the environment and capacity to meet EWRs in the unregulated water sources of the Lachlan WRPA [E(W)]

Unregulated water source	Consequence	Likelihood						Overall risk rating – E(W)					
		Zero flow periods	Base flow or low flows	Fresh flows	High and infrequent flows			Zero flow periods	Base flow or low flows	Fresh flows	High and infrequent flows		
					OB 1.5 ARI	OB 2.5 ARI	OB 5.0 ARI				OB 1.5 ARI	OB 2.5 ARI	OB 5.0 ARI
Abercrombie R above Wyangala **	H	L+	L-	L-	L0	L0	L0	L	L	L	L	L	L
Belubula R above Carcoar Dam	L	H+	H-	L-	L0	L0	L0	M	M	L	L	L	L
Belubula Tributaries below Carcoar Dam	M	H+	H-	H-	L0	L0	L0	H	H	H	L	L	L
Bogandillon and Manna Creeks	M	L+	H-	L-	L0	L0	L0	L	H	L	L	L	L
Boorowa River and Hovells Creek	M	H+	H-	L-	L0	L0	L0	H	H	L	L	L	L
Burrangong Creek	L	H+	H-	L-	L-	L-	L0	M	M	L	L	L	L
Crookwell River **	H	L0	H-	L-	L-	L0	L0	L	H	L	L	L	L
Crowther Creek	M	M+	H-	L-	L0	L0	L0	M	H	L	L	L	L
Goobang and Billabong Creeks	M	H+	H-	L-	L-	L0	L0	H	H	L	L	L	L
Goonigal and Kangarooby Creeks	L	M+	H-	H-	L0	L0	L0	L	M	M	L	L	L
Gunningbland and Yarrabandai	L	L+	L-	L-	L0	L0	L0	L	L	L	L	L	L
Humbug Creek	L	L+	L-	L-	L0	L0	L0	L	L	L	L	L	L
Lachlan River above Reids Flat **	VH	L0	M-	L-	L0	L0	L0	M	H	M	M	M	M
Lake Forbes and Back Yamma Creek	L	L+	L-	L0	L0	L0	L0	L	L	L	L	L	L

Unregulated water source	Consequence	Likelihood						Overall risk rating – E(W)					
		Zero flow periods	Base flow or low flows	Fresh flows	High and infrequent flows			Zero flow periods	Base flow or low flows	Fresh flows	High and infrequent flows		
					OB 1.5 ARI	OB 2.5 ARI	OB 5.0 ARI				OB 1.5 ARI	OB 2.5 ARI	OB 5.0 ARI
Mandagery Creek **	H	L+	H-	M-	L-	L-	L0	L	H	M	L	L	L
Mid Lachlan Unreg	H	L+	M-	L-*	L-	L-	L-	L	M	L	L	L	L
Mount Hope Area	L	L+	L-	L-	L0	L0	L0	L	L	L	L	L	L
Naradhan Area	L	L+	L-	L-	L0	L0	L0	L	L	L	L	L	L
Ooma Creek and Tributaries	L	L+	H-	L-	L-	L0	L0	L	M	L	L	L	L
Tyagong Creek	L	M+	H-	L-	L0	L0	L0	L	M	L	L	L	L
Unreg Effluent Creeks	M	L0	H+	M+*	M-	M-	M-	L	H	M	M	M	M
Waugoola Creek	M	H+	H-	L-	L0	L0	L0	H	H	L	L	L	L
Western Bland Creek	M	L+	H-	L-	L0	L0	L0	L	H	L	L	L	L

Key: L = Low; M = Medium; H = High; ; N/A = no hydrological data available

+ increase near-natural condition; - decrease near-natural condition; 0 no change from near-natural condition

* no risk outcome or modelling available due to lack of data

** A Cease to Pump (CtP) was included in the modelling scenario

4.4 Risks to water available for the environment from extraction under basic landholder rights [E(BLR)]

All landholders in NSW have rights to access water for some basic purposes. There are three types of basic landholder rights (BLR) in NSW under the *Water Management Act 2000*:

- Native title rights: holders of native title with respect to water, as determined under the Commonwealth Native Title Act 1993, can take and use water for a range of personal, domestic and non-commercial purposes

  There are currently no native title rights to water in NSW; however, these rights may be activated during the term of a WSP
- Domestic and stock rights: owners or occupiers of land which has river, estuary or lake frontage can take water without a licence for domestic (household) purposes or to water stock
- harvestable rights (dams): harvestable right water allows landholders in most rural areas to collect a proportion of BLR runoff on their property and store it in one or more farm dams up to a certain size

  Note that any volume of water that exceeds the maximum harvestable right dam capacity must be licensed; any dam which exceeds the maximum harvestable right dam capacity is subject to a works approval. The requirements of harvestable rights have been inherently considered as the design of access rules is also based on river flows that result after harvestable rights extractions have occurred (NOW 2011).

In both regulated and unregulated water sources, the principles of the WMA 2000 require that water sharing must protect BLR. Water requirements for BLR are identified in water sharing plans and have been taken into consideration when designing rules for licensed water extractions (NOW 2011). Access rules for water access licences (such as cease to pump rules) do not apply to BLR users and provide them with a higher level priority of water access. Impacts to the environment due to farm dams are discussed in Section 4.5.1.

In some areas, basic right use may be a significant proportion of low flows and therefore contributes to hydrological stress. Increased extraction of surface water under BLR may reduce the water available for the environment, as shown in the impact pathway below (Figure 4-7). The nature of water extraction under BLR means that this activity has no effect on flow regimes other than low flows. Therefore, the likelihood of impact was assessed only against low flows and the risk to other parts of the flow regime is '**low**'. The likelihood is described by the ratio of low flow to the estimated BLR within each water source, while the consequence is assessed by considering the ecological assets and functions that would be impacted.

Figure 4-7. Impact pathway showing risk of growth in BLR reducing water available for the environment

4.4.1 Determining the likelihood rating

4.4.1.1 Regulated river water source

In regulated systems, BLR is managed in order to maintain supply of BLR water requirements. Sufficient reserves of water are set aside and held in storage to ensure supply of domestic and stock rights and native title rights. Therefore there is no pathway for impact on water for the environment from BLR extraction in regulated river sections, and a 'nil' likelihood has been assigned to all regulated rivers (Table 4-15 and Table 4-16). The 'nil' likelihood rating was assigned to all components of the flow regime (all EWRs; Table 4-5).

4.4.1.2 Unregulated river water source

The nature of BLR extraction cannot impact upon medium to high flows, and therefore has a 'nil' risk on these components of the flow regime. The assessment of risks of BLR extraction impacting on the environment are relevant to base flows, very-low flows and cease-to-flows (EWRs: BF1, VF1, CF1; Table 4-5). The likelihood of growth in BLR causing a reduction in water available for the environment in unregulated rivers is described by the ratio of the following two metrics:

- Daily 80th percentile flow (of full development of unregulated entitlement)
- Daily BLR extraction.

This ratio was calculated for each water source and is based on the rationale that where the 80th percentile flow is high and the daily BLR take is low, then the likelihood is low. Alternatively, where the 80th percentile flow is low when compared to the daily extraction of BLR, the likelihood is high. If the 80th percentile flow is zero (i.e. an intermittent stream), then a high likelihood is also assigned.

The 80th percentile flows were calculated from recorded flows in each water source and were those used for the macro-planning process. The 80th percentile was selected as it is generally considered to represent the low flow portion.

The BLR volume was estimated using the same method developed for the macro planning process. This method calculated the annual stock use based on potential grazing areas within a water source (including unimproved and improved irrigated grazing land) and stock water allowances. Rural domestic use was also estimated using data from the Australian Bureau of Statistics population and housing census data and assumed domestic water consumption for rural lots.

Likelihood category definitions are defined by the ratios identified in Table 4-13. The likelihood results for water sources in the unregulated Lachlan system are shown in Table 4-14.

Table 4-13. Likelihood metrics for risk of growth in BLR in unregulated water sources

Likelihood metric	Metric category	Metric category definition
Ratio of daily 80th percentile flow to estimated daily BLR extraction	Low	Daily 80th percentile: daily BLR extraction >2 i.e. extraction is less than 50% of the 80th percentile flow
	Medium	Daily 80th percentile: daily BLR extraction between 1.01 – 2 i.e. extraction is 50% – 99% of the 80th percentile flow
	High	Daily 80th percentile: daily BLR extraction <1 i.e. extraction is equal to 100% or more of 80th percentile flow Intermittent streams (80th percentile flow is zero)

Table 4-14. Likelihood results for unregulated water sources in the Lachlan WRPA

Unregulated water source	Likelihood rating
Abercrombie River above Wyangala	Medium
Belubula River above Carcoar Dam	Low
Belubula Tributaries below Carcoar Dam	Low
Bogandillon and Manna Creeks	Low
Boorowa River and Hovells Creek	Low
Burrangong Creek	Low
Crookwell River	Low
Crowther Creek	Low
Goobang and Billabong Creeks	Low
Goonigal and Kangarooby Creeks	Low
Gunningbland and Yarrabandai	Low
Humbug Creek	High
Lachlan River above Reids Flat	Low
Lake Forbes and Back Yamma Creek	Low
Mandagery Creek	Low
Mid Lachlan Unregulated	Low
Mount Hope Area	High
Naradhan Area	Low
Ooma Creek and Tributaries	Low
Tyagong Creek	Low
Unreg Effluent Creeks	Low
Waugoola Creek	Low
Western Bland Creek	Low
N/A = Risk could not be calculated because hydrological data was unavailable or unsuitable for this analysis	

4.4.2 Existing water management actions and mechanisms

Under the *Water Management Act 2000*, BLR are made up of domestic and stock rights, harvestable rights and native title rights. Water sharing plans recognise basic landholder rights in their respective water sources. Water may be extracted under these rights without the need for a water access licence, although in the case of accessing groundwater under a domestic and stock right, the bore must still be approved by the Department. The water sharing plan cannot limit or restrict these rights, but the Act itself provides for restrictions on BLR through the development of mandatory guidelines. Additionally during periods of water shortage, domestic and stock users may be required, by Ministerial Order, to restrict usage to essential purposes.

The proliferation of new domestic and stock rights through the subdivision of land will be managed through a further regulation to the *Water Management Act 2000*. This regulation, made under section 52(2) of the Act, will limit the growth in basic landholder rights when a landholding is subdivided. Effectively this will mean that the reasonable use for the pre-subdivision landholding will be ‘frozen’ and the vendor will have to apportion this reasonable use limit between the proposed lots in the subdivision. Although still in development, it is intended that such limitations will be applied only to rivers and aquifers that could be subject to high hydrologic

stress or high instream risk.

Additionally, the water supply system is managed to ensure sufficient water is set aside to supply basic landholder rights while maintaining compliance with the long term average annual extraction limit (LTAAEL). If extractions are determined to be exceeding the LTAAEL, water use will be reduced until compliance with the LTAAEL occurs. This provides for the protection of planned environmental water above the extraction limit.

4.4.3 Risk outcomes

The risk matrix used to determine the risk of BLR extraction impacting the availability of water to the environment in the unregulated water sources in the Lachlan WRPA is provided in Table 4-15.

Table 4-15. Risk matrix to determine risk outcomes of increased BLR extraction impacting on water available for the environment

		Likelihood (low flow against BLR extraction)			
		Nil	Low	Medium	High
Consequence (HEVAE consequence score)	Very Low	Nil	Low	Low	Low
	Low	Nil	Low	Low	Medium
	Medium	Nil	Low	Medium	High
	High	Nil	Low	Medium	High
	Very High	Nil	Medium	High	High

Combining the risk consequence and likelihood ratings (Table 4-2 and Table 4-14 for the Lachlan regulated and unregulated water sources results in the overall risk levels to ecological assets and functions as shown in Table 4-16 and Table 4-17 respectively. Overall, all regulated water sources had '**Nil**' risk, three unregulated water sources had a '**Medium**' risk and twenty water sources had a '**Low**' risk due to extraction by BLR.

Table 4-16 Risk of increased BLR extraction impacting on water available for the environment in the regulated water source of the Lachlan Surface WRPA [E(BLR)]

	Consequence	Likelihood	Overall risk rating - E(BLR)
Regulated river water source	Medium – Very High	Nil	Nil

Table 4-17. Risk of increased BLR extraction impacting on water available for the environment in the unregulated water sources of the Lachlan WRPA [E(BLR)]

Risk factor/source	Consequence	Likelihood	Overall risk rating – E(BLR)
Abercrombie River above Wyangala	Low	Medium	Low
Belubula River above Carcoar Dam	Low	Low	Low
Belubula Tributaries below Carcoar Dam	Medium	Low	Low
Bogandillon and Manna Creeks	Medium	Low	Low
Boorowa River and Hovells Creek	Medium	Low	Low
Burrangong Creek	Low	Low	Low
Crookwell River	High	Low	Low

Risk factor/source	Consequence	Likelihood	Overall risk rating – E(BLR)
Crowther Creek	Medium	Low	Low
Goobang and Billabong Creeks	Medium	Low	Low
Goonigal and Kangarooby Creeks	Low	Low	Low
Gunningbland and Yarrabandai	Low	Low	Low
Humbug Creek	Low	High	Medium
Lachlan River above Reids Flat	Very High	Low	Medium
Lake Forbes and Back Yamma Creek	Low	Low	Low
Mandagery Creek	Medium	Low	Low
Mid Lachlan Unregulated	High	Low	Medium
Mount Hope Area	Low	High	Medium
Naradhan Area	Low	Low	Low
Ooma Creek and Tributaries	Low	Low	Low
Tyagong Creek	Low	Low	Low
Unreg Effluent Creeks	Medium	Low	Low
Waugoola Creek	Medium	Low	Low
Western Bland Creek	Medium	Low	Low
Key: L = Low; M = Medium; H = High * N/A Risk could not be calculated because hydrological data was unavailable or unsuitable for this analysis.			

4.5 Risk to water available for the environment from interception activities [E(I-FD), E(I-PF), E(I-M), E(I-FH)]

Interception activities can impact on environmental assets and ecosystem functions by altering the hydrology of a system.

The National Water Commission (NWC) defined interception as occurring when flows of surface water or groundwater are stopped, reduced or redirected (SKM et al. 2010). This definition excludes precipitation and focuses solely on changes to runoff and recharge. This is further expanded by NWC to imply that interception activities, for the purpose of water management, are human-induced activities that intercept significant volumes of water and therefore decrease the amount of water reaching surface water and groundwater bodies.

Chapter 10 Part 5 of the Basin Plan identifies the following interception activities which may have the potential to impact on the water resources of a WRPA:

- Interception by runoff dams
- Interception by commercial plantations
- Interception by mining activities, including coal seam gas mining
- Interception by floodplain harvesting.

The impact pathways shown in each section demonstrate that the threat of flow alteration driven by the interception activities identified in the Basin Plan can impact on water available for the environment. The key threat is the interception of water that would otherwise reach a water course, thereby reducing the water available for the environment.

For the purpose of risk due to interception in the risk assessment, NSW utilised results published in the CSIRO Murray–Darling Basin Sustainable Yields (MDBSY) project (CSIRO 2008a; CSIRO 2008b) and model outputs that contributed to the MDBSY project. Comparative results were also produced by NSW. Details on the methodology used for determining likelihood ratings and consequence scores for risk due to interception are detailed in the section below.

4.5.1 Farm dams (runoff dams) [E(I-FD)]

For the purpose of this risk assessment, runoff dams refer to private dams that intercept catchment runoff which would otherwise have contributed to stream flow. The impacts of runoff dams are considered to have implications primarily for surface flow; any potential impact on recharge to aquifers is considered to be minor. Interception by runoff dams is considered only in surface water risk assessments.

While the impact of an individual dam is generally small, the cumulative impact of runoff dams on stream flows can be significant. The larger the total volume of runoff dams in a catchment, the greater the potential impact. The magnitude of demand is also important as higher rates of extraction result in reduced volumes of stored water, which in turn increases the potential for dams to intercept runoff. The seasonal pattern of demand has a direct impact on the likelihood of drawdown at different times of the year, with implications for environmental flows and security of supply. The impacts of runoff dams are also heavily dependent on the seasonal distribution of flows, the nature of antecedent conditions, consumption patterns, and the distribution of rainfall. Caution is needed when inferring impacts from dam size and average stream flows based on hillside dams.

Under the NSW *Water Management Act 2000*, harvestable rights are a basic landholder right that permits landholders to capture rainwater runoff on their property, within limits, without requiring a licence. The harvestable right is intended to satisfy essential farm needs such as stock and household water, but can be used for any purpose, including commercial irrigation.

The maximum amount of rainwater runoff that can be captured in a water source is defined by a harvestable rights order (HRO). NSW currently has two harvestable rights order (HRO) divisions, the Eastern and Central division and the Western Division. The maximum harvestable right dam capacity (MHRDC) is calculated as a proportion of the average regional overland flow, applied at the scale of each landholding.

This MHRDC means that, although the number of farm dams within a water source is permitted to grow over time, the total allowable dam capacity cannot be exceeded unless the extra capacity is licenced. The combined capacity of all dams must stay within the maximum allowed in the HRO division.

For any dam with a capacity larger than the MHRDC, the volume of water that exceeds the MHRDC must be licensed, unless the water is taken under a domestic and stock right or native title right. A water supply works approval, which includes a calculation of MHRDC, is required for all new dams.

Growth in farm dams may reduce the water available for the environment, as shown in the impact pathway (Figure 4-8).

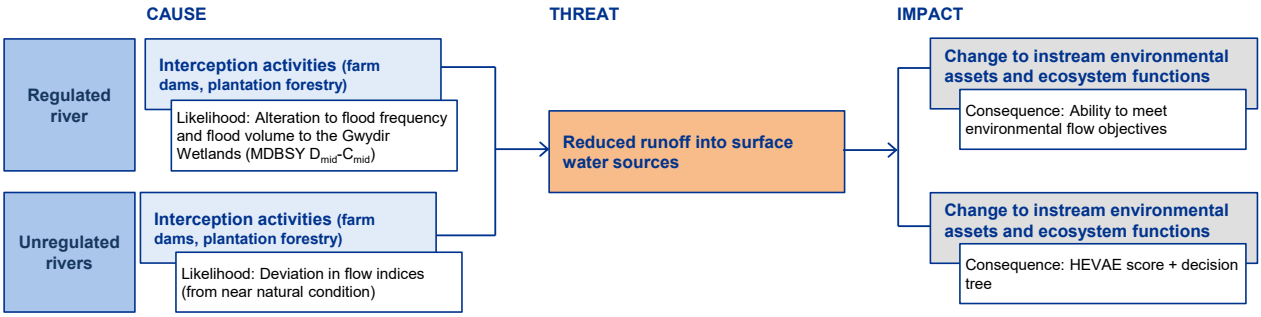


Figure 4-8 Impact pathway showing impact of interception activities on ecological functions and assets

4.5.1.1 Assigning a consequence score

4.5.1.1.1 Regulated river water source

Geoscience Australia mapped farm dams in the MDB in 2006 (in CSIRO 2008a). Satellite imagery analysis was used to detect which of the farm dams mapped using the 2004/5 imagery also existed in 1994. This mapping was used to determine growth trends over a ten year period.

The CSIRO MDBSY project (CSIRO 2008a; CSIRO 2008b) considered the impacts of climate change, increases in farm dams and plantation forests and changes in groundwater use on water resources across the MDB. In the MDBSY project, farm dams refer only to dams with their own water supply catchment and do not include those dams that store diverted (and licensed) water, as these are already included within existing river system models. A 2030 farm dam development scenario was developed by considering current distribution and storage volume, and policy controls and trends in farm dam expansion. The NSW maximum harvestable right volume was also considered.

Environmental asset – Booligal Wetlands and Great Cumbung Swamp

In assigning a consequence level to farm dams, the approach undertaken by the NSW Office of Water (NOW 2010) for the *Assessment of risk to NSW Murray–Darling Basin shared water resources* was applied in this current risk assessment. The approach used in NSW Office of Water (2010) adopted indicators that were based on information readily available in the MDBSY reports (CSIRO 2008a; CSIRO 2008b).

The MDBSY project engaged technical experts that examined assets and environmental water requirements and flow objectives required for the assets. Changes caused by the activity (including farm dams, plantation forestry and climate change) where classified according to whether they are considered critical or non-critical.

The criteria used were:

- Critical – ecosystem values associated with other flow objectives will not be maintained if this objective is not met; or
- Non-critical – ecosystem values associated with other flow objectives will be maintained, even if this flow objective is not met.

The Booligal Wetlands and Great Cumbung Swamp were assessed in the MDBSY project. Customised hydrological indicators were developed based on key parts of the hydrologic regime (SKM 2008). For the Booligal Wetlands, the hydrological indicators are based on a recommendation made in Driver et al. (2005) for the purpose of waterbird breeding. The Great Cumbung Swamp is based on a recommendation by Brady et al. (1998) for the purpose of broad-scale flooding (CSIRO 2008a) (Table 4-18 Environmental flow indicators developed in the MDBSY Project for the Booligal Wetlands and Great Cumbung Swamp (CSIRO 2008a)).

Table 4-18 Environmental flow indicators developed in the MDBSY Project for the Booligal Wetlands and Great Cumbung Swamp (CSIRO 2008a)

Environmental flow indicator	Description
Booligal wetlands	
Average period between winter–spring floods	Average period (years) between flows in excess of 2,500 ML/day at Booligal gauge for 2 months between 15 May to 15 November
Maximum period between winter–spring floods	Maximum period (years) between flows in excess of 2,500 ML/day at Booligal gauge for 2 months between 15 May to 15 November
Average winter–spring flooding volume per year	Average flow volume above 2,500 ML/day at Booligal gauge for 2 months between 15 May to 15 November per year
Average winter–spring flooding volume per event	Average flow volume above 2,500 ML/day at Booligal gauge for 2 months between 15 May to 15 November per event
Great Cumbung Swamp	
Average period between winter–spring floods	Average period (years) between flows in excess of 3,000 ML/day at Booligal gauge between 15 May to 15 November
Maximum period between winter–spring floods	Maximum period (years) between flows in excess of 3,000 ML/day at Booligal gauge between 15 May to 15 November
Average winter–spring flooding volume per year	Average flow volume above 3,000 ML/day at Booligal gauge between 15 May to 15 November per year
Average winter–spring flooding volume per event	Average flow volume above 3,000 ML/day at Booligal gauge between 15 May to 15 November per event
Reference: CSIRO (2008a)	

A consequence score was determined by assessing the ability to meet the defined environmental flow objectives under the base case of historical climate and 2004/5 water sharing arrangements and development levels (Scenario A0) (see Table 4-21).

The consequence of meeting all objectives was then classified based on level of objectives being met for the Booligal Wetlands and Great Cumbung Swamp (SKM 2008). The consequence score for this asset is negligible (Table 4-19).

Table 4-19. Consequence results for environmental assets in the Lachlan regulated water source in the Lachlan WRPA

Environmental asset	Consequence
Booligal Wetlands and Great Cumbung Swamp	Negligible
Reference: NOW (2010)	

Regulated river

The consequence scores used in the assessment of farm dam interception impacts on regulated water sources other than wetlands were determined using the HEVAE instream values listed in Table 4-2

4.5.1.1.2 Unregulated water sources

Consequence scores for the unregulated water sources were determined using the HEVAE instream value (Section 4.2) at the reach intersecting the site where likelihood was determined (Table 4-20).

Table 4-20. Consequence results for the unregulated water sources in the Lachlan WRPA

Gauging station	Consequence rating (HEVAE consequence score)
Abercrombie River @ Abercrombie	High
Abercrombie River @ Hadley No.2	Medium
Belubula River @ the Needles+	Low
Bland Creek @ Morangarell	Low
Boorowa River @ Prossers Crossing	Medium
Coombing Creek @ Near Neville	Very low
Crookwell River @ Narrawa North	Low
Flyers Creek @ Beneree	Very low
Lachlan River @ Gunning	Low
Lachlan River @ Narrawa	Low
Mandagery Creek @ u/s Eugowra (Smithfield)	Low
Pudmans Creek @ Kennys Creek Rd	Low
Rocky Bridge @ Near Neville	Low
Tuena Creek @ Tuena	Low
Wattle Creek @ Dudauman	Low
Reference: Healey et al. (2018)	

4.5.1.2 Determining the likelihood rating

4.5.1.2.1 Regulated river water source

For the purpose of determining the likelihood of farm dams intercepting runoff which would otherwise have contributed to stream flow, likelihood was calculated by the difference between two MDBSY scenarios (D_{mid} - C_{mid}) (Table 4-21). The farm dam component of this impact was estimated at 50% of the total (NOW 2010).

Table 4-21. MDBSY project scenarios

MDBSY scenario		Description
P	Modelling period standardised to 1/7/1895-30/6/2006 and all water regulation and usage removed	Estimate of natural flow regime
A	Historical climate and current development	When compared to A0 risk from current groundwater usage determined
A0	Historical climate and 2004/5 water sharing arrangements and development levels	Baseline for comparison with projected climate change and development scenarios
B	Same as A0 with future climate based on recent decade's climate	
Cdry	2nd driest of 45 estimates of future climate, and 2004/5 levels of development	When compared to A0 climate change risk determined
Cmid	Median of 45 estimates of future climate, and 2004/5 levels of development	When compared to A0 climate change risk determined

Cwet	2nd wettest of 45 estimates of future climate, and 2004/5 levels of development	When compared to A0 climate change risk determined
Ddry	Cdry with projected 2030 levels of groundwater usage, and increases in farm dams and plantation forestry	When compared to Cdry development risk (farm dams and plantations) determined When compared to A0 cumulative risk (climate change + development) determined
Dmid	Cmid with projected 2030 levels of groundwater usage, and increases in farm dams and plantation forestry	When compared to Cmid development risk (farm dams and plantations) determined When compared to A0 cumulative risk (climate change + development) determined
Dwet	Cwet with projected 2030 levels of groundwater usage, and increases in farm dams and plantation forestry	When compared to Cmid development risk (farm dams and plantations) determined When compared to A0 cumulative risk (climate change + development) determined

Likelihood metrics were adopted from SKM (2008), which developed guidelines for assessing risks to shared water resources in the Murray–Darling Basin, however it is important to note that the SKM report used a different definition of likelihood compared to how it has been defined in the rest of this risk assessment (Section 2.2).

The SKM report defined likelihood as the chance of a specified event occurring under different climate scenarios, with events being the specific flow indicators identified for a WRPA. Specified flow indicators for the Lachlan WRPA, based on flow thresholds in the Booligal wetlands and Great Cumbung Swamp, are described in Table 4-17. Likelihoods are therefore the chance that a given flow indicator would be reported under a given climate scenario (Table 4-22).

Table 4-22. Likelihood metrics selected for modelled scenarios in the Lachlan Regulated River Water Source in the Lachlan WRPA

Likelihood metric	Metric category	Probability (%)
Rare	May occur only in exceptional circumstances	<1
Unlikely	Could occur at some time	1–33
Possible	Might occur at some time	33–66
Likely	Would occur at some time	66–99
Almost Certain	Expected to occur in most circumstances	>99
Reference: SKM (2008)		

Environmental asset – Booligal Wetlands and Great Cumbung Swamp

As stated, the likelihood rating is based on the differences between the MDBSY $D_{mid} - C_{mid}$ scenario and relates to high flows (EWRs: LF2, OB1-5; Table 4-5). The likelihood rating for the Booligal Wetlands and the Great Cumbung Swamp from interception by farm dams was assessed as possible (Table 4-23).

Table 4-23. Likelihood results for modelled scenarios in the Booligal Wetlands and Great Cumbung Swamp

Environmental asset	Likelihood
Booligal Wetlands	Possible

Great Cumbung Swamp	Possible
Reference: NOW (2010)	

Regulated river

The basin-wide growth in numbers of farm dams was estimated at about 0.5-0.6% per year, with growth rates at the time higher in the north than the south (MDBA 2008). The volumetric growth rate was lower than the numerical growth rate as the newer dams are smaller on average than the dams constructed pre-1994. As the *Harvestable Rights Policy* commenced in 1999, it is likely the volumetric growth rate in the period 1994 to 1999 was higher than the period 2000 to 2004.

Estimates of inflow reductions to the entire Lachlan River catchment due to farm dams were used as likelihood ratings for the Lachlan regulated river water source (NOW 2010). These estimates were calculated at the valley scale and were used as the likelihood metric for each regulated water source (Table 4-24). The effect of farm dams on runoff is greatest on low flows and high flows (SKM et al. 2010). Low flows cannot be affected by farm dam interception because of regulation and management of BLR (see Section 4.4.1). Similarly, medium flows (i.e. bankful flows) are not impacted by farm dams (SKM et al. 2010). Therefore, the likelihood and associated risks of low and medium flows is '**low**'. The following likelihood ratings are based on inflow reduction and impacts on high flows (EWRs: LF2, OB1-5, Table 4-5).

Table 4-24 Likelihood metrics for Regulated river water sources

Likelihood metric	Metric category	Metric category definition
Flow Deviation	Very Low	< 2% reduction of inflows
	Low	< 20% reduction of inflows
	Medium	20-50% reduction of inflows
	High	> 50% reduction of inflows

In 2008 the volume of in-stream farm dams in the Lachlan valley was estimated at 261 GL (NOW 2010). The MDBSY Project estimated growth rate of 0.6% for the entire Basin was applied to the 2008 Lachlan valley estimated volume, yielding a predicted increase of 36 GL. This equates to a reduction of inflows of 1.3-1.6% to streams as a result of farm dam interception, depending on the climatic scenario adopted (NOW 2010). Furthermore, river regulation and Planned Environmental Water rules within the Lachlan Regulated WSP substantially reduce any effect of farm dams on river flows.

Based on this estimate of reduced inflows, all regulated water sources were assessed as having a very low likelihood of reduced flows due to farm dams (Table 4-25). The 'very low' likelihood rating was assigned to high flows.

Table 4-25 Likelihood results for Lachlan regulated river

Regulated river reach	Likelihood
All regulated water sources	Very Low

4.5.1.2.2 Unregulated water sources

The MDBSY Project did not assess unregulated rivers; therefore the SKM (2011) assessment of the hydrological impacts of farm dams in the MDB was used to describe likelihood. This study assessed the impact of existing farm dams at a detailed regional scale and fits into the hydrology theme of the Sustainable Rivers Audit 2 (SRA2) (Davies et al. 2012). The assessment undertook a sensitivity analysis on the results of the SRA hydrology metrics to identify those most sensitive to farm dams. Sixteen flow stress indices were calculated across 162 study catchments using catchments and flow gauges that met a set of criteria, including a record of at least 15 years of

gauged streamflow data. In this work, the reference regime assumes no direct human influence on water management (that is, with no storages or diversions in place. The current regime represents actual licensed current demands as per NSW's hydrological model at the time of the project.

The median score of every index exceeded 0.9, indicating only a small departure from reference condition, and the overall small impact due to farm dams. The three indices which showed moderate to high sensitivity to farm dams (SKM 2011) were:

- The low flow (LF) index had the greatest sensitivity to farm dams, consistent with other studies that note that farm dams tend to take a greater proportion of available flow during low flow periods (EWRs: BF1, VF1, CF1; Table 4-5);
- The annual variation index (CV) (the ratio of coefficient of variation of flow in reference and current regime) was moderately affected by farm dams, possibly because flow variability was increased as low flows are made lower by farm dams (EWRs: BF1, VF1, CF1; Table 4-5);
- The high flow (HF) index was moderately affected, possibly because farm dams can delay the onset of high flows at the start of winter in highly developed catchments (EWRs: LF1-2, OB1-5; Table 4-5).

These indices were selected as the metrics to describe the likelihood in unregulated water sources in the Lachlan WRPA.

Likelihood category definitions are defined by the extent of deviation from the near-natural condition. Likelihood results are provided in Table 4-27 for fifteen flow gauges used in the hydrological assessment (SKM 2011) that are within the Lachlan WRPA.

Table 4-26. Likelihood metrics for risk to water available for the environment in unregulated water sources due to interception

Likelihood metric	Metric category	Metric category definition
Departure of current regime from reference (near-natural) regime	Low	0.66-1.33
	Medium	0.33-0.66 or 1.33-1.66
	High	0-0.33 or 1.66-2.0
Reference: NOW (2010)		

Table 4-27. Likelihood results for risk to water for the environment in unregulated water sources in the Lachlan WRPA due to interception activities

Gauging station	Likelihood		
	CV	LF Q_{90}	HF Q_{10}
Abercrombie River @ Abercrombie	Low	Low	Low
Abercrombie River @ Hadley No.2	Low	Low	Low
Belubula River @ the Needles	Low	High	Low
Bland Creek @ Morangarell	Low	Low	Low
Boorowa River @ Prossers Crossing	Low	Low	Low
Coombing Creek @ Near Neville	Low	Low	Low
Crookwell River @ Narrawa North	Low	Medium	Low
Flyers Creek @ Beneree	Low	Medium	Low
Lachlan River @ Gunning	Low	Medium	Low

Lachlan River @ Narrawa	Low	Low	Low
Mandagery Creek @ u/s Eugowra (Smithfield)	Low	Low	Low
Pudmans Creek @ Kennys Creek Rd	Low	Low	Low
Rocky Bridge @ Near Neville	Low	Low	Low
Tuena Creek @ Tuena	Low	Low	Low
Wattle Creek @ Dudauman	Low	Low	Low

4.5.1.3 Existing water management actions and mechanisms

The current harvestable rights provisions for farm dams became official policy in 1999 prior to being included in the WMA in 2000 as a component of basic landholder rights (BLR). The harvestable rights provisions allow a maximum harvestable right dam capacity (MHRDC) for each water source, based on the average regional overland flow for the water source. The number of farm dams within a water source is permitted to grow over time, providing that the total allowed dam capacity is not exceeded. The mechanism therefore limits the total amount of water that can be intercepted in a water source, rather than the number of individual dams. Also see Section 4.4.2.

4.5.1.4 Risk outcomes

4.5.1.4.1 Regulated river water source

Environmental asset – Booligal Wetlands and Great Cumbung Swamp

As mentioned in Section 4.5.1.2, SKM (2008) used different definitions of likelihood and consequence in their assessment of environmental assets compared to the rest of this report, hence the SKM risk matrix has also been used for this section (Table 15-1 in SKM 2008). The SKM matrix has been modified by merging high and very high risks into a single 'high' category. This was done to maintain consistency with the risk mitigation strategies in the rest of this report. The adapted risk matrix is provided in Table 4-28

Table 4-28. Matrix used to determine risk outcomes of insufficient water available for the environment from potential interception activities in Lachlan Regulated River Water Source

		Likelihood of projected change				
		Rare	Unlikely	Possible	Likely	Almost Certain
Consequence (%change in water use)	Negligible	Low	Low	Low	Medium	Medium
	Minor	Low	Low	Low	Medium	High
	Moderate	Low	Low	Medium	High	High
	Major	Low	Medium	Medium	High	High
	Severe	Medium	Medium	High	High	High

Combining the risk consequence and likelihood rating (Table 4-19 and Table 4-23) results in a low overall risk level to ecological assets and functions at the Booligal Wetlands and Great Cumbung Swamp (Table 4-29).

Table 4-29 Risks of insufficient water available for the environment in the Booligal Wetlands and Great Cumbung Swamp as a result of growth in interception by farm dams [E(I-FD)]

Environmental asset	Consequence	Likelihood	Risk level – E(I-FD)
Booligal Wetlands	Minor	Possible	Low
Great Cumbung Swamp	Minor	Possible	Low
Reference: NOW (2010)			

Regulated rivers

The risk matrix used to determine the risk rating of flow alteration from an increase in farm dams intercepting runoff and impacting the availability of water for the environment in the Lachlan regulated river water sources is provided in Table 4-30.

Table 4-30. Matrix used to determine risk outcomes of insufficient water available for the environment from potential interception activities in Lachlan Regulated River Water Source

		Likelihood (reduction of inflows)			
		Very Low	Low	Medium	High
Consequence (HEVAE consequence score)	Very Low	Low	Low	Low	Low
	Low	Low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Low	Medium	High
	Very High	Low	Medium	High	High

Combining the risk consequence and likelihood ratings results in a low risk level to ecological assets and functions in regulated water sources in the Lachlan Surface WRPA from interception due to farm dams (Table 4-31).

Table 4-31. Risks of insufficient water available for the environment in the regulated Lachlan River as a result of growth in interception by farm dams [E(I-FD)]

Water source	Consequence		Likelihood	Risk level - E(I-FD)
Regulated rivers	Medium – Very High		Very Low	Low

4.5.1.4.2 Unregulated water sources

The risk matrix used to determine the risk rating of flow alteration from an increase in farm dams intercepting runoff and impacting the availability of water for the environment in the Lachlan unregulated water sources is provided in Table 4-32.

Table 4-32. Matrix used to determine risk outcomes of insufficient water available for the environment from potential interception activities in unregulated water sources in the Lachlan WRPA

	Likelihood – current farm dam development		
	Low Departure from reference: 0.66-1.33	Medium Departure from reference: 0.33-0.66 or 1.33-1.66	High Departure from reference: 0-0.33 or 1.66-2.0

Consequence (HEVAE)				
	Very Low	Low	Low	Low
	Low	Low	Low	Medium
	Medium	Low	Medium	High
	High	Low	Medium	High
	Very High	Medium	High	High

Combining the risk consequence and likelihood ratings (Table 4-20 and Table 4-27) results in a low risk level to ecological assets and functions in the majority of unregulated water sources in the Lachlan WRPA (Table 4-33) from interception due to farm dams. Belubula River at the Needles has a medium risk to low flows due to farm dams.

Table 4-33. Risks of insufficient water available for the environment in unregulated water sources in the Lachlan WRPA as a result of growth in interception by farm dams [E(I-FD)]

Gauging station	Consequence *	Likelihood			Risk level – E(I-FD)		
		CV	LF Q_{90}	HF Q_{10}	CV	LF Q_{90}	HF Q_{10}
Abercrombie River @ Abercrombie	High	Low	Low	Low	Low	Low	Low
Abercrombie River @ Hadley No.2	Medium	Low	Low	Low	Low	Low	Low
Belubula River @ the Needles+	Low	Low	High	Low	Low	Medium	Low
Bland Creek @ Morangarell	Low	Low	Low	Low	Low	Low	Low
Boorowa River @ Prossers Crossing	Medium	Low	Low	Low	Low	Low	Low
Coombing Creek @ Near Neville	Very low	Low	Low	Low	Low	Low	Low
Crookwell River @ Narrawa North	Low	Low	Medium	Low	Low	Low	Low
Flyers Creek @ Beneree	Very low	Low	Medium	Low	Low	Low	Low
Lachlan River @ Gunning	Low	Low	Medium	Low	Low	Low	Low
Lachlan River @ Narrawa	Low	Low	Low	Low	Low	Low	Low
Mandagery Creek @ u/s Eugowra	Low	Low	Low	Low	Low	Low	Low
Pudmans Creek @ Kennys Creek Rd	Low	Low	Low	Low	Low	Low	Low
Rocky Bridge @ Near Neville	Low	Low	Low	Low	Low	Low	Low
Tuena Creek @ Tuena	Low	Low	Low	Low	Low	Low	Low
Wattle Creek @ Dudauman	Low	Low	Low	Low	Low	Low	Low

CV = variation index annual; HF Q_{10} = high flow index; LF Q_{90} = low flow index

* HEVAE instream value at the same location

4.5.2 Commercial plantations [E(I-PF)]

Plantation forestry is an increasingly important land use in Australia (ABS 2010). Although plantation forestry can contribute both commercial and environmental benefits, land use change to plantations can have an impact on catchment hydrology (SMEC 2010).

In the long-term, water yield from a catchment, including streamflow and groundwater recharge, is the difference between rainfall and evapotranspiration, assuming no net change in soil water storage in the catchment. Consequently, any change in evapotranspiration will translate directly to a change in catchment yield. For example, if a large number of trees are removed from a

catchment, total evapotranspiration will be reduced and this may cause the water table to rise, leading to increased water yield. Conversely large plantations will increase evapotranspiration and therefore reduce water yield (SMEC 2010).

Afforestation is defined as the large-scale planting of trees for timber production, carbon offsetting, land conservation or other environmental purposes.

For this assessment only commercial plantations have been considered as there is no reliable regional or national data available on other types of tree plantings.

The planting of trees for timber production can be broadly classified as:

- Softwood forest plantations – stands of softwood trees for commercial production using various species of pines (including Radiata pine). Rotation lengths are typically 25-35 years
- Hardwood forestry plantations – stands of hardwood trees for commercial production typically on a short rotation (i.e. 10-15 years). The species used varies across the MDB.

As part of the MDBSY Project (CSIRO 2008a), a 2030 scenario for commercial forestry plantations for the MDB was developed using regional projections from the Bureau of Rural Sciences which takes into account trends, policies and industry feedbacks. The increase in commercial forestry plantations is distributed to areas adjacent to existing plantations (which are not natural forest land use) to project likely growth.

The Bureau of Rural Sciences projected negligible growth in commercial forestry plantations in the Lachlan region. Therefore no growth in plantation forestry was included in the modelling completed for the MDBSY Project in the Lachlan (CSIRO 2008a).

Consequence and likelihood were calculated as per methods detailed for interception from farm dams. Additionally in the calculation of the likelihood score for interception from plantations, estimates on the proportion of interception were based on advice from the industry for future demands might be (NOW 2010). In the Lachlan advice provided to the MDBSY Project for future demands were estimated as zero.

Where there is no projected growth in commercial plantations there is no pathway for additional future impact and therefore this risk has not been assessed.

There is no available information on the effects of plantation forests on different parts of the flow regime. Therefore, the likelihood and associated risks equally assess all components of the flow regime.

Growth in plantation forestry may reduce the water available for the environment, as shown in the impact pathway below Figure 4-9).

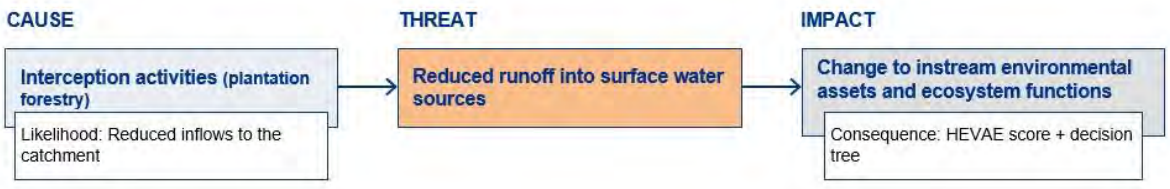


Figure 4-9. Impact pathway showing risk of growth in plantation forests reducing water available for the environment

4.5.2.1 Assigning a consequence score

The consequence scores used in the assessment of the impact of plantation forests on regulated and unregulated water sources were determined using the HEVAE instream values listed in Table 4-2 and Table 4-3.

4.5.2.2 Determining the likelihood rating

The Bureau of Rural Sciences projected negligible growth in commercial forestry plantations in the Lachlan region. Therefore no growth in plantation forestry was included in the modelling completed for the MDBSY Project in the Lachlan (CSIRO 2007).

Where there is no projected growth in commercial plantations there is no pathway for additional future impact, and a 'nil' category was assigned to both regulated and unregulated water sources (Table 4-34 and Table 4-35).

4.5.2.3 Existing water management actions & mechanisms

The NSW regulatory approach including compliance to plantation forests is described in DWE (2008). Compliance with the NSW *Plantations and Reafforestation Act 1999* (PRA) is considered to be high as it provides a basis for legal harvesting. The PRA and regulations exclude the consideration of water impacts from the assessment process. However scope for amending the PRA will be considered as part of NSW response to its interception obligations under the NWI and COAG Water Reform agenda.

4.5.2.4 Risk outcomes

The risk matrix used to determine the risk of commercial plantations impacting the availability of water to the environment in the regulated and unregulated water sources in the Lachlan Surface WRPA is provided in Table 4-35.

Table 4-34. Risk matrix to determine risk outcomes of increased commercial plantations impacting on water available for the environment

		Likelihood (commercial plantations reducing flow)			
		Nil	Low	Medium	High
Consequence (HEVAE consequence score)	Very Low	Nil	Low	Low	Low
	Low	Nil	Low	Low	Medium
	Medium	Nil	Low	Medium	High
	High	Nil	Low	Medium	High
	Very High	Nil	Medium	High	High

Combining the risk consequence (Table 4-2 and Table 4-3) and the likelihood rating of 'nil', the overall risk levels to ecological assets and functions have been assessed as 'Nil' (Table 4-35).

Table 4-35. Risks of insufficient water available for the environment in regulated and unregulated water sources in the Lachlan Surface WRPA as a result of plantation forests [E(I-PF)]

	Consequence	Likelihood	Overall risk rating - E(I-PF)
Regulated river water sources	Medium – Very High	Nil	Nil
Unregulated river water sources	Low – Very High	Nil	Nil

4.5.3 Mining [E(I-M)]

This section considers the potential for impacts from growth in mining reducing the availability and quality of surface water for the environment.

Mining activities in the Lachlan catchment currently comprise of less than one percent of the total catchment area (ABS 2010). There are currently five operating mines extracting gold, copper and silver at Lake Cowal, North Parkes, Ridgeway, Cadia and Cadia East (Australian

Mining 2015; NSW DPE 2019). There are no coal mines operating in the Lachlan catchment. No commercial coal seam gas extraction has occurred or is currently occurring in the Lachlan catchment.

Mining may cause water quality degradation in surface and groundwater sources through both point and diffuse sources. Under the Water Act 2007 subsections 22(9)-(12) the Basin Plan does not regulate land use, management of natural resources that are not water, or the control of pollution. As such, strategies to mitigate the likelihood of this risk fall outside the scope of the water resource plan, the water quality management plan and this risk assessment.

NSW does accept there is potential for this risk to occur and has legislated controls in place to manage both the likelihood and consequences of this risk (see Section 4.5.3.1).

Mining activities may impact on water quantity and quality for the environment, as shown in the pathway below (Figure 4-10).

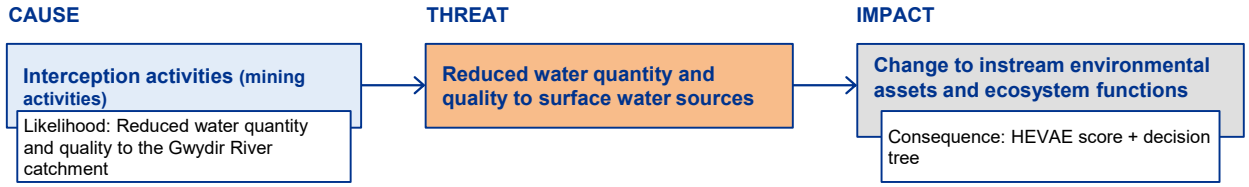


Figure 4-10. Impact pathway showing risk of mining activities reducing water quantity and quantity for the environment

4.5.3.1 Existing water management actions & mechanisms

Access licences under the WMA 2000 must be obtained for any impacts on the quantity of water in immediate or nearby water sources. In most of the Basin, these must be obtained via the market. As such, mining activities cannot increase water use and reduce water available for the environment. The NSW *Aquifer Interference Policy* (AI Policy) details the water licensing and impact assessment processes for aquifer interference activities under the *Water Management Act 2000* and other relevant legislation. The assessment criteria are called 'minimal impact considerations' and include impacts on surface water systems, connected alluvial aquifers, various groundwater impacts and water-dependent assets. Thresholds are set in the Policy so that the impacts of both an individual activity and the cumulative impacts of a number of activities within each water source can be considered.

In NSW, the planning approval processes for mining currently mitigates against water quality impacts. The impacts of mining and coal seam gas activities (and other mining activities) are assessed under the *Environmental Planning and Assessment Act 1979*. If approved, these developments are conditioned to mitigate impacts on water and related resources. As part of the development approval process, proponents must assess not only their process requirements for water take, but also the impact the activity may have on the quantity and quality of water in all water sources.

Furthermore, the *Protection of the Environment Operations Act 1997* and the *Protection of the Environment Operations Act 1997* (POEO Act) the Environment Protection Authority (EPA) uses environment protection licences to regulate the activities to avoid and minimise harm caused by water pollution both at the site level, and cumulatively. Therefore, these legislative arrangements result in a '**low**' risk for water quality impacts due to mining.

4.5.3.2 Risk outcomes

Because of the legislative and licencing arrangements controlling water quantity impacts from mining, there is no pathway for this impact to occur, and a '**nil**' risk category was assigned to both regulated and unregulated water sources. This risk rating applies to all components of the flow regime.

The legislative arrangements managing water quality impacts due to mining result in a '**low**' risk.

Although there is some potential new mining identified by an examination of the MinView website (NSW DPE, 2019), on a WRPA scale this is considered to be of low significance. Therefore, the risk of mining causing impacts to structural integrity that lead to reduced surface water for the environment is '**low**'. Note that risks to the structural integrity of groundwater systems are assessed as part of the *Lachlan Alluvium Risk Assessment.*.

Table 4-36. Risks of insufficient water available for the environment in regulated and unregulated water sources in the Lachlan Surface WRPA as a result of mining activities [E(I-M)]

Risk	Water source type	Overall risk rating - E(I-M)
Reduced water quantity	Regulated river water source	Nil
	Unregulated river water sources	Nil
Poor water quality	Regulated river water sources	Low
	Unregulated river water sources	Low
Structural integrity	Regulated river water sources	Low
	Unregulated river water sources	Low

4.5.4 Floodplain harvesting [E(I-FH)]

The unconstrained harvesting of water from floodplains reduces the amount of water reaching or returning to rivers. This decreases the amount of water available to meet downstream river health and wetland and floodplain needs. Floodplain harvesting can affect the connectivity between the local floodplain wetlands and the river through the loss of flow volume and the redirection of flood flows. The impact pathway for floodplain harvesting is shown in Figure 4-11.

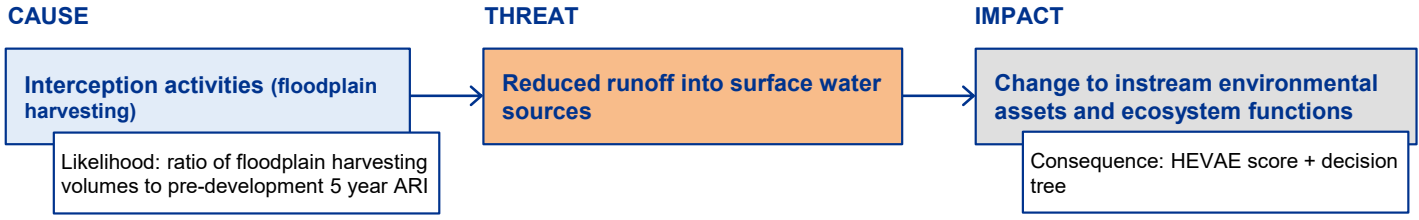


Figure 4-11. Impact pathway showing risk of growth in floodplain harvesting reducing water available for the environment

4.5.4.1 Assigning a consequence score

The consequence scores used in the assessment of the impact of floodplain harvesting on ecological assets and functions within regulated and unregulated water sources were determined using the HEVAE instream values listed in Table 4-2 and Table 4-3. However, because the total volume floodplain harvesting (likelihood) was assessed at the WRP area scale (see below), and the consequence scores for the water sources ranged from 'low' to 'very high', a 'very high' consequence was used in determining the risk outcomes. In addition, there are significant floodplain wetlands (Booligal Wetlands and Great Cumbung Swamp) that could be impacted by floodplain harvesting, hence the adoption of a 'very high' consequence score. The 'very high' consequence score also ensures that a conservative estimate of risk is undertaken.

4.5.4.2 Determining the likelihood rating

The likelihood metrics are defined in Table 4-37. No interim modelling is available for floodplain harvesting in the Southern Basin including the Lachlan WRPA so the following is a qualitative assessment based upon expert opinion. There is no material floodplain harvesting activity occurring in the Lachlan WRPA and no entitlements are expected to be issued through the Healthy Floodplains program. The landscape does not lend itself to the infrastructure required for floodplain harvesting. In any case, it is intended that any new floodplain harvesting activity

will be treated as illegal take and subject to compliance actions where appropriate. Therefore we have defined the likelihood as '**Nil'.**

Table 4-37. Likelihood metrics for floodplain harvesting

Likelihood metric	Metric category	Metric category definition
Flow Deviation	Low	< 20% FPH volume / volume of 5 year ARI
	Medium	20-50% FPH volume / volume of 5 year ARI
	High	> 50% FPH volume / volume of 5 year ARI

4.5.4.3 Existing water management actions and mechanisms

Floodplain harvesting is identified in the Basin Plan as a potential interception activity. In NSW, the Floodplain Harvesting Policy and Healthy Floodplains Projects are converting this form of historical take into a licensable right in the Northern Basin. As no historical floodplain harvesting has been identified in the Lachlan WRPA there is no need to apply the Floodplain Harvesting Policy and issue licenses under the Healthy Floodplains Project. Any new floodplain harvesting of water is likely to be treated as illegal take and compliance actions taken where appropriate.

4.5.4.4 Risk outcomes

Floodplain harvesting can only affect medium to high flows (i.e. overbank flows) and there is no pathway for lower flows to be impacted and thus is considered to be '**nil**' risk. The following risk outcomes pertain to the medium and high flows only.

The risk matrix used to determine the risk of floodplain harvesting activities impacting the availability of water to the environment in the Lachlan Surface WRPA is provided in Table 4-10.

Table 4-38. Risks of insufficient water available for the environment in regulated and unregulated water sources in the Lachlan Surface WRPA as a result of floodplain harvesting activities [E(I-FH)]

	Consequence	Likelihood	Overall risk rating - E(I-FH)
Lachlan River water sources	Very High	Nil	Nil

4.6 Risk to water available for the environment due to climate change [E(CC)]

There has been a sustained and statistically unambiguous increase in mean temperatures across the MDB. Increases in mean annual temperature tend to be slightly greater (more than 0.2˚C per decade) in the northern parts of the Basin and lower (less than 0.1˚C per decade) in the southeast. There is also some evidence that warming is greater at higher elevation than at lower elevation (Van Dijk et al. 2006).

The impacts of climate change by 2030 are uncertain; however, surface water availability across the entire Basin is more likely to decline than increase (Van Dijk et al. 2006).

Change in climate across the Basin is likely to result in:

- Greater annual variability in rainfall and the intensity of rainfall events
- Change in regional and seasonal rainfall patterns
- Changes to the flow regime
- Change in water security

- Altered water quality and the health of rivers, environmental assets and ecosystem functions over time
- Potential increases in evaporation.

The impact pathway is shown in Figure 4-12. and demonstrates how change in climate can alter patterns and volumes of surface runoff impacting water availability for the environment in the Lachlan WRPA. The likelihood is described by changes in flow indices while the consequence is assessed as the loss of annual water diversions for environmental entitlements.

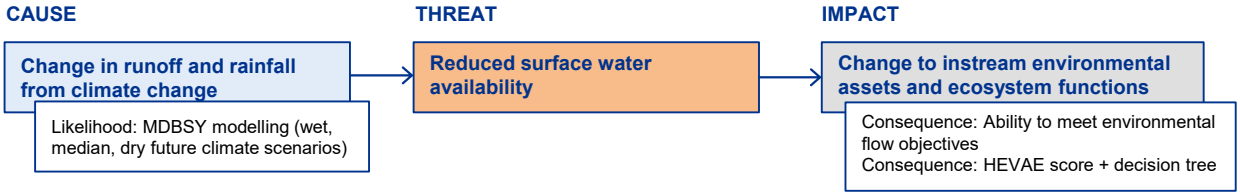


Figure 4-12. Impact pathway showing how change in climate can impact on the availability of water for the environment

4.6.1 Assigning a consequence rating

4.6.1.1 Regulated river water source

Environmental asset – Booligal Wetlands and great Cumbung Swamp

The MDBSY Project (CSIRO 2008a; CSIRO 2008b) considered the impacts of climate change on water resources across the Murray–Darling Basin. A range of likely climate conditions at the year 2030 was assessed by analysing three global warming scenarios in 15 global climate models (GCM) to provide a spectrum of 45 climate variants. The method also took into account overall changes in total runoff for a dry, median and wet climate change scenarios (scenario type C), these were compared to scenario A0 (Table 4-21) (NOW 2010).

As noted in Section 4.5.1.1, the environmental assets assessed in the MDBSY Project were the Booligal Wetlands and Great Cumbung Swamp along the lower Lachlan River. The consequence scores for this asset are provided below (Table 4-39). Consequence levels were defined by the magnitude of change and were set by experienced consultants at levels considered to be 'reasonable'.

Table 4-39. Consequence results for environmental assets receiving flows from the Lachlan regulated river in the Lachlan WRPA

Environmental asset	Consequence		
	Dry climate change scenario	Median climate change scenario	Wet climate change scenario
Booligal Wetlands	Severe	Moderate	Negligible
Great Cumbung Swamp	Severe	Moderate	Negligible

Regulated rivers

The consequence scores used in the assessment of climate change impacts on regulated water sources were determined using the HEVAE instream values listed in Table 4-2.

4.6.1.2 Unregulated water sources

The consequence scores used in the assessment of climate change impacts on regulated water sources were determined using the HEVAE instream values listed in Table 4-3.

4.6.2 Determining the likelihood rating

4.6.2.1 Regulated river water source

Environmental asset – Booligal Wetlands and great Cumbung Swamp

As discussed earlier in Section 4.5.1.2, customised hydrological indicators were developed in the MDBSY Project for the Booligal Wetlands and Great Cumbung Swamp (CSIRO 2008a). Comparing MDBSY Project C scenarios to the 2004/05 (A0 scenario) determines likelihood of climate change impacting water available for the environment under the three different climate projections (wet, dry, median) (Table 4-40). Likelihood rankings are provided in Table 4-41. Also as discussed in Section 4.5.1.2, likelihood rankings were adapted from the SKM (2008) guidelines for assessing risks to shared water resources in the Murray–Darling Basin (Table 4-41) which defined likelihood differently to how it has been defined in the majority of this risk assessment (Section 2.2). This likelihood assessment applies to high flows (EWRs: LF2, OB1-5; Table 4-5).

Table 4-40. Data used to assess risk likelihood to the Booligal Wetlands and Great Cumbung Swamp from change in climate (CSIRO 2008a)

Environmental flow indicator	A0	C_{dry} (% change from A0)	C_{mid} (% change from A0)	C_{wet} (% change from A0)
Booligal – Average period between winter–spring floods	8.3 yrs	87%	24%	-21%
Booligal – Maximum period between winter–spring floods	22.2 yrs	47%	0%	-16%
Booligal – Average winter–spring flooding volume per year	40.7 GL	-51%	-21%	20%
Booligal – Average winter–spring flooding volume per event	376 GL	-2%	5%	-4%
Cumbung – Average period between winter-spring floods	2.5 yrs	131%	24%	-11%
Cumbung – Maximum period between winter-spring floods	16 yrs	39%	16%	0%
Cumbung – Average winter–spring flooding volume per year	47 GL	-56%	-23%	11%
Cumbung – Average winter–spring flooding volume per event	124 GL	3%	-4%	-1%
Reference: CSIRO 2008a				
A0: historical climate, 2004/2005 level of development and water management arrangements C_{dry}: 2004/2005 levels of development; dry climate change projections for 2030 C_{mid}: 2004/2005 levels of development; median climate change projections for 2030 C_{wet}: 2004/2005 levels of development; wet climate change projections for 2030				

Table 4-41. Likelihood results for environmental assets receiving flows from the Lachlan regulated river in the Lachlan WRPA

Environmental asset	Likelihood		
	Dry climate change scenario	Median climate change scenario	Wet climate change scenario
Booligal Wetlands	Likely	Possible	Unlikely
Great Cumbung Swamp	Likely	Possible	Unlikely

Regulated rivers

In the Lachlan River valley, there was no direct assessment of climate change impacts on surface water flows in the regulated river other than for the Boolial Wetlands and Great Cumbung Swamp (NOW 2010). Therefore, the three climate change scenarios (dry, median, wet) were used to define likelihood ratings (Table 4-42 and Table 4-43). The C_{Dry} scenario was used to define the likelihood rating and a 'medium' likelihood category was assigned to all water sources. There is no detailed information on the effects of climate change on different parts of the flow regime. Therefore, the 'medium' likelihood and associated risks equally assess all components of the flow regime (all EWRs; Table 4-5.

Table 4-42. Impacts of climate change scenarios on mean annual runoff and rainfall

Scenario	Change to mean annual rainfall (%)	Change to mean annual runoff (%)
C_{dry}	-17	-34
C_{mid}	-4	-10
C_{wet}	+8	+17

According to the MDBSY Project (CSIRO 2008a), wet scenario climate change is predicted to increase mean annual runoff by 17%, but there is a predicted 34% and 10% reduction in runoff for the dry and median climate change scenarios, respectively.

Table 4-43. Likelihood metrics for climate change impacts on surface water

Likelihood metric	Metric category	Metric category definition
Change to mean annual runoff (%)	Low	< 20% reduction in runoff
	Medium	20-50% reduction in runoff
	High	> 50% reduction in runoff

4.6.2.2 Unregulated water sources

Similar to the regulated rivers, the three climate change scenarios were used to define likelihood ratings. To determine the highest potential risk to the environment from surface water reductions due to climate change, the C_{Dry} scenario was used to define the likelihood rating and a 'medium' likelihood category was assigned to all water sources. The 'medium' likelihood applies to all components of the flow regime (all EWRs; Table 4-5).

4.6.3 Existing water management actions and mechanisms

The WSPs for NSW MDB catchments were developed in consultation with community stakeholders, and are applicable for 10 year periods. The WSPs are designed to share the available water on both a daily and longer term basis for the full range of known (historical) climate variability. There is provision in the *Water Management Act 2000* (WMA) to suspend WSPs. In extreme climatic circumstances, prescriptive sharing rules cannot allow for real-time management of transmission losses, understanding of antecedent and forecast conditions and competing user requirements. This WMA provision has been invoked in NSW MDB valleys where actual climatic conditions have occurred outside the range of prior climate variability.

4.6.4 Risk outcomes

4.6.4.1 Regulated river water source

The impact of the three climate scenarios (i.e. dry, median, and wet) on rainfall varied according to season. Rainfall increased in summer and decreased in spring and winter, with little impact in autumn (NOW 2010).

Individually, these are considered small changes in rainfall, but when combined with potential evapotranspiration rates, the seasonal runoff changes are magnified, with higher summer runoff offset by lower runoff for the other seasons (NOW 2010).

Environmental asset – Booligal Wetlands and great Cumbung Swamp

As mentioned in Section 4.5.1.2, the risk matrix used to determine the risk rating of flow alteration from change in climate impacting the availability of water for the environment in the Lachlan valley is adapted from SKM (2008) with high and very high risks merged into a single 'high' category. This was done to maintain consistency with the risk mitigation strategies in the rest of this report. The risk matrix used to determine the risk rating of flow alteration from change in climate impacting the availability of water for the environment in the Booligal Wetlands and Great cumbungi Swamp is provided in Table 4-44.

Table 4-44. Matrix used to determine risk of insufficient water available for the environment from potential change in climate

		Likelihood of insufficient water availability				
		Rare	Unlikely	Possible	Likely	Almost Certain
Consequence (%change in water use)	Negligible	Low	Low	Low	Medium	Medium
	Minor	Low	Low	Low	Medium	High
	Moderate	Low	Low	Medium	High	High
	Major	Low	Medium	Medium	High	High
	Severe	Medium	Medium	High	High	High

Combining the risk consequence and likelihood ratings (Table 4-39 and Table 4-41) results in the overall risk levels to the ecological assets and functions at the Booligal Wetlands and Great Cumbung Swamp, as shown in Table 4-45. The risk assessment determined a low risk from the wet scenario. Under a medium climate change scenario, these areas are at medium risk of a reduction in inflows and in a dry scenario a high risk.

Table 4-45. Risks of insufficient water available for the environment in the Booligal Wetlands and Great Cumbung Swamp as a result of change in climate [E(CC)]

Environmental asset	Consequence	Likelihood	Risk level – E(CC)
Wet climate change scenario	Negligible	Unlikely	Low
Median climate change scenario	Moderate	Possible	Medium
Dry climate change scenario	Severe	Likely	High

Regulated rivers

The risk matrix used to determine the risk rating of flow alteration from change in climate impacting the availability of water for the environment is provided in Table 4-46.

Table 4-46. Risk matrix to determine risk outcomes of insufficient water for the environment from potential change in climate in regulated and unregulated rivers

		Likelihood (of reduction in runoff)		
		Low	Medium	High
Consequence	Very Low	Low	Low	Low

	Low	Low	Low	Medium
	Medium	Low	Medium	High
	High	Low	Medium	High
	Very High	Medium	High	High

Combining the risk consequence (Table 4-2) and 'medium' likelihood ratings resulted in 'High' and 'Medium" risk levels to all regulated river reaches (Table 4-47).

Table 4-47. Risks of insufficient water available for the environment in regulated river sections in the Lachlan Surface WRPA as a result of climate change [E(CC)]

Regulated river reach	Consequence	Likelihood	Overall risk rating - E(CC)
Lachlan @ Wyangala Dam	Medium	Medium	Medium
Lachlan @ Jemalong Weir	Very high	Medium	High
Lachlan @ Willandra Weir	Very high	Medium	High
Lachlan @ Booligal Weir	High	Medium	Medium
Willandra Creek flow node	High	Medium	Medium
Belubula River @ Carcoar	High	Medium	Medium
Belubula River @ Helensholme	High	Medium	Medium

4.6.4.2 Unregulated water sources

The risk matrix used to determine the risk rating of flow alteration from change in climate impacting the availability of water for the environment is provided in Table 4-46.

Combining the unregulated risk consequence (Table 4-3) and 'medium' likelihood ratings resulted in the majority (12) of water sources having '**Medium'** risk ratings, one with a 'High' rating and the remainder a 'Low' rating (Table 4-48).

Table 4-48. Risks of insufficient water available for the environment in unregulated river sections in the Lachlan Surface WRPA as a result of climate change [E(CC)]

Unregulated water source	Consequence	Likelihood	Overall risk rating – E(CC)
Abercrombie R above Wyangala	High	Medium	Medium
Belubula R above Carcoar Dam	Low	Medium	Low
Belubula Tributaries below Carcoar Dam	Medium	Medium	Medium
Bogandillon and Manna Creeks	Medium	Medium	Medium
Boorowa River and Hovells Creek	Medium	Medium	Medium
Burrangong Creek	Low	Medium	Low
Crookwell River	High	Medium	Medium

Unregulated water source	Consequence	Likelihood	Overall risk rating – E(CC)
Crowther Creek	Medium	Medium	Medium
Goobang and Billabong Creeks	Medium	Medium	Medium
Goonigal and Kangarooby Creeks	Low	Medium	Low
Gunningbland and Yarrabandai	Low	Medium	Low
Humbug Creek	Low	Medium	Low
Lachlan River above Reids Flat	Very high	Medium	High
Lake Forbes and Back Yamma Creek	Low	Medium	Low
Mandagery Creek	High	Medium	Medium
Mid Lachlan Unreg	High	Medium	Medium
Mount Hope Area	Low	Medium	Low
Naradhan Area	Low	Medium	Low
Ooma Creek and Tributaries	Low	Medium	Low
Tyagong Creek	Low	Medium	Low
Unreg Effluent Creeks	Medium	Medium	Medium
Waugoola Creek	Medium	Medium	Medium
Western Bland Creek	Medium	Medium	Medium

5 Risk to environmental assets and functions from pest plants and animals

The main strategies to mitigate the likelihood of impact from freshwater pest species risk fall outside the scope of the water resource plan, the water quality management plan and this risk assessment. In NSW, the *Biosecurity Act 2015* and the *Biodiversity Conservation Act 2016* provide a number of controls to manage aquatic pests. In addition, the environmental flows rules of the Lachlan and Belubula Regulated WSPs and the Lachlan Unregulated WSP described in section 4.2 of the Lachlan Surface Water Resource Plan will also assist in mitigating the impacts of pest species. The following is a qualitative assessment based on Department of Planning and Environment ecohydrology specialist expert opinion. There are potential risks to environmental assets and functions in the Lachlan Surface WRP from pest plants and animals. In particular, pest plants, such as willows, and pest animals, such as carp, have the potential to pose significant threats to the condition of water resources. Willow can lead to seasonal increases in biological oxygen demand and decreases in dissolved oxygen levels. Invasive species such as carp can increase turbidity in stream systems, while trout can predate on native fish species. The Murray-Darling system has a high proportion of alien species (~21%) and make up approximately 70% of fish numbers and up to 80-90% of the fish biomass (Lintermans 2009).

Due to the uncertainties of the exact location and nature of impacts form pest species, risk was assessed at the WRP spatial scale. The likelihood of pest species impacting on ecological assets and functions within the Lachlan Surface WRP area was 'medium', and the consequence of the impact from pest species was 'medium'. Using the risk matrix Table 4-10, the overall risk rating was '**medium**' (Table 5-1).

Table 5-1. Risk to environmental assets and functions within the Lachlan Surface WRPA due to pest plants and animals

	Consequence	Likelihood	Overall risk rating
Lachlan Surface WRP area water sources	Medium	Medium	Medium

6 Risks to health of water-dependent ecosystems from poor water quality [E(WQ)]

6.1 Background

Water quality is an important driver of ecological processes and determines the overall condition of a waterway. Physical and chemical parameters such as temperature, pH, electrical conductivity, nutrients, turbidity and dissolved oxygen affect the biology and ecology of aquatic organisms, especially when outside tolerable levels (Watson et al. 2009).

The Basin Plan requires that a WRP must include a water quality management plan (WQM Plan). A separate water quality management plan for the Lachlan has been prepared to meet the requirements of the Basin Plan. The water quality management plan is supported by a number of other documents including:

- Incident response guide for the Lachlan water resource plan (SW10)
- Salinity technical report for the Lachlan water resource plan area (SW10)
- Water quality technical report for the Lachlan water resource plan area (SW10)

Water quality problems occurring within the Lachlan catchment are mostly caused by a combination of alteration to natural flow regimes and land use change (DPI Water 2016). There are a number of causes and threats that will impact the health of water-dependent ecosystems. In the NSW MDB, the types of water quality degradation include:

- Water temperatures outside natural temperature range
- Elevated levels of nutrients and suspended sediments
- Dissolved oxygen and pH outside of natural ranges
- Elevated levels of instream salinity.

These impacts could all lead to the alteration of instream ecological functions and reductions in the condition of ecological assets. Risks arising from elevated levels of salinity or other types of water quality degradation to the condition and continued availability of water resources have been assessed below. The risk pathways for considering potential impacts of poor water quality on water-dependent ecosystems are provided in the following sections.

Under the *Water Act* 2007 subsections 22(9)-(12), the Basin Plan does not regulate land use, management of natural resources that are not water, or the control of pollution. As such, strategies to mitigate the impacts to water-dependent ecosystems from pathogens, pesticides, heavy metals and other toxic contaminants fall outside the scope of the water resource plan, the water quality management plan and this risk assessment.

NSW does accept there is potential for this risk to occur and has legislated controls in place to manage both the likelihood and consequences of the risk.

6.2 Existing water management actions and mechanisms

Under the WMA a key principle sets a requirement that water quality of all water sources should be protected and, wherever possible, enhanced. Key objectives within the WSPs also relate to the maintenance of water quality.

There are a suite of rules within the WSPs that assist in protecting and maintaining water quality within the valley. Under the current water sharing plan there are restrictions on drawdowns on in-river and off-river pools when the volume of water is less than full capacity of the pool. Cease to pump rules and commence to pump rules also reduce the pressure on pools by extraction of water. During these low flow periods and as pools contract, water quality can deteriorate, algal blooms occur, dissolved oxygen levels decline. Restricting the extraction pressure on these systems helps protect water quality.

There are also rules in the regulated system that benefits water quality. These rules include:

- Reserve all water above the long term average annual extraction limit for planned environmental water. This helps maintain base flows which are important to slow the decline in water quality by preventing pools from stratifying and stagnating
- The protection of small freshes is important for flushing and turning over stratified pools. There are rules to allow the passing of some inflows through Wyangala Dam (called 'translucent' releases) and prohibiting the extraction of some tributary inflows, or the diversion of flows into Lake Brewster or Lake Cargelligo to improve lower system flows and winter/spring variability
- To reserve water in Wyangala Dam to the limit of 20,000 ML to strategically use for water quality management purposes
- To provide for specified replenishment flows that refill pools or waterholes in effluent systems downstream of a water source and provide water for stock and domestic purposes
- The plans also provide for licensed water to be committed for adaptive environmental water purposes.

Further details can be found in the Lachlan water quality management plan and supporting technical reports.

6.3 Risks due to water temperature outside natural ranges

The Basin Plan identifies water temperature outside natural ranges as one type of water quality degradation in the MDB (Schedule 10). One cause of water temperature below natural ranges is the release of stored water from below the thermocline from large water storages in spring, summer and autumn. Release of stored water during winter may cause water temperature above natural ranges, as well as the removal of shading riparian vegetation and reduced flows.

Schedule 11 of the Basin Plan identifies target temperatures (monthly median) within the range of the 20th and 80th percentiles of natural monthly water temperature. Natural monthly temperature has not been specified for the Lachlan WRPA.

This risk assessment focuses on cold water pollution (CWP) (see Preece 2004 *Cold water pollution below dams in NSW)*, and warm water pollution (WWP). Wyangala Dam on the Lachlan River and Carcoar Dam on the Belubula River are the two large storages located in the Lachlan WRPA. The risk from CWP and WWP is relevant to the regulated rivers only.

Water temperature influences many biological and ecosystem processes. The release of cold water from Wyangala Dam in the regulated Lachlan River can impact on ecosystem function and condition by causing temperature depression in the mid-Lachlan regulated river. Releases from Carcoar Dam during summer can result in localised cold water impacts in the Belubula River downstream of the dam. Warmer temperatures can increase growth rates and metabolism of in-stream plants, animals and algae. Temperature influences spawning, breeding and migration patterns of many aquatic animals.

The impact pathway for CWP and WWP is shown in Figure 6-1and Figure 6-2.

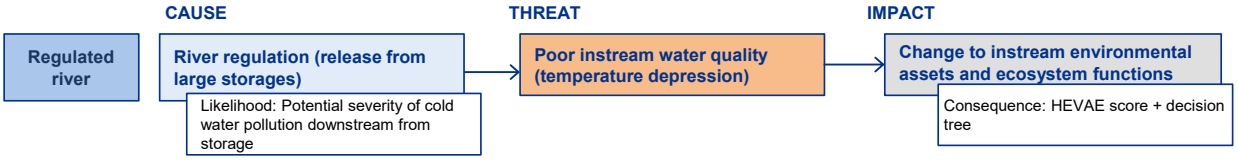


Figure 6-1. Impact pathway showing impact of cold water pollution on ecological functions and assets

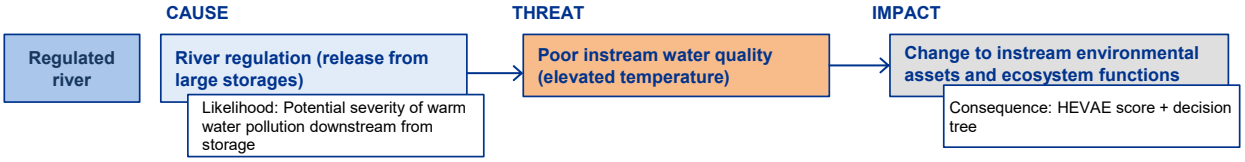


Figure 6-2. Impact pathway showing impact of warm water pollution on ecological functions and assets

6.3.1 Assigning a consequence rating

Temperature has a wide range of influences on biological processes. The release of cold water can interrupt important biological cues such as fish spawning and other fauna, and can reduce the growth rate of fish, and increase mortality (Lugg & Copeland 2014). CWP also has the potential to impact on the recovery potential of fish (as a result of increased environmental water) in the Lachlan catchment (DPI Water 2016).

Thermal pollution from Wyangala Dam results in water temperatures below natural during the summer months and above natural during the winter months. Releases from Wyangala Dam are typically drawn from the hypolimnion (the lower layer in a stratified lake) via fixed-level intakes. Based on extrapolation from other storages, NSW Fisheries (Lugg 1999) estimated that severe cold water pollution (defined as more than 5°C peak depression) persists for 400 km downstream of the dam. This estimate was refined to 200 km (ending at Forbes approximately) by the NSW Department of Planning and Environment using temperature data from July 2009 to June 2016. Due to the low release volumes, the impacts from Carcoar Dam are potentially large, but localised in nature, with the temperature regime returned to a normal state prior to the junction with the Lachlan River.

The impact of CWP and WWP on water-dependent ecosystems is applicable to the regulated Lachlan and Belubula Rivers only.

As HEVAE scoring for the majority of the length of the Lachlan regulated river to Forbes is **High**, it has been assessed as one reach only. Similarly the regulated Belubula River has been assessed as 'Medium' for its entire length. These consequence scores are used to assess risks due to water temperatures falling below natural ranges due to releases from major storages.

6.3.2 Determining the likelihood rating

The potential for CWP was described by two indicators, the size of the structure (namely intake depth) and the scale of downstream temperature disturbance (being summer discharge) (Preece 2004). These two metrics provide a basis for categorising dams according to the potential severity of downstream CWP. These same categories have been used to define likelihood categories for CWP (Table 6-1).

Table 6-1. Likelihood metrics for risk to the health of water-dependent ecosystems from CWP

Likelihood metric	Metric category	Metric category definition
Potential severity of downstream CWP	Low	Minor CWP Shallower intake (<10 m) and smaller discharge (<1,000 ML/d)
	Medium	Moderate CWP Deep intake (>10 m) and smaller discharge (>5 and <1,000 ML/d)
	High	Severe CWP Deep intake (>10 m) and large discharge (>1,000 ML/d)
Reference: Preece, 2004		

Wyangala Dam thermally stratifies from spring to autumn with temperature differentials between surface and bottom waters of 12°C recorded in January (Bowling et al. 1995). Wyangala Dam has two fixed level intakes at different heights. The lower intake is a trashrack covered pipe 65 m below full storage level. The second, higher level intake, extends from 20 to 34 m below full storage level (Preece 2004). Historical discharge data shows that the median January discharge is approximately 1,700 ML/day, acknowledging that there is considerable variation from year to year depending on rainfall.

The outlet works at Carcoar Dam include a single fixed level intake with trashrack covered inlets between 20 and 31 m below full storage level. Unaudited profile data for January 2001 (DSNR, unpub.), when the storage was close to full storage level, indicated a temperature difference between surface and bottom waters of 12.5°C. Historical discharge data shows that the median January discharge is approximately 45 ML/day, with considerable variation from year to year depending on rainfall.

Based on the above criteria, Wyangala Dam has a high likelihood for causing CWP, while Carcoar Dam has a medium likelihood.

There are no long term, water temperature monitoring sites on the Belubula River upstream of Carcoar Dam. A comparison of the downstream median monthly temperature against reference 20th and 80th percentile data cannot be made. The outlet works at Carcoar Dam include a single fixed level intake with trashrack covered inlets between 20 and 31 m below full storage level. Due to the depth of release, the likelihood of WWP from Carcoar Dam is assessed as '**Low'**

There are water temperature monitoring sites on the two main tributaries upstream of Wyangala Dam, one on the Abercrombie River at Abercrombie and one on the Lachlan River at Reids Flat. The data from these two sites has been incorporated into the combined "reference site" data for upstream of Wyangala Dam. Maximum warming during winter is about 3°C.

Table 6-2 Likelihood metrics for risk to the health of water-dependent ecosystems from WWP

Likelihood metric	Metric category	Metric category definition
Potential severity of downstream WWP	Low	< 2 °C maximum difference of mean monthly temperatures in winter (July) between Lachlan River below Wyangala Dam reference site
	Medium	2 °C – 4 °C maximum difference of mean monthly temperatures in winter (July) between CopetonLachlan River below Wyangala Dam reference sites
	High	≥ 6 °C maximum difference of mean monthly temperatures in winter (July) Lachlan River below Wyangala Dam reference site

Based on the likelihood criteria for WWP above, the likelihood rating was 'Medium'.

6.3.3 Risk outcomes

The risk matrix used to determine the risk rating of CWP and WWP impacting the health of water-dependent ecosystems in the regulated system of the Lachlan WRPA is provided in Table 6-3.

Table 6-3. Risk matrix to determine risk outcomes of water temperature outside natural range impacting the health of water-dependent ecosystems

		Likelihood (of instream structure having the potential to cause CWP & WWP)		
		Low	Medium	High
Consequence (HEVAE consequence score)	Very Low	Low	Low	Low
	Low	Low	Low	Medium
	Medium	Low	Medium	High
	High	Low	Medium	High
	Very High	Medium	High	High

Combining the risk consequence and likelihood ratings for the Lachlan regulated river results in an overall high risk level to ecological assets and functions downstream to Forbes, as shown in Table 6-4. The Belubula regulated river has a '**medium**' risk of CWP extending from Carcoar Dam to the Needles gauging station and a '**high'** risk for the Lachlan River up to 200 km downstream of Wyangala Dam. There is a '**low'** risk of warm water pollution downstream of Carcoar Dam and a '**medium'** risk downstream of Wyangala Dam.

Table 6-4. Risks of water temperature outside natural range impacting the health of water-dependent ecosystems [E(WQ-CWP)] and [E(WQ-WWP)].

Regulated river reach	Consequence rating	Likelihood rating	Risk rating – E(WQ-CWP/WWP)
E(WQ-CWP) 200 km downstream of Wyangala Dam (includes Lachlan at downstream Wyangala Dam and Lachlan at Cowra)	High	High	High
100 km downstream of Carcoar Dam (includes Belubula River at Carcoar and Belubula at the Needles)	Medium	Medium	Medium

E(WQ-WWP) Immediately downstream of Carcoar Dam	Medium	Low	Low
Immediately downstream of Wyangala Dam,	High	Medium	Medium

6.4 Risks due to turbidity, TP, TN, pH and DO

Elevated levels of suspended matter, nutrients, dissolved oxygen (DO) and pH outside natural ranges are also types of water quality degradation identified in Schedule 10 of the Basin Plan. There are a range of causes that contribute to water quality degradation of this type. Schedule 11 of the Basin Plan identifies target values for water quality indicators for application zones across the Basin.

Nutrient concentrations are influenced by land use, rainfall and discharge, as well as the combination of naturally occurring high concentrations of nitrogen and phosphorus in soils and erosion. Soil erosion can be exacerbated by clearing, degradation of stream banks and other land use issues. Turbidity and suspended sediment are also influenced by high flows, particularly in those reaches where bank and riparian condition is poor (DPI Water 2016).

Dissolved oxygen is influenced by organic carbon concentrations, nutrient concentrations and temperature, particularly during low and cease to flow periods.

The impact pathway is shown in Figure 6-3. The consequence is described using HEVAE scoring for 50 km river reaches based around river monitoring stations. Likelihood is described by the frequency that Basin Plan water quality targets are exceeded.

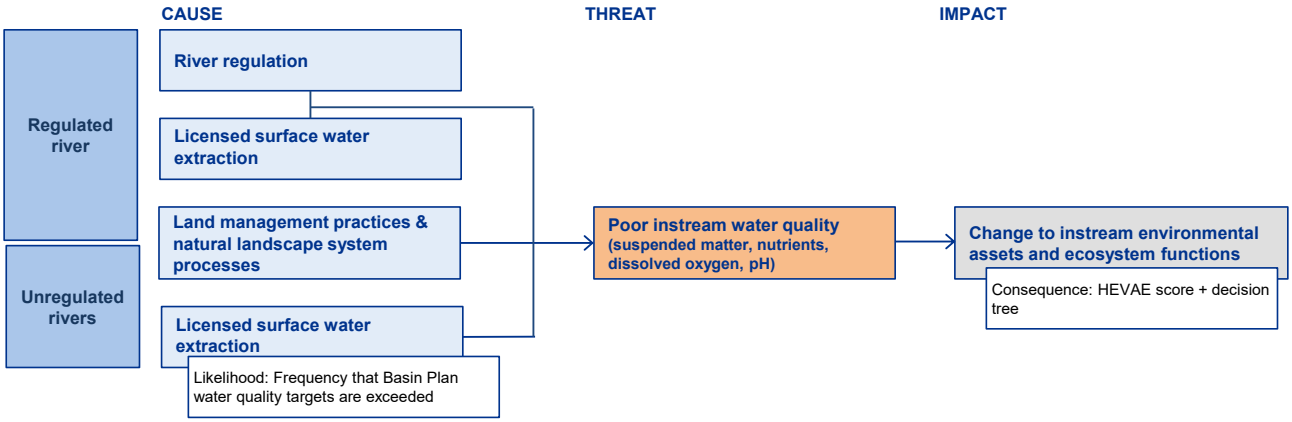


Figure 6-3. Impact pathway showing impact of water quality degradation (increased turbidity, TP, TN, pH and DO) on ecological functions and assets

6.4.1 Assigning a consequence rating

There are 10 NSW Department of Planning and Environment water quality monitoring sites in the Lachlan WRPA spread across the unregulated and regulated systems. For each monitoring station, a reach was defined as 25 km upstream and downstream (Figure 6-4) as a conservative estimate of the spatial representativeness of water quality data and movement of instream biota within the river channel.

Risk consequence was determined using the HEVAE instream value scoring (Section 4.2.1). The consequence decision support tree (Section 4.2.2) was then used to define the final consequence score using the HEVAE instream values within each reach area. Consequence scores for regulated and unregulated reaches are shown in Table 6-5 and Table 6-6.

6.4.1.1 Regulated river water source

Table 6-5. Consequence results for regulated reaches of the Lachlan WRPA

River reach	Consequence Rating
412009 Belubula River at Canowindra	High
412004 Lachlan River at Forbes (Cotton's Weir)	High
412006 Lachlan River at Condobolin Bridge	High
412011 Lachlan River at Lake Cargelligo Weir	High
412039 Lachlan River at Hillston Weir	Very high
412005 Lachlan River at Booligal	High
412045 Lachlan River at Corrong	Low

6.4.1.2 Unregulated water sources

Table 6-6. Consequence ratings in unregulated reaches in the Lachlan WRPA

River reach	Consequence rating
412027 Lachlan River at Reids Flat	Very High
41210123 Abercrombie River at camping area	High
412029 Boorowa River at Prossers Crossing	High

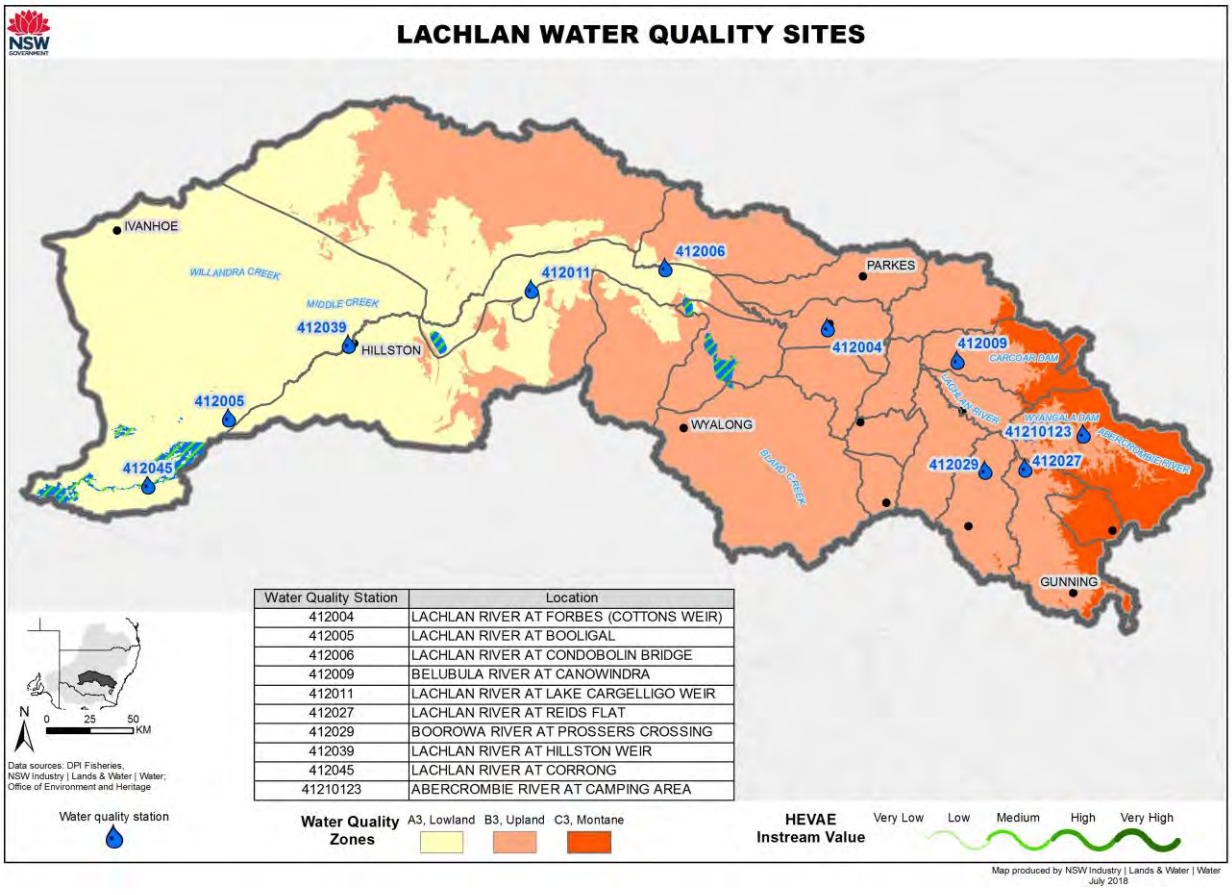


Figure 6-4. Lachlan water quality monitoring sites used to determine water quality target application zones for water-dependent ecosystems (Schedule 11 of the Basin Plan)

6.4.2 Determining the likelihood rating

Likelihood is described by the frequency that the water quality target, as nominated by the Basin Plan, was exceeded over a five year monitoring period. Data was based on monthly sampling for the period 2010/11 to 2014/15.

The Schedule 11 water quality target values used for this risk assessment were for 'other water-dependent ecosystems' in the Montane, Upland and Lowland zones (C3, B3 and A3 zones respectively) (Figure 6-4, Table 6-7).

Table 6-7. Basin Plan (Schedule 11) water quality targets for 'other water-dependent ecosystems'

Ecosystem type	Target application zone	Turbidity (NTU) (annual median)	Total Phosphorus (µg/L) (annual median)	Total Nitrogen (µg/L) (annual median)	Dissolved oxygen (mg/L; or saturation (%)) (annual median within the range)	pH (annual median within the range)
Streams, rivers, lakes & wetlands	C3 (includes Lachlan WRPA Montane zone)	10	20	250	>8.5 mg/L or 90–110%	6.5–7.5
	B3 (includes Lachlan WRPA Upland zone)	20	35	600	>8.0 mg/L or 90–110%	7.0–8.0
	A3 (includes Lachlan WRPA Lowland zone)	35	50	600	>7.0 mg/L or 80–110%	7.0–8.3

Likelihood category definitions are defined by the frequency that the water quality target is exceeded over the five year sampling period (Table 6-8). Likelihood scores for regulated and unregulated reaches are shown in Table 6-9 and Table 6-10

Table 6-8. Likelihood metrics for risk of water quality impacting water-dependent ecosystems in the Lachlan WRPA

Likelihood metric	Metric category	Metric category definition
Number of years the annual medium water quality exceeds the Basin Plan target	Low	The annual site median exceeds the water quality target no more than once between 2010/11 – 2014/15
	Medium	The annual site median exceeds the water quality target at least two twice but not more than three times between 2010/11 – 2014/15
	High	The annual site median exceeds the water quality target at least four times between 2010/11 – 2014/15

Unless otherwise noted, a minimum of five samples per year were used when calculating the median.

6.4.2.1 Regulated river water source

Table 6-9. Likelihood results in regulated river reaches exceeding Basin Plan water quality targets

Regulated river reach	Turbidity	Total phosphorus	Total nitrogen	pH	DO
412009 Belubula River at Canowindra	Low	High	Medium	Medium	Low
412004 Lachlan River at Forbes (Cotton's Weir)	High	High	Medium	Low	High
412006 Lachlan River at Condobolin Bridge	High	High	Medium	Medium	Medium
412011 Lachlan River at Lake Cargelligo Weir	Medium	Medium	Medium	Medium	Medium
412039 Lachlan River at Hillston Weir	High	High	High	Low	Medium
412005 Lachlan River at Booligal	High	High	High	Low	Medium
412045 Lachlan River at Corrong	High	High	High	Low	Low

6.4.2.2 Unregulated water sources

Table 6-10. Likelihood results in unregulated river reaches exceeding Basin Plan water quality targets

Unregulated river reach	Turbidity	Total phosphorus	Total nitrogen	pH	DO
412027 Lachlan River at Reids Flat	Low	Low	Medium	Low	Medium
41210123 Abercrombie River at Camping Area	Low	Low	Low	Low	Low
412029 Boorowa River at Prossers Crossing	Low	High	High	Low	Medium

6.4.3 Risk outcomes

The risk matrix used to determine the risk to the health of water-dependent ecosystems due to water quality targets being exceeded is provided in Table 6-11.

Table 6-11. Risk matrix to determine risk outcomes of exceeding water quality targets on water-dependent ecosystems

		Likelihood (of water quality targets being exceeded)		
		Low	Medium	High
Consequence (HEVAE consequence score)	Very low	Low	Low	Low
	Low	Low	Low	Medium
	Medium	Low	Medium	High
	High	Low	Medium	High
	Very high	Medium	High	High

Combining the risk consequence (Table 6-5 and Table 6-6) and likelihood ratings (Table 6-11) for the Lachlan WRPA results in the overall risk levels to ecological assets and functions as shown in Table 6-12 and Table 6-13 for regulated and unregulated water sources respectively.

The highest risk to water-dependent ecosystems was generally found in the lower section of the Lachlan WRPA. Low concentrations of dissolved oxygen and elevated levels of nutrients and suspended sediment are the highest risks to water-dependent ecosystems. There are also high risks from total phosphorus and total nitrogen to water-dependent ecosystems in the Boorowa River and total nitrogen and dissolved oxygen in the upper Lachlan River at Reids Flat.

6.4.3.1 Regulated river water source

Table 6-12. Risks of exceeding water quality targets impacting the health of water-dependent ecosystems in the regulated reaches of the Lachlan WRPA [E(WQ)]

Regulated river reach	Consequence	Turbidity		Total phosphorus		Total nitrogen		pH		DO	
		Likelihood	Overall risk rating	Likelihood	Overall risk rating	Likelihood	Overall risk rating	Likelihood	Overall risk rating	Likelihood	Overall risk rating
412009 Belubula River at Canowindra	High	Low	Low	High	High	Medium	Medium	Medium	Medium	Low	Low
412004 Lachlan River at Forbes (Cotton's Weir)	High	High	High	High	High	Medium	Medium	Low	Low	High	High
412006 Lachlan River at Condobolin Bridge	High	High	High	High	High	Medium	Medium	Medium	Medium	Medium	Medium
412011 Lachlan River at Lake Cargelligo Weir	High	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium
412039 Lachlan River at Hillston Weir	Very high	High	High	High	High	High	High	Low	Medium	Medium	High
412005 Lachlan River at Booligal	High	High	High	High	High	High	High	Low	Low	Medium	Medium
412045 Lachlan River at Corrong	Low	High	Medium	High	Medium	High	Medium	Low	Low	Low	Low

6.4.3.2 Unregulated water sources

Table 6-13. Risks of exceeding water quality targets impacting the health of water-dependent ecosystems in the unregulated water sources of the Lachlan WRPA [E(WQ)]

Unregulated river reach	Consequence	Turbidity		Total phosphorus		Total nitrogen		pH		DO	
		Likelihood	Overall risk rating	Likelihood	Overall risk rating	Likelihood	Overall risk rating	Likelihood	Overall risk rating	Likelihood	Overall risk rating
412027 Lachlan River at Reids Flat	Very high	Low	Medium	Low	Medium	Medium	High	Low	Medium	Medium	High
41210123 Abercrombie River at Camping Area	High	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
412029 Boorowa River at Prossers Crossing	High	Low	Low	High	High	High	High	Low	Low	Medium	Medium

6.5 Risks due to elevated levels of instream salinity [E(WQ-S)]

Elevated levels of instream salinity can be caused by the mobilisation of salt stores in the landscape and/or a geological predisposition to salinity development.

Salinity targets referred to in the Basin Plan are end-of-valley salinity targets described in Schedule B, Appendix 1 of the Commonwealth Water Act (2007). These targets have been used to assess risks to water-dependent ecosystems from salinity.

The impact pathway is shown in Figure 6-5. The consequence is described using HEVAE scoring for 50 km river reaches based around the relevant river monitoring stations. Likelihood is described by the frequency that the Basin Plan end-of-valley target is exceeded.

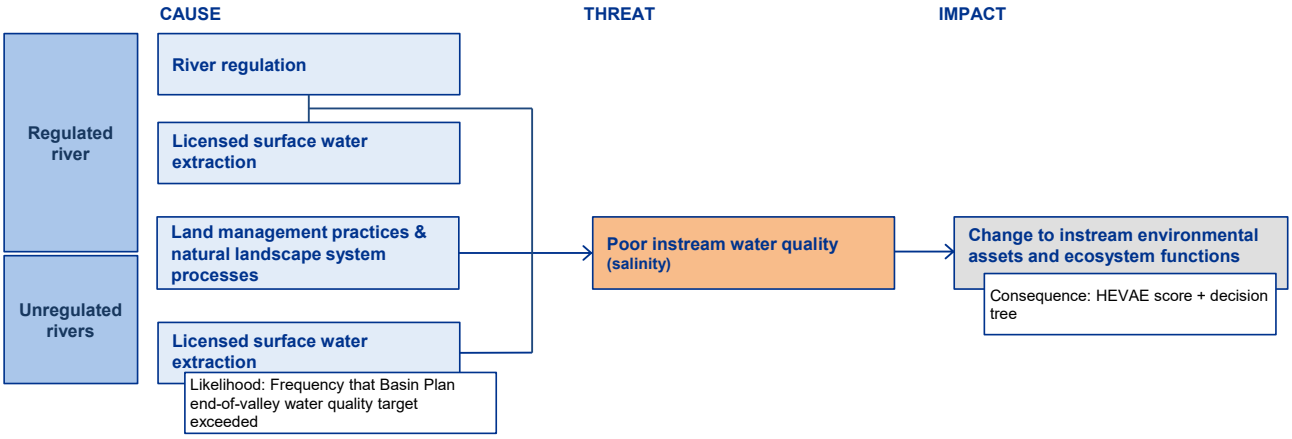


Figure 6-5. Impact pathway showing impact of elevated levels of instream salinity on ecological functions and assets in the Lachlan WRPA

6.5.1 Assigning a consequence rating

The same consequence rating as applied in Section 6.4.1 was used. The end-of-valley target for the Lachlan is nominated for Gauging Station 412004 (Lachlan River at Forbes (Cottons Weir)) (Schedule B, Appendix 1 of the Commonwealth Water Act 2007). This station has a high consequence rating (Table 6-5).

6.5.2 Determining the likelihood rating

Likelihood is described by the frequency that the end-of-valley electrical conductivity target was exceeded during the five year period 2010/11 to 2014/15. Data was based on continuous electrical conductivity data for the period 2010/11 to 2014/15.

The end-of-valley salinity targets for the Lachlan WRPA nominated in the Basin Plan is the 80th percentile should not exceed 693 µS/cm.

Likelihood category definitions are defined by the frequency that the end-of-valley target is exceeded over the five year sampling period (Table 6-14).

Table 6-14. Likelihood metrics for risk to health of water-dependent ecosystems from poor water quality in the regulated river in the Lachlan WRPA

Likelihood metric	Metric category	Metric category definition
Number of years the annual 80th percentile salinity exceeds the end-of-valley target of 693 µS/cm	Low	The annual 80th percentile exceeds the end-of-valley target no more than once between 2010/11 - 2014/15
	Medium	The annual 80th percentile exceeds the end-of-valley target at least two twice but not more than three times between 2010/11 - 2014/15
	High	The annual 80th percentile exceeds the end-of-valley target at least four times between 2010/11 - 2014/15

The annual 80th percentile salinity level in the Lachlan River at Forbes (Station 412004) exceeded the salinity target two out of the five years between 2010/11 and 2014/15. Therefore this risk has a medium likelihood rating.

6.5.3 Risk outcomes

The risk matrix used to determine the risk to the health of water-dependent ecosystems due to water quality targets being exceeded is provided in Table 6-15.

Table 6-15. Risk matrix to determine risk outcomes of elevated levels of instream salinity on water-dependent ecosystems

		Likelihood (of salinity target being exceeded)		
		Low	Medium	High
Consequence (HEVAE consequence score)	Very Low	Low	Low	Low
	Low	Low	Low	Medium
	Medium	Low	Medium	High
	High	Low	Medium	High
	Very High	Medium	High	High

Combining the high risk consequence (Table 6-5) and medium likelihood rating (Section 6.5.2) results in a medium overall risk rating (Table 6-16). There was a medium risk outcome as the annual 80th percentile result exceeded the salinity target two out of the five years between 2010/11 and 2014/15.

Table 6-16. Risks of elevated levels of instream salinity impacting the health of water-dependent ecosystems in the regulated system of the Lachlan WRPA [E(WQ-S)]

Regulated river reach	Consequence rating	Likelihood rating	Risk rating – E(WQ-S)
412004 Lachlan River at Forbes	High	Medium	Medium

6.6 Risks due to pathogens and toxicants [E(WQ-PT)]

Under the *Water Act* 2007 subsections 22(9)-(12) the Basin Plan does not regulate land use, management of natural resources that are not water, or the control of pollution. As such, strategies to mitigate the likelihood of this risk fall outside the scope of the water resource plan, the water quality management plan and this risk assessment.

NSW does accept there is potential for this risk to occur and has legislated controls in place to manage both the likelihood and consequences of the risk. The approach to assessing this risk is the broad consideration of whether there are effective legislated processes and controls that manage both the likelihood and consequence of risk occurrence.

Effective management systems are proactive, responsive, risk based and reliant on good knowledge of:

- processes through which contamination can occur,
- levels of toxicity and persistence of contaminants,
- processes by which contaminants enter river systems,
- effectiveness of measures to mitigate risk likelihood such as licencing and compliance activities, and
- effectiveness of measures to mitigate risk consequence such as extraction controls and water treatment activities

The pathway for impact shown in Figure 6-6is that surface water contaminants from such sources as onsite septics, sewage treatment plants, agriculture and industry may enter river systems where best practice land management is not in place or where there is ineffective or non-compliance with pollution controls. Controls around entry of contaminants (likelihood) and the ecological assets and functions that could be affected (consequence) are assessed to provide the risk outcome.

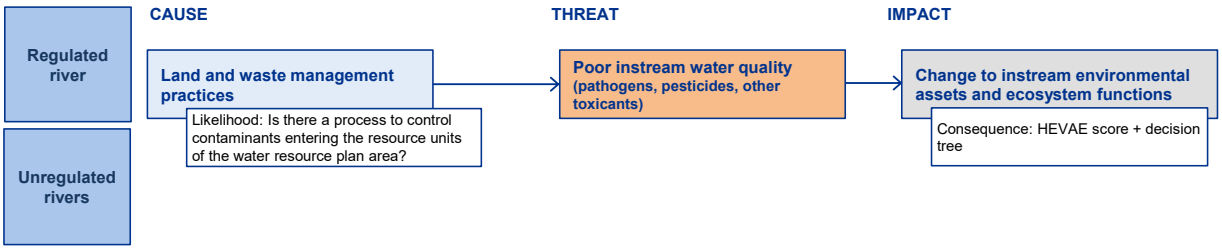


Figure 6-6. Impact pathway showing how risk of poor water quality (pathogens, pesticides and other toxic contaminants) can impact on ecological assets and functions

6.6.1 Assigning a consequence rating

Risk consequence was determined using the HEVAE instream value scoring (Section 4.2.1). The consequence decision support tree (Section 4.2.2) was then used to define the final consequence score using the HEVAE instream values within each reach area. However, because the likelihood rating was assessed at the WRP area scale, and the consequence scores for the water sources ranged from ‘low’ to ‘very high’, a ‘very high’ consequence was used in determining the risk outcomes. The ‘very high’ consequence score ensures that a conservative estimate of risk was undertaken.

6.6.2 Determining the likelihood rating

Likelihood can be conceptualised with consideration to the process of minimising contamination from a range of sources entering surface waters.

In NSW the EPA and local councils implement a risk based approach to the management of potential point source contaminants under the *Protection of the Environment Operations Act 1997,* the *Local Government Act 1993* and the *Local Government (General) Regulation 2005*. The EPA is responsible for event monitoring as a result of licence compliance issues. Under the

Protection of the Environment Operations Act 1997 (POEO Act), the Environment Protection Authority (EPA) uses a risk-based licensing system that aims to ensure that all environment protection licensees receive an appropriate level of regulation based on the environmental risk of the activity taking into account site specific risks. Licenced industries include sewage treatment plants and various agricultural processing activities. Licensing conditions also include a monitoring and reporting component for compliance.

There are limited levers within scope of water planning to manage contaminants from diffuse agricultural sources such as nutrients and pathogens from animal waste. Strategies to address this potential risk include those established by Natural Resource Management agencies (e.g. Local Land Services) to provide advisory services that support and enable landholders to implement improved natural resource and agricultural management practices. These management measures contribute to reducing contaminants from poor quality water entering surface waters leading to water quality degradation and impacts on aquatic ecosystems.

NSW considers the EPA's risk based licensing and approval system and local councils' regulation of onsite sewage management adequately manages the major causes of water quality degradation from major contaminants entering the surface waters. Therefore, a likelihood ranking of 'low' has been applied to both regulated and unregulated water sources (Table 6-17).

Table 6-17. Likelihood metrics and categories for risk to health of water-dependent ecosystems from poor water quality (pathogens and toxicants) in the Lachlan Surface WRPA

Likelihood metric	Metric category	Category definition
Is there a process to control contaminants entering the resource units of the water resource plan area?	Low	Legislated risk based management is in place
	Medium	Legislated or other risk based management is in place
	High	Legislated or other risk based management not in place

6.6.3 Risk outcomes

Combining the '**low**' likelihood (Table 6-17) and **very high**' consequence rating results in the overall risk of surface water contamination from land and waste management practices as '**medium'** in all resource units (Table 6-18).

Table 6-18. Risk matrix to determine risk outcomes of impact of pathogens and toxicants on water-dependent ecosystems

		Likelihood (of process to control contaminants entering surface waters)		
		Low	Medium	High
Consequence (HEVAE consequence score)	Very Low	Low	Low	Low
	Low	Low	Low	Medium
	Medium	Low	Medium	High
	High	Low	Medium	High
	Very High	Medium	High	High

7 Risk to other water uses due to unsuitable water quality [O(WQ)]

7.1 Background

There are a number of risks that may reduce the quality of water used for a number of consumptive and other economic uses in the Lachlan WRPA. Land use within the Lachlan catchment is predominantly agricultural, and includes livestock grazing, dryland cropping and irrigated cropping.

7.2 Existing water management actions and mechanisms

As discussed in Section 6.2 above, under the WMA a key principle sets a requirement that water quality of all water sources should be protected and, wherever possible, enhanced. Key objectives within the WSPs also relate to the maintenance of water quality. Refer to Chapter 5 above, and the WQM Plan, Salinity Technical Report and the Surface Water Quality Technical Report.

7.3 Risks to irrigation water from elevated instream salinity [O(WQ-S)]

The Basin Plan sets targets and objectives to ensure that water quality is protected for social, economic, environmental, cultural and spiritual use. Elevated levels of salinity is one of the causes of water quality degradation that the Basin Plan seeks to address.

Protecting water quality from elevated levels of salinity is fundamental to both river and human health. It sustains riverine ecological processes that support native plants and animals as well as the health of wetlands. Addressing risks of elevated levels of salinity is also important for farming, industries, human consumption and recreation as well as for cultural and spiritual needs.

Irrigation water with elevated levels of salinity can lead to potential crop damage. The Basin Plan sets water quality targets for irrigation water and for the purposes of long-term salinity planning and management (Part 4 of Chapter 9). The target for water for irrigation is for the 95th percentile of each 10 year period that ends at the end of a water accounting period. These targets apply at sites where water is extracted by an irrigation infrastructure operator (IIO) for the purpose of irrigation. In NSW, irrigation infrastructure operators are defined as a separate third party that holds a water access entitlement and delivers water to shareholders. These include NSW Irrigation Corporations, Private Irrigation Districts and Private Water Trusts. Jemalong Irrigation Limited is the only irrigation infrastructure operator in the Lachlan WRPA. The water supply for the Jemalong and Wyldes Plains Irrigation District is diverted by Jemalong Weir, located approximately 20 km downstream of Forbes. The Lachlan River at Forbes gauging station (412004) is the closest continuous electrical conductivity monitoring site.

This risk assessment has had regard to water being unsuitable for use due to elevated salinity levels (Basin Plan s.4.02(1)(b)) through the assessment of risk to the environment due to elevated level of salinity (Section 6.5). Addressing the risks from elevated salinity in E(WQ-S) will ensure water is of suitable quality for social, economic, environmental, cultural and spiritual use. In addition, the Water Quality Management Plan and the Basin Salinity Management Strategy 2030 (BSM2030) outline the processes to ensure salinity is suitable for both the environment and irrigation uses.

7.3.1 Assigning a consequence rating

Consequence is based on a measure of potential crop damage caused by the salinity of irrigation water taken from the river (ANZECC and ARMCANZ 2000, Chapter 9 Table 9.2.5). A single irrigation event of highly saline water can damage crops. Therefore the consequence metric is the maximum mean daily electrical conductivity recorded between 2005/06 and 2014/15 that falls within the classification of a high, medium or low degree of crop damage. The mean daily electrical conductivity did not exceed 1300 µS/cm, resulting in a low consequence score.

7.3.2 Determining the likelihood rating

The likelihood is described by the frequency that the 95th percentile of the daily mean electrical conductivity exceeded the irrigation salinity target of 833 µS/cm for the 10 year period of 2004/05 to 2014/15. The likelihood score was calculated using the continuous electrical conductivity data.

Likelihood category definitions are defined by the frequency that the irrigation target is exceeded over the 10 year sampling period (Table 7-1). The Lachlan River at Forbes (Cottons Weir) exceeded the irrigation target two years out of 10, resulting in a medium likelihood rating.

Table 7-1. Likelihood metrics for risk of water quality being unsuitable for irrigation use in the Lachlan WRPA

		Likelihood for the risk from poor water quality for irrigation use		
		Low yearly 95th percentile of daily means never exceed the irrigation salinity target for the 10 year period;	Medium yearly 95th percentile of daily means exceed the irrigation salinity target for at least one year but no more than 4 years of the 10 year period	High yearly 95th percentile of daily means exceeds the irrigation salinity target for more than 4 years of the 10 year period
Consequence (Potential crop damage)	Low maximum score over 10 years <1300 µS/cm	Low	Low	Medium
	Medium maximum score over 10 years 1300 – 5200 µS/cm	Low	Medium	High
	High maximum score over 10 years >5200 µS/cm	Medium	High	High

7.3.3 Risk outcomes

The risk matrix used to determine the risk of water being of a quality unsuitable for irrigation use in the Lachlan River at Forbes is provided in Table 7-2. Combining the low consequence and medium likelihood rating results in a '**low'** overall risk rating (Table 7-3).

Table 7-2. Risk matrix to determine risk outcomes of elevated levels of instream salinity on irrigation infrastructure operators

		Likelihood (of irrigation salinity target being exceeded)		
		Low	Medium	High
Consequence (Potential crop damage)	Very low	Low	Low	Low
	Low	Low	Low	Medium
	Medium	Low	Medium	High
	High	Low	Medium	High
	Very high	Medium	High	High

Table 7-3. Risks of elevated levels of instream salinity impacting irrigation water in the regulated system of the Lachlan WRPA [E(WQ-S)]

Regulated river reach	Consequence rating	Likelihood rating	Risk rating – E(WQ-S)
412004 Lachlan River at Forbes	Low	Medium	Medium

7.4 Risks to water used for recreational purposes [O(WQ-BGA)]

Most algae are safe and are a natural part of aquatic ecosystems. However, some types of blue-green algae (cyanobacteria) can produce hepatotoxins, neurotoxins and other toxins. Blue-green algae can increase to excessive levels if conditions are suitable and form visible ‘blooms’ that can adversely affect water quality.

Blue-green algae can cause environmental problems, disrupt drinking water supplies, recreational activities and water-dependent industries, and pose a risk to livestock, wildlife and human health.

Blue-green algae was chosen as the indicator for risk to recreational water quality because of the potential for some species of blue-green algae to impact on health through direct contact. Some species can produce potent neurotoxins and hepatotoxins, allergens or irritants to the skin and eyes as well as compounds that affect the taste of water and produce unpleasant odours. In severe cases the toxins can cause damage to the liver and nervous systems and there have been human deaths associated with non-routine exposure to algal toxins through dialysis.

The impact pathway is shown in Figure 7-1 and demonstrates the threat to water used for recreational purposes due to blue-green algae blooms. The consequence is described by the level of recreational use at the assessed location, while the likelihood is described by the frequency of red alert occurrence.

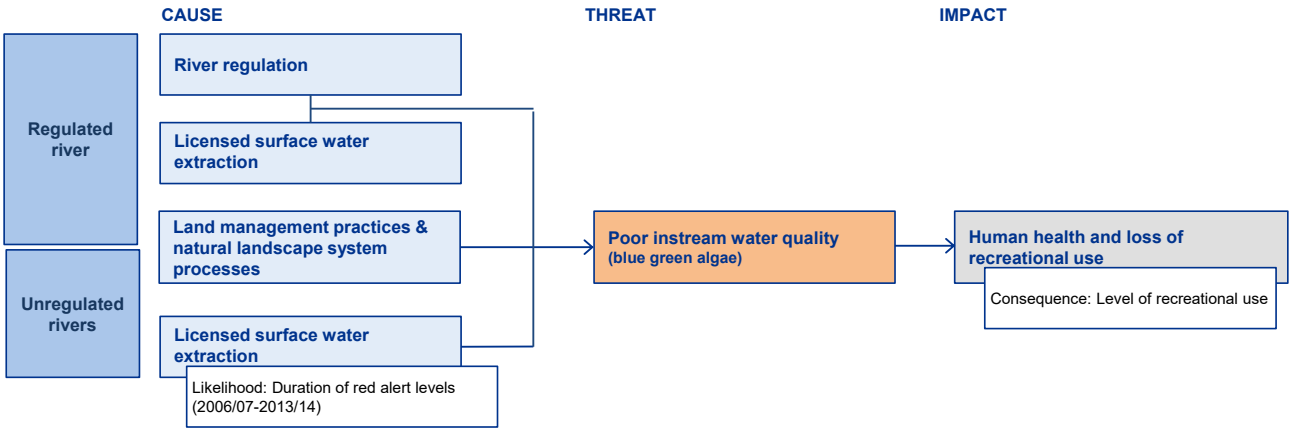


Figure 7-1. Impact pathway showing risk to recreation water quality and human health from blue-green algae

7.4.1 Existing water management actions and mechanisms

The risk of human exposure to blue-green algal blooms is managed in NSW through a coordinated regional approach with the Regional Algal Coordination Committees (RACC). State-wide and regional contingency plans and guidelines have been developed to provide methodologies on the management of algal blooms (NOW 2014). The objective of the guidelines is to provide a risk assessment framework to assist with effective management response to freshwater, estuarine and marine algal blooms. The guidelines aim to minimise the impact of algal blooms by providing adequate warning to the public ensuring their health and safety in recreational situations and for stock and domestic use.

Alert levels have been developed to determine the actions to be implemented in response to an algal bloom. These levels were adopted from the National Health and Medical Research Council algal bloom response guidelines (NHMRC 2008). A conceptual model of how these guidelines are applied for cyanobacterial blooms in waters used for stock, domestic, farm use and recreation is provided in Figure 7-2 The stock alert is also triggered within an amber alert if waters are used for stock watering and the stock alert levels are exceeded.

Water bodies with high levels of recreational use, or those used as a source of potable supply, have algal contingency plans for the issuing of warnings and treatment of town water supplies if sampling reveals potentially toxic levels of blue-green algae.

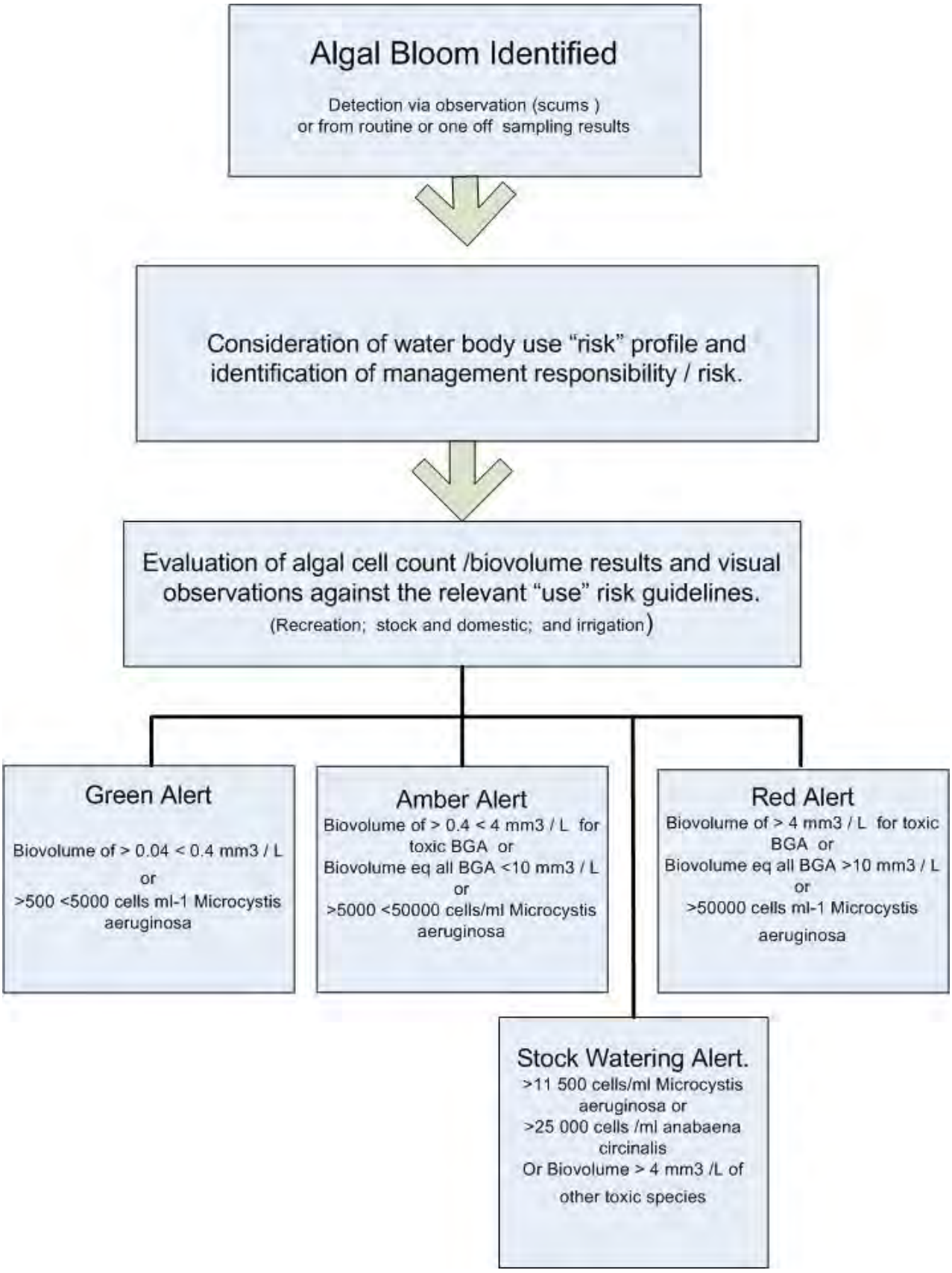


Figure 7-2. Conceptual outline of how algal alert levels are used in NSW

7.4.2 Assigning a consequence rating

Consequence is described by the degree of recreational use of the water source. Recreational usage of the four sites monitored for blue-green algae was determined during sampling to assign a use level.

Consequence categories are defined by usage levels (Table 7-4). Consequence ratings are provided in Table 7-5.

Table 7-4. Consequence metrics for risk to water used for recreational uses due to blue-green algae in the Lachlan WRPA

Consequence metric	Metric category	Metric category definition
Degree of use for recreational purposes	Low	No, or very little, use of untreated water supplies Public advised to avoid contact with water body
	Medium	Some recreational usage (e.g. bush camping)
	High	Untreated water used for domestic use or town water supply High levels of recreational usage

Table 7-5. Consequence results for risk to recreational water users in the Lachlan WRPA

River reach	Consequence
Carcoar Dam	Low
Belubula River downstream Carcoar Dam	Low
Water Supply Reservoir, Cadia Gold Mine	Low
Wyangala Dam	Low
Lachlan River downstream Wyangala Dam	Low
Lachlan River at Cowra	Low
Lachlan River at Forbes (Cottons Weir)	Low
Lake Forbes	Low
Lachlan River at Condobolin	Low
Gum Bend Lake	Low
Lachlan River at Lake Cargelligo Weir	Low
Lake Cargelligo	Low
Curlew Water	Low
Lake Creek at Lake Cargelligo outlet	Low
Lachlan River at Willandra Weir	Low
Lachlan River at Lake Brewster Weir	Low
Lake Brewster	Low
Lachlan River at Hillston	Low
Lachlan River at Booligal	Low
Lachlan River at Corrong	Low

7.4.3 Determining the likelihood rating

The likelihood is described by the annual frequency of red alerts during the period 2006/07 to 2013/14.

A red alert level is triggered when >50,000 cells/mL of *Microcystis aeruginosa* are present or the biovolume of all toxin producing blue-green algae exceeds 4 mm^3/L are detected. This alert level is also triggered if the total of all blue-green algae (toxic and non-toxic) exceeds 10 mm^3/L or scums are present for long periods. This alert level triggers contact to be made with relevant local authorities including health services and appropriate measures are taken to assess the risks and to inform users.

Likelihood categories are defined by length of time a red alert is in place (Table 7-6). Likelihood ratings are provided in Table 7-7.

Table 7-6. Likelihood metrics for risks from blue-green algae in the Lachlan WRPA

Likelihood metric	Metric category	Metric category definition[1]
Annual duration of red alerts	Low	< 2 weeks / year
	Medium	2 – 4 weeks / year
	High	> 4 weeks /year

Table 7-7. Likelihood results for risk due to blue-green algae

River reach	Likelihood
Carcoar Dam	Medium
Belubula River downstream Carcoar Dam	Low
Water Supply Reservoir, Cadia Gold Mine	High
Wyangala Dam	Medium
Lachlan River downstream Wyangala Dam	Low
Lachlan River at Cowra	Low
Lachlan River at Forbes (Cottons Weir)	Low
Lake Forbes	High
Lachlan River at Condobolin	Low
Gum Bend Lake	High
Lachlan River at Lake Cargelligo Weir	Low
Lake Cargelligo	High
Curlew Water	Low
Lake Creek at Lake Cargelligo outlet	Low
Lachlan River at Willandra Weir	Low
Lachlan River at Lake Brewster Weir	Low
Lake Brewster	High
Lachlan River at Hillston	Medium
Lachlan River at Booligal	Low
Lachlan River at Corrong	Medium

7.4.4 Risk outcomes

The risk matrix used to determine the risk to recreational water users from blue-green algae in the Lachlan WRPA is provided in Table 7-8.

Table 7-8. Risk matrix to determine risk outcomes of blue-green algae to recreational water uses

		Likelihood (annual duration of red alerts)		
		Low	Medium	High
Consequence (degree of recreational use)	Low	Low	Low	Medium
	Medium	Low	Medium	High
	Very high	Medium	High	High

Combining the risk consequence and likelihood ratings results in the overall risk as '**medium**' for Lake Forbes, Lake Cargelligo, Lake Brewster, Gum Bend Lake and the water supply reservoir for Cadia Gold Mine (Table 7-9).

Table 7-9. Risks from blue-green algae to recreational water uses in the Lachlan WRPA [O(WQ-BGA)]

Regulated river reach	Consequence rating	Likelihood rating	Risk rating – (9WQ-BGA)
Carcoar Dam	Low	Medium	Low
Belubula River downstream Carcoar Dam	Low	Low	Low
Water Supply Reservoir, Cadia Gold Mine	Low	High	Medium
Wyangala Dam	Low	Medium	Low
Lachlan River downstream Wyangala Dam	Low	Low	Low
Lachlan River at Cowra	Low	Low	Low
Lachlan River at Forbes (Cottons Weir)	Low	Low	Low
Lake Forbes	Low	High	Medium
Lachlan River at Condobolin	Low	Low	Low
Gum Bend Lake	Low	High	Medium
Lachlan River at Lake Cargelligo Weir	Low	Low	Low
Lake Cargelligo	Low	High	Medium
Curlew Water	Low	Low	Low
Lake Creek at Lake Cargelligo outlet	Low	Low	Low
Lachlan River at Willandra Weir	Low	Low	Low
Lachlan River at Lake Brewster Weir	Low	Low	Low
Lake Brewster	Low	High	Medium
Lachlan River at Hillston	Low	Medium	Low
Lachlan River at Booligal	Low	Low	Low
Lachlan River at Corrong	Low	Medium	Low

7.5 Risks to water used for human consumption

Water utilities in NSW implement a risk-based approach to drinking water management to ensure a secure and safe drinking water supply. The *Public Health Act 2010* and the Public Health Regulation 2012 require drinking water suppliers to develop and adhere to a Drinking Water Management System (DWMS) that takes a "multiple barrier approach" from catchment to tap. The DWMS addresses the elements of the Framework for Management of Drinking Water Quality (Australian Drinking Water Guidelines) and is a requirement of a water suppliers operating licence (NSW Ministry of Health 2013).

Risks to raw water and their management strategies are identified in the Drinking Water Management Systems for the following water suppliers in the Lachlan WRPA:

- Blayney Shire Council
- Boorowa Shire Council
- Cowra Shire Council
- Central Tablelands Water
- Corowa Shire Council
- Lachlan Shire Council
- Parkes Shire Council
- Temora Shire Council
- Upper Lachlan Shire Council
- Weddin Shire Council

7.6 Other values

Regard has been had to risks to the suitability of water for public benefit values (i.e. Indigenous, social, cultural) as required under 10.41(3)(a) in relation to 4.02(2)(b) through the assessment of risks to other water uses due to unsuitable water quality. These risks are linked to a number of public benefit values. The benefits and values associated with improved water quality and ecosystem health provide both directly and indirectly for various social, cultural and other public benefit values. Consideration within the development of the WRP is limited on the basis that current methodologies to assess broader benefits are still under development.

Future risk assessments will include an assessment of these risks as further data becomes available. As there is a related requirement in 10.53(1)(f), refer to sections 1.3.1 and 1.7 of the WRP for further information relevant to risks to Indigenous values and uses of surface waters.

8 Risks to water available for other uses

8.1 Background

In this section of the risk assessment, an attempt has been made to estimate the risk of interception activities on other users.

The National Water Commission (NWC) defined interception as occurring when flows of surface water or groundwater are stopped, reduced or redirected (SKM et al. 2010). This definition excludes precipitation and focuses solely on changes to runoff and recharge. This is further expanded by NWC to imply that interception activities, for the purpose of water management, are human-induced activities that intercept significant volumes of water and therefore decrease the amount of water reaching surface water and groundwater bodies.

Chapter 10 Part 5 of the Basin Plan identifies the following interception activities which may have the potential to impact on the water resources of a WRPA:

- Interception by runoff dams
- Interception by commercial plantations
- Interception by mining activities, including coal seam gas mining
- Interception by floodplain harvesting.

The impact pathways demonstrate the threat of flow alteration driven by the interception activities identified in the Basin Plan can impact on water available for other users. The key threat is the interception of water that would otherwise reach a water course, thereby reducing the water available for other users.

For the purpose of risk due to interception, NSW utilised results published in the CSIRO Murray–Darling Basin Sustainable Yields (MDBSY) project (CSIRO 2008a; CSIRO 2008b) and model outputs that contributed to the MDBSY project. Comparative results were also produced by NSW. Details on the methodology used for determining likelihood ratings and consequence scores for risk due to interception are detailed in the section below.

8.2 Risks to other water users from interception activities [O(I-FD), O(I-PF), O(I-M), O(I-FH)]

Just as interception activities can impact on environmental assets and ecosystem functions by altering the hydrology of a system, they can also impact on the water available for other uses. Interception activities identified in the Basin Plan are discussed below.

8.2.1 Farm dams (runoff dams) [O(I-FD)]

The basin-wide growth in numbers of farm dams was estimated at about 0.5-0.6% per year, with growth rates at the time higher in the north than the south (MDBA 2008). The volumetric growth rate was lower than the numerical growth rate as the newer dams are smaller on average than the dams constructed pre-1994. As the Harvestable Rights Policy commenced in 1999, it is likely the volumetric growth rate in the period 1994 to 1999 was higher than the period 2000 to 2004.

In 2008 the volume of in-stream farm dams in the Lachlan valley was estimated at 261 GL (CSIRO 2008a). The MDBSY Project estimated growth rate of 0.6% for the entire Basin was applied to the 2008 Lachlan valley estimated volume, yielding a predicted increase of 36 GL. This equates to a reduction of inflows of 1.3 to 1.6% to streams as a result of farm dam interception, depending on the climatic scenario adopted (NOW 2010).

The WMA places limits on allowable farm dam capacity as a proportion of average regional rainfall runoff, applied at the scale of each landholding. The mechanism places a limit on the

total runoff that can be intercepted within a water source because even though the number of dams in a catchment can increase, dam capacity is limited to the rate of rainfall runoff relative to the size of each landholding. The combined capacity of all dams must stay within the maximum allowed under the HRO. See section 4.5.1 for more detail.

The impact pathways demonstrate how the threat of flow alteration driven by the interception activities identified in the Basin Plan can impact on water available for other users. The key threat is the interception of water that would otherwise reach a water course, thereby reducing the water available for other users in the system.

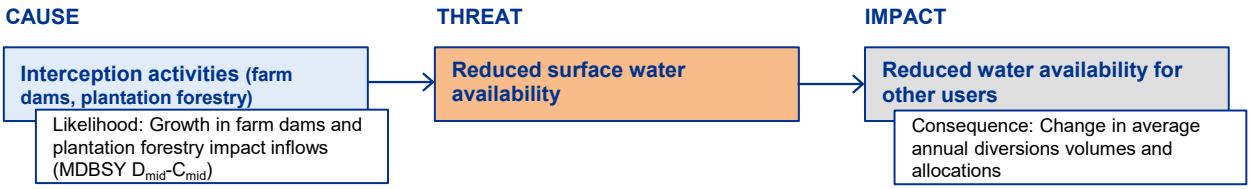


Figure 8-1. Impact pathway showing impact of interception activities on water available for other uses

8.2.1.1 Assigning a consequence score

8.2.1.1.1 Unregulated river water sources

The consequence scores for each unregulated water source are based on community dependence on water use within each water source. These scores were developed as part of the development of macro water sharing plans (NOW 2011).

8.2.1.1.2 Regulated river water source

In assigning a consequence level to farm dams, the approach undertaken by the NSW Office of Water (NOW 2010) was applied in this current risk assessment. This approach was provided to the MDBA Independent Audit Group which described the process used to assess risks to different water access entitlements and to the achievement of environmental objectives. The approach taken by NSW Office of Water (NOW 2010) adopted indicators that were based on information readily available in the Murray–Darling Basin Sustainable Yields (MDBSY) reports (CSIRO 2008a; CSIRO 2008b).

To assess risks to other water users, three types of water access licences were considered based on information readily available in the MDBSY reports, these are:

- High security water access licences, local utilities, and stock and domestic licences
- General security water access licences
- Supplementary access licences.

The change in average annual diverted volumes was used to calculate consequences of interception by farm dams. For general security access licences, change in the number of years with 100 % allocation, and the percentage of years with 0 % allocation were also considered. Consequence levels were defined by the magnitude of change and were set by experienced consultants at levels considered to be ‘reasonable’ (Table 8-1) (NOW 2010).

Data used to assess consequence is presented in Table 8-2; results are provided in Table 8-3

Table 8-1. Consequence thresholds for different types of water access licences in regulated rivers

Consequence levels	Percent change relative to base case				
	High security	General security			Supplementary access
	Average annual diversions	Average annual diversions	% years with 100% allocation	% years with 0% allocation	Average annual diversions
Negligible	x < 1	x < 1	x < 1	x < 1	x < 1
Minor	1 ≤ x < 10	1 ≤ x < 10	1 ≤ x < 10	1 ≤ x < 5	1 ≤ x < 10
Moderate	10 ≤ x < 20	10 ≤ x < 20	10 ≤ x < 20	5 ≤ x < 10	10 ≤ x < 20
Major	20 ≤ x < 30	20 ≤ x	20 ≤ x	10 ≤ x	20 ≤ x
Severe	30 ≤ x	N/A*	N/A	N/A	N/A

Reference: NOW (2010)
N/A = This consequence level was not used for this indicators

Table 8-2. Data used to assess consequences to different types of water access licences in the regulated river due to interception by farm dams

Water access licence type	Consequence		
	% change in average annual diversions	% change years with 100% allocation	% change in years with 0% allocation
High security – Lachlan	0	N/A	N/A
General security – Lachlan	-2.0	-1.4	+0.4
High security – Belubula	0	N/A	N/A
General security – Belubula	-0.5	-0.5	+0.9

Reference: NOW (2010)
N/A = This metric was not used for this type of water access licence

Table 8-3. Consequence results for different types of water access licences in the Lachlan and Belubula regulated rivers due to interception by farm dams

Water access licence type	Consequence		
	% change in average annual diversions	% change years with 100% allocation	% change in years with 0% allocation
High security – Lachlan	Negligible	Minor*	Negligible*
General security – Lachlan	Negligible	Minor	Negligible
High security – Belubula	Negligible	Minor*	Negligible*
General security – Belubula	Negligible	Minor**	Negligible
Supplementary/Uncoltrolled – Lachlan	Negligible	Negligible	Negligible
Supplementary/Uncontrolled – Belubula*	Negligible	Negligible	Negligible

Reference: NOW (2010)
*Supplementary not assessed by NOW (2010) as there were no supplementary licenses at the time, One supplementary license issued in 2012 on Belubula. Risk rating based on expert opinion.
**An overall consequence level of minor will be applied to general security to calculate risk (i.e. the most conservative)

8.2.1.2 Determining the likelihood rating

8.2.1.2.1 Regulated river water source

For the purpose of determining likelihood for farm dams, likelihood was calculated by differences between MDBSY scenarios D_{mid} - C_{mid} (see Table 4-21). The farm dam component of this impact was estimated at 50% of the total (NOW 2010).

As previously mentioned, SKM have developed guidelines for assessing risks to shared water resources in the Murray–Darling Basin. Likelihood metrics were adopted from SKM (2008), which developed guidelines for assessing risks to shared resources in the Murray–Darling Basin. However it is important to note that the SKM report used a different definition of likelihood compared to how it has been defined in the rest of this risk assessment (Section 2.2).

The SKM report defined likelihood as the change of a specified event occurring under different climate scenarios, with events being the specific flow indicators identified for a WRPA. Specified flow indicators for the Lachlan WRPA, based on flow thresholds in the Booligal wetlands and Great Cumbung Swamp, are described in Table 4-18. Likelihoods are therefore the chance that a given flow indicator would be reported under a given climate scenario. These thresholds describe the overall chance that the scenario will have on the assessed impact.

The likelihood rating is based on the differences between the MDBSY D_{mid} – C_{mid} scenario. The likelihood rating for the other users from interception by farm dams is provided below (Table 8-4).

Table 8-4. Likelihood results for different types of water access licences in the regulated Lachlan and Belubula rivers

Water access entitlement holder	Likelihood
High Security – Lachlan and Belubula	Possible
General Security – Lachlan and Belubula	Possible
Supplementary/Uncontrolled – Lachlan and Belubula	Possible
Reference: NOW (2010)	

8.2.1.2.2 Unregulated water sources

As described in Section 4.5.1 the MDBSY Project did not assess unregulated rivers; therefore the SKM (2010) assessment of the hydrological impacts of farm dams in the MDB was used to describe likelihood. This study assessed the impact of existing farms dams at a detailed regional scale and fits into the hydrology theme of the Sustainable Rivers Audit 2 (SRA2) (Davies et al. 2012).

The likelihood method and ratings used for unregulated water sources are listed in Table 4-26and Table 4-27.

8.2.1.3 Existing water management actions & mechanisms

The current harvestable rights provisions allow for farm dams to capture some rainfall runoff under BLR, as previously discussed in section 4.4.2. If estimates of BLR increase over time, extraction by other users will be reduced to ensure compliance with the Long Term Average Annual Extraction Limit, also see section 4.4.2.

The harvestable rights provisions allow a maximum harvestable right dam capacity (MHRDC), based on the average regional overland flow for the water source at the scale of the landholding. This means that, although the number of farm dams within a water source is permitted to grow over time, the total allowed dam capacity cannot be exceeded unless the extra capacity is licenced. The mechanism therefore limits the total amount of water that can be intercepted in a water source, rather than limiting the number of individual dams. See Section 4.4.2 for more detail.

Under existing legislation the category of an access licence defines the level of priority when resources are being allocated in regulated rivers. The *Water Management Act 2000* and *Water Management (General) Regulation 2011* describe priority of licences in the following order (these may be varied by an individual water sharing plan):

1 Local water utility access licences, major utility access licences and domestic and stock access licences have priority over all other access licences
2 Regulated river (high security) access licences have priority over other regulated river access licence subcategories, and supplementary access licences
3 Regulated river (general security) access licences and other regulated river access licence subcategories
4 Supplementary water access licences have priority below all other access licences.

Understanding the priority of licence categories and subcategories enables licence holders to appropriately manage risk.

8.2.1.4 Risk outcomes

8.2.1.4.1 Regulated river water source

The risk matrix used to determine the risk rating of flow alteration from an increase in farm dams intercepting runoff and impacting the water available to different categories of water access licences in the Lachlan WRPA is provided in Table 8-5

Table 8-5. Matrix used to determine risk from potential interception activities to other water users

		Likelihood of insufficient water access				
		Rare	Unlikely	Possible	Likely	Almost certain
Consequence (%change)	Negligible	Low	Low	Low	Medium	Medium
	Minor	Low	Low	Low	Medium	High
	Moderate	Low	Low	Medium	High	High
	Major	Low	Medium	Medium	High	High
	Severe	Medium	Medium	High	High	High

Combining the consequence and likelihood ratings (Table 8-3 and Table 8-4) resulted in the overall risk levels to water access licences and other users in the Lachlan regulated river shown in Table 8-6.

Table 8-6. Risks of insufficient water available for different categories of water access licences in the Lachlan and Belubula regulated river as a result of growth in interception by farm dams [O(I-FD)]

Water access licence type	Consequence	Likelihood	Risk level – O(I-FD)
Lachlan			
High security	Negligible	Possible	Low
General security[1]	Minor	Possible	Low
Supplementary/Uncontrolled access	Negligible	Possible	Low
Belubula			
High security	Negligible	Possible	Low
General security[1]	Minor	Possible	Low
Supplementary/Uncontrolled access	Negligible	Possible	Low

Reference: CSIRO 2008a
[1] An overall consequence level of minor was applied to general security to calculate risk

8.2.1.4.2 Unregulated water sources

The risk matrix used to determine the risk rating of flow alteration from an increase in farm dams intercepting runoff and impacting the water available to other water users in the unregulated Lachlan Surface WRPA is provided in Table 8-7.

Table 8-7. Matrix used to determine risk from potential interception activities to other water users in Lachlan unregulated water sources

		Likelihood - current farm dam development		
		Low Departure from reference: 0.66-1.33	Medium Departure from reference: 0.33-0.66 or 1.33-1.66	High Departure from reference: 0-0.33 or 1.66-2.0
Consequence (community dependence)	Low	Low	Low	Medium
	Medium	Low	Medium	High
	High	Medium	Medium	High

Combining the consequence and likelihood ratings resulted in low overall risk levels to other water users in the Lachlan unregulated river for all water section except two. (Table 8-8). The Crookwell River at Narrawa North has a medium risk and the Belubula River at the Needles has a high risk to low flows due to farm dam interception.

Table 8-8. Risks of insufficient water available for other users in unregulated water sources in the Lachlan Surface WRPA as a result of growth in interception by farm dams [O(I-FD)]

Gauging Station	Consequence*	Likelihood			Risk level - O(I-FD)		
		CV	LF Q_{90}	HF Q_{10}	CV	LF Q_{90}	HF Q_{10}
Abercrombie River @ Abercrombie	High	Low	Low	Low	Low	Low	Low
Abercrombie River @ Hadley No.2	Medium	Low	Low	Low	Low	Low	Low
Belubula River @ the Needles+	Medium	Low	High	Low	Low	High	Low
Bland Creek @ Morangarell	Low	Low	Low	Low	Low	Low	Low
Boorowa River @ Prossers Crossing	Low	Low	Low	Low	Low	Low	Low
Coombing Creek @ Near Neville	Very low	Low	Low	Low	Low	Low	Low
Crookwell River @ Narrawa North	Medium	Low	Medium	Low	Low	Medium	Low
Flyers Creek @ Beneree	Very low	Low	Medium	Low	Low	Low	Low
Lachlan River @ Gunning	Very low	Low	Medium	Low	Low	Low	Low
Lachlan River @ Narrawa	Low	Low	Low	Low	Low	Low	Low
Mandagery Creek @ u/s Eugowra	Low	Low	Low	Low	Low	Low	Low
Pudmans Creek @ Kennys Creek Rd	Low	Low	Low	Low	Low	Low	Low
Rocky Bridge @ Near Neville	Low	Low	Low	Low	Low	Low	Low
Tuena Creek @ Tuena	Medium	Low	Low	Low	Low	Low	Low
Wattle Creek @ Dudauman	Low	Low	Low	Low	Low	Low	Low

CV = variation index annual; HF Q_{10} = high flow index; LF Q_{90} = low flow index

* HEVAE instream value at the same location

8.2.2 Commercial plantations [O(I-PF)]

As discussed in section 4.5.2, afforestation is defined as the large-scale planting of trees for timber production, carbon offsetting, land conservation or other environmental purposes. The Bureau of Rural Sciences projected negligible growth in commercial forestry plantations in the Lachlan region. As such, no growth in plantation forestry was included in the modelling completed for the MDBSY Project in the Lachlan (CSIRO 2008a).

The pathway for impacts associated with growth in plantation forestry is the reduction of water available for other water is shown in Figure 8-2.

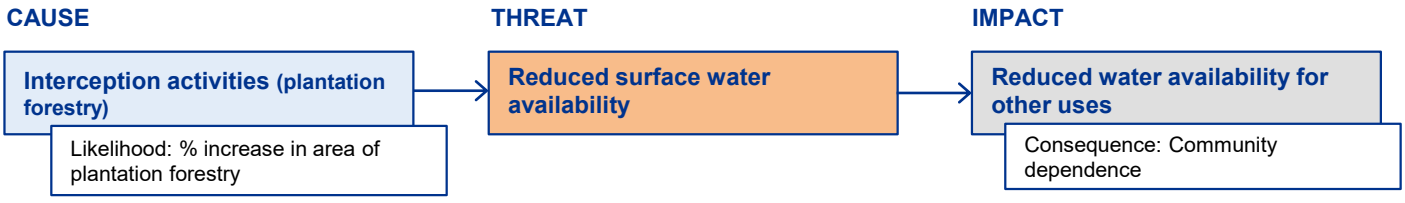


Figure 8-2. Impact pathway showing impact of commercial plantations on water available for other uses

Where there is no projected growth in commercial plantations there is no pathway for additional future impact, and a '**nil**' likelihood category was assigned to both regulated and unregulated water sources. The consequence scores in unregulated water sources were based on

community dependence on water use (NOW 2011). For regulated reaches, a 'High' consequence (i.e. high community dependence) was assigned.

The existing water management strategies and mechanisms for plantation forests are outlined in Section 4.5.2.3.

8.2.2.1 Risk outcomes

Combining the consequence and likelihood ratings resulted in '**Nil**' overall risk levels to other water users in the Lachlan river catchment (Table 8-9. Risks of insufficient water available for other water users in regulated and unregulated water sources in the Lachlan Surface WRPA as a result of plantation forests [O(I-PF)]).

Table 8-9. Risks of insufficient water available for other water users in regulated and unregulated water sources in the Lachlan Surface WRPA as a result of plantation forests [O(I-PF)]

	Consequence	Likelihood	Overall risk rating - O(I-PF)
Regulated river water sources	Medium – Very High	Nil	Nil
Unregulated river water sources	Low – Very High	Nil	Nil

8.2.3 Mining (including CSG) [O(I-M)]

Mining activities in the Lachlan catchment are described in Section 4.5.3. The impact pathway for mining activities impacting on water availability for other uses is described in Figure 8-3.

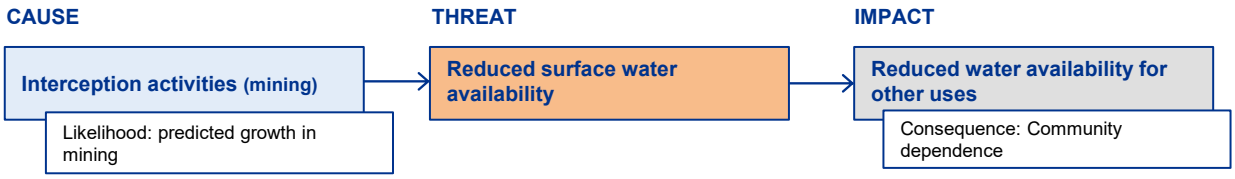


Figure 8-3. Impact pathway showing impact of mining on water available for other uses

8.2.3.1 Existing water management actions and mechanisms

The existing water management strategies and mechanisms for mining activities are outlined in Section 4.5.3.1.

8.2.3.2 Risk outcomes

Because of the legislative and licencing arrangements controlling water quantity impacts from mining, there is no pathway for this impact to occur, and a '**nil**' risk category was assigned to both regulated and unregulated water sources.

The legislative arrangements managing water quality impacts due to mining result in a '**low**' risk to other water users.

Although there is some potential new mining identified by an examination of the MinView website (NSW DPE, 2019), on a WRPA scale this is considered to be of low significance. Therefore, the risk of mining causing impacts to other users that lead to reduced surface water for other users is '**low**'. Note that risks to the structural integrity of groundwater systems are assessed as part of the *Lachlan Alluvium Risk Assessment.*

Table 8-10. Risks of insufficient water available for other water users in regulated and unregulated water sources in the Lachlan Surface WRPA as a result of mining [O(I-M)]

Risk	Water source type	Overall risk rating - E(I-M)
Reduced water quantity	Regulated river water source	Nil
	Unregulated river water sources	Nil
Reduced water quality	Regulated river water sources	Low
	Unregulated river water sources	Low
Structural integrity	Regulated river water sources	Low
	Unregulated river water sources	Low

8.2.4 Floodplain harvesting [O(I-FH)]

Floodplain harvesting is identified in the Basin Plan as a potential interception activity. In NSW, the Floodplain Harvesting Policy and Healthy Floodplains Projects are converting this form of take into a licensable right.

Floodplain harvesting activities in the Lachlan catchment are described in Section 4.5.4.

8.2.4.1 Determining the likelihood rating

Growth in floodplain harvesting (FPH) was determined by comparing the current estimate of total FPH diversions compared to total FPH diversions under BDL (measured as % increase). The data used for the likelihood rating are preliminary estimates from the Water Modelling team within DPE - Water, and should be considered as indicative only. The likelihood metrics are defined in Table 8-11.

Table 8-11. Likelihood metrics for floodplain harvesting

Likelihood metric	Metric category	Metric category definition
Flow Deviation	Low	< 20% increase in FPH volumes
	Medium	20-50% increase in FPH volumes
	High	> 50% increase in FPH volumes

No interim modelling is available for floodplain harvesting in the Southern Basin including the Lachlan WRPA so the following is a qualitative assessment based upon expert opinion. There is no material floodplain harvesting activity occurring in the Lachlan WRPA and no entitlements are expected to be issued through the Healthy Floodplains program and the landscape does not lend itself to the infrastructure required for floodplain harvesting. In any case, it is intended that any new floodplain harvesting activity will be treated as illegal take and subject to compliance actions where appropriate. Therefore we have defined the likelihood as '**Nil'.**

8.2.4.2 Assigning a consequence score

The consequence scores in unregulated water sources were based on community dependence on water use (NOW 2011). For regulated reaches, a 'High' consequence (i.e. high community dependence) was assigned.

The impact pathway for floodplain harvesting activities impacting on water availability for other uses is described in Figure 8-4.

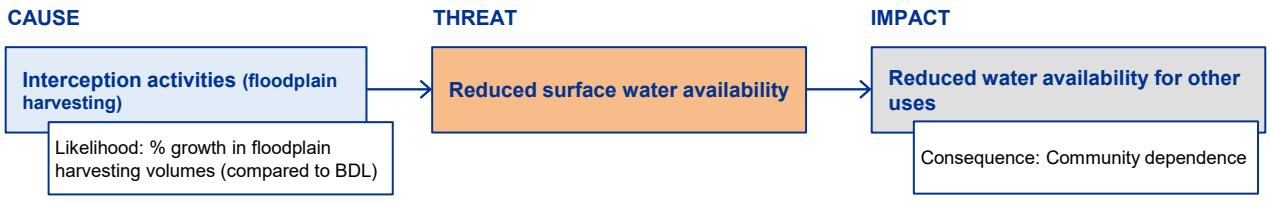


Figure 8-4. Impact pathway showing impact of floodplain harvesting on water available for other uses

8.2.4.3 Risk outcomes

The risk matrix used to determine the risk rating of flow alteration from an increase in floodplain harvesting intercepting runoff and impacting the water available to other users is provided in Table 8-12.

Table 8-12. Risk matrix to determine risk outcomes of increased floodplain harvesting to other water users

		Likelihood (% growth in FPH)			
		Nil	Low	Medium	High
Consequence (community dependence)	Low	Nil	Low	Low	Medium
	Medium	Nil	Low	Medium	High
	High	Nil	Medium	High	High

Combining the consequence and likelihood ratings resulted in '**Nil**' overall risk level to other water users in the regulated and unregulated water sources (Table 8-13).

Table 8-13. Risks of insufficient water available for other water users in regulated and unregulated water sources in the Lachlan Surface WRPA as a result of floodplain harvesting [O(I-FH)]

	Consequence	Likelihood	Overall risk rating - O(I-M)
Regulated river water source	High	Nil	Nil
Unregulated river water sources	Low – Medium	Nil	Nil

8.3 Risk to other water users due to climate change [O(CC)]

As discussed in section 4.6, there has been a sustained and statistically unambiguous increase in mean temperatures across the MDB.

For the purpose of risk to other users due to climate change in the risk assessment, NSW utilised results published in the CSIRO Murray–Darling Basin Sustainable Yields (MDBSY) project (CSIRO 2008a; CSIRO 2008b) and model outputs that contributed to the MDBSY project. Comparative results were also produced by NSW. Details on the methodology used for determining likelihood ratings and consequence scores are detailed in the section below. The impact pathway is shown in Figure 8-5.

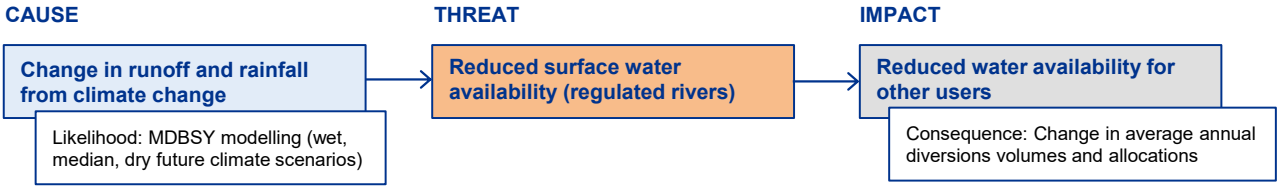


Figure 8-5. Impact pathway showing impact of change in climate on ability to meet other water user's water requirements.

8.3.1 Assigning a consequence rating

8.3.1.1 Regulated river water source

Using the approach taken in NSW Office of Water (NOW 2010) in assigning a consequence score, indicators were adopted that were based on information readily available in the Murray Darling Basin Sustainable Yields (MDBSY) reports (CSIRO 2007; CSIRO 2008a).

To assess risks to other water users in the Lachlan WRPA, two types of water access licences were considered based on information readily available in the MDBSY reports, these are:

- High security water access licences, local utilities, and stock and domestic licences
- General security water access licences.

The MDBSY reports covered a range of possible 2030 climate scenarios (CSIRO 2008a). Dry, median and wet climate change scenarios were selected after implementing a daily scaling method to produce a comparable long-time series and ranking the overall change in total runoff. These scenarios were used in each catchment to assess the risks of the climate change by NOW (2010). The scenarios were compared against the base case to determine the percentage change to predict the level of the consequence.

Consequence levels selected for each type of water use category are located in the 2008 Risk Assessment (NOW 2010) and shown in Table 8-2

Data used to assess consequence is presented in Table 8-15; results are provided in Table 8-14.

Table 8-14. Consequence results for different types of water access licences in the Lachlan and Belubula regulated rivers

Water access licence type	Consequence
Wet climate change scenario	
High Security	Negligible
General Security	Negligible
Median climate change scenario	
High Security	Negligible
General Security	Minor
Dry climate change scenario	
High Security	Negligible
General Security	Major
Reference: NOW 2010	

Table 8-15. Data used to assess consequences to different types of water access licences in the Lachlan and Belubula regulated rivers due to climate change

Water access licence type	Consequence		
	% change in average annual diversions	% change years with 100% allocation	% change in years with 0% allocation
Wet climate change scenario			
High security – Lachlan	0.0	N/A	N/A
General security – Lachlan	+4.0	+4.5	+0.0
High security – Belubula	+3.0	N/A	N/A
General security – Belubula	0.0	+0.9	+0.9
Median climate change scenario			
High security – Lachlan	+5.0	N/A	N/A
General security – Lachlan	-9.0	-12.6	+8.1
High security – Belubula	+7.0	N/A	N/A
General security – Belubula	-2.0	-11.7	+6.3
Dry climate change scenario			
High security – Lachlan	+20.0	N/A	N/A
General security – Lachlan	-26.0	-24.3	+16.2
High security – Belubula	+18.0	N/A	N/A
General security – Belubula	-6.0	-24.3	+15.3
Reference: NOW (2010) N/A = This metric was not used for this type of water access licence			

8.3.1.2 Unregulated river water sources

The consequence scores in unregulated water sources were based on community dependence on water use (NOW 2011) and are shown in Table 8-19.

8.3.2 Determining the likelihood rating

8.3.2.1 Regulated river water sources

Comparing MDBSY Project C scenarios to the 2004/05 (A0 scenario) determines likelihood of climate change impacting water available for other users under the three different climate projections (wet, median and dry) (Table 4-40). Likelihood rankings are provided in Table 8-16.

Table 8-16. Likelihood results for different types of water access licences in the Lachlan and Belubula regulated rivers under different climate change scenarios

Water access licence type	Likelihood
Wet climate change scenario	
High Security	Unlikely
General Security	Unlikely
Median climate change scenario	
High Security	Possible
General Security	Possible
Dry climate change scenario	
High Security	Likely
General Security	Likely
Reference: NOW (2010)	

8.3.2.2 Unregulated river water sources

The three climate change scenarios outlined in Table 4-43 were used to define likelihood ratings in unregulated water sources. To determine the highest potential risk to the environment from surface water reductions due to climate change, the C_{Dry} scenario was used to define the likelihood rating and a 'medium' likelihood category was assigned to all water sources. The 'medium' likelihood applies to all components of the flow regime.

8.3.3 Existing water management actions and mechanisms

Existing actions and mechanisms correspond to those identified in Section 4.6.3.

8.3.4 Risk outcomes

8.3.4.1. Regulated river water source

The risk matrix used to determine the risk rating of flow alteration from changes in climate impacting the availability of water for other uses in the Lachlan regulated river is provided in Table 8-17.

Table 8-17. Matrix used to determine risk from potential change in climate

		Likelihood of 2030 projected hydrologic change from baseline (modelled C runs)				
		Rare	Unlikely	Possible	Likely	Almost Certain
Consequence (%change in water use)	Negligible	Low	Low	Low	Medium	Medium
	Minor	Low	Low	Low	Medium	High
	Moderate	Low	Low	Medium	High	High
	Major	Low	Medium	Medium	High	High
	Severe	Medium	Medium	High	High	High

Combining the risk consequence and likelihood ratings (Table 8-14 and Table 8-16) results in the overall risk levels to other users from climate change as shown in Table 8-18. The risk assessment determined a low risk under the wet scenario for all licenses and the median

scenario for high security licenses. A medium risk was assessed for general security licenses under the medium scenario and high security licenses under the dry scenarios. A high risk was assessed for general security licenses under the dry scenario.

Table 8-18. Risks to different types of water access licences in the Lachlan and Belubula regulated rivers under different climate change scenarios [O(CC)]

Water access licence type	Consequence	Likelihood	Risk level – O(CC)
Wet climate change scenario			
High Security	Negligible	Unlikely	Low
General Security	Negligible	Unlikely	Low
Median climate change scenario			
High Security	Negligible	Possible	Low
General Security	Moderate	Possible	Medium
Dry climate change scenario			
High Security	Negligible	Likely	Medium
General Security	Major	Likely	High
Reference: NOW 2010			

8.3.4.2 Unregulated river water sources

The risk matrix used to determine the risk rating of flow alteration from change in climate impacting the availability of water for other users is provided in Table 4-46.

Combining the unregulated risk consequence and 'medium' likelihood ratings resulted in the majority of water sources having '**Low**' risk ratings (Table 8-19).

Table 8-19. Risks of insufficient water available for other water users in unregulated river sections in the Lachlan Surface WRPA as a result of climate change [O(CC)]

Unregulated water source	Consequence rating (Community dependence)	Likelihood	Overall risk rating – O(CC)
Abercrombie R above Wyangala	Low	Medium	Low
Belubula R above Carcoar Dam	Low	Medium	Low
Belubula Tributaries below Carcoar Dam	Low	Medium	Low
Bogandillon and Manna Creeks	Low	Medium	Low
Boorowa River and Hovells Creek	Low	Medium	Low
Burrangong Creek	Medium	Medium	Medium
Crookwell River	Low	Medium	Low
Crowther Creek	Low	Medium	Low
Goobang and Billabong Creeks	Low	Medium	Low
Goonigal and Kangarooby Creeks	Low	Medium	Low
Gunningbland and Yarrabandai	Low	Medium	Low
Humbug Creek	Low	Medium	Low
Lachlan River above Reids Flat	Low	Medium	Low

Unregulated water source	Consequence rating (Community dependence)	Likelihood	Overall risk rating – O(CC)
Lake Forbes and Back Yamma Creek	Low	Medium	Low
Mandagery Creek	Medium	Medium	Medium
Mid Lachlan Unreg	Low	Medium	Low
Mount Hope Area	Low	Medium	Low
Naradhan Area	Low	Medium	Low
Ooma Creek and Tributaries	Low	Medium	Low
Tyagong Creek	Low	Medium	Low
Unreg Effluent Creeks	Low	Medium	Low
Waugoola Creek	Low	Medium	Low
Western Bland Creek	Medium	Medium	Medium

8.4 Risk to other water users due to growth in BLR [O(BLR)]

As described earlier in Section 4.4, all landholders in NSW have rights to access water for some basic purposes. The principles of the WMA 2000 require that water sharing must protect BLR.

Access to BLR is not controlled by access rules that restrict licensed water users in unregulated water sources (for example, low flow access cease to pump rules); BLR is afforded a higher priority of access.

Any future growth in BLR therefore represents a potential future risk to other (licensed) water users at very low flows. Any increase in the volume taken by BLR access will necessitate a decrease in the volume share of access by licensed water users.

This risk is not applicable in regulated systems where the system is managed in such a way to maintain supply of BLR water requirements. This is further discussed in Section 8.4.2.1.

The nature of water extraction under BLR means that this activity has no effect on flow regimes other than low flows in unregulated rivers. Therefore, the likelihood of impact was assessed only against low flows and risks to other parts of the flow regime are negligible.

The impact pathway is shown in Figure 8-6. and demonstrates the risk to water availability for licensed water uses driven by growth in BLR in unregulated water sources. The consequence is described by the volume of licensed entitlement in the unregulated water source. Likelihood is described by the ratio of BLR to licensed entitlement. The greater the ratio of BLR to entitlement, the greater the likelihood that there will be less water available to other licensed water users; this consequence will be greater in areas of high entitlement.

Figure 8-6. Impact pathway showing risk to licensed water users due to growth in BLR access in unregulated water sources in the Lachlan WRPA

8.4.1 Assigning a consequence rating

8.4.1.1 Regulated river water source

For regulated reaches, a 'High' consequence (i.e. high community dependence) was assigned to all reaches.

8.4.1.2 Unregulated river water sources

In unregulated water sources consequence was described by the current volume of entitlement in each water source. It is assumed that the higher the level of entitlement within a water source, the greater the impact on licensed water users if cease to pump (CtP) levels are triggered more frequently due to increased BLR access.

Consequence categories are defined in Table 8-20. Consequence ratings are shown in Table 8-21.

It is assumed that all entitlement is fully active and utilised. That is, the volume extracted is the volume of entitlement for each water source.

Table 8-20. Consequence metrics for increased extraction by BLR in unregulated water sources in the Lachlan WRPA

Consequence metric	Metric category	Metric category definition
Volume of entitlement	Low	Volume of entitlement < 5,000 ML
	Medium	Volume of entitlement 5,000 – 10,000 ML
	High	Volume of entitlement > 10,000 ML
Reference: NSW Water Register; https://waterregister.waternsw.com.au/water-register-frame		

Table 8-21. Consequence ratings for increased extraction by BLR in unregulated water sources in the Lachlan WRPA

Water source	Consequence rating
Abercrombie River above Wyangala	Low
Belubula River above Carcoar Dam	Low
Belubula Tributaries below Carcoar Dam	Medium
Bogandillon and Manna Creeks	Low
Boorowa River and Hovells Creek	Low
Burrangong Creek	Low
Crookwell River	Low
Crowther Creek	Low
Goobang and Billabong Creeks	Low
Goonigal and Kangarooby Creeks	Low
Gunningbland and Yarrabandai	Low
Humbug Creek	Low
Lachlan River above Reids Flat	Low
Lake Forbes and Back Yamma Creek	Low
Mandagery Creek	Medium
Mid Lachlan Unregulated	High

Water source	Consequence rating
Mount Hope Area	Low
Naradhan Area	Low
Ooma Creek and Tributaries	Low
Tyagong Creek	Low
Unreg Effluent Creeks	Low
Waugoola Creek	Low

8.4.2 Determining the likelihood rating

8.4.2.1 Regulated river water source

In regulated systems, BLR is managed in such a way to maintain supply of BLR water requirements. Sufficient reserves of water are set aside and held in storage to ensure supply of domestic and stock rights and native title rights.

Therefore there is no pathway for impact on water for other users from BLR extraction in regulated river sections, and a 'nil' likelihood has been assigned to all regulated rivers.

8.4.2.2 Unregulated river water sources

Likelihood is described by the ratio of the volume of BLR to all licensed water entitlement in each water source (i.e. irrigation, town water supply, etc.). Entitlement is the current volume of licensed entitlement in each water source. It was assumed that all entitlement is fully active in the unregulated water sources.

Likelihood categories are defined in Table 8-22. Consequence ratings are shown in Table 8-23.

Table 8-22. Likelihood metrics for increased extraction by BLR in unregulated water sources in the Lachlan WRPA

Likelihood metric	Metric category	Metric category definition[1]
Ratio of BLR volume to total licensed entitlement	Low	BLR/Entitlement ≤ 0.5
	Medium	BLR/Entitlement 0.5-1
	High	BLR/Entitlement ≥ 1
Reference: NSW Water Register; https://waterregister.waternsw.com.au/water-register-frame		

Table 8-23. Likelihood ratings for increased extraction by BLR in unregulated water sources in the Lachlan WRPA

Water source	Likelihood rating
Abercrombie River above Wyangala	Medium
Belubula River above Carcoar Dam	Low
Belubula Tributaries below Carcoar Dam	Low
Bogandillon and Manna Creeks	Low
Boorowa River and Hovells Creek	Low
Burrangong Creek	Low
Crookwell River	Low

Water source	Likelihood rating
Crowther Creek	Low
Goobang and Billabong Creeks	Low
Goonigal and Kangarooby Creeks	Low
Gunningbland and Yarrabandai	Low
Humbug Creek	High
Lachlan River above Reids Flat	Low
Lake Forbes and Back Yamma Creek	Low
Mandagery Creek	Low
Mid Lachlan Unregulated	Low
Mount Hope Area	High
Naradhan Area	Low
Ooma Creek and Tributaries	Low
Tyagong Creek	Low
Unreg Effluent Creeks	Low
Waugoola Creek	Low
Abercrombie River above Wyangala	Medium
Belubula River above Carcoar Dam	Low
Belubula Tributaries below Carcoar Dam	Low
Bogandillon and Manna Creeks	Low
Boorowa River and Hovells Creek	Low
Burrangong Creek	Low
Crookwell River	Low
Crowther Creek	Low
Goobang and Billabong Creeks	Low

8.4.3 Existing water management actions and mechanisms

Under the *Water Management Act 2000*, BLR are made up of domestic and stock rights, harvestable rights and native title rights. Water sharing plans recognise basic landholder rights in their respective water sources. Water may be extracted under these rights without the need for a water access licence, although in the case of accessing groundwater under a domestic and stock right, the bore must still be approved by the Department. The water sharing plan cannot limit or restrict these rights, but the Act itself provides for restrictions on BLR through the development of mandatory guidelines. Additionally during periods of water shortage, domestic and stock users may be required, by Ministerial Order, to restrict usage to essential purposes.

The proliferation of new domestic and stock rights through the subdivision of land will be managed through a further regulation to the *Water Management Act 2000*. This regulation, made under section 52(2) of the Act, will limit the growth in basic landholder rights when a landholding is subdivided. Effectively this will mean that the reasonable use for the pre-subdivision landholding will be ‘frozen’ and the vendor will have to apportion this reasonable use limit between the proposed lots in the subdivision. Although still in development, it is intended that such limitations will be applied only to rivers and aquifers that could be subject to high hydrologic stress or high instream risk.

8.4.4 Risk outcomes

8.4.4.1 Regulated water source

Table 8-24. Risk of increased BLR extraction impacting on water available for other water users in the regulated water source of the Lachlan Surface WRPA [O(BLR)]

	Consequence	Likelihood	Overall risk rating - O(BLR)
Regulated river water sources	High	Nil	Nil

8.4.4.2 Unregulated water sources

The risk matrix used to determine the risk to water availability for other uses due to growth in BLR extraction is provided in Table 8-25.

Note that the standard matrix has been altered so that when the likelihood is low (i.e. the ratio of BLR to entitlement <0.5), the risk outcome is always considered low regardless of the level of consequence. This change was made to avoid falsely assigning medium risk outcomes when BLR ratios are very low but entitlement is high. High BLR ratios (e.g. >0.5) usually reflect higher levels of urban/peri-urban development within a water source and therefore a higher likelihood of future BLR growth.

Table 8-25. Risk matrix to determine risk outcomes of increased BLR extraction to other water users in unregulated water sources

		Likelihood (ratio of BLR to entitlement)		
		Low	Medium	High
Consequence (licensed volume of entitlement)	Low	Low	Low	Medium
	Medium	Low	Medium	High
	High	Low	High	High

Combining the risk consequence and likelihood ratings (Table 8-21 and Table 8-23) results in the overall risk being low for all unregulated water sources in the Lachlan WRPA except for the Humbug Creek, Mid-Lachlan Unregulated and Mount Hope Area water sources (Table 8-26). The risk level in these water sources is medium. Table 8-27 shows data on BLR volumes and entitlement volumes for these three water sources.

There is potential in the Humbug Creek and Mount Hope Area water sources for growth in BLR to potentially reduce water available to entitlement holders by a small amount due to the priority of access set by legislation in NSW.

Table 8-26. Risks of increased BLR extraction to other water users in unregulated water sources in the Lachlan WRPA [O(BLR)]

Water source	Consequence rating	Likelihood rating	Risk level – O(BLR)
Abercrombie River above Wyangala	Low	Medium	Low
Belubula River above Carcoar Dam	Low	Low	Low
Belubula Tributaries below Carcoar Dam	Medium	Low	Low
Bogandillon and Manna Creeks	Low	Low	Low
Boorowa River and Hovells Creek	Low	Low	Low
Burrangong Creek	Low	Low	Low

Water source	Consequence rating	Likelihood rating	Risk level – O(BLR)
Crookwell River	Low	Low	Low
Crowther Creek	Low	Low	Low
Goobang and Billabong Creeks	Low	Low	Low
Goonigal and Kangarooby Creeks	Low	Low	Low
Gunningbland and Yarrabandai	Low	Low	Low
Humbug Creek	Low	High	Medium
Lachlan River above Reids Flat	Low	Low	Low
Lake Forbes and Back Yamma Creek	Low	Low	Low
Mandagery Creek	Medium	Low	Low
Mid Lachlan Unregulated	High	Low	Medium
Mount Hope Area	Low	High	Medium
Naradhan Area	Low	Low	Low
Ooma Creek and Tributaries	Low	Low	Low
Tyagong Creek	Low	Low	Low
Unreg Effluent Creeks	Low	Low	Low
Waugoola Creek	Low	Low	Low

Table 8-27. BLR and entitlement volumes for medium and high risk water sources in the Lachlan WRPA

Water source	BLR rights[1] (ML/yr)	Total entitlement[2] (ML/yr)	Number of WALs
Humbug Creek	31	9	2
Mid Lachlan Unregulated	52	12821	15
Mount Hope Area	131	27	2
References: 1 *Water Sharing Plan for the Lachlan Unregulated River Water Sources 2012* 2 NSW Department of Planning and Environment Register for the 2017/18 Water Year			

8.5 Other values

Regard has been had to risks to the availability and suitability of water for public benefit values (i.e. Indigenous, social, cultural) as required under 10.41(3)(a) in relation to 4.02(2)(b) through the assessment of risks to other water availability for other uses. These risks are linked to a number of public benefit values. The benefits and values associated with improved water availability and ecosystem health provide both directly and indirectly for various social, cultural and other public benefit values. Consideration within the development of the WRP is limited on the basis that current methodologies to assess broader benefits are still under development.

Future risk assessments will include an assessment of these risks as further data becomes available. As there is a related requirement in 10.53(1)(f), refer to sections 1.3.1 and 1.7 of the WRP for further information relevant to risks to Indigenous values and uses of surface waters.

9 Risk treatment overview

Section 10.43(1) of the Basin Plan requires WRPs to describe water resource management strategies to address medium or high levels of risk or explain why the risk cannot be addressed by the WRP in a manner commensurate with the level of risk. As strategies are not required for risk results that are low, they have not been further considered in the risk treatment overview.

Medium and high risk results were reviewed to determine whether they are adequately addressed by existing strategies, or whether modifications or new strategies may be required. Risk treatment options were developed following a systematic approach outlined in Figure 9-1 and further explained in Figure 9-1. Defining tolerable risk results (those high or medium results that NSW considers are acceptable or are adequately managed by existing water resource management strategies) were also part of this approach.

Explanations for risk results that the WRP cannot address in a manner commensurate with the level of risk are provided in the consolidated risk table at the start of this document (Table 2).

As this risk assessment examines risks to water quality, it is relevant to note that s10.31 of the Basin Plan also requires the WQM Plan to include measures to address water quality risks. Where the WQM Plan identifies measures that are contained within the WRP or WSPs, these strategies are also shown in this chapter. Note this material is included to show linkages between the two documents and the WQM Plan should be referred to in the first instance.

The risk treatment options reflect the complex nature of risk based water resource management and allow for a range of strategies to be identified and applied irrespective of their legislative base or approach.

Option A is used when other risk options have been assessed and no further strategies are available, or by default when a risk is defined as tolerable.

Options B and C guide the development of strategies that aim to improve knowledge about the risk or the resource. They allow for instances where there has not been adequate information available to fully assess a risk or to develop or modify an existing mitigation strategy. Although associated strategies cannot directly mitigate risk, they aim to provide sufficient information to enable mitigation strategies to be reassessed or developed under options D to G. Options B and C may be linked to adaptive management strategies that are responsive to information improvements during the term of the WRP or related plan. Additional information on strategies related to these options can be found in the Lachlan Monitoring, Evaluation and Reporting (MER) Plan.

Options D to G guide the modification of existing or development of new strategies that mitigate risk through activity control mechanisms. Strategies related to these options may need consideration of impacts on other risk results or third parties. This element has been included to reflect Basin Plan and NSW principles for WRP development which recognise the competing economic, social, cultural, and environmental demands on water resources. Identifying where strategy trade-offs have been applied is particularly important where mitigation strategies may not result in the full mitigation of an identified risk. The pathway allows the likely effects of adjusted or new strategies on risk results to be considered as residual risks. It also enables the acceptance of a high or medium risk result as tolerable if predefined criteria are met or following the application of a risk treatment option. The difference between these tolerable risks is discussed in Chapter 9.2 below.

For detailed information on the application of the options and strategies applied to individual risk results see the consolidated risk table (Table 2). Note risk results that are low or have been assigned a tolerable status based on predefined criteria are assumed to have adequate strategies in place and have not been further reviewed in this risk assessment.

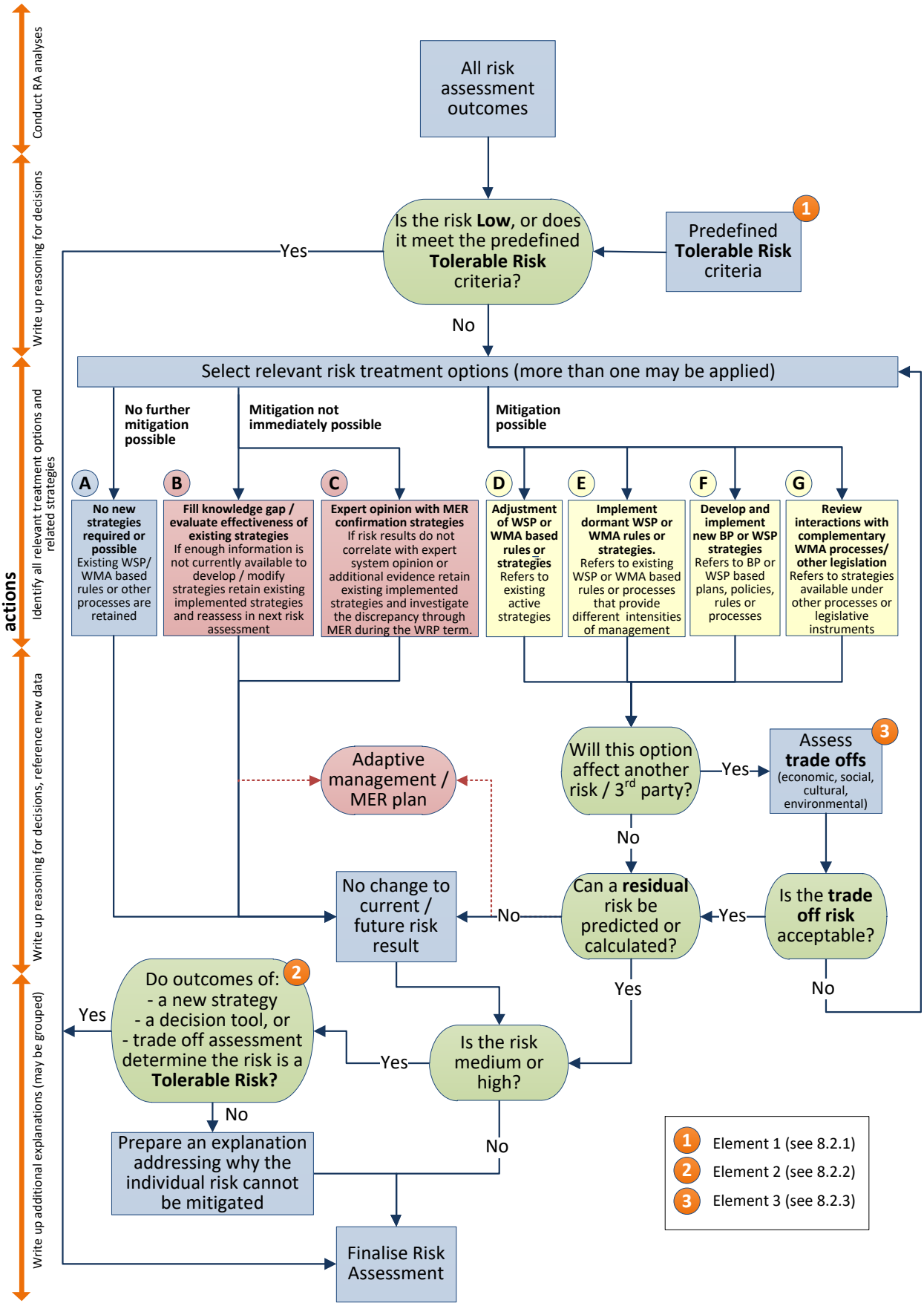


Figure 9-1. Risk treatment pathway

Table 9-1. Risk treatment options explained

Element	Description
A No new strategies required or possible	No further mitigation is possible and no new strategies are proposed. This may be relevant where the risk is adequately managed via existing strategies or where a risk cannot be fully mitigated and trade-offs limit other options. *Note:* existing strategies are retained and the risk result does not change.
B Fill knowledge gap / evaluate effectiveness of existing strategies	Mitigation is not immediately possible and knowledge improvement is proposed. Where there is not enough information available regarding the resource and/or the effectiveness of existing or alternative strategies this option can be used. The MER plan will address the knowledge gaps to enable the existing strategies to be reviewed in the future. *Note:* existing strategies are retained and the risk result does not change
C Expert opinion with MER confirmation strategies	Mitigation is not immediately possible and knowledge improvement via the MER plan is proposed. This option may be used where there is a discrepancy between risk assessment results and expert opinion or alternative evidence. Differences may be due to conservative estimations of consequence or likelihood in risk assessment calculations, knowledge from complementary WRP activities such as LTWP development (including identification of asset watering requirements), type of data available for risk calculation, or other factors that affect results such as data confidence. Note: existing strategies are retained and the risk result does not change. Alternative information sources may enable decisions around the tolerability of a risk result to be made.
D Adjustment of WSP or WMA 2000 based rules or strategies	Mitigation is possible through adjustment of an existing active (i.e. implemented) water sharing strategy. These strategies are generally those currently implemented via WSPs, the WMA 2000 or related policies. Note: existing strategies that are not modified by this risk treatment option are retained. Other risk results may change as a result of strategy modification. As use of this option may affect risks or a third party, care should be taken to assess the proposed changes through secondary lenses as indicated by the flow chart.
E Implement dormant WSP or WMA 2000 strategies	Mitigation is possible through the implementation of an existing dormant (i.e. non-implemented but available for use via WSP or WMA 2000) water sharing strategy. These strategies often describe alternative levels of management intensity than the implemented active strategy. Examples include IDELs/TDELs or local area management in groundwater systems where they are not already in place. Note: unaffected existing strategies are retained, risk results may change. As use of this option may affect risks or a third party, care should be taken to assess the proposed changes through secondary lenses as indicated by the flow chart.
F (i) Develop and implement new water sharing strategies	Mitigation is possible through the development and implementation of new WSP or WMA 2000 based sharing strategies such as rules, policies or other processes. Note: unaffected existing strategies are retained, risk results may change. As use of this option may affect risks or a third party, care should be taken to assess the proposed changes through secondary lenses as indicated by the flow chart.
F (ii) Develop / implement new strategies (WRP/WQSMP/IRG/LTWP/BP)	Mitigation is possible through the development and implementation of new strategies that are not covered by F(i) and are related to the introduction of the Basin Plan and appear in associated instruments. Note: unaffected existing strategies are retained, risk results may change. As use of this option may affect risks or a third party, care should be taken to assess the proposed changes through secondary lenses as indicated by the flow chart.

Element	Description
G (i) Review interaction with complementary WMA 2000 processes	The WMA 2000 covers a broad range of activities of which water sharing is one. This option focuses on reviewing linkages to WMA 2000 based strategies that are complementary to water sharing such as floodplain harvesting and floodplain management. Note: unaffected existing strategies are retained, risk results may change. As use of this option may affect risks or a third party, care should be taken to assess the proposed changes through secondary lenses as indicated by the flow chart.
G (ii) Review interaction with strategies available under other legislation	Other legislative instruments that contain strategies that may mitigate risk to water sources (e.g. the *Environmental Planning and Assessment Act 1979, Contaminated Land Management Act 1997, Dam Safety Act 2015*). Multi agency strategies such as the NSW Cold Water Pollution Strategy and others covering land management should also be included. This strategy type aims to review interaction with and improve linkages to complementary non WMA 2000 or Basin Plan processes and controls. Examples include: major storage infrastructure upgrades can mitigate risk to the environment from cold water pollution; improvement in land use management practices can reduce the risk to the environment by reducing suspended solid loads. Note: unaffected existing strategies are retained, risk results may change. As use of this option may affect risks or a third party, care should be taken to assess the proposed changes through secondary lenses as indicated by the flow chart.

9.1 Existing water resource management strategies, actions and mechanisms

This risk assessment has assessed risks with existing WSP or WMA 2000 based rules in place. It builds on the knowledge and experience of earlier risk based approaches to water planning and management in NSW (NOW, 2011). A range of strategies under the WMA 2000 and associated WSPs address risk for the WRP area, these are consistent with strategies applied elsewhere in the NSW portion of the Basin and other areas of the State. These strategies have been identified for each risk as water management actions and mechanisms in previous sections of this report. They are also shown later in this chapter in the strategy summary table (Table 9-7) and the consolidated risk table. Further information on existing strategies and the way in which they address risk can also be found in the following documents (Table 9-2), and other material available from the NSW Department of Planning and Environment website. These references are provided for background information purposes and may be replaced with updated references as water resource plans are finalised and implemented.

Table 9-2. Further information regarding existing WMA 2000 based strategies, actions and mechanisms

Document
Evaluation of NSW Water sharing plans for the major regulated rivers in the Murray–Darling Basin (DPI 2017) (in final draft)
Water Sharing Plan for the Lachlan Unregulated River Water Sources 2012 Background Document, DPI Water 2012
Macro water sharing plans – the approach for unregulated rivers. A report to assist community consultation, Office of Water 2011
Water sharing plans – Inland NSW unregulated and alluvial water sources – Overview NSW, Office of Water 2011
NSW Harvestable Rights Orders - *NSW Government Gazette number 40, 31 March 2006*

9.2 Tolerable risk results

A medium or high risk result does not necessarily imply that existing water management strategies require change or are inadequate. In many circumstances these risks will already have an appropriate level of management in place under the WMA 2000 that is commensurate with the risk result (i.e. via the relevant water sharing or other water management plans, water management policies etc.). In these situations NSW has made an informed decision to accept the risk result as an acceptable or tolerable risk in line with the *Basin Plan Water Resource Plan Requirements Position Statement 9B Strategies for addressing risks* (see https://www.mdba.gov.au/sites/default/files/pubs/WRP-position-statement-9B_1.pdf). Where a risk result is considered tolerable, the Basin Plan does not require further strategies to be implemented. These results are not further considered in this document.

9.2.1 Predefined tolerable risk criteria

This section refers to element 1 on the risk treatment pathway. Risk results that meet the predefined tolerable risk criteria are automatically assigned risk treatment option A as no new strategies are required or possible.

There are a variety of reasons why medium or high risk results may be tolerable including acceptance of the fundamental changes that river regulation has made to some NSW rivers and the balancing of environmental, social, cultural and economic demands on water resources. Table 9-3 lists the criteria that have been used to predefine risk results as tolerable. If a risk does not appear, no predefined criteria have been identified. The consolidated risk table identifies for each river reach the tolerable status and relevant rationale for each risk result. As noted earlier, strategies relating to risks to water quality are not discussed in this chapter; refer to the WQM Plan for this material.

Table 9-3. Tolerable risk result rationale

Risk	Component	Tolerable rationale
E(W) Risk to water available for the environment due to river regulation and licensed extraction (regulated rivers)	Zero flows	Zero flow periods cannot be scheduled due to dam operational constraints and requirements to deliver water orders and BLR (stock and domestic) replenishment flows. This impact is most pronounced in reaches closest to dams that deliver bulk irrigation water. Zero flow periods may exhibit more natural patterns towards the downstream end of the water source.
	Base flows	Base flows cannot be scheduled due to dam operational constraints and requirements to deliver water orders and BLR (stock and domestic) replenishment flows. This impact of elevated baseflows compared to natural is most pronounced in reaches closest to dams and storages that deliver irrigation water orders. The end of system flow rule whereby a visible flow is required to be maintained in the lower Lachlan River at Geramy, replenishment flow rules for the Unregulated Effluent Creeks Water Source and the Wyangala and Lake Brewster Environmental Water Allowances all help to improve base flows. These planned environmental water rules are critical to providing environmental outcomes in the Lachlan River and its distributary channels. Base flows will exhibit more natural patterns towards the downstream end of the regulated river.
	Fresh flows	Water ordering patterns have altered the duration and timing of freshes leading to unnaturally long duration elevated flows in summer and fewer fresh events in winter. This impact is more pronounced in the Lachlan River than the Belubula due to the large number of unregulated tributaries flowing into the Belubula River below Carcoar Dam. The translucency rule in the Water Sharing Plan for the Lachlan River Regulated Water Source helps deliver fresh flows to the lower reaches of the Lachlan regulated river system. The proposed Belubula River Water Sharing Plan first

Risk	Component	Tolerable rationale
		fresh protection rule helps to protect important first fresh events in the lower reaches of the Belubula River at Helensholme. Modelling of the regulated reach of Willandra Creek flow node shows a medium likelihood of a reduction in fresh flows and a medium risk which is considered tolerable because of fundamental hydrological changes arising from river regulation.
	Bank full flows ARI 1.5	River regulation has altered the duration and timing of bank full events. This impact is most pronounced in the reach immediately downstream of Wyangala Dam but decreases to a low likelihood further downstream at Jemmalong Weir, Willandra Weir and Booligal Weir. The translucency rule in the Water Sharing Plan for the Lachlan River Regulated Water Source helps deliver ARI 1.5 flows to the lower reaches of the Lachlan regulated river system. The medium risk result for the Lachlan River at Willandra Weir and Booligal Weir is driven by a low likelihood and a very high ecological consequence. The risk is tolerable because of the low likelihood. Modelling of the regulated reach of Willandra Creek flow node shows a medium likelihood of a reduction in ARI 1.5 flows and a medium risk which is considered tolerable because of fundamental hydrological changes arising from river regulation.
	Over bank flows ARI 2.5	River regulation and third party inundation risks have altered the duration and timing of overbank ARI 2.5 events. This impact is most pronounced in the reach immediately downstream of Wyangala Dam but decreases to a low likelihood further downstream at Jemmalong Weir, Willandra Weir and Booligal Weir. The medium risk result for the Lachlan River at Willandra Weir and Booligal Weir is driven by a low likelihood and a very high ecological consequence. The risk is tolerable because of the low likelihood. Modelling of the regulated reach of Willandra Creek flow node shows a medium likelihood of a reduction in ARI 2.5 flows and a medium risk which is considered tolerable because of fundamental hydrological changes arising from river regulation.
	Over bank flows ARI 5.0	River regulation and third party inundation risks have altered the duration and timing of overbank ARI 5.0 events. This impact is most pronounced in the reach immediately downstream of Wyangala Dam but decreases to a low likelihood further downstream at Jemmalong Weir, Willandra Weir and Booligal Weir. The medium risk result for the Lachlan River at Willandra Weir and Booligal Weir is driven by a low likelihood and a very high ecological consequence. The risk is tolerable because of the low likelihood. Modelling of the regulated reach of Willandra Creek flow node shows a medium likelihood of a reduction in ARI 5.0 flows and a medium risk which is considered tolerable because of fundamental hydrological changes arising from river regulation.
E(I-FD) Risk of insufficient water available for the environment due to growth in farm dams	CV (annual variation) LF (low flows) HF (high flows)	The total volume of water that can be collected in farm dams is controlled by the Harvestable Rights Order that applies to the relevant water source. If the threshold for allowable water capture has already been reached, no additional harvestable right is permitted a water access licence is obtained through the WSP. The medium risk identified in the Belubula River @ Needles is driven by a low consequence and high likelihood in the LF category. The risk is tolerable because of the low consequence and because growth in take is controlled by the harvestable rights order.

9.2.2 Risks assessed as tolerable following application of a risk treatment option

This section refers to element 2 on the risk treatment pathway. Although risk results may arrive at this element following the application of any risk treatment option, only those where a tolerable risk has been determined are discussed.

In this assessment risk treatment option C *Expert opinion with MER confirmation* has been applied to the following risks.

9.2.2.1 Risk to the environment and capacity to meet environmental water requirements from insufficient water (unregulated rivers)

The level of risk to the environment from water extraction in unregulated rivers has been difficult to assess. As there is little water extraction information collected, volumes and patterns of current use cannot be used to determine the likelihood of extraction impacts. The best available information is the entitlement information shown on water access licences and in WSPs. While this can be used to assess the risk to the environment for full extraction development, the information reflects potential risk rather than the current risk in those water sources where extraction has not reached full development levels.

In many circumstances these water sources may already have an appropriate level of management in place under the WMA 2000 that is commensurate with the risk from current levels of water extraction. As the level of risk for many unregulated water sources is unclear, risk treatment option C has been applied and a strategy developed to improve the knowledge used to assess risk from extraction in unregulated sections of the WRP area (see strategy 18 in Table 9-6).

As the results of this strategy will not be available for some time, a decision tool was used to compare expert knowledge of individual water sources to the full development risk to assign a tolerable status to each result, and to make recommendations for ongoing monitoring. Further information on the decision tool can be found in Appendix G. Refer to the MER Plan for more information regarding the implementation of strategy 18.

The consolidated risk table indicates where tolerable risks have been identified for unregulated water sources. As no additional strategies have been applied to these results, they are not discussed further in this document. The table also addresses those risks this strategy has not determined to be tolerable.

9.2.3 Trade-off assessments

This section refers to element 3 on the risk treatment pathway. Risk results may arrive at this element of the pathway following the application of options D to G where a new or modified strategy affects another risk result or may result in a third party impact.

9.3 New or modified water resource management strategies, actions and mechanisms

This section refers to strategies developed or modified as a result of applying options D to G on the risk treatment pathway. Although several options for new or modified strategies were developed for consideration, only those that are proceeding into the WRP have been included in this section. Appendix G contains further information on strategy development constraints, decision processes and draft strategies. The WRP describes the consultation undertaken to determine which strategies will be implemented.

A number of overarching principles guide the development of WRPs in NSW. These acknowledge the legislative framework and water resource management strategies in place in NSW prior to the introduction of the Basin Plan. These principles have been considered during the preparation of new actions and mechanisms and are summarised in Table 9-4

Table 9-4. Principles guiding development of strategies in NSW

Instrument or source	Principles
Commonwealth Water Act 2007	There will be no net reduction in the protection of planned environmental water
	The Commonwealth is responsible for funding the gap between existing limits and the Sustainable Diversion Limits (SDL).
	WRPs will meet the requirements set out in the Basin Plan
Basin Plan	Nothing in the Basin Plan requires a change in the reliability of water allocations of a kind that would trigger Subdivision B of Division 4 of Part 2 of the Act (s. 6.14)
NSW Water Management Act 2000	WSPs are required to balance social, cultural, economic and environmental needs of the community and catchments (this is a fundamental objective of water management in NSW and is described in the objects of the Act).
Delivering WRP Plans for NSW Roadmap 2016–2019	WRPs are cost neutral for NSW licence holders
	Development of WRPs minimises change to NSW WSPs within their initial 10-year terms

The strategies outlined in this section were developed with consideration to their implementation. As this is primarily through the rules and conditions within the WRP and the WSP, strategies have been limited to water management actions and mechanisms as these are within the scope of Basin Plan strategies and controls. As previously mentioned, strategies outside this scope that relate to the management of water quality risks are outlined in the WQM Plan. Table 9-5 provides information on the new strategies and explains how risk is addressed.

Table 9-5. New or modified water management actions and mechanisms

Mechanism	Description
N1 Sustainable Diversion Limits	This new mechanism is a Basin Plan requirement
N2 Proposed first fresh protection rule in the WSP for the Belubula Regulated River Water Source 2012	Risk: Risk to the environment and risk to the capacity to meet environmental water requirements from insufficient water. Risk driver addressed: Frequency of freshes Locations: Belubula Regulated River at Helensholme Benefits: Protection of first fresh for environmental benefit along full length of Belubula River. Reduced likelihood of need for suspension of Belubula WSP due to emptying of Carcoar Dam under end of system flow rule.
N3 Strategic use of environmental water and water quality allowances (EWAs and WQA) (and relevant held environmental water licences) as guided by the LTWP and WSP.	Risk: Risk to the environment and risk to the capacity to meet environmental and water quality water requirements due to insufficient water. Risk drivers addressed: Reduced frequency and seasonality of in-channel and bankfull freshes along the Regulated Lachlan River and its distributary and anabranching channels; risk of poor water quality such as low dissolved oxygen. Locations: Regulated Lachlan River and its distributary and anabranching channels. Benefits: Improved pattern of freshes and watering of riparian zones and near channel wetlands through improved environmental water management; improved water quality.

9.4 Knowledge strategies

This section refers to strategies developed as a result of applying options B and C on the risk treatment pathway. Although knowledge improvement strategies cannot directly mitigate risk results, these strategies aim to provide information on which to base future calculations of risk and to inform planning decisions regarding strategy or mechanism application. A

summary of these strategies is provided in Table 9-6, further information can be found in the MER Plan.

Table 9-6. Knowledge strategies

Strategy	Mechanism and description
18 Improve knowledge used to assess risk in unregulated sections of the WRP area.	N5 Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies It is expected there will be ongoing satellite based monitoring to determine current extraction in the unregulated water sources of the WRP area resulting in a dataset that can be used to assess and monitor the likelihood component of relevant risks. *Note: N5 may also be used in conjunction with N6*
19 Improve knowledge of effectiveness of existing strategies	N6 Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies This risk assessment recommends review of current extraction management strategies in those unregulated water sources where medium or high risks have not been assessed as tolerable and no new strategies have been identified. Refer to the MER plan for further information. In this WRP area those water sources are: Belubula Tributaries below Carcoar Dam; Boorowa River and Hovells Creek; Burrangong Creek; Lachlan River above Reids Flat; Mandagery Creek; Mid Lachlan Unregulated; Unregulated Effluent Creeks; Western Bland Creek. *Note: where N6 applies, N5 also applies*

9.5 Summary of strategies to address risk

A summary of strategies is presented in Table 9-7 to complement the consolidated risk table. Hydrology components used in this risk assessment and the EWR references from Table 6 of the Lachlan Long-term Water Plan Technical Report (OEH 2018) are provided where relevant in the 'relevant risks column'. This meets the requirements of 10.41(2)(a) and 10.17(1). The listed strategies align with those used in the WRP, WSP, WQM Plan and LTWP objectives. Here, strategies are described with associated actions and mechanisms for each risk and the relevant WRP and water quality objectives. The applicable risk treatment option is included as well as links to relevant sections of the Basin Plan in order to streamline strategy assessment. For more information refer to the document map. Table 9-8 contains a list of abbreviations used in Table 9-7.

Table 9-7. Summary of strategies to address risk.

Strategy	Water management actions and mechanisms / supporting activities	RTO ED	Associated management plan or instrument	Relevant risks and EWR ref	Relevant BP clauses	Relevant objectives
1 Limit 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: * native fish communities * flow dependent vegetation communities * low flow macroinvertebrate communities * carbon and nutrient flow pathways * flow dependent frog communities * significant in-stream refuge pools, lagoons, wetlands and upland wetlands * connectivity with the Lachlan WRP area.	E1 Reserve all water above the long-term average annual extraction limit (LTAAEL) for the environment as PEW (defined and managed by the listed WSPs). E2 Available Water Determinations (AWD) adjust extractive use according to water availability. N1 Sustainable Diversion Limits E3 Extraction limits for individual extractors and associated accounting provisions to manage extraction at the extraction point. E4 Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage entitlement growth. E5 Prohibit trade between surface water and groundwater sources.	**D** **A** **F**	*Water Sharing Plan for the Lachlan Regulated River Water Source 2016* *Water Sharing Plan for the Lachlan Unregulated River Water Sources 2012* *Lachlan Water Resource Plan* *Water Take Measurement and Metering Policy* *Water Sharing Plan for the Belubula Regulated River Water Source 2012* *Water Sharing Plan for the Lachlan Alluvial Groundwater Sources 2020*	**E(W)** Z, BF, F, BKF1.5, OB2.5, OB5 **EWR ref.** LTWP CF1, LTWP VF1, LTWP BF1, LTWP BF2, LTWP SF1, LTWP SF2, LTWP LF1, LTWP LF2, LTWP WL1, LTWP WL2, LTWP WL3 LTWP WL4, LTWP OB1, LTWP OB2, LTWP OB3, LTWP OB4, LTWP OB5	**4.03(3)** **(a)(iii)** **(a)(iv)** **(c)** **(f)** **(i)(i)** **Ch. 10 Part 3, Part 8 Part 10**	**WSP** 1-4 **WQ** 1

Strategy	Water management actions and mechanisms / supporting activities	RTO ED	Associated management plan or instrument	Relevant risks and EWR ref	Relevant BP clauses	Relevant objectives
2 Protect a portion of high flow events in the Lachlan and Belubula WSP areas in the Lachlan WRP area. This strategy reserves a share of high flows for the environment and aims to: * wet benches, banks, wetlands and floodplains, and recharge shallow groundwater lenses to facilitate vegetation growth and recruitment and provide fish and frog habitat, * facilitate the mobilisation of carbon and nutrients from river benches and floodplains, and facilitate deposition into lowland streams and floodplains, * facilitate fish recruitment and movement, * provide connectivity across the Unregulated Effluent Creeks and Mid Lachlan Unregulated water sources.	E6 Translucent flow releases from Wyangala Dam as per environmental flow rules in the WSP for the Lachlan Regulated River Water Source E7 Rules governing uncontrolled flow access for general and high security entitlement holders as per the WSP for the Belubula River Regulated Water Source N2 Proposed first fresh protection rule in the WSP for the Belubula Regulated River Water Source 2012	**A** **F**	*Water Sharing Plan for the Lachlan Regulated River Water Source 2016* *Water Sharing Plan for the Belubula Regulated River Water Source 2012* *Lachlan Long Term Water Plan*	**E(W)** F, BKF1.5, OB2.5, OB5 **E(WQ)** turbidity, TP, TN, dissolved oxygen **EWR ref.** LTWP CF1, LTWP VF1, LTWP BF1, LTWP BF2, LTWP SF1, LTWP SF2, LTWP LF1, LTWP LF2, LTWP WL1, LTWP WL2, LTWP WL3 LTWP WL4, LTWP OB1, LTWP OB2, LTWP OB3, LTWP OB4, LTWP OB5	**4.03(3)** **(a)(i)** **(a)(ii)** **(a)(iv)** **(c)** **(d)** **Ch. 10** **Part 6** **Part 7**	**WSP** 1-4 **WQ** 3 - 6 **WQ 11**

Strategy	Water management actions and mechanisms / supporting activities	RTO ED	Associated management plan or instrument	Relevant risks and EWR ref	Relevant BP clauses	Relevant objectives
3 Provide discretionary environmental watering events in the regulated Lachlan River. This strategy offsets some effects of river regulation on the environment and aims to: * support the completion of waterbird breeding events * support native fish breeding and fish passage * provide wetland watering * increase flow variability * support environmental assets or environmental functions within and downstream of this water source that have been identified as water-dependent Aboriginal cultural values * manage any water quality event but in particular for reduction of salinity levels and mitigation of blue-green algae impacts.	E8 Strategic use of the Wyangala and Brewster environmental water allowances (EWAs) and the water quality allowance (WQA) as described in the WSP. N3 Strategic use of environmental water (EWAs) (and relevant held environmental water licences) as guided by the LTWP.	**A** **F**	*Water Sharing Plan for the Lachlan Regulated River Water Source 2016* *Lachlan Annual Environmental Water Plans* *Lachlan Long Term Water Plan*	**E(W)** Z, BF, F, BKF1.5, OB2.5, OB5 **E(WQ) EC** TP TN DO pH **EWR ref.** LTWP VF1, LTWP BF1, LTWP BF2, LTWP SF1, LTWP SF2, LTWP LF1, LTWP LF2, LTWP BK1, LTWP WL1, LTWP WL2, LTWP WL3, LTWP WL4, LTWP OB1, LTWP OB2, LTWP OB3, LTWP OB4, LTWP OB5	**4.03(3)** **(a)(i)** **(a)(ii)** **(a)(iv)** **(c)** **Ch. 10** **Part 6** **Part 7**	**WSP** 1-4 **WQ** 2, 3, 4, 5, 7, 8, 11

Strategy	Water management actions and mechanisms / supporting activities	RTO ED	Associated management plan or instrument	Relevant risks and EWR ref	Relevant BP clauses	Relevant objectives
4 Manage environmental water to meet flow targets specified in the Lachlan LTWP. This strategy aims to improve environmental water management in the WRP area.	E9 Coordinate release of environmental water allowances (EWAs), and held environmental water with natural flow events when appropriate.	**A** **F**	*Water Sharing Plan for the Lachlan Regulated River Water Source 2016* *Lachlan Annual Environmental Water Plans* *Lachlan Long Term Water Plan*	**E(W)** Z, BF, F, BKF1.5, OB2.5, OB5 **EWR ref.** LTWP VF1, LTWP BF1, LTWP BF2, LTWP SF1, LTWP SF2, LTWP LF1, LTWP LF2, LTWP BK1, LTWP WL1, LTWP WL2, LTWP WL3, LTWP WL4, LTWP OB1, LTWP OB2, LTWP OB3, LTWP OB4, LTWP OB5	**4.03(3)** **(a)(i)** **(a)(iv)** **(c)** **Ch. 10 Part 6**	**WSP** 1-4

Strategy	Water management actions and mechanisms / supporting activities	RTO ED	Associated management plan or instrument	Relevant risks and EWR ref	Relevant BP clauses	Relevant objectives
5 Protect low flow habitats from accelerated rates of drying. This strategy offsets impacts of water extraction in rivers of the WRP area and aims to: * maintain surface water connectivity and habitat variability, * prevent accelerated rates of deterioration in water quality, * maintain surface/groundwater connectivity where there is groundwater-dependent riparian vegetation. *Note: BLR, domestic and stock replenishment flows may provide incidental environmental benefit in line with this strategy in the Unregulated Effluent Creeks Water Source.*	E11 Cease / commence to pump rules for streams. E8 Strategic use of the Wyangala and Brewster environmental water allowances (EWAs) and the water quality allowance (WQA) as described in the WSP. N2 Proposed first fresh protection rule in the Belubula Regulated River Water Source 2012 N3 Strategic use of environmental water allowance (EWA) (and relevant held environmental water licences) as guided by the LTWP. *Note: Complimentary groundwater actions and mechanisms are identified in the Lachlan Alluvium Water Resource Plan (GW15).*	**A** **A** **A** **F**	*Water Sharing Plan for the Lachlan Unregulated River Water Sources 2012* *Water Sharing Plan for the Lachlan Regulated River Water Source 2016* *Water Sharing Plan for the Belubula Regulated River Water Source 2012* *Lachlan Long Term Water Plan* *Lachlan Annual Environmental Water Plans* *Water Sharing Plan for the Lachlan Alluvial Groundwater Sources 2020*	**E(W)** Z, BF, F **E(WQ)** DO TN TP NTU **EWR ref.** LTWP VF1, LTWP BF1, LTWP BF2, LTWP SF1, LTWP SF2, LTWP LF1, LTWP LF2,	**4.03(3)** **(a)(i)** **(a)(ii)** **(a)(iv)** **(c)** **(d)** **Ch. 10 Part 4, Part 6**	**WSP** 1-4 **WQ 3, 4**
6 Protect pools in streams, wetlands, lagoons and floodplains within the WRP area during dry periods. This strategy offsets impacts of water extraction from Lake Waljeers and Lake Forbes to protect water quality, and provide habitat for fish, frogs and other water-dependent biota.	E12 Cease / commence to pump rules for in-stream and off-river pools. E13 – Authorised in-river dam construction, operation, and passing flow requirements as specified on the dam approval. E14 – Restrict construction of in-river dams on 3rd order or higher streams.	**A**	*Water Sharing Plan for the Lachlan Unregulated River Water Sources 2012*	**E(W)** Z, BF, F **E(WQ)** DO TN TP NTU **EWR ref.** LTWP CF1, LTWP VF1, LTWP BF1, LTWP BF2, LTWP SF1	**4.03(3)** **(a)(i)** **(a)(ii)** **(a)(iv)** **(c)** **Ch. 10 Part 4 Part 6 Part 7**	**WSP** 1-4 **WQ 3, 4**

Strategy	Water management actions and mechanisms / supporting activities	RTO ED	Associated management plan or instrument	Relevant risks and EWR ref	Relevant BP clauses	Relevant objectives
7 Protect the connectivity between the regulated water source and downstream connected unregulated water sources of the WRP area. This strategy aims to optimise environmental water delivery to the Booligal Wetlands and Great Cumbung Swamp in dry seasons by restricting extraction of low flows.	E6 Translucent flow releases from Wyangala Dam as per environmental flow rules in the WSP for the Lachlan Regulated Water Source	**A**	*Water Sharing Plan for the Lachlan Unregulated River Water Sources 2012*	**E(W)** Z, BF, F **EWR ref.** LTWP VF1, LTWP BF1, LTWP BF2, LTWP SF1, LTWP SF2, LTWP LF1, LTWP LF2, LTWP BK1, LTWP WL1, LTWP WL2, LTWP WL3, LTWP WL4, LTWP OB1, LTWP OB2, LTWP OB3, LTWP OB4, LTWP OB5	**4.03(3)** **(a)(i)** **(a)(iv)** **(c)** **(d)** **Ch. 10 Part 6**	**WSP** 1-4 **WQ** 11

Strategy	Water management actions and mechanisms / supporting activities	RTO ED	Associated management plan or instrument	Relevant risks and EWR ref	Relevant BP clauses	Relevant objectives
8 Protect the regulated river sections of the WRP area from rapid increases and decreases in river stage and flow following releases from Wyangala Dam. This strategy protects the integrity of river banks and assists in the management of suspended sediment loads.	E10 Rates of change to storage release protocol.	**A**	*WaterNSW Wyangala and Belubula Dam Water Supply Work Approvals*	**E(WQ)** Turbidity LTWP SF1, LTWP SF2, LTWP LF1, LTWP LF2, LTWP BK1, LTWP WL1, LTWP WL2, LTWP WL3, LTWP WL4, LTWP OB1, LTWP OB2, LTWP OB3, LTWP OB4, LTWP OB5	**4.03(3) (a)(ii) (a)(iv) (c)** **Ch. 10 Part 7**	**WSP** 1-4 **WQ** 3

Strategy	Water management actions and mechanisms / supporting activities	RTO ED	Associated management plan or instrument	Relevant risks and EWR ref	Relevant BP clauses	Relevant objectives
9 Recognise the contribution of Wyangala and Carcoar Dam release strategies towards the maintenance of water quality within the regulated sections of the WRP area. This strategy aims to mitigate the following water quality impacts of river regulation and flow regime alteration: * minimise the risk of cold or warm water thermal shock, * reduce the risk poor water quality, *Note: all releases made from Wyangala and Carcoar Dams contribute to the achievement of this aspect of the strategy.*	E6 Translucent flow releases from Wyangala Dam as per environmental flow rules in the WSP for the Lachlan Regulated River Water Source E8 Strategic use of the Wyangala and Brewster environmental water allowances (EWAs) and the water quality allowance (WQA) as described in the WSP. E10 Rates of change to storage release protocol. E9 Coordinate release of environmental water allowances (EWAs), and held environmental water with natural flow events when appropriate. N2 Proposed first fresh protection rule in the Belubula Regulated River Water Source 2012 E7 Rules governing uncontrolled flow access for general and high security entitlement holders as per the WSP for the Belubula River Regulated Water Source E15 Improve dam infrastructure and its management so that water releases are more closely matched to ambient river temperatures.	**A** **F**	*Water Sharing Plan for the Lachlan Regulated River Water Source 2016* *Water Sharing Plan for the Lachlan Regulated River Water Source 2016* *Water Sharing Plan for the Lachlan Regulated River Water Source 2016* *Lachlan Long Term Water Plan* *Lachlan Annual Environmental Water Plans* *NSW Cold Water Pollution Strategy* *WaterNSW Wyangala and Carcoar Dam Water Supply Work Approval*	**E(WQ-S)** **E(WQ-CWP)** **E(WQ)** TN TP NTU pH DO **O(WQ-BGA)**	**4.03(3)** **(a)(i)** **(a)(ii)** **(a)(iv)** **(c)** **(d)** **Ch. 10** **Part 6** **Part 7**	**WSP** 1-4 **WQ 2 -6** **WQ 8, 11**
10 Implement the WQM Plan for the WRP area.	*Refer to the WQM Plan for detailed listing. Note: actions and mechanisms are relevant to the WRP are listed in previous strategies.*	**F**	*Water Quality Management Plan for the Lachlan WRP area* *Basin Salinity Management Strategy*	**E(WQ-S)** **E(WQ-CWP)** **E(WQ-WWP)** **E(WQ)** **O(WQ-BGA)**	**4.03(3)** **(a)(ii)** **(i)(ii)** **Ch. 10** **Part 7**	**WSP** 1-4 **WQ** 1-11

Strategy	Water management actions and mechanisms / supporting activities	RTO ED	Associated management plan or instrument	Relevant risks and EWR ref	Relevant BP clauses	Relevant objectives
11 Protect stream flow from reduced runoff attributable to farm dam interception. This strategy aims to reduce impacts on the health of rivers and on other consumptive water users.	E16 Require farm dams with a capacity above the maximum harvestable right dam capacity (MHRDC) to be licensed and comply with extraction limits as described in strategy 1. E21 Ongoing monitoring of potential growth in number of farm dams within medium and high risk water sources	**A**	*Water Sharing Plan for the Lachlan Unregulated River Water Sources 2012* *Harvestable Rights Policy (commenced 1999)* *Harvestable Rights Order - NSW Government Gazette 40 dated 31 March 2006*	**E(I-FD)** **O(I-FD)**	**4.03(3)** **(a)(iv)** **(c)** **(h)(i)** **Ch. 10 Part 5**	N/A
12 Protect stream flow from reduced runoff attributable to plantation forestry interception. This strategy aims to reduce impacts on the health of rivers and on other consumptive water users.	E17 Plantation forestry interception is considered low risk therefore no mechanisms have been implemented under the WMA 2000. E18 Ongoing risk monitoring to determine impact of future expansion of forest plantations at local and regional scales.	**A** **B**	*Plantation forestry policy (in prep)* *Plantations and Reafforestation Act 1999 (PRA)* *Plantations and Reafforestation (Code) Regulation 2001* *Lachlan Monitoring, Evaluation and Reporting Plan*	**E(I-PF)** **O(I-PF)**	**4.03(3)** **(a)(iv)** **(c)** **(h)(i)** **Ch. 10 Part 5**	N/A
13 Protect the environment and water users from changes in flow attributable to climate change. This strategy aims to reduce impacts on the health of rivers and on other consumptive water users. *Note: significant volumes of held environmental water may offset climate change impacts under the median scenario.*	E1 Reserve all water above the long-term average annual extraction limit (LTAAEL) for the environment as PEW (defined and managed by the listed WSPs). E2 Available Water Determinations (AWD) adjust extractive use according to water availability. E22 Review and update climate change models when new data is available. N1 Sustainable Diversion Limits.	**D** **F**	*Water Sharing Plan for the Lachlan Regulated River Water Source 2016* *Water Sharing Plan for the Lachlan Unregulated River Water Sources 2012* *Lachlan Water Resource Plan* *Draft Lachlan Regional Water Strategy 2021* *Draft NSW State Water Strategy 2021* *Lachlan Incident Response Guide (included as a schedule in the Lachlan WRP)*	**E(CC)** **O(CC)**	**4.03(3)** **(a)(iv)** **(c)** **(g)(iii)** **(h)(ii)** **(h)(iii)** **Ch. 10 Part 3**	N/A

Strategy	Water management actions and mechanisms / supporting activities	RTO ED	Associated management plan or instrument	Relevant risks and EWR ref	Relevant BP clauses	Relevant objectives
14 Protect the environment from changes in flow attributable to growth in BLR extractive use. This strategy aims to reduce impacts on the health of rivers and on other consumptive water users.	E1 Reserve all water above the long-term average annual extraction limit (LTAAEL) for the environment as PEW (defined and managed by the listed WSPs). E2 Available Water Determinations (AWD) adjust extractive use according to water availability. N1 Sustainable Diversion Limits E19 Minister may restrict BLR access through the establishment of mandatory guidelines under the WMA s. 52(2) and S. 336B.	**A** **D** **F** **D**	*Water Sharing Plan for the Lachlan Regulated River Water Source 2016* *Water Sharing Plan for the Lachlan Unregulated River Water Sources 2012* *Lachlan Water Resource Plan*	**E(BLR)**	**4.03(3)** **(a)(iv)** **(c)** **h(ii)** **Ch 10 Part 3**	N/A
15 Protect licenced water users from changes in flow attributable to growth in BLR extractive use. This strategy aims to reduce impacts on other consumptive water users. *Note: BLR are established and controlled through the WMA and are recognised in WSPs. Control mechanisms are only applied when required.*	E19 Minister may restrict BLR access through the establishment of mandatory guidelines under the WMA s. 52(2) and S. 336B. E20 Minister may temporarily restrict access under the WMA s. 324 when there are water shortages.	**A** **D**	*Water Management Act 2000 s.52(2), s.336B, s.324*	**O(BLR)**	**4.03(3)** **(a)(iv)** **(c)** **(d)** **h(ii)** **Ch. 10 Part 3**	N/A
16 Improve knowledge used to assess risk in unregulated water sources and river reaches in the WRP area.	N5 Projects resulting from application of risk treatment option C Fill knowledge gap / evaluate effectiveness of existing strategies. *Note: It is expected there will be ongoing monitoring to determine current extraction in the unregulated water sources of the WRP area resulting in a dataset that can be used to assess and monitor the likelihood component of relevant risks.*	**C**	*Lachlan Monitoring, Evaluation and Reporting Plan*	**E(W)** unregulated Z, BF, F **EWR ref.** LTWP CF1, LTWP VF1, LTWP BF1, LTWP BF2, LTWP SF1	**4.03(3)** **(c)** **(i)(i)** **(i)(ii)**	N/A

Strategy	Water management actions and mechanisms / supporting activities	RTO ED	Associated management plan or instrument	Relevant risks and EWR ref	Relevant BP clauses	Relevant objectives
17 Improve knowledge of effectiveness of existing strategies.	N6 Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies.	**B**	*Lachlan Monitoring, Evaluation and Reporting Plan.*	**E(W)** unregulated Z, BF, F **EWR ref.** LTWP CF1, LTWP VF1, LTWP BF1, LTWP BF2, LTWP SF1	**4.03(3)** **(b)** **(c)** **(e)** **(g)** **(i)(i)** **(i)(i)** **(i)(ii)**	N/A

Table 9-8. Abbreviations used in Table 9-7.

Abbreviation	Explanation
RTO	Risk treatment option refer Figure 9-1
E	Existing action / mechanism / supporting activity
N	New or modified action / mechanism / supporting activity
E(W)	Risks to water available for the environment due to river regulation and licensed extraction (regulated and unregulated)
E(BLR)	Risks to water available for the environment from extraction by basic landholder rights
E(I-FD)	Risk to water available for the environment from interception activities (farm dams)
E(I-PF)	Risk to water available for the environment from interception activities (plantation forestry)
E(I-M)	Risk to water available for the environment from interception activities (mining)
E(I-FH)	Risk to water available for the environment from interception activities (floodplain harvesting)
E(CC)	Risk to water available for the environment due to climate change (regulated)
E(WQ-CWP)	Risk to the health of water-dependent ecosystems from poor water quality (cold water pollution)
E(WQ-WWP)	Risk to the health of water-dependent ecosystems from poor water quality (warm water pollution)
E(WQ)	Risk to the health of water-dependent ecosystems from poor water quality (TP, TN, pH, Turbidity, DO)
E(WQ-S)	Risk to the health of water-dependent ecosystems from poor water quality (instream salinity)
O(WQ-BGA)	Risks to recreational water quality and human health from blue-green algae
O(I-FD)	Risk to water available for other uses from interception activities (farm dams) (regulated rivers)
O(I-PF)	Risk to water available for other uses from interception activities (plantation forestry)
O(I-M)	Risk to water available for other uses from interception activities (mining)
O(I-FH)	Risk to water available for other uses from interception activities (floodplain harvesting)
O(CC)	Risk to water available for other uses from climate change (regulated rivers)
O(BLR)	Risk to water available for other uses from growth in BLR (unregulated rivers)
E(W)	Risks to water available for the environment due to river regulation and licensed extraction (regulated and unregulated)
E(BLR)	Risks to water available for the environment from extraction by basic landholder rights (unregulated)
Z	Zero flows
BF	Base flows
F	Fresh flows
BKF1.5	Bank full flows, average recurrence interval 1.5 years
OB2.5	Over bank flows, average recurrence interval 2.5 years
OB5	Over bank flows, average recurrence interval 5 years
LTWP CF1	Cease-to-flow, no greater than modelled natural maximum inter-flow period, frequency no greater than natural
LTWP VF1	Very-low flow, no greater than modelled natural maximum inter-flow period, frequency in line with natural
LTWP BF1	Base flow, 1 year maximum inter-flow period, annual frequency in line with natural. This term is defined in the LTWP as the flow required to provide minimum depth and connectivity requirements

Abbreviation	Explanation
	to support migratory fish. This is different to the definition used in this risk assessment which defines base flow as a flow percentile or flow component.
LTWP BF2	Base flow, 2 year maximum inter-flow period, frequency 5-10 years in 10 in line with natural. This term is defined in the LTWP as the flow required to provide minimum depth and connectivity requirements to support migratory fish. This is different to the definition used in this risk assessment which defines base flow as a flow percentile or flow component.
LTWP SF1	Small fresh, 1 year maximum inter-flow period, annual frequency.
LTWP SF2	Small fresh, 2 years maximum inter-flow period, frequency 5-10 years in 10.
LTWP LF1	Large fresh, 2 years maximum inter-flow period, frequency 5-10 years in 10.
LTWP LF2	Large Fresh, 4 years maximum inter-flow period, frequency 3-5 years in 10.
LTWP WL1	Small wetland inundation, 18 months maximum inter-event period, frequency 8-10 years in 10
LTWP WL2	Small wetland inundation, 2 years maximum inter-event period, frequency 7-8 years in 10
LTWP WL3	Large wetland inundation, 3 years maximum inter-event period, frequency 5-7 years in 10
LTWP WL4	Large wetland inundation, 5 years maximum inter-event period, frequency 3-5 years in 10
LTWP OB1	Over bank, 2 years maximum inter-flow period, frequency 7-8 years in 10.
LTWP OB2	Over bank, 3–5 years maximum inter-flow period, frequency 4-7 years in 10.
LTWP OB3	Over bank, 4 years maximum inter-flow period, frequency 3-5 years in 10.
LTWP OB4	Over bank, 5 years maximum inter-flow period, frequency 2-3 years in 10.
WSP 1	Regulated and Unregulated WSP — (a) (i) Protect and, where possible, enhance the recorded distribution or extent, and the population structure of, target ecological populations
WSP 2	Regulated and Unregulated WSP — (a) (ii) Protect and, where possible, enhance the longitudinal and lateral connectivity within and between water sources to support target ecological processes
WSP 3	Regulated and Unregulated WSP — (a) (iii) Protect and, where possible, enhance water quality to support water dependent ecosystems and ecosystem functions
WSP 4	Regulated WSP — (b) Support environmental watering to contribute to the maintenance or enhancement of ecological condition in streams, riparian zones, dependent wetlands and floodplains within the water source
WQ 1	Protect, maintain or enhance water quality to ensure it is fit-for-purpose
WQ 2	Manage water source salinity concentrations and salt mobilisation within Lachlan end-of-valley targets
WQ 3	Maintain turbidity, total nitrogen and total phosphorus within target ranges to minimise eutrophication
WQ 4	Maintain dissolved oxygen and pH measurements within target ranges that support water dependent ecosystems
WQ 5	Manage the risk of blackwater events resulting from inundation of benches and floodplains during major flooding events
WQ 6	Maintain water temperature within the regulated Lachlan River within target ranges that support water dependent ecosystems
WQ 7	Manage the risk of harmful algal blooms in recreational use areas.
WQ 8	Manage the risk of harmful algal blooms within the Lachlan regulated river sources
WQ 9	Reduce contamination from pathogens into water sources.

Abbreviation	Explanation
WQ 10	Protect, maintain or enhance connectivity between water sources to support downstream processes including priority carbon and nutrient pathways

Definitions

Access licence	Access licences allow the licence holder a share of the available water in the water source. An access licence is separate from the approvals to use the water or to construct and operate the works to extract the water e.g. pump, dam. Access licences do not have to be renewed.
Allocation	The volume of water assigned to water allocation accounts in a given season, defined according to rules in the relevant water plan.
Aquatic ecosystems	Ecosystems that are dependent on flows, or periodic or sustained inundation/waterlogging for their ecological integrity. Examples include wetlands, rivers, karst and other groundwater-dependent ecosystems, saltmarshes, estuaries and areas of marine water not exceeding 6 m deep at low tide.
Available water	In relation to a water management area or water source, is the water that is available in that area or water source in accordance with an available water determination that is in force in respect of that area or water source.
Available water determination (AWD)	A determination referred to in section 59 of the *Water Management Act 2000* that defines the proportion of the share component that will be available for extraction under each category of water access licence.
Bank full events	Reshapes the channel, creating habitats such as pools, bars and benches. Also called 'high flows'.
Base flows	Flows that are confined to the lower part of the channel and are also often called 'low flows'. These flows are between pools and riffle areas between pools.
Basic landholder rights (BLR)	Domestic and stock rights, harvestable rights or native title rights.
Blue-green algae (cyanobacteria)	A type of microscopic, algae-like bacteria that inhabit freshwater, coastal and marine waters. Some species are known to produce toxins which are harmful to humans and livestock.
Cold water pollution	An artificial decrease in the temperature of water in a natural river.
Consequence	The loss of value for an impacted receptor
Dissolved oxygen	Concentration of oxygen dissolved in water.
Domestic consumption	In relation to land means consumption for normal household purposes in domestic premises on the land.
Ecological value	The perceived importance of an ecosystem which is underpinned by the biotic and/or abiotic components and processes that characterise that ecosystem.
Ecologically significant components of the flow regime	Comprise of cease to flow periods, base flows (low flows), freshes, bank full flows and over bank flows.
Ecosystem	A specific composition of animals and plants that interact with one another and their environment.
Ecosystem functions	The processes that occur between organisms and within and between populations and communities. They include interactions with the nonliving environment that result in existing ecosystems and bring about dynamism through changes in ecosystems over time.
Effluent	An effluent stream is one which leaves the main river and does not return.
Endangered ecological community	Ecological communities as listed in Schedule 1 of the *Threatened Species Conservation Act 1995* or Schedule 4 of the *Fisheries Management Act 1994*.

Eutrophication	The process where an accumulation of nutrients in water bodies leads to rapid growth of aquatic plants.
Farm dams	Private dams that are used to intercept catchment runoff that would otherwise contributed to streamflow or recharge of aquifers. For this risk assessment they are predominantly hillside dams. It does not include floodplain harvesting dams.
Floodplain harvesting dams	Are often entirely encircled by embankments and rely mainly on pumped diversions during episodic flushes or overland flow. Prevalent in southern Queensland and northern NSW.
Freshes	Larger flows that inundate the sides of the banks and any in-channel benches that may be present.
Groundwater-dependent ecosystems	Ecosystems that require access to groundwater to meet all or some of their water requirements so as to maintain their communities of plants and animals, ecological processes and ecosystem services.
High Flows	Reshapes the channel, creating habitats such as pools, bars and benches. Also called bank full events.
Indices	Metrics are combined as indicators and indicators are combined as indices.
Instream Value	Ecological condition value of river reaches based upon High Ecological Value Aquatic Ecosystems (HEVAE). In NSW HEVAE was calculated using the 4 criteria: distinctiveness, diversity, naturalness and vital habitat.
Interception	Occurs when flows or surface or groundwater are stopped, reduced or redirected.
Key Environmental Asset	Better studied key environmental assets identified across the Murray–Darling Basin with significant and representative high-flow requirements.
Likelihood	The probability that a cause will result in a threat. It is not an indication of the size of the threat, but rather conveys the probability that the threat will be significant.
Long term average annual extraction limit	The target for total extractions (under all water access licences plus an estimate of basic landholder rights within an EMU or water source) which is used to assess whether growth in extractions has occurred.
Low flows	Flows that are confined to the lower part of the channel and are also often called base flows. These flows are between pools and riffle areas between pools. Generally defined as the 80th percentile flow.
Macro water sharing plans	Water sharing plans that apply to a number of water sources across catchments or different types of aquifers. The macro planning process is designed to develop broader scale water sharing plans covering most of the remaining water sources in NSW.
Management zones	An area within a water source used for defining the location and applicability of water sharing rules, but secondary to the water source. A management zone is more likely to be designated where local dealing restrictions are in place or where ‘cease to pump’ (CtP) rules for works approvals apply.
Metric	A numerical comparison of an observed variable and its value expected under reference condition.
Nitrogen and phosphorous	Chemical nutrients essential for growth and added to many fertilisers.
Operational constraints	Existing infrastructure systems that may preclude the delivery of certain flows.
Over bank flows	Connect the river to floodplain and wetlands allowing the exchange of nutrients and sediment to these areas.

Pools	Lentic water bodies (standing water), including anything falling within the definition of a “lake” found in the Dictionary of the *Water Management Act 2000*, except for tidal pools and estuaries.
Reference condition	Is the benchmark against which the health of the ecosystem metric is assessed. Reference condition describes the patterns and processes that would be expected to prevail without substantial human intervention. A reference condition is not a target or an implied objective for management but is merely representing the river ecosystem in a definitive state of good health.
Regulated river	Gazetted under the NSW *Water Management Act 2000* and is a river where downstream flows are regulated by a major state-owned storage or dam to supply irrigation water.
Replenishment flows	Flows provided along effluent systems to supply water for household, town use and stock.
Salinity	The concentration of sodium chloride or other dissolved minerals in water, usually expressed in EC units or milligrams of total dissolved solids per litre. Conversion factor is 0.64 mg/l TDS = 1000 µS/cm = 1 dS/m.
SDL resource unit	Means the water sources, or particular parts of the water resources, of a water resource plan area that is either a surface water SDL resource unit or groundwater SDL resource unit.
Seasonality	The timing of flooding and low flow events.
Stock watering	The watering of stock animals being raised on the land but does not include water in connection with the raising of stock animals on an intensive commercial basis that are housed or kept in feedlots or buildings for all (or a substantial part) of the period during which the stock animals are being raised.
Stratification	The formation of separate water layers.
Supplementary water	Formerly known as off-allocation water, this is surplus flow resulting from storm events that cannot be captured in storages or weirs. When the water is not needed to meet current demands or commitments, then it is considered surplus to requirements and a period of Supplementary Access is announced. Supplementary Water Access Licence holders can only pump water against these licences during these announced periods. Other categories of licence holders may also pump water during these periods.
Trade zones	A trading zone represents a portion of a water source which may then be specified so that trading rules can be applied, if required.
Warm water pollution	An artificial increase in the temperature of water in a natural river.
Water access entitlement	A water product issued under the *Water Management Act 2000*.
Water sources	Under the *Water Management Act 2000*, is defined as the whole or any part of: (a) one or more rivers, lakes or estuaries, or (b) one or more places where water occurs on or below the surface of the ground (including overland flow water flowing over or lying there for the time being), and includes the coastal waters of the State. Water sources are used to define where water sharing rules apply

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Appendix A - Data summary tables

Table A-1. Summary of data used for the Lachlan Water Resource Plan Area risk assessment

#	Metric	Data description	Report reference	Relevant risk #		Data source/s	Reference	Time period	Data confidence	Reasoning
	Basin Plan requirements	The MDBA provides a number of Position Statements (PS) that provide guidance material	not listed (generic background information logic to the RA)			1. Relevant Position Statements (PS) for the development of a Risk Assessment include but are not limited to: PS 1B, 4A, 5A, 6A, 7B, 9A, 9B, 12A	https://www.mdba.gov.au/publications/policies-guidelines/water-resource-plans-what-they-are-how-they-are-developed	Not Applicable (N/A)	N/A	Position statements are designed to assist in the development of water resource plans by the Basin states.
1	Hydrological modelling - regulated river	Flow Metrics (hydrological alteration): 2800 GL reduction scenario (MDBA 2012) against near-natural condition scenario	4.3.1 (Regulated river water source)	E(W)	Likelihood	1. MDBA 2012. Hydrologic modelling to inform the proposed Basin Plan - methods and results. Murray–Darling Basin Authority, Canberra, ACT. 2. Alluvium (2010) Key ecosystem functions and their environmental water requirements. Report by Alluvium for Murray–Darling Basin Authority, Canberra, ACT. 3. Regulated River Sites: NSW Department of Planning and Environment IQQM (Integrated Quantity Quality Model) used for both MDBA and NSW Department of Planning and Environment sites. 4. MDBA modelling report appendix - 2800 GL scenario - 847	**Regulated River Hydrologic Sites**: Lachlan at Wyangala Dam Lachlan at Jemalong Weir Lachlan at Willandra Weir Lachlan at Booligal Weir Willandra Creek flow node Belubula River at Carcoar Belubula River at Helensholme	July 1895 to June 2009	High	Peer reviewed MDBA (MDBA 2012) & Alluvium (2010) reports. The models provide a tool to apply new management of water resources across a longer period to see how the new arrangements would work under different water availability conditions. For the Basin Plan, the proposed new arrangements have been applied to the historical climate period of July 1895 to June 2009, which covers periods of drought as well as floods. A detailed description for the development of environmental watering requirements for key ecosystem functions and the basis for adopting the flow metrics can be found in 'Attachment C Technical Paper-3' (pp.90-134) in Alluvium (2010).

#	Metric	Data description	Report reference	Relevant risk #		Data source/s	Reference	Time period	Data confidence	Reasoning
2	Hydrological modelling - unregulated water sources	Flow Metrics (hydrological alteration): 2,800 GL reduction scenario (MDBA 2012) against near-natural condition scenario	4.3.1 (Unregulated water sources)	E(W)	Likelihood	1. Unregulated water sources: single reach the NSW Department of Planning and Environment IQQM.	**Unregulated River hydrologic Sites:** Abercrombie R above Wyangala Belubula R above Carcoar Dam Belubula Tributaries below Carcoar Dam Bogandillon and Manna Creeks Boorowa River and Hovells Creek Burrangong Creek Crookwell River Crowther Creek Goobang and Billabong Creeks Goonigal and Kangarooby Creeks Gunningbland and Yarrabandai Humbug Creek Lachlan River above Reids Flat Lake Forbes and Back Yamma Creek Mandagery Creek ** Mid Lachlan Unreg Mount Hope Area Naradhan Area Ooma Creek and Tributaries Tyagong Creek Unreg Effluent Creeks Waugoola Creek Western Bland Creek	July 1895 to June 2009	Moderate	The assessment assumes all entitlement is active, whereas this is unlikely to be the case. The method assumes the worst case scenario and therefore likelihood may be overemphasised.

#	Metric	Data description	Report reference	Relevant risk #		Data source/s	Reference	Time period	Data confidence	Reasoning
3	basic landholder rights - unregulated water sources	Based on dividing the 80th percentile flow (for all days) for each water source by the estimated BLR.	4.4.1	E(BLR)	Likelihood	1. Unregulated water sources: single reach NSW Department of Planning and Environment IQQM. 2. Basic landholder rights for NSW: Estimations of stock & domestic rights Dept of Water & Energy, September 2009. 3. NOW (2011), Macro water sharing plans - the approach for unregulated rivers. A report to assist community consultation, 2nd edition. Published by the NSW Office of Water, August 2011, ISBN 978 0 7371 3917	**Unregulated River hydrologic Sites:** Abercrombie R above Wyangala Belubula R above Carcoar Dam Belubula Tributaries below Carcoar Dam Bogandillon and Manna Creeks Boorowa River and Hovells Creek Burrangong Creek Crookwell River Crowther Creek Goobang and Billabong Creeks Goonigal and Kangarooby Creeks Gunningbland and Yarrabandai Humbug Creek Lachlan River above Reids Flat Lake Forbes and Back Yamma Creek Mandagery Creek ** Mid Lachlan Unreg Mount Hope Area Naradhan Area Ooma Creek and Tributaries Tyagong Creek Unreg Effluent Creeks Waugoola Creek Western Bland Creek		Low / Moderate	Low confidence level: some water sources had insufficient or no data. Moderate confidence: BLR usage figures are estimates only: i.e., all entitlements are assumed to be active. Method needs further testing across valleys. A WRP must ensure that BLRs are maintained at baseline diversion levels (generally set at the 30 June 2009 diversion limit) (MDBA 2017. Water Compliance Review. ISBN (online): 978-1-925599-55-8)
4	Pest plants and animals	Qualitative assessment	5			Expert opinion	none	Not applicable (N/A)	Low	Qualitative assessment based on NSW Department of Planning and Environment ecohydrology specialist expert opinion
5	Risk from climate change – estimated for regulated and unregulated water sources	Extrapolation of CSIRO MDBSY Project modelling of Booligal Wetlands and Great Cumbung Swamp	4.6.4	E(CC)	Likelihood	1. CSIRO (2007) Water availability in the Lachlann. A report to the Australian Government from the CSIRO Murray-darling Basin Sustainable Yields Project. CSIRO, Australia 2. CSIRO 2008, Water availability in the Murray-Darling Basin; A report to the Australian Government from the CSIRO Murray-Darling Basin Sustainable Yields Project. CSIRO, Australia.	Booligal Wetlands and Great Cumbung Swamp		Low	Extrapolation of outcomes from a single modelled location, applied to all reaches and water sources in WRP area
6	Interception due to floodplain harvesting	Preliminary modelled estimate of total floodplain harvesting volume	4.5.4	E(HFH)	Likelihood	DPI Water modelling			Low	Preliminary modelling, indicative only. Modelled estimate is for the WRP Area, no finer scale available

<table>
<tr><th>#</th><th>Metric</th><th>Data description</th><th>Report reference</th><th>Relevant risk #</th><th></th><th>Data source/s</th><th>Reference</th><th>Time period</th><th>Data confidence</th><th>Reasoning</th><th></th></tr>
<tr><td>7</td><td>High ecological value aquatic ecosystems</td><td>HEVAE (high ecological value aquatic ecosystem) - Identifying environmental assets and ecosystems functions</td><td>4.2
4.2.3
4.3.3
4.5.1.1
4.5.2.1
4.5.4.1
6.3.1 (Regulated river water source)
6.4.1
6.5.1
See also Appendix B: HEVAE alignment with Basin Plan Schedules 8 & 9 Appendix C: HEVAE consequence scoring & decision tree</td><td>E(W)
E(BLR)
E(I-FD)
E(I-PF)
E(I-FH)
E(CC)
E(WQ-CWP)
E(WQ-WWP)
E(WQ)
E(WQ-S)</td><td>Consequence</td><td>1. HEVAE data based on the following sources:

Table 1: Data sources used in each of the criteria
<table><tr><th>Criteria</th><th>Data Sources</th></tr><tr><td>Base layer in all criteria</td><td>• River Styles® (DPI Water)
• Geofabric data layer (BOM)
• IBRA Subregions layer (OEH)</td></tr><tr><td>Diversity</td><td>• Fish diversity data (DPI Fisheries)
• AUSRIVAS macroinvertebrate data (OEH)</td></tr><tr><td>Distinctiveness</td><td>• Threatened species, populations and communities (recorded, known and predicted data) (OEH and DPI Fisheries)
• Rare River Styles® (DPI Water)</td></tr><tr><td>Vital Habitat</td><td>• Riparian Woody Extent raster dataset (DECC 2008)
• River Styles® recovery potential (DPI Water)</td></tr><tr><td>Naturalness</td><td>• Hydrologic stress and catchment disturbance (from River Condition Index) (DPI Water);
• Natural Parks estate (OEH)
• RAMSAR/DIWA/SEPP14 (Coastal) (OEH)
• Observed/Expected (O/E) macroinvertebrate data (OEH)</td></tr></table>Table A1 within Healey et al. (2017) also provides examples of primary evidence for each attribute within a HEVAE Criteria that is influenced / associated with hydrological flow.</td><td>1. Healey et al. 2017. Draft Applying the High Ecological Value Aquatic Ecosystem (HEVAE) Framework to Water Management Needs in NSW. DPI Water. June 2017.
2. Aquatic Ecosystems Task Group. 2012. Aquatic Ecosystems Toolkit Module 3: Guidelines for identifying high ecological value aquatic ecosystems (HEVAE). Australian Government Department of Sustainability, Environment, Water, Population and Communities, Canberra.</td><td>Time periods vary for each source: Examples for the following criteria: 'Diversity' fish species abundance data covered a 10-yr period: 2002 - 2011. 'Naturalness' macroinvertebrate data from 1994 - 2013. For more information see Healey et al. 2017.</td><td>High</td><td>A. External Peer review by three independent organisations and also from NSW DPI-Fisheries.
B. The Threatened Species Table below provides an example list of threatened species of the Lachlan Catchment. This information is used in helping determine consequence outcomes in the HEVAE process.</td><td>How Consequence Scores are derived:
Unregulated rivers, the scale of assessment was the Water Source. Each was analysed separately using the HEVAE layer, a licensing layer and the reg river layer (where reg river is excluded from water source);
Regulated river reaches are assessed separately, using the same process and decision tree, but based on individual reaches centred on Hydrologic Indicator sites.
Decision Tree:
The decision tree pushes the user through a series of questions about the ecological value of the Water Source, whether there is extraction in the Water Source, and whether the HEVAE result includes a high 'distinctiveness' metric (i.e. threatened species, populations, communities or rare river styles)</td></tr>
</table>

#	Metric	Data description	Report reference	Relevant risk #		Data source/s	Reference	Time period	Data confidence	Reasoning
	Water quality	Documented procedures are stored in the Corporate Data Quality System (Scientific and Technical Operating Procedures; STOP). All laboratory analysis undertaken at a NATA accredited laboratory. All data was audited and validated in accordance with documented procedures. Quality codes were assigned and the data archived in the Corporate Database (KiWQM).	6. Risks to health of water-dependent ecosystems from poor water quality	E(WQ) E(WQ-CWP) E(WQ-WWP) E(WQ-S)		1. Schedule 11 of Basin Plan lists water quality targets for water-dependent ecosystems and Ramsar wetlands.	Basin Plan 2012, Compilation No.2 (24 November 2016) registered 23 January 2017. W*ater Act 2007*, Commonwealth.	2010/11 - 2014/15 (5-year period)	High	The Basin States are required to report against these targets to the MDBA every five years. For this reason, five years of water quality data was used in the Risk assessment, to be consisted with the MDBA reporting requirement. All data are generated according to documented procedures for collecting samples, providing quality control samples and the preservation and transport of samples as recommended in Australia Standard AS/NZS 5667.1:1998 Water Quality Sampling. All procedures are based on, and comply with, recognised departmental and external standards to ensure that the project delivers data of the highest possible standard. HEVAE instream values used to determine impact of water quality on instream biota only at the reach scale (25-km upstream and downstream) and are therefore an approximation for the whole water source.
8	Cold and warm water pollution	Real-time gauge based monitoring	6.3.2	E(WQ-CWP) E(WQ-WWP)	Likelihood	1. WaterNSW water quality monitoring stations. 2. Preece, R 2004, Cold water pollution below dams in New South Wales, Department of Infrastructure, Planning and Natural Resources, Sydney. 3. Lugg A & Copeland C 2014, Review of cold water pollution in the Murray–Darling Basin and the impacts on fish communities, *Ecological Management & Restoration* vol. 15, pp. 71-79.	Lachlan River Wyangala Dam downstream to approximately Forbes (approx. 200 km)	July 2009 to June 2016.	High	Based on Real-time data.
9	Water quality - pH, turbidity, total phosphorus & nitrogen, dissolved oxygen	Routine real-time site based sampling	6.4.2	E(WQ)	Likelihood	1. WaterNSW water quality monitoring stations	412009 Belubula River at Canowindra 412004 Lachlan River at Forbes (Cotton's Weir) 412006 Lachlan River at Condobolin Bridge 412011 Lachlan River at Lake Cargelligo Weir 412039 Lachlan River at Hillston Weir 412005 Lachlan River at Booligal 412045 Lachlan River at Corrong 412027 Lachlan River at Reids Flat 41210123 Abercrombie River at Camping Area 412029 Boorowa River at Prossers Crossing	2010/11 - 2014/15 (5-year period)	High	Based on Real-time data.

#	Metric	Data description	Report reference	Relevant risk #		Data source/s	Reference	Time period	Data confidence	Reasoning
10	Levels of instream salinity	Real-time gauge based monitoring	6.5.2	E(WQ-S)	Likelihood	1. WaterNSW water quality monitoring stations	End of valley target: 412004 Lachlan River at Forbes	2010/11 - 2014/15 (5-year period)	High	Based on Real-time data.
	Water quality for other uses		7. Risk to other water uses due to unsuitable water quality	O(WQ) O(WQ-BGA) O(WQ-S)		1. WaterNSW water quality monitoring stations	End of valley target: 412004 Lachlan River at Forbes	2010/11 - 2014/15 (5-year period)	High	Based on Real-time data.
11	Recorded mean daily electrical conductivity 2005/06 – 2014/15	Continuous real-time gauge based monitoring	7.3.1	O(WQ-S)	Consequence	1. WaterNSW water quality monitoring stations	End of valley target: 412004 Lachlan River at Forbes	2010/11 - 2014/15 (5-year period)	High	Based on Real-time data.
12	Annual 95th percentile of daily mean electrical conductivity recorded between 2004/05 to 2014/15	Frequency that the 95th percentile of mean daily electrical conductivity exceeds the irrigation salinity target for 10-yr (Northern Basin target = 957µS/cm)	7.3.2	O(WQ-S)	Likelihood	1. WaterNSW water quality monitoring stations	End of valley target: 412004 Lachlan River at Forbes	2010/11 - 2014/15 (5-year period)	High	Based on Real-time data.
13	Degree of recreation usage	Level of recreational usage for four monitoring sites	7.4.2	O(WQ-BGA)	Consequence	1. WaterNSW water quality monitoring stations	Carcoar Dam Belubula River downstream Carcoar Dam Water Supply Reservoir, Cadia Gold Mine Wyangala Dam Lachlan River downstream Wyangala Dam Lachlan River at Cowra Lachlan River at Forbes (Cottons Weir) Lake Forbes Lachlan River at Condobolin Gum Bend Lake Lachlan River at Lake Cargelligo Weir Lake Cargelligo Curlew Water Lake Creek at Lake Cargelligo outlet Lachlan River at Willandra Weir Lachlan River at Lake Brewster Weir Lake Brewster Lachlan River at Hillston Lachlan River at Booligal Lachlan River at Corrong	2006/07 – 2013/14 (8 year period)	Moderate	Based on monitoring data

#	Metric	Data description	Report reference	Relevant risk #		Data source/s	Reference	Time period	Data confidence	Reasoning
14	Average annual duration of red alters for blue-green algae	Blue-green algae (BGA) samples used as an indicator because of the potential for some species of BGA to impact on health. Alert levels in place and are used to determine the actions that need to be undertaken in respect to an algal incident adopted from the National Health and Medical Research Council algal bloom response guidelines (NHRMC 2008).	7.4.3	O(WQ-BGA)	Likelihood	1. WaterNSW Algal Website: http://www.waternsw.com.au/water-quality/algae	Carcoar Dam Belubula River downstream Carcoar Dam Water Supply Reservoir, Cadia Gold Mine Wyangala Dam Lachlan River downstream Wyangala Dam Lachlan River at Cowra Lachlan River at Forbes (Cottons Weir) Lake Forbes Lachlan River at Condobolin Gum Bend Lake Lachlan River at Lake Cargelligo Weir Lake Cargelligo Curlew Water Lake Creek at Lake Cargelligo outlet Lachlan River at Willandra Weir Lachlan River at Lake Brewster Weir Lake Brewster Lachlan River at Hillston Lachlan River at Booligal Lachlan River at Corrong	2006/07 – 2013/14 (8 year period)	High	Based on Real-time data. The water quality targets for water used for recreational purposes are that the values for cyanobacteria cell counts or bio-volume meet the guideline values set out in Chapter 6 of the Guidelines for Managing Risks in Recreational Water. National Health and Medical Research Council 2008, Guidelines for managing risks in recreational water. (National Health and Medical Research Council, Canberra).
15	Human consumption		7.5	O		1. The Public Health Act 201 2. Public Health Regulation 2012 r 3. Drinking Water Management System (DWMS)		N/A	N/A	Local councils have management strategies identified in the Drinking Water Management Systems.
16	Indigenous & Socio-economic	Placeholder.	7.6 & 8.5	O				N/A	N/A	Cultural requirements addressed in a separate document. Socio-economic not assessed due to lack of data.
	Interception activities	Risk due to interception activities - farm dams, commercial plantations, mining, floodplain harvesting	4.5 8.2	E(I-FD) E(I_PF) O(I-FD) O(I-PF)		1. CSIRO 2008b, Water availability in the Murray–Darling Basin; A report to the Australian Government from the CSIRO Murray–Darling Basin Sustainable Yields Project. CSIRO, Australia. 2. Van Dijk AIJM, et al. (2008) Uncertainty in river modelling across the Murray–Darling Basin. A report to the Australian Government from the CSIRO Murray–Darling Basin Sustainable Yields Project, CSIRO Australia. 93pp.			Moderate / High	CSIRO project undergone extensive peer review. Furthermore, NSW obtained the model output data from the MDBYS project (2008) and extracted 112 year time series on a daily time-step as well as the reliability data to improve the quality of analysis (NOW 2010).

#	Metric	Data description	Report reference	Relevant risk #		Data source/s	Reference	Time period	Data confidence	Reasoning
17	Growth in farm dams	Farm dam and plantation impacts on streamflow estimated using the SIMHYD rainfall-runoff model; this data was adapted to fit into river system models of state agencies (Van Dijk et al. 2008). A 2030 farm dam development scenario was developed by considering current distribution and policy controls and trends in farm dam expansion.	4.5.1.2 8.2.1.2	E(I-FD) O(I-FD)	Likelihood	1. NOW 2010, *Assessment of risk to NSW Murray–Darling Basin shared water resources – 2008*, NSW Office of Water, Sydney. 2. Sustainable Rivers Audit 2 (SRA) in: MDBA 2011, Assessment of the hydrological impact of farm dams in the Murray–Darling Basin. Murray– Darling Basin Authority, Canberra. https://www.mdba.gov.au/sites/default/files/archived/annualreports/2011-12/chapter_02_6.html 3. CSIRO 2008, Water availability in the Murray–Darling Basin; A report to the Australian Government from the CSIRO Murray–Darling Basin Sustainable Yields Project. CSIRO, Australia.	Booligal Wetlands Great Cumbung Swamp High Security General Security	Based on 2004/2005 satellite imagery (MDBYS Project) compared to 1994 to determine growth trends over 10-yr. Also based on period of prediction (from 2020 - 2030) and current period (from 2003 - 2008) (Van Dijk, 2008).	Moderate / High	Peer reviewed. 1. The estimated uncertainty associated with farm dam growth and plantation expansion is estimated in the order of 1 percent of total inflows across the MDB, increasing up to about 3 percent in sensitive regions, and more in certain catchments within regions. These are small numbers when compared to climate and other uncertainties (Van Dijk, 2008). 2. The uncertainty associated with the impact of farm dams is greater than that associated with forestry, particularly when considering the large uncertainty in farm dam expansion rate estimates. The estimate rate is about an order of magnitude smaller than rates in the recent past and therefore this must still be considered a significant uncertainty. If farm dam construction rates were to be closer to historical rates their impact would be very significant in several regions, and therefore this may still be considered a significant risk (Van Dijk, 2008). 1. Control measure: harvestable rights provisions which are one of the basic landholder rights under the WMA (NOW 2010). 2. Farm dams, forestry plantations and floodplain harvesting are all instances of non-metered take. Therefore, the hydrometric network and hydrological modelling are the way in which estimates are derived (MDBA 2017. The Murray–Darling Basin Water Compliance Review. Licensed from the MDBA under a Creative Commons Attribution 4.0 Licence).
18	Ability to meet environmental flow objectives		4.5.1.1	E(I-FD)	Consequence		Booligal Wetlands Great Cumbung Swamp		Moderate / High	
19	Change in average annual diversions and allocations for licence holders		8.2.1.1	O(I-FD)	Consequence		High Security General Security		Moderate / High	

#	Metric	Data description	Report reference	Relevant risk #		Data source/s	Reference	Time period	Data confidence	Reasoning
20	Growth in farm dams	Deviation in flow indices from the reference (near natural) regime (SKM 2011)	4.5.1.2	E(I-FD)	Likelihood	1. Sustainable Rivers Audit 2 (SRA) in: MDBA 2011, Assessment of the hydrological impact of farm dams in the Murray–Darling Basin. 2. Murray–Darling Basin Authority, Canberra. https://www.mdba.gov.au/sites/default/files/archived/annualreports/2011-12/chapter_02_6.html 2. NOW 2010, Assessment of risk to NSW Murray–Darling Basin shared water resources – 2008, NSW Office of Water, Sydney. 3. CSIRO 2008, Water availability in the Murray–Darling Basin; A report to the Australian Government from the CSIRO Murray–Darling Basin Sustainable Yields Project. CSIRO, Australia. 4. NOW 2010, Assessment of risk to NSW Murray–Darling Basin shared water resources – 2008, NSW Office of Water, Sydney. 5. SKM (2011) Assessment of the hydrological impact of farm dams in the Murray–Darling Basin. Murray–Darling Basin Authority, Canberra, ACT	Abercrombie River at Abercrombie Abercrombie River at Hadley No.2 Belubula River at the Needles Bland Creek at Morangarell Boorowa River at Prossers Crossing Coombing Creek at Near Neville Crookwell River at Narrawa North Flyers Creek at Beneree Lachlan River at Gunning Lachlan River at Narrawa Mandagery Creek at u/s Eugowra (Smithfield) Pudmans Creek at Kennys Creek Rd Rocky Bridge at Near Neville Tuena Creek at Tuena Wattle Creek at Dudauman	Based on 2008/2010 SRA2 Audit. Also based on period of prediction (from 2020 - 2030) and current period (from 2003 - 2008) (Van Dijk, 2008).	Moderate / High	Peer reviewed. The estimated uncertainty associated with farm dam growth and plantation expansion is estimated in the order of 1 percent of total inflows across the MDB, increasing up to about 3 percent in sensitive regions, and more in certain catchments within regions. These are small numbers when compared to climate and other uncertainties. The uncertainty associated with the impact of farm dams is greater than that associated with forestry, particularly when considering the large uncertainty in farm dam expansion rate estimates. The estimate rate is about an order of magnitude smaller than rates in the recent past and therefore this must still be considered a significant uncertainty. If farm dam construction rates were to be closer to historical rates their impact would be very significant in several regions, and therefore this may still be considered a significant risk (Van Dijk, 2008). Farm dams, forestry plantations and floodplain harvesting are all instances of non-metered take. Therefore, the hydrometric network and hydrological modelling are the way in which estimates are derived (MDBA 2017. The Murray–Darling Basin Water Compliance Review. Licensedfrom the MDBA under a Creative Commons Attribution 4.0 Licence).
21	HEVAE (see 4 above)	See 4 above	4.5.1.1	E(I-FD)	Consequence	See 4 above	Abercrombie River at Abercrombie Abercrombie River at Hadley No.2 Belubula River at the Needles Bland Creek at Morangarell Boorowa River at Prossers Crossing Coombing Creek at Near Neville Crookwell River at Narrawa North Flyers Creek at Beneree Lachlan River at Gunning Lachlan River at Narrawa Mandagery Creek at u/s Eugowra (Smithfield) Pudmans Creek at Kennys Creek Rd Rocky Bridge at Near Neville Tuena Creek at Tuena Wattle Creek at Dudauman	See42 above	See 4 above	See 4 above.

#	Metric	Data description	Report reference	Relevant risk #		Data source/s	Reference	Time period	Data confidence	Reasoning
22	Growth in plantation forestry (regulated)	Farm dam and plantation impacts on streamflow estimated using the SIMHYD rainfall-runoff model; this data was adapted to fit into river system models of state agencies (Van Dijk et al. 2008). A 2030 farm dam development scenario was developed by considering current distribution and policy controls and trends in farm dam expansion.	4.5.2 8.2.2	E(I-PF) O(I-PF)	Likelihood	1. SMEC 2010, Afforestation risks to water resources in the Murray–Darling Basin, Murray–Darling Basin Authority, Canberra; 2. CSIRO 2008, Water availability in the Murray–Darling Basin; A report to the Australian Government from the CSIRO Murray–Darling Basin Sustainable Yields Project. CSIRO, Australia. 3. NOW 2010, Assessment of risk to NSW Murray–Darling Basin shared water resources – 2008, NSW Office of Water, Sydney. 4. SKM (2011) Assessment of the hydrological impact of farm dams in the Murray–Darling Basin. Murray–Darling Basin Authority, Canberra, ACT	Booligal Wetlands Great Cumbung Swamp High Security General Security	Based on 2004/2005 satellite imagery (MDBYS Project). Also based on period of prediction (from 2020 - 2030) and current period (from 2003 - 2008) (Van Dijk, 2008).	Moderate / High	Peer reviewed. The estimated uncertainty associated with farm dam growth and plantation expansion is estimated in the order of 1 percent of total inflows across the MDB, increasing up to about 3 percent in sensitive regions, and more in certain catchments within regions. These are small numbers when compared to climate and other uncertainties (Van Dijk, 2008). Plantations and Reafforestation Act controls the establishment and harvesting of plantations, although importantly it doesn't currently account for water use impacts. No methods have yet been developed to look at the probability of future bushfires and their hydraulic impact (NOW 2010).
23	Ability to meet environmental flow objectives		4.5.2	E(I-PF)	Consequence	1. NOW 2010, Assessment of risk to NSW Murray–Darling Basin shared water resources – 2008, NSW Office of Water, Sydney. 2. Sustainable Rivers Audit 2 (SRA) in: MDBA 2011, Assessment of the hydrological impact of farm dams in the Murray–Darling Basin. Murray– Darling Basin Authority, Canberra. https://www.mdba.gov.au/sites/default/files/archived/annualreports/2011-12/chapter_02_6.html 3. CSIRO 2008, Water availability in the Murray–Darling Basin; A report to the Australian Government from the CSIRO Murray–Darling Basin Sustainable Yields Project. CSIRO, Australia.	Booligal Wetlands Great Cumbung Swamp			
24	Change in average annual diversions and allocations for licence holders		8.2.2	O(I-PF)	Consequence		High Security General Security			
25	Mining area and growth	Mining area, type and growth	4.5.3 & 8.2.3	E(I-M) O(I-M)		1. 'Catchment scale land use mapping for Australia update November 2012 (CLUM Update 11/12) dataset'. Australian Bureau of Agricultural and Resource Economics and Sciences, Canberra 2. https://minview.geoscience.nsw.gov.au		2014 - urrent	Moderate/High	
26	Floodplain harvesting volumes	Qualitative/Expert opinion	4.5.4 and 8.2.3	E(I-FH) O(I-FH)		1. DPI-Water 2017. Draft Floodplain harvesting Monitoring Policy. March 2017. Department of Primary Industries - Water. https://www.water.nsw.gov.au/__data/assets/pdf_file/0016/700801/Draft-floodplain-harvesting-monitoring-policy.pdf		N/A	N/A	To be managed under Floodplain licencing framework. Farm dams, forestry plantations and floodplain harvesting are all instances of non-metered take. Therefore, the hydrometric network and hydrological modelling are the way in which estimates are derived (MDBA 2017. The Murray–Darling Basin Water Compliance Review. Licensed from the MDBA under a Creative Commons Attribution 4.0 Licence).

#	Metric	Data description	Report reference	Relevant risk #		Data source/s	Reference	Time period	Data confidence	Reasoning
27	Future climate scenarios	The MDBSY project assessed scenarios: i.e., historical climate change & current development; recent climate change & current development; future climate change and current & future development, respectively. All scenarios are defined at daily time series of climate variables based on different scaling of the historical 1895 - 2006 climate sequence (Van Dijk et al. 2008).	4.6.2 8.4.2	E(CC) O(CC)	Likelihood	1. NOW 2010, Assessment of risk to NSW Murray–Darling Basin shared water resources – 2008, NSW Office of Water, Sydney. 2. CSIRO 2008, Water availability in the Murray–Darling Basin; A report to the Australian Government from the CSIRO Murray–Darling Basin Sustainable Yields Project. CSIRO, Australia. 3. Van Dijk, et al. (2008) Uncertainty in river modelling across the Murray–Darling Basin. A report to the Australian Government from the CSIRO Murray–Darling Basin Sustainable Yields Project, CSIRO Australia. 93pp.	Booligal Wetlands Great Cumbung Swamp High Security General Security	The average rainfall during the calibration period (Lachlan: 1985-1990) was compared to the long-term average rainfall, the number of years in the historical record (1895 to 2006) (Van Dijk 2008).	Low / Moderate	CSIRO project undergone extensive peer review. NSW obtained the model output data from the MDBYS project (2008) and extracted 112 year time series on a daily time-step as well as the reliability data to improve the quality of analysis (NOW 2010). Historical 112-year climate transformed to have the same statistics as the second-wettest, second-driest and median predictions of climate change by 15 different global climate models given three alternative emission scenarios (Cwet, Cdry and Cmid scenarios). However, there is still relatively high uncertainty associated with natural variability and also uncertainty associated with the range of climate models, with this combined uncertainty considered greater than the 'best estimate' climate change projection (Van Dijk, et al. 2008). 1. This section addresses NSW's obligations under the Basin Plan (2012): Chapter 10, Part 9: Section 10.41(1) - A water resource plan must be prepared having regard to current and future risks to the condition and continued availability of the water resource plan area. 2. Water Sharing Plans are the control mechanism which base water sharing decisions on the availability of flow and therefore they implicitly adjust for both climate variability and change. The legislation enables powers to temporarily suspend water sharing rules during extreme climatic conditions. WSPs are reviewed on a 10-yr cycle and the climatic record used as input to these planning decisions is based on all of the available data up to that point. 3. There is currently no explicit adjustment to the input data or selective sequencing from the data to use as input to the planning process to allow for potential future climate change. Water sharing plans cover all of the regulated systems in NSW, i.e. all but the Barwon-Darling in this risk assessment. In the Barwon-Darling, licence conditions on entitlements specify access rules based on the occurrence of flows above a specified level prior to allowing pumping to occur. These therefore implicitly allow for both climate variability & change (NOW 2010).
28	Ability to meet environmental flow objectives		4.6	E(CC)	Consequence		Booligal Wetlands Great Cumbung Swamp			
29	Change in average annual diversions and allocations for licence holders		8.3.2	O(CC)	Consequence		High Security General Security			

#	Metric	Data description	Report reference	Relevant risk #		Data source/s	Reference	Time period	Data confidence	Reasoning
Growth in basic landholder rights										
30	Growth in basic landholder rights	Based on dividing the 80th percentile flow (for all days) for each water source by the estimated BLR.	4.4.1 8.4 (other uses)	E(BLR)	Likelihood	1. WaterNSW gauging stations	Abercrombie River above Wyangala Belubula River above Carcoar Dam Belubula Tributaries below Carcoar Dam Bogandillon and Manna Creeks Boorowa River and Hovells Creek Burrangong Creek Crookwell River Crowther Creek Goobang and Billabong Creeks Goonigal and Kangarooby Creeks Gunningbland and Yarrabandai Humbug Creek Lachlan River above Reids Flat Lake Forbes and Back Yamma Creek Mandagery Creek Mid Lachlan Unregulated Mount Hope Area Naradhan Area Ooma Creek and Tributaries Tyagong Creek Unreg Effluent Creeks Waugoola Creek Western Bland Creek		Low	BLR usage figures are estimates only: i.e., all entitlements are assumed to be active. Method needs further testing across valleys. This section also addresses Chapter 10, part 9: section 10.41 (1) outlined above. Also covers NSW obligations under section 10.41 (3) in identifying risk, and regard to risks identified in Section 4.02 (2). A WRP must ensure that BLRs are maintained at baseline diversion levels (generally set at the 30 June 2009 diversion limit) (MDBA 2017. Water Compliance Review. ISBN (online): 978-1-925599-55-8)
31	Growth in basic landholder rights	Ratio of BLR volume to total licensed entitlement	8.4.2	O(BLR)	Likelihood	1. WaterNSW gauging stations 2. NSW Water Register 3. Basic landholder rights for NSW: Estimations of stock & domestic rights Dept of Water & Energy, September 2009.	Abercrombie River above Wyangala Belubula River above Carcoar Dam Belubula Tributaries below Carcoar Dam		High	

#	Metric	Data description	Report reference	Relevant risk #		Data source/s	Reference	Time period	Data confidence	Reasoning	
32	Volume of entitlement	Volume of entitlement (2015)	8.4.1	O(BLR)	Consequence	1. NSW Water Register	Bogandillon and Manna Creeks Boorowa River and Hovells Creek Burrangong Creek Crookwell River Crowther Creek Goobang and Billabong Creeks Goonigal and Kangarooby Creeks Gunningbland and Yarrabandai Humbug Creek Lachlan River above Reids Flat Lake Forbes and Back Yamma Creek Mandagery Creek Mid Lachlan Unregulated Mount Hope Area Naradhan Area Ooma Creek and Tributaries Tyagong Creek Unreg Effluent Creeks Waugoola Creek Western Bland Creek		High		

Table A-2. Threatened species in Lachlan Catchment

Common name	Scientific name	Distinctiveness parameter	NSW status	Commonwealth listing	Flow sensitivity weighting	Status weights	Layers from OEH
Lowland Lachlan River EEC	Lowland Lachlan River EEC	EEC	Endangered Ecological Community	Not Listed	4	3	Known
Booroolong Frog	*Litoria booroolongensis*	Frog	Endangered	Endangered	4	3	Known
Yellow-spotted tree frog	*Litoria castanea*	Frog	Critically endangered	Endangered	4	4	Predicted
Southern Bell	*Litoria raniformis*	Frog	Endangered	Vulnerable	4	3	Known & Predicted
Stuttering Frog	*Mixophyes balbus*	Frog	Endangered	Vulnerable	4	3	Known
Macquarie Perch	*Macquaria australasica*	Fish	Endangered	Endangered	4	3	Recorded
Southern pygmy perch	*Nannoperca australis*	Fish	Endangered	not listed	4	3	Recorded
Murray cod	*Maccullochella peelii*	Fish	not listed	Vulnerable	4	2	Recorded
Silver perch	*Bidyanus bidyanus*	Fish	Vulnerable	Critically Endangered	4	4	Recorded
Eel tailed catfish in the Murray–Darling Basin	*Tandanus tandanus*	EP	Endangered Population	not listed	4	3	Recorded
Western population Olive Perchlet	*Ambassis agassizii*	EP	Endangered Population	Not Listed	4	3	Recorded
Menindee nightshade	*Solanum karsense*	Plant	Vulnerable	Vulnerable	**3**	**2**	Known
Sloanes Froglet	*Crinia sloanei*	Frog	Vulnerable	Not Listed	3	2	Known & Predicted
Murray crayfish	*Euastacus armatus*	other aquatic species	Vulnerable	not listed	3	2	Known
Winged Peppercress	*Lepidium monoplocoides*	Plant	Endangered	Endangered	**2**	**3**	Known & Predicted
Southern Myotis	*Myotis macropus*	Mammal	Vulnerable	Not Listed	2	2	Known & Predicted
Greater Broad-nosed Bat	*Scoteanax rueppellii*	Mammal	Vulnerable	Not Listed	2	2	Known & Predicted
Australasian Bittern	*Botaurus poiciloptilus*	Bird	Endangered	Endangered	2	3	Known & Predicted
Australian Painted snipe	*Rostratula australis*	Bird	Endangered	Endangered	2	3	Known & Predicted
Blue-billed Duck	*Oxyura australis*	Bird	Vulnerable	Not Listed	2	2	Known
Black-necked stork	*Ephippiorhynchus asiaticus*	Bird	Endangered	Not Listed	2	3	Known
Brolga	*Grus rubicunda*	Bird	Vulnerable	Not Listed	2	2	Known & Predicted
Black-tailed Godwit	*Limosa limosa*	Bird	Vulnerable	Not Listed	2	2	Known
Curlew Sandpiper	*Calidris ferruginea*	Bird	Endangered	Not listed/ Critically endangered	2	3, now 4	known & predicted
Freckled duck	*Stictonetta naevosa*	Bird	Vulnerable	Not Listed	2	2	Known
Magpie Goose	*Anseranas semipalmata*	Bird	Vulnerable	Not Listed	2	2	Known
Spike rush	*Eleocharis obicis*	Plant	Vulnerable	Vulnerable	**1**	**2**	Known & Predicted
Austral Pillwort	*Pilularia novae-hollandiae*	Plant	Endangered	Not Listed	**1**	**3**	Known
Klaphake's Sedge	*Carex klaphakei*	Plant	Endangered	Not Listed	**1**	**3**	Known
Dense cord rush	*Baloskion longipes*	Plant	Vulnerable	Vulnerable	**1**	**2**	Known
A spear-grass	*Austrostipa wakoolica*	Plant	Endangered	Endangered	**1**	**3**	Known & Predicted

Common name	Scientific name	Distinctiveness parameter	NSW status	Commonwealth listing	Flow sensitivity weighting	Status weights	Layers from OEH
Eastern Osprey	*Pandion cristatus*	Bird	Vulnerable	Not Listed	1	2	Known
Flathead Galaxia	*Galaxias rostratus*	Fish	Critically Endangered	not listed	4	4	Maxent
Purple spotted gudgeon	*Mogurnda adspersa*	Fish	Endangered	not listed	4	3	Maxent

Appendix B - HEVAE alignment with Schedules 8 and 9 of the Basin Plan

Table B-1. Alignment of Schedule 8 Key environmental asset criteria with HEVAE criteria

Key environmental asset criteria (Schedule 8)	HEVAE criteria/associated attributes
Criterion 1: The water-dependent ecosystem is formally recognised in international agreements or, with environmental watering, is capable of supporting species listed in those agreements Assessment indicator: A water-dependent ecosystem is an environmental asset that requires environmental watering if it is: (a) A declared Ramsar wetland; or (b) With environmental watering, capable of supporting a species listed in or under the JAMBA, CAMBA, ROKAMBA or the Bonn Convention.	Vital Habitat: An aquatic ecosystem provides vital habitat for flora and fauna species if it supports (see details below)
Criterion 2: The water-dependent ecosystem is natural or near-natural, rare or unique Assessment indicator: A water-dependent ecosystem is an environmental asset that requires environmental watering if it: (a) Represents a natural or near-natural example of a particular type of water-dependent ecosystem as evidenced by a relative lack of post-1788 human induced hydrologic disturbance or adverse impacts on ecological character; or (b) Represents the only example of a particular type of water-dependent ecosystem in the Murray–Darling Basin; or (c) Represents a rare example of a particular type of water-dependent ecosystem in the Murray–Darling Basin.	Naturalness: The ecological character of the aquatic ecosystem is not adversely affected by modern human activity. • Geomorphic recovery (conservation or rapid) potential of River Styles® • Hydrologic stress (demand versus low flow percentile) • Catchment Disturbance Index (infrastructure density, land use index & land cover change) • Macroinvertebrate (AUSRIVAS) O/E bands (i.e. deviation from reference) • River reaches in National Parks Estate
Criterion 3: The water-dependent ecosystem provides vital habitat Assessment indicator: A water-dependent ecosystem is an environmental asset that requires environmental watering if it: (a) Provides vital habitat, including: (i) A refugium for native water-dependent biota during dry spells and drought; or (ii) Pathways for the dispersal, migration and movements of native water-dependent biota; or (iii) Important feeding, breeding and nursery sites for native water-dependent biota; or (b) Is essential for maintaining, and preventing declines of, native water-dependent biota.	Vital Habitat: An aquatic ecosystem provides vital habitat for flora and fauna species if it supports: i. unusually large numbers of a particular native or migratory species; and/or ii. maintenance of populations of specific species at critical life cycle stages; and/or iii) key/significant refugia for aquatic species that are dependent on the habitat, particularly at times of stress. • Vital wetlands (Ramsar and DIWA listed wetlands) • Dissolved Organic Carbon (DOC) input (surrogate measure = river reaches of 60% woody riparian vegetation cover & measure of unconfined or partially confined River Style)

Key environmental asset criteria (Schedule 8)	HEVAE criteria/associated attributes
	• Large Woody Debris (LWB) (surrogate measure = river reaches of 60% woody riparian vegetation cover & specific River Styles®)
Criterion 4: Water-dependent ecosystems that support Commonwealth, State or Territory listed threatened species or communities Assessment indicator: A water-dependent ecosystem is an environmental asset that requires environmental watering if it: (a) Supports a listed threatened ecological community or listed threatened species; or Note: See the definitions of listed threatened ecological community and listed threatened species in section 1.07. (b) Supports water-dependent ecosystems treated as threatened or endangered (however described) under State or Territory law; or (c) Supports one or more native water-dependent species treated as threatened or endangered (however described) under State or Territory law.	Distinctiveness: The aquatic ecosystem is rare/threatened or unusual; and/or The aquatic ecosystem supports rare/threatened/ endemic species/communities/genetically unique populations; and/or The aquatic ecosystem exhibits rare or unusual geomorphological features/processes and/or environmental conditions, and is likely to support unusual assemblages of species adapted to these conditions, and/or are important in demonstrating key features of the evolution of Australia's landscape, riverscape or biota. • State and/or Commonwealth listed threatened species, endangered populations and endangered ecological communities • Rare River Styles®
Criterion 5: The water-dependent ecosystem supports, or with environmental watering is capable of supporting, significant biodiversity Assessment indicator: A water-dependent ecosystem is an environmental asset that requires environmental watering if it supports, or with environmental watering is capable of supporting, significant biological diversity. This includes a water-dependent ecosystem that: (a) Supports, or with environmental watering is capable of supporting, significant numbers of individuals of native water-dependent species; or (b) Supports, or with environmental watering is capable of supporting, significant levels of native biodiversity at the genus or family taxonomic level, or at the ecological community level.	Diversity: The aquatic ecosystem exhibits exceptional diversity of species (native/migratory), habitats, and/or geomorphological features/processes. • Macroinvertebrate Diversity (No. of AUSRIVAS Families) • Fish Diversity (Fish biodiversity hot spots assigned to specific River Styles® reach)
Reference: Healey M, Raine A, Lewis A, Hossain B, Hancock F & Sayers J (2018) *Applying the High Ecological Value Aquatic Ecosystem (HEVAE) Framework to Water Management Needs in NSW*, NSW DPI Water, Sydney, NSW.	

Table B-2. Alignment of Schedule 9 Key ecosystem function criteria with HEVAE criteria

Key ecosystem function criteria (Schedule 9)	HEVAE or risk assessment criteria/associated attributes
Criterion 1: The ecosystem function supports the creation and maintenance of vital habitats and populations Assessment indicator: An ecosystem function requires environmental watering to sustain it if it provides vital habitat, including: (a) a refugium for native water-dependent biota during dry periods and drought; or (b) pathways for the dispersal, migration and movement of native water-dependent biota; or (c) a diversity of important feeding, breeding and nursery sites for native water-dependent biota; or (d) a diversity of aquatic environments including pools, riffle and run environments; or (e) a vital habitat that is essential for preventing the decline of native water-dependent biota.	HEVAE The HEVAE method identifies a diverse range of instream and riparian riverine areas in very poor through to very high ecological value. Highest ecological value areas are assumed to provide a diverse range of aquatic habitats for native water-dependent flora and fauna. Vital habitat is a key criteria assessed in the HEVAE method. Vital Habitat: An aquatic ecosystem provides vital habitat for flora and fauna species if it supports: i. unusually large numbers of a particular native or migratory species; and/or ii. maintenance of populations of specific species at critical life cycle stages; and/or iii) key/significant refugia for aquatic species that are dependent on the habitat, particularly at times of stress. • Vital wetlands (Ramsar and DIWA listed wetlands) • Dissolved Organic Carbon (DOC) input (surrogate measure = river reaches of 60% woody riparian vegetation cover & measure of unconfined or partially confined River Style) • Large Woody Debris (LWB) (surrogate measure = river reaches of 60% woody riparian vegetation cover & specific River Styles®) Risk Assessment The risk assessment process has identified key features of flow regimes which have impacts on key ecosystem functions identified by the MDBA (2010; 2012) and Alluvium (2010). Within the risk assessment method, impacts on ecosystem function are considered through assessment of altered stream flow in regulated and unregulated rivers. Flow regimes influence the hydrologic connectivity, longitudinal and lateral pathways for ecological dispersal, nutrient and organic and inorganic material delivery in river systems.
Criterion 2: The ecosystem function supports the transportation and dilution of nutrients, organic matter and sediment Assessment indicator: An ecosystem function requires environmental watering to sustain it if it provides for the transportation and dilution of nutrients, organic matter and sediment, including: (a) pathways for the dispersal and movement of organic and inorganic sediment, delivery to downstream reaches and to the ocean, and to and from the floodplain; or (b) the dilution of carbon and nutrients from the floodplain to the river systems.	
Criterion 3: The ecosystem function provides connections along a watercourse (longitudinal connections) Assessment indicator: An ecosystem function requires environmental watering to sustain it if it provides connections along a watercourse or to the ocean, including longitudinal connections: (a) for dispersal and re-colonisation of native water-dependent communities; or (b) for migration to fulfil requirements of life-history stages; or (c) for in-stream primary production.	
Criterion 4: The ecosystem function provides connections across floodplains, adjacent wetlands and billabongs (lateral connections) Assessment indicator: An ecosystem function requires environmental watering to sustain it if it provides connections across floodplains, adjacent wetlands and billabongs, including:	

Key ecosystem function criteria (Schedule 9)	HEVAE or risk assessment criteria/associated attributes
(a) lateral connections for foraging, migration and re-colonisation of native water-dependent species and communities; or (b) lateral connections for off-stream primary production.	
References Alluvium, (2010), *Key ecosystem functions and their environmental water requirements*. Report by Alluvium for Murray–Darling Basin Authority, Canberra, ACT. MDBA, (2010), *Guide to the proposed Basin Plan: Technical Background, Murray–Darling Basin Authority, Volume 2, Part 1*, Canberra, ACT. MDBA, (2012), *Hydrologic modelling to inform the proposed Basin Plan - methods and results*. Murray–Darling Basin Authority, Canberra, ACT.	

Appendix C - HEVAE consequence scoring

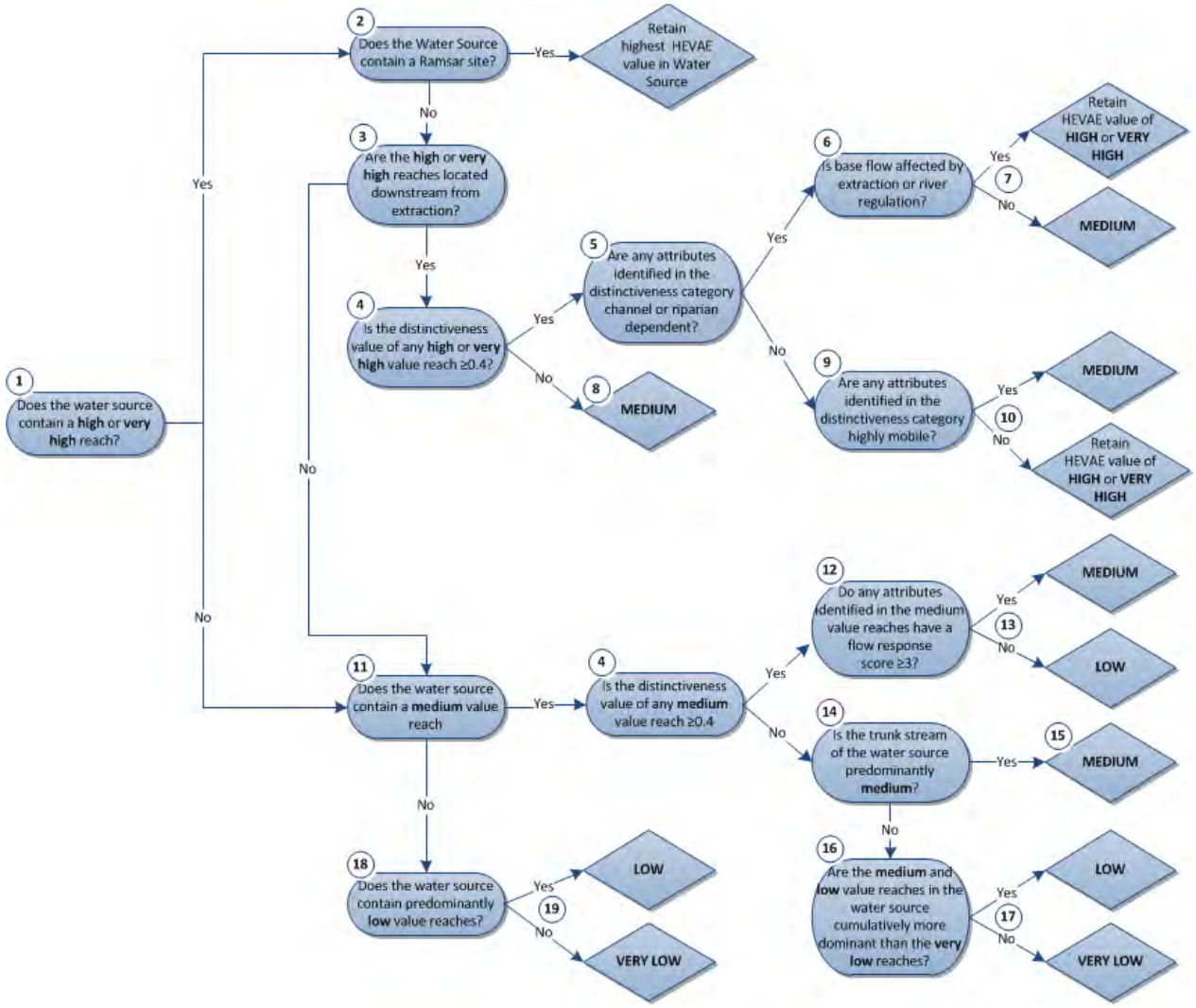

Figure C-1. Consequence decision tree used to convert HEVAE scores to a consequence rank

Table C-1. Rationale for each bifurcation in the decision tree used for converting HEVAE scores to 'consequence of extraction pressure on aquatic ecosystem condition' ranks

Decision tree annotation	Rationale
1	• Management for retention of conservation values is a higher priority in high and very high value reaches • Limiting extraction is easier to justify in high and very high value reaches, than it is in medium reaches
2	• Ramsar sites are valued for their contribution to international conservation efforts for migratory species. Australia is a signatory country and has an obligation to maintain these sites. This includes maintenance of flows.
3	• The attributes of high or very high value sites are influenced by extraction pressure. • Sites that are upstream of extraction points are assumed to be unaffected by extraction pressure, so the assessment focus shifts to whether there are medium value reaches in the water source. • If a high or very high value site is likely to be affected by extraction pressure the focus shift to whether any threatened species, populations, communities or rare River Styles® could be affected.
4	• The attributes of high or very high value sites are influenced by extraction pressure. • The most 'at risk' HEVAE criterion from extraction pressure (in the short-term) is distinctiveness. Distinctiveness includes consideration of biotic and abiotic characteristics and function of the reach (i.e. threatened species, populations, communities and rare River Styles®). • A distinctiveness score of ≥ 0.4 in the HEVAE means the reach has a medium, high or very high value as habitat for threatened species, populations, or communities, or a rare River Style®. • Habitat for threatened species, populations and communities is protected under State and Commonwealth legislation.
5	• Distinguishes between species, populations, communities and/or rare River Styles® that occur on the floodplain versus the channel and riparian zone because (it was assumed) extraction pressure is more likely to affect attributes that occur in the channel and riparian zone, rather than the floodplain. • *This is a decision that relies on expert understanding of the attribute's ecology and biology.*
6	• Given the attribute is identified as relying on channel and riparian habitat (from 5), this step assumes the least possible habitat available to the attribute occurs under low flow conditions, and asks whether the lowest flows in the system are affected by extraction.
7	• Any attributes that are channel and/or riparian dependent, and are considered vulnerable to extraction of low flows retain their original high or very high value category. • Any attributes that are channel and/or riparian dependent and are considered resilient to extraction of low flows are allocated a 'medium' consequence category.
8	• High or very high value reaches that have low distinctiveness are assumed to have attributes that are more resilient to extraction pressure (at least in the short-term), and are assigned a 'medium' consequence category.

Decision tree annotation	Rationale
9	• Establishes that attributes are floodplain dependent, and asks whether they are able to move (i.e. birds, bats) or not (i.e. plant). The assumption is that more mobile species/population/community can move to avoid changes in habitat owing to extraction pressure.
10	• If the species can move they are assigned a risk category of 'medium'. • If the species/population/community is sessile, it is assumed to be at greater risk of harm from extraction pressure (because it can't move to avoid the pressure), and retains its original categorisation of 'high' or 'very high'.
11	• Establishes that the water source either doesn't have 'high' or 'very high' reaches, OR there are 'high' or 'very high' reaches but they are above extraction points (and therefore assumed unaffected by extraction pressure), and asks whether there are 'medium' value reaches in the water source. • This allows the risk of extraction pressure on medium value aquatic ecosystems to be assessed independently of the 'low' and 'very low' value aquatic ecosystems.
12	• Asks whether species/populations/communities in the reach are moderately to highly sensitive to extraction, primarily because they specific flow requirements and limited ability to move if those flow requirements are not met (e.g. fish, frogs, turtles, macrophytes). • This information is in the MS Excel Distinctiveness file for each catchment, in the column labelled 'Flow Sensitivity Weighting'
13	• If a species/population/community has a flow response score ≥3 (i.e. it is sensitive to extraction), it is assigned a risk category of 'medium'. • If a species/population/community has a flow response score <3 (i.e. it is less sensitive to extraction), it is assigned a risk category of 'low'.
14	• Deals with 'medium' value reaches that don't have high Distinctiveness (i.e. ≥0.4). • Asks whether the main river in the water source has a predominantly 'medium' value. This question weights the value of the main river higher than any tributaries, because it is assumed the main river is likely more affected by extraction pressure than tributaries.
15	• If the main river in a water source has a predominantly medium HEVAE condition, the consequence ranking is also medium.
16	• Asks whether the combined length of medium and low HEVAE reaches in a main river in an assessment area is less than the length of reaches in the same main river with a very low HEVAE rank. • The rationale is if the main river is comprised of mostly low with some medium HEVAE reaches, then a conservative approach should be adopted and the low consequence rank prevails.
17	• If the reach has a mainly very low HEVAE rank, and there is little apparent reliance on the reach by freshwater-dependent flora and fauna, the consequence awarded is 'very low'.
18	• There are no very high, high or medium HEVAE ranked reaches in the assessment area – only low and very low. • It is assumed there is little reliance on habitats in these reaches by freshwater-dependent flora and fauna.
19	• The assessment area is awarded the same consequence rank as the predominant HEVAE rank for the area.

Decision tree annotation	Rationale
	• It is assumed there is little reliance on habitats in these reaches by freshwater-dependent flora and fauna.

Appendix D - Threatened fish species and distribution

Fish data from the MDB Sustainable Rivers Audit (Davies et al. 2012) and other sources were analysed by NSW Fisheries to assess the distribution of threatened species and to identify areas of relative high fish biodiversity within the Lachlan WRPA. These data have been included in the HEVAE assessment and the results presented below. They are also further detailed in the Water Source Summaries provided in Volume 2.

The lower Lachlan River endangered ecological community includes all fish and aquatic invertebrates within all natural rivers, creeks, streams and associated lagoons, billabongs, lakes, wetlands, paleochannels, floodrunners, effluent streams (those that flow away from the river) and floodplains, as well as Lake Brewster, Lake Cargelligo and Lake Cowal.

There is a significant spread of threatened fish species or endangered populations within the Lachlan WRPA. Macquarie Perch and Silver Perch have been frequently sampled in the upper Lachlan and Abercrobie River catchments upstream of Wyangala Dam and there are historical records of Trout Cod from this area as well. Eel-tailed Catfish, Murray Cod and Silver Perch have been sampled within the central and lower catchment zones and Olive Perchlet have been sampled within the lower catchment zone. Fish biodiversity was highest in the headwater reaches and lowland reaches of the Lachlan River catchment.

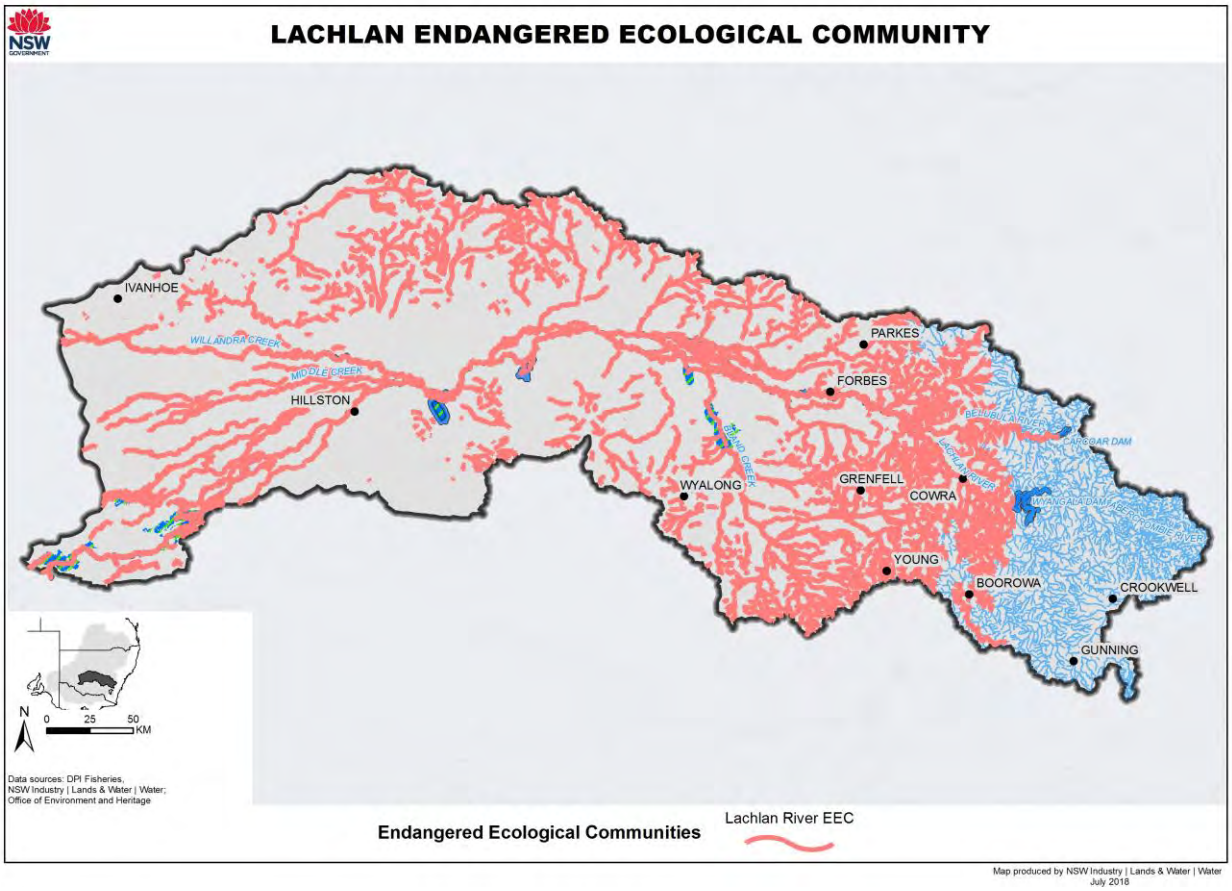

Figure D-1. Distribution of endangered ecological communities in the Lachlan WRPA

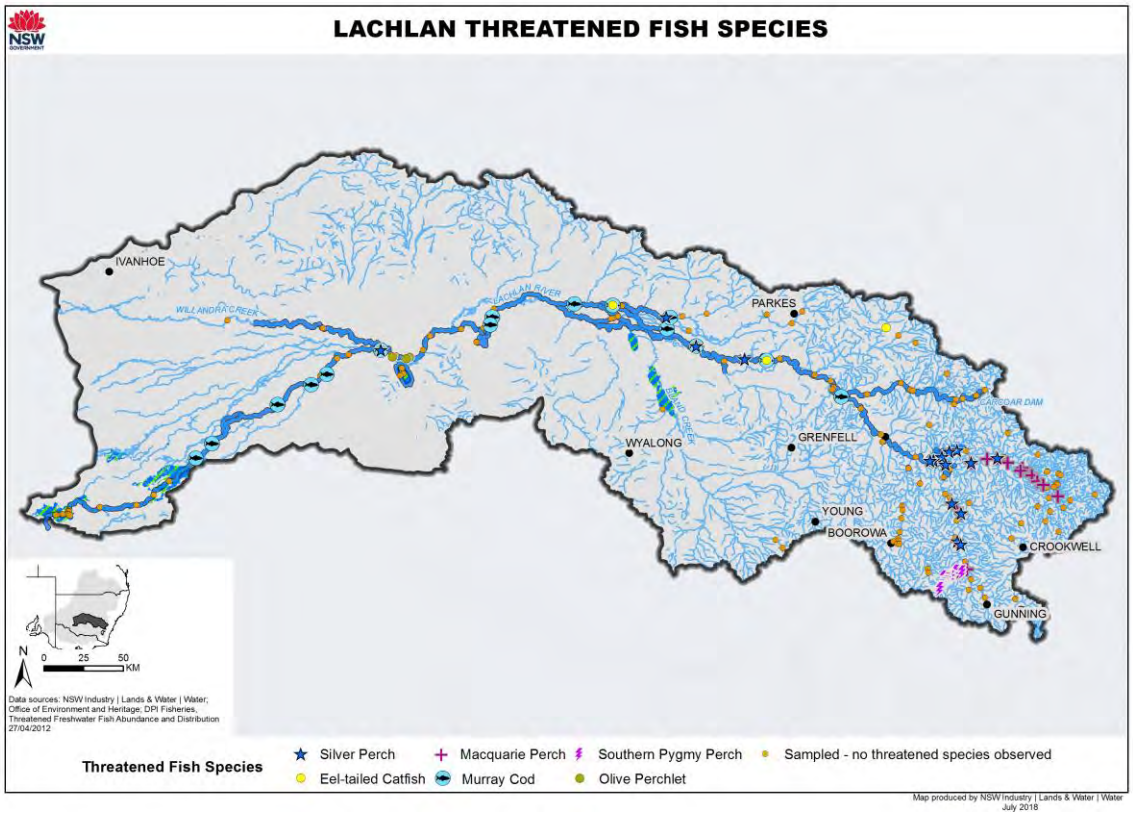

Figure D-2. Distribution of threatened fish species within the Lachlan WRPA

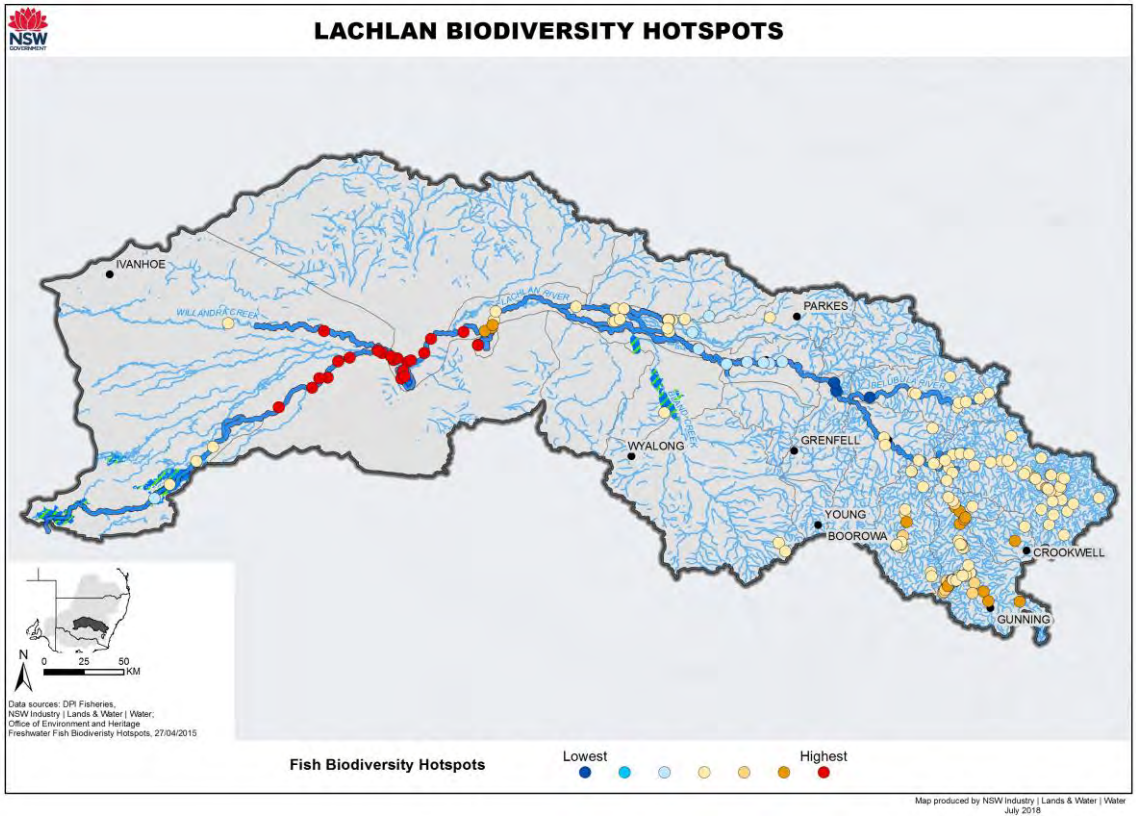

Figure D-3. Fish biodiversity hotspots in the Lachlan WRPA

Appendix E - Flow variation indices in unregulated water sources

Maps showing the flow variation indices and metrics used to assess the likelihood of farm dams impacting on surface flows in unregulated water sources in the Lachlan WRPA are shown in the figures below.

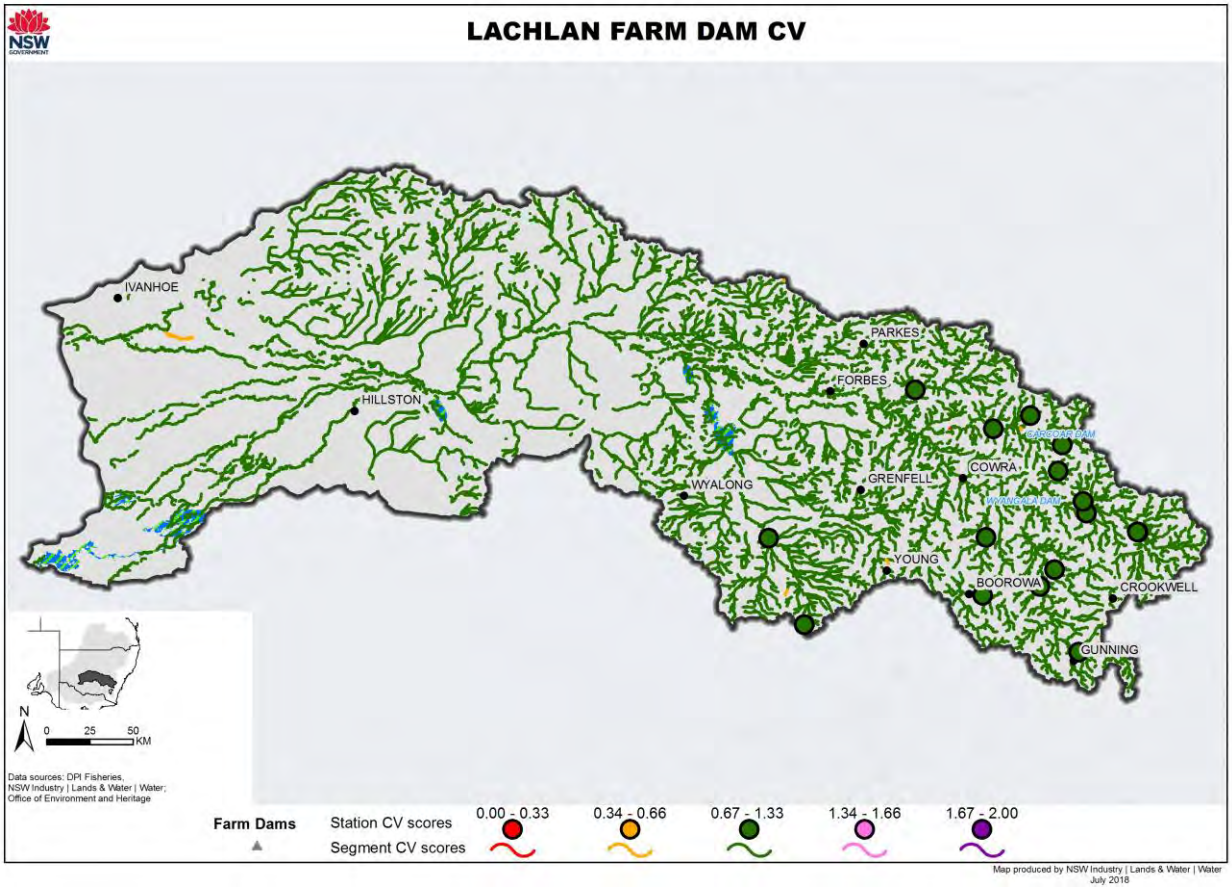

Figure E-1. Flow variation index (CV) results for farm dams in the Lachlan WRPA (SKM 2011)

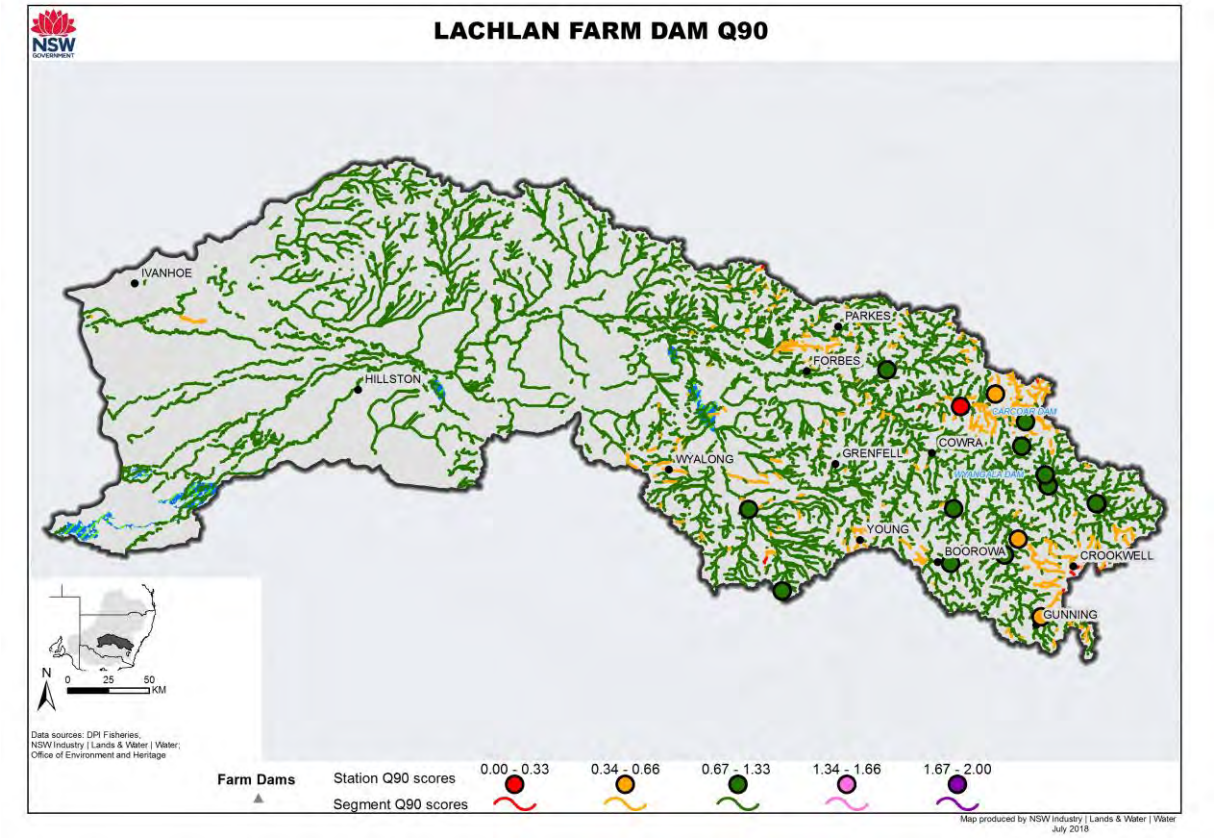

Figure E-2. Results for the Q90 low flow metric for farm dams in the Lachlan WRPA (SKM 2011)

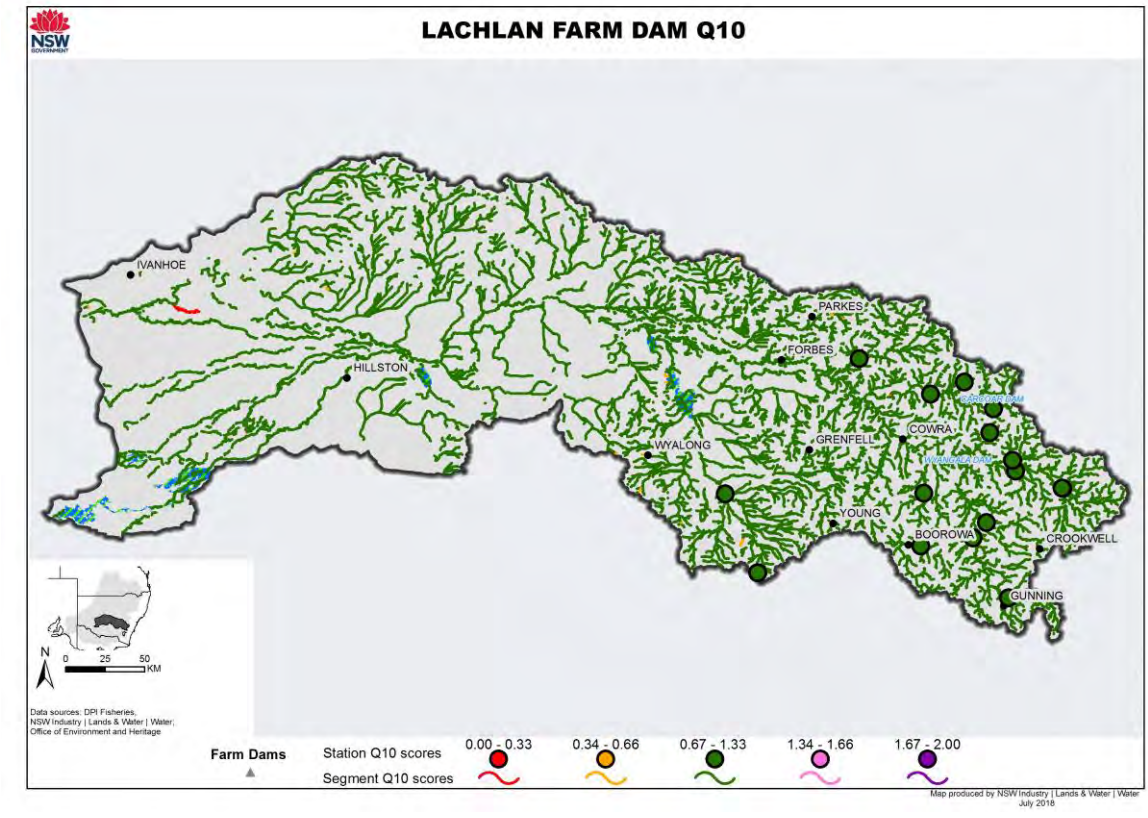

Figure E-3. Results for the Q10 high flow metric for farm dams in the Lachlan WRPA (SKM 2011)

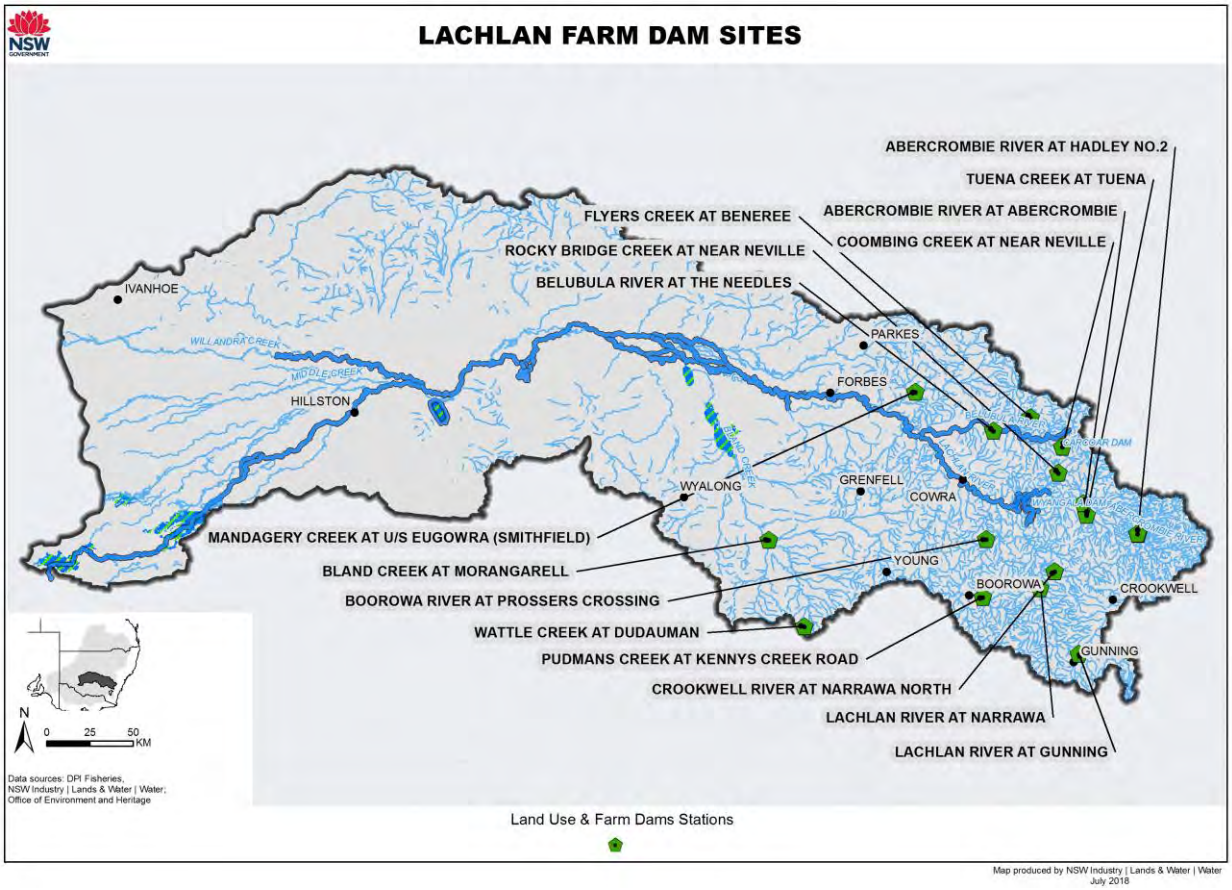

Figure E-4. Location of land use and farm dam stations in the Lachlan WRPA (MDBA 2011)

Appendix F - Unregulated rivers tolerable risk decision tool

This appendix relates to Figure 9-1 (in particular element 2 and risk treatment option C), associated text in section 9.2.2.1, and strategy 18 in Table 9-6.

The assessment of *Risk to water available for the environment due to licensed extraction in unregulated rivers* E(W) uses likelihood ratings based on potential risk rather than current risk. This is because best available likelihood information is entitlement data rather than actual use data. This may result in overestimations of risk in those unregulated water sources where extraction has not reached full development levels. In order to apply appropriate risk mitigation strategies to medium or high risk results, a decision tool was used to compare expert knowledge of individual water sources to the full development likelihood results determined via single reach IQQM. This resulted in an assignment of tolerable status to each risk result and a recommendation for the intensity of ongoing access licence activation monitoring via remote sensing. Note that low risk results are not considered by the tool as the Basin Plan does not require strategies to be described for these risk results. Also note that neither likelihood data nor risk results change through the use of this decision tool.

Figure F-1 shows the additional information used to determine the tolerable status of risk results and the decision tool's relationship to the risk treatment pathway through the likelihood metric. To use the decision tool, follow the decision tree in Figure F-2.

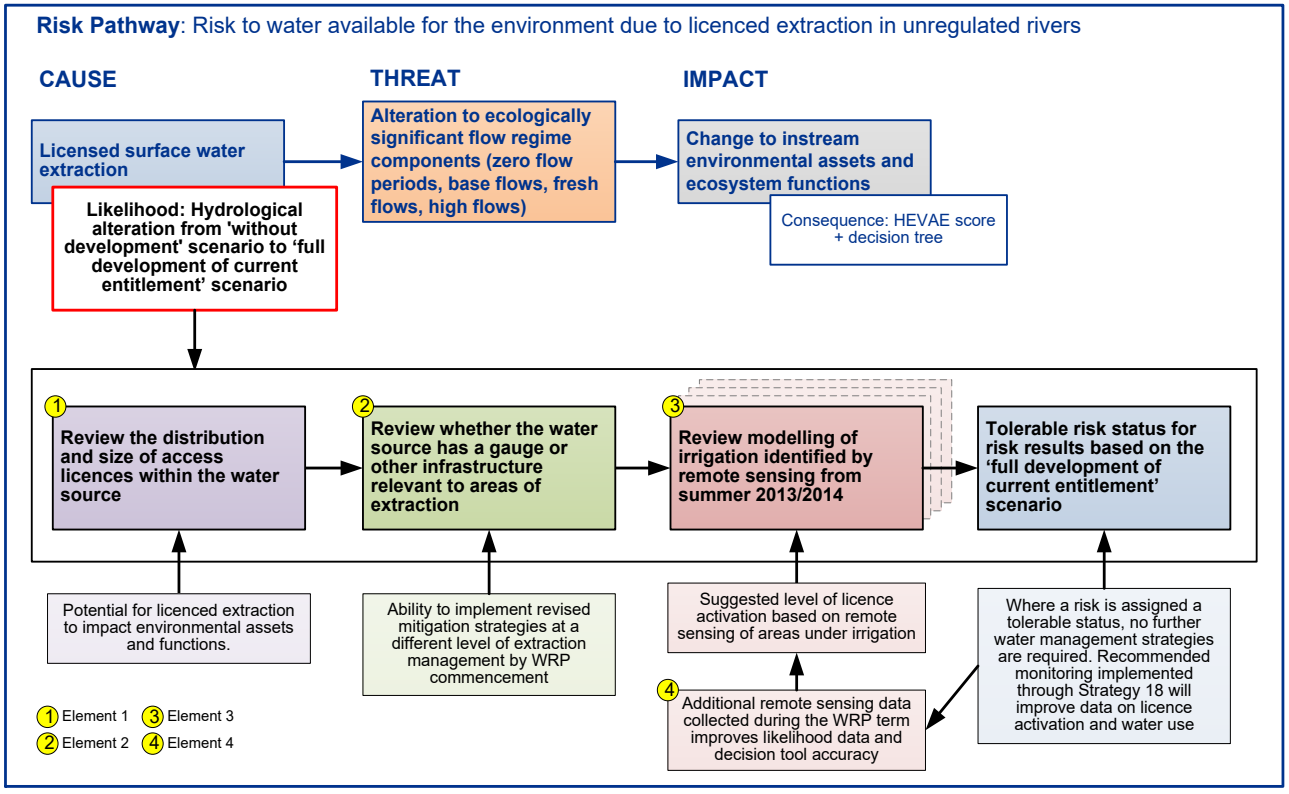

Figure F-1. Overview of decision tool

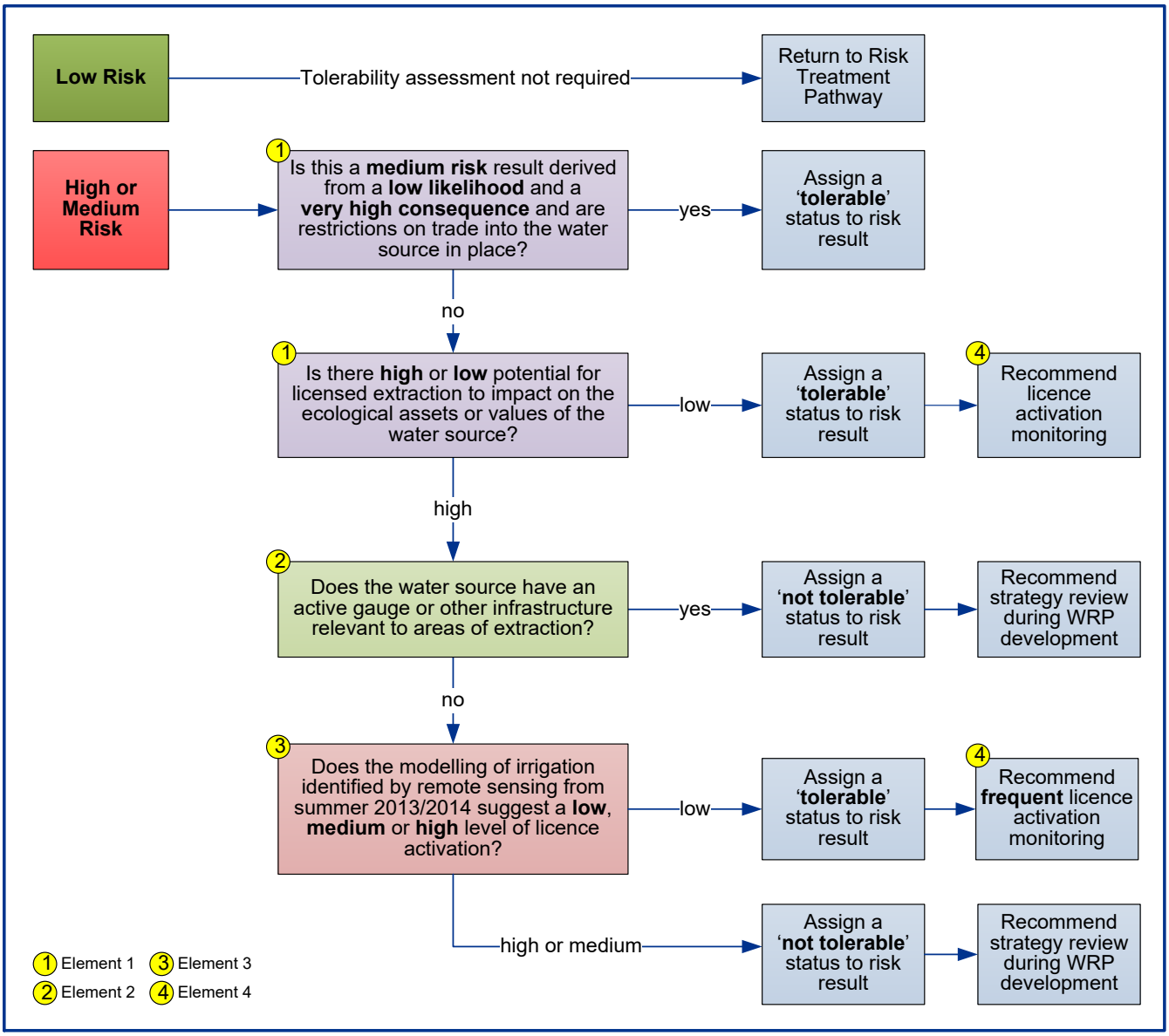

Figure F-2. Decision tree used as a guide to apply elements of the unregulated rivers tolerable risk decision tool

Review the distribution and size of access licences within the water source

Element 1 of the decision tool reviews the potential for licensed extraction to impact on the ecological assets and values of a water source if all access licences were activated[1]. Where ecological value drivers of the consequence result occur upstream or on stream sections that are disconnected from access licence locations, there is little potential for extraction to impact environmental assets or functions. An exception to this statement may occur where an asset has high dispersal characteristics (e.g. fish such as Murray cod or silver perch).

Where there are significant access licences on the main stem of a stream in the water source, the single reach IQQMs will reflect the impact along the main stream and at the end of the water source. Where there are only a few small access licences on different tributaries, or just one tributary, the single reach IQQMs may not reflect the impacts on the ecological values in the water source (see Figure F-3 for examples). This is most likely to be seen in headwater water sources where there is little floodplain extractive development. The complexity of a river

[1] An access licence must be linked to at least one pump (water supply work) for extraction to be possible.

system's structure (e.g. multiple tributaries) may need to be revised and updated in future versions of the single reach IQQMs prior to the next risk assessment.

Medium risk results driven by a very high consequence combined with a low likelihood were also considered in this step and automatically assigned a 'tolerable' status in the decision tree (Figure F-2) if rules were in place to prevent trade into the water source. Further information on the ecological value drivers for each water source can be found in Part 2 (Water Source Summaries) of this document.

There are two possible outcomes from this assessment of potential impact from access licences; high or low. Where the result is high, the risk result moves to the assessment of element 2. Where low is applied, the risk result is assigned a 'tolerable' status and further monitoring of access licence activation via remote sensing is recommended (element 4).

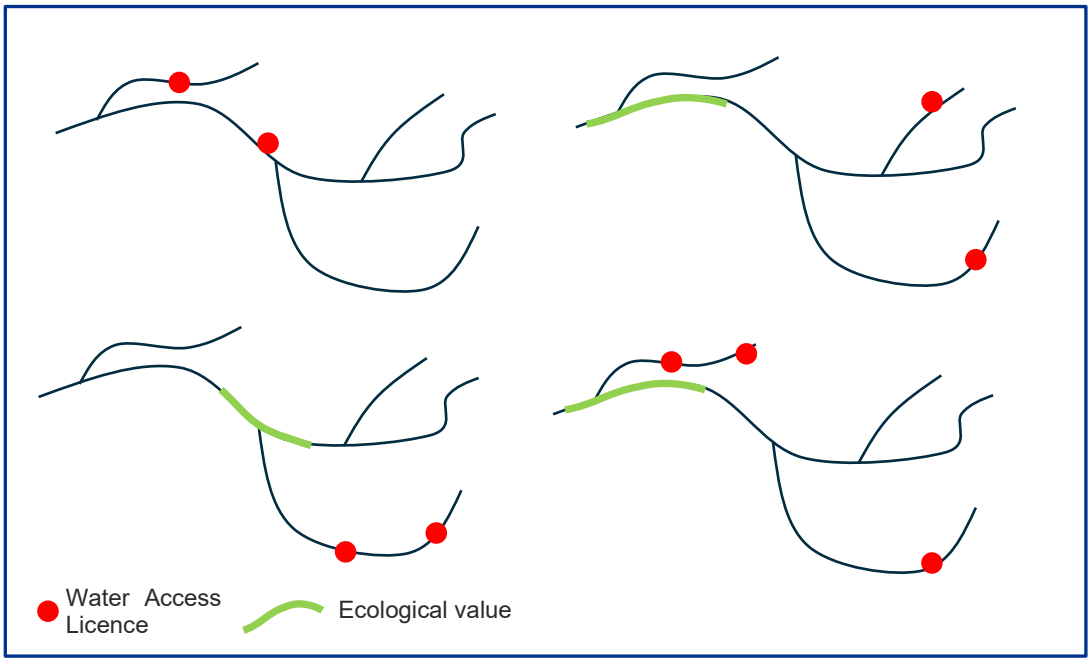

Figure F-3. Examples of the distribution of insignificant entitlement distribution

Review availability of infrastructure to implement revised mitigation strategies

Element 2 of the decision tool reviews whether it would be possible to implement a variation to the level of extraction management by WRP commencement. In unregulated rivers many high and medium risk results occur against base flow and zero flow characteristics. Commence and cease to pump (CtP) rules are often used to protect streams during these periods of low or no flow. To implement a CtP above visible flow, or to implement flow classes for management of fresh or higher flows, a river height monitoring gauge or other infrastructure is generally required.

A check for active flow gauges was made on the appropriate GIS layer and the results confirmed through consultation with WaterNSW Hydrometrics. There are two possible outcomes from this element; yes or no. Where the result is yes, the risk is assigned a 'not tolerable' status as alternative management strategies could be developed and implemented through the water resource plan or water sharing plan. Where no is applied, the risk result moves to the assessment of element 3. Note that any variations to the current river gauge network would have considerable resourcing implications for NSW which are unlikely to be resolved prior to water resource plan commencement. This is why recommendations for new gauge installations have not been considered by this decision tool.

Modelling of irrigation identified by remote sensing to suggest a level of access licence activation

Element 3 utilises modelling of irrigation identified by remote sensing from summer 2013/14 to suggest a level of access licence activation. The whole-of-MDB summer 2013/14 Landsat mosaic compiled and analysed for this assessment represents a 'first step' in NSW's ongoing efforts to better quantify change over time in spatial patterns of active irrigation. Further information on the 2013/14 Landsat mosaic is available at: https://trade.maps.arcgis.com/apps/webappviewer/index.html?id=57c2e2ba75cd4c93aa0328ef469ed0a2.

Landsat assessment of irrigated areas across NSW is an ongoing joint collaboration between NSW Department of Planning and Environment, Geoscience Australia and the MDBA. It is expected that this program will provide a comprehensive insight into spatial patterns of irrigated areas across both unregulated and regulated water sources in the MDB and coastal catchments. It is important to note that unlike extractive water use in regulated rivers, unregulated river extraction is highly variable and often opportunistic. As the dataset used for this element is from a single season in a single year it does not provide enough information to generate a meaningful likelihood result for a current use scenario that can be used to assess risk in this report. It is anticipated that throughout the WRP term a more comprehensive indication of current use should be provided through the analysis of further remote sensing imagery (see Strategy 18 and the MER Plan for further information). This is indicated in Figure F-1 by the broken line boxes underlying element 3.

Possible outcomes from this element are the suggested activation levels high, medium, and low. Where low is applied, the risk result is assigned a ‘tolerable’ status and further frequent monitoring of access licence activation via remote sensing is recommended (element 4). Where medium or high is applied the risk is assigned a ‘not tolerable’ status as the current use level is likely to be similar to the full entitlement scenario. This indicates the risk result should prompt the consideration of alternative risk mitigation strategies during WRP development.

Appendix G - Strategy development – constraints and decision trees

Material in this appendix has previously been presented in earlier drafts of this document. It describes considerations and decision processes supporting strategy development. A list of draft strategies that were considered for inclusion in the WRP has also been included.

The draft strategies outlined in this section have been developed with consideration to the means through which they can be implemented, which is primarily through the rules and conditions within the WRP. Risks that are associated with high flow events, however, may also be mitigated through discretionary environmental water, which is part of the operational scope of the LTWP rather than a WRP. In such instances, the mitigation strategy suggests that the risk would be most effectively managed by the LTWP. Mitigation strategies for water quality risks may be represented in one or more of the WRP, LTWP and WQM Plan. However, there may be unavoidable circumstances or constraints that prevent a strategy from being implemented, including:

- Operational constraints due to infrastructure or channel capacity, or
- Constraints due to a proposed strategy resulting in a risk to social and economic interests that is considered to outweigh the risk to the environment, or
- Environmental or other external constraints which limit a strategy from achieving its full ecological objective.

Operational constraints considered in developing and implementing new strategies

Operational constraints were identified through consultation with WaterNSW and other water management agencies that provided technical input around the operation of water regulation structures. Some examples of operational constraints may be the ability of a stream channel to convey a certain volume of water without incurring third party impacts (for example, through over bank flows), the inability of dam outlet works to be turned off, or conversely, to release a certain volume of water.

Operational constraints were considered against the anticipated resources that would be required to remedy them. Often the significance of these constraints means they are unable to be abated.

Social or economic constraints to implementing a strategy

The Basin Plan's objective is to achieve an optimal outcome for all water stakeholders in the Basin. Sections 5.02(1) (c) and 5.02(1) (d) of the Basin Plan state that:

The objectives of the Basin Plan as a whole are:

> *(c) To optimise social, economic and environmental outcomes arising from the use of Basin water resources in the Murray–Darling Basin; and*
>
> *(d) To improve water security for all uses of Basin water resources.*

NSW WSPs also have the objective of achieving optimal outcomes for social, economic and environmental objectives, but there are instances where it is not possible to achieve all of these outcomes in equal measure. Each mitigation strategy must therefore be considered in view of the potential impacts on water-dependent communities. If those impacts are considered to be significant, then the strategy may have to be constrained or modified.

Potential social or economic constraints were identified by:

- Estimating the community dependence on water extraction in each unregulated water source
- Directly consulting with stakeholders through forums such as Stakeholder Advisory Panels (SAPs).

Estimates of community dependence on water extraction were based on previous calculations undertaken as part of the Macro Water Sharing Plan process (NOW, 2011).

Community dependence was estimated by combining information about the volumes and economic value of water extraction (value of irrigated industries, town water supply, proportion of community employment in agriculture etc.) with information about community resilience to change, based on data obtained from the Australian Bureau of Statistics Index of Advantage and Disadvantage.

Community dependence for each unregulated water source was classified as either low, medium or high (Figure G-1). The regulated river network, however, was not assessed but deemed to always have high community dependence.

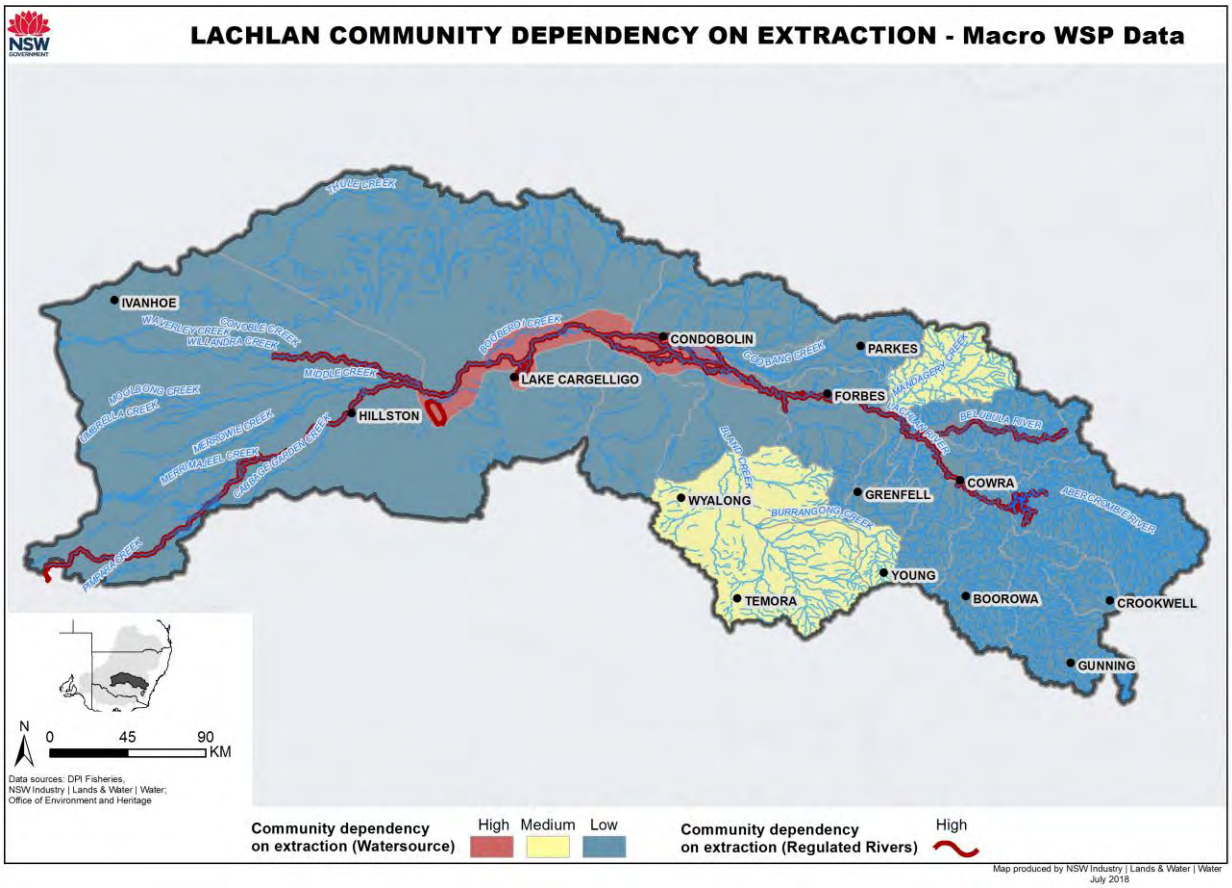

Figure G-1. Community dependency on extraction

In each unregulated water source, community dependence and risk to the environment were compared using an indicative matrix (Table G-1) to guide the prioritisation of mitigation strategies. Potential strategies were presented to stakeholders for consideration and further development undertaken if required. Preliminary strategies were formulated based on a general principle that if one risk is greater than the other, the proposed strategy should then be commensurate with this fact.

For example, there are two potential strategies that a WSP can employ to mitigate medium or high risks to low flows in an unregulated water source: restricting future water trade into the water source, or restricting water use by creating or amending access rules. If the risk to the environment from low flows is high and community dependence is low, then both of these

strategies may be considered. If community dependence is high however, then trade restrictions may be the only viable strategy. Trade restrictions need not be applied to an entire water source but instead, may be targeted to the particular sub-catchments where key ecological assets have been identified.

Table G-1. Indicative matrix to guide the development of strategies relative to community dependence versus risk to the environment

		Community dependence on extraction		
		Low	Medium	High
Risk to the environment	Low	No strategy required	No strategy required	No strategy required
	Medium	Prioritise risk mitigation strategy	Reassess and modify strategy	Reassess and modify strategy
	High	Prioritise risk mitigation strategy	Prioritise risk mitigation strategy	Reassess and modify strategy

Environmental or other external constraints to implementing a strategy

Many of the draft strategies identified in this report aim to mitigate impacts resulting from changes in the flow regime due to river regulation and water extraction. Significant changes in the volume and timing of flows are identified in the likelihood metrics and strategies have been formulated to address high and medium risk as required in the Basin Plan.

Strategies can be formulated to address hydrological changes; however, their success in meeting the underlying ecological objectives may be reliant upon other externalities or environmental constraints, which may not be directly related to the hydrological regime. Examples of such externalities include; cold water pollution from instream storages, barriers to fish passage due to water regulation or road infrastructure, the entrainment of fish in irrigation infrastructure (such as channels or pumps), the condition of riparian vegetation or the degree of catchment disturbance. In these cases, complementary strategies to address the external constraints may also be required to achieve the maximum ecological benefit.

There are opportunities for government agencies, including NSW Local Land Services (LLS), to work closely with the NSW Department of Planning and Environment in managing external constraints through complementary measures. Collaboration between natural resource management (NRM) groups to examine alignment of priorities has been a continued focus of NSW Government (NRC 2010). Alignment of NRM continues to be identified as a priority for LLS (Local Land Services 2016) and for the management of environmental water and water quality in NSW (OEH 2014). Alignment of NRM priorities for river management will assist in strengthening the outcomes of mitigation measures identified through this risk assessment.

This section identifies the major environmental and external constraints to implementing strategies in the Lachlan WRP.

Cold water pollution

Cold water pollution is the release of unseasonable cold water from deeper layers of thermally stratified storages. This occurs most often during the warmer months when irrigation water is in high demand. Temperature has a wide range of influences on biological processes, where the release of cold water can interrupt important biological cues such as spawning in fish and other fauna, creating a physiological barrier to habitat connectivity, reducing the growth rate of fish and also result in mortality (Lugg & Copeland 2014).

The NSW Department of Planning and Environment has analyses water temperature data below Wyangala Dam and determined that cold water pollution extends for approximately 200 km downstream to Forbes. Cold water pollution has the potential to significantly influence the ecological outcomes from environmental water releases impacting the survival, growth, movement, spawning and recruitment of native fish, resulting in the reduction of their recovery potential in the Lachlan valley.

Cold water pollution is therefore a potentially significant external constraint to the success of some strategies identified in this report. This constraint can be addressed by the implementation of concurrent mitigation strategies such as a thermal curtain, or other variable offtake infrastructure on the inlet works of Wyangala Dam. Such infrastructure would allow the warmer waters located near the surface of the storage to be released during the warmer months.

Barriers to fish passage

Migratory pathways across the majority of rivers in NSW have been disrupted through the construction of instream structures associated with river regulation such as dams and weirs as well as road crossings, culverts and other road infrastructure.

NSW Department of Primary Industries (2015) report that barriers to fish passage can impact native fish populations by:

- Interrupting spawning and seasonal migrations;
- Restricting access to preferred habitat, food resources and breeding partners;
- Reducing genetic flow between populations;
- Increasing susceptibility to predation and disease through aggregation below barriers;
- Stranding fish on floodplains or in drying waterbodies;
- Fragmenting communities and preventing colonisation;
- Advantage introduced species such as Carp (NSW Department of Primary Industries 2015b); and
- Disrupting downstream movement of adults and impeding larval drift (Jones & Stuart 2004; NSW Department of Primary Industries 2006; Jones & Stuart 2008; Jones 2009).

Instream structures and other mechanisms that alter natural flow regimes have been listed as a key threatening process under the *Fisheries Management Act 1994*. The NSW Office of Environment and Heritage has also listed instream barriers as a key threatening process under the *Threatened Species Conservation Act 1995*. The construction of fishways at major barriers and the management of instream structures to reduce their impact on biodiversity and habitats (for example, opening of flood gates at certain times of year) have been identified as high priority abatement actions.

DPI Fisheries have identified 325 barriers to fish passage in the Lachlan WRPA (Harris and Throncraft 2000) including weirs, regulators and road crossings (Figure 23). These fish barriers have a varying degree of impact on native fish, with some drowning out more frequently than others to provide suitable passage. The cumulative impact of such structures across the catchment impedes natural flow and connectivity, which is a fundamental ecological feature (NSW Department of Primary Industries 2015) and likely to be a considerable constraint to the success of strategies. DPI Fisheries have identified 19 barriers which are considered to be high priority for mitigation action and 13 of these high priority barriers occur in the Mid-Lachlan Unregulated Water Source. These barriers are identified in the summaries presented in Volume 2 and are considered potential constraints to the success of hydrological risk mitigation strategies.

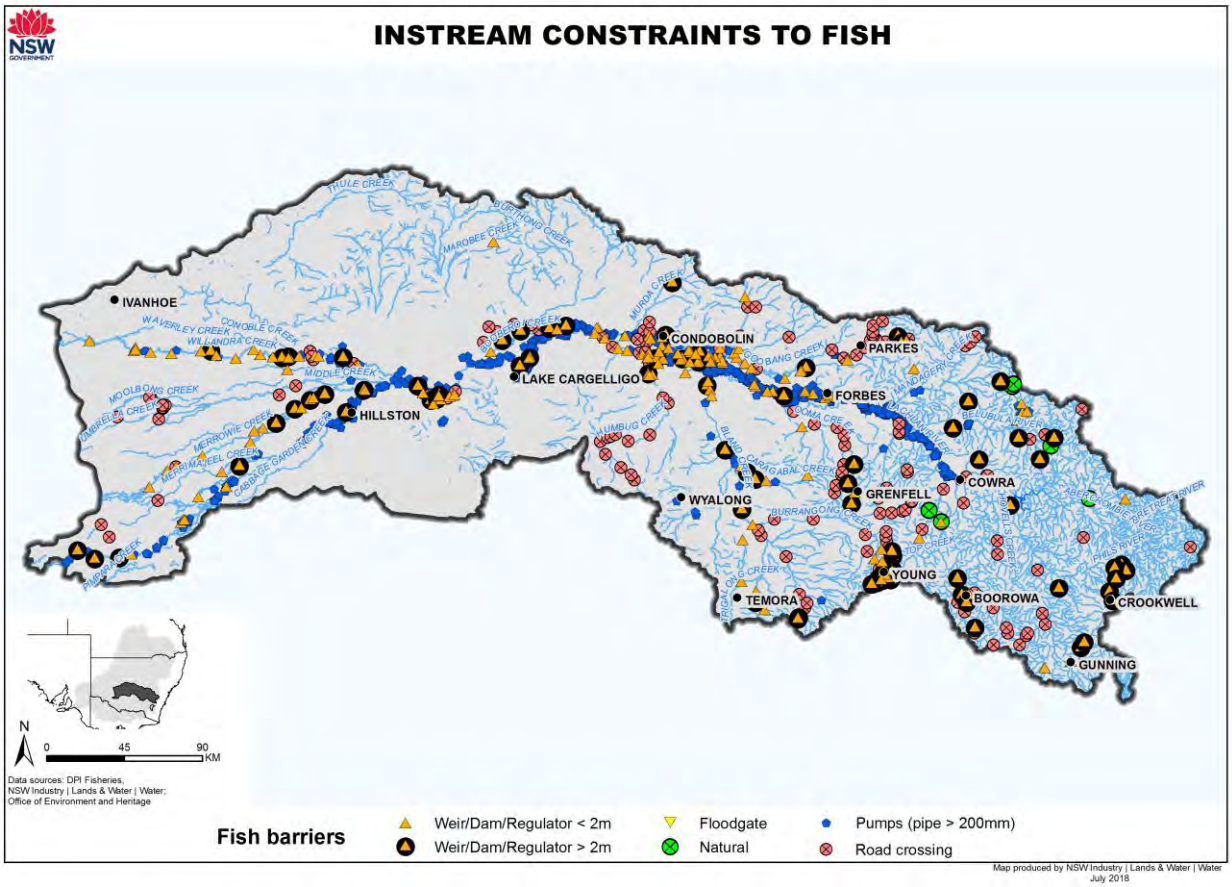

Figure G-2. Instream constraints to fish in the Lachlan WRPA

Water diversion

The diversion of water by pumps, pipelines, irrigation canals or regulators can have a significant impact on native fish by altering habitat and affecting flow dependent life history strategies such as spawning and recruitment (Baumgartner & Boys 2012). Diversion and stranding in off-channel irrigation systems is said to be particularly problematic for the larval stage of most native fish species, especially golden perch, silver perch and Murray cod, as the timing of irrigation diversion coincides with the peak egg and larval drift during the spring and summer seasons (Baumgartner et al. 2007).

The entrainment of fish in irrigation infrastructure is an issue which may influence the ability of flow management strategies to meet their ecological objectives. In Europe and the United States, a wide variety of pump screens are currently applied which could be readily adapted for use in the MDB. In New Zealand, the screen designs routinely applied are modifications of existing designs to meet the requirements of local conditions (Baumgartner & Boys 2012). For some years, DPI Fisheries have been advocating a screening program as the best way to reduce fish losses without compromising the needs of irrigators within the MDB.

In the Lachlan WRPA, it is reported that there are over 300 pump offtakes with a diameter greater than 200 mm (Figure 23). There is some suggestion that irrigation pump offtakes, with a diameter greater than 200 mm, influence the entrainment of freshwater fish (NSW Department of Primary Industries 2015). Based on the current information from the QLD Department of Agriculture and Fisheries and NSW DPI Fisheries, a 200 mm diameter size threshold was selected as a potential threat to native fish; however this threshold has not been substantiated and therefore should be considered as an interim threshold. The cumulative effect of these offtakes is expected to have a significant impact on native fish populations in the lower Lachlan WRPA during peak extraction times.

Riparian vegetation condition and catchment disturbance

Riparian vegetation is a key attribute connecting rivers and terrestrial ecosystems. It is important for controlling river bank stability, mitigating runoff, providing sediment and nutrients from the adjacent land, providing habitat for a range of biota and influences instream processes (Lovett & Price 2007). Leaf litter derived from riparian vegetation is also a key contributor of allochthonous energy sources into rivers, driving primary production and stimulating the development of food chains (Robertson et al. 1999; Westhorpe et al. 2010). Native riparian vegetation cover greater than 60% and a riparian buffer zone width of up to 30 m are considered to be within the ranges important for influencing good riparian condition (Jansen et. al. 2003). A positive increase in the presence of large woody debris (LWD) within rivers was correlated with a positive increase in riparian tree cover, maximising when tree cover reaches 60 percent (Matheson & Thoms 2017). LWD derived from the riparian zone is associated with primary control on geomorphic stability and habitat heterogeneity in rivers (Brooks & Brierley 2002; Treadwell et al. 2007).

Changes to riparian vegetation can reduce the geomorphic condition of rivers (Brierley & Fryirs 2005). Reduction in geomorphic condition from good to moderate can be linked to reductions in macrophyte and macroinvertebrate assemblages (Chessman et. al 2006a), while freshwater mussel abundance declines in river reaches where geomorphic condition also reduces (Jones & Byrne 2010). River Styles® recovery potential is synonymous with geomorphic condition. Recovery potential represents geomorphic stability and can indicate the capacity of a stream to return to good condition or to a realistic rehabilitated condition (Brierley & Fryirs 2005). Streams rated as having conservation or rapid recovery potential are likely to be the most stable and in a good condition, whereas streams with low recovery potential may never recover to a natural condition or may continue to decline quickly without intervention (Cook & Schneider 2006).

Long-lasting and complicated changes to stream ecosystems can occur through catchment disturbance impacts attributed to land use change (Maloney & Weller 2011). Catchment disturbance is recognised as an important factor that influences river condition (NLWRA 2002), where land use changes close to streams can have a more pronounced impact on reducing stream condition (Peterson et. al. 2011).

Figure G-3 and Figure G-4 provide a general overview of riparian and geomorphic condition for the Lachlan WRPA. For river recovery potential (Figure G-4), river reaches identified as being “strategic” can be in good, moderate or poor geomorphic condition. These reaches are often undergoing rapid change and should be a focus for action to control degradation. Where these constraints are considered to be particularly important for a specific water source and its mitigation strategies, further details are in the water source summaries (Volume 2).

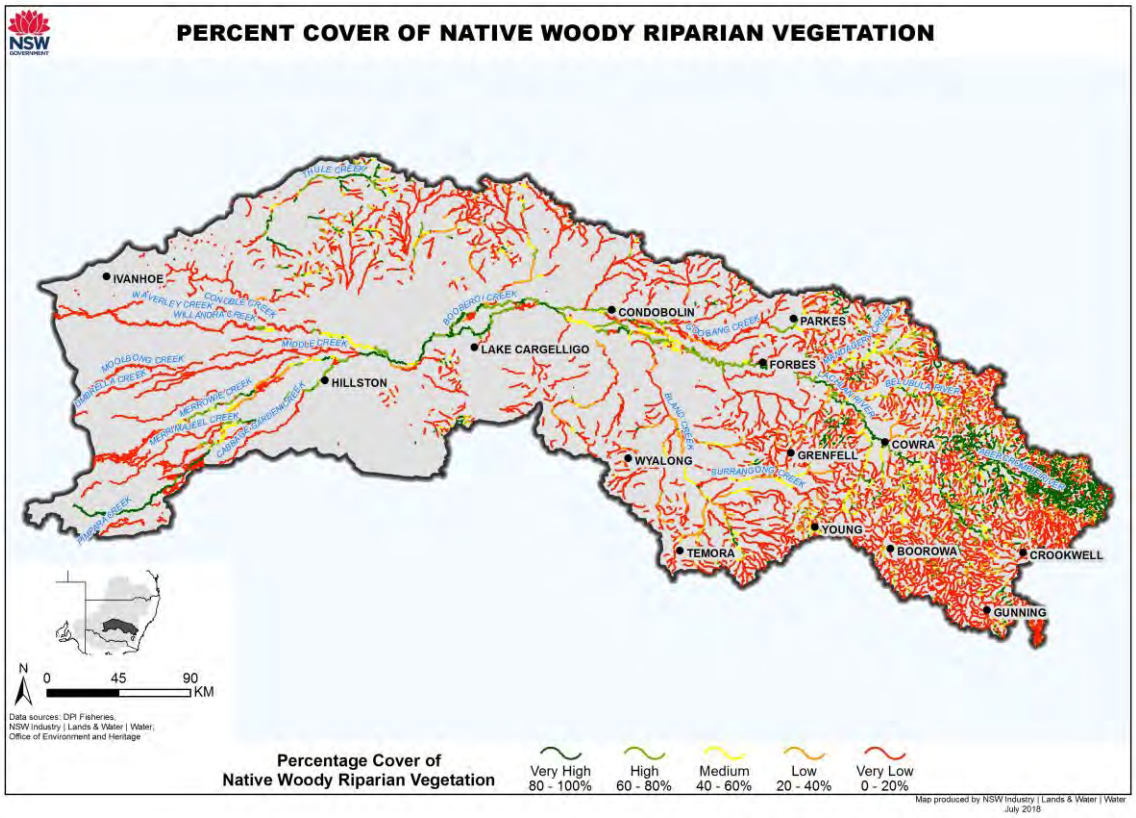

Figure G-3. Percent cover categories of native woody riparian vegetation in the Lachlan WRPA

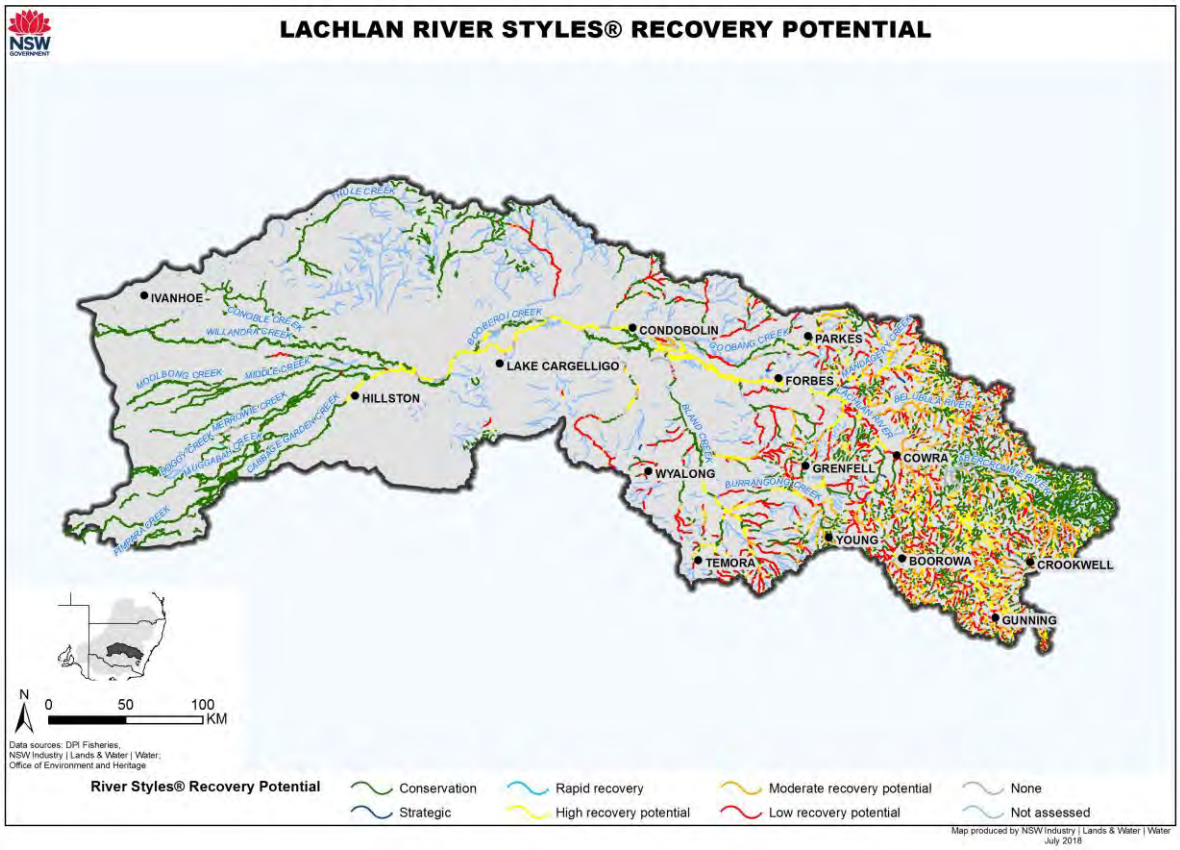

Figure G-4. Geomorphic recovery potential in streams in the Lachlan WRPA

Determining new or modified strategies for unregulated water sources

A decision tree logic (Figure G-5) was used to examine risks due to insufficient water available for the environment, and to prioritise mitigation strategies addressing these risks in unregulated water sources. Through this process, each risk is considered using the decision tree as a guide to offer a level of objectivity in the development of strategies whilst allowing for flexibility and adaptive management where necessary. Strategies are then discussed through consultation with the NSW Department of Planning and Environment, Water Resource Plan Stakeholder Advisory Panels, the MDBA and other relevant stakeholders. The outcomes of these discussions can influence the development of the final strategies within the WRP in order to reduce the impact of medium and high risks of insufficient water for key ecosystem functions and assets.

The decision tree is focused on specific rules, such as a flow-based cease to pump (CtP). This is considered an immediate strategy with the potential to mitigate medium and high risks identified in a water source. Although the trade of entitlement is another potential rule to manage medium and high risks, it is not considered an immediate mitigation measure, as there is no certainty of it occurring. Should trade of entitlement occur within a medium or high risk water source, it will likely have a longer term benefit by also assisting in mitigating the impact on instream values via reduced levels of extraction.

Each bifurcation in the decision tree was annotated, allowing for a rationale for each decision to be explained (Table G-2).

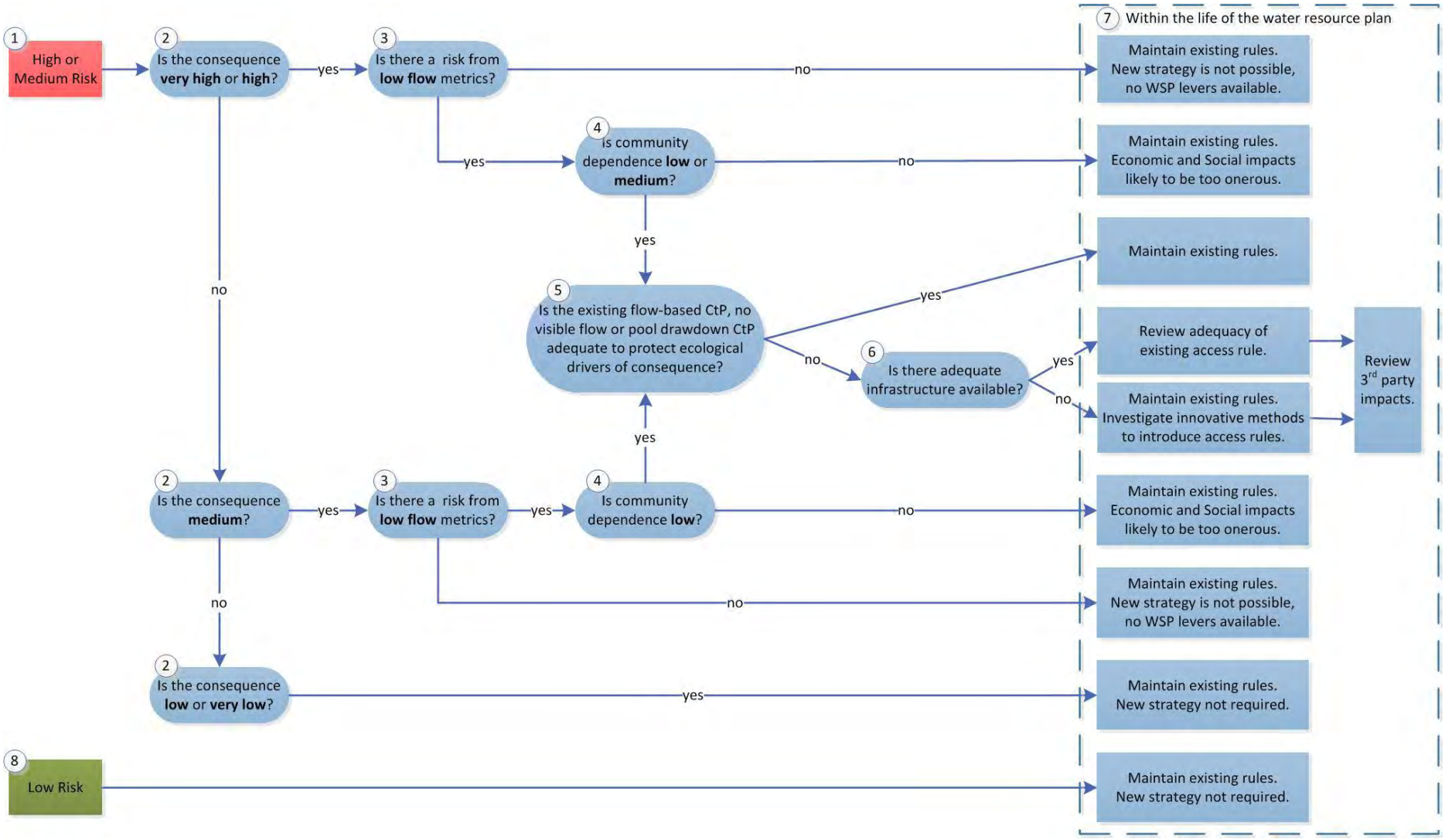

Figure G-5. Decision tree used as a guide for developing strategies in unregulated water sources

Table G-2. Rationale for each bifurcation in the decision tree used for determining strategies for unregulated water sources

Decision tree annotation	Rationale
1	• This step breaks up the strategies based on the Murray–Darling Basin Plan requirements that strategies are commensurate with the level of risk. • Where possible, draft strategies are being proposed to address water sources classified as medium or high risk. • Medium and high risks are considered the most important categories for ensuring adequate mitigation measures are determined. • Confidence in the data is high.
2	• This step is associated with medium and high risk water sources. • High and very high consequence categories are considered the most important for ensuring adequate mitigation measures are determined. • Medium consequence categories are considered important but are not prioritised over high and very high consequence. • Low and very low consequence categories do not provide sufficient evidence to justify the changing of access rules. • Confidence in the data is high.
3	• Low and high flow risks to instream values are determined through the risk assessment process, where risks to six flow metrics were assessed. • Low flows are considered to be zero flows, base flows and freshes. High flows are considered to be the bank full to over bank flows, identified in the risk assessment as an average recurrence intervals (ARI) of 1.5, 2.5 and 5 years. • In unregulated systems, there are only opportunities to consider mitigation measures in low flows within a WSP. • Mitigation measures for high flows are outside the influence of a WSP/WRP, where low flow management is the key focus. • Confidence in the data is high.
4	• Community dependence is a factor that identifies the economic value of water extracted and the social benefit of extraction within a water source. • Where community dependence is high and the consequence is high or very high, competition for water between licensed extractors and the environment is greatest. Hence the need for more certainty in a CtP level using accurate, flow-based infrastructure. Low or medium community dependence allows high and very high consequence water sources to be further investigated for potential access rule options. • Medium consequence water sources are not prioritised for access rule reviews if the community dependence is considered to be high or medium. However, if community dependence is low, there is potential to further investigate access rule options.

Decision tree annotation	Rationale
	• Confidence in the data is LOW due to the data being collated in 2005-06 to support the macro WSP process. If the community dependence was updated with the latest data from the Australian Bureau of Statistics (ABS), confidence would be higher. • * Where there is no Community Dependency data, by-pass this step and the decision tree moves from step 4 to step 5. The attributes of high or very high value sites are influenced by extraction pressure.
5	• This step breaks up either medium and or high risk water sources to ensure steps progressing towards the strategies continue to be commensurate with the level of risk and available infrastructure. • Existing rules are determined to be adequate to help mitigate medium or high risk waters sources following: o An assessment of any monitoring of the rules during the life of the previous State-based WSP, o There is existing evidence that indicates connectivity and water quality are managed through the CtP measures, o There is inter-agency agreement that based on any of the above steps, existing WSP rules are adequate to reduce or limit the level of risk on the medium or high risk water sources. • Within the water source, consider the influence of any constraints that include: o The location of 200 mm pumps. This should also be considered in relation to the potential influence (entrainment) they may have on instream assets and function below and above where these pumps are located. o The location of priority instream barriers (weirs, road crossings, instream dams) that have the most influence on reducing or removing longitudinal flow connectivity during low flows need to be identified. o The condition of the riparian zone, including changes to riparian vegetation and the geomorphic recovery potential of river reaches.
6	• The presence or absence of infrastructure is a key factor that may influence how medium and/or high risk water sources may be managed during low flow periods. • If infrastructure is available, it must also be reliable and accurate before considering access rule-based mitigation strategies.
7	• All existing or new strategies to assist in mitigating the risk to medium and high risk water sources will operate for the life of a WSP (10 years) unless otherwise changed by the Minister. • If existing rules are considered to be adequate, it is unlikely cases of third party impacts will arise, as the access licence holders will be familiar with pre-existing rules and would have already made comment in earlier public exhibition phases of water sharing plan development.
8	• The Murray–Darling Basin Plan does not require mitigation strategies for water sources identified as low risk.

Determining new or modified strategies for regulated water sources

As identified in previous sections, the operational, social, economic and environmental constraints to mitigating risks often provide limited scope for addressing risks in regulated rivers. The ability to mitigate a risk in a regulated water source primarily depends upon the flow class in which the risk occurs, the rules available within the WSP or WRP, and any potential impact upon third parties. The rules available in a WSP for planned environmental water generally only apply to low and medium flows. Rules are specific and can be unique to each regulated river. They can take the form of rules to manage supplementary water, or in some WSP areas, translucency rules, which allow small volumes of water to be released from storages to introduce flow variability, often subject to seasonal and flow triggers. Large volumes of held environmental water are managed by NSW OEH through the LTWP component of the Basin Plan. The operation of held environmental water is not within the scope of either the WSP or the WRP.

Figure G-6 shows the general decision making process to address risks of insufficient water for the environment in regulated rivers. A rationale was not provided for this diagram as it is a consolidation of the concepts that are already detailed above.

Further draft strategies for future consideration

The following draft strategies were also considered during the development of the WRP (Table G-3).

Table G-3. Draft strategies

Draft strategy details	Relevant river reaches
Strategic delivery of irrigation orders to mimic natural flow events This draft strategy will investigate whether the risk associated with the reduced frequency of freshes during late spring and summer can be mitigated by delivering bulk water in patterns that mimic natural flow conditions. The ability to implement this strategy will vary between years and seasons and must be consistent with the need for efficient and timely water deliver. Discussions would need to be undertaken with OEH and WaterNSW at the start of the irrigation planning season to examine whether delivery patterns can be varied without impacting on water security and efficiency.	Regulated river reaches below Wyangala and Carcoar Dams

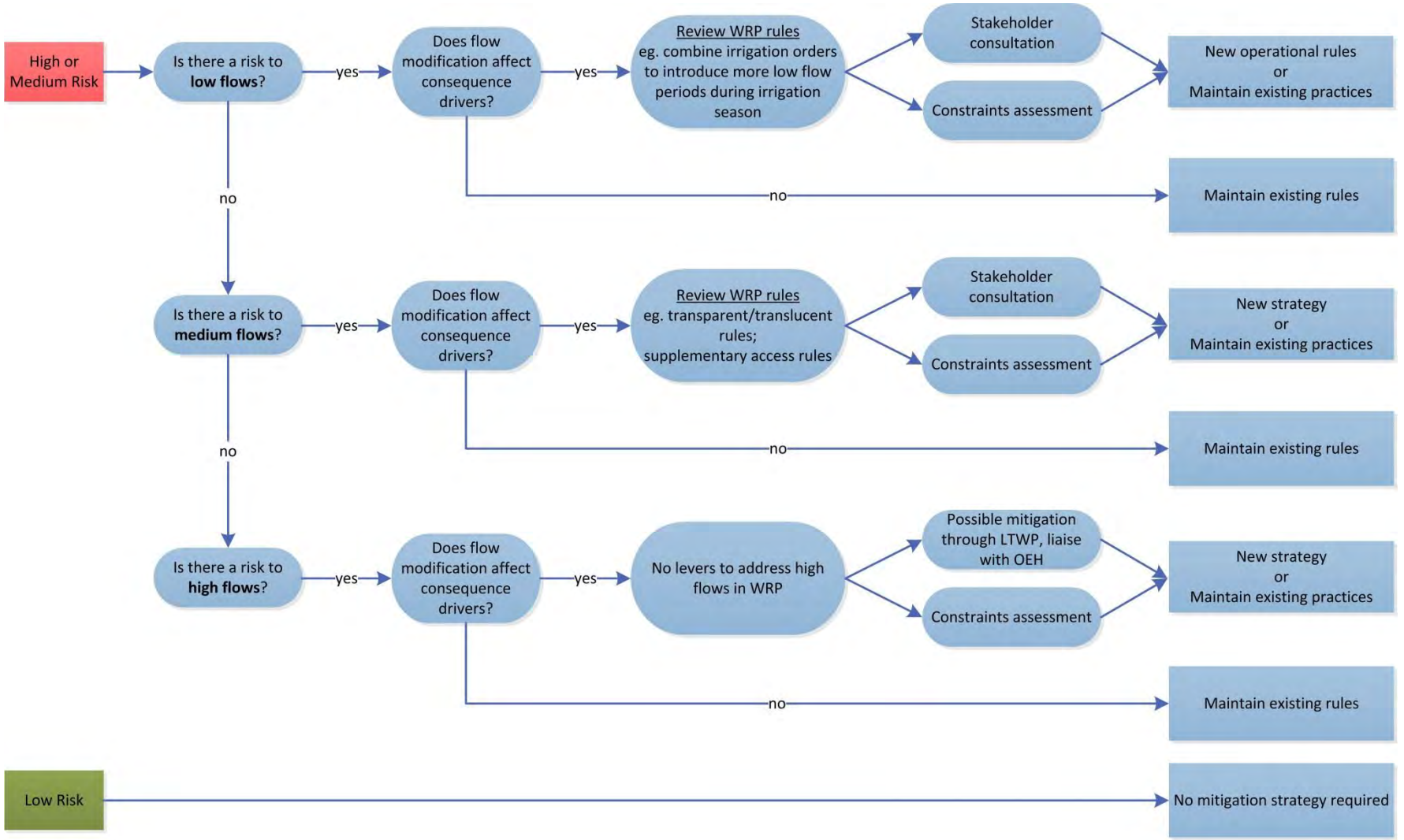

Figure G-6. Decision tree used as a guide for developing strategies in regulated water sources

Appendix H - Risk assessment definitions