BASIN PLAN IMPLEMENTATION

NSW Murray and Lower Darling Surface Water Resource Plan Risk Assessment (SW8)

Schedule D

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Acknowledgments

The maps in this report contain data sourced from:

Murray-Darling Basin Authority

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NSW DPI Water

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NSW Office of Environment and Heritage Atlas of NSW Wildlife data

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NSW DPI Fisheries Fish Community Status and Threatened Species data

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NSW DPI 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 NSW Murray and Lower Darling Water Resource Plan Area (SW8)* 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 NSW Murray and Lower Darling 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 risks	
	(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 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.

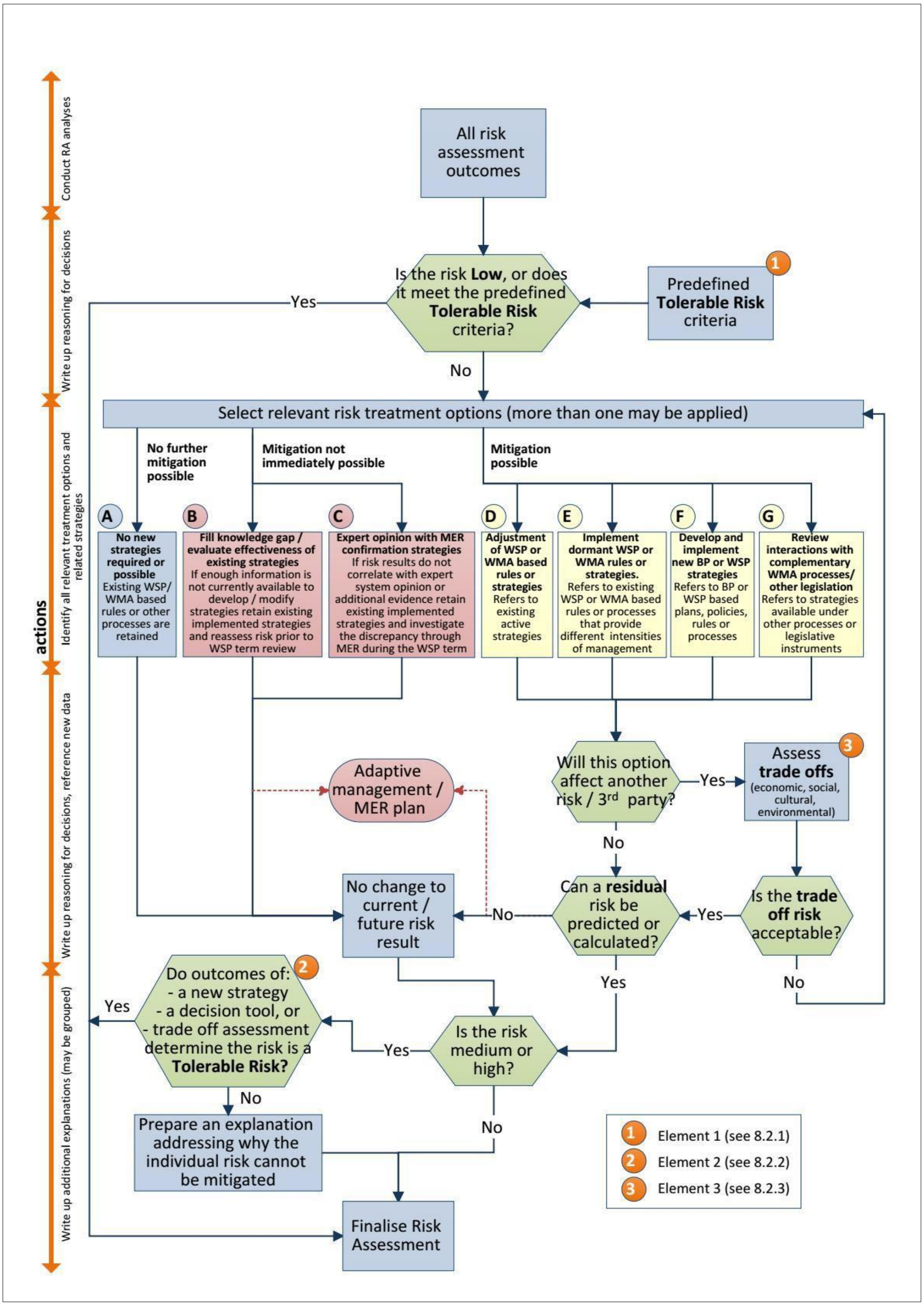

Figure 1. Risk treatment pathway.

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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.

Consolidated risk table interpretation

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 & 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	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						

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* 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

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 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 NSW MURRAY AND LOWER DARLING SURFACE WRPA FROM WATER QUALITY AND PESTS DUE TO CONNECTIVITY WITH OTHER WRPAs										
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**
Lower Darling regulated river water source	M	L	L	H/H	N/A	None required. Risk is low		N/A	N/A	No MER planned
Lower Darling unregulated water source	M	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	No MER planned
NSW Murray regulated river water source	M	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	No MER planned
NSW Murray unregulated river water sources	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 **Note** Hydrological connectivity risks from other WRPAs are addressed in section 4.3										

SECTION 3.2 RISKS OF INSUFFICIENT SURFACE WATER IMPACTING ON PRIORITY GROUNDWATER ASSETS AND FUNCTIONS (SURFACE WATER – GROUNDWATER CONNECTIVITY)										
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										

<table>
<tr><th colspan="15">SECTION 4.3 RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT & CAPACITY TO MEET EWRS [E(W)] - REGULATED SYSTEM AND MENINDEE LAKES</th></tr>
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OR
Explanation of why risk cannot be addressed</th><th>Monitoring & Evaluation</th></tr>
<tr><td>Lake Cawndilla</td><td>Overbank 1 (low level lake fill)</td><td rowspan="6">E1 Reserve all water above the long-term average annual extraction limit (LTAAEL)</td><td>H</td><td>M-</td><td>M-</td><td>H / H</td><td>M</td><td>A</td><td rowspan="6">2 Protect a portion of high flow events in the Barwon-Darling WRP area.</td><td rowspan="6">N1 Sustainable Diversion Limits
New strategies from the Barwon-Darling WRPA:
• Implementation of a first flush rule to manage the resumptions of flows after a cease to flow period (proposed new active management option)
• Protection of Held Environmental Water through water take restrictions (proposed new active management option)
• Investigate and implement water/flow protection measures to improve northern hydrological connectivity between Northern Basin catchments (proposed new active management option)</td><td>tolerable</td><td>Likelihood represents a decrease in the duration and number of days below the specific EWR (i.e. below a specific lake volume). This actually represents an increase in the likelihood of achieving the EWRs and is not considered an actual risk.</td><td rowspan="6">MER planned for the Menindee Lakes Savings project</td></tr>
<tr><td>Lake Cawndilla</td><td>Overbank 2 (mid-level lake fill)</td><td>H</td><td>M-</td><td>M-</td><td>H / H</td><td>M</td><td>A</td><td>tolerable</td><td>Likelihood represents a decrease in the duration and number of days below the specific EWR (i.e. below a specific lake volume). This actually represents an increase in the likelihood of achieving the EWRs and is not considered an actual risk.</td></tr>
<tr><td>Lake Cawndilla</td><td>Overbank 3 (high level lake fill)</td><td>H</td><td>M-</td><td>M-</td><td>H / H</td><td>M</td><td>A</td><td>tolerable</td><td>Likelihood represents a decrease in the duration and number of days below the specific EWR (i.e. below a specific lake volume). This actually represents an increase in the likelihood of achieving the EWRs and is not considered an actual risk.</td></tr>
<tr><td>Lake Cawndilla</td><td>Overbank 4 (very high level lake fill)</td><td>H</td><td>M-</td><td>M-</td><td>H / H</td><td>M</td><td>A</td><td>tolerable</td><td>Likelihood represents a decrease in the average rate of drawdown (falls) and is not considered an actual risk</td></tr>
<tr><td>Lake Cawndilla</td><td>Drawdown (rate and duration of falls)</td><td>H</td><td>M+</td><td>M-</td><td>H / H</td><td>M</td><td>A</td><td>tolerable</td><td>Likelihood represents a decrease in the average rate of drawdown (falls) and is not considered an actual risk</td></tr>
<tr><td>Lake Cawndilla</td><td>Filling (rate and duration of rises)</td><td>H</td><td>M-</td><td>M-</td><td>H / H</td><td>M</td><td>A</td><td>tolerable</td><td>Likelihood represents a decrease in the average duration of filling events (rises). Filling rates relate to upstream water resource development and cannot be mitigated within the WRP</td></tr>
<tr><td>Lake Menindee</td><td>Overbank 1 (low level lake fill)</td><td rowspan="4">E1 Reserve all water above the long-term average annual extraction limit (LTAAEL)</td><td>H</td><td>M-</td><td>M-</td><td>H / H</td><td>M</td><td>A</td><td rowspan="4">2 Protect a portion of high flow events in the Barwon-Darling WRP area.</td><td rowspan="4">N1 Sustainable Diversion Limits
New strategies from the Barwon-Darling WRPA:
• Implementation of a first flush rule to manage the resumptions of flows after a cease to flow period (proposed new active management option)
• Protection of Held Environmental Water through water take restrictions (proposed new active management option)
• Investigate and implement water/flow protection measures to improve northern</td><td>tolerable</td><td>Likelihood represents a decrease in the duration and number of days below the specific EWR (i.e. below a specific lake volume). This actually represents an increase in the likelihood of achieving the EWRs and is not considered an actual risk.</td><td rowspan="4">MER planned for the Menindee Lakes Savings project</td></tr>
<tr><td>Lake Menindee</td><td>Overbank 2 (mid-level lake fill)</td><td>H</td><td>M-</td><td>M-</td><td>H / H</td><td>M</td><td>A</td><td>tolerable</td><td>Likelihood represents a decrease in the duration and number of days below the specific EWR (i.e. below a specific lake volume). This actually represents an increase in the likelihood of achieving the EWRs and is not considered an actual risk.</td></tr>
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SECTION 4.3 RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT & CAPACITY TO MEET EWRS [E(W)] - REGULATED SYSTEM AND MENINDEE LAKES

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 & Evaluation
Lake Menindee	Drawdown (rate and duration of falls)		H	M-	M-	H / H	M	A		hydrological connectivity between Northern Basin catchments (proposed new active management option)	tolerable	Likelihood represents a decrease in the average rate of drawdown (falls) and is not considered an actual risk	
Lake Menindee	Filling (rate and duration of rises)		H	M-	M-	H / H	M	A			tolerable	Likelihood represents a decrease in the duration and number of days below the specific EWR (i.e. below a specific lake volume). This actually represents an increase in the likelihood of achieving the EWRs and is not considered an actual risk.	
Lake Wetherell	Overbank 1 (low level lake fill)	E1 Reserve all water above the long-term average annual extraction limit (LTAAEL)	VH	H-	H-	H / H	H	A	2 Protect a portion of high flow events in the Barwon-Darling WRP area.	N1 Sustainable Diversion Limits New strategies from the Barwon-Darling WRPA: • Implementation of a first flush rule to manage the resumptions of flows after a cease to flow period (proposed new active management option) • Protection of Held Environmental Water through water take restrictions (proposed new active management option) • Investigate and implement water/flow protection measures to improve northern hydrological connectivity between Northern Basin catchments (proposed new active management option)	tolerable	Likelihood represents a decrease in the duration and number of days below the specific EWR (i.e. below a specific lake volume). This actually represents an increase in the likelihood of achieving the EWRs and is not considered an actual risk.	MER planned for the Menindee Lakes Savings project
Lake Wetherell	Overbank 2 (mid-level lake fill)		VH	L+	M+	H / H	M	A			tolerable	The likelihood is low, hence the risk is tolerable.	
Lake Wetherell	Overbank 3 (high level lake fill)		VH	L-	M-	H / H	M	A			tolerable	Likelihood represents a decrease in the duration and number of days below the specific EWR (i.e. below a specific lake volume). This actually represents an increase in the likelihood of achieving the EWRs and is not considered an actual risk.	
Lake Wetherell	Overbank 4 (very high level lake fill)		VH	H-	H-	H / H	H	A			tolerable	Likelihood represents a decrease in the duration and number of days below the specific EWR (i.e. below a specific lake volume). This actually represents an increase in the likelihood of achieving the EWRs and is not considered an actual risk.	
Lake Wetherell	Drawdown (rate and duration of falls)		VH	L+	M-	H / H	M	A			tolerable	The likelihood is low, hence the risk is tolerable.	
Lake Wetherell	Filling (rate and duration of rises)		VH	L-	M+	H / H	M	A			tolerable	The likelihood is low, hence the risk is tolerable.	
Darling River at Menindee u/s weir 32	Zero Flow Periods	E8 Supplementary access to natural flow events may be permitted once flows are in excess of those required by the WSP.	M	H-	H	H / H	H	Predefined Tolerable	1 Limit consumptive water extractions in the WRP area to the predefined share of available water.	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 Hume Dam, Menindee Lakes and other major weirs. Zero flow periods will exhibit more natural patterns towards the downstream end of the water source.	No MER planned

SECTION 4.3 RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT & CAPACITY TO MEET EWRS [E(W)] - REGULATED SYSTEM AND MENINDEE LAKES

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 & Evaluation
Darling River at Menindee u/s weir 32	Base-flow or Low Flows	E9 Strategic use of the Lower Darling Environmental Water Allowance (the Lower Darling Allowance) as described in the WSP. E10 Coordinate release of the Lower Darling Environmental Water Allowance (the Lower Darling Allowance) and held environmental water with natural flow events.	M	H-	H	H / H	H	B,C, D.F. G	Protect a portion of high flow events in the Lower Darling and Murray WRP area. Provide discretionary 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 NSW Murray and Lower Darling LTWP. This strategy aims to improve environmental water management in the WRP area. Protect low flow habitats from accelerated rates of drying. Protect pools in streams, wetlands, lagoons and floodplains within the WRP area during dry periods.	Sustainable Diversion Limits N7 Strategic use of the Lower Darling River Flow Restart Allowance N10 No current mechanism available. Further knowledge required to improve strategies.	H	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. This impact is most pronounced in reaches closest to Hume Dam, Menindee Lakes and other major weirs. Base flow periods will exhibit more natural patterns towards the downstream end of the water source.	MER planned for WSP objectives
Darling River at Menindee u/s weir 32	Fresh Flows	E10 Coordinate release of held environmental water with natural flow events.	M	H-	H	H / H	H	B,C, D,G, F			H	Water ordering patterns have altered the duration and timing of freshes leading to unnaturally long events in summer and less events in winter.	MER planned for WSP objectives
Darling River at Menindee u/s weir 32	High and Infrequent Flows - Bank Full 1.5 years ARI		M	H-	H	H / H	H	D; F(i)-(ii)		N1 Sustainable Diversion Limits N2 Strategic use of held environmental water licences as described in the LTWP and Annual Watering Plans N3 Protection of environmental water from extraction by implementing the prerequisite policy measures into the WSP. Environmental Water Plans. N4 Improve environmental water delivery by implementing the Constraints Management Strategies within the Murray and Lower Darling key focus areas.	tolerable	There are no unregulated NSW tributaries in the river reach below Hume Dam or Menindee Lakes to supplement PEW or HEW releases to order to achieve bank full or over bank flows. The ability to mitigate the likelihood is low, hence the risk is tolerable.	MER planned for WSP objectives
Darling River at Menindee u/s weir 32	High and Infrequent Flows - Over Bank 2.5 years ARI		M	H-	H	H / H	H	Predefined Tolerable		None required – risks are tolerable.	N/A	There are no unregulated NSW tributaries in the river reach below Hume Dam or Menindee Lakes to supplement PEW or HEW releases to order to achieve bank full or over bank flows. 2.5 year ARI flows are unlikely to be returned via discretionary or non-discretionary environmental water due to the magnitudes required. The ability to mitigate the likelihood is low, hence the risk is tolerable.	MER planned for WSP objectives
Darling River at Menindee u/s weir 32	High and Infrequent Flows - Over Bank 5.0 years ARI		M	H-	H	H / H	H	Predefined Tolerable			N/A	There are no unregulated NSW tributaries in the river reach below Hume Dam or Menindee Lakes to supplement PEW or HEW releases to order to achieve bank full or over bank flows. 5.0 year ARI flows are unlikely to be returned via discretionary or non-discretionary environmental water due to the magnitudes required. The ability to mitigate the likelihood is low, hence the risk is tolerable.	MER planned for WSP objectives

SECTION 4.3 RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT & CAPACITY TO MEET EWRS [E(W)] - REGULATED SYSTEM AND MENINDEE LAKES

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 & Evaluation
Darling River at Burtundy	Zero Flow Periods	E9 Strategic use of the Lower Darling Environmental Water Allowance (the Lower Darling Allowance) as described in the WSP.	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 in the Lower Darling and Murray WRP area. 3 Provide discretionary 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 NSW Murray and Lower Darling LTWP. This strategy aims to improve environmental water management in the WRP area. 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.	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 Hume Dam, Menindee Lakes and other major weirs. Zero flow periods will exhibit more natural patterns towards the downstream end of the water source.	No MER planned
Darling River at Burtundy (425007)	Base-flow or Low Flows	E10 Coordinate release of the Lower Darling Environmental Water Allowance (the Lower Darling Allowance) and held environmental water with natural flow events.	M	H-	H	H / H	H	D; F(i)-(ii)		N1 Sustainable Diversion Limits N2 Strategic use of held environmental water licences as described in the LTWP and Annual Watering Plans. N3 Protection of environmental water from extraction by implementing the prerequisite policy measures into the WSP. Environmental Water Plans. N4 Improve environmental water delivery by implementing the Constraints Management Strategies within the Murray and Lower Darling key focus areas. N7 Strategic use of the Lower Darling River Flow Restart Allowance	H	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. This impact is most pronounced in reaches closest to Hume Dam, Menindee Lakes and other major weirs. Base flow periods will exhibit more natural patterns towards the downstream end of the water source.	MER planned for WSP objectives
Darling River at Burtundy	Fresh Flows	E10 Coordinate release of held environmental water with natural flow events.	M	H-	H	H / H	H				H	Water ordering patterns have altered the duration and timing of freshes leading to unnaturally long events in summer and less events in winter.	MER planned for WSP objectives
Darling River at Burtundy	High and Infrequent Flows - Bank Full 1.5 years ARI		M	L-	L	H / H	N/A	N/A		None required – risks are low	N/A		No MER planned
Darling River at Burtundy	High and Infrequent Flows - Over Bank 2.5 years ARI		M	L-	L	H / H	N/A	N/A			N/A		No MER planned
Darling River at Burtundy	High and Infrequent Flows - Over Bank 5.0 years ARI		M	L-	L	H / H	N/A	N/A			N/A		No MER planned
Great Darling Anabranch at outlet Lake Cawndilla	Zero Flow Periods	E10 Coordinate release of the Lower Darling Environmental Water Allowance (the Lower Darling Allowance) and held environmental water with natural flow events.	L	L	L*	H / L	N/A	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 Darling and Murray WRP area. 3 Provide discretionary environmental watering events in the regulated river and	None required – risks are low	N/A		No MER planned
Great Darling Anabranch at outlet Lake Cawndilla	Base-flow or Low Flows		L	M-	L	H / L	M	Predefined Tolerable		None required – risks are 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. Consequence is also Low.	No MER planned
Great Darling Anabranch at outlet Lake Cawndilla	Fresh Flows		L	H-	M	H / L	N/A	N/A		None required – risks are low	N/A		No MER planned

SECTION 4.3 RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT & CAPACITY TO MEET EWRS [E(W)] - REGULATED SYSTEM AND MENINDEE LAKES

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 & Evaluation
Great Darling Anabranch at outlet Lake Cawndilla	High and Infrequent Flows - Bank Full 1.5 years ARI		L	M-	L	H / L	N/A	N/A	downstream unregulated river sections of the WRP area. 4 Manage environmental water to meet flow targets specified in the NSW Murray and Lower Darling LTWP. This strategy aims to improve environmental water management in the WRP area. Protect low flow habitats from accelerated rates of drying. Protect pools in streams, wetlands, lagoons and floodplains within the WRP area during dry periods.	None required – risks are low	N/A		No MER planned
Great Darling Anabranch at outlet Lake Cawndilla	High and Infrequent Flows - Over Bank 2.5 years ARI		L	L-	L*	H / L	N/A	N/A			N/A		No MER planned
Great Darling Anabranch at outlet Lake Cawndilla	High and Infrequent Flows - Over Bank 5.0 years ARI		L	L+	L*	H / L	N/A	N/A			N/A		No MER planned
Great Darling Anabranch at Redbank Ck d/s Packers Crossing	Zero Flow Periods	E10 Coordinate release of held environmental water with natural flow events.	L	M-	L	H / H	N/A	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 Darling and Murray WRP area. 3 Provide discretionary 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 NSW Murray and Lower Darling LTWP. This strategy aims to improve environmental water management in the WRP area. 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.	None required – risks are low	N/A		No MER planned
Great Darling Anabranch at Redbank Ck d/s Packers Crossing	Base-flow or Low Flows		L	H-	M	H / H	M	D; F(i)-(ii)		N1 Sustainable Diversion Limits N2 Strategic use held environmental water licences as described in the LTWP and Annual Watering Plans.	tolerable	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. Consequence is also Low.	No MER planned
Great Darling Anabranch at Redbank Ck d/s Packers Crossing	Fresh Flows		L	M-	L	H / H	N/A	N/A		None required – risks are low	N/A		No MER planned
Great Darling Anabranch at Redbank Ck d/s Packers Crossing	High and Infrequent Flows - Bank Full 1.5 years ARI		L	L-	L	H / H	N/A	N/A			N/A		No MER planned
Great Darling Anabranch at Redbank Ck d/s Packers Crossing	High and Infrequent Flows - Over Bank 2.5 years ARI		L	L+	L	H / H	N/A	N/A			N/A		No MER planned

SECTION 4.3 RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT & CAPACITY TO MEET EWRS [E(W)] - REGULATED SYSTEM AND MENINDEE LAKES

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 & Evaluation
Great Darling Anabranch at Redbank Ck d/s Packers Crossing	High and Infrequent Flows - Over Bank 5.0 years ARI		L	L+	L	H / H	N/A	N/A		None required – risks are low	N/A		No MER planned
Murray River at Doctors Point	Zero Flow Periods	E8 Supplementary access to natural flow events may be permitted once flows are in excess of those required by the WSP. E9 Strategic use of the Barmah-Millewa Allowance (BMA), Barmah-Millewa Overdraw (BMO), Murray Additional Environmental Allowance (Murray AEA) as described in the WSP. E10 Coordinate release of Barmah-Millewa Allowance, Barmah-Millewa Overdraw, Murray Additional Environmental Allowance and held environmental water with natural flow events.	M	L^0	L	H / H	N/A	N/A	Limit consumptive water extractions in the WRP area to the predefined share of available water. Protect a portion of high flow events in the Lower Darling and Murray WRP area. Provide discretionary environmental watering events in the regulated river and downstream unregulated river sections of the WRP area. Manage environmental water to meet flow targets specified in the NSW Murray and Lower Darling LTWP. This strategy aims to improve environmental water management in the WRP area. 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. Protect important lagoons and wetlands within the WRP area. Protect tributary flows within the WRP area as they move from the unregulated water source into the regulated river water source.	None required – risks are low	N/A		No MER planned
Murray River at Doctors Point	Base-flow or Low Flows		M	H+	H	H / H	H	D; F(i)-(ii)		N1 Sustainable Diversion Limits N2 Strategic use of the Barmah-Millewa Allowance (BMA), Barmah-Millewa Overdraw (BMO), Murray Additional Environmental Allowance (Murray AEA), River Murray Increased Flows (RMIF) and held environmental water licences as described in the LTWP and Annual Watering Plans. N3 Protection of environmental water from extraction by implementing the prerequisite policy measures into the WSP. Environmental Water Plans. N4 Improve environmental water delivery by implementing the Constraints Management Strategies within the Murray and Lower Darling key focus areas.	tolerable	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. This impact is most pronounced in reaches closest to Hume Dam, Menindee Lakes and other major weirs. Base flow periods will exhibit more natural patterns towards the downstream end of the water source.	MER planned for WSP objectives
Murray River at Doctors Point	Fresh Flows		M	H+	H	H / H	H				tolerable	Water ordering patterns have altered the duration and timing of freshes leading to unnaturally long events in summer and less events in winter.	MER planned for WSP objectives
Murray River at Doctors Point	High and Infrequent Flows - Bank Full 1.5 years ARI		M	M-	M	H / H	M				tolerable	There are no unregulated NSW tributaries in the river reach below Hume Dam or Menindee Lakes to supplement PEW or HEW releases to order to achieve bank full or over bank flows. The ability to mitigate the likelihood is low, hence the risk is tolerable.	MER planned for WSP objectives
Murray River at Doctors Point	High and Infrequent Flows - Over Bank 2.5 years ARI		M	M-	M	H / H	M	Predefined Tolerable		None required – risks are tolerable.	N/A	There are no unregulated NSW tributaries in the river reach below Hume Dam or Menindee Lakes to supplement PEW or HEW releases to order to achieve bank full or over bank flows. 2.5 year ARI flows are unlikely to be returned via discretionary or non-discretionary environmental water due to the magnitudes required. The ability to mitigate the likelihood is low, hence the risk is tolerable.	No MER planned
Murray River at Doctors Point	High and Infrequent Flows - Over Bank 5.0 years ARI		M	M-	M	H / H	M	Predefined Tolerable		None required – risks are tolerable.	N/A	There are no unregulated NSW tributaries in the river reach below Hume Dam or Menindee Lakes to supplement PEW or HEW releases to order to achieve bank full or over bank flows. 5.0 year ARI flows are unlikely to be returned via discretionary or non-discretionary environmental water due to the magnitudes required. The ability to mitigate the likelihood is low, hence the risk is tolerable.	No MER planned

SECTION 4.3 RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT & CAPACITY TO MEET EWRS [E(W)] - REGULATED SYSTEM AND MENINDEE LAKES

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 & Evaluation
Murray River d/s Yarrawonga Weir	Zero Flow Periods	E8 Supplementary access to natural flow events may be permitted once flows are in excess of those required by the WSP. E9 Strategic use of the Barmah-Millewa Allowance (BMA), Barmah-Millewa Overdraw (BMO), Murray Additional Environmental Allowance (Murray AEA) as described in the WSP. E10 Coordinate release of Barmah-Millewa Allowance, Barmah-Millewa Overdraw and the Murray Additional Environmental Allowance and held environmental water with natural flow events.	VH	H-	H	H / H	H	Predefined Tolerable	Limit consumptive water extractions in the WRP area to the predefined share of available water. Protect a portion of high flow events in the Lower Darling and Murray WRP area. Provide discretionary environmental watering events in the regulated river and downstream unregulated river sections of the WRP area. Manage environmental water to meet flow targets specified in the NSW Murray and Lower Darling LTWP. This strategy aims to improve environmental water management in the WRP area. 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. Protect important lagoons and wetlands within the WRP area. Protect tributary flows within the WRP area as they move from the unregulated water source into the regulated river water source.	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 Hume Dam, Menindee Lakes and other major weirs. Zero flow periods will exhibit more natural patterns towards the downstream end of the water source.	No MER planned
Murray River d/s Yarrawonga Weir	Base-flow or Low Flows		VH	H+	H	H / H	H	D; F(i)-(ii)		N1 Sustainable Diversion Limits N2 Strategic use of the Barmah-Millewa Allowance (BMA), Barmah-Millewa Overdraw (BMO), Murray Additional Environmental Allowance (Murray AEA), River Murray Increased Flows (RMIF) and held environmental water licences as described in the LTWP and Annual Watering Plans. N3 Protection of environmental water from extraction by implementing the prerequisite policy measures into the WSP. Environmental Water Plans. N4 Improve environmental water delivery by implementing the Constraints Management Strategies within the Murray and Lower Darling key focus areas.	tolerable	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. This impact is most pronounced in reaches closest to Hume Dam, Menindee Lakes and other major weirs. Base flow periods will exhibit more natural patterns towards the downstream end of the water source.	MER planned for WSP objectives
Murray River d/s Yarrawonga Weir	Fresh Flows		VH	H+	H	H / H	H				tolerable	Water ordering patterns have altered the duration and timing of freshes leading to unnaturally long events in summer and less events in winter.	MER planned for WSP objectives
Murray River d/s Yarrawonga Weir	High and Infrequent Flows - Bank Full 1.5 years ARI		VH	M-	H	H / H	H				tolerable	There are no unregulated NSW tributaries in the river reach below Hume Dam or Menindee Lakes to supplement PEW or HEW releases to order to achieve bank full or over bank flows. The ability to mitigate the likelihood is low, hence the risk is tolerable.	MER planned for WSP objectives
Murray River d/s Yarrawonga Weir	High and Infrequent Flows - Over Bank 2.5 years ARI		VH	M-	H	H / H	H	Predefined Tolerable		None required – risks are tolerable.	N/A	There are no unregulated NSW tributaries in the river reach below Hume Dam or Menindee Lakes to supplement PEW or HEW releases to order to achieve bank full or over bank flows. 2.5 year ARI flows are unlikely to be returned via discretionary or non-discretionary environmental water due to the magnitudes required. The ability to mitigate the likelihood is low, hence the risk is tolerable.	No MER planned
Murray River d/s Yarrawonga Weir	High and Infrequent Flows - Over Bank 5.0 years ARI		VH	L-	M	H / H	M	Predefined Tolerable		None required – risks are tolerable.	N/A	There are no unregulated NSW tributaries in the river reach below Hume Dam or Menindee Lakes to supplement PEW or HEW releases to order to achieve bank full or over bank flows. 5.0 year ARI flows are unlikely to be returned via discretionary or non-discretionary environmental water due to the magnitudes required. The ability to mitigate the likelihood is low, hence the risk is tolerable.	No MER planned
Murray River at Echuca	Zero Flow Periods	E8 Supplementary access to natural flow events may be permitted once flows are in excess of those required by the WSP.	H	H+	H*	H / L	H	Predefined Tolerable	1 Limit consumptive water extractions in the WRP area to the predefined share of available water.	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 Hume Dam, Menindee Lakes and other major weirs. Zero flow periods will exhibit more natural patterns towards the downstream end of the water source.	No MER planned

SECTION 4.3 RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT & CAPACITY TO MEET EWRS [E(W)] - REGULATED SYSTEM AND MENINDEE LAKES

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 & Evaluation
Murray River at Echuca	Base-flow or Low Flows	E9 Strategic use of the Barmah-Millewa Allowance (BMA), Barmah-Millewa Overdraw (BMO), Murray Additional Environmental Allowance (Murray AEA) as described in the WSP. E10 Coordinate release of Barmah-Millewa Allowance, Barmah-Millewa Overdraw and the Murray Additional Environmental Allowance and held environmental water with natural flow events.	H	M-	M*	H / L	M	Predefined Tolerable	2 Protect a portion of high flow events in the Lower Darling and Murray WRP area. 3 Provide discretionary 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 NSW Murray and Lower Darling LTWP. This strategy aims to improve environmental water management in the WRP area. 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. 7 Protect important lagoons and wetlands within the WRP area. 8 Protect tributary flows within the WRP area as they move from the unregulated water source into the regulated river water source.	None required – risks are 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. This impact is most pronounced in reaches closest to Hume Dam, Menindee Lakes and other major weirs. Base flow periods will exhibit more natural patterns towards the downstream end of the water source.	MER planned for WSP objectives
Murray River at Echuca	Fresh Flows		H	H-	H*	H / L	H	Predefined Tolerable			N/A	Water ordering patterns have altered the duration and timing of freshes leading to unnaturally long events in summer and less events in winter.	MER planned for WSP objectives
Murray River at Echuca	High and Infrequent Flows - Bank Full 1.5 years ARI		H	L-	L*	H / L	N/A	N/A		None required – risks are low	N/A		MER planned for WSP objectives
Murray River at Echuca	High and Infrequent Flows - Over Bank 2.5 years ARI		H	L-	L*	H / L	N/A	N/A		None required – risks are low	N/A		No MER planned
Murray River at Echuca	High and Infrequent Flows - Over Bank 5.0 years ARI		H	L-	L*	H / L	N/A	N/A		None required – risks are low	N/A		No MER planned
Murray River at Torrumbarry	Zero Flow Periods	E8 Supplementary access to natural flow events may be permitted once flows are in excess of those required by the WSP. E9 Strategic use of the Murray Additional Environmental Allowance (Murray AEA) as described in the WSP. E10 Coordinate release of the Murray Additional Environmental Allowance and held environmental	VH	H+	H	H / H	H	Predefined Tolerable	Limit consumptive water extractions in the WRP area to the predefined share of available water. Protect a portion of high flow events in the Lower Darling and Murray WRP area. Provide discretionary 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	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 Hume Dam, Menindee Lakes and other major weirs. Zero flow periods will exhibit more natural patterns towards the downstream end of the water source.	No MER planned
Murray River at Torrumbarry	Base-flow or Low Flows		VH	M-	H	H / H	H	D; F(i)-(ii)		N1 Sustainable Diversion Limits N2 Strategic use of the Murray Additional Environmental Allowance (Murray AEA), River Murray Increased Flows (RMIF) and held environmental water	tolerable	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. This impact is most pronounced in reaches closest to Hume Dam, Menindee Lakes and other major weirs. Base flow periods will exhibit more natural patterns towards the downstream end of the water source.	MER planned for WSP objectives

SECTION 4.3 RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT & CAPACITY TO MEET EWRS [E(W)] - REGULATED SYSTEM AND MENINDEE LAKES													
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 & Evaluation**
Murray River at Torrumbarry	Fresh Flows	water with natural flow events.	VH	H-	H	H / H	H		the NSW Murray and Lower Darling LTWP. This strategy aims to improve environmental water management in the WRP area. 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. 7 Protect important lagoons and wetlands within the WRP area. 8 Protect tributary flows within the WRP area as they move from the unregulated water source into the regulated river water source.	licences as described in the LTWP and Annual Watering Plans. N3 Protection of environmental water from extraction by implementing the prerequisite policy measures into the WSP. Environmental Water Plans.	tolerable	Water ordering patterns have altered the duration and timing of freshes leading to unnaturally long events in summer and less events in winter.	MER planned for WSP objectives
Murray River at Torrumbarry	High and Infrequent Flows - Bank Full 1.5 years ARI		VH	L-	M	H / H	M			N4 Improve environmental water delivery by implementing the Constraints Management Strategies within the Murray and Lower Darling key focus areas.	tolerable	There are no unregulated NSW tributaries in the river reach below Hume Dam or Menindee Lakes to supplement PEW or HEW releases to order to achieve bank full or over bank flows. The ability to mitigate the likelihood is low, hence the risk is tolerable.	No MER planned
Murray River at Torrumbarry	High and Infrequent Flows - Over Bank 2.5 years ARI		VH	L-	M	H / H	M	Predefined Tolerable		None required – risks are tolerable.	N/A	There are no unregulated NSW tributaries in the river reach below Hume Dam or Menindee Lakes to supplement PEW or HEW releases to order to achieve bank full or over bank flows. 2.5 year ARI flows are unlikely to be returned via discretionary or non-discretionary environmental water due to the magnitudes required. The ability to mitigate the likelihood is low, hence the risk is tolerable.	No MER planned
Murray River at Torrumbarry	High and Infrequent Flows - Over Bank 5.0 years ARI		VH	L-	M	H / H	M	Predefined Tolerable		None required – risks are tolerable.	N/A	There are no unregulated NSW tributaries in the river reach below Hume Dam or Menindee Lakes to supplement PEW or HEW releases to order to achieve bank full or over bank flows. 5.0 year ARI flows are unlikely to be returned via discretionary or non-discretionary environmental water due to the magnitudes required. The ability to mitigate the likelihood is low, hence the risk is tolerable.	No MER planned
Murray River at d/s Wakool Junction	Zero Flow Periods	E8 Supplementary access to natural flow events may be permitted once flows are in excess of those required by the WSP. E9 Strategic use of the Murray Additional Environmental Allowance (Murray AEA) as described in the WSP. E10 Coordinate release of the Murray Additional Environmental Allowance and held environmental water with natural flow events.	M	L^{0}	L	H / H	N/A	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 Darling and Murray WRP area. 3 Provide discretionary 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 NSW Murray and Lower Darling LTWP. This strategy aims to improve environmental water management in the WRP area. 5 Protect low flow habitats from accelerated rates of drying. 6 Protect pools in streams, wetlands, lagoons and	None required – risks are low	N/A		No MER planned
Murray River at d/s Wakool Junction	Base-flow or Low Flows		M	M-	M	H / H	M	D; F(i)-(ii)		N1 Sustainable Diversion Limits N2 Strategic use of the Murray Additional Environmental Allowance (Murray AEA), River Murray Increased Flows (RMIF) and held environmental water licences as described in the LTWP and Annual Watering Plans. N3 Protection of environmental water from extraction by implementing the prerequisite policy measures into the WSP. Environmental Water Plans. N4 Improve environmental water delivery by implementing the Constraints Management Strategies within the Murray and Lower Darling key focus areas.	tolerable	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. This impact is most pronounced in reaches closest to Hume Dam, Menindee Lakes and other major weirs. Base flow periods will exhibit more natural patterns towards the downstream end of the water source.	MER planned for WSP objectives
Murray River at d/s Wakool Junction	Fresh Flows		M	M-	M	H / H	M				tolerable	Water ordering patterns have altered the duration and timing of freshes leading to unnaturally long events in summer and less events in winter.	MER planned for WSP objectives
Murray River at d/s Wakool Junction	High and Infrequent Flows - Bank Full 1.5 years ARI		M	M-	M	H / H	M				tolerable	There are no unregulated NSW tributaries in the river reach below Hume Dam or Menindee Lakes to supplement PEW or HEW releases to order to achieve bank full or over bank flows. The ability to mitigate the likelihood is low, hence the risk is tolerable.	MER planned for WSP objectives

SECTION 4.3 RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT & CAPACITY TO MEET EWRS [E(W)] - REGULATED SYSTEM AND MENINDEE LAKES

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 & Evaluation
Murray River at d/s Wakool Junction	High and Infrequent Flows - Over Bank 2.5 years ARI		M	M-	M	H / H	M	Predefined Tolerable	floodplains within the WRP area during dry periods. 7 Protect important lagoons and wetlands within the WRP area. 8 Protect tributary flows within the WRP area as they move from the unregulated water source into the regulated river water source.	None required – risks are tolerable.	N/A	There are no unregulated NSW tributaries in the river reach below Hume Dam or Menindee Lakes to supplement PEW or HEW releases to order to achieve bank full or over bank flows. 2.5 year ARI flows are unlikely to be returned via discretionary or non-discretionary environmental water due to the magnitudes required. The ability to mitigate the likelihood is low, hence the risk is tolerable.	No MER planned
Murray River at d/s Wakool Junction	High and Infrequent Flows - Over Bank 5.0 years ARI		M	M-	M	H / H	M	Predefined Tolerable		None required – risks are tolerable.	N/A	There are no unregulated NSW tributaries in the river reach below Hume Dam or Menindee Lakes to supplement PEW or HEW releases to order to achieve bank full or over bank flows. 5.0 year ARI flows are unlikely to be returned via discretionary or non-discretionary environmental water due to the magnitudes required. The ability to mitigate the likelihood is low, hence the risk is tolerable.	No MER planned
Murray River at Euston	Zero Flow Periods	E8 Supplementary access to natural flow events may be permitted once flows are in excess of those required by the WSP. E9 Strategic use of the Murray Additional Environmental Allowance (Murray AEA) as described in the WSP. E10 Coordinate release of the Murray Additional Environmental Allowance and held environmental water with natural flow events.	H	L^0	L	H / H	N/A	N/A	Limit consumptive water extractions in the WRP area to the predefined share of available water. Protect a portion of high flow events in the Lower Darling and Murray WRP area. 3 Provide discretionary environmental watering events in the regulated river and downstream unregulated river sections of the WRP area. Manage environmental water to meet flow targets specified in the NSW Murray and Lower Darling LTWP. This strategy aims to improve environmental water management in the WRP area. Protect low flow habitats from accelerated rates of drying. Protect pools in streams, wetlands, lagoons and floodplains within the WRP area during dry periods. Protect important lagoons and wetlands within the WRP area. Protect tributary flows within the WRP area as they move from the unregulated water source into the regulated river water source.	None required – risks are low	N/A		No MER planned
Murray River at Euston	Base-flow or Low Flows		H	H-	H	H / H	H	D; F(i)-(ii)		N1 Sustainable Diversion Limits N2 Strategic use of the Murray Additional Environmental Allowance (Murray AEA), River Murray Increased Flows (RMIF) and held environmental water licences as described in the LTWP and Annual Watering Plans. N3 Protection of environmental water from extraction by implementing the prerequisite policy measures into the WSP. Environmental Water Plans. N4 Improve environmental water delivery by implementing the Constraints Management Strategies within the Murray and Lower Darling key focus areas.	tolerable	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. This impact is most pronounced in reaches closest to Hume Dam, Menindee Lakes and other major weirs. Base flow periods will exhibit more natural patterns towards the downstream end of the water source.	MER planned for WSP objectives
Murray River at Euston	Fresh Flows		H	H-	H	H / H	H				tolerable	Water ordering patterns have altered the duration and timing of freshes leading to unnaturally long events in summer and less events in winter.	MER planned for WSP objectives
Murray River at Euston	High and Infrequent Flows - Bank Full 1.5 years ARI		H	M-	M	H / H	M				tolerable	There are no unregulated NSW tributaries in the river reach below Hume Dam or Menindee Lakes to supplement PEW or HEW releases to order to achieve bank full or over bank flows. The ability to mitigate the likelihood is low, hence the risk is tolerable.	MER planned for WSP objectives
Murray River at Euston	High and Infrequent Flows - Over Bank 2.5 years ARI		H	M-	M	H / H	M	Predefined Tolerable		None required – risks are tolerable.	N/A	There are no unregulated NSW tributaries in the river reach below Hume Dam or Menindee Lakes to supplement PEW or HEW releases to order to achieve bank full or over bank flows. 2.5 year ARI flows are unlikely to be returned via discretionary or non-discretionary environmental water due to the magnitudes required. The ability to mitigate the likelihood is low, hence the risk is tolerable.	No MER planned
Murray River at Euston	High and Infrequent Flows - Over Bank 5.0 years ARI		H	M-	M	H / H	M	Predefined Tolerable		None required – risks are tolerable.	N/A	There are no unregulated NSW tributaries in the river reach below Hume Dam or Menindee Lakes to supplement PEW or HEW releases to order to achieve bank full or over bank flows. 5.0 year ARI flows are unlikely to be returned via discretionary or non-discretionary environmental water due to the magnitudes required. The ability to mitigate the likelihood is low, hence the risk is tolerable.	No MER planned

SECTION 4.3 RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT & CAPACITY TO MEET EWRS [E(W)] - REGULATED SYSTEM AND MENINDEE LAKES

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 & Evaluation
Murray River at Wentworth	Zero Flow Periods	E8 Supplementary access to natural flow events may be permitted once flows are in excess of those required by the WSP. E9 Strategic use of the Murray Additional Environmental Allowance (Murray AEA) as described in the WSP. E10 Coordinate release of the Murray Additional Environmental Allowance and held environmental water with natural flow events.	H	L^0	L*	H / L	N/A	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 Darling and Murray WRP area. 3 Provide discretionary 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 NSW Murray and Lower Darling LTWP. This strategy aims to improve environmental water management in the WRP area. 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. 7 Protect important lagoons and wetlands within the WRP area. 8 Protect tributary flows within the WRP area as they move from the unregulated water source into the regulated river water source.	None required – risks are low.	N/A		No MER planned
Murray River at Wentworth	Base-flow or Low Flows		H	H-	H*	H / L	H	D; F(i)-(ii)		N1 Sustainable Diversion Limits N2 Strategic use of the Murray Additional Environmental Allowance (Murray AEA), River Murray Increased Flows (RMIF) and held environmental water licences as described in the LTWP and Annual Watering Plans. N3 Protection of environmental water from extraction by implementing the prerequisite policy measures into the WSP. Environmental Water Plans. N4 Improve environmental water delivery by implementing the Constraints Management Strategies within the Murray and Lower Darling key focus areas.	tolerable	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. This impact is most pronounced in reaches closest to Hume Dam, Menindee Lakes and other major weirs. Base flow periods will exhibit more natural patterns towards the downstream end of the water source.	No MER planned
Murray River at Wentworth	Fresh Flows		H	H-	H*	H / L	H				tolerable	Water ordering patterns have altered the duration and timing of freshes leading to unnaturally long events in summer and less events in winter.	No MER planned
Murray River at Wentworth	High and Infrequent Flows - Bank Full 1.5 years ARI		H	M-	M*	H / L	M				tolerable	There are no unregulated NSW tributaries in the river reach below Hume Dam or Menindee Lakes to supplement PEW or HEW releases to order to achieve bank full or over bank flows. The ability to mitigate the likelihood is low, hence the risk is tolerable.	No MER planned
Murray River at Wentworth	High and Infrequent Flows - Over Bank 2.5 years ARI		H	M-	M*	H / L	M	Predefined Tolerable		None required – risks are tolerable.	N/A	There are no unregulated NSW tributaries in the river reach below Hume Dam or Menindee Lakes to supplement PEW or HEW releases to order to achieve bank full or over bank flows. 2.5 year ARI flows are unlikely to be returned via discretionary or non-discretionary environmental water due to the magnitudes required. The ability to mitigate the likelihood is low, hence the risk is tolerable.	No MER planned
Murray River at Wentworth	High and Infrequent Flows - Over Bank 5.0 years ARI		H	M-	M*	H / L	M	Predefined Tolerable		None required – risks are tolerable.	N/A	There are no unregulated NSW tributaries in the river reach below Hume Dam or Menindee Lakes to supplement PEW or HEW releases to order to achieve bank full or over bank flows. 5.0 year ARI flows are unlikely to be returned via discretionary or non-discretionary environmental water due to the magnitudes required. The ability to mitigate the likelihood is low, hence the risk is tolerable.	No MER planned
Murray River at Lock 9 downstream	Zero Flow Periods	E8 Supplementary access to natural flow events may be permitted once flows are in excess of those required by the WSP. E9 Strategic use of the Murray Additional Environmental Allowance (Murray AEA) as described in the WSP.	H	L^0	L	H / H	N/A	N/A	Limit consumptive water extractions in the WRP area to the predefined share of available water. Protect a portion of high flow events in the Lower Darling and Murray WRP area. 3 Provide discretionary environmental watering events in the regulated river and	N/A	N/A		No MER planned
Murray River at Lock 9 downstream	Base-flow or Low Flows		H	H-	H	H / H	H	D; F(i)-(ii)		N1 Sustainable Diversion Limits N2 Strategic use of the Murray Additional Environmental Allowance (Murray AEA), River Murray Increased Flows (RMIF) and held environmental water	tolerable	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. This impact is most pronounced in reaches closest to Hume Dam, Menindee Lakes and other major weirs. Base flow periods will exhibit more natural patterns towards the downstream end of the water source.	MER planned for WSP objectives

SECTION 4.3 RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT & CAPACITY TO MEET EWRS [E(W)] - REGULATED SYSTEM AND MENINDEE LAKES

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 & Evaluation
Murray River at Lock 9 downstream	Fresh Flows	E10 Coordinate release of the Murray Additional Environmental Allowance and held environmental water with natural flow events.	H	H-	H	H / H	H		downstream unregulated river sections of the WRP area. 4 Manage environmental water to meet flow targets specified in the NSW Murray and Lower Darling LTWP. This strategy aims to improve environmental water management in the WRP area. 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. 7 Protect important lagoons and wetlands within the WRP area. 8 Protect tributary flows within the WRP area as they move from the unregulated water source into the regulated river water source.	licences as described in the LTWP and Annual Watering Plans. N3 Protection of environmental water from extraction by implementing the prerequisite policy measures into the WSP. Environmental Water Plans. N4 Improve environmental water delivery by implementing the Constraints Management Strategies within the Murray and Lower Darling key focus areas. N5 Investigate opportunities to implement Weir Pool Manipulation in the Murray River	tolerable	Water ordering patterns have altered the duration and timing of freshes leading to unnaturally long events in summer and less events in winter.	MER planned for WSP objectives
Murray River at Lock 9 downstream	High and Infrequent Flows - Bank Full 1.5 years ARI		H	M-	M	H / H	M				tolerable	There are no unregulated NSW tributaries in the river reach below Hume Dam or Menindee Lakes to supplement PEW or HEW releases to order to achieve bank full or over bank flows. The ability to mitigate the likelihood is low, hence the risk is tolerable.	MER planned for WSP objectives
Murray River at Lock 9 downstream	High and Infrequent Flows - Over Bank 2.5 years ARI		H	M-	M	H / H	M	Predefined Tolerable		None required – risks are tolerable.	N/A	There are no unregulated NSW tributaries in the river reach below Hume Dam or Menindee Lakes to supplement PEW or HEW releases to order to achieve bank full or over bank flows. 2.5 year ARI flows are unlikely to be returned via discretionary or non-discretionary environmental water due to the magnitudes required. The ability to mitigate the likelihood is low, hence the risk is tolerable.	No MER planned
Murray River at Lock 9 downstream	High and Infrequent Flows - Over Bank 5.0 years ARI		H	M-	M	H / H	M	Predefined Tolerable		None required – risks are tolerable.	N/A	There are no unregulated NSW tributaries in the river reach below Hume Dam or Menindee Lakes to supplement PEW or HEW releases to order to achieve bank full or over bank flows. 5.0 year ARI flows are unlikely to be returned via discretionary or non-discretionary environmental water due to the magnitudes required. The ability to mitigate the likelihood is low, hence the risk is tolerable.	No MER planned
Murray River Flow to South Australia	Zero Flow Periods	E8 Supplementary access to natural flow events may be permitted once flows are in excess of those required by the WSP. E9 Strategic use of the Murray Additional Environmental Allowance (Murray AEA) as described in the WSP. E10 Coordinate release of the Murray Additional Environmental Allowance and held environmental	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 in the Lower Darling and Murray WRP area. 3 Provide discretionary environmental watering events in the regulated river and downstream unregulated river sections of the WRP area.	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 Hume Dam, Menindee Lakes and other major weirs. Zero flow periods will exhibit more natural patterns towards the downstream end of the water source.	No MER planned
Murray River Flow to South Australia	Base-flow or Low Flows		M	H-	H	H / H	H	D; F(i)-(ii)		N1 Sustainable Diversion Limits N2 Strategic use of the Murray Additional Environmental Allowance (Murray AEA), River Murray Increased Flows (RMIF) and held environmental water	tolerable	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. This impact is most pronounced in reaches closest to Hume Dam, Menindee Lakes and other major weirs. Base flow periods will exhibit more natural patterns towards the downstream end of the water source.	MER planned for WSP objectives

SECTION 4.3 RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT & CAPACITY TO MEET EWRS [E(W)] - REGULATED SYSTEM AND MENINDEE LAKES

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 & Evaluation
Murray River Flow to South Australia	Fresh Flows	water with natural flow events.	M	H-	H	H / H	H		4 Manage environmental water to meet flow targets specified in the NSW Murray and Lower Darling LTWP. This strategy aims to improve environmental water management in the WRP area. 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. 7 Protect important lagoons and wetlands within the WRP area. 8 Protect tributary flows within the WRP area as they move from the unregulated water source into the regulated river water source.	licences as described in the LTWP and Annual. N3 Protection of environmental water from extraction by implementing the prerequisite policy measures into the WSP. Environmental Water Plans. N4 Improve environmental water delivery by implementing the Constraints Management Strategies within the Murray and Lower Darling key focus areas. N5 Investigate opportunities to implement Weir Pool Manipulation in the Murray River	tolerable	Water ordering patterns have altered the duration and timing of freshes leading to unnaturally long events in summer and less events in winter.	MER planned for WSP objectives
Murray River Flow to South Australia	High and Infrequent Flows - Bank Full 1.5 years ARI		M	L-	L	H / H	N/A	N/A		None required – risks are low	N/A		No MER planned
Murray River Flow to South Australia	High and Infrequent Flows - Over Bank 2.5 years ARI		M	L-	L	H / H	N/A	N/A		None required – risks are low	N/A		No MER planned
Murray River Flow to South Australia	High and Infrequent Flows - Over Bank 5.0 years ARI		M	L-	L	H / H	N/A	N/A		None required – risks are low	N/A		No MER planned
Edward River at Toonalook	Zero Flow Periods	E8 Supplementary access to natural flow events may be permitted once flows are in excess of those required by the WSP. E9 Strategic use of the Barmah-Millewa Allowance (BMA), Barmah-Millewa Overdraw (BMO), Murray Additional Environmental Allowance (Murray AEA) as described in the WSP. E10 Coordinate release of Barmah-Millewa Allowance, Barmah-Millewa Overdraw and the Murray Additional Environmental Allowance and held environmental	VH	H+	H	H / H	H	Predefined Tolerable	Limit consumptive water extractions in the WRP area to the predefined share of available water. Protect a portion of high flow events in the Lower Darling and Murray WRP area. Provide discretionary 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 NSW Murray and Lower Darling LTWP. This strategy aims to improve 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. This impact is most pronounced in reaches closest to Hume Dam, Menindee Lakes and other major weirs. Zero flow periods will exhibit more natural patterns towards the downstream end of the water source.	No MER planned
Edward River at Toonalook	Base-flow or Low Flows		VH	H+	H	H / H	H	D; F(i)-(ii)		N1 Sustainable Diversion Limits N2 Strategic use of the Barmah-Millewa Allowance (BMA), Barmah-Millewa Overdraw (BMO), Murray Additional Environmental Allowance (Murray AEA) and held environmental water licences as described in the LTWP and Annual Watering Plans. N3 Protection of environmental water from extraction by implementing the prerequisite	tolerable	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. This impact is most pronounced in reaches closest to Hume Dam, Menindee Lakes and other major weirs. Base flow periods will exhibit more natural patterns towards the downstream end of the water source.	MER planned for WSP objectives
Edward River at Toonalook	Fresh Flows		VH	H+	H	H / H	H				tolerable	Water ordering patterns have altered the duration and timing of freshes leading to unnaturally long events in summer and less events in winter.	MER planned for WSP objectives

SECTION 4.3 RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT & CAPACITY TO MEET EWRS [E(W)] - REGULATED SYSTEM AND MENINDEE LAKES

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 & Evaluation
Edward River at Toonalook	High and Infrequent Flows - Bank Full 1.5 years ARI	water with natural flow events.	VH	M-	H	H / H	H		water management in the WRP area. 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. Protect important lagoons and wetlands within the WRP area. Protect tributary flows within the WRP area as they move from the unregulated water source into the regulated river water source.	policy measures into the WSP. Environmental Water Plans. N4 Improve environmental water delivery by implementing the Constraints Management Strategies within the Murray and Lower Darling key focus areas.	tolerable	There are no unregulated NSW tributaries in the river reach below Hume Dam or Menindee Lakes to supplement PEW or HEW releases to order to achieve bank full or over bank flows. The ability to mitigate the likelihood is low, hence the risk is tolerable.	MER planned for WSP objectives
Edward River at Toonalook	High and Infrequent Flows - Over Bank 2.5 years ARI		VH	M-	H	H / H	H	Predefined Tolerable		None required – risks are tolerable.	N/A	There are no unregulated NSW tributaries in the river reach below Hume Dam or Menindee Lakes to supplement PEW or HEW releases to order to achieve bank full or over bank flows. 2.5 year ARI flows are unlikely to be returned via discretionary or non-discretionary environmental water due to the magnitudes required. The ability to mitigate the likelihood is low, hence the risk is tolerable.	No MER planned
Edward River at Toonalook	High and Infrequent Flows - Over Bank 5.0 years ARI		VH	L-	M	H / H	M	Predefined Tolerable		None required – risks are tolerable.	N/A	There are no unregulated NSW tributaries in the river reach below Hume Dam or Menindee Lakes to supplement PEW or HEW releases to order to achieve bank full or over bank flows. 5.0 year ARI flows are unlikely to be returned via discretionary or non-discretionary environmental water due to the magnitudes required. The ability to mitigate the likelihood is low, hence the risk is tolerable.	No MER planned
Edward River at Deniliquin	Zero Flow Periods	E8 Supplementary access to natural flow events may be permitted once flows are in excess of those required by the WSP. E9 Strategic use of the Barmah-Millewa Allowance (BMA), Barmah-Millewa Overdraw (BMO), Murray Additional Environmental Allowance (Murray AEA) as described in the WSP. E10 Coordinate release of Barmah-Millewa Allowance, Barmah-Millewa Overdraw and the Murray Additional Environmental Allowance and held environmental water with natural flow events.	VH	L⁰	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 high flow events in the Lower Darling and Murray WRP area. 3 Provide discretionary 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 NSW Murray and Lower Darling LTWP. This strategy aims to improve environmental water management in the WRP area. 5 Protect low flow habitats from accelerated rates of drying. 6 Protect pools in streams, wetlands, lagoons and	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 Hume Dam, Menindee Lakes and other major weirs. Zero flow periods will exhibit more natural patterns towards the downstream end of the water source.	No MER planned
Edward River at Deniliquin	Base-flow or Low Flows		VH	H+	H	H / H	H	D; F(i)-(ii)		N1 Sustainable Diversion Limits N2 Strategic use of the Barmah-Millewa Allowance (BMA), Barmah-Millewa Overdraw (BMO), Murray Additional Environmental Allowance (Murray AEA) and held environmental water licences as described in the LTWP and Annual Watering Plans. N3 Protection of environmental water from extraction by implementing the prerequisite policy measures into the WSP. Environmental Water Plans. N4 Improve environmental water delivery by implementing the Constraints Management Strategies within the Murray and Lower Darling key focus areas.	tolerable	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. This impact is most pronounced in reaches closest to Hume Dam, Menindee Lakes and other major weirs. Base flow periods will exhibit more natural patterns towards the downstream end of the water source.	MER planned for WSP objectives
Edward River at Deniliquin	Fresh Flows		VH	H+	H	H / H	H				tolerable	Water ordering patterns have altered the duration and timing of freshes leading to unnaturally long events in summer and less events in winter.	MER planned for WSP objectives
Edward River at Deniliquin	High and Infrequent Flows - Bank Full 1.5 years ARI		VH	H-	H	H / H	H				tolerable	There are no unregulated NSW tributaries in the river reach below Hume Dam or Menindee Lakes to supplement PEW or HEW releases to order to achieve bank full or over bank flows. The ability to mitigate the likelihood is low, hence the risk is tolerable.	MER planned for WSP objectives

SECTION 4.3 RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT & CAPACITY TO MEET EWRS [E(W)] - REGULATED SYSTEM AND MENINDEE LAKES

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 & Evaluation
Edward River at Deniliquin	High and Infrequent Flows - Over Bank 2.5 years ARI		VH	M-	H	H / H	H	Predefined Tolerable	floodplains within the WRP area during dry periods. 7 Protect important lagoons and wetlands within the WRP area. 8 Protect tributary flows within the WRP area as they move from the unregulated water source into the regulated river water source.	None required – risks are tolerable.	N/A	There are no unregulated NSW tributaries in the river reach below Hume Dam or Menindee Lakes to supplement PEW or HEW releases to order to achieve bank full or over bank flows. 2.5 year ARI flows are unlikely to be returned via discretionary or non-discretionary environmental water due to the magnitudes required. The ability to mitigate the likelihood is low, hence the risk is tolerable.	No MER planned
Edward River at Deniliquin	High and Infrequent Flows - Over Bank 5.0 years ARI		VH	M-	H	H / H	H	Predefined Tolerable		None required – risks are tolerable.	N/A	There are no unregulated NSW tributaries in the river reach below Hume Dam or Menindee Lakes to supplement PEW or HEW releases to order to achieve bank full or over bank flows. 5.0 year ARI flows are unlikely to be returned via discretionary or non-discretionary environmental water due to the magnitudes required. The ability to mitigate the likelihood is low, hence the risk is tolerable.	No MER planned
Edward River d/s Stevens Weir	Zero Flow Periods	E8 Supplementary access to natural flow events may be permitted once flows are in excess of those required by the WSP. E9 Strategic use of the Murray Additional Environmental Allowance (Murray AEA) as described in the WSP. E10 Coordinate release of the Murray Additional Environmental Allowance and held environmental water with natural flow events.	H	L^0	L	H / H	N/A	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 Darling and Murray WRP area. 3 Provide discretionary 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 NSW Murray and Lower Darling LTWP. This strategy aims to improve environmental water management in the WRP area. 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. 7 Protect important lagoons and wetlands within the WRP area. 8 Protect tributary flows within the WRP area as they move from the unregulated water source into the regulated river water source.	None required – risks are low	N/A		No MER planned
Edward River d/s Stevens Weir	Base-flow or Low Flows		H	H-	H	H / H	H	D; F(i)-(ii)		N1 Sustainable Diversion Limits N2 Strategic use of the Murray Additional Environmental Allowance (Murray AEA) and held environmental water licences as described in the LTWP and Annual Watering Plans. N3 Protection of environmental water from extraction by implementing the prerequisite policy measures into the WSP. Environmental Water Plans. N4 Improve environmental water delivery by implementing the Constraints Management Strategies within the Murray and Lower Darling key focus areas.	tolerable	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. This impact is most pronounced in reaches closest to Hume Dam, Menindee Lakes and other major weirs. Base flow periods will exhibit more natural patterns towards the downstream end of the water source.	MER planned for WSP objectives
Edward River d/s Stevens Weir	Fresh Flows		H	H+	H	H / H	H				tolerable	Water ordering patterns have altered the duration and timing of freshes leading to unnaturally long events in summer and less events in winter.	MER planned for WSP objectives
Edward River d/s Stevens Weir	High and Infrequent Flows - Bank Full 1.5 years ARI		H	H-	H	H / H	H				tolerable	There are no unregulated NSW tributaries in the river reach below Hume Dam or Menindee Lakes to supplement PEW or HEW releases to order to achieve bank full or over bank flows. The ability to mitigate the likelihood is low, hence the risk is tolerable.	MER planned for WSP objectives
Edward River d/s Stevens Weir	High and Infrequent Flows - Over Bank 2.5 years ARI		H	M-	M	H / H	M	Predefined Tolerable		None required – risks are tolerable.	N/A	There are no unregulated NSW tributaries in the river reach below Hume Dam or Menindee Lakes to supplement PEW or HEW releases to order to achieve bank full or over bank flows. 2.5 year ARI flows are unlikely to be returned via discretionary or non-discretionary environmental water due to the magnitudes required. The ability to mitigate the likelihood is low, hence the risk is tolerable.	No MER planned
Edward River d/s Stevens Weir	High and Infrequent Flows - Over Bank 5.0 years ARI		H	M-	M	H / H	M	Predefined Tolerable		None required – risks are tolerable.	N/A	There are no unregulated NSW tributaries in the river reach below Hume Dam or Menindee Lakes to supplement PEW or HEW releases to order to achieve bank full or over bank flows. 5.0 year ARI flows are unlikely to be returned via discretionary or non-discretionary environmental water due to the magnitudes required. The ability to mitigate the likelihood is low, hence the risk is tolerable.	No MER planned

SECTION 4.3 RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT & CAPACITY TO MEET EWRS [E(W)] - REGULATED SYSTEM AND MENINDEE LAKES

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 & Evaluation
Edward River at Leiwah	Zero Flow Periods	E8 Supplementary access to natural flow events may be permitted once flows are in excess of those required by the WSP. E9 Strategic use of the Murray Additional Environmental Allowance (Murray AEA) as described in the WSP. E10 Coordinate release of the Murray Additional Environmental Allowance and held environmental water with natural flow events.	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 in the Lower Darling and Murray WRP area. 3 Provide discretionary 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 NSW Murray and Lower Darling LTWP. This strategy aims to improve environmental water management in the WRP area. 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. 7 Protect important lagoons and wetlands within the WRP area. 8 Protect tributary flows within the WRP area as they move from the unregulated water source into the regulated river water source.	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 Hume Dam, Menindee Lakes and other major weirs. Zero flow periods will exhibit more natural patterns towards the downstream end of the water source.	No MER planned
Edward River at Leiwah	Base-flow or Low Flows		H	H+	H	H / H	H	D; F(i)-(ii)		N1 Sustainable Diversion Limits N2 Strategic use of the Murray Additional Environmental Allowance (Murray AEA) and held environmental water licences as described in the LTWP and Annual Watering Plans. N3 Protection of environmental water from extraction by implementing the prerequisite policy measures into the WSP. Environmental Water Plans. N4 Improve environmental water delivery by implementing the Constraints Management Strategies within the Murray and Lower Darling key focus areas.	tolerable	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. This impact is most pronounced in reaches closest to Hume Dam, Menindee Lakes and other major weirs. Base flow periods will exhibit more natural patterns towards the downstream end of the water source.	MER planned for WSP objectives
Edward River at Leiwah	Fresh Flows		H	M+	M	H / H	M				tolerable	Water ordering patterns have altered the duration and timing of freshes leading to unnaturally long events in summer and less events in winter.	MER planned for WSP objectives
Edward River at Leiwah	High and Infrequent Flows - Bank Full 1.5 years ARI		H	L-	L	H / H	N/A	N/A		None required – risks are low	N/A		No MER planned
Edward River at Leiwah	High and Infrequent Flows - Over Bank 2.5 years ARI		H	M-	M	H / H	M	Predefined Tolerable		None required – risks are tolerable.	N/A	There are no unregulated NSW tributaries in the river reach below Hume Dam or Menindee Lakes to supplement PEW or HEW releases to order to achieve bank full or over bank flows. 2.5 year ARI flows are unlikely to be returned via discretionary or non-discretionary environmental water due to the magnitudes required. The ability to mitigate the likelihood is low, hence the risk is tolerable.	No MER planned
Edward River at Leiwah	High and Infrequent Flows - Over Bank 5.0 years ARI		H	L-	L	H / H	N/A	N/A		None required – risks are low	N/A		No MER planned
Wakool River at Offtake Regulator	Zero Flow Periods	E8 Supplementary access to natural flow events may be permitted once flows	VH	H-	H	H / H	H	Predefined Tolerable	1 Limit consumptive water extractions in the WRP area to the predefined share of available water.	None required – risks are tolerable.	N/A		No MER planned

SECTION 4.3 RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT & CAPACITY TO MEET EWRS [E(W)] - REGULATED SYSTEM AND MENINDEE LAKES

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 & Evaluation
Wakool River at Offtake Regulator	Base-flow or Low Flows	are in excess of those required by the WSP. E9 Strategic use of the Murray Additional Environmental Allowance (Murray AEA) as described in the WSP. E10 Coordinate release of the Murray Additional Environmental Allowance and held environmental water with natural flow events.	VH	H-	H	H / H	H	D; F(i)-(ii)	2 Protect a portion of high flow events in the Lower Darling and Murray WRP area. 3 Provide discretionary 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 NSW Murray and Lower Darling LTWP. This strategy aims to improve environmental water management in the WRP area. 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. 7 Protect important lagoons and wetlands within the WRP area. 8 Protect tributary flows within the WRP area as they move from the unregulated water source into the regulated river water source.	N1 Sustainable Diversion Limits N2 Strategic use of the Murray Additional Environmental Allowance (Murray AEA) and held environmental water licences as described in the LTWP and Annual Watering Plans. N3 Protection of environmental water from extraction by implementing the prerequisite policy measures into the WSP. Environmental Water Plans. N4 Improve environmental water delivery by implementing the Constraints Management Strategies within the Murray and Lower Darling key focus areas.	tolerable	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. This impact is most pronounced in reaches closest to Hume Dam, Menindee Lakes and other major weirs. Base flow periods will exhibit more natural patterns towards the downstream end of the water source.	MER planned for WSP objectives
Wakool River at Offtake Regulator	Fresh Flows		VH	H-	H	H / H	H				tolerable	Water ordering patterns have altered the duration and timing of freshes leading to unnaturally long events in summer and less events in winter.	MER planned for WSP objectives
Wakool River at Offtake Regulator	High and Infrequent Flows - Bank Full 1.5 years ARI		VH	H-	H	H / H	H				tolerable	There are no unregulated NSW tributaries in the river reach below Hume Dam or Menindee Lakes to supplement PEW or HEW releases to order to achieve bank full or over bank flows. The ability to mitigate the likelihood is low, hence the risk is tolerable.	MER planned for WSP objectives
Wakool River at Offtake Regulator	High and Infrequent Flows - Over Bank 2.5 years ARI		VH	M-	H	H / H	H	Predefined Tolerable		None required – risks are tolerable.	N/A	There are no unregulated NSW tributaries in the river reach below Hume Dam or Menindee Lakes to supplement PEW or HEW releases to order to achieve bank full or over bank flows. 2.5 year ARI flows are unlikely to be returned via discretionary or non-discretionary environmental water due to the magnitudes required. The ability to mitigate the likelihood is low, hence the risk is tolerable.	No MER planned
Wakool River at Offtake Regulator	High and Infrequent Flows - Over Bank 5.0 years ARI		VH	L-	M	H / H	M	Predefined Tolerable		None required – risks are tolerable.	N/A	There are no unregulated NSW tributaries in the river reach below Hume Dam or Menindee Lakes to supplement PEW or HEW releases to order to achieve bank full or over bank flows. 5.0 year ARI flows are unlikely to be returned via discretionary or non-discretionary environmental water due to the magnitudes required. The ability to mitigate the likelihood is low, hence the risk is tolerable.	No MER planned
Wakool River at Wakool/Barham Rd	Zero Flow Periods	E8 Supplementary access to natural flow events may be permitted once flows are in excess of those required by the WSP. E9 Strategic use of the Murray Additional Environmental Allowance (Murray AEA) as described in the WSP. E10 Coordinate release of the Murray Additional Environmental Allowance and held environmental water with natural flow events.	VH	H-	H*	H / L	H	Predefined Tolerable	1 Limit consumptive water extractions in the WRP area to the predefined share of available water.	None required – risks are tolerable.	N/A		No MER planned
Wakool River at Wakool/Barham Rd	Base-flow or Low Flows		VH	H-	H*	H / L	H	D; F(i)-(ii)	2 Protect a portion of high flow events in the Lower Darling and Murray WRP area. 3 Provide discretionary 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 NSW Murray and Lower Darling LTWP. This strategy	N1 Sustainable Diversion Limits N2 Strategic use of the Murray Additional Environmental Allowance (Murray AEA) and held environmental water licences as described in the LTWP and Annual Watering Plans. N3 Protection of environmental water from extraction by implementing the prerequisite	tolerable	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. This impact is most pronounced in reaches closest to Hume Dam, Menindee Lakes and other major weirs. Base flow periods will exhibit more natural patterns towards the downstream end of the water source.	MER planned for WSP objectives
Wakool River at Wakool/Barham Rd	Fresh Flows		VH	H-	H*	H / L	H				tolerable	Water ordering patterns have altered the duration and timing of freshes leading to unnaturally long events in summer and less events in winter.	MER planned for WSP objectives

SECTION 4.3 RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT & CAPACITY TO MEET EWRS [E(W)] - REGULATED SYSTEM AND MENINDEE LAKES

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 & Evaluation
Wakool River at Wakool/Barham Rd	High and Infrequent Flows - Bank Full 1.5 years ARI		VH	H-	H*	H / L	H		aims to improve environmental water management in the WRP area. 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. 7 Protect important lagoons and wetlands within the WRP area. 8 Protect tributary flows within the WRP area as they move from the unregulated water source into the regulated river water source.	policy measures into the WSP. Environmental Water Plans. N4 Improve environmental water delivery by implementing the Constraints Management Strategies within the Murray and Lower Darling key focus areas.	tolerable	There are no unregulated NSW tributaries in the river reach below Hume Dam or Menindee Lakes to supplement PEW or HEW releases to order to achieve bank full or over bank flows. The ability to mitigate the likelihood is low, hence the risk is tolerable.	MER planned for WSP objectives
Wakool River at Wakool/Barham Rd	High and Infrequent Flows - Over Bank 2.5 years ARI		VH	M-	H*	H / L	H	Predefined Tolerable		None required – risks are tolerable.	N/A	There are no unregulated NSW tributaries in the river reach below Hume Dam or Menindee Lakes to supplement PEW or HEW releases to order to achieve bank full or over bank flows. 2.5 year ARI flows are unlikely to be returned via discretionary or non-discretionary environmental water due to the magnitudes required. The ability to mitigate the likelihood is low, hence the risk is tolerable.	No MER planned
Wakool River at Wakool/Barham Rd	High and Infrequent Flows - Over Bank 5.0 years ARI		VH	L-	M*	H / L	M	Predefined Tolerable		None required – risks are tolerable.	N/A	There are no unregulated NSW tributaries in the river reach below Hume Dam or Menindee Lakes to supplement PEW or HEW releases to order to achieve bank full or over bank flows. 5.0 year ARI flows are unlikely to be returned via discretionary or non-discretionary environmental water due to the magnitudes required. The ability to mitigate the likelihood is low, hence the risk is tolerable.	No MER planned
Wakool River at Gee Gee Bridge (No.2)	Zero Flow Periods	E8 Supplementary access to natural flow events may be permitted once flows are in excess of those required by the WSP. E9 Strategic use of the Murray Additional Environmental Allowance (Murray AEA) as described in the WSP. E10 Coordinate release of the Murray Additional Environmental Allowance and held environmental water with natural flow events.	VH	H-	H*	H / L	H	Predefined Tolerable	Limit consumptive water extractions in the WRP area to the predefined share of available water. Protect a portion of high flow events in the Lower Darling and Murray WRP area. Provide discretionary 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 NSW Murray and Lower Darling LTWP. This strategy aims to improve environmental water management in the WRP area. Protect low flow habitats from accelerated rates of drying. Protect pools in streams, wetlands, lagoons and floodplains within the WRP area during dry periods.	None required – risks are tolerable.	N/A		No MER planned
Wakool River at Gee Gee Bridge (No.2)	Base-flow or Low Flows		VH	H-	H*	H / L	H	D; F(i)-(ii)		N1 Sustainable Diversion Limits N2 Strategic use of the Murray Additional Environmental Allowance (Murray AEA) and held environmental water licences as described in the LTWP and Annual Watering Plans.	tolerable	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. This impact is most pronounced in reaches closest to Hume Dam, Menindee Lakes and other major weirs. Base flow periods will exhibit more natural patterns towards the downstream end of the water source.	MER planned for WSP objectives
Wakool River at Gee Gee Bridge (No.2)	Fresh Flows		VH	H-	H*	H / L	H			N3 Protection of environmental water from extraction by implementing the prerequisite policy measures into the WSP. Environmental Water Plans.	tolerable	Water ordering patterns have altered the duration and timing of freshes leading to unnaturally long events in summer and less events in winter.	MER planned for WSP objectives
Wakool River at Gee Gee Bridge (No.2)	High and Infrequent Flows - Bank Full 1.5 years ARI		VH	H-	H*	H / L	H			N4 Improve environmental water delivery by implementing the Constraints Management Strategies within the Murray and Lower Darling key focus areas.	tolerable	There are no unregulated NSW tributaries in the river reach below Hume Dam or Menindee Lakes to supplement PEW or HEW releases to order to achieve bank full or over bank flows. The ability to mitigate the likelihood is low, hence the risk is tolerable.	MER planned for WSP objectives
Wakool River at Gee Gee Bridge (No.2)	High and Infrequent Flows - Over Bank 2.5 years ARI		VH	M-	H*	H / L	H	Predefined Tolerable		None required – risks are tolerable.	N/A	There are no unregulated NSW tributaries in the river reach below Hume Dam or Menindee Lakes to supplement PEW or HEW releases to order to achieve bank full or over bank flows. 2.5 year ARI flows are unlikely to be returned via discretionary or non-discretionary environmental water due to the magnitudes required. The ability to mitigate the likelihood is low, hence the risk is tolerable.	No MER planned

SECTION 4.3 RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT & CAPACITY TO MEET EWRS [E(W)] - REGULATED SYSTEM AND MENINDEE LAKES

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 & Evaluation
Wakool River at Gee Gee Bridge (No.2)	High and Infrequent Flows - Over Bank 5.0 years ARI		VH	L-	M*	H / L	M	Predefined Tolerable	7 Protect important lagoons and wetlands within the WRP area. 8 Protect tributary flows within the WRP area as they move from the unregulated water source into the regulated river water source.	None required – risks are tolerable.	N/A	There are no unregulated NSW tributaries in the river reach below Hume Dam or Menindee Lakes to supplement PEW or HEW releases to order to achieve bank full or over bank flows. 5.0 year ARI flows are unlikely to be returned via discretionary or non-discretionary environmental water due to the magnitudes required. The ability to mitigate the likelihood is low, hence the risk is tolerable.	No MER planned
Wakool River at Stoney Crossing	Zero Flow Periods	E8 Supplementary access to natural flow events may be permitted once flows are in excess of those required by the WSP. E9 Strategic use of the Murray Additional Environmental Allowance (Murray AEA) as described in the WSP. E10 Coordinate release of the Murray Additional Environmental Allowance and held environmental water with natural flow events.	H	L0	L	H / H	N/A	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 Darling and Murray WRP area. 3 Provide discretionary 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 NSW Murray and Lower Darling LTWP. This strategy aims to improve environmental water management in the WRP area. 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. 7 Protect important lagoons and wetlands within the WRP area. 8 Protect tributary flows within the WRP area as they move from the unregulated water source into the regulated river water source.	None required – risks are low	N/A		No MER planned
Wakool River at Stoney Crossing	Base-flow or Low Flows		H	H+	H	H / H	H	D; F(i)-(ii)		N1 Sustainable Diversion Limits N2 Strategic use of the Murray Additional Environmental Allowance (Murray AEA) and held environmental water licences as described in the LTWP and Annual. N3 Protection of environmental water from extraction by implementing the prerequisite policy measures into the WSP. Environmental Water Plans. N4 Improve environmental water delivery by implementing the Constraints Management Strategies within the Murray and Lower Darling key focus areas.	tolerable	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. This impact is most pronounced in reaches closest to Hume Dam, Menindee Lakes and other major weirs. Base flow periods will exhibit more natural patterns towards the downstream end of the water source.	MER planned for WSP objectives
Wakool River at Stoney Crossing	Fresh Flows		H	H+	H	H / H	H				tolerable	Water ordering patterns have altered the duration and timing of freshes leading to unnaturally long events in summer and less events in winter.	MER planned for WSP objectives
Wakool River at Stoney Crossing	High and Infrequent Flows - Bank Full 1.5 years ARI		H	M-	M	H / H	M				tolerable	There are no unregulated NSW tributaries in the river reach below Hume Dam or Menindee Lakes to supplement PEW or HEW releases to order to achieve bank full or over bank flows. The ability to mitigate the likelihood is low, hence the risk is tolerable.	MER planned for WSP objectives
Wakool River at Stoney Crossing	High and Infrequent Flows - Over Bank 2.5 years ARI		H	M-	M	H / H	M	Predefined Tolerable		None required – risks are tolerable.	N/A	There are no unregulated NSW tributaries in the river reach below Hume Dam or Menindee Lakes to supplement PEW or HEW releases to order to achieve bank full or over bank flows. 2.5 year ARI flows are unlikely to be returned via discretionary or non-discretionary environmental water due to the magnitudes required. The ability to mitigate the likelihood is low, hence the risk is tolerable.	No MER planned
Wakool River at Stoney Crossing	High and Infrequent Flows - Over Bank 5.0 years ARI		H	M-	M	H / H	M	Predefined Tolerable		None required – risks are tolerable.	N/A	There are no unregulated NSW tributaries in the river reach below Hume Dam or Menindee Lakes to supplement PEW or HEW releases to order to achieve bank full or over bank flows. 5.0 year ARI flows are unlikely to be returned via discretionary or non-discretionary environmental water due to the magnitudes required. The ability to mitigate the likelihood is low, hence the risk is tolerable.	No MER planned
Wakool River at Kyalite	Zero Flow Periods	E8 Supplementary access to natural flow events may be permitted once flows are in excess of those required by the WSP. E9 Strategic use of the Murray Additional Environmental Allowance	H	L^0	L	H / H	N/A	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 Darling and Murray WRP area. 3 Provide discretionary environmental watering events in	None required – risks are low	N/A		No MER planned
Wakool River at Kyalite	Base-flow or Low Flows		H	H+	H	H / H	H	D; F(i)-(ii)		N1 Sustainable Diversion Limits N2 Strategic use of the Murray Additional Environmental Allowance (Murray AEA) and held environmental water licences as	tolerable	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. This impact is most pronounced in reaches closest to Hume Dam, Menindee Lakes and other major weirs. Base flow periods will exhibit more natural patterns towards the downstream end of the water source.	MER planned for WSP objectives

SECTION 4.3 RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT & CAPACITY TO MEET EWRS [E(W)] - REGULATED SYSTEM AND MENINDEE LAKES

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 & Evaluation
Wakool River at Kyalite	Fresh Flows	(Murray AEA) as described in the WSP. E10 Coordinate release of the Murray Additional Environmental Allowance and held environmental water with natural flow events.	H	M+	H	H / H	H		the regulated river and downstream unregulated river sections of the WRP area. 4 Manage environmental water to meet flow targets specified in the NSW Murray and Lower Darling LTWP. This strategy aims to improve environmental water management in the WRP area. 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. 7 Protect important lagoons and wetlands within the WRP area. 8 Protect tributary flows within the WRP area as they move from the unregulated water source into the regulated river water source.	described in the LTWP and Annual. N3 Protection of environmental water from extraction by implementing the prerequisite policy measures into the WSP. Environmental Water Plans. N4 Improve environmental water delivery by implementing the Constraints Management Strategies within the Murray and Lower Darling key focus areas.	tolerable	Water ordering patterns have altered the duration and timing of freshes leading to unnaturally long events in summer and less events in winter.	MER planned for WSP objectives
Wakool River at Kyalite	High and Infrequent Flows - Bank Full 1.5 years ARI		H	H-	M	H / H	M				tolerable	There are no unregulated NSW tributaries in the river reach below Hume Dam or Menindee Lakes to supplement PEW or HEW releases to order to achieve bank full or over bank flows. The ability to mitigate the likelihood is low, hence the risk is tolerable.	MER planned for WSP objectives
Wakool River at Kyalite	High and Infrequent Flows - Over Bank 2.5 years ARI		H	M-	M	H / H	M	Predefined Tolerable		None required – risks are tolerable.	N/A	There are no unregulated NSW tributaries in the river reach below Hume Dam or Menindee Lakes to supplement PEW or HEW releases to order to achieve bank full or over bank flows. 2.5 year ARI flows are unlikely to be returned via discretionary or non-discretionary environmental water due to the magnitudes required. The ability to mitigate the likelihood is low, hence the risk is tolerable.	No MER planned
Wakool River at Kyalite	High and Infrequent Flows - Over Bank 5.0 years ARI		H	M-	M	H / H	M	Predefined Tolerable		None required – risks are tolerable.	N/A	There are no unregulated NSW tributaries in the river reach below Hume Dam or Menindee Lakes to supplement PEW or HEW releases to order to achieve bank full or over bank flows. 5.0 year ARI flows are unlikely to be returned via discretionary or non-discretionary environmental water due to the magnitudes required. The ability to mitigate the likelihood is low, hence the risk is tolerable.	No MER planned
Yallakool Creek at Offtake	Zero Flow Periods	E8 Supplementary access to natural flow events may be permitted once flows are in excess of those required by the WSP. E9 Strategic use of the Murray Additional Environmental Allowance (Murray AEA) as described in the WSP. E10 Coordinate release of the Murray Additional Environmental Allowance 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 in the Lower Darling and Murray WRP area. 3 Provide discretionary 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 NSW Murray and Lower Darling LTWP. This strategy aims to improve environmental water management in the WRP area. 5 Protect low flow habitats from accelerated rates of drying. 6 Protect pools in streams, wetlands, lagoons and	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 Hume Dam, Menindee Lakes and other major weirs. Zero flow periods will exhibit more natural patterns towards the downstream end of the water source.	No MER planned
Yallakool Creek at Offtake	Base-flow or Low Flows		VH	H+	H	H / H	H	D; F(i)-(ii)		N1 Sustainable Diversion Limits N2 Strategic use of the Murray Additional Environmental Allowance (Murray AEA) and held environmental water licences as described in the LTWP and Annual. N3 Protection of environmental water from extraction by implementing the prerequisite policy measures into the WSP. Environmental Water Plans. N4 Improve environmental water delivery by implementing the Constraints Management Strategies within the Murray and Lower Darling key focus areas.	tolerable	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. This impact is most pronounced in reaches closest to Hume Dam, Menindee Lakes and other major weirs. Base flow periods will exhibit more natural patterns towards the downstream end of the water source.	MER planned for WSP objectives
Yallakool Creek at Offtake	Fresh Flows		VH	H-	H	H / H	H				tolerable	Water ordering patterns have altered the duration and timing of freshes leading to unnaturally long events in summer and less events in winter.	MER planned for WSP objectives
Yallakool Creek at Offtake	High and Infrequent Flows - Bank Full 1.5 years ARI		VH	H-	H	H / H	H				tolerable	There are no unregulated NSW tributaries in the river reach below Hume Dam or Menindee Lakes to supplement PEW or HEW releases to order to achieve bank full or over bank flows. The ability to mitigate the likelihood is low, hence the risk is tolerable.	MER planned for WSP objectives

SECTION 4.3 RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT & CAPACITY TO MEET EWRS [E(W)] - REGULATED SYSTEM AND MENINDEE LAKES

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 & Evaluation
Yallakool Creek at Offtake	High and Infrequent Flows - Over Bank 2.5 years ARI		VH	M-	H	H / H	H	Predefined Tolerable	floodplains within the WRP area during dry periods. 7 Protect important lagoons and wetlands within the WRP area. 8 Protect tributary flows within the WRP area as they move from the unregulated water source into the regulated river water source.	None required – risks are tolerable.	N/A	There are no unregulated NSW tributaries in the river reach below Hume Dam or Menindee Lakes to supplement PEW or HEW releases to order to achieve bank full or over bank flows. 2.5 year ARI flows are unlikely to be returned via discretionary or non-discretionary environmental water due to the magnitudes required. The ability to mitigate the likelihood is low, hence the risk is tolerable.	No MER planned
Yallakool Creek at Offtake	High and Infrequent Flows - Over Bank 5.0 years ARI		VH	L-	M	H / H	M	Predefined Tolerable		None required – risks are tolerable.	N/A	There are no unregulated NSW tributaries in the river reach below Hume Dam or Menindee Lakes to supplement PEW or HEW releases to order to achieve bank full or over bank flows. 5.0 year ARI flows are unlikely to be returned via discretionary or non-discretionary environmental water due to the magnitudes required. The ability to mitigate the likelihood is low, hence the risk is tolerable.	No MER planned
Colligen Creek at below Regulator	Zero Flow Periods	E8 Supplementary access to natural flow events may be permitted once flows are in excess of those required by the WSP. E9 Strategic use of the Murray Additional Environmental Allowance (Murray AEA) as described in the WSP. E10 Coordinate release of the Murray Additional Environmental Allowance 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 in the Lower Darling and Murray WRP area. 3 Provide discretionary 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 NSW Murray and Lower Darling LTWP. This strategy aims to improve environmental water management in the WRP area. 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. 7 Protect important lagoons and wetlands within the WRP area. 8 Protect tributary flows within the WRP area as they move from the unregulated water source into the regulated river water source.	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 Hume Dam, Menindee Lakes and other major weirs. Zero flow periods will exhibit more natural patterns towards the downstream end of the water source.	No MER planned
Colligen Creek at below Regulator	Base-flow or Low Flows		VH	H+	H	H / H	H	D; F(i)-(ii)		N1 Sustainable Diversion Limits N2 Strategic use of the Murray Additional Environmental Allowance (Murray AEA) and held environmental water licences as described in the LTWP and Annual. N3 Protection of environmental water from extraction by implementing the prerequisite policy measures into the WSP. Environmental Water Plans. N4 Improve environmental water delivery by implementing the Constraints Management Strategies within the Murray and Lower Darling key focus areas.	tolerable	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. This impact is most pronounced in reaches closest to Hume Dam, Menindee Lakes and other major weirs. Base flow periods will exhibit more natural patterns towards the downstream end of the water source.	MER planned for WSP objectives
Colligen Creek at below Regulator	Fresh Flows		VH	H-	H	H / H	H				tolerable	Water ordering patterns have altered the duration and timing of freshes leading to unnaturally long events in summer and less events in winter.	MER planned for WSP objectives
Colligen Creek at below Regulator	High and Infrequent Flows - Bank Full 1.5 years ARI		VH	M-	H	H / H	H				tolerable	There are no unregulated NSW tributaries in the river reach below Hume Dam or Menindee Lakes to supplement PEW or HEW releases to order to achieve bank full or over bank flows. The ability to mitigate the likelihood is low, hence the risk is tolerable.	MER planned for WSP objectives
Colligen Creek at below Regulator	High and Infrequent Flows - Over Bank 2.5 years ARI		VH	M-	H	H / H	H	Predefined Tolerable		None required – risks are tolerable.	N/A	There are no unregulated NSW tributaries in the river reach below Hume Dam or Menindee Lakes to supplement PEW or HEW releases to order to achieve bank full or over bank flows. 2.5 year ARI flows are unlikely to be returned via discretionary or non-discretionary environmental water due to the magnitudes required. The ability to mitigate the likelihood is low, hence the risk is tolerable.	No MER planned
Colligen Creek at below Regulator	High and Infrequent Flows - Over Bank 5.0 years ARI		VH	L-	M	H / H	M	Predefined Tolerable		None required – risks are tolerable.	N/A	There are no unregulated NSW tributaries in the river reach below Hume Dam or Menindee Lakes to supplement PEW or HEW releases to order to achieve bank full or over bank flows. 5.0 year ARI flows are unlikely to be returned via discretionary or non-discretionary environmental water due to the magnitudes required. The ability to mitigate the likelihood is low, hence the risk is tolerable.	No MER planned

SECTION 4.3 RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT & CAPACITY TO MEET EWRS [E(W)] - REGULATED SYSTEM AND MENINDEE LAKES

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 & Evaluation
Niemur River at Barham/Moulamein Rd	Zero Flow Periods	E8 Supplementary access to natural flow events may be permitted once flows are in excess of those required by the WSP. E9 Strategic use of the Murray Additional Environmental Allowance (Murray AEA) as described in the WSP. E10 Coordinate release of the Murray Additional Environmental Allowance and held environmental water with natural flow events.	H	H-	H*	H / L	H	Predefined Tolerable	Limit consumptive water extractions in the WRP area to the predefined share of available water. Protect a portion of high flow events in the Lower Darling and Murray WRP area. Provide discretionary environmental watering events in the regulated river and downstream unregulated river sections of the WRP area. Manage environmental water to meet flow targets specified in the NSW Murray and Lower Darling LTWP. This strategy aims to improve environmental water management in the WRP area. Protect low flow habitats from accelerated rates of drying. Protect pools in streams, wetlands, lagoons and floodplains within the WRP area during dry periods. 7 Protect important lagoons and wetlands within the WRP area. Protect tributary flows within the WRP area as they move from the unregulated water source into the regulated river water source.	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 Hume Dam, Menindee Lakes and other major weirs. Zero flow periods will exhibit more natural patterns towards the downstream end of the water source.	No MER planned
Niemur River at Barham/Moulamein Rd	Base-flow or Low Flows		H	H+	H*	H / L	H	D; F(i)-(ii)		N1 Sustainable Diversion Limits N2 Strategic use of the Murray Additional Environmental Allowance (Murray AEA) and held environmental water licences as described in the LTWP and Annual. N3 Protection of environmental water from extraction by implementing the prerequisite policy measures into the WSP. Environmental Water Plans. N4 Improve environmental water delivery by implementing the Constraints Management Strategies within the Murray and Lower Darling key focus areas.	tolerable	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. This impact is most pronounced in reaches closest to Hume Dam, Menindee Lakes and other major weirs. Base flow periods will exhibit more natural patterns towards the downstream end of the water source.	MER planned for WSP objectives
Niemur River at Barham/Moulamein Rd	Fresh Flows		H	H-	H*	H / L	H				tolerable	Water ordering patterns have altered the duration and timing of freshes leading to unnaturally long events in summer and less events in winter.	MER planned for WSP objectives
Niemur River at Barham/Moulamein Rd	High and Infrequent Flows - Bank Full 1.5 years ARI		H	M-	M*	H / L	M				tolerable	There are no unregulated NSW tributaries in the river reach below Hume Dam or Menindee Lakes to supplement PEW or HEW releases to order to achieve bank full or over bank flows. The ability to mitigate the likelihood is low, hence the risk is tolerable.	MER planned for WSP objectives
Niemur River at Barham/Moulamein Rd	High and Infrequent Flows - Over Bank 2.5 years ARI		H	M-	M*	H / L	M	Predefined Tolerable		None required – risks are tolerable.	N/A	There are no unregulated NSW tributaries in the river reach below Hume Dam or Menindee Lakes to supplement PEW or HEW releases to order to achieve bank full or over bank flows. 2.5 year ARI flows are unlikely to be returned via discretionary or non-discretionary environmental water due to the magnitudes required. The ability to mitigate the likelihood is low, hence the risk is tolerable.	No MER planned
Niemur River at Barham/Moulamein Rd	High and Infrequent Flows - Over Bank 5.0 years ARI		H	L-	L*	H / L	N/A	Predefined Tolerable		None required – risks are low	N/A	There are no unregulated NSW tributaries in the river reach below Hume Dam or Menindee Lakes to supplement PEW or HEW releases to order to achieve bank full or over bank flows. 5.0 year ARI flows are unlikely to be returned via discretionary or non-discretionary environmental water due to the magnitudes required. The ability to mitigate the likelihood is low, hence the risk is tolerable.	No MER planned
Bullatale Creek u/s Edward R	Zero Flow Periods	E8 Supplementary access to natural flow events may be permitted once flows are in excess of those required by the WSP.	H	H+	H*	H / L	H	N/A	1 Limit consumptive water extractions in the WRP area to the predefined share of available water.	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 Hume Dam, Menindee Lakes and other major weirs. Zero flow periods will exhibit more natural patterns towards the downstream end of the water source.	No MER planned

SECTION 4.3 RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT & CAPACITY TO MEET EWRS [E(W)] - REGULATED SYSTEM AND MENINDEE LAKES

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 & Evaluation
Bullatale Creek u/s Edward R	Base-flow or Low Flows	E9 Strategic use of the Barmah-Millewa Allowance (BMA), Barmah-Millewa Overdraw (BMO), Murray Additional Environmental Allowance (Murray AEA) as described in the WSP. E10 Coordinate release of Barmah-Millewa Allowance, Barmah-Millewa Overdraw and the Murray Additional Environmental Allowance and held environmental water with natural flow events.	H	H+	H*	H / L	H	D; F(i)-(ii)	2 Protect a portion of high flow events in the Lower Darling and Murray WRP area. 3 Provide discretionary 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 NSW Murray and Lower Darling LTWP. This strategy aims to improve environmental water management in the WRP area. 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. 7 Protect important lagoons and wetlands within the WRP area. 8 Protect tributary flows within the WRP area as they move from the unregulated water source into the regulated river water source.	N1 Sustainable Diversion Limits N2 Strategic use of the Murray Additional Environmental Allowance (Murray AEA) and held environmental water licences as described in the LTWP and Annual. N3 Protection of environmental water from extraction by implementing the prerequisite policy measures into the WSP. Environmental Water Plans. N4 Improve environmental water delivery by implementing the Constraints Management Strategies within the Murray and Lower Darling key focus areas.	tolerable	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. This impact is most pronounced in reaches closest to Hume Dam, Menindee Lakes and other major weirs. Base flow periods will exhibit more natural patterns towards the downstream end of the water source.	MER planned for WSP objectives
Bullatale Creek u/s Edward R	Fresh Flows		H	H+	H*	H / L	H				tolerable	Water ordering patterns have altered the duration and timing of freshes leading to unnaturally long events in summer and less events in winter.	MER planned for WSP objectives
Bullatale Creek u/s Edward R	High and Infrequent Flows - Bank Full 1.5 years ARI		H	M-	M*	H / L	M				tolerable	There are no unregulated NSW tributaries in the river reach below Hume Dam or Menindee Lakes to supplement PEW or HEW releases to order to achieve bank full or over bank flows. The ability to mitigate the likelihood is low, hence the risk is tolerable.	MER planned for WSP objectives
Bullatale Creek u/s Edward R	High and Infrequent Flows - Over Bank 2.5 years ARI		H	M-	M*	H / L	M	N/A		None required – risks are tolerable.	N/A	There are no unregulated NSW tributaries in the river reach below Hume Dam or Menindee Lakes to supplement PEW or HEW releases to order to achieve bank full or over bank flows. 2.5 year ARI flows are unlikely to be returned via discretionary or non-discretionary environmental water due to the magnitudes required. The ability to mitigate the likelihood is low, hence the risk is tolerable.	No MER planned
Bullatale Creek u/s Edward R	High and Infrequent Flows - Over Bank 5.0 years ARI		H	L-	L*	H / L	N/A	N/A		None required – risks are low.	N/A	There are no unregulated NSW tributaries in the river reach below Hume Dam or Menindee Lakes to supplement PEW or HEW releases to order to achieve bank full or over bank flows. 5.0 year ARI flows are unlikely to be returned via discretionary or non-discretionary environmental water due to the magnitudes required. The ability to mitigate the likelihood is low, hence the risk is tolerable.	No MER planned
Gulpa Creek at Offtake	Zero Flow Periods	E8 Supplementary access to natural flow events may be permitted once flows are in excess of those required by the WSP. E9 Strategic use of the Barmah-Millewa Allowance (BMA), Barmah-Millewa Overdraw (BMO), Murray Additional Environmental Allowance (Murray AEA) as described in the WSP. E10 Coordinate release of Barmah-Millewa Allowance, Barmah-Millewa Overdraw and the Murray Additional Environmental Allowance and held environmental	VH	H+	H	H / H	H	Predefined Tolerable	Limit consumptive water extractions in the WRP area to the predefined share of available water. Protect a portion of high flow events in the Lower Darling and Murray WRP area. Provide discretionary 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 NSW Murray and Lower Darling LTWP. This strategy aims to improve 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. This impact is most pronounced in reaches closest to Hume Dam, Menindee Lakes and other major weirs. Zero flow periods will exhibit more natural patterns towards the downstream end of the water source.	No MER planned
Gulpa Creek at Offtake	Base-flow or Low Flows		VH	H+	H	H / H	H	D; F(i)-(ii)		N1 Sustainable Diversion Limits N2 Strategic use of the Barmah-Millewa Allowance (BMA), Barmah-Millewa Overdraw (BMO), Murray Additional Environmental Allowance (Murray AEA) and held environmental water licences as described in the LTWP and Annual. N3 Protection of environmental water from extraction by implementing the prerequisite	tolerable	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. This impact is most pronounced in reaches closest to Hume Dam, Menindee Lakes and other major weirs. Base flow periods will exhibit more natural patterns towards the downstream end of the water source.	MER planned for WSP objectives
Gulpa Creek at Offtake	Fresh Flows		VH	M-	H	H / H	H				tolerable	Water ordering patterns have altered the duration and timing of freshes leading to unnaturally long events in summer and less events in winter.	MER planned for WSP objectives

SECTION 4.3 RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT & CAPACITY TO MEET EWRS [E(W)] - REGULATED SYSTEM AND MENINDEE LAKES													
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 & Evaluation**
Gulpa Creek at Offtake	High and Infrequent Flows - Bank Full 1.5 years ARI	water with natural flow events.	VH	L-	M	H / H	M		water management in the WRP area. 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. Protect important lagoons and wetlands within the WRP area. Protect tributary flows within the WRP area as they move from the unregulated water source into the regulated river water source.	policy measures into the WSP. Environmental Water Plans. N4 Improve environmental water delivery by implementing the Constraints Management Strategies within the Murray and Lower Darling key focus areas.	tolerable	There are no unregulated NSW tributaries in the river reach below Hume Dam or Menindee Lakes to supplement PEW or HEW releases to order to achieve bank full or over bank flows. The ability to mitigate the likelihood is low, hence the risk is tolerable.	MER planned for WSP objectives
Gulpa Creek at Offtake	High and Infrequent Flows - Over Bank 2.5 years ARI		VH	L+	M	H / H	M	Predefined Tolerable		None required – risks are tolerable.	N/A	There are no unregulated NSW tributaries in the river reach below Hume Dam or Menindee Lakes to supplement PEW or HEW releases to order to achieve bank full or over bank flows. 2.5 year ARI flows are unlikely to be returned via discretionary or non-discretionary environmental water due to the magnitudes required. The ability to mitigate the likelihood is low, hence the risk is tolerable.	No MER planned
Gulpa Creek at Offtake	High and Infrequent Flows - Over Bank 5.0 years ARI		VH	L0	M	H / H	M	Predefined Tolerable		None required – risks are tolerable.	N/A	There are no unregulated NSW tributaries in the river reach below Hume Dam or Menindee Lakes to supplement PEW or HEW releases to order to achieve bank full or over bank flows. 5.0 year ARI flows are unlikely to be returned via discretionary or non-discretionary environmental water due to the magnitudes required. The ability to mitigate the likelihood is low, hence the risk is tolerable.	No MER planned

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).
* Where likelihood information was unavailable a qualitative approach determined the likelihood for that flow characteristic. This was based on expert opinion and likelihood from the nearest gauge was used.

SECTION 4.3 RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT & CAPACITY TO MEET EWRS [E(W)] - UNREGULATED WATER SOURCES													
Water source 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**	**Tolerable Risk Level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and Evaluation**
Indi	Zero Flow Periods	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. E3 Require all take to be licensed except for BLR. E4 Extraction limits for individual extractors and associated accounting provisions to manage extraction at the extraction point. E5 Compliance with individual extraction limits E11 - 13 Cease-to-pump rules for unregulated water sources	L	L	L	H/M	N/A	N/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. 7 Protect important lagoons and wetlands within the WRP area. 8 Protect tributary flows within the WRP area as they move from the unregulated water source into the regulated river water source.	None required – risks are low	N/A		
Indi	Base-flow or Low Flows		L	L-	L	H/M	N/A	N/A		None required – risks are low	N/A		
Indi	Fresh Flows	E6 Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage entitlement growth.	L	L-	L	H/M	N/A	N/A		None required – risks are low	N/A		
Indi	High and Infrequent Flows - Bank Full 1.5 years ARI		L	L-	L	H/M	N/A	N/A		None required – risks are low	N/A		
Indi	High and Infrequent Flows - Over Bank 2.5 years ARI		L	L-	L	H/M	N/A	N/A			N/A		
Indi	High and Infrequent Flows - Over Bank 5.0 years ARI		L	L-	L	H/M	N/A	N/A			N/A		
Swampy Plain	Zero Flow Periods	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. E3 Require all take to be licensed except for BLR. E4 Extraction limits for individual extractors and associated accounting provisions to manage extraction at the extraction point. E5 Compliance with individual extraction limits E11 - 13 Cease-to-pump rules for unregulated water sources	M	L	L	H/M	N/A	N/A	1 Limit consumptive water extractions in the WRP area to the predefined share of available water. Risks are inherent to water diversions from Geehi Dam to Murray 1 Power Station and then into Khancoban Dam.	None required – risks are low	N/A		
Swampy Plain	Base-flow or Low Flows		M	H+	H	H/M	H	Predefined Tolerable		None required – risks are tolerable	tolerable	Risk inherent to regulated river reaches. Base flows cannot be scheduled due to dam operational constraints and requirements to transfer water to Murray 1 Power Station and generate hydroelectricity. This impact is most pronounced in reaches closest to Geehi Dam. Base flow periods will exhibit more natural patterns towards the downstream end of the water source.	
Swampy Plain	Fresh Flows	E6 Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage entitlement growth.	M	H+	H	H/M	H	Predefined Tolerable		None required – risks are tolerable	tolerable	Water transfer patterns and hydroelectricity generation have altered the duration, frequency and timing of freshes leading to unnaturally long events and hydropeaking. The ability to mitigate the likelihood is low, hence the risk is tolerable.	

SECTION 4.3 RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT & CAPACITY TO MEET EWRS [E(W)] - UNREGULATED WATER SOURCES

Water source 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	Tolerable Risk Level	Explanation of tolerable risk application OR Explanation of why risk cannot be addressed	Monitoring and Evaluation
Swampy Plain	High and Infrequent Flows - Bank Full 1.5 years ARI		M	M-	M	H/M	M	Predefined Tolerable	1 Limit consumptive water extractions in the WRP area to the predefined share of available water. Risks are inherent to water diversions from Geehi Dam to Murray 1 Power Station and then into Khancoban Dam.	None required – risks are tolerable	tolerable	Risk inherent to regulated reaches used for water transfers and hydropower production. Small tributary inputs below the Geehi River junction may provide some mitigation to flow alteration. However, the ability to mitigate the likelihood is low, hence the risk is tolerable.	
Swampy Plain	High and Infrequent Flows - Over Bank 2.5 years ARI		M	M-	M	H/M	M	Predefined Tolerable			tolerable		
Swampy Plain	High and Infrequent Flows - Over Bank 5.0 years ARI		M	M-	M	H/M	M	Predefined Tolerable			tolerable		
Upper Murray	Zero Flow Periods	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. E3 Require all take to be licensed except for BLR. E4 Extraction limits for individual extractors and associated accounting provisions to manage extraction at the extraction point. E5 Compliance with individual extraction limits E11 - 13 Cease-to-pump rules for unregulated water sources	M	L	L	L	H/M	N/A	1 Limit consumptive water extractions in the WRP area to the predefined share of available water. Risks are inherent to water transfers from Khancoban Dam to Hume Dam via Swampy Plain River and the Murray River.	None required – risks are low	N/A		
Upper Murray	Base-flow or Low Flows		M	H+	H	H/M	H	Predefined Tolerable		None required – risks are tolerable	tolerable	Risk inherent to regulated river reaches. Base flows cannot be scheduled due to dam operational constraints and requirements to transfer water to Hume Dam for irrigation use in the downstream Murray River. This impact is most pronounced in reaches closest to Khancoban Dam. Base flow periods will exhibit more natural patterns towards the downstream end of the water source.	
Upper Murray	Fresh Flows	E6 Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage entitlement growth.	M	H+	H	H/M	H	Predefined Tolerable		None required – risks are tolerable	tolerable	Water transfer patterns have altered the duration, frequency and timing of freshes leading to unnaturally long and unseasonal fresh events. The ability to mitigate the likelihood is low, hence the risk is tolerable.	
Upper Murray	High and Infrequent Flows - Bank Full 1.5 years ARI		M	L-	L	H/M	N/A	N/A		None required – risks are low	N/A		
Upper Murray	High and Infrequent Flows - Over Bank 2.5 years ARI		M	L-	L	H/M	N/A	N/A		None required – risks are low	N/A		
Upper Murray	High and Infrequent Flows - Over Bank 5.0 years ARI		M	L-	L	H/M	N/A	N/A		None required – risks are low	N/A		

SECTION 4.3 RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT & CAPACITY TO MEET EWRS [E(W)] - UNREGULATED WATER SOURCES

Water source 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	Tolerable Risk Level	Explanation of tolerable risk application OR Explanation of why risk cannot be addressed	Monitoring and Evaluation
Tooma	Zero Flow Periods	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. E3 Require all take to be licensed except for BLR. E4 Extraction limits for individual extractors and associated accounting provisions to manage extraction at the extraction point. E5 Compliance with individual extraction limits E11 - 13 Cease-to-pump rules for unregulated water sources	M	H+	H	H/M		D; F; 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. 7 Protect important lagoons and wetlands within the WRP area. 8 Protect tributary flows within the WRP area as they move from the unregulated water source into the regulated river water source.	N8 Projects resulting from application of risk treatment option C Fill knowledge gap / evaluate effectiveness of existing strategies. N9 Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies.	H	Decision tool indicates risk is not tolerable as there is high potential for extraction to impact ecological values and a river gauge is available. Frequent likelihood monitoring is recommended. These risk results cannot be addressed during WRP development as NSW planning principles minimise change for WSPs within their initial ten year period to provide certainty for water users.	MER planned for WSP objectives MER for N8 and N9
Tooma	Base-flow or Low Flows		M	L-	L	H/M	N/A			None required – risks are low	N/A		
Tooma	Fresh Flows	E6 Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage entitlement growth.	M	L-	L	H/M	N/A	N/A			N/A		
Tooma	High and Infrequent Flows - Bank Full 1.5 years ARI		M	L	L	H/M	N/A	N/A			N/A		
Tooma	High and Infrequent Flows - Over Bank 2.5 years ARI		M	L	L	H/M	N/A	N/A			N/A		
Tooma	High and Infrequent Flows - Over Bank 5.0 years ARI		M	L	L	H/M	N/A	N/A			N/A		
Maragle	Zero Flow Periods	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. E3 Require all take to be licensed except for BLR. E4 Extraction limits for individual extractors and associated accounting provisions to manage extraction at the extraction point. E5 Compliance with individual extraction limits E11 - 13 Cease-to-pump rules for unregulated water sources	L	M+	L	H/M	N/A	N/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. 7 Protect important lagoons and wetlands within the WRP area. 8 Protect tributary flows within the WRP area as they move from the unregulated water source into the regulated river water source.	None required – risks are low	N/A		
Maragle	Base-flow or Low Flows		L	L-	L	H/M	N/A	N/A			N/A		
Maragle	Fresh Flows	E6 Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage entitlement growth.	L	L-	L	H/M	N/A	N/A			N/A		
Maragle	High and Infrequent Flows - Bank Full 1.5 years ARI		L	L	L	H/M	N/A	N/A			N/A		

SECTION 4.3 RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT & CAPACITY TO MEET EWRS [E(W)] - UNREGULATED WATER SOURCES													
Water source 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**	**Tolerable Risk Level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and Evaluation**
Maragle	High and Infrequent Flows - Over Bank 2.5 years ARI		L	L	L	H/M	N/A	N/A		None required – risks are low	N/A		
Maragle	High and Infrequent Flows - Over Bank 5.0 years ARI		L	L	L	H/M	N/A	N/A			N/A		
Tumbarumba	Zero Flow Periods	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. E3 Require all take to be licensed except for BLR. E4 Extraction limits for individual extractors and associated accounting provisions to manage extraction at the extraction point. E5 Compliance with individual extraction limits E11 - 13 Cease-to-pump rules for unregulated water sources	VL	H+	L	H/M	N/A	N/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. 7 Protect important lagoons and wetlands within the WRP area. 8 Protect tributary flows within the WRP area as they move from the unregulated water source into the regulated river water source.	None required – risks are low	N/A		
Tumbarumba	Base-flow or Low Flows		VL	L-	L	H/M	N/A	N/A			N/A		
Tumbarumba	Fresh Flows	E6 Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage entitlement growth.	VL	L-	L	H/M	N/A	N/A			N/A		
Tumbarumba	High and Infrequent Flows - Bank Full 1.5 years ARI		VL	L	L	H/M	N/A	N/A			N/A		
Tumbarumba	High and Infrequent Flows - Over Bank 2.5 years ARI		VL	L	L	H/M	N/A	N/A			N/A		
Tumbarumba	High and Infrequent Flows - Over Bank 5.0 years ARI		VL	L	L	H/M	N/A	N/A			N/A		
Mannus	Zero Flow Periods	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. E3 Require all take to be licensed except for BLR. E4 Extraction limits for individual extractors and associated accounting provisions to manage extraction at the extraction point. E5 Compliance with individual extraction limits	M	H+	H	H/M		D; F; 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. 7 Protect important lagoons and wetlands within the WRP area. 8 Protect tributary flows within the WRP area as they move from the unregulated water source into the regulated river water source.	N8 Projects resulting from application of risk treatment option C Fill knowledge gap / evaluate effectiveness of existing strategies. N9 Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies.	H	Decision tool indicates risk is not tolerable as there is high potential for extraction to impact ecological values and a river gauge is available. Frequent likelihood monitoring is recommended. These risk results cannot be addressed during WRP development as NSW planning principles minimise change for WSPs within their initial ten year period to provide certainty for water users.	MER planned for WSP objectives MER for N8 and N9

SECTION 4.3 RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT & CAPACITY TO MEET EWRS [E(W)] - UNREGULATED WATER SOURCES

Water source 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	Tolerable Risk Level	Explanation of tolerable risk application OR Explanation of why risk cannot be addressed	Monitoring and Evaluation
Mannus	Base-flow or Low Flows	E11 - 13 Cease-to-pump rules for unregulated water sources	M	L-	L	H/M	N/A	N/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. 7 Protect important lagoons and wetlands within the WRP area. 8 Protect tributary flows within the WRP area as they move from the unregulated water source into the regulated river water source.	None required – risks are low	N/A		
Mannus	Fresh Flows	E6 Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage entitlement growth.	M	L-	L	H/M	N/A	N/A			N/A		
Mannus	High and Infrequent Flows - Bank Full 1.5 years ARI		M	L-	L	H/M	N/A	N/A			N/A		
Mannus	High and Infrequent Flows - Over Bank 2.5 years ARI		M	L	L	H/M	N/A	N/A			N/A		
Mannus	High and Infrequent Flows - Over Bank 5.0 years ARI		M	L	L	H/M	N/A	N/A			N/A		
Ournie Welaregang	Zero Flow Periods	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.	L	L	L	H/M	N/A	N/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. 7 Protect important lagoons and wetlands within the WRP area. 8 Protect tributary flows within the WRP area as they move from the unregulated water source into the regulated river water source.	None required – risks are low	N/A		
Ournie Welaregang	Base-flow or Low Flows	E3 Require all take to be licensed except for BLR. E4 Extraction limits for individual extractors and associated accounting provisions to manage extraction at the extraction point. E5 Compliance with individual extraction limits E11 - 13 Cease-to-pump rules for unregulated water sources	L	L-	L	H/M	N/A	N/A			N/A		
Ournie Welaregang	Fresh Flows	E6 Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage entitlement growth.	L	L-	L	H/M	N/A	N/A			N/A		
Ournie Welaregang	High and Infrequent Flows - Bank Full 1.5 years ARI		L	L	L	H/M	N/A	N/A			N/A		
Ournie Welaregang	High and Infrequent Flows - Over Bank 2.5 years ARI		L	L	L	H/M	N/A	N/A			N/A		
Ournie Welaregang	High and Infrequent Flows - Over Bank 5.0 years ARI		L	L	L	H/M	N/A	N/A			N/A		

SECTION 4.3 RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT & CAPACITY TO MEET EWRS [E(W)] - UNREGULATED WATER SOURCES

Water source 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	Tolerable Risk Level	Explanation of tolerable risk application OR Explanation of why risk cannot be addressed	Monitoring and Evaluation
Jingellic	Zero Flow Periods	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. E3 Require all take to be licensed except for BLR. E4 Extraction limits for individual extractors and associated accounting provisions to manage extraction at the extraction point. E5 Compliance with individual extraction limits E11 - 13 Cease-to-pump rules for unregulated water sources	M	L	L	H/M	N/A	N/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. 7 Protect important lagoons and wetlands within the WRP area. 8 Protect tributary flows within the WRP area as they move from the unregulated water source into the regulated river water source.	None required – risks are low	N/A		
Jingellic	Base-flow or Low Flows		M	L-	L	H/M	N/A	N/A			N/A		
Jingellic	Fresh Flows	E6 Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage entitlement growth.	M	L-	L	H/M	N/A	N/A			N/A		
Jingellic	High and Infrequent Flows - Bank Full 1.5 years ARI		M	L	L	H/M	N/A	N/A			N/A		
Jingellic	High and Infrequent Flows - Over Bank 2.5 years ARI		M	L	L	H/M	N/A	N/A			N/A		
Jingellic	High and Infrequent Flows - Over Bank 5.0 years ARI		M	L	L	H/M	N/A	N/A			N/A		
Dora Dora	Zero Flow Periods	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. E3 Require all take to be licensed except for BLR. E4 Extraction limits for individual extractors and associated accounting provisions to manage extraction at the extraction point. E5 Compliance with individual extraction limits E11 - 13 Cease-to-pump rules for unregulated water sources	M	L	L	H/M	N/A	N/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. 7 Protect important lagoons and wetlands within the WRP area. 8 Protect tributary flows within the WRP area as they move from the unregulated water source into the regulated river water source.	None required – risks are low	N/A		
Dora Dora	Base-flow or Low Flows		L	L	L	H/M	N/A	N/A			N/A		
Dora Dora	Fresh Flows	E6 Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage entitlement growth.	L	L	L	H/M	N/A	N/A			N/A		
Dora Dora	High and Infrequent Flows - Bank Full 1.5 years ARI		L	L	L	H/M	N/A	N/A			N/A		
Dora Dora	High and Infrequent Flows - Over Bank 2.5 years ARI		L	L	L	H/M	N/A	N/A			N/A		

SECTION 4.3 RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT & CAPACITY TO MEET EWRS [E(W)] - UNREGULATED WATER SOURCES

Water source 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	Tolerable Risk Level	Explanation of tolerable risk application OR Explanation of why risk cannot be addressed	Monitoring and Evaluation
Dora Dora	High and Infrequent Flows - Over Bank 5.0 years ARI		L	L	L	H/M	N/A	N/A		None required – risks are low	N/A		
Hume	Zero Flow Periods	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. E3 Require all take to be licensed except for BLR. E4 Extraction limits for individual extractors and associated accounting provisions to manage extraction at the extraction point. E5 Compliance with individual extraction limits E11 - 13 Cease-to-pump rules for unregulated water sources	M	L	L	H/M	N/A	N/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. 7 Protect important lagoons and wetlands within the WRP area. 8 Protect tributary flows within the WRP area as they move from the unregulated water source into the regulated river water source.	None required – risks are low	N/A	Decision tool indicates risk is not tolerable as there is high potential for extraction to impact ecological values and a river gauge is available. Frequent likelihood monitoring is recommended. These risk results cannot be addressed during WRP development as NSW planning principles minimise change for WSPs within their initial ten year period to provide certainty for water users.	MER planned for WSP objectives MER for N8 and N9
Hume	Base-flow or Low Flows		M	M-	M	H/M		D; F; C		N8 Projects resulting from application of risk treatment option C Fill knowledge gap / evaluate effectiveness of existing strategies. N9 Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies.	M		
Hume	Fresh Flows	E6 Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage entitlement growth.	M	L-	L	H/M	N/A	N/A		None required – risks are low	N/A		
Hume	High and Infrequent Flows - Bank Full 1.5 years ARI		M	L	L	H/M	N/A	N/A			N/A		
Hume	High and Infrequent Flows - Over Bank 2.5 years ARI		M	L	L	H/M	N/A	N/A			N/A		
Hume	High and Infrequent Flows - Over Bank 5.0 years ARI		M	L	L	H/M	N/A	N/A			N/A		
Albury	Zero Flow Periods	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. E3 Require all take to be licensed except for BLR. E4 Extraction limits for individual extractors and associated accounting provisions to manage extraction at the extraction point. E5 Compliance with individual extraction limits E11 - 13 Cease-to-pump rules for unregulated water sources	L	L	L	H/M	N/A	N/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. 7 Protect important lagoons and wetlands within the WRP area. 8 Protect tributary flows within the WRP area as they move from the unregulated water source into the regulated river water source.	None required – risks are low	N/A		
Albury	Base-flow or Low Flows		L	H-	M	H/M		D; F; C		N8 Projects resulting from application of risk treatment option C Fill knowledge gap / evaluate effectiveness of existing strategies. N9 Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies.	M	Decision tool indicates risk is not tolerable as there is high potential for extraction to impact ecological values and a river gauge is available. Frequent likelihood monitoring is recommended. These risk results cannot be addressed during WRP development as NSW planning principles minimise change for WSPs within their initial ten year period to provide certainty for water users.	MER planned for WSP objectives MER for N8 and N9
Albury	Fresh Flows	E6 Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage entitlement growth.	L	L-	L	H/M	N/A	N/A		None required – risks are low	N/A		

SECTION 4.3 RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT & CAPACITY TO MEET EWRS [E(W)] - UNREGULATED WATER SOURCES

Water source 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	Tolerable Risk Level	Explanation of tolerable risk application OR Explanation of why risk cannot be addressed	Monitoring and Evaluation
Albury	High and Infrequent Flows - Bank Full 1.5 years ARI		L	L	L	H/M	N/A	N/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. 7 Protect important lagoons and wetlands within the WRP area. 8 Protect tributary flows within the WRP area as they move from the unregulated water source into the regulated river water source.	None required – risks are low	N/A		
Albury	High and Infrequent Flows - Over Bank 2.5 years ARI		L	L	L	H/M	N/A	N/A			N/A		
Albury	High and Infrequent Flows - Over Bank 5.0 years ARI		L	L	L	H/M	N/A	N/A			N/A		
Majors	Zero Flow Periods	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. E3 Require all take to be licensed except for BLR. E4 Extraction limits for individual extractors and associated accounting provisions to manage extraction at the extraction point. E5 Compliance with individual extraction limits E11 - 13 Cease-to-pump rules for unregulated water sources	L	L	L	H/M	N/A	N/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. 7 Protect important lagoons and wetlands within the WRP area. 8 Protect tributary flows within the WRP area as they move from the unregulated water source into the regulated river water source.	None required – risks are low	N/A		
Majors	Base-flow or Low Flows		L	L-	L	H/M	N/A	N/A			N/A		
Majors	Fresh Flows	E6 Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage entitlement growth.	L	L-	L	H/M	N/A	N/A			N/A		
Majors	High and Infrequent Flows - Bank Full 1.5 years ARI		L	L-	L	H/M	N/A	N/A			N/A		
Majors	High and Infrequent Flows - Over Bank 2.5 years ARI		L	L	L	H/M	N/A	N/A			N/A		
Majors	High and Infrequent Flows - Over Bank 5.0 years ARI		L	L	L	H/M	N/A	N/A			N/A		

SECTION 4.3 RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT & CAPACITY TO MEET EWRS [E(W)] - UNREGULATED WATER SOURCES

Water source 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	Tolerable Risk Level	Explanation of tolerable risk application OR Explanation of why risk cannot be addressed	Monitoring and Evaluation
Lower Wangamong	Zero Flow Periods	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).	L	L	L	H/M	N/A	N/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. 7 Protect important lagoons and wetlands within the WRP area. 8 Protect tributary flows within the WRP area as they move from the unregulated water source into the regulated river water source.	None required – risks are low	N/A		
Lower Wangamong	Base-flow or Low Flows	E2 Available Water Determinations (AWD) adjust extractive use according to water availability. E3 Require all take to be licensed except for BLR. E4 Extraction limits for individual extractors and associated accounting provisions to manage extraction at the extraction point. E5 Compliance with individual extraction limits E11 - 13 Cease-to-pump rules for unregulated water sources	L	L	L	H/M	N/A	N/A			N/A		
Lower Wangamong	Fresh Flows	E6 Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage entitlement growth.	L	L	L	H/M	N/A	N/A			N/A		
Lower Wangamong	High and Infrequent Flows - Bank Full 1.5 years ARI		L	L	L	H/M	N/A	N/A			N/A		
Lower Wangamong	High and Infrequent Flows - Over Bank 2.5 years ARI		L	L	L	H/M	N/A	N/A			N/A		
Lower Wangamong	High and Infrequent Flows - Over Bank 5.0 years ARI		L	L	L	H/M	N/A	N/A			N/A		
Murray below Mulwala	Zero Flow Periods	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).	H	L	L*	H/N/A	N/A	N/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. 7 Protect important lagoons and wetlands within the WRP area. 8 Protect tributary flows within the WRP area as they move from the unregulated water source into the regulated river water source.	None required – risks are low	N/A		
Murray below Mulwala	Base-flow or Low Flows	E2 Available Water Determinations (AWD) adjust extractive use according to water availability. E3 Require all take to be licensed except for BLR. E4 Extraction limits for individual extractors and associated accounting provisions to manage extraction at the extraction point. E5 Compliance with individual extraction limits E11 - 13 Cease-to-pump rules for unregulated water sources	H	L	L*	H/N/A	N/A	N/A			N/A		
Murray below Mulwala	Fresh Flows	E6 Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage entitlement growth.	H	L	L*	H/N/A	N/A	N/A			N/A		
Murray below Mulwala	High and Infrequent Flows - Bank Full 1.5 years ARI		H	L	L*	H/N/A	N/A	N/A			N/A		
Murray below Mulwala	High and Infrequent Flows - Over Bank 2.5 years ARI		H	L	L*	H/N/A	N/A	N/A			N/A		

SECTION 4.3 RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT & CAPACITY TO MEET EWRS [E(W)] - UNREGULATED WATER SOURCES

Water source 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	Tolerable Risk Level	Explanation of tolerable risk application OR Explanation of why risk cannot be addressed	Monitoring and Evaluation
Murray below Mulwala	High and Infrequent Flows - Over Bank 5.0 years ARI		H	L	L*	H/N/A	N/A	N/A		None required – risks are low	N/A		
Lower Murray – Darling	Zero Flow Periods	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).	M	L	L*	H/N/A	N/A	N/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. 7 Protect important lagoons and wetlands within the WRP area. 8 Protect tributary flows within the WRP area as they move from the unregulated water source into the regulated river water source.	None required – risks are low	N/A		
Lower Murray – Darling	Base-flow or Low Flows	E2 Available Water Determinations (AWD) adjust extractive use according to water availability. E3 Require all take to be licensed except for BLR. E4 Extraction limits for individual extractors and associated accounting provisions to manage extraction at the extraction point. E5 Compliance with individual extraction limits E11 - 13 Cease-to-pump rules for unregulated water sources	M	L	L*	H/N/A	N/A	N/A			N/A		
Lower Murray – Darling	Fresh Flows	E6 Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage entitlement growth.	M	L	L*	H/N/A	N/A	N/A			N/A		
Lower Murray – Darling	High and Infrequent Flows - Bank Full 1.5 years ARI		M	L	L*	H/N/A	N/A	N/A			N/A		
Lower Murray – Darling	High and Infrequent Flows - Over Bank 2.5 years ARI		M	L	L*	H/N/A	N/A	N/A			N/A		
Lower Murray – Darling	High and Infrequent Flows - Over Bank 5.0 years ARI		M	L	L*	H/N/A	N/A	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).

* Where likelihood information was unavailable a qualitative approach determined the likelihood for that flow characteristic. This was based on expert opinion and likelihood from the nearest gauge was used.

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
Lower Darling regulated river water source	BLR (D&S) extraction	L-VH	Nil	Nil	H/H	N/A	None required. Risk is nil.		N/A	N/A	
NSW Murray regulated river water source	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	Strategy	New Critical Mechanisms	Tolerable Risk Level	Explanation of Tolerable Risk Application OR Explanation (required if risk is above tolerable level)	Monitoring and Evaluation
Indi	BLR (D&S) extraction	L	L	L	H/M	N/A	None required. Risk is low.		N/A	N/A	
Swampy Plain	BLR (D&S) extraction	M	L	L	H/M	N/A	None required. Risk is low.		N/A	N/A	
Upper Murray River	BLR (D&S) extraction	H	H	H	H/M	F	16 Protect the other water users from changes in flow attributable to growth in BLR extractive use.	N/A	tolerable	See below.	MER planned for WSP objectives
Tooma	BLR (D&S) extraction	M	L	L	H/M	N/A	None required. Risk is low.		N/A	N/A	
Maragle	BLR (D&S) extraction	M	L	L	H/M	N/A	None required. Risk is low.		N/A	N/A	
Tumbarumba	BLR (D&S) extraction	M	L	L	H/M	N/A	None required. Risk is low.		N/A	N/A	
Mannus	BLR (D&S) extraction	L	L	L	H/M	N/A	None required. Risk is low.		N/A	N/A	
Ournie Welaregang	BLR (D&S) extraction	M	L	L	H/M	N/A	None required. Risk is low.		N/A	N/A	
Jingellic	BLR (D&S) extraction	L	L	L	H/M	N/A	None required. Risk is low.		N/A	N/A	
Dora Dora	BLR (D&S) extraction	L	L	L	H/M	N/A	None required. Risk is low.		N/A	N/A	
Hume	BLR (D&S) extraction	M	L	L	H/M	N/A	None required. Risk is low.		N/A	N/A	
Albury	BLR (D&S) extraction	M	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	Strategy	New Critical Mechanisms	Tolerable Risk Level	Explanation of Tolerable Risk Application OR Explanation (required if risk is above tolerable level)	Monitoring and Evaluation
Majors	BLR (D&S) extraction	VL	L	L*	H/L	N/A	None required. Risk is low.		N/A	N/A	
Lower Wangamong	BLR (D&S) extraction	M	L	L*	H/L	N/A	None required. Risk is low.		N/A	N/A	
Murray Below Mulwala	BLR (D&S) extraction	H	L	L	H/M	N/A	None required. Risk is low.		N/A	N/A	
Lower Murray Darling	BLR (D&S) extraction	M	L	L	H/M	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. 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. 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.

* Where likelihood information was unavailable a qualitative approach determined the likelihood for that flow characteristic. This was based on expert opinion and likelihood from the nearest gauge was used.

SECTION 4.5.1 RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT FROM INTERCEPTION ACTIVITIES BY FARM DAMS [E(I-FD)] - UNREGULATED WATER SOURCES ONLY

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	Tooma River at Pinegrove	Variation Annual Index CV	M	L	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	Tooma River at Pinegrove	Low Flow Index Q90	M	L	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	Tooma River at Pinegrove	High Flow Index Q10	M	L	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	Maragle Creek at Maragle	Variation Annual Index CV	L	L	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	Maragle Creek at Maragle	Low Flow Index Q90	L	L	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	Maragle Creek at Maragle	High Flow Index Q10	L	L	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	Jingellic Creek at Jingellic	Variation Annual Index CV	L	L	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	Jingellic Creek at Jingellic	Low Flow Index Q90	L	L	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	Jingellic Creek at Jingellic	High Flow Index Q10	L	L	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	Bowna Creek at Yambla	Variation Annual Index CV	L	L	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	Bowna Creek at Yambla	Low Flow Index Q90	L	L	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	Bowna Creek at Yambla	High Flow Index Q10	L	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	

Current Critical Mechanisms - E(I-FD)
E17 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)

Strategy: None required. Risks are low.

N/A no data available or not applicable

SECTION 4.5.2 RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT FROM INTERCEPTION ACTIVITIES BY FARM DAMS [E(I-FD) - REGULATED WATER SOURCES ONLY

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	River Murray Channel	N/A	Negligible	Possible	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)	Regulated	Barmah-Millewa Forest	N/A	Negligible	Possible	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)	Regulated	Gunbower-Koondrook-Perricoota Forest	N/A	Negligible	Possible	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)	Regulated	Darling Anabranch Lakes	N/A	Negligible	Possible	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)	Regulated	Lower Darling	Low flows (LF) and Overbank flows (OB)	L-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)	Regulated	NSW Murray	Low flows (LF) and Overbank flows (OB)	M-VH	VL	L	H/M	N/A	None required. Risk is low		N/A	N/A	

Current Critical Mechanisms - E(I-FD)
E17 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)

Strategy: None required. Risks are low.

N/A no data available or not applicable

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

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 plantation forestry interception E(I-PF)	Regulated	River Murray Channel	N/A	Negligible*	Probable	L	H/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for the environment from plantation forestry interception E(I-PF)	Regulated	Barmah-Millewa Forest	N/A	Negligible*	Probable	L	H/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for the environment from plantation forestry interception E(I-PF)	Regulated	Gunbower-Koondrook-Perricoota Forest	N/A	Negligible*	Probable	L	H/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for the environment from plantation forestry interception E(I-PF)	Regulated	Darling Anabranch Lakes	N/A	Negligible*	Probable	L	H/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for the environment from plantation forestry interception E(I-PF)	Regulated	Lower Darling	N/A	Negligible*	Rare	L	H/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for the environment from plantation forestry interception E(I-PF)	Regulated	NSW Murray	N/A	Negligible*	Probable	L	H/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for the environment from plantation forestry interception E(I-PF)	Unregulated	Upper Murray unregulated water sources	N/A	M	Probable	H	M/M	B	E18 and E19 (see below)	N9 Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies.	tolerable	Risk is considered tolerable due to the low confidence in data available. Further information is required to establish the likelihood and consequence of Plantation Forestry interception on Upper Murray unregulated water users for specific water sources with these activities occurring. Future MER should aim to demonstrate if these risks apply to specific water sources and what management actions can be undertaken.	MER to establish the key water sources impacted by PF and monitor for growth in activity
Risk to water available for the environment from plantation forestry interception E(I-PF)	Unregulated	Lower Murray-Darling and mid-Murray unregulated water sources	N/A	Negligible*	Rare	L	H/M	N/A	None required. Risk is low	N/A	N/A	N/A	

Current Critical Mechanisms - E(I-PF)

E18 Plantation forestry interception managed under the Plantation forestry policy (in prep), Plantations and Reafforestation Act 1999 and the Plantation and Reafforestation (Code) Regulation 2001.
E19 Ongoing risk monitoring to determine impact of future expansion of forest plantations at local and regional scales.

*SKM 2009 defined the consequence as 'none' for the annotated assets, which meant that no measurable change was expected in the ability to achieve objectives.

N/A no data available or not applicable

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)	NSW Murray River regulated and unregulated	VH	Nil	Nil	H/M	N/A	N/A		N/A	N/A	
Risk to water available for the environment from floodplain harvesting E(I-FH)	Lower Darling regulated and unregulated	M	Nil	Nil	H/M	N/A	N/A		N/A	N/A	

Current Critical Mechanisms - E(I-FH)
None required as there is no material Floodplain Harvesting occurring within the NSW Murray and Lower Darling WRPA

SECTION 4.6 RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT DUE TO CLIMATE CHANGE [E(CC)]													
Regulated or Unregulated water source	**Location, Reach, or Extraction Type within WRP Area**	**Climate Change Scenario (MDBSY)**	**Current Critical Mechanisms**	**Consequence**	**Likelihood**	**Risk Rating**	**Data confidence (consq/like)**	**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 Murray Channel	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	M	L/M	B C F	14 Protect the environment and water users from changes in flow attributable to climate change.	N1 Sustainable Diversion Limits N8 Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies N9 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 N8 and N9
Regulated	River Murray Channel	Median climate change scenario		Severe	Possible	H	L/M				H		
Regulated	River Murray Channel	Dry climate change scenario		Severe	Almost Certain	H	L/M				H		
Regulated	Barmah-Millewa Forest	Wet climate change scenario		Severe	Unlikely	H	L/M				H		
Regulated	Barmah-Millewa Forest	Median climate change scenario		Severe	Possible	H	L/M				H		
Regulated	Barmah-Millewa Forest	Dry climate change scenario		Severe	Almost Certain	H	L/M				H		
Regulated	Gunbower-Koondrook-Perricoota Forest	Wet climate change scenario		Severe	Unlikely	H	L/M				H		
Regulated	Gunbower-Koondrook-Perricoota Forest	Median climate change scenario		Severe	Possible	H	L/M				H		
Regulated	Gunbower-Koondrook-Perricoota Forest	Dry climate change scenario		Severe	Almost Certain	H	L/M				H		
Regulated	Darling Anabranch Lakes	Wet climate change scenario		Negligible	Unlikely	M	L/M				M		
Regulated	Darling Anabranch Lakes	Median climate change scenario		Severe	Possible	H	L/M				H		
Regulated	Darling Anabranch Lakes	Dry climate change scenario		Severe	Almost Certain	H	L/M				H		
Regulated	Darling River at Menindee u/s Weir 32 (425012)	Dry climate change scenario		M	M	M	L/M				M		
Regulated	Darling River at Burtundy (425007)	Dry climate change scenario		M	M	M	L/M				M		

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

Regulated or Unregulated water source	Location, Reach, or Extraction Type within WRP Area	Climate Change Scenario (MDBSY)	Current Critical Mechanisms	Consequence	Likelihood	Risk Rating	Data confidence (consq/like)	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	Great Darling Anabranch at outlet Lake Cawndilla (425014)	Dry climate change scenario		L	M	L	L/M	F	None required. Risk is low.	N/A	N/A		
Regulated	Great Darling Anabranch at Redbank Ck d/s Packers Crossing (425019)	Dry climate change scenario		L	M	L	L/M	F	None required. Risk is low.	N/A	N/A		
Regulated	Murray River at Doctors Point (409017)	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.	M	M	M	L/M	B C F	14 Protect the environment and water users from changes in flow attributable to climate change.	N1 Sustainable Diversion Limits N8 Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies N9 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 N8 and N9
Regulated	Murray River d/s Yarrawonga Weir (409025)	Dry climate change scenario		VH	M	H	L/M				H		
Regulated	Murray River at Echuca (409200A)	Dry climate change scenario		H	M	M	L/M				M		
Regulated	Murray River at Torrumbarry (409207B)	Dry climate change scenario		VH	M	H	L/M				H		
Regulated	Murray River at d/s Wakool Junction (414200	Dry climate change scenario		M	M	M	L/M				M		
Regulated	Murray River at Euston (414203)	Dry climate change scenario		H	M	M	L/M				M		
Regulated	Murray River at Wentworth (425010)	Dry climate change scenario		H	M	M	L/M				M		
Regulated	Murray River at Lock 9 downstream (426506)	Dry climate change scenario		H	M	M	L/M				M		
Regulated	Murray River Flow to South Australia (426510)	Dry climate change scenario		M	M	M	L/M				M		
Regulated	Edward River at Toonalook (409047)	Dry climate change scenario		VH	M	H	L/M				H		
Regulated	Edward River at Deniliquin (409003)	Dry climate change scenario		VH	M	H	L/M				H		
Regulated	Edward River d/s Stevens Weir (409023)	Dry climate change scenario		H	M	M	L/M				M		

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

Regulated or Unregulated water source	Location, Reach, or Extraction Type within WRP Area	Climate Change Scenario (MDBSY)	Current Critical Mechanisms	Consequence	Likelihood	Risk Rating	Data confidence (consq/like)	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	Edward River at Leiwah (409035)	Dry climate change scenario		H	M	M	L/M				M		
Regulated	Wakool River at Offtake Regulator (409019)	Dry climate change scenario		VH	M	H	L/M				H		
Regulated	Wakool River at Wakool / Barham Rd (409045)	Dry climate change scenario		VH	M	H	L/M				H		
Regulated	Wakool River at Gee Gee Bridge [No. 2] (409062)	Dry climate change scenario		VH	M	H	L/M				H		
Regulated	Wakool River at Stoney Crossing (409013)	Dry climate change scenario		H	M	M	L/M				M		
Regulated	Wakool River at Kyalite (409034)	Dry climate change scenario		H	M	M	L/M				M		
Regulated	Yallakool Creek at Offtake (409020)	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.	VH	M	H	L/M	B C F	14 Protect the environment and water users from changes in flow attributable to climate change.	N1 Sustainable Diversion Limits N8 Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies N9 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 N8 and N9
Regulated	Colligen Creek at below Regulator (409024)	Dry climate change scenario		VH	M	H	L/M				H		
Regulated	Niemur River at Barnham / Moulamein Rd (409048)	Dry climate change scenario		H	M	M	L/M				M		
Regulated	Bullatale Creek u/s Edward R (409075)	Dry climate change scenario		H	M	M	L/M				M		
Regulated	Gulpa Creek at offtake (409030)	Dry climate change scenario		VH	M	H	L/M				H		
Unregulated	Dora Dora	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).	L	M	L	L/M	F	Only for M or H risks: 5 Protect low flow habitats from accelerated rates of drying. 6 Protect pools in streams, wetlands, lagoons and floodplains	Only for M or H risks: N1 Sustainable Diversion Limits N8 Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies	N/A	Medium and high flows are less accessible for unregulated water users in the NSW MLD WRPA. Base and low flows are protected by cease-to-pump (CtP) rules and extraction limits. Cease to pump rules are set to restrict water take once	MER planned for WSP objectives MER for N8 and N9 Existing strategies (i.e. CtP thresholds) are reviewed during the WSP review process. Ineffective rules will be assessed with DPI Fisheries and DPE-BCD to ensure they are suitable to
Unregulated	Indi	Dry climate change scenario		L	M	L	L/M	F			N/A		
Unregulated	Jingellic	Dry climate change scenario		M	M	M	L/M	B C F			M		
Unregulated	Majors	Dry climate change scenario		L	M	L	L/M	F			N/A		

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

Regulated or Unregulated water source	Location, Reach, or Extraction Type within WRP Area	Climate Change Scenario (MDBSY)	Current Critical Mechanisms	Consequence	Likelihood	Risk Rating	Data confidence (consq/like)	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
Unregulated	Mannus	Dry climate change scenario	E4 Extraction limits for individual extractors and associated accounting provisions to manage extraction at the extraction point. E11 - 13 Cease-to-pump rules for unregulated water sources	M	M	M	L/M	B C F	within the WRP area during dry periods. 7 Protect important lagoons and wetlands within the WRP area. 8 Protect tributary flows within the WRP area as they move from the unregulated water source into the regulated river water source. 14 Protect the environment and water users from changes in flow attributable to climate change. 19 Improve knowledge of effectiveness of existing strategies	N9 Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies	M	unregulated stream flows reach a specific threshold. This threshold applies regardless of the climatic scenario.	protect the environment under future climates.
Unregulated	Swampy Plain	Dry climate change scenario		M	M	M	L/M	B C F			M		
Unregulated	Albury	Dry climate change scenario		L	M	L	L/M	F			N/A		
Unregulated	Hume	Dry climate change scenario		M	M	M	L/M	B C F			M		
Unregulated	Lower Wangamong	Dry climate change scenario		L	M	L	L/M	F			N/A		
Unregulated	Maragle	Dry climate change scenario		L	M	L	L/M	F			N/A		
Unregulated	Ournie Welaregang	Dry climate change scenario		L	M	L	L/M	F			N/A		
Unregulated	Tooma	Dry climate change scenario		M	M	M	L/M	B C F			M		
Unregulated	Tumbarumba	Dry climate change scenario		VL	M	L	L/M	F			N/A		
Unregulated	Upper Murray	Dry climate change scenario		M	M	M	L/M	B C F			M		
Unregulated	Murray below Mulwala	Dry climate change scenario		H	M	H	L/M				H		
Unregulated	Lower Murray – Darling	Dry climate change scenario		M	M	M	L/M				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**
NSW Murray and Lower Darling Surface WRP area water sources	H	M	M	M/M	A	National Carp Control Plan		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), E(WQ-CWP), E(WQ-WWP), 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 /	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 NSW Murray and Lower Darling WRPA. Additional actions and mechanisms relevant to the WRP are listed below.				**WQ** 1, 2, 3, 4, 5, 6, 7
E(WQ)	Regulated	Darling River at Menindee Weir 32	Turbidity	E9 Strategic use of the Lower Darling Environmental Water Allowance (the Lower Darling Allowance) as described in the WSP.	M	H	H	M/H	F	Refer to WQM Plan	N2 Strategic use of environmental water allowance (EWA) (and relevant held environmental water licences) as described in the MLD LTWP. N4 Support implementation of the Constraints Management Strategies within the Murray and Lower Darling key focus areas	Refer to WQM		
E(WQ)	Regulated	Darling River at Menindee Weir 32	Total Phosphorus		M	M	M	M/H	F					
E(WQ)	Regulated	Darling River at Menindee Weir 32	Total Nitrogen		M	M	M	M/H	F					
E(WQ)	Regulated	Darling River at Menindee Weir 32	pH		M	L	L	M/H	F					
E(WQ)	Regulated	Darling River at Menindee Weir 32	Dissolved Oxygen		M	M	M	M/H	F					
E(WQ)	Regulated	Darling River at Burtundy	Turbidity	E9 Strategic use of the Lower Darling Environmental Water Allowance (the Lower Darling Allowance) as described in the WSP.	M	H	H	M/H	F	Refer to WQM Plan	N2 Strategic use of environmental water allowance (EWA) (and relevant held environmental water licences) as described in the MLD LTWP. N4 Support implementation of the Constraints Management Strategies within the Murray and Lower Darling key focus areas	Refer to WQM Plan.		
E(WQ)	Regulated	Darling River at Burtundy	Total Phosphorus		M	M	M	M/H	F					
E(WQ)	Regulated	Darling River at Burtundy	Total Nitrogen		M	M	M	M/H	F					
E(WQ)	Regulated	Darling River at Burtundy	pH		M	M	M	M/H	F					
E(WQ)	Regulated	Darling River at Burtundy	Dissolved Oxygen		M	M	M	M/H	F					
E(WQ)	Regulated	Murray River d/s Yarrawonga Weir	Turbidity	E8 Supplementary access to natural flow events may be permitted once flows are in excess of those required by the WSP. E9 Strategic use of the Barmah-Millewa Allowance (BMA), Barmah-Millewa Overdraw (BMO), Murray Additional Environmental Allowance (Murray AEA) as described in the WSP. E15 Rates of change to storage release protocol.	M	L	L	M/H	F	Refer to WQM Plan	N2 Strategic use of environmental water allowance (EWA) (and relevant held environmental water licences) as described in the MLD LTWP. N3 Codify and implement the Pre-Requisite Policy Measures (PPMs) into the WSP N4 Support implementation of the Constraints Management Strategies within the Murray and Lower Darling key focus areas	Refer to WQM Plan.		
E(WQ)	Regulated	Murray River d/s Yarrawonga Weir	Total Phosphorus		M	L	L	M/H	F	Refer to WQM Plan				
E(WQ)	Regulated	Murray River d/s Yarrawonga Weir	Total Nitrogen		M	L	L	M/H	F	Refer to WQM Plan				
E(WQ)	Regulated	Murray River d/s Yarrawonga Weir	pH		M	L	L	M/H	F	Refer to WQM Plan				
E(WQ)	Regulated	Murray River d/s Yarrawonga Weir	Dissolved Oxygen		M	L	L	M/H	F	Refer to WQM Plan				
E(WQ)	Regulated	Murray River at Lock 8	Turbidity	E8 Supplementary access to natural flow events may be permitted once flows are in excess of those required by the WSP. Continued next page.	M	H	H	M/H	F	Refer to WQM Plan	N2 Strategic use of environmental water allowance (EWA) (and relevant held environmental water licences) as described in the MLD LTWP. N3 Codify and implement the Pre-Requisite Policy Measures (PPMs) into the WSP	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), E(WQ-CWP), E(WQ-WWP), 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 NSW Murray and Lower Darling WRPA. Additional actions and mechanisms relevant to the WRP are listed below.				**WQ** 1, 2, 3, 4, 5, 6, 7
E(WQ)	Regulated	Murray River at Lock 8	Total Phosphorus	E9 Strategic use of the Barmah-Millewa Allowance (BMA), Barmah-Millewa Overdraw (BMO), Murray Additional Environmental Allowance (Murray AEA) as described in the WSP. E15 Rates of change to storage release protocol.	M	M	M	M/H	F	Refer to WQM Plan	N2 Strategic use of environmental water allowance (EWA) (and relevant held environmental water licences) as described in the MLD LTWP. N3 Codify and implement the Pre-Requisite Policy Measures (PPMs) into the WSP	Refer to WQM Plan.		
E(WQ)	Regulated	Murray River at Lock 8	Total Nitrogen		M	M	M	M/H	F	Refer to WQM Plan				
E(WQ)	Regulated	Murray River at Lock 8	pH		M	L	L	M/H	F	Refer to WQM Plan				
E(WQ)	Regulated	Murray River at Lock 8	Dissolved Oxygen		M	L	L	M/H	F	Refer to WQM Plan				
E(WQ)	Regulated	Murray River u/s Euston Weir	Turbidity	E8 Supplementary access to natural flow events may be permitted once flows are in excess of those required by the WSP. E9 Strategic use of the Barmah-Millewa Allowance (BMA), Barmah-Millewa Overdraw (BMO) or Murray Additional Environmental Allowance (Murray AEA) as described in the WSP. E15 Rates of change to storage release protocol.	H	M	M	M/H	F	Refer to WQM Plan	N2 Strategic use of environmental water allowance (EWA) (and relevant held environmental water licences) as described in the MLD LTWP. N3 Codify and implement the Pre-Requisite Policy Measures (PPMs) into the WSP	Refer to WQM Plan.		
E(WQ)	Regulated	Murray River u/s Euston Weir	Total Phosphorus		H	M	M	M/H	F					
E(WQ)	Regulated	Murray River u/s Euston Weir	Total Nitrogen		H	L	L	M/H	F					
E(WQ)	Regulated	Murray River u/s Euston Weir	pH		H	L	L	M/H	F					
E(WQ)	Regulated	Murray River u/s Euston Weir	Dissolved Oxygen		H	L	L	M/H	F					
E(WQ)	Regulated	Edward River at Deniliquin	Turbidity	E8 Supplementary access to natural flow events may be permitted once flows are in excess of those required by the WSP. E9 Strategic use of the Barmah-Millewa Allowance (BMA), Barmah-Millewa Overdraw (BMO) or Murray Additional Environmental Allowance (Murray AEA) as described in the WSP. E15 Rates of change to storage release protocol.	H	H	H	M/H	F	Refer to WQM Plan	N2 Strategic use of environmental water allowance (EWA) (and relevant held environmental water licences) as described in the MLD LTWP. N3 Codify and implement the Pre-Requisite Policy Measures (PPMs) into the WSP N4 Support implementation of the Constraints Management Strategies within the Murray and Lower Darling key focus areas	Refer to WQM Plan.		
E(WQ)	Regulated	Edward River at Deniliquin	Total Phosphorus		H	M	M	M/H	F					
E(WQ)	Regulated	Edward River at Deniliquin	Total Nitrogen		H	L	L	M/H	F					
E(WQ)	Regulated	Edward River at Deniliquin	pH		H	L	L	M/H	F					
E(WQ)	Regulated	Edward River at Deniliquin	Dissolved Oxygen		H	L	L	M/H	F					
E(WQ)	Regulated	Murray River at Barham	Turbidity	E8 Supplementary access to natural flow events may be permitted once flows are in excess of those required by the WSP. E9 Strategic use of the Barmah-Millewa Allowance (BMA), Barmah-Millewa Overdraw (BMO) or Murray Additional Environmental Allowance (Murray AEA) as described in the WSP. E15 Rates of change to storage release protocol.	VH	H	H	M/H	F	Refer to WQM Plan	N2 Strategic use of environmental water allowance (EWA) (and relevant held environmental water licences) as described in the MLD LTWP. N3 Codify and implement the Pre-Requisite Policy Measures (PPMs) into the WSP N4 Support implementation of the Constraints Management Strategies within the Murray and Lower Darling key focus areas	Refer to WQM Plan.		
E(WQ)	Regulated	Murray River at Barham	Total Phosphorus		VH	M	H	M/H	F					
E(WQ)	Regulated	Murray River at Barham	Total Nitrogen		VH	M	H	M/H	F					
E(WQ)	Regulated	Murray River at Barham	pH		VH	L	M	M/H	F					
E(WQ)	Regulated	Murray River at Barham	Dissolved Oxygen		VH	L	M	M/H	F					

SECTION 6.3, 6.4, 6.5, 6.6 RISKS TO THE HEALTH OF WATER DEPENDENT ECOSYSTEMS FROM POOR WATER QUALITY [E(WQ), E(WQ-CWP), E(WQ-WWP), 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 NSW Murray and Lower Darling WRPA. Additional actions and mechanisms relevant to the WRP are listed below.				**WQ** 1, 2, 3, 4, 5, 6, 7
E(WQ)	Regulated	Wakool River at Kyalite	Turbidity	E8 Supplementary access to natural flow events may be permitted once flows are in excess of those required by the WSP. Continued next page. E9 Strategic use of the Barmah-Millewa Allowance (BMA), Barmah-Millewa Overdraw (BMO) or Murray Additional Environmental Allowance (Murray AEA) as described in the WSP. E15 Rates of change to storage release protocol.	H	H	H	M/H	F	Refer to WQM Plan	N2 Strategic use of environmental water allowance (EWA) (and relevant held environmental water licences) as described in the MLD LTWP. N3 Codify and implement the Pre-Requisite Policy Measures (PPMs) into the WSP N4 Support implementation of the Constraints Management Strategies within the Murray and Lower Darling key focus areas	Refer to WQM Plan.		
E(WQ)	Regulated	Wakool River at Kyalite	Total Phosphorus		H	M	M	M/H	F					
E(WQ)	Regulated	Wakool River at Kyalite	Total Nitrogen		H	M	M	M/H	F					
E(WQ)	Regulated	Wakool River at Kyalite	pH		H	L	L	M/H	F					
E(WQ)	Regulated	Wakool River at Kyalite	Dissolved Oxygen		H	M	M	M/H	F					
E(WQ)	Regulated	Wakool River at Stoney Crossing	Turbidity	E8 Supplementary access to natural flow events may be permitted once flows are in excess of those required by the WSP. E9 Strategic use of the Barmah-Millewa Allowance (BMA), Barmah-Millewa Overdraw (BMO) or Murray Additional Environmental Allowance (Murray AEA) as described in the WSP. E15 Rates of change to storage release protocol.	H	H	H	M/H	F	Refer to WQM Plan	N2 Strategic use of environmental water allowance (EWA) (and relevant held environmental water licences) as described in the MLD LTWP. N3 Codify and implement the Pre-Requisite Policy Measures (PPMs) into the WSP N4 Support implementation of the Constraints Management Strategies within the Murray and Lower Darling key focus areas	Refer to WQM Plan.		
E(WQ)	Regulated	Wakool River at Stoney Crossing	Total Phosphorus		H	M	M	M/H	F	Refer to WQM Plan		Refer to WQM Plan.		
E(WQ)	Regulated	Wakool River at Stoney Crossing	Total Nitrogen		H	M	M	M/H	F	Refer to WQM Plan		Refer to WQM Plan.		
E(WQ)	Regulated	Wakool River at Stoney Crossing	pH		H	L	L	M/H	F	Refer to WQM Plan		Refer to WQM Plan.		
E(WQ)	Regulated	Wakool River at Stoney Crossing	Dissolved Oxygen		H	M	M	M/H	F	Refer to WQM Plan		Refer to WQM Plan.		
E(WQ)	Regulated	Murray River at Merebein Pump Station	Turbidity	E8 Supplementary access to natural flow events may be permitted once flows are in excess of those required by the WSP. E9 Strategic use of the Barmah-Millewa Allowance (BMA), Barmah-Millewa Overdraw (BMO) or Murray Additional Environmental Allowance (Murray AEA) as described in the WSP. E15 Rates of change to storage release protocol.	H	L	L	M/H	F	Refer to WQM Plan	N2 Strategic use of environmental water allowance (EWA) (and relevant held environmental water licences) as described in the MLD LTWP. N3 Codify and implement the Pre-Requisite Policy Measures (PPMs) into the WSP N4 Support implementation of the Constraints Management Strategies within the Murray and Lower Darling key focus areas	Refer to WQM Plan.		
E(WQ)	Regulated	Murray River at Merebein Pump Station	Total Phosphorus		H	L	L	M/H	F	Refer to WQM Plan				
E(WQ)	Regulated	Murray River at Merebein Pump Station	Total Nitrogen		H	L	L	M/H	F	Refer to WQM Plan				
E(WQ)	Regulated	Murray River at Merebein Pump Station	pH		H	L	L	M/H	F	Refer to WQM Plan				
E(WQ)	Regulated	Murray River at Merebein Pump Station	Dissolved Oxygen		H	L	L	M/H	F	Refer to WQM Plan				
E(WQ)	Unregulated	Tooma River at Warbrook	Turbidity	E1 Reserve all water above the long-term average annual extraction limit (LTAAEL)	M	H	H	M/H	F	Refer to WQM Plan	N2 Strategic use of environmental water allowance (EWA) (and relevant held environmental water	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), E(WQ-CWP), E(WQ-WWP), 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 NSW Murray and Lower Darling WRPA. Additional actions and mechanisms relevant to the WRP are listed below.				**WQ** 1, 2, 3, 4, 5, 6, 7
				for the environment as PEW (defined and managed by the listed WSPs). Continued next page.							licences) as described in the MLD LTWP. N4 Support implementation of the Constraints Management Strategies within the Murray and Lower Darling key focus areas			
E(WQ)	Unregulated	Tooma River at Warbrook	Total Phosphorus	E2 Available Water Determinations (AWD) adjust extractive use according to water availability. E3 Require all take to be licensed except for BLR. E4 Extraction limits for individual extractors and associated accounting provisions to manage extraction at the extraction point. E5 Compliance with individual extraction limits E11 Cease-to-pump rules for streams, in-stream pools and off-river pools.	M	M	M	M/H	F	Refer to WQM Plan	N2 Strategic use of environmental water allowance (EWA) (and relevant held environmental water licences) as described in the MLD LTWP. N4 Support implementation of the Constraints Management Strategies within the Murray and Lower Darling key focus areas	Refer to WQM Plan.		
E(WQ)	Unregulated	Tooma River at Warbrook	Total Nitrogen		M	M	M	M/H	F					
E(WQ)	Unregulated	Tooma River at Warbrook	pH		M	L	L	M/H	F					
E(WQ)	Unregulated	Tooma River at Warbrook	Dissolved Oxygen		M	L	L	M/H	F					
E(WQ)	Unregulated	Murray River at Jingellic	Turbidity	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. E3 Require all take to be licensed except for BLR. E4 Extraction limits for individual extractors and associated accounting provisions to manage extraction at the extraction point. E5 Compliance with individual extraction limits E11 Cease-to-pump rules for streams, in-stream pools and off-river pools.	M	M	M	M/H	F	Refer to WQM Plan	N2 Strategic use of environmental water allowance (EWA) (and relevant held environmental water licences) as described in the MLD LTWP. N4 Support implementation of the Constraints Management Strategies within the Murray and Lower Darling key focus areas	Refer to WQM Plan.		
E(WQ)	Unregulated	Murray River at Jingellic	Total Phosphorus		M	L	L	M/H	F					
E(WQ)	Unregulated	Murray River at Jingellic	Total Nitrogen		M	L	L	M/H	F					
E(WQ)	Unregulated	Murray River at Jingellic	pH		M	L	L	M/H	F					
E(WQ)	Unregulated	Murray River at Jingellic	Dissolved Oxygen		M	L	L	M/H	F					
E(WQ)	Unregulated	Murray River at Indi	Turbidity	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.	L	L	L	M/H	F	Refer to WQM Plan	N2 Strategic use of environmental water allowance (EWA) (and relevant held environmental water licences) as described in the MLD LTWP. N4 Support implementation of the Constraints Management Strategies within the Murray and Lower Darling key focus areas	Refer to WQM Plan.		
E(WQ)	Unregulated	Murray River at Indi	Total Phosphorus		L	L	L	M/H	F					
E(WQ)	Unregulated	Murray River at Indi	Total Nitrogen		L	L	L	M/H	F					

SECTION 6.3, 6.4, 6.5, 6.6 RISKS TO THE HEALTH OF WATER DEPENDENT ECOSYSTEMS FROM POOR WATER QUALITY [E(WQ), E(WQ-CWP), E(WQ-WWP), 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 /	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 NSW Murray and Lower Darling WRPA. Additional actions and mechanisms relevant to the WRP are listed below.				**WQ** 1, 2, 3, 4, 5, 6, 7
E(WQ)	Unregulated	Murray River at Indi	pH	E3 Require all take to be licensed except for BLR. Continued next page.	L	L	L	M/H	F					
E(WQ)	Unregulated	Murray River at Indi	Dissolved Oxygen	E4 Extraction limits for individual extractors and associated accounting provisions to manage extraction at the extraction point. E5 Compliance with individual extraction limits E11 Cease-to-pump rules for streams, in-stream pools and off-river pools.	L	L	L	M/H	F	Refer to WQM Plan	N2 Strategic use of environmental water allowance (EWA) (and relevant held environmental water licences) as described in the MLD LTWP. N4 Support implementation of the Constraints Management Strategies within the Murray and Lower Darling key focus areas	Refer to WQM Plan.		
E(WQ)	Unregulated	Murray River at Albury	Turbidity	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. E3 Require all take to be licensed except for BLR. E4 Extraction limits for individual extractors and associated accounting provisions to manage extraction at the extraction point. E5 Compliance with individual extraction limits E11 Cease-to-pump rules for streams, in-stream pools and off-river pools.	M	L	L	M/H	F	Refer to WQM Plan	N2 Strategic use of environmental water allowance (EWA) (and relevant held environmental water licences) as described in the MLD LTWP. N4 Support implementation of the Constraints Management Strategies within the Murray and Lower Darling key focus areas	Refer to WQM Plan.		
E(WQ)	Unregulated	Murray River at Albury	Total Phosphorus		M	L	L	M/H	F					
E(WQ)	Unregulated	Murray River at Albury	Total Nitrogen		M	L	L	M/H	F					
E(WQ)	Unregulated	Murray River at Albury	pH		M	L	L	M/H	F					
E(WQ)	Unregulated	Murray River at Albury	Dissolved Oxygen		M	M	M	M/H	F					
E(WQ-CWP)	Regulated	Hume Dam (Murray River 200 km d/s of dam)	Cold Water Pollution	E8 Supplementary access to natural flow events may be permitted once flows are in excess of those required by the WSP E9 Strategic use of environmental water allowance (EWA) as described in the WSP. E15 Rates of change to storage release protocol. E16 Improve dam infrastructure and its management so that water releases are more closely matched to Murray River ambient temperatures.	H	H	H	M/M	F	Refer to WQM Plan	N2 Strategic use of environmental water allowance (EWA) (and relevant held environmental water licences) as described in the MLD LTWP.	Refer to WQM Plan.		
E(WQ-CWP)	Regulated (Hydro power regulation)	Khancoban Dam (Murray River up to 120 km downstream of dam)	Cold Water Pollution		M	H	H	M/M	F			Refer to WQM Plan.		
E(WQ-WWP)	Regulated	Hume Dam (Murray River directly downstream of Hume Dam)	Warm Water Pollution	E15 Rates of change to storage release protocol.	H	M	M	M/M	F	Refer to WQM Plan	N2 Strategic use of environmental water allowance (EWA) (and relevant held environmental water licences) as described in the MLD LTWP.	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), E(WQ-CWP), E(WQ-WWP), 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 /	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 NSW Murray and Lower Darling WRPA. Additional actions and mechanisms relevant to the WRP are listed below.				**WQ** 1, 2, 3, 4, 5, 6, 7
E(WQ-WWP)	Regulated (Hydro power regulation)	Khancoban Dam (Swampy Plain River from Khancoban Dam to the Murray River confluence)	Warm Water Pollution	E16 Improve dam infrastructure and its management so that water releases are more closely matched to Murray River ambient temperatures.	M	L	L	M/M	F					
E(WQ-S)	Regulated	Darling River at Menindee Weir 32	Salinity	E8 Supplementary access to natural flow events may be permitted once flows are in excess of those required by the WSP E9 Strategic use of environmental water allowance (EWA) as described in the WSP.	M	H	H	M/H	F	Refer to WQM Plan	N2 Strategic use of environmental water allowance (EWA) (and relevant held environmental water licences) as described in the MLD LTWP.	Refer to WQM Plan.		
E(WQ-S)	Regulated	Darling River at Burtundy	Salinity		M	M	M	M/H	F					
E(WQ-S)	Regulated	Edward River at Deniliquin	Salinity		H	L	L	M/H	F					
E(WQ-S)	Regulated	Murray River at Barham	Salinity		VH	L	M	M/H	F		N2 Strategic use of environmental water allowance (EWA) (and relevant held environmental water licences) as described in the MLD LTWP.	Refer to WQM Plan		
E(WQ-S)	Regulated	Murray River d/s Yarrawonga Weir	Salinity		M	L	L	M/H	F					
E(WQ-S)	Regulated	Murray River d/s Rufus River	Salinity		M	L	L	M/H	F					
E(WQ-S)	Regulated	Murray River at Lock 8	Salinity		M	H	H	M/H	F					
E(WQ-PT)	Regulated & unregulated	Lower Darling regulated and unregulated water sources	Pathogens and toxicants	Protection of the Environment Operations Act 1997 Local Government Act 1993 Local Government (General) Regulation 2005	M	L	L	M/H	F			Refer to WQM Plan	Risk is tolerable. Other legislative processes mitigate risk	NA
E(WQ-PT)	Regulated & unregulated	NSW Murray regulated and unregulated water sources	Pathogens and toxicants		VH	L	M	M/H	F			Refer to WQM Plan	Risk is tolerable. Other legislative processes mitigate risk	NA

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 NSW Murray and Lower Darling 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	Copi Hollow	Recreational Water Quality (BGA)	Refer to WQM Plan	L	L	L	H/M	F	Refer to WQM Plan				
O(WQ-BGA)	Risks to recreational water quality	Reservoir	Lake Pamamaroo	Recreational Water Quality (BGA)		L	H	M	H/M	F	Refer to WQM Plan				
O(WQ-BGA)	Risks to recreational water quality	Reservoir	Lake Wetherell	Recreational Water Quality (BGA)	Refer to WQM Plan	L	H	M	H/M	F	Refer to WQM Plan				
O(WQ-BGA)	Risks to recreational water quality	Reservoir	Lake Menindee	Recreational Water Quality (BGA)	Refer to WQM Plan	L	M	L	H/M	F	Refer to WQM Plan				
O(WQ-BGA)	Risks to recreational water quality	Reservoir	Lake Cawndilla	Recreational Water Quality (BGA)	Refer to WQM Plan	L	M	L	H/M	F	None required. Risk is low.				
O(WQ-BGA)	Risks to recreational water quality	Regulated	Darling River at Menindee	Recreational Water Quality (BGA)	Refer to WQM Plan	L	M	L	H/M	F	Refer to WQM Plan				
O(WQ-BGA)	Risks to recreational water quality	Regulated	Darling River at Weir 32	Recreational Water Quality (BGA)	Refer to WQM Plan	L	M	L	H/M	F	Refer to WQM Plan				
O(WQ-BGA)	Risks to recreational water quality	Regulated	Darling River at Tolarno	Recreational Water Quality (BGA)	Refer to WQM Plan	L	L	L	H/M	F	None required. Risk is low.				
O(WQ-BGA)	Risks to recreational water quality	Regulated	Darling River at Menincourt	Recreational Water Quality (BGA)	Refer to WQM Plan	L	L	L	H/M	F	None required. Risk is low.				
O(WQ-BGA)	Risks to recreational water quality	Regulated	Darling River at Pooncarie	Recreational Water Quality (BGA)	Refer to WQM Plan	L	L	L	H/M	F	None required. Risk is low.				
O(WQ-BGA)	Risks to recreational water quality	Regulated	Darling River at Tulney Point	Recreational Water Quality (BGA)	Refer to WQM Plan	L	L	L	H/M	F	None required. Risk is low.				
O(WQ-BGA)	Risks to recreational water quality	Regulated	Darling River at Burtundy	Recreational Water Quality (BGA)	Refer to WQM Plan	L	L	L	H/M	F	None required. Risk is low.				
O(WQ-BGA)	Risks to recreational water quality	Regulated	Darling River at Ellerslie	Recreational Water Quality (BGA)	Refer to WQM Plan	L	L	L	H/M	F	None required. Risk is low.				
O(WQ-BGA)	Risks to recreational water quality	Regulated	Darling River at Tapio	Recreational Water Quality (BGA)	Refer to WQM Plan	L	L	L	H/M	F	None required. Risk is low.				
O(WQ-BGA)	Risks to recreational water quality	Regulated	Lake Victoria outlet regulator	Recreational Water Quality (BGA)	Refer to WQM Plan	L	L	L	H/M	F	None required. Risk is low.				
O(WQ-BGA)	Risks to recreational water quality	Regulated	Murray River at Lock 8	Recreational Water Quality (BGA)	Refer to WQM Plan	L	L	L	H/M	F	None required. Risk is low.				
O(WQ-BGA)	Risks to recreational water quality	Regulated	Murray River at Fort Courage	Recreational Water Quality (BGA)	Refer to WQM Plan	L	L	L	H/M	F	None required. Risk is low.				

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 NSW Murray and Lower Darling 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	Regulated	Murray River at Curlwaa	Recreational Water Quality (BGA)	Refer to WQM Plan	L	L	L	H/M	F	None required. Risk is low.				
O(WQ-BGA)	Risks to recreational water quality	Regulated	Murray River at Merbein	Recreational Water Quality (BGA)	Refer to WQM Plan	L	L	L	H/M	F	Refer to WQM Plan				
O(WQ-BGA)	Risks to recreational water quality	Regulated	Murray River at Buronga	Recreational Water Quality (BGA)	Refer to WQM Plan	L	L	L	H/M	F	Refer to WQM Plan				
O(WQ-BGA)	Risks to recreational water quality	Regulated	Murray River at Mount Dispersion	Recreational Water Quality (BGA)	Refer to WQM Plan	L	L	L	H/M	F	None required. Risk is low.				
O(WQ-BGA)	Risks to recreational water quality	Regulated	Murray River at Euston	Recreational Water Quality (BGA)	Refer to WQM Plan	L	L	L	H/M	F	Refer to WQM Plan				
O(WQ-BGA)	Risks to recreational water quality	Reservoir	Lake Benanee Rec Area	Recreational Water Quality (BGA)	Refer to WQM Plan	L	L	L	H/M	F	Refer to WQM Plan				
O(WQ-BGA)	Risks to recreational water quality	Regulated	Murray River at Tooleybuc	Recreational Water Quality (BGA)	Refer to WQM Plan	L	L	L	H/M	F	Refer to WQM Plan				
O(WQ-BGA)	Risks to recreational water quality	Regulated	Murray River at Murray Downs	Recreational Water Quality (BGA)	Refer to WQM Plan	L	L	L	H/M	F	Refer to WQM Plan				
O(WQ-BGA)	Risks to recreational water quality	Regulated	Murray River at Barham	Recreational Water Quality (BGA)	Refer to WQM Plan	L	L	L	H/M	F	Refer to WQM Plan				
O(WQ-BGA)	Risks to recreational water quality	Regulated	Murray River at Moama	Recreational Water Quality (BGA)	Refer to WQM Plan	L	L	L	H/M	F	Refer to WQM Plan				
O(WQ-BGA)	Risks to recreational water quality	Regulated	Murray River at Picnic Point	Recreational Water Quality (BGA)	Refer to WQM Plan	L	L	L	H/M	F	None required. Risk is low.				
O(WQ-BGA)	Risks to recreational water quality	Regulated	Murray River at Tocumwal	Recreational Water Quality (BGA)	Refer to WQM Plan	L	L	L	H/M	F	Refer to WQM Plan				
O(WQ-BGA)	Risks to recreational water quality	Regulated	Murray River at Cobram	Recreational Water Quality (BGA)	Refer to WQM Plan	L	L	L	H/M	F	Refer to WQM Plan				
O(WQ-BGA)	Risks to recreational water quality	Regulated	Murray River downstream of Yarrawonga	Recreational Water Quality (BGA)	Refer to WQM Plan	L	L	L	H/M	F	Refer to WQM Plan				
O(WQ-BGA)	Risks to recreational water quality	Regulated	Mulwala Canal offtake	Recreational Water Quality (BGA)	Refer to WQM Plan	L	L	L	H/M	F	None required. Risk is low.				
O(WQ-BGA)	Risks to recreational water quality	Reservoir	Lake Mulwala	Recreational Water Quality (BGA)	Refer to WQM Plan	L	L	L	H/M	F	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 NSW Murray and Lower Darling 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	Regulated	Murray River at Corowa	Recreational Water Quality (BGA)	Refer to WQM Plan	L	M	L	H/M	F	Refer to WQM Plan				
O(WQ-BGA)	Risks to recreational water quality	Regulated	Murray River at Albury	Recreational Water Quality (BGA)	Refer to WQM Plan	L	L	L	H/M	F	Refer to WQM Plan				
O(WQ-BGA)	Risks to recreational water quality	Reservoir	Lake Hume	Recreational Water Quality (BGA)	Refer to WQM Plan	L	H	M	H/M	F	Refer to WQM Plan				
O(WQ-BGA)	Risks to recreational water quality	Regulated	Wakool River at Wakool-Barham Road	Recreational Water Quality (BGA)	Refer to WQM Plan	L	L	L	H/M	F	None required. Risk is low.				
O(WQ-BGA)	Risks to recreational water quality	Regulated	Wakool River at Kyalite	Recreational Water Quality (BGA)	Refer to WQM Plan	L	L	L	H/M	F	None required. Risk is low.				
O(WQ-BGA)	Risks to recreational water quality	Regulated	Gulpa Creek at Mathoura	Recreational Water Quality (BGA)	Refer to WQM Plan	L	L	L	H/M	F	None required. Risk is low.				
O(WQ-BGA)	Risks to recreational water quality	Regulated	Edward River at Deniliquin	Recreational Water Quality (BGA)	Refer to WQM Plan	L	L	L	H/M	F	None required. Risk is low.				
O(WQ-BGA)	Risks to recreational water quality	Regulated	Edward River at Old Morago	Recreational Water Quality (BGA)	Refer to WQM Plan	L	L	L	H/M	F	None required. Risk is low.				
O(WQ-BGA)	Risks to recreational water quality	Regulated	Edward River at Moulamein	Recreational Water Quality (BGA)	Refer to WQM Plan	L	L	L	H/M	F	None required. Risk is low.				

SECTION 7.2 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	NSW Murray 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	NSW Murray general 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	NSW Murray supplementary	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	NSW Murray conveyance	N/A	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	Lower Darling cap diversions	Negligible	Possible	L	M/H	N/A	None required. Risk is low.		N/A	N/A	

Current Critical Mechanisms - O(I-FD)
E17 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 (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 users from farm dam interception O(I-FD)	Unregulated	Bowna Creek at Yambla	Variation Annual Index CV	L	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for other users from farm dam interception O(I-FD)	Unregulated	Bowna Creek at Yambla	Low Flow Index Q90	L	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for other users from farm dam interception O(I-FD)	Unregulated	Bowna Creek at Yambla	High Flow Index Q10	L	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for other users from farm dam interception O(I-FD)	Unregulated	Jingellic Creek at Jingellic	Variation Annual Index CV	L	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for other users from farm dam interception O(I-FD)	Unregulated	Jingellic Creek at Jingellic	Low Flow Index Q90	L	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for other users from farm dam interception O(I-FD)	Unregulated	Jingellic Creek at Jingellic	High Flow Index Q10	L	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for other users from farm dam interception O(I-FD)	Unregulated	Maragle Creek at Maragle	Variation Annual Index CV	M	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for other users from farm dam interception O(I-FD)	Unregulated	Maragle Creek at Maragle	Low Flow Index Q90	M	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for other users from farm dam interception O(I-FD)	Unregulated	Maragle Creek at Maragle	High Flow Index Q10	M	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for other users from farm dam interception O(I-FD)	Unregulated	Tooma River at Pinegrove	Variation Annual Index CV	M	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for other users from farm dam interception O(I-FD)	Unregulated	Tooma River at Pinegrove	Low Flow Index Q90	M	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for other users from farm dam interception O(I-FD)	Unregulated	Tooma River at Pinegrove	High Flow Index Q10	M	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	

Current Critical Mechanisms - O(I-FD)
E17 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 (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)	NSW Murray high security	Negligible	Probable	L	H/M	N/A	None required. Consequence is 'negligible'		M	Medium risk is driven by a 'probable' likelihood. However, the consequence is 'negligible' which results in no material impact to water users therefore the risk is considered tolerable. N/A	
Risk to water available for other uses from plantation forestry O(I-PF)	NSW Murray general security	Negligible	Probable	L	H/M	N/A			M		
Risk to water available for other uses from plantation forestry O(I-PF)	NSW Murray supplementary	Negligible	Probable	L	H/M	N/A			M		
Risk to water available for other uses from plantation forestry O(I-PF)	NSW Murray conveyance	Nil	Probable	Nil	H/M		None required. Risk is 'nil'		N/A		
Risk to water available for other uses from plantation forestry O(I-PF)	Lower Darling cap diversions	Nil	Probable	Nil	H/M				N/A		
Risk to water available for other uses from plantation forestry O(I-PF)	Upper Murray unregulated water sources	M	Probable	H	H/L	B	13 Protect stream flow from reduced runoff attributable to plantation forestry interception.	N9 Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies.	H	Further information is required to improve the confidence in the likelihood of Plantation Forestry interception on unregulated water users for specific water sources with these activities occurring. Future MER should aim to demonstrate if these risks apply to specific water sources and what management actions can be undertaken.	MER for N9 to establish the key water sources impacted by PF
Risk to water available for other uses from plantation forestry O(I-PF)	Lower Murray-Darling and mid-Murray unregulated water sources	L	Rare	L	H/L	B			M		

Current Critical Mechanisms - O(I-PF)
E18 Plantation forestry interception managed under the Plantation forestry policy (in prep), Plantations and Reafforestation Act 1999 and the Plantation and Reafforestation (Code) Regulation 2001.
E19 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 [O(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 O(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 - O(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 river water source	H	Nil	Nil	H/M	N/A	None required. Risk is 'nil'.		NA	There is no material floodplain harvesting activity occurring in the NSW Murray and Lower Darling WRPA and the risk of future growth in this area is very low due to the absence of on farm storage facilities and the lack of supplementary access entitlements that have been a key driver for the development of on farm storage facilities in northern basin valleys.	
Risk to water available for other uses from floodplain harvesting O(I-FH)	Murray unregulated river water sources	M	Nil	Nil	H/M	N/A			NA		
Risk to water available for other uses from floodplain harvesting O(I-FH)	Lower Darling unregulated river water sources	L	Nil	Nil	H/M	N/A			NA		

Current Critical Mechanisms - O(I-FH)
None required as there is no material Floodplain Harvesting occurring within the NSW Murray and Lower Darling WRPA.

SECTION 8.3 RISKS TO WATER AVAILABLE FOR OTHER USES DUE TO CLIMATE CHANGE [O(CC)] – REGULATED 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	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)	NSW Murray high security	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	Rare	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)	NSW Murray general security	Wet climate change scenario		Minor	Rare	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)	NSW Murray supplementary	Wet climate change scenario		Minor	Rare	L	M/M	F	None required. Risk is low.		N/A		
Risk to water available for other uses due to climate change O(CC)	NSW Murray conveyance	Wet climate change scenario		Negligible	Rare	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)	Lower Darling cap diversions	Wet climate change scenario		Negligible	Rare	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)	NSW Murray high security	Median climate change scenario		Moderate	Possible	M	M/M	F	14 Protect the environment and water users from changes in flow attributable to climate change.	N1 Sustainable Diversion Limits. N8 Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies N9 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 N8 and N9
Risk to water available for other uses due to climate change O(CC)	NSW Murray general security	Median climate change scenario		Moderate	Possible	M	M/M	F			M		
Risk to water available for other uses due to climate change O(CC)	NSW Murray supplementary	Median climate change scenario		Moderate	Possible	M	M/M	F			M		
Risk to water available for other uses due to climate change O(CC)	NSW Murray conveyance	Median climate change scenario		Minor	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)	Lower Darling cap diversions	Median climate change scenario		Minor	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)	NSW Murray high security	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	Severe	Probable	H	M/M	F	14 Protect the environment and water users from changes in flow attributable to climate change.	N1 Sustainable Diversion Limits. N8 Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies N9 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 N8 and N9

SECTION 8.3 RISKS TO WATER AVAILABLE FOR OTHER USES DUE TO CLIMATE CHANGE [O(CC)] – REGULATED 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	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)	NSW Murray general security	Dry climate change scenario	extractive use according to water availability.	Severe	Probable	H	M/M	F	14 Protect the environment and water users from changes in flow attributable to climate change.	N1 Sustainable Diversion Limits. N8 Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies N9 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 N8 and N9
Risk to water available for other uses due to climate change O(CC)	NSW Murray supplementary	Dry climate change scenario		Major	Probable	H	M/M	F			H		
Risk to water available for other uses due to climate change O(CC)	NSW Murray conveyance	Dry climate change scenario		Moderate	Probable	H	M/M	F			H		
Risk to water available for other uses due to climate change O(CC)	Lower Darling cap diversions	Dry climate change scenario		Major	Probable	H	M/M	F			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)	Dora Dora	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.	L	M	L	H/M		None required. Risk is low.		N/A		
Risk to water available for other uses due to climate change O(CC)	Hume	Dry climate change scenario		L	M	L	H/M	F	None required. Risk is low.		N/A		
Risk to water available for other uses due to climate change O(CC)	Jingellic	Dry climate change scenario		L	M	L	H/M	N/A	None required. Risk is low.		N/A		
Risk to water available for other uses due to climate change O(CC)	Lower Wangamong	Dry climate change scenario		L	M	L	H/M	N/A	None required. Risk is low.		N/A		
Risk to water available for other uses due to climate change O(CC)	Majors	Dry climate change scenario		L	M	L	H/M	N/A	None required. Risk is low.		N/A		
Risk to water available for other uses due to climate change O(CC)	Ournie Welaregang	Dry climate change scenario		L	M	L	H/M	N/A	None required. Risk is low.		N/A		
Risk to water available for other uses due to climate change O(CC)	Lower Murray Darling	Dry climate change scenario		L	M	L	H/M	N/A	None required. Risk is low.		N/A		
Risk to water available for other uses due to climate change O(CC)	Albury	Dry climate change scenario		M	M	M	H/M	B C F	I4 Protect the environment and water users from changes in flow attributable to climate change.	N1 Sustainable Diversion Limits. N8 Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies N9 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 N8 and N9
Risk to water available for other uses due to climate change O(CC)	Indi	Dry climate change scenario		M	M	M	H/M				M		
Risk to water available for other uses due to climate change O(CC)	Mannus	Dry climate change scenario		H	M	M	H/M				M		
Risk to water available for other uses due to climate change O(CC)	Maragle	Dry climate change scenario		M	M	M	H/M				M		
Risk to water available for other uses due to climate change O(CC)	Swampy Plain	Dry climate change scenario		M	M	M	H/M				M		
Risk to water available for other uses due to climate change O(CC)	Tooma	Dry climate change scenario		M	M	M	H/M				M		
Risk to water available for other uses due to climate change O(CC)	Tumbarumba	Dry climate change scenario		M	M	M	H/M				M		
Risk to water available for other uses due to climate change O(CC)	Upper Murray	Dry climate change scenario		M	M	M	H/M				M		
Risk to water available for other uses due to climate change O(CC)	Murray Below Mulwala	Dry climate change scenario		M	M	M	H/M				M		

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**
NSW Murray regulated river water source	BLR (D&S) extraction	E20 Restrict BLR access through the establishment of mandatory guidelines under the WMA s. 52(2) and S. 336B. E21 Temporarily restrict access under the WMA s. 324 when there are water shortages. E22 Minister may limit growth in BLR when a land holding is subdivided and there is high hydrological stress on the river or aquifer	H	Nil	Nil	N/A	N/A	None required. Risk is 'nil'.		N/A		
Lower Darling regulated river water source	BLR (D&S) extraction		H	L	L	N/A	N/A	None required. Risk is low.		N/A		

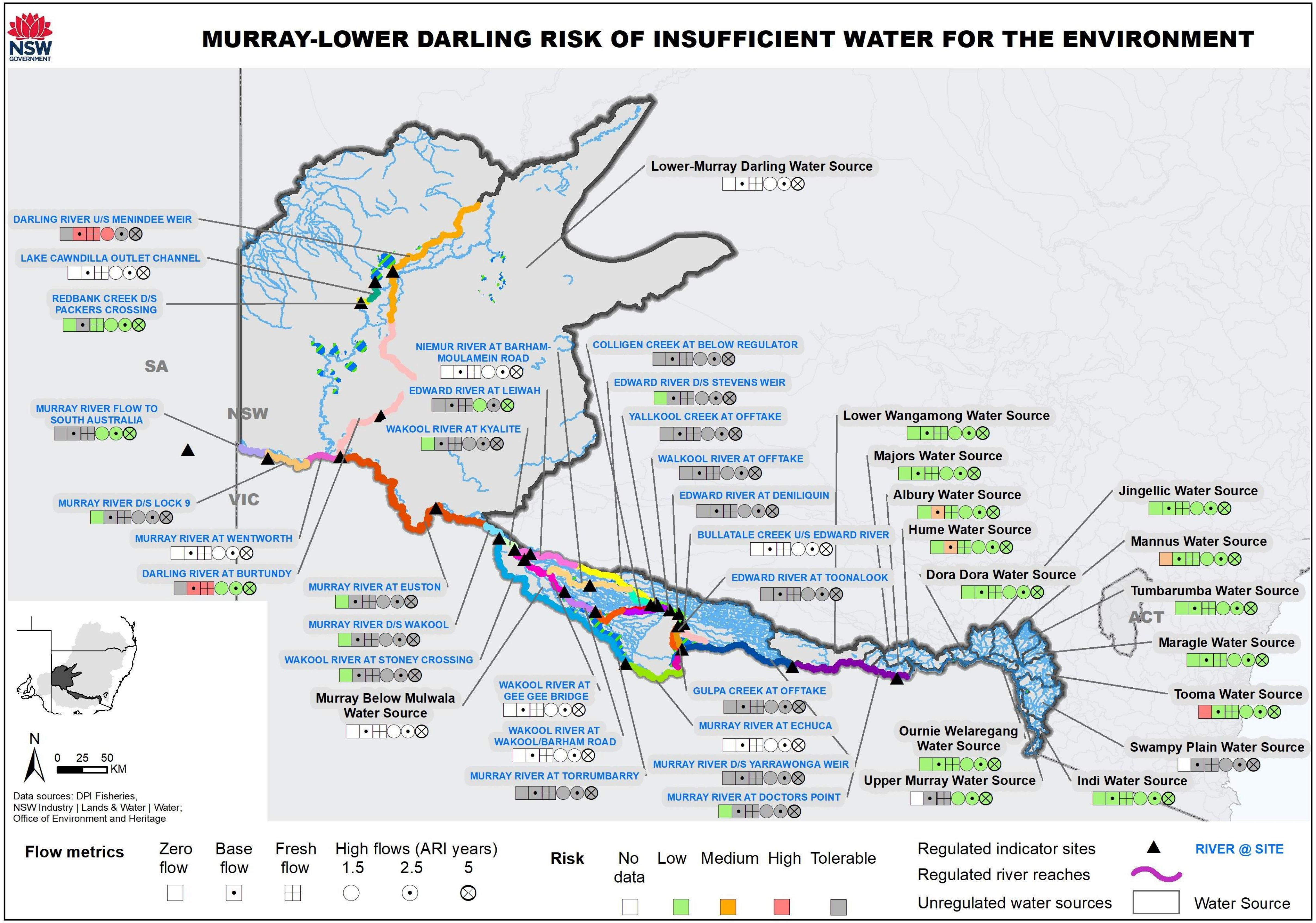
SECTION 8.4 RISKS TO WATER AVAILABLE FOR OTHER USES DUE TO GROWTH IN BLR [O(BLR)] – UNREGULATED WATER SOURCES												
Water Source Type	**Location, Reach, or Extraction Type within WRP Area**	**Current Critical Mechanisms**	**Consequence**	**Likelihood**	**Risk Rating**	**Data confidence (Consequence / 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	Albury	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. E20 Restrict BLR access through the establishment of mandatory guidelines under the WMA s. 52(2) and S. 336B. E21 Temporarily restrict access under the WMA s. 324 when there are water shortages. E22 Minister may limit growth in BLR when a land holding is subdivided and there is high hydrological stress on the river or aquifer	L	L	L*	M/L	N/A	None required. Risk is low.		N/A		
Unregulated	Dora Dora		L	L	L	M/M	N/A	None required. Risk is low.		N/A		
Unregulated	Hume		L	L	L	M/M	N/A	None required. Risk is low.		N/A		
Unregulated	Indi		L	L	L	M/M	N/A	None required. Risk is low.		N/A		
Unregulated	Jingellic		L	L	L	M/M	N/A	None required. Risk is low.		N/A		
Unregulated	Lower Murray Darling		H	L	L	M/M	N/A	None required. Risk is low.		N/A		
Unregulated	Lower Wangamong		L	L	L*	M/L	N/A	None required. Risk is low.		N/A		
Unregulated	Majors		L	L	L*	M/L	N/A	None required. Risk is low.		N/A		

SECTION 8.4 RISKS TO WATER AVAILABLE FOR OTHER USES DUE TO GROWTH IN BLR [O(BLR)] – UNREGULATED WATER SOURCES

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	Mannus	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. E20 Restrict BLR access through the establishment of mandatory guidelines under the WMA s. 52(2) and S. 336B. E21 Temporarily restrict access under the WMA s. 324 when there are water shortages. E22 Minister may limit growth in BLR when a land holding is subdivided and there is high hydrological stress on the river or aquifer	L	L	L	M/M	N/A	None required. Risk is low.		N/A		
Unregulated	Maragle		L	L	L	M/M	N/A	None required. Risk is low.		N/A		
Unregulated	Murray below Mulwala		H	L	L	M/M	N/A	None required. Risk is low.		N/A		
Unregulated	Ournie Welaregang		L	H	M	M/M	D	16 Protect licensed water users from changes in flow attributable to growth in BLR extractive use.		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	Swampy Plain		L	L	L	M/M	N/A	None required. Risk is low.		N/A		
Unregulated	Tooma		L	L	L	M/M	N/A	None required. Risk is low.		N/A		
Unregulated	Tumbarumba		L	L	L	M/M	N/A	None required. Risk is low.		N/A		
Unregulated	Upper Murray River		L	L	L	M/M	N/A	None required. Risk is low.		N/A		

* Where likelihood information was unavailable a qualitative approach determined the likelihood for that flow characteristic. This was based on expert opinion and likelihood from the nearest gauge was used.

Consolidated risk maps



Map produced by NSW Industry | Lands & Water | Water
September 2019

Figure 2. Consolidated risk map – Insufficient water for the environment.

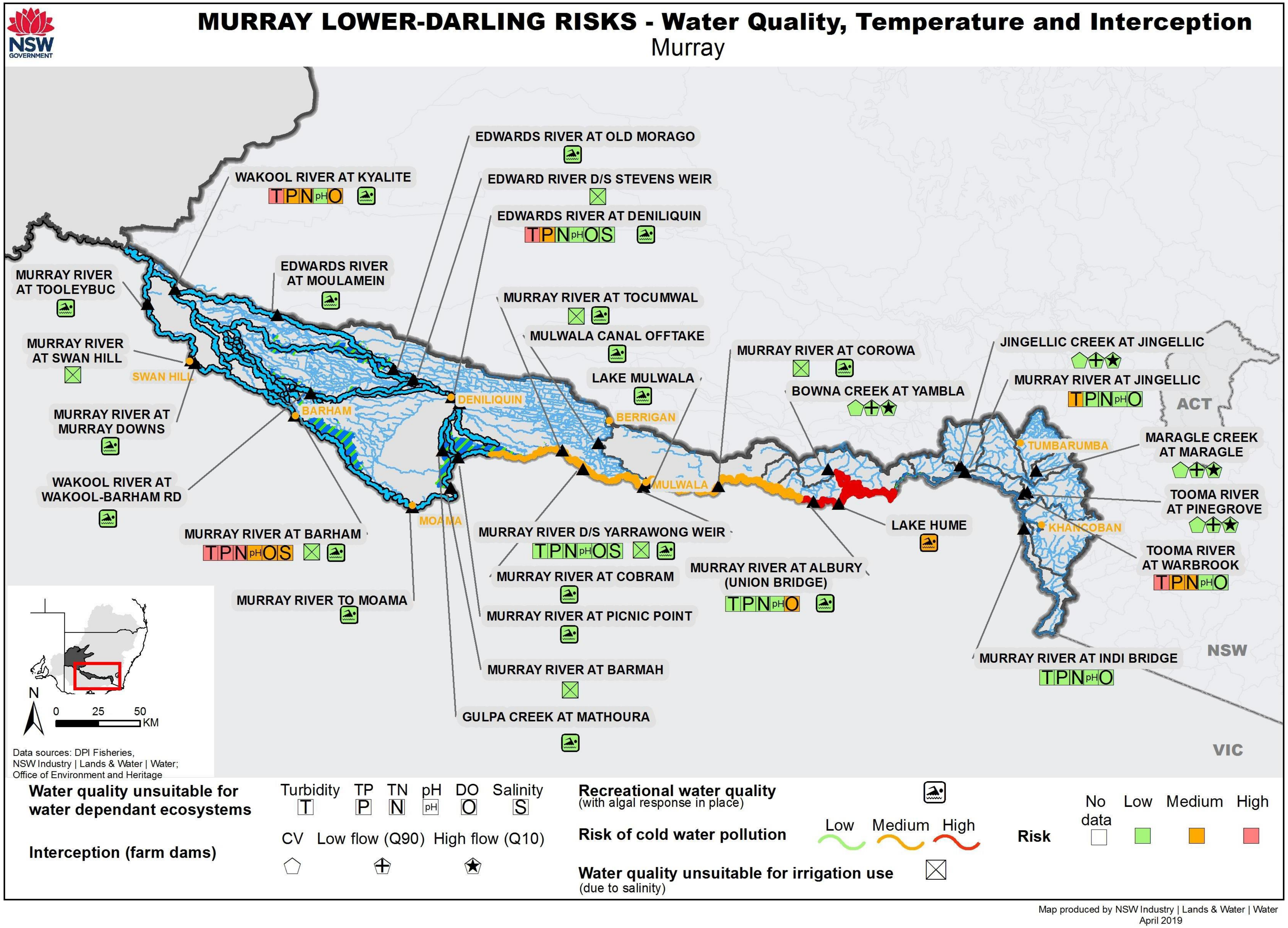
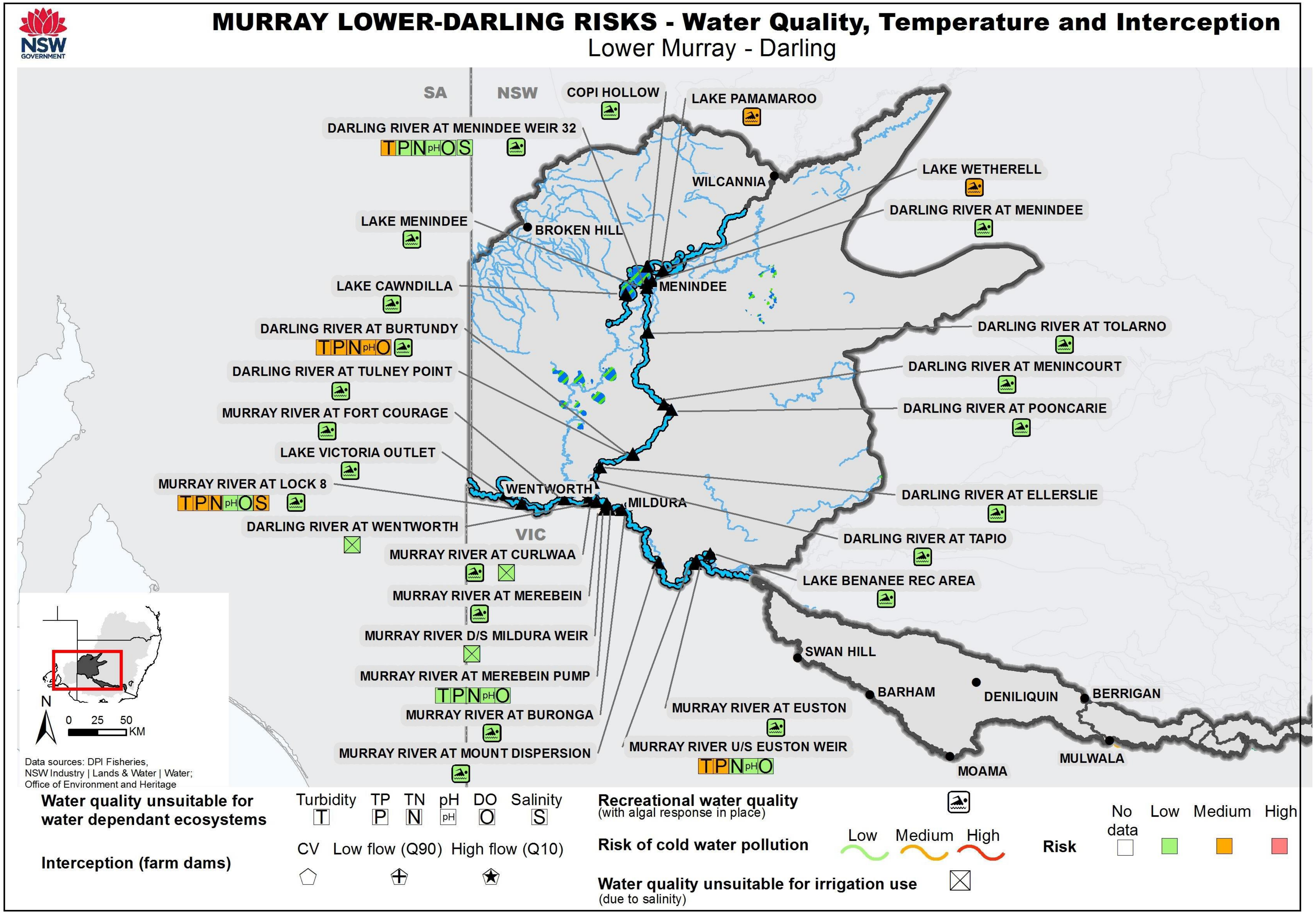


Figure 3.Consolidated risk map – Water quality, temperature and interception for the NSW Murray section of the NSW Murray and Lower Darling WRPA.



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March 2019

Figure 4. Consolidated risk map – Water quality, temperature and interception for the Lower Darling section of the NSW Murray and Lower Darling WRPA.

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 DoI-Water)
EWA	Environmental water allowance (replacing environmental contingency allowance EWA)
EWR	Environmental watering requirements
HEVAE	High Ecological Value Aquatic Ecosystems
LLS	Local Land Services
LTWP	Long Term Water Plan
MLD	Murray-Lower Darling
MDB	Murray-Darling Basin
MDBSY Project	Murray-Darling Basin Sustainable Yield Project
MDBA	Murray-Darling Basin Authority
NOW	NSW Office of Water (now Department of Planning and Environment-Water)
NRC	Natural Resources Commission
PPM	Pre-requisite Policy Measures
NRM	Natural Resource Management
NWI	National Water Initiative
SDL	Sustainable diversion limit
WMA	*Water Management Act 2000*
WRP	Water Resource Plan
WRPA	Water Resource Plan Area
WSP	Water Sharing Plan
WQM Plan	Water Quality Management Plan
WWP	Warm water pollution
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(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

Abbreviation	Description
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(BLR)	Risk to water available for other uses from growth in BLR
O(I-FD)	Risk to water available for other uses from interception activities (farm dams)
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
O(WQ-BGA)	Risks to recreational water quality and human health from blue-green algae

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 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 - 6) and risks to other water-dependent values and users (Sections 7 and 8) 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 8 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.

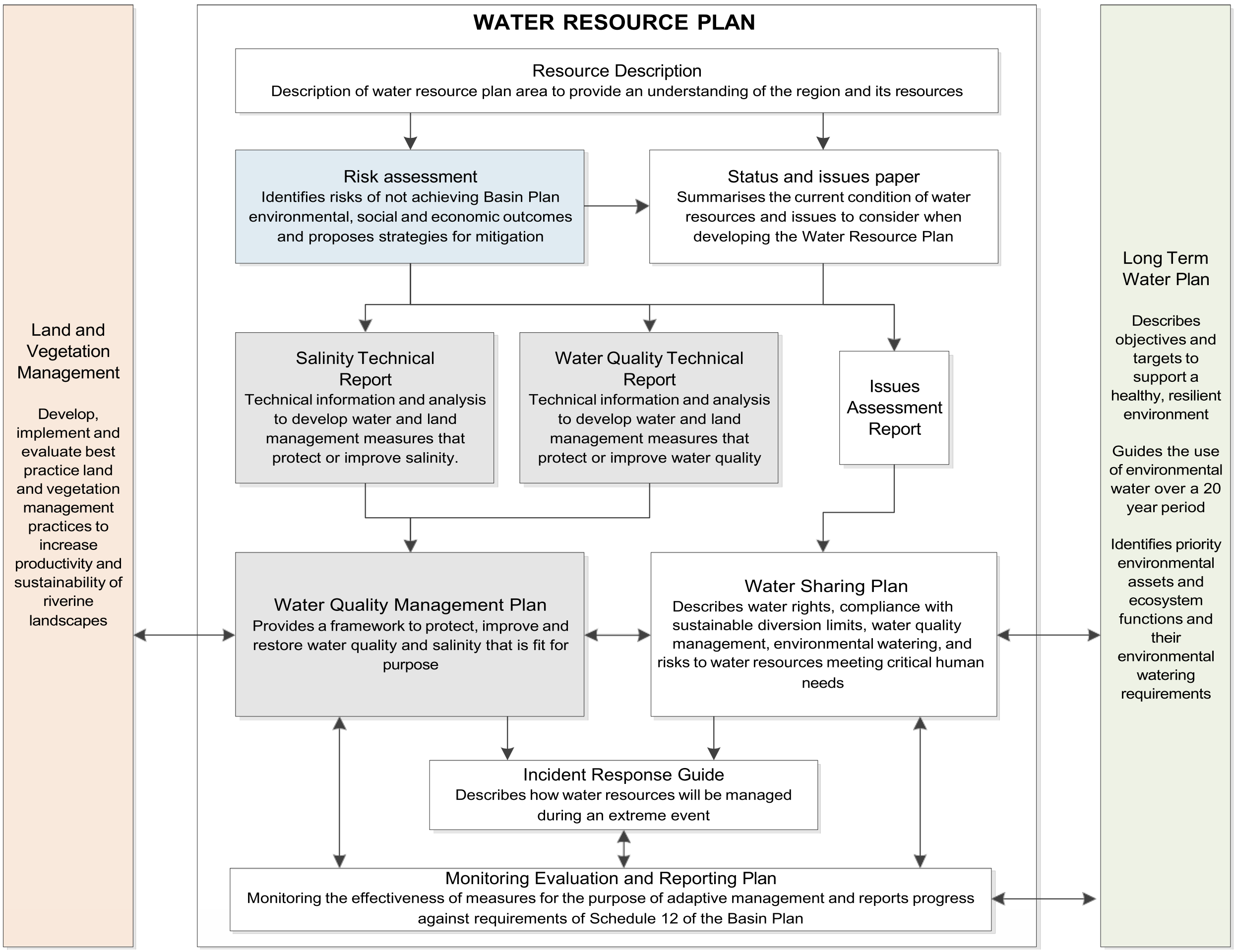


Figure 1-1. Components of the WRP.

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

Basin Plan requirement		Location in risk assessment report		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)	

Basin Plan requirement		Location in risk assessment report		Location in WRP
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
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	

Basin Plan requirement		Location in risk assessment report		Location in WRP
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	
		8.4	Other values	
10.41(1), 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

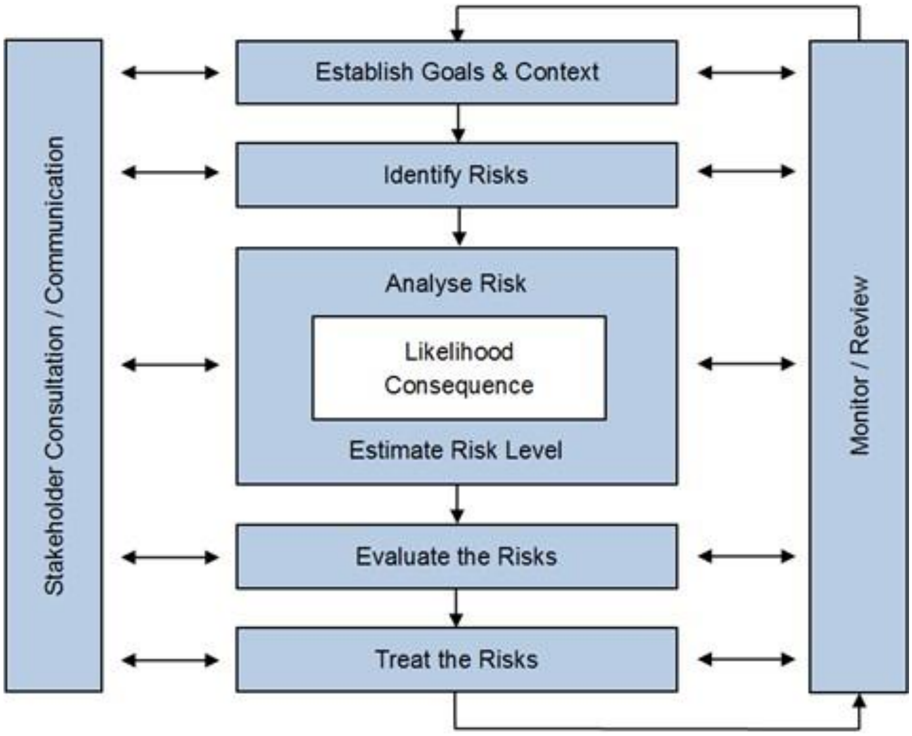
Risk-based management is not a new concept in water resource planning in NSW. Considerable work has been undertaken by State governments and under Commonwealth-level intergovernmental initiatives to design and implement risk-based water planning. The *National Water Initiative* (NWI) *Policy Guidelines 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 1998 b and c). 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.

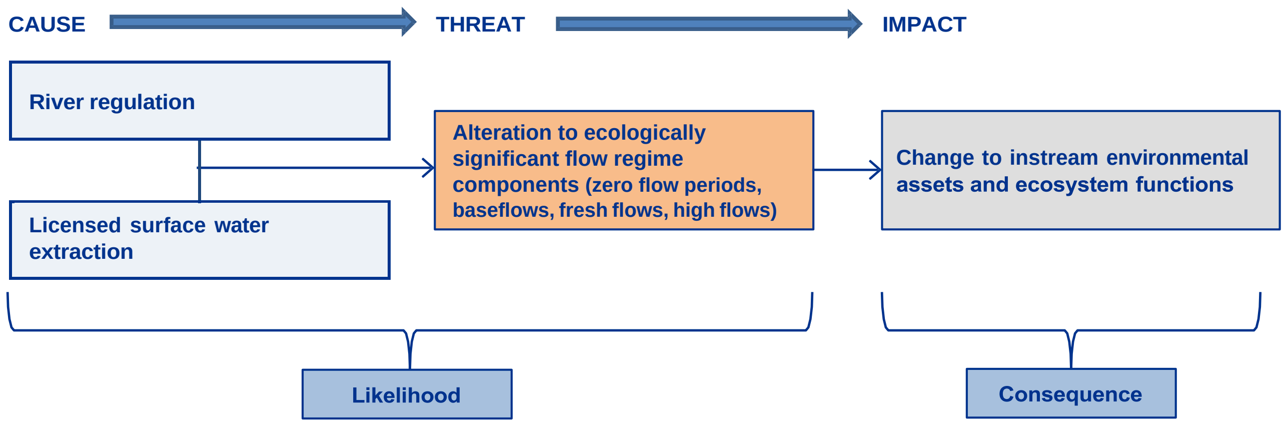


Figure 2-2. Example of an impact pathway for identifying risks to the environment associated with river regulation and licensed extraction.

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	Likelihood 2	Likelihood 3
Consequence	1	Low	Low	Medium
Consequence	2	Low	Medium	High
Consequence	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 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, 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 for which data was available. In the unregulated system, a water source scale was adopted to match current WSP boundaries. A reach scale for regulated rivers within the NSW Murray and Lower Darling 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 metrics 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 addressing 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 NSW Murray and Lower Darling water resource plan area (SW8)

3.1. Identification of the NSW Murray and Lower Darling 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 NSW Murray and Lower Darling WRPA.

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

- The SDL resource unit in the NSW Murray and Lower Darling WRPA is that described in section 6.02 and Schedule 2 to the Basin Plan within the NSW Murray and Lower Darling WRPA, (being the New South Wales Murray (SS14) and the Lower Darling (SS18) surface water SDL resource units) and
- The water resources within that SDL resource unit are those described in section 6.02 and Schedule 2 of the Basin Plan within the NSW Murray and Lower Darling WRPA

3.2. Characterisation of the NSW Murray and Lower Darling water resource plan area

The River Murray is 2,530 km long from its source in the Australian Alps to its mouth in South Australia (SKM, 2009). The NSW Murray River WRPA covers approximately 1,650 km from the Australian Alps to the South Australian border. The NSW portion of the Lower Darling river stretches from Tilpa to the confluence with the Murray River near Wentworth. The WRPA is also bounded by the South Australian border to the west and Victoria to the south (Figure 3-1).

Rising in alpine grasslands, the Murray River travels into steep forested western slopes then to the south western slopes with elevations of 600-300 m. Major NSW tributaries to the Upper Murray include the Geehi River, Swampy Plain River, Tooma Rivers, and Tumbarumba Creek. The major Victorian tributary of the upper Murray is the Mitta Mitta River which enters Hume Dam near Tallangatta. Below Hume Dam the Murray River travels onto the flat riverine plains with elevations less than 200 m featuring many billabongs and lagoons. The Kiewa River and Ovens Rivers from Victoria are the major tributaries between Hume Dam and Yarrawonga Weir. Downstream of Yarrawonga, a complex series of effluent channels break away from the river, with the major regulated tributaries and anabranches in NSW being the Edward River / Kolety, Wakool River, Niemur River, Billabong Creek, Yallakool Creek and Colligen Creek. Major tributaries from Victoria entering the river downstream of Yarrawonga are the Goulburn, Campaspe and Loddon Rivers. The lower Darling River below Tilpa includes the Great Anabranch of the Darling River (the Anabranch) and the associated Menindee Lakes.

The NSW Murray and Lower Darling Rivers are highly regulated, with the major storages being Hume Dam in NSW and Dartmouth Dam in Victoria. The river system is supplemented with water stored in the Snowy Mountains Hydro-electric Scheme, Dartmouth Dam (released to Hume Dam), Menindee Lakes on the lower Darling River and Lake Victoria in far south-western NSW, to meet the needs of irrigators and urban centres. Water for the lower Murray is preferentially released from the Menindee Lakes and Lake Victoria rather than upstream storages (Department of Primary Industries and Murray Darling Basin Authority websites).

For the unregulated water sources, the NSW Murray and Lower Darling WRPA can be divided into three main areas, the Upper and Middle Murray extraction management units and the Lower Murray Darling water source (Figure 3-2). For the purpose of this risk assessment in the NSW Murray and Lower Darling WRPA, the Murray and Lower Darling regulated rivers were divided into reaches based upon hydrologic modelling at specific hydrologic indicator sites. Unregulated rivers are categorised into water sources, which are the management boundaries also used in NSW water sharing plans (WSP). Figure 3-4 shows the unregulated water sources in the NSW Murray and Lower Darling WRPA and the spatial distribution of licence entitlements.

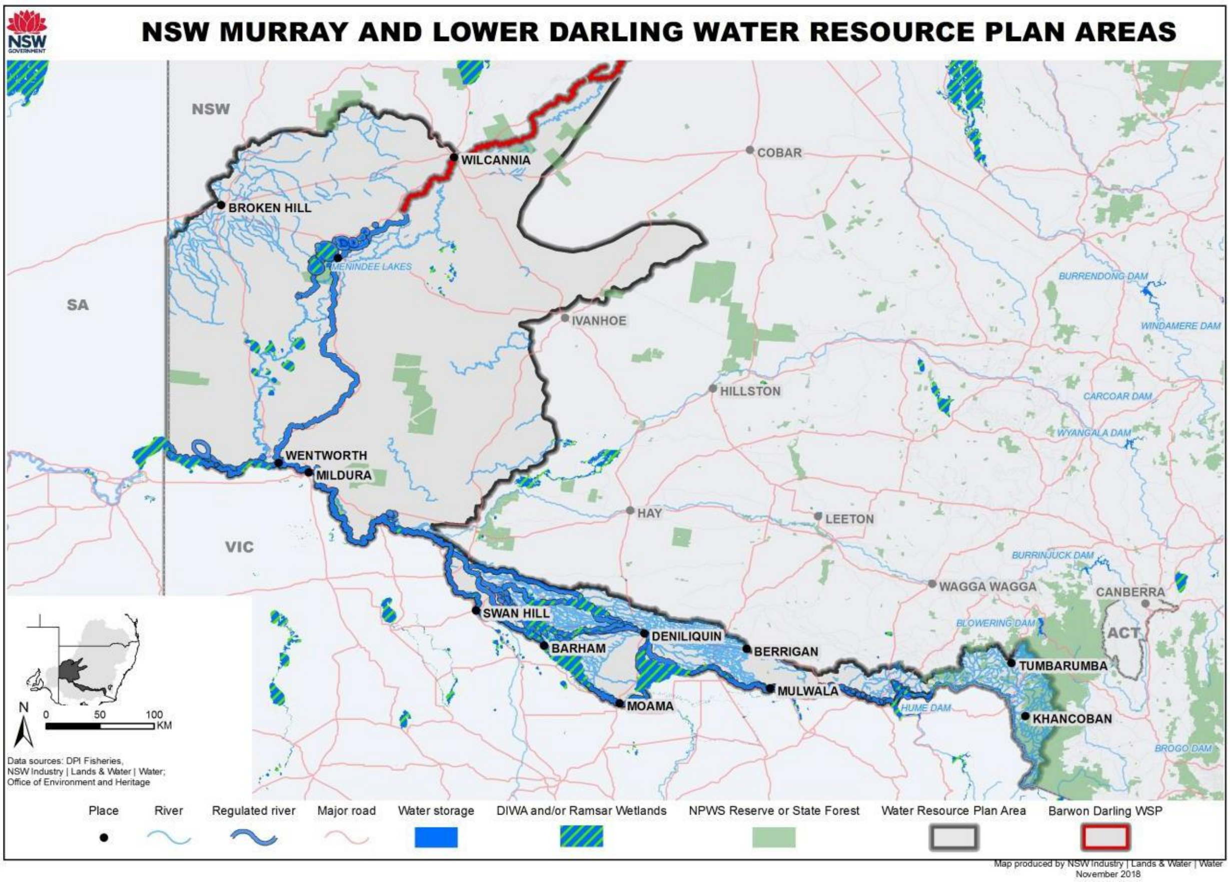


Figure 3-1. The NSW Murray and Lower Darling WRPA (SW8).

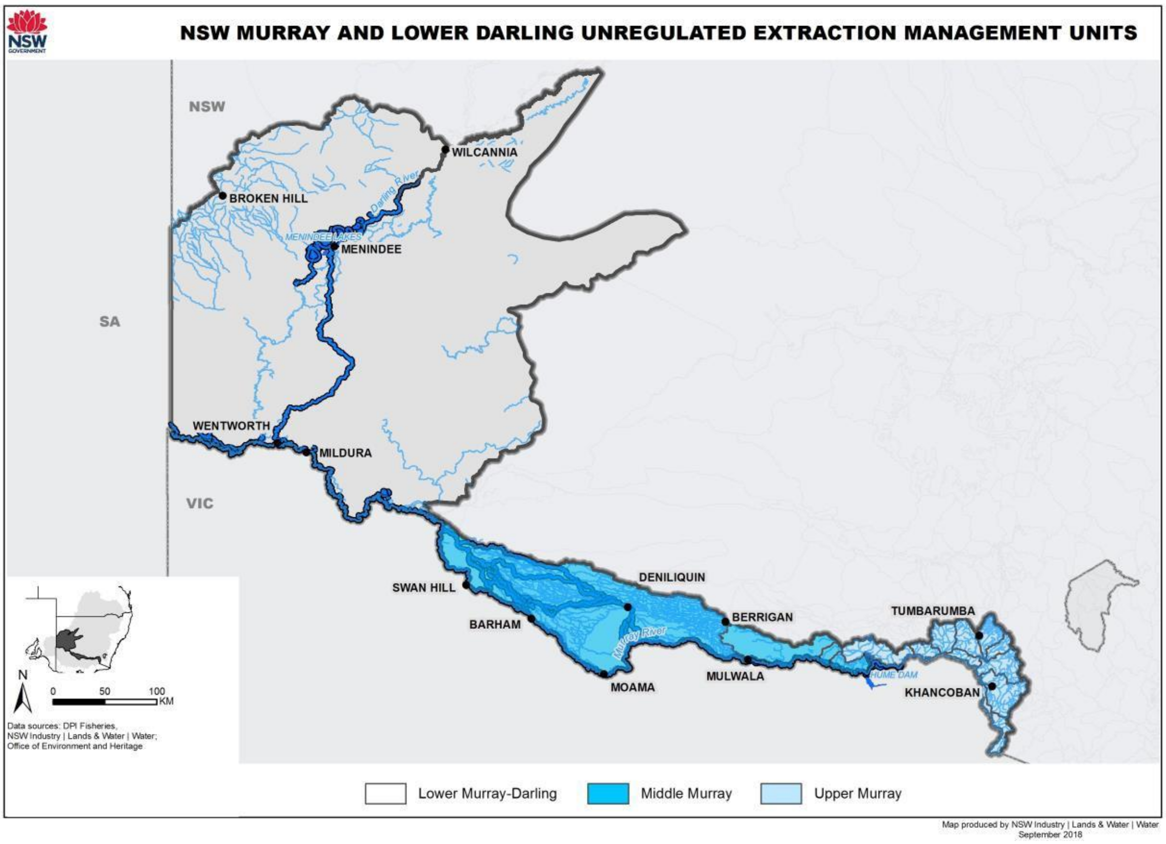


Figure 3-2. Extraction management units of the NSW Murray and Lower Darling WRPA (SW8).

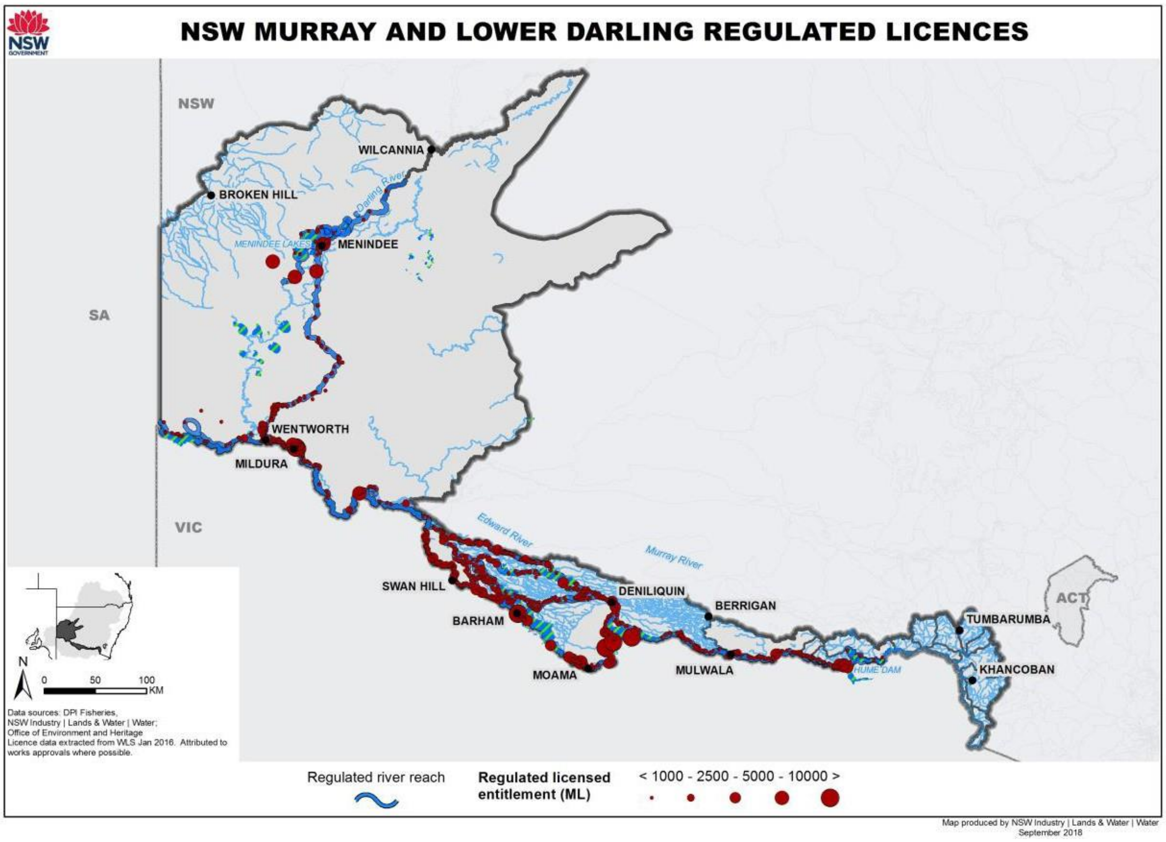


Figure 3-3. Regulated river entitlement in the NSW Murray and Lower Darling WRPA (SW8).

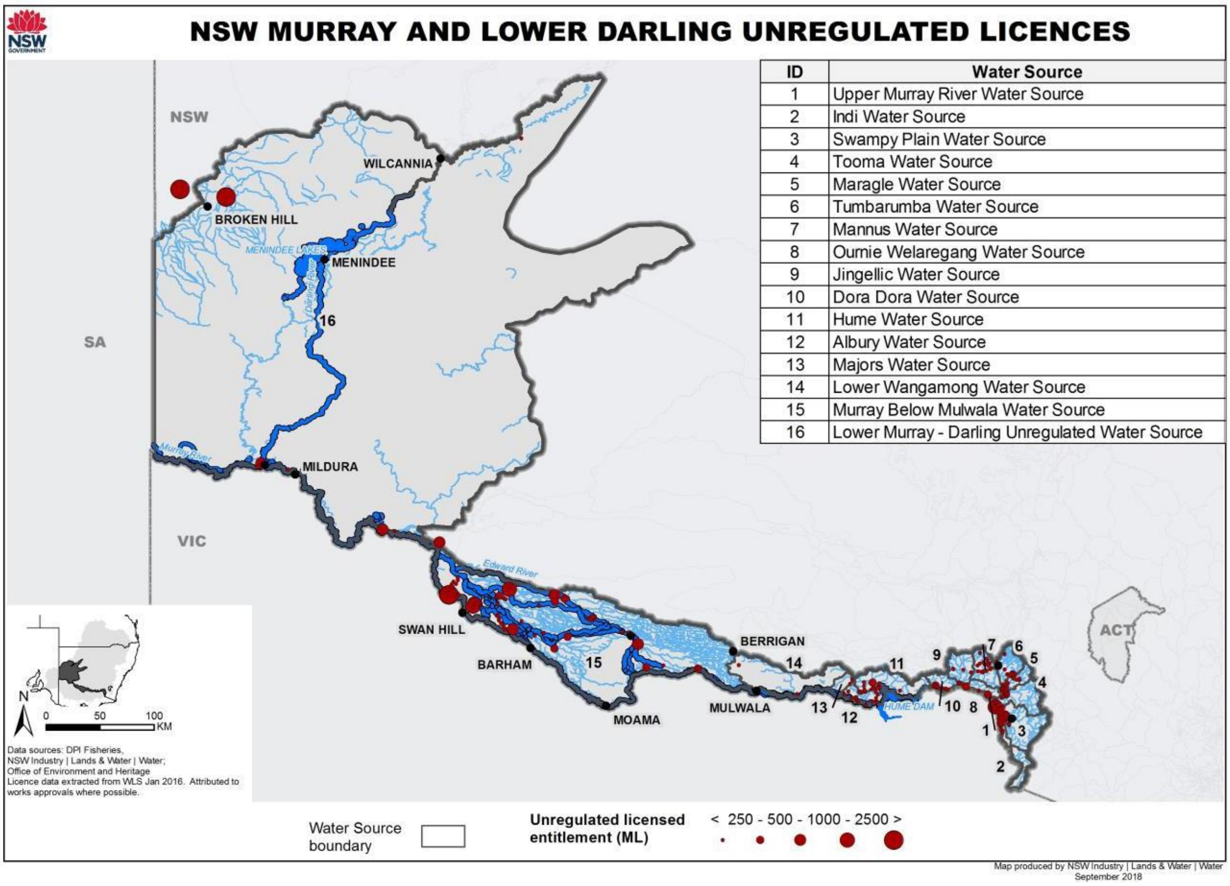


Figure 3-4. Unregulated water sources and entitlement in the NSW Murray and Lower Darling WRPA (SW8).

3.3. Connectivity

The NSW Murray and Lower Darling WRPA contain two SDL resource units, the NSW Murray SS14 and Lower Darling SS18. Within these resource units, the three WSPs within the NSW MLD 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 NSW Murray and Lower Darling Regulated Rivers Water Sources 2016*, the *Water Sharing Plan for the Murray Unregulated River Water Sources 2011*, and the *Water Sharing Plan for the Lower Murray-Darling Unregulated River Water Source 2011* to manage hydrological connections within the WRP area are discussed below.

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

3.3.1. Connectivity between unregulated and regulated water sources within the NSW Murray and Lower Darling WRPA

The connectivity between the unregulated and regulated water sources is managed by a suite of rules within the WSPs. The relevant connectivity issues are:

- Murray unregulated water sources and the Murray regulated water source
- Lower Darling unregulated water source and the Lower Darling regulated water source
- The Lower Darling regulated water source and the Murray regulated water source

Unregulated water sources are both upstream and downstream of the regulated river water sources 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 Murray Unregulated River Water Sources 2011* and the *Water Sharing Plan for the Lower Murray-Darling Unregulated River Water Source 2011* provides cease to pump rules at the lowest downstream point for some water sources. Cease to pump rules specify a flow requirement to benefit important environmental attributes in that water source 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 NSW Murray and Lower Darling Regulated Rivers Water Sources 2016* establishes provisions for environmental water in the Lower Darling and Murray regulated rivers. These provisions include rules that protect a portion of uncontrolled inflows into the regulated water source. The objective of these provisions is to achieve a range of environmental purposes, and incidentally connectivity between the regulated and unregulated water sources. There are also restrictions on extractions under supplementary water access licences where supplementary water or uncontrolled events is protected for the environment.

3.3.2. Connectivity with other WRP areas

Surface water to surface water

For the purposes of section 10.05 of the Basin Plan, the NSW Murray and Lower Darling WRPA (SW8) is considered to have significant hydrological connection to surface water SDL resource units within the downstream SA Murray (SS11). There is also upstream connectivity from the Barwon-Darling Watercourse (SS19) into the Lower Darling (SS18). Connectivity in the NSW Murray (SS14) from upstream Victoria includes the Victorian Murray (SS2), Kiewa (SS3), Ovens (SS4), Broken (SS5), Goulburn (SS6), Campaspe (SS7), Loddon (SS8) and Wimmera-Mallee (SS9) SDL resource units. Adjacent SDL resource units and WRPAs are summarised in Table 3-3.

The following is a qualitative assessment based on Department of Planning and Environment (Water) ecohydrology specialist expert opinion. There are potential risks to environmental assets and functions in the NSW Murray and Lower Darling Surface WRP from other WRPA. 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 Lower Darling or NSW Murray was ‘low’ given the impacts of existing invasive species in these systems, and the consequence score was ‘medium’. Using the risk matrix Table 4-11, the overall risk rating was ‘**low**’ (Table 3-1)

Hydrological connectivity risks from upstream WRPAs are addressed in section 4.3.3.

Table 3-1 Risk to environmental assets and functions within the NSW Murray and Lower Darling Surface WRPA due to connectivity with other WRPAs.

Water source	Consequence	Likelihood	Overall risk rating
Lower Darling			
Regulated river water source	Medium	Low	Low
Unregulated river water sources	Medium	Low	Low
NSW Murray			
Regulated river water source	Medium	Low	Low
Unregulated river water sources	Medium	Low	Low

Lateral and longitudinal connectivity between the regulated sections of the Murray River is considerable and has been managed through shared responsibility of environmental water allowances and Schedule 1 of the Water Act (2007).

Connectivity between the upstream Barwon-Darling Watercourse WRPA (SW12) and the Lower Darling River which falls within the NSW Murray and Lower Darling WRPA is managed by rules in the *Water Sharing Plan for the Barwon-Darling Unregulated Water Sources 2012,* specifically via minimum flow targets in the Darling River at Wilcannia and Brewarrina as listed under the former Interim Unregulated Flow Management Plan for the North-West (currently under review) and any 324 order made by the Minister. The specific flow targets are:

- During the period September to February, inclusive, a flow for 5 consecutive days of 14,000 ML/day in the Darling River at Brewarrina gauge (422002) (provided two such flow events have not already occurred during that period in that water year) - aim is to enable fish passage, and
- During the period October to April, inclusive, a flow for 5 consecutive days of 2,000 ML/day in the Darling River at Wilcannia gauge (425008) (provided flows of this quantity have not been reached during the preceding three months) - aim is to use flow to suppress blue-green algae blooms.

At the time of writing this document, the *Water Sharing Plan for the Barwon-Darling Unregulated Water Sources 2012* was under review as part of the NSW Water Reform Action Plan. This review may suggest improvements to connectivity issues with the Lower Darling River. Hydrologic connectivity within the Barwon-Darling unregulated water sources is managed by a suite of rules in the WSPs. The current rules impacting on connectivity are associated with existing cease-to pump rules, proposed Total Daily Extraction Limits (TDELs) and Individual Daily Extraction Limits (IDELs), the flow targets associated with the Interim *Unregulated Flow Management Plan for the North-West* (DWR 1992) and any 324 order made by the Minister.

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. These rules occur within each of the fourteen management zones and are associated with A, B and C class licences. Within each management zone hydrologic connectivity is influenced by the cease-to- and commence-to-pump rules for each licence class. However, the C class cease-to-pump rules may enable a degree of hydrologic connectivity between management zones if these higher river flows occur over a longer time frame. Cease-to-pump rules specify a low or no-flow requirement to benefit important environmental attributes in that water source and provides for connectivity between water sources and management zones. The *Water Sharing Plan for the Barwon-Darling Unregulated Water Source 2012* establishes provisions for planned environmental water to enable some but not all of the water management mechanisms described below.

Under a Section 324 Order of the NSW *Water Management Act* 2007, the Minister may restrict the take of water in upstream WSPs under the processes described in the *Interim Unregulated Flow Management Plan for the North-West* (DWR 1992). The aim of this Plan is to enable inflows from the Border Rivers, Gwydir, Namoi and Macquarie valleys to the Barwon-Darling and subsequently to Menindee Lakes. These inflows are focused at providing for the following three operational flow targets:

i) Riparian flows at specific levels at seven towns along the WRPA to enable the provision of town water supply and stock and domestic water needs,
ii) A flow of 14,000 ML/day at Brewarrina for five consecutive days, or 10,000 ML/day at Bourke for five consecutive days, during September to February inclusive to encourage fish passage,
iii) A flow of 2,000 ML/day at Wilcannia for five consecutive days during October to April, inclusive, providing flows of this quantity have not already been reached during the preceding three months within the October to April with aim to supress algal blooms should they occur.

Should any of these flows be protected to enable the flow targets to be reached, varying degrees of hydrologic connectivity will occur within and between management zones within the WRPA, but is also dependent on the origin of the inflows from the above mentioned tributaries.

Under the current WSP, IDELs and TDELs were proposed to be established during the life of the Plan. They are being discussed during the development of the WRP and may also influence connectivity within and between management zones.

Proposed new active management options for improved environmental water outcome are relevant in providing for connectivity outcomes within and between the WRPA (e.g. from the Gwydir and Macquarie Rivers into the Barwon-Darling) in addition to existing WSP processes. The NSW Water Renewal Taskforce and planning activities associated with developing the Barwon-Darling WRP, have been discussing three key active management options:

i) A first flush rule - this would likely be implemented to manage the resumption of flows after a prolonged cease-to-flow period,
ii) Protection of Held Environmental Water through water take restrictions, and,
iii) Investigations of possible flow protection measures to improve hydrologic connectivity between northern basin catchments.

Lastly, the Plan reserves water above the Plan limit which provides for environmental benefits that may influence connectivity between the fourteen management zones within the unregulated rivers in the WRP area.

The NSW Murray and Lower Darling WRPA are also connected to the upstream Murrumbidgee WRPA (SW9) at two points in the plan area:

- Lower Murrumbidgee River into the Murray River
- Billabong Creek into the Edward River / Kolety.

Connectivity with the NSW Murray is maintained by rules within the *Water Sharing Plan for the Murrumbidgee Regulated River Water Source 2016.* For the Lower Murrumbidgee, a minimum daily flow equivalent of the 95 percentile is required at the Balranald gauge throughout the year whilst connectivity is managed between Billabong Creek and the Edward River / Kolety by a minimum daily flow of 50ML/day at Darlot gauge.

An environmental water allowance (EWA) also specifies a volume of water to be set aside in Hume Dam and Menindee Lakes to deliver water for environmental purposes, including longitudinal connectivity from the NSW Murray River and Lower Darling into South Australia. The operational guidelines defined in the *Water Sharing Plan for the NSW Murray and Lower Darling Regulated Rivers Water Sources 2016* provide 1,850 GL per annum to the Murray at the South Australian border. This includes minimum flows from Hume Dam, upstream of the Kiewa River of 600 ML/day and at Doctors Point of 1200 ML/day, minimum flows downstream of Curlwaa pumps on the Murray is recommended to be 1200 ML/day during the summer months, and recommended minimum flows from Menindee Lakes into the Lower Darling River (Table 3-1). However, the recommended minimum flows in the Lower Darling River do not provide a legislated connectivity requirement and are often not met.

Table 3-2. Minimum recommended daily flows in the Lower Darling River at Weir 32 and the NSW Murray River at the SA border as per the regulated river WSP.

Month	Lower Darling at Weir 32 Minimum flow (ML/day)	NSW Murray at SA border Minimum flow (ML/day)
January	350	7,000
February	350	6,929
March	350	6,000
April	300	4,500
May	200	3,000
June	200	3,000
July	200	3,500
August	200	4,000
September	200	4,500
October	200	5,500
November	300	6,000
December	350	7,000
Reference: Water Sharing Plan for the NSW Murray and Lower Darling Regulated Rivers 2016		

Lastly, the Plan reserves water above the Plan limit which provides water for environmental benefits and for connectivity between the regulated rivers and unregulated rivers in the NSW Murray and Lower Darling WRPA.

These strategies manage potential risks to the downstream connected surface water resources, including risks to the environment and other uses, and are not considered further in this risk assessment.

Table 3-3 Adjacent SDL resource units

SDLRU	Adjacent SDLRU	Adjacent WRP / non Basin WSP
Lower Darling (SS18)	**Groundwater**	
	Adelaide Fold Belt MDB (GS10)	NSW Murray-Darling Basin Fractured Rock WRP (GW11)
	Kanmantoo Fold Belt MDB (GS19)	NSW Murray-Darling Basin Fractured Rock WRP (GW11)

SDLRU	Adjacent SDLRU	Adjacent WRP / non Basin WSP
	Lachlan Fold Belt MDB (GS20)	NSW Murray-Darling Basin Fractured Rock WRP (GW11)
	Lower Darling Alluvium (GS23)	Darling Alluvium (GW7)
	Upper Darling Alluvium (GS42)	Darling Alluvium (GW7)
	Western Porous Rock (GS50)	NSW Murray-Darling Basin Porous Rock WRP (GW6)
	Surface water	
	Barwon-Darling Watercourse (SS19)	Barwon-Darling Watercourse (SW12)
	NSW Murray (SS14)	NSW Murray and Lower Darling (SW8)
NSW Murray (SS14)	**Groundwater**	
	Lower Murray Shallow Alluvium (GS27a)	Murray Alluvium (GW8)
	Lower Murray Deep Alluvium (GS27b)	Murray Alluvium (GW8)
	Lachlan Fold Belt MDB (GS20)	NSW Murray-Darling Basin Fractured Rock WRP (GW11)
	Oaklands Basin (GS38)	NSW Murray-Darling Basin Porous Rock WRP (GW6)
	Upper Murray Alluvium (GS46)	Murray Alluvium (GW8)
	Surface water	
	Victorian Murray (SS2)	Victorian Murray (SW2)
	Kiewa (SS3)	Victorian Murray (SW2)
	Ovens (SS4)	Northern Victoria (SW3)
	Broken (SS5)	Northern Victoria (SW3)
	Goulburn (SS6)	Northern Victoria (SW3)
	Campaspe (SS7)	Northern Victoria (SW3)
	Loddon (SS8)	Northern Victoria (SW3)
	Wimmera-Mallee (SS9)	Wimmera-Mallee (SW4)
	SA Murray (SS11)	South Australian River Murray (SW6)
	Lower Darling (SS18)	NSW Murray and Lower Darling (SW8)

Surface water to groundwater

Adjacent resource units are summarised in Table 3-3. In NSW, connectivity between surface and groundwater is primarily managed through rules for specific areas in groundwater WSPs and by managing surface and groundwater extraction to LTAAELs and SDLs. Any potential groundwater risks from surface water extraction are managed by PEW rules in the surface water WSPs that also protect the surface water resources.

The impact pathway for the risk of potential for changes in surface water management impacting on groundwater recharge and priority environmental assets (PEAs) and priority ecosystem functions (PEFs) is described in Figure 3-5.

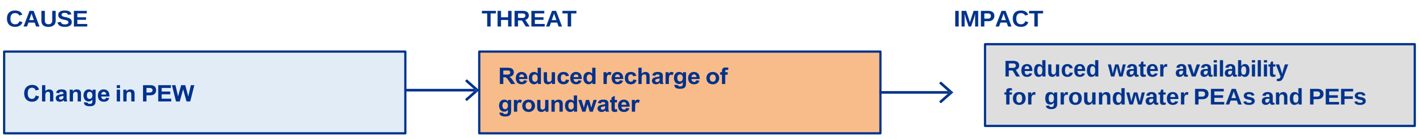


Figure 3-5 Impact pathway showing risk to groundwater ecological assets and functions from reduced recharge.

The protection of the environmental water provisions under section 4.5 of the WRP ensures that the PEW in the WRP area is protected. Therefore, the volume of water available as groundwater recharge throughout the NSW Murray and Lower Darling surface WRP is protected and cannot be reduced, thus the likelihood rating is 'low'. The consequence of reduced groundwater recharge was assessed as 'medium'. Using the risk matrix outlined in Table 4-11, the likelihood and consequence metrics result in a '**low**' risk rating for both regulated and unregulated water sources (Table 3-4).

Table 3-4 Risk of insufficient surface water impacting on groundwater priority assets and functions in regulated and unregulated water sources in the NSW Murray and Lower Darling Surface WRPA.

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

The NSW Murray and Lower Darling WRPA (SW8) is not highly connected to any groundwater sources (DPI Water 2015). However, the WRPA does have limited hydrological connection to groundwater resource units within the Darling Alluvium (GW7), the Murray Alluvium (GW8), the NSW Murray-Darling Basin Porous Rock (GW6) and the NSW Murray-Darling Basin Fractured Rock (GW11) WRPAs. There is no significant connection with alluvial groundwater sources in the adjacent Lachlan (GW10), Goulburn-Murray (GW2) and Wimmera-Mallee (GW3) WRP areas.

The Murray River is generally considered to be under losing conditions downstream of Albury and gaining between Albury and Hume Dam. Whilst the regulated Murray River is considered to be hydraulically connected along its reach within the Upper Murray Alluvium, due to the depth and width of the alluvium, groundwater pumping impacts at the river are subdued and/or delayed. This lag time of groundwater pumping impacts is acknowledged in setting the extraction limit of the resource hence the Upper Murray Alluvium is managed independently from the river. Shallow aquifers of the Lower Murray Shallow Alluvium are also considered to be in hydraulic connection to major rivers, creeks, irrigation channels and other water bodies. In the western part of the water source, saline groundwater discharges do occur intermittently depending on the river height. However, due to the lag time of pumping impacts at the river the Lower Murray Shallow Alluvium is also managed independently from the river.

The Darling alluvium is hydraulically connected to the Darling River. During large flow events, the river recharges the shallow aquifer system, giving rise to the freshwater lens present in the near-river aquifer. During low flow conditions, at some locations depending on geology and topography, the aquifer discharges into the river. Groundwater access rules in the *Water Sharing Plan for the Darling Alluvial Groundwater Sources 2020* consider connectivity between the surface and groundwater sources. From a water management perspective, the Darling Alluvium is considered "less highly connected" to the Darling River. This means that the management of groundwater access from the alluvium is not directly linked to access to the overlying river.

The interaction between the Murray River and the NSW Murray-Darling Basin Porous Rock aquifers is complex and dynamic. During periods of high flows fresh river water recharges the shallow alluvial aquifer whereas saline groundwater flows into the river during low flow conditions. Groundwater and surface water level data indicate that the river reach between Euston and the South Australian border alternates from losing to gaining conditions. This depends on river levels, groundwater heads in the alluvial aquifers and the underlying Parilla Sand. Groundwater recharge or discharge to the river is controlled by the presence or absence of aquitards separating the local and regional aquifers, as well as the locations of locks and weirs and the influence of underlying basement structures. Although the Murray River is considered to be hydraulically connected to the recent alluvium confined to the floodplain, the groundwater pumping impacts in the river from the regional aquifer (Parilla Sand) are subdued or delayed. This lag time of groundwater pumping impacts is acknowledged in setting the extraction limit of the resource and the WPR is managed independently from the river.

Groundwater in the Oaklands Basin is not connected to surface water. The higher elevated areas associated with the Sydney Basin, along with the higher rainfall, and more incised nature of the sediments would facilitate groundwater to discharge as baseflow into creeks along the upper catchments. As such, stream flows may be reliant on groundwater discharge during drought times.

For the purposes of Chapter 10.20(1), a number of considerations were made to recognise and manage the hydrological connections between these water sources.

The level of impact on the hydraulic relationships and properties between the groundwater systems and connected surface water systems (and between these groundwater systems and others, and within these groundwater systems) was 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.

Groundwater access rules in the *Water Sharing Plan for the Murray Alluvial Groundwater Sources 2020* also consider connectivity to manage seasonal impacts on surface water flows. In highly connected systems where groundwater pumping could potentially impact on seasonal surface water flows, groundwater access rules are in place. These rules reflect the degree of connectivity and the time lag between extraction and impact.

Alluvial groundwater systems that are highly connected to regulated systems have specific rules that recognise the level of connectivity based on annual management through linked available water determinations (i.e. available water determinations (AWDs) for aquifer access licences are linked to the AWDs for associated regulated river access licences, recognising that a component of groundwater recharge is derived from the regulated river system). Alluvial groundwater systems that are highly connected to perennial unregulated systems have specific rules that recognise the level of connectivity based on daily access linking their management to the associated unregulated surface water daily access rules.

Any potential risks to surface water /groundwater hydraulic relationships as a result of ground water extraction are considered in the Risk Assessment for the GW7 Darling Alluvium WRPA (DPIE Water 2019a), GW8 Murray Alluvium WRPA (DPIE Water 2019b), GW6 NSW Murray-Darling Basin Porous Rock (DPIE Water 2019c) and the GW11 NSW Murray-Darling Basin Fractured Rock (DPIE Water 2019d) WRPAs.

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 recolonisation 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, plantation forestry, mining and floodplain harvesting)
- Climate change.

These threats could impact 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.

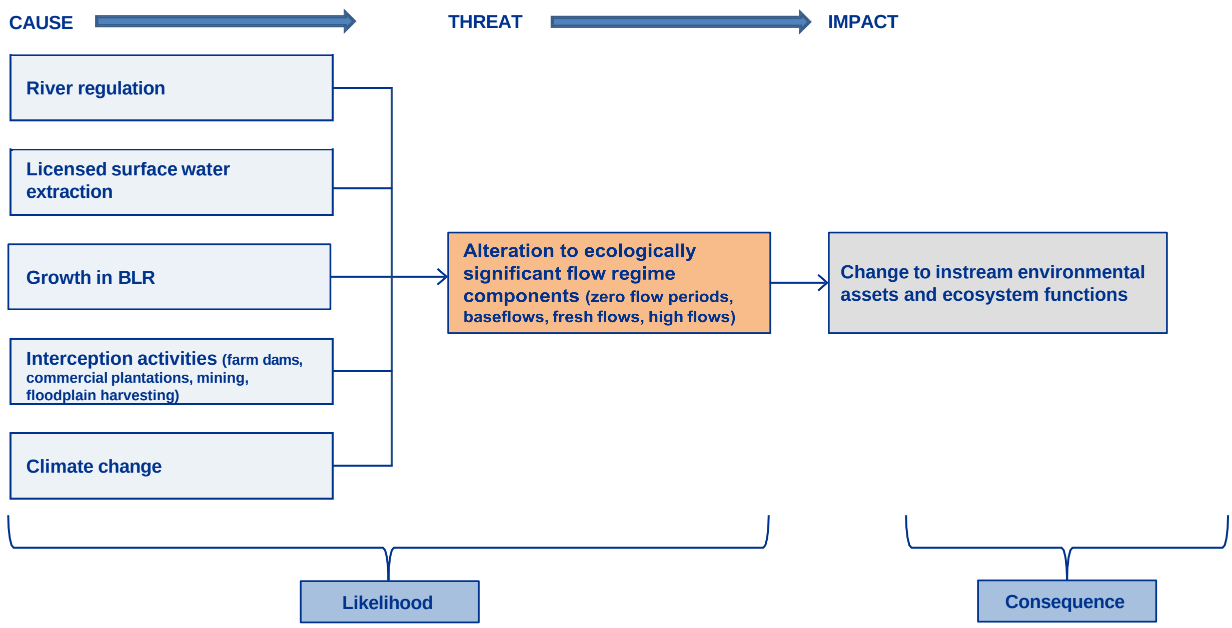


Figure 4-1. Risk pathways for risks of insufficient water for the environment and capacity to meet environmental watering requirements.

4.2. Assigning a consequence rating

River reaches

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.

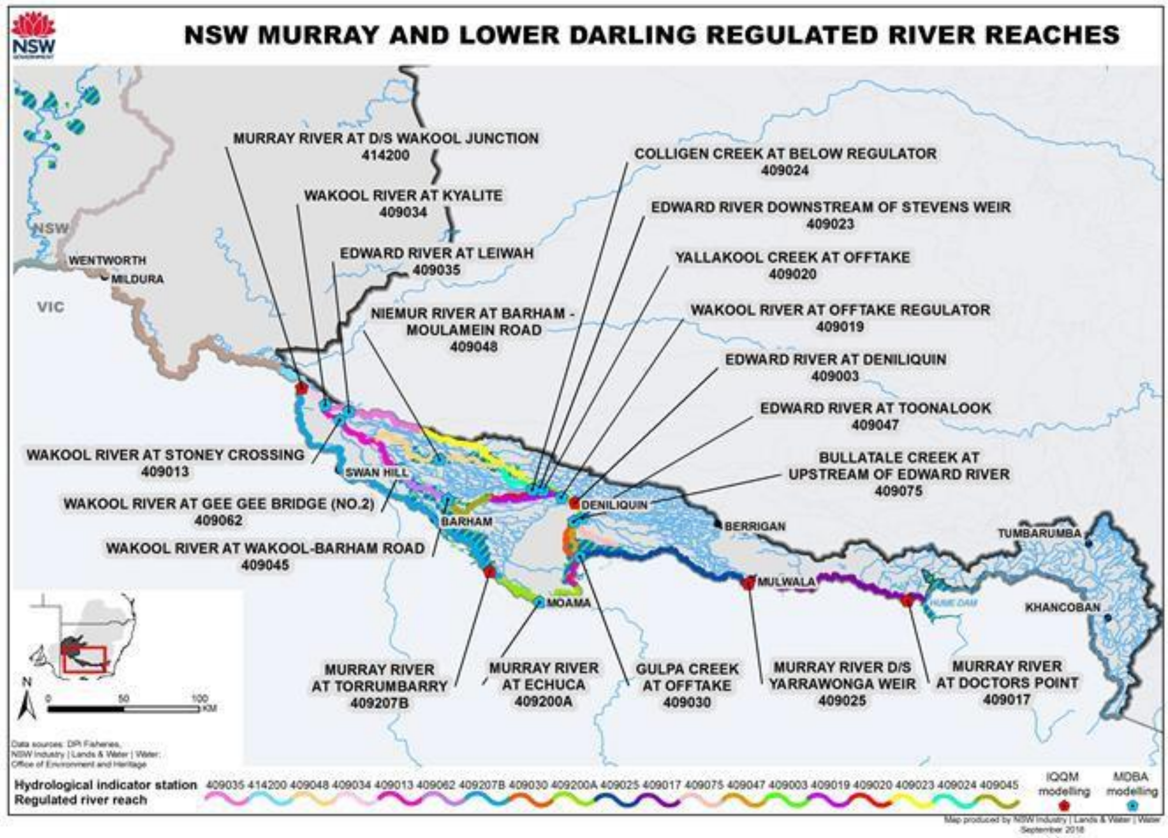
A consequence score is assigned at a reach scale for regulated rivers. The regulated river was broken into reaches that were represented by MDBA hydrologic indicator sites used for modelling (Figure 4-2). These sites correspond to selected streamflow gauging stations. The reaches represented by the hydrologic indicator sites were selected by identifying where significant tributaries, effluents or regulators both upstream and downstream of the site change the hydrology significantly. For example, in Figure 4-2, the reach assigned to the indicator site 425007 Darling River at Burtundy extends from the Darling-Murray confluence at Wentworth upstream towards Menindee.

A consequence score is assigned at a water source scale for unregulated rivers. Single reach Integrated Quantity and Quality Models (IQQM) were applied 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 (Figure 4-3).

To ensure the HEVAE outcomes developed by the Department of Planning and Environment - Water (Healey et al. 2012; Healey et al. 2018) could be useful spatially and report 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.

Menindee Lakes

HEVAE was not explicitly designed to incorporate information on ecological functions and assets in lakes and storages unless they were included as a RAMSAR or DIWA listed site. The consequence scores assigned to Menindee Lakes were therefore based on the adjacent river reach HEVAE outcomes whilst considering other documented functions and assets of the lakes (Section 4.2.3). We assigned consequence scores to four of the key lakes within the Menindee Lakes system: Lake Cawndilla, Lake Menindee and Lake Wetherell.



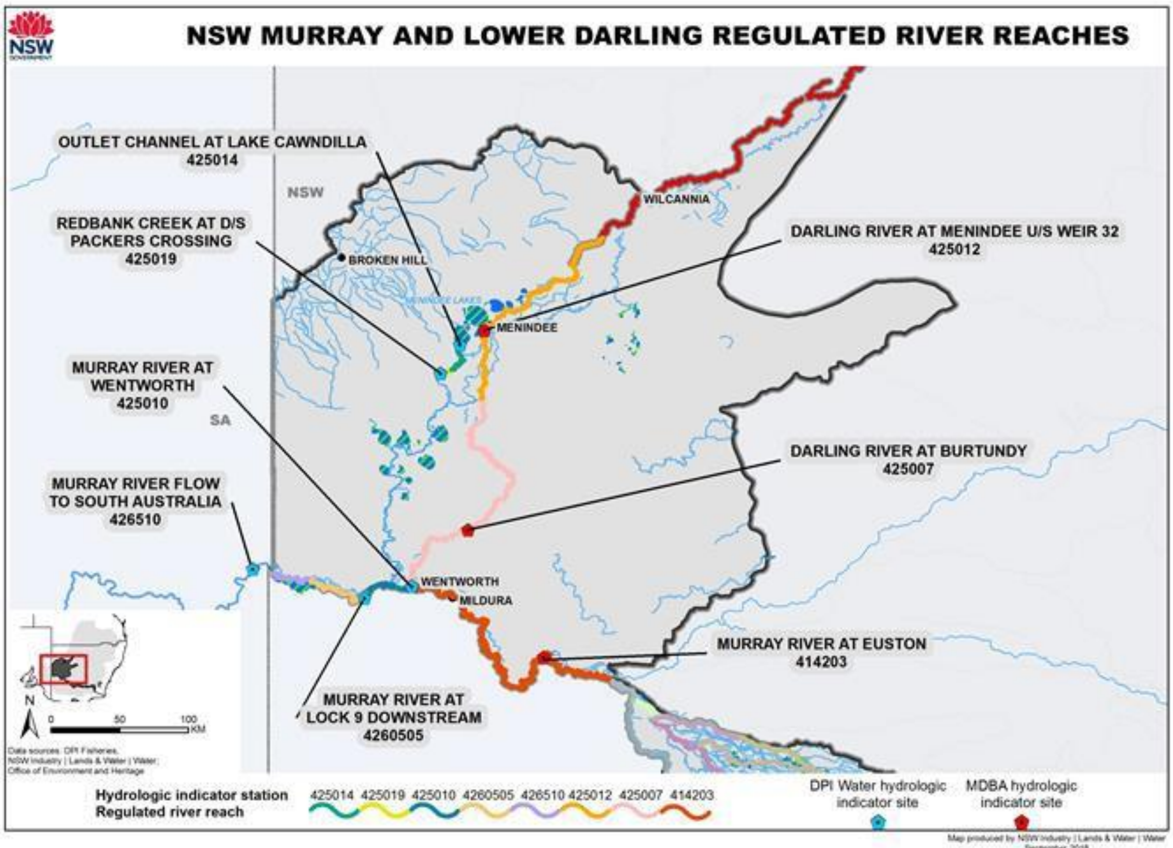


Figure 4-2. MDBA and Department of Planning and Environment Water hydrologic indicator sites and representative regulated reaches for the MLD WRPA.

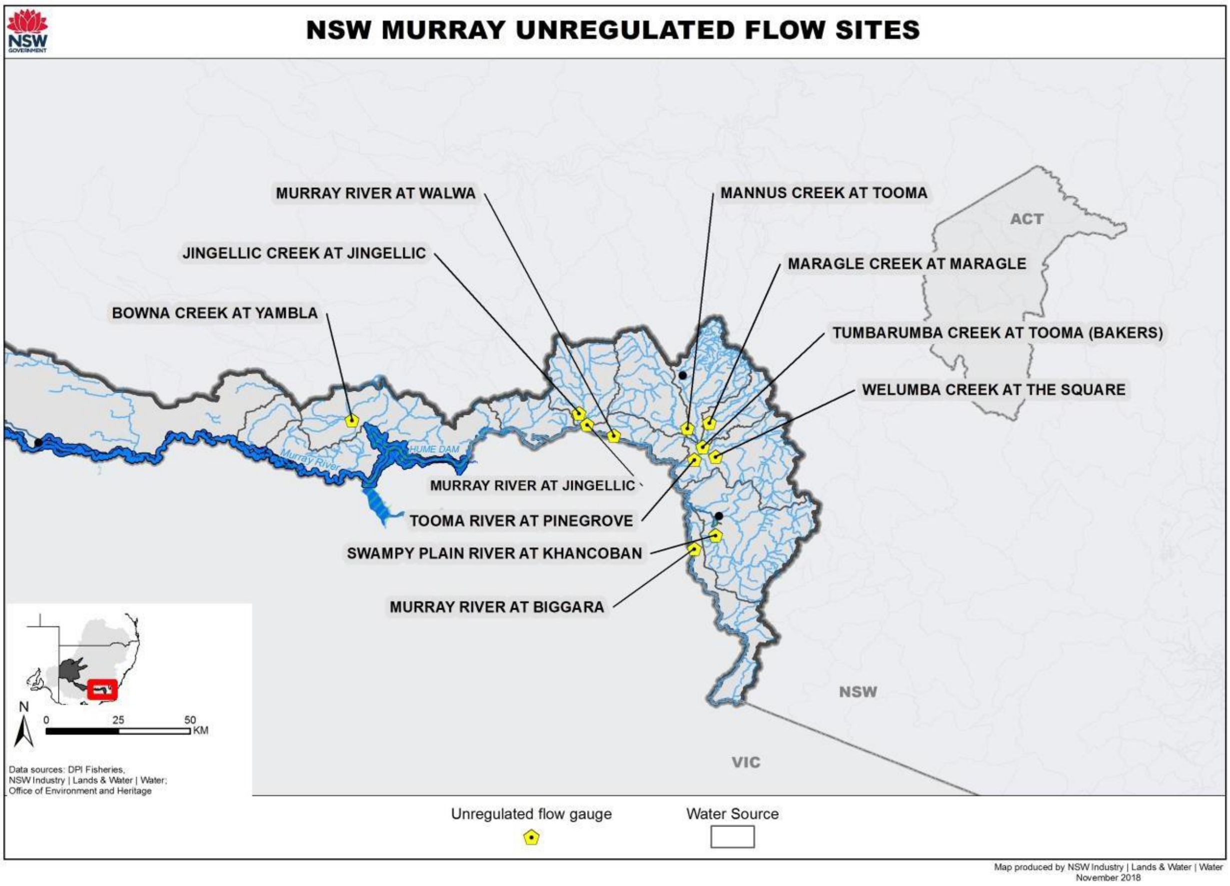


Figure 4-3. Location of unregulated flow gauges and the MDBA hydrologic indicator site used for generating flow sequences in unregulated rivers in the NSW Murray and Lower Darling WRPA.

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 Appendix B. The assigning of HEVAE scoring was developed using the same data and mobility weightings used by the Department of Planning and Environment - Conservation and Biodiversity 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 4-4); 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 (Table 4-1) of in-stream flow dependent threatened species, populations and communities (NOW 2011; DIPNR 2005). The weightings for each species were agreed upon through discussions with participating NSW agencies with consideration to the importance of flow alteration as a key threatening process. 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.

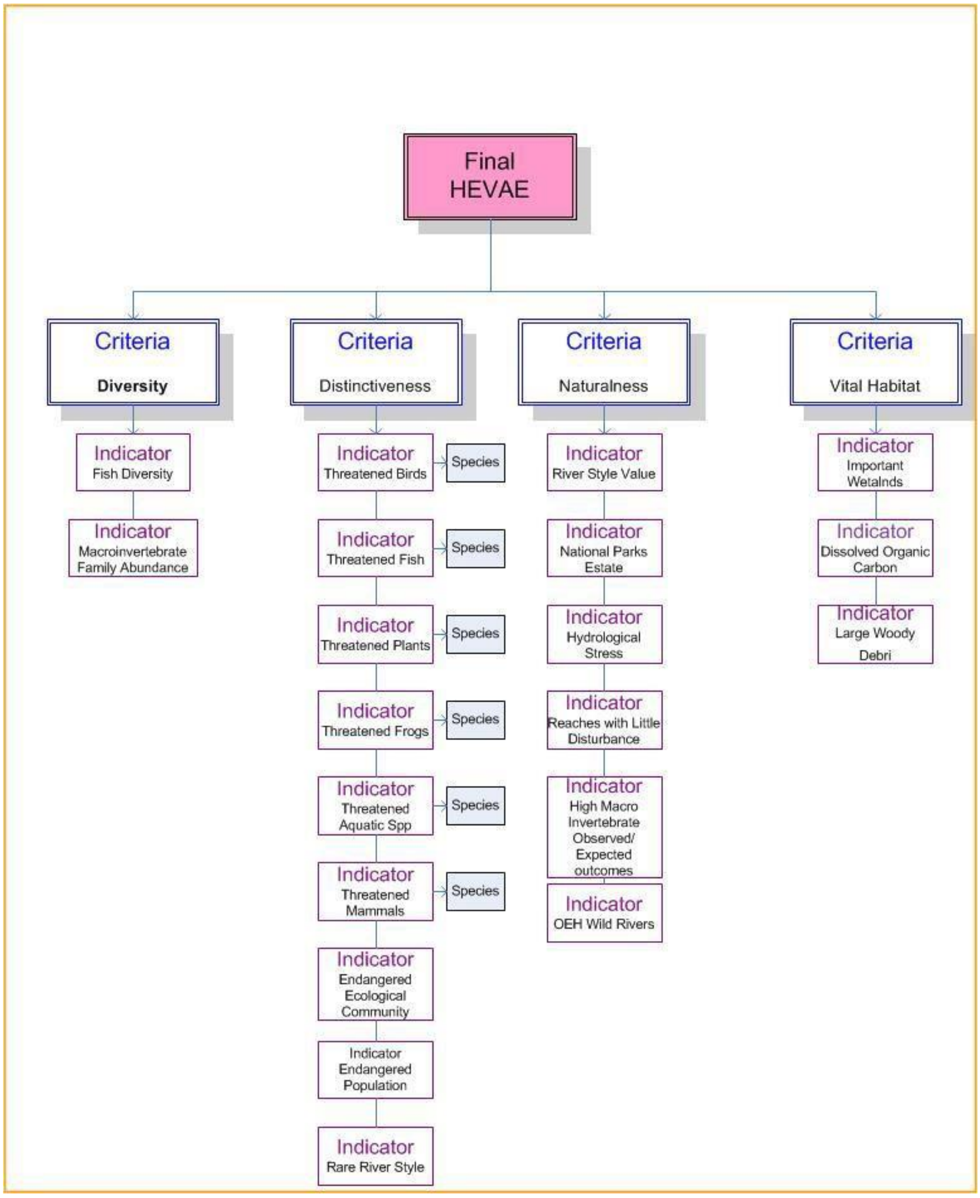


Figure 4-4. The four HEVAE criteria and associated attributes used in assessing HEVAE in NSW.

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

Score/ Weighting	Definition	Typical 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

Score/ Weighting	Definition	Typical examples
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 occurrences and “known records” (‘known records’ are predicted occurrences within the vicinity of recorded data: 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

Key aquatic ecological assets in the NSW Murray and Lower Darling WRPA include:

- The alpine wetlands of Kosciusko National Park including the Ramsar listed Blue Lake;
- 262,000 ha of wetlands in the Murray catchment, including 2,360 ha of freshwater lakes and 20 ha of saline wetlands, which provide habitat for over 60 species of waterbird and 18 species of migratory bird;
- 269,000 ha of wetlands and floodplain woodlands in the Lower Darling catchment, including the Great Darling Anabranch and the 9 ephemeral lakes of the Menindee Lakes system, which can support hundreds of thousands of waterbirds including migratory shorebirds;
- The Ramsar listed NSW Central Murray State Forests which includes the Barmah-Millewa forest on the Murray River floodplain covering 500 km^2 and is part of the largest river red gum forest in the southern hemisphere, Werai Forest and Koondrook-Perricoota Forest;
- The 440 km^2 Kinchega National Park in the Lower Darling catchment includes substantial areas of river red gums and important waterbird habitat extending for 62 km along the western side of the Darling River and surrounds Lakes Menindee and Cawndilla;
- River reaches with high fish diversity;
- Threatened fish species including silver perch, Murray cod, trout cod, olive perchlet, southern pygmy perch, Murray hardyhead, flathead galaxia and Macquarie perch.
- Strategic population of Murray cod in the Darling River;

- Key natural spawning recruitment pathway for golden perch in Menindee lakes and the lower Darling;
- Threatened species such as the Australasian bittern, blue-billed duck, Brolga, southern bell frog, Sloane's froglet, southern myotis bat, Murray crayfish and threatened endangered populations including eel-tailed catfish;
- Endangered ecological communities (EECs) including the Montane Peatlands Swamp EEC, the Lower Murray River EEC predicted to occur throughout the WRPA downstream of Lake Hume and the Darling River EEC predicted throughout the Lower Darling region;
- Off-river lagoons and wetlands located throughout the catchment;
- Rare River Styles including chain of ponds, anabranching gravel, low sinuosity and meandering gravel;
- In-stream pools and low flow refuges that support local and migratory species.

Menindee Lakes specific:

- 24 inundation dependent vegetation communities (wetlands, lignum, red gum, black box);
- Significant bird breeding sites for 18 migratory bird species listed under international agreements;
- 14 native fish species including golden perch populations of Basin-scale significance
- Nationally important wetlands
- Threatened species, populations and communities – Coolibah-Black Box community, Lowland Darling River EEC, Menindee nightshade, silver perch, Murray Cod and 37 waterbirds

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 NSW Murray and Lower Darling WRPA. The results show a significant spread of threatened fish species or endangered populations in the NSW Murray and Lower Darling WRPA. Murray cod and Silver perch were widespread, with a cluster of Trout cod in the central section of the regulated Murray River. There were several records of Southern pygmy perch throughout the WRPA. Eel-tailed catfish occurred in isolated sites in the Lower Murray River and the Darling WRPA. There was only one record of Macquarie perch, olive perchlet and flathead galaxia. However, several species including flathead galaxia are predicted to occur throughout the MLD WRPA. Fish biodiversity was highest in the mid reaches of the regulated Murray and on the Murray River between Mildura and the darling confluence and lowest in the Upper Murray and Menindee Lakes. These data are included in the HEVAE assessment; results are provided in Appendix D. Additional information provided by NSW Department of Planning and Environment-Conservation and Biodiversity and NSW DPI Fisheries has been incorporated into the Lower Darling consequence results due to concerns around disparate datasets used within the HEVAE framework for this water source (Bogenhuber *et al*. (2012), Bogenhuber *et al*. (2013), Ellis *et al*. (2016), Sharpe (2011)).

Regulated river water source and Menindee Lakes

Consequence scoring shows that the NSW Murray and Lower Darling regulated rivers have a diverse range of scores with low to very high consequences (Figure 4-5; Table 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. Predominantly the consequence scores were in the high to very high range with over 70% of the reaches returning a score in these categories.

Consequence scores for the Lower Darling River and Great Darling Anabranch ranged from Low to Medium (Figure 4-5; Table 4-2). The highest consequence score for the Lower Darling River was used as the base consequence outcome for the four major lakes within the Menindee Lakes system. In addition, we took into account the importance of these lakes for the Lowland Darling River EEC, waterbird breeding sites, golden perch recruitment sites and native vegetation communities. Lake Cawndilla and Lake Menindee were assigned high consequence scores based on these additional environmental assets. Lake Wetherell (and Tandure) are significant native fish refuges during dry years and therefore were assigned Very High consequence ratings.

Table 4-2. Consequence results for the NSW Murray and Lower Darling regulated water source in the NSW Murray and Lower Darling WRPA.

Regulated river reach	Consequence Rating (HEVAE consequence score)
Lake Cawndilla	High
Lake Menindee	High
Lake Wetherell	Very High
Darling River at Menindee u/s weir 32	Medium
Darling River at Burtundy	Medium
Great Darling Anabranch at outlet Lake Cawndilla	Low
Great Darling Anabranch at Redbank Ck d/s Packers Crossing	Low
Murray River at Doctors Point	Medium
Murray River d/s Yarrawonga Weir	Very High
Murray River at Echuca	High
Murray River at Torrumbarry	Very High
Murray River at d/s Wakool Junction	Medium
Murray River at Euston	High
Murray River at Wentworth	High
Murray River at Lock 9 downstream	High
Murray River Flow to South Australia	Medium
Edward River at Toonalook	Very High
Edward River at Deniliquin	Very High
Edward River d/s Stevens Weir	High
Edward River at Leiwah	High
Wakool River at Offtake Regulator	Very High
Wakool River at Wakool/Barham Rd	Very High
Wakool River at Gee Gee Bridge	Very High
Wakool River at Stoney Crossing	High

Regulated river reach	Consequence Rating (HEVAE consequence score)
Wakool River at Kyalite	High
Yallakool Creek at Offtake	Very High
Colligen Creek at below Regulator	Very High
Niemur River at Barham/Moulamein Rd	High
Bullatale Creek u/s Edward River	High
Gulpa Creek at Offtake	Very High
Reference: Healey et al. 2018.	

Unregulated water sources

Unregulated rivers in the NSW Murray and Lower Darling WRPA returned very low to high consequence scores (Table 4-3). Overall, the results show that most of the unregulated WRPA has low ecological value, primarily due to low vital habitat and low diversity.

Table 4-3. Consequence results for the NSW Murray and Lower Darling unregulated water sources in the NSW Murray and Lower Darling WRPA.

Unregulated water source	Consequence Rating (HEVAE consequence score)
Albury	Low
Dora Dora	Low
Hume	Medium
Indi	Low
Jingellic	Medium
Lower Murray – Darling	Medium
Lower Wangamong	Low
Majors	Low
Mannus	Medium
Maragle	Low
Murray Below Mulwala	High
Ournie Welaregang	Low
Swampy Plain	Medium
Tooma	Medium
Tumbarumba	Very Low
Upper Murray	Medium

Reference: Healey et al. 2018.

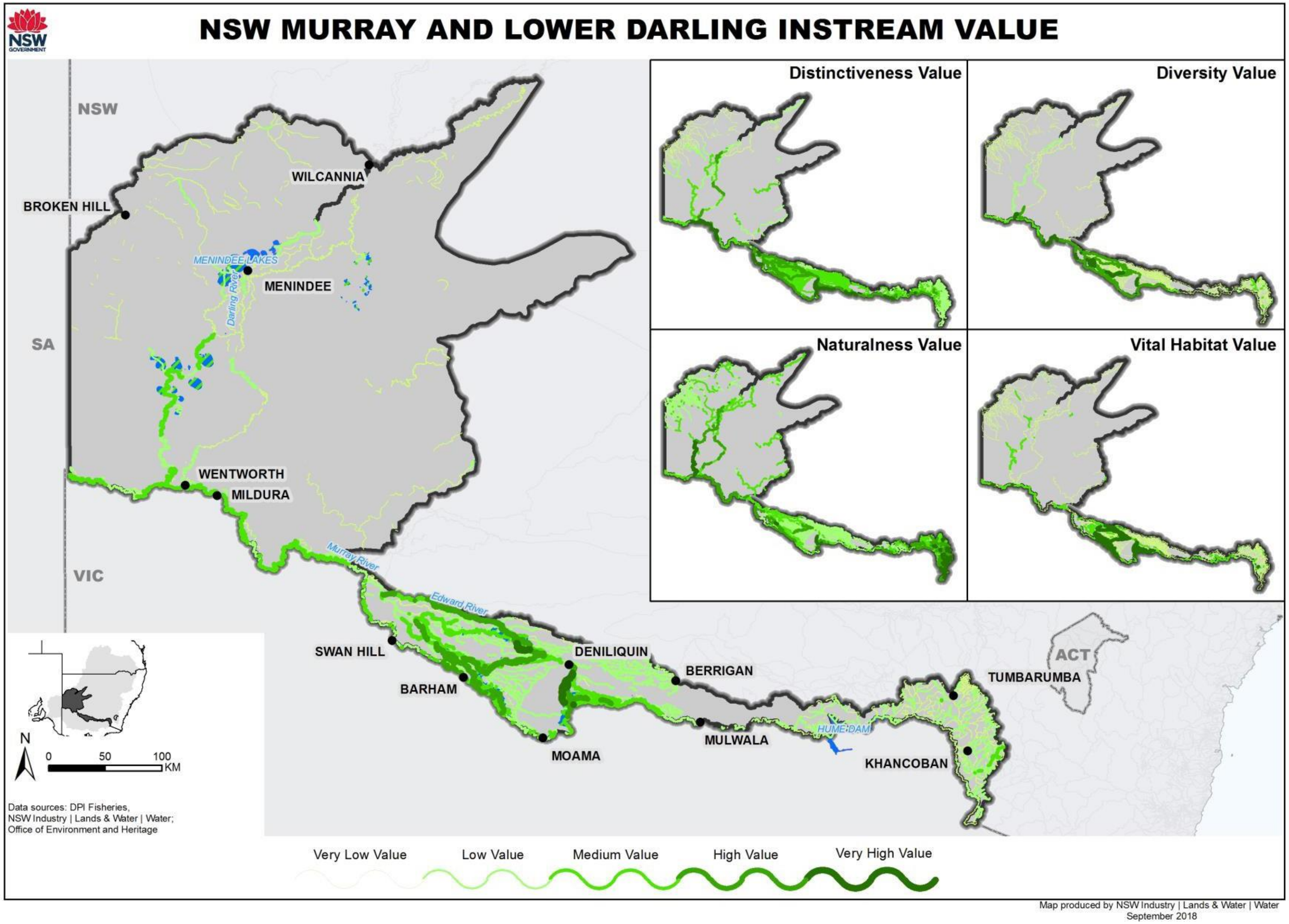


Figure 4-5. HEVAE scoring of instream values in the NSW Murray and Lower Darling WRPA.

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.

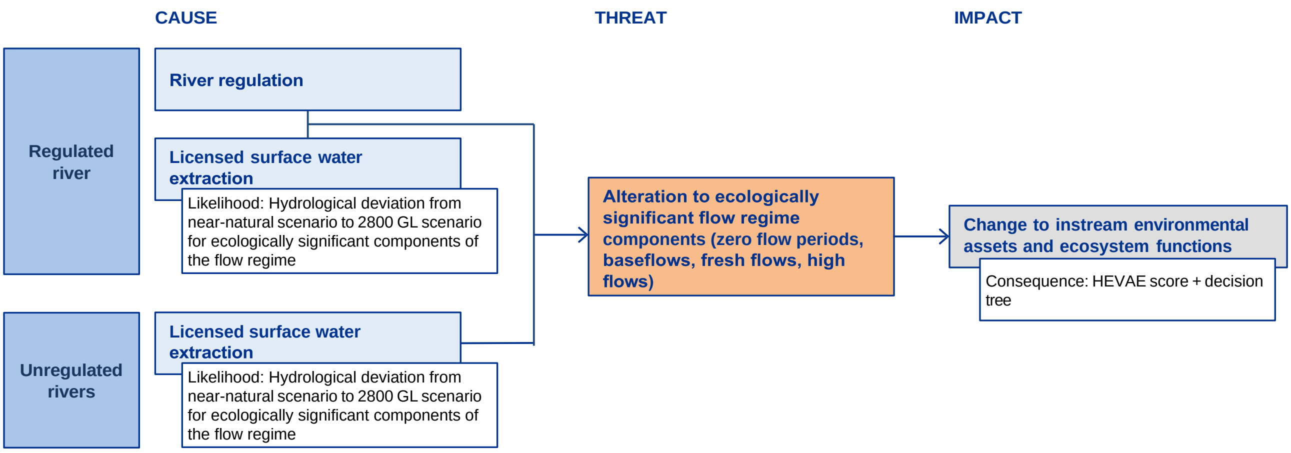


Figure 4-6. Impact pathway showing impact of river regulation and licensed extraction on water available for the environment.

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 and lake volumes (Menindee Lakes) 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 which 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.

Flow regime component	Key feature
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. Overbank flows are also considered in the context of Menindee Lakes. These flows represent filling flows and volumes/water levels required to achieve ecological outcomes within the network of lakes that make up Menindee Lakes.
Reference: MDBA 2010, 2012; Alluvium 2010, Chessman et al. 2006	

Risks to ecosystem functions and environmental assets from not meeting environmental watering requirements 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 and lake volumes 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).
- Low – Very high lake filling events (OB1-4)
- Changes to lake drawdown and filling (D and F).

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 the flow targets required to achieve ecological objectives for priority environmental assets (PEAs) and priority ecosystem functions (PEFs). EWRs are identified for PEAs and PEFs in the NSW Murray and Lower Darling WRPA in the LTWP developed by Department of Planning and Environment-Conservation and Biodiversity (2019; Table 6) and are based on a number of 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 finalised for the NSW Murray and Lower Darling WRPA; therefore the ideal timing of EWRs 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 NSW Murray and Lower Darling 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 NSW Murray and Lower Darling WRPA risk assessment.

Long Term Water Plan (Department of Planning and Environment – Conservation and Biodiversity)[1]						NSW Murray and Lower Darling WRPA risk assessment (Department of Planning and Environment – Water)	
			Ideal EWR				
Flow component[1]	EWR reference	Maximum inter-flow period (note LTWP flow components do not provide definitions of percentiles or frequencies)	Timing	Duration	Frequency	Flow component assessed (section 4.3)	How this risk assessment considers the EWR
Mid-Murray combined Note: LTWP EWRs for the Mid-Murray include Murray at Doctors Point, Murray d/s Yarrawonga and Murray d/s Torrumbarry							
Cease-to-flow	CF1	0 days	All year	365 days	Annual	Zero flow (Z)	Metrics used to calculate likelihood for the zero flow component identifies changes in timing, duration and ideal frequency
Very-low flow	VF1	60-75 days	All year	362-365 days min (265-296 days minimum in very dry years)	Annual	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)
"Base flow"[2]	BF1	91-113 days	All year	278-307 days min (184-208 days minimum in very dry years)	Annual	Base flow (BF)	
"Base flow"[2]	BF2	113-130 days	Apr-Aug	128-137 days min (71-78 days minimum in very dry years)	Annual	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]	BF3	2 years	Anytime (prefer summer but most likely winter)	60 days min	5-10 years in 10	Base flow (BF)	
Nesting flow	NFF1	2 years	Sep-Nov	21-60 days min	5-10 years in 10	Base flow (BF)	
Small fresh	SF1	1 year	Oct-Apr	10 days min	Annually	Base flow (BF)	
Small fresh	SF2	2 years	Sep-Dec	90 days min	5-10 years in 10	Base flow (BF)	
Large fresh	LF1	2 years	Jul-Sep	5 days min	5-10 years in 10	Base flow/Fresh (BF, F)	Metrics used to calculate likelihood of base flow components as stated above and

Long Term Water Plan (Department of Planning and Environment – Conservation and Biodiversity)[1]						NSW Murray and Lower Darling WRPA risk assessment (Department of Planning and Environment – Water)	
			Ideal EWR				
Flow component[1]	EWR reference	Maximum inter-flow period (note LTWP flow components do not provide definitions of percentiles or frequencies)	Timing	Duration	Frequency	Flow component assessed (section 4.3)	How this risk assessment considers the EWR
Large Fresh	LF2	2 years	Oct-Apr	10 days min	6-7 years in 10	Base flow/Fresh (BF, 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 LF1-2.
Large Fresh	LF3	2 years	Aug (or Jul-Sep)	9 days min	7-8 years in 10	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 LF3.
Bankfull	BK1	2-3 years	Aug-Nov* & Jun-Sep* *anytime for natural events	15-45 days min	5-10 years in 10	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 BK1.
Small over bank	OB1	2 years	Sep-Nov* *anytime for natural events	Barmah: 45 days min followed by 105 days min Koondrook-Perricoota: 60 days min	8-10 years in 10	Fresh (F)	
Small over bank	OB2	2 years	Aug-Nov (or Aug-Jan for natural events)	21 days min (>25,000ML) and 100 days (>15,000ML)	6-8 years in 10	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 OB1-OB6
Small over bank	OB3	5 years	Aug-Nov* *anytime for natural events	30-90 days min	7-10 years in 10	Fresh (F)	
Large over bank	OB4	5 years	Aug-Feb	21 days min	3-4 years in 10	Fresh (F)	

Long Term Water Plan (Department of Planning and Environment – Conservation and Biodiversity)[1]						NSW Murray and Lower Darling WRPA risk assessment (Department of Planning and Environment – Water)	
			Ideal EWR				
Flow component[1]	EWR reference	Maximum inter-flow period (note LTWP flow components do not provide definitions of percentiles or frequencies)	Timing	Duration	Frequency	Flow component assessed (section 4.3)	How this risk assessment considers the EWR
Large over bank	OB5	5 years	Jul-Feb	21-40 days min	2.5-4 years in 10	Fresh (F)	
Large over bank	OB6	5 years	Jul-Feb	14 days min	2-4 years in 10	Fresh (F)	
Large over bank	OB7	7 years	Anytime	10 days min	2-3 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 OB7.
Large over bank	OB8	7 years	Anytime		1 year in 10	ARI 5.0 (OB5.0)	Metrics used to calculate likelihood of ARI 5.0 flow component identifies changes to OB8.
Edward-Wakool combined **Note: LTWP EWRs for the Edward-Wakool include Edward River / Kolety, Colligen Creek, Yallakool Creek, Wakool River, and Niemur River**							
Cease-to-flow	CF1	0 days	All year	365 days	Annual	Zero flow (Z)	Metrics used to calculate likelihood for the zero flow component identifies changes in timing, duration and ideal frequency
Very-low flow	VF1	60 days (for Stevens Weir maintenance)	All year	365 days min (may not be achievable during Stevens Weir maintenance)	Annual	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)
"Base flow"[2]	BF1	46-142 days	All year	112-321 days min (0-210 days minimum in very dry years)	Annual	Base flow (BF)	Metrics used to calculate likelihood of base flow components included identifying low flows during 'wet' and 'dry' seasons.
"Base flow"[2]	BF2	113-130 days	May-Aug	172-365 days min* *Median 69-227 days min* *95th percentile	Annual	Base flow (BF)	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]	BF3	2 years	Apr-Jul	60 days min	5-10 years in 10	Base flow/Fresh (BF, F)	

Long Term Water Plan (Department of Planning and Environment – Conservation and Biodiversity)[1]						NSW Murray and Lower Darling WRPA risk assessment (Department of Planning and Environment – Water)	
			Ideal EWR				
Flow component[1]	EWR reference	Maximum inter-flow period (note LTWP flow components do not provide definitions of percentiles or frequencies)	Timing	Duration	Frequency	Flow component assessed (section 4.3)	How this risk assessment considers the EWR
Small fresh	SF1	1 year	Oct-Apr	10 days min	Annual	Base flow/Fresh (BF, F)	Metrics used to calculate likelihood of base flow components included identifying low flows during 'wet' and 'dry' seasons.
Small fresh	SF2	2 years	Sep-Dec	90 days min	5-10 years in 10	Base flow/Fresh (BF, F)	Likelihoods of 'wet' low flows capture some of the alterations to BF3, SF1, SF2 and LF1, and
Large fresh	LF1	2 years	Jul-Sep	5 days min	5-10 years in 10	Base flow/Fresh (BF, 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 BF3, SF1, SF2 and LF1.
Large Fresh	LF2	2 years	Oct-Apr	10 days min	6-7 years in 10 Or 3-5 years in 10 (location dependent)	Fresh (F)	
Large Fresh	LF3	2 years Or 4 years (location dependent)	Aug-Mar* *anytime for natural events	30-60 days min	6-8 years in 10 Or 4-6 years in 10 (location dependent)	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 LF2-LF4.
Large Fresh	LF4	3 years	Aug-Mar*		3-6 years	Fresh	
			Bankfull BK1	2-3 years	*anytime for natural events	Aug-Nov*	*anytime for natural events

120 days min	in 10	(F)	
10-30 days min	5-8 years in 10 Or 4-5 years in 10	Fresh/ARI 1.5 (F/OB 1.5)	Metrics used to calculate likelihood of fresh flow components as stated capture some of the alterations to BK1, OB1 and OB2, and

Long Term Water Plan (Department of Planning and Environment – Conservation and Biodiversity)[1]						NSW Murray and Lower Darling WRPA risk assessment (Department of Planning and Environment – Water)	
			Ideal EWR				
Flow component[1]	EWR reference	Maximum inter-flow period (note LTWP flow components do not provide definitions of percentiles or frequencies)	Timing	Duration	Frequency	Flow component assessed (section 4.3)	How this risk assessment considers the EWR
Small over bank	OB1	2 years	Aug-Nov* *anytime for natural events	10-30 days min	(location dependent) 3-4 years in 10	Fresh/ARI 1.5 (F/OB 1.5)	Metrics used to calculate likelihood of ARI 1.5 flow component identifies changes to BK1, OB1 and OB2.
Small over bank	OB2	2 years	Anytime	10-28 days min	3-4 years in 10	Fresh/ARI 1.5 (F/OB 1.5)	
Medium over bank	OB3	5 years	Anytime	7-10 days min	3-4 years in 10	ARI 1.5/ARI 2.5 (OB 1.5/OB 2.5)	Metrics used to calculate likelihood of ARI 1.5 and ARI 2.5 flow component identifies changes to OB3.
Large over bank	OB4	7 years	Anytime	10 days min	1-2 years in 10	ARI 2.5/ARI 5.0 (OB 2.5/OB 5.0)	Metrics used to calculate likelihood of ARI 2.5 and ARI 5.0 flow component identifies changes to OB4.
Lower Murray combined **Note: LTWP EWRs for the Lower Murray to SA Border includes Murray d/s Lock 7, Murray d/s Lock 8, Murray d/s Lock 9 and Murray at Wentworth**							
Very-low flow	VF1	N/A	All year	Continuous	Annual	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)
”Base flow”[2]	BF1	1 year	Jul-Dec	180 days min (135 days minimum in very dry years)	Annual	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.
Weir pool drawdown							
Weir pool	raising						

7-10

N/A

Not assessed

years

WP1

N/A

Not assessed

3 years

Jan-May

90 days min

in 10

6-10 years

WP2

3 years

Jul-Dec

60 days min

in 10

Long Term Water Plan (Department of Planning and Environment – Conservation and Biodiversity)[1]						NSW Murray and Lower Darling WRPA risk assessment (Department of Planning and Environment – Water)	
			Ideal EWR				
Flow component[1]	EWR reference	Maximum inter-flow period (note LTWP flow components do not provide definitions of percentiles or frequencies)	Timing	Duration	Frequency	Flow component assessed (section 4.3)	How this risk assessment considers the EWR
Nesting flow	NFF1	4 years	Oct-Nov	21 days min	5-10 years in 10	Base flow/Fresh (BF, F)	Metrics used to calculate likelihood of base flow components included identifying low flows during 'wet' and 'dry' seasons. Likelihoods of 'wet' low flows capture some of the alterations to NFF1, and
Small fresh	SF1	2 year	Jun-Sep	15 days min	5-10 years in 10		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 NFF1 and SF1.
Small fresh	SF2	1 year	Jun-Sep	15 days min	5-10 years in 10	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 SF2.
Large fresh	LF1	2 years	Sep-Feb	15 days min	8-10 years in 10	Fresh/ARI 1.5 (F/OB 1.5)	Metrics used to calculate likelihood of fresh flow components as stated capture some of the alterations to LF 1 and BK1.
Bankfull	BK1	3 years	Aug-Mar *anytime for natural events	40 days min	6-8 years in 10		Metrics used to calculate likelihood of ARI 1.5 flow component identifies changes to BK1.
Small over bank	OB1	4 years	Aug-Mar *anytime for natural events	30 days min	3-7 years in 10	ARI 1.5/ARI 2.5 (OB 1.5/OB 2.5)	Metrics used to calculate likelihood of ARI 1.5 and ARI 2.5 flow component identifies changes to OB1 and 2.
Medium over bank	OB2	5 years	Anytime	30 days min	3-5 years in 10		
Large over bank	OB3	7 years	Anytime	30 days min	2-3 years in 10	ARI 2.5/ARI 5.0 (OB 2.5/OB 5.0)	Metrics used to calculate likelihood of ARI 2.5 and ARI 5.0 flow component identifies changes to OB3 and 4.
Large over bank	OB4	10 years	Anytime	20 days min	1-2 year in 10		
Lower Darling combined							
Note: LTWP EWRs for the Lower Darling include Lower Darling u/s Weir 32 and Lower Darling d/s Burtundy							
Cease-to-flow	CF1	0 days	All year	365 days	Annual	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 (Department of Planning and Environment – Conservation and Biodiversity)[1]						NSW Murray and Lower Darling WRPA risk assessment (Department of Planning and Environment – Water)	
Flow component[1]	EWR reference	Maximum inter-flow period (note LTWP flow components do not provide definitions of percentiles or frequencies)	Ideal EWR Timing	Ideal EWR Duration	Ideal EWR Frequency	Flow component assessed (section 4.3)	How this risk assessment considers the EWR
Very-low flow	VF1	21-40 days	Anytime	343 days min (148-172 days minimum in very dry years)	Annual	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)
"Base flow"[2]	BF1	30-60 days	Anytime	320 days min (148 days minimum in very dry years)	Annual	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	Sep-Mar	192 days min (61 days minimum in very dry years)	5-10 years in 10		
Nesting flow	NFF1	2 years	Oct-Nov	21 days min	5-10 years in 10	Base flow/Fresh (BF, F)	Metricsused to calculate likelihood of base flow components included identifying low flows during 'wet'and'dry' seasons. Likelihoods of 'wet' low flowscapture some of the alterations to NFF1, and metrics used to calculate likelihood of fresh flowcomponentsincluded identifying 20%ile flows during 'wet' and 'dry' seasons and would capture alterations to the NFF1.
Small fresh	SF1	1 year	Oct-Apr	10 days min	Annual	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 SF1 – BK2.
Small fresh	SF2	2 years	Dec-Apr	10 days min	5-10 years in 10	Fresh (F)	
Large fresh	LF1	2 years	Sep-Dec	5 days min	5-10 years in 10	Fresh (F)	
Large Fresh	LF2	4 years	Feb-Jun	5 days min	3-5 years in 10	Fresh (F)	
Large Fresh	LF3	2 years	Aug-Dec	15 days min	5-10 years in 10	Fresh (F)	
Bankfull	BK1	2 years	Aug-Oct *OR* Jan-Apr*	15 days min	5-8 years in 10	Fresh (F)	

Long Term Water Plan (Department of Planning and Environment – Conservation and Biodiversity)[1]						NSW Murray and Lower Darling WRPA risk assessment (Department of Planning and Environment – Water)	
			Ideal EWR				
Flow component[1]	EWR reference	Maximum inter-flow period (note LTWP flow components do not provide definitions of percentiles or frequencies)	Timing	Duration	Frequency	Flow component assessed (section 4.3)	How this risk assessment considers the EWR
Bankfull	BK2	4 years	*anytime for natural events Aug-May* *anytime for natural events	21 days min	2-3 years in 10	Fresh (F)	
Small over bank	OB1	2 years	Aug-Nov* *anytime for natural events	15 days min	5 years in 10	Fresh/ARI 1.5 (F/OB 1.5)	Metrics used to calculate likelihood of fresh flow components as stated capture some of the alterations to OB1 and 2.
Small over bank	OB2	2 years	Anytime	15 days min	5 years in 10	Fresh/ARI 1.5 (F/OB 1.5)	Metrics used to calculate likelihood of ARI 1.5 flow component identifies changes to OB2.
Small over bank	OB3	4 years	Anytime	30 days min	2-3 years in 10	ARI 1.5/ARI 2.5 (OB 1.5/OB 2.5)	Metrics used to calculate likelihood of ARI 1.5 and ARI 2.5 flow component identifies changes to OB3.
Large over bank	OB4	10 years	Anytime	10 days min	1 year in 10	ARI 2.5 (OB 2.5)	Metrics used to calculate likelihood of ARI 2.5 flow component identifies changes to OB4.
Large over bank	OB5	10 years	Anytime	5 days min	1 year in 10	ARI 2.5/ARI 5.0 (OB 2.5/OB 5.0)	Metrics used to calculate likelihood of ARI 2.5 and ARI 5.0 flow component identifies changes to OB5.
Menindee Lakes combined **Note: LTWP EWRs for the Menindee Lakes include Lake Cawndilla, Menindee and Wetherell + Tandure**							
Overbank 1 – Low level lake fill	OB1	18 days for Wetherell and Tandure. 2-3 years for Menindee and Cawndilla	Anytime. Filling to be triggered by inflows	Min of 3-5 months and max 3 years for Menindee and Cawndilla. Continuous for Lake Wetherell and Tandure	6-8 years in 10 for Menindee and Cawndilla. Continuous for Lake Wetherell and Tandure	Overbank 1, Drawdown and Filling rates (OB1, D, F)	Metrics used to calculate likelihood of OB1 identifies changes to duration and frequency of OB1 Metrics used to calculate likelihood of D and F identifies changes to drawdown and filling events for each lake

Long Term Water Plan (Department of Planning and Environment – Conservation and Biodiversity)[1]						NSW Murray and Lower Darling WRPA risk assessment (Department of Planning and Environment – Water)	
			Ideal EWR				
Flow component[1]	EWR reference	Maximum inter-flow period (note LTWP flow components do not provide definitions of percentiles or frequencies)	Timing	Duration	Frequency	Flow component assessed (section 4.3)	How this risk assessment considers the EWR
Overbank 2 – Mid level lake fill	OB2	4 years	Anytime. Filling to be triggered by inflows	Min of 3-5 months and max 1-2 years for Menindee and Cawndilla (1-2cm/d drawdown). 30 days minimum for Lake Wetherell and Tandure	3-5 years in 10	Overbank 2, Drawdown and Filling rates (OB2, D, F)	Metrics used to calculate likelihood of OB2 identifies changes to duration and frequency of OB2 Metrics used to calculate likelihood of D and F identifies changes to drawdown and filling events for each lake
Overbank 3 – High level lake fill	OB3	4 years for Wetherell and Tandure. 8 years for Menindee and Cawndilla	Anytime. Filling to be triggered by inflows	Min of 3-5 months and max 1 year for Menindee and Cawndilla (1-2cm/d drawdown). 30 days minimum for Lake Wetherell and Tandure	1.5 years in 10 for Menindee and Cawndilla. 2-3 years for Lake Wetherell and Tandure	Overbank 3, Drawdown and Filling rates (OB3, D, F)	Metrics used to calculate likelihood of OB3 identifies changes to duration and frequency of OB3 Metrics used to calculate likelihood of D and F identifies changes to drawdown and filling events for each lake
Overbank 4 – Very high level lake fill	OB4	10 years for Menindee and Cawndilla only	Anytime. Filling to be triggered by inflows	Min of 3-5 months and max 1 year for Menindee and Cawndilla (1-2cm/d drawdown).	1 year in 10	Overbank 4, Drawdown and Filling rates (OB4, D, F)	Metrics used to calculate likelihood of OB4 identifies changes to duration and frequency of OB4 Metrics used to calculate likelihood of D and F identifies changes to drawdown and filling events for each lake

[1] Table 6, Department of Planning and Environment -Conservation and Biodiversity 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.

Regulated river water source

The MDBA modelled a 2800 gigalitre (GL) reduction target across the Basin (MDBA 2012). Flow sequences were generated by the MDBA using Department of Planning and Environment-Water 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 2750 GL, the 2800 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 (2012) are the percentage change of the 2800 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 2800 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 NSW Murray and Lower Darling WRPA.

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 (+/-)
* Flow deviations for Menindee Lakes refer to deviations in lake volumes/levels and drawdown/filling rates Reference: Alluvium 2010; VanLaarhoven & van der Wielen 2009		

In total, 24 hydrological indicator sites were used for this WRPA. This consisted of seven MDBA hydrologic indicator sites (BigMod modelling) and 17 Department of Planning and Environment-Water (IQQM modelling) indicator sites (Figure 4-2. MDBA and Department of Planning and Environment Water hydrologic indicator sites and representative regulated reaches for the MLD WRPA.). These sites were used to calculate likelihood results in the assessment of risk for the NSW Murray and Lower Darling regulated rivers (Table 4-7).

Menindee Lakes

In total, three hydrological indicator sites were used for the Menindee Lakes. This consisted of three MDBA hydrologic indicator sites (BigMod modelling). The sites were Lake Cawndilla (425023), Lake Menindee (425022) and Lake Wetherell (425020). Likelihood metrics for Lake Wetherell includes Lake Tandure. These sites were used to calculate likelihood results in the assessment of risk for the Menindee Lakes system (Table 4-8). Two likelihood assessments for water available to achieve EWRs were undertaken:

- comparison of the modelled 2,800 GL scenario to the modelled natural (without development) conditions
- comparison of the modelled 2,800 GL scenario to the modelled baseline (development as of 2009) conditions.

Whilst we present two EWR likelihood comparisons for Menindee Lakes, it was deemed inappropriate to use the natural (without development) comparison for the overall risk outcomes. This is because the configuration of these natural lakes into a water infrastructure storage system makes comparisons to natural conditions inappropriate. We instead use the likelihood comparisons between the baseline and 2,800 scenario for the overall risk outcomes. The modelled natural comparisons are included for future reference and provide information on the hydrology of the lakes prior to storage development (Table 4-8).

Table 4-7. Likelihood results for the NSW Murray and Lower Darling 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
Darling River at Menindee u/s Weir 32	H^-	H^-	H^-	H^-	H^-	H^-
Darling River at Burtundy	H^-	H^-	H^-	L^-	L^-	L^+
Great Darling Anabranch at outlet Lake Cawndilla	L	M^-	H^-	M^-	L^-	L
Great Darling Anabranch at Redbank Ck d/s Packers Crossing	M^-	H^-	M^-	L^-	L^+	L^+
Murray River at Doctor's Point	L^0	H^+	H^+	M^-	M^-	M^-
Murray River d/s Yarrawonga Weir	H^-	H^+	H^+	M^-	M^-	L^-
Murray River d/s Torumbarry Weir	N/A	N/A	N/A	N/A	N/A	N/A
Murray River at Torrumbarry	H^+	M^-	H^-	L^-	L^-	L^-
Murray River at d/s Wakool Junction	L^0	M^-	M^-	M^-	M^-	M^-
Murray River at Euston	L^0	H^-	H^-	M^-	M^-	M^-
Murray River at Wentworth	L^0	H^-	H^-	M^-	M^-	M^-
Murray River at Lock 9 downstream	L^0	H^-	H^-	M^-	M^-	M^-

Regulated river reach	Likelihood rating					
Murray River Flow to South Australia	H^{-}	H^{-}	H^{-}	L^{-}	L^{-}	L^{-}
Edward River at Deniliquin	L^{0}	H^{+}	H^{+}	H^{-}	M^{-}	M^{-}
Edward River downstream of Stevens Weir	L^{0}	H^{-}	H^{+}	H^{-}	M^{-}	M^{-}
Edward River at Leiwah	H^{+}	H^{+}	M^{+}	L^{-}	M^{-}	L^{-}
Wakool River at Offtake Regulator	H^{-}	H^{-}	H^{-}	H^{-}	M^{-}	L^{-}
Wakool River at Wakool / Barham Road	H^{-}	H^{-}	H^{-}	H^{-}	M^{-}	L^{-}
Wakool River at Gee Gee Bridge	N/A	N/A	N/A	N/A	N/A	N/A
Wakool River at Stoney Crossing	L^{0}	H^{+}	H^{+}	M^{-}	M^{-}	M^{-}
Wakool River at Kyalite	L^{0}	H^{+}	M^{+}	H^{-}	M^{-}	M^{-}
Yallakool Creek at Offtake	H^{-}	H^{+}	H^{-}	H^{-}	M^{-}	L^{-}
Colligen Creek at below Regulator	H^{-}	H^{+}	H^{-}	M^{-}	M^{-}	L^{-}
Niemur River @ Barham/Moulamein Road	H^{-}	H^{+}	H^{-}	M^{-}	M^{-}	L^{-}
Bullatale Creek u/s Edward River	H^{+}	H^{+}	H^{+}	M^{+}	M^{+}	L^{+}
Gulpa Creek at Offtake	H^{+}	H^{+}	M^{-}	L^{-}	L^{+}	L^{0}
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						

Table 4-8. Likelihood results for Lake Cawndilla, Menindee, and Wetherell.

Regulated river reach	Likelihood rating					
	Overbank 1 (low-level lake fill)	**Overbank 2 (mid-level lake fill)**	**Overbank 3 (high-level lake fill)**	**Overbank 4 (very high level lake fill)**	**Drawdown (falls)**	**Filling (rises)**
Natural (without development) compared to 2,800 GL scenario						
Lake Cawndilla	H^-	H^-	H^-	H^+	H^+	H^+
Lake Menindee	H^+	H^-	H^-	H^+	H^+	H^+
Lake Wetherell	H^-	H^+	H^+	N/A	H^+	H^+
Baseline (development as of 2009) compared to 2,800 GL scenario						
Lake Cawndilla	M^-	M^-	M^-	M^-	M^+	M^+
Lake Menindee	M^-	M^-	M^-	M^-	M^-	M^-
Lake Wetherell	H^-	L^+	L^-	N/A	L^+	L^-

Key: L = low; M = medium; H = high; N/A = Likelihood rating not relevant
+ increase from near-natural condition; – decrease from near natural condition; 0 no change from near-natural condition

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.

MDBA modelling was generally not used in the unregulated rivers as it is not representative of the hydrology at the water source scale; however, in some locations, the hydrologic alteration metrics for the regulated river could be used.

Similar to regulated systems, likelihood category definitions are defined based on the extent of deviation from the near-natural condition (Table 4-9).

Table 4-9. Likelihood metrics for risk of insufficient water available for the environment and risk to EWRs in unregulated water sources in the NSW Murray and Lower Darling 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 NSW Murray and Lower Darling water sources are shown in Table 4-10.

Table 4-10. Likelihood results for unregulated water sources in the NSW Murray and Lower Darling 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
Albury	L^0	H	L^-	L^0	L^0	L^0
Dora Dora	L^0	L^0	L^0	L^0	L^0	L^0
Hume	L^0	M^-	L^-	L^0	L^0	L^0
Indi**	L^0	L^-	L^-	L^-	L^-	L^-
Jingellic**	L^0	L^-	L^-	L^0	L^0	L^0
Lower Wangamong	L^0	L^0	L^0	L^0	L^0	L^0
Majors	L^0	L^-	L^-	L^-	L^0	L^0
Mannus**	H^+	L^-	L^-	L^-	L^0	L^0
Maragle**	M^+	L^-	L^-	L^0	L^0	L^0
Ournie Welaregang	L^0	L^-	L^-	L^0	L^0	L^0
Swampy Plain	L^0	H^+	H^+	M^-	M^-	M^-
Tooma**	H^+	L^-	L^-	L^0	L^0	L^0
Tumbarumba**	H^+	L^-	L^-	L^0	L^0	L^0
Upper Murray River	L^0	H^+	H^+	L^-	L^-	L^-
Murray below Mulwala*	L	L	L	L	L	L
Lower Murray – Darling*	L	L	L	L	L	L

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
* refers to a lack of appropriate modelling data
** refers to the unregulated water source modelled with CtP implemented
Reference: MDBA 2012

4.3.2. Existing water management actions & 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 NSW Murray and Lower Darling valleys. 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 New South Wales Murray and Lower Darling Regulated Rivers Water Sources 2016* 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
- The Barmah-Millewa Allowance. The Allowance may hold a volume up to 350,000 ML, and may be carried over from one year to the next. The following volumes of water must be credited to the allowance: (1) 50,000 ML multiplied by the percentage of the seasonal allocation for Victorian high reliability water shares in the Murray Water Source; (2) Any time a seasonal allocation is made minus the volume of the Barmah-Millewa Overdraw released in the preceding water year

- The Barmah-Millewa Overdraw. When there are sufficient water reserves available to NSW without constraining annual water determinations, a volume of up to 50,000 ML must be credited to the Overdraw. Releases from the Overdraw must be used to provide environmentally beneficial outcomes for the Barmah-Millewa Forest in accordance with any interstate agreements
- The Murray Additional Allowance. The Allowance may be credited with a volume equivalent to 0.03 ML multiplied by the total number of unit shares specified in the share components of the Murray Water Source regulated river (high security) access licences, when the sum of available water determinations to regulated river (high security) access licences in the Murray Water Source for the water year has reached 0.97 ML per unit share. The maximum credit that may be held in the Murray Additional Allowance at any time must be equal to 0.15 ML multiplied by the number of unit shares specified in the share components of regulated river (high security) access licences. Releases from the Murray Additional Allowance may be made for any purpose consistent with the environmental objectives of the Plan
- The Lower Darling Allowance. The volume of water that is credited to the Allowance at any time must be (1) 0 if the volume stored in Menindee Lakes is below 480,000ML, or 0 if the volume stored in Menindee Lakes has not risen above 640,000ML, since the volume stored last fell below 480,000 ML; (2) 30,000 ML minus any release from the Lower Darling Allowance during the current water year that has resulted in a loss of total water volume available to NSW under the accounting rules applying to interstate water sharing in the NSW Murray and Lower Darling River. Releases may be made whenever a high blue-green algal alert level is announced by the Minister in the Lower Darling Water Source
- Restrictions to access of supplementary water events in the Murray Water Source if (1) the flows could be stored in Lake Victoria; and (2) the flows could contribute to supply requirements in South Australia in accordance with the Murray-Darling Basin Agreement (Schedule 1 of the *Water Act 2007*); and (3) the flows could reduce surface water salinity measured in the Murray River at Morgan as being in excess of 800 electrical conductivity units; and (4) the flows could assist in the reduction of existing medium or high blue-green algal alerts; and (5) the flows are required to facilitate conditions for waterbird breeding or if there absence would threaten the success of an existing waterbird breeding event; and (6) between 1 April and 30 October each year, in the Minister's opinion, the taking of water will prevent significant flow variations in those sections of the water source where flow heights are unaffected by weirs, or reduce beneficial flooding of the Barmah-Millewa forests or any other Murray Water Source riverine ecosystems
- Restrictions to access of supplementary water events in the Lower Darling Water Source if (1) the water level in Menindee Lakes are below capacity, and upstream flows are not sufficient to fill them; and (2) if flows could be stored in Lake Victoria; and (3) the flows could contribute to supply requirements in South Australia in accordance with the Murray-Darling Basin Agreement (Schedule 1 of the *Water Act 2007*); and (4) the flows could be used to supply regulated river (general security) allocations in the Murray River; and (5) the flows could reduce surface water salinity measured in the Murray River at Morgan as being in excess of 800 electrical conductivity units; and (6) the flows could assist in the reduction of existing medium or high blue-green algal alerts; and (7) the flows are required to facilitate conditions for waterbird breeding or if there absence would threaten the success of an existing waterbird breeding event; and (8) if the taking of water will prevent flows in the Darling River from reaching 7,000 ML/day at Weir 32 for a period of time which, in the Minister's opinion, will restrict fish passage over Weir 32; and (9) between 1 April and 30 October each year, in the Minister's opinion, the taking of water will prevent significant flow variations occurring in those sections of the water source where flow heights are unaffected by weirs
- Minimum daily flows in the Murray at the South Australian Border and in the Lower Darling at Weir 32

- To maintain hydrological connectivity between water sources and wetlands and provide support for environmental events such as bird breeding, fish passage and weed management
- Restrictions on trade if there is more than minimal likelihood that the environment will be affected
- The Minister can specify rules relating to the rates of change to releases from water storages to minimise environmental and geomorphological impacts
- Adjust available water determinations to ensure compliance with the long term average annual extraction limit
- The plan also provides for licensed water to be committed for adaptive environmental water purposes.

The *Water Sharing Plan for the Lower Murray-Darling Unregulated River Water Source 2011* and the *Water Sharing Plan for the Murray Unregulated River Water Sources 2011* 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
- 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.

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 4-11.

Table 4-11. 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

Regulated river water source

Combining the risk consequence and likelihood ratings (Table 4-2 and Table 4-7) for the NSW Murray and Lower Darling regulated river results in the overall risk levels to ecological assets and functions as shown in Table 4-12. Overall, there were high and medium risks across all flow components (i.e. zero flow, base flows, fresh flows and each ARI). Regulation of the river system has caused significant alterations to base and fresh flows in particular, with the moderate to high flows reduced in most reaches of the regulated river(s). Medium to high risk was identified in all but two reaches of the Murray and Lower regulated river source.

The Darling had varied likelihood outcomes (hydrologic alteration) for the majority of hydrological characteristics, with high and medium risk outcomes for the Darling River and the Great Darling Anabranch, particularly for the zero flow, base-flow and fresh flows. Medium, high and very high consequence scores in the Murray River regulated water source influenced risk levels resulting in a significant number of medium and high risk levels for base-flows and fresh flows.

Menindee Lakes

Combining the risk consequence and likelihood ratings (Table 4-2 and Table 4-7) for the Menindee Lakes; results in the overall risk levels to the environment as shown in Table 4-13. There were medium and high risks to all EWRs for the three lakes assessed. However, the majority of these risks are due to lake volumes/levels being higher under the 2,800 GL scenario compared to baseline. These are not considered actual risks to the environment, as the EWRs developed by Department of Planning and Environment-Conservation and Biodiversity in the LTWP target higher volumes in the lakes. Key risks to note are the medium risks to Lake Cawndilla and Menindee due to a reduction in the mean duration of filling events (rises).

Unregulated water sources

Combining the risk consequence and likelihood ratings (Table 4-3 and Table 4-10) for the NSW Murray and Lower Darling unregulated water sources results in the overall risk levels to ecological assets and functions as shown in Table 4-14 Overall, risks to unregulated water sources were largely restricted to the zero flow and base flow components. Of the 16 water sources within the NSW Murray and Lower Darling, one demonstrated a medium risk to an increase in zero flow periods, while 3 water sources had a high risk. There were four water sources with a medium to high risk to the reduction in base flows. All the consequence scores were medium to very low which meant that risk levels were predominantly low. Only two water sources had high risks associated with freshes and larger ARI flow components.

Table 4-12. Risk of insufficient water for the environment and capacity to meet EWRs in the regulated rivers of the NSW Murray and Lower Darling [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
Darling River at Menindee u/s Weir 32 (425012)	M	H-	H-	H-	H-	H-	H-	H-	H-	H-	H-	H-	H-
Darling River at Burtundy (425007)	M	H-	H-	H-	L-	L-	L-	H-	H-	H-	L-	L-	L-
Great Darling Anabranch at outlet Lake Cawndilla (425014)*	L	L	M-	H-	M-	L-	L+	L+	L	M-	L-	L-	L-
Great Darling Anabranch at Redbank Ck d/s Packers Crossing (425019)	L	M-	H-	M-	L-	L+	L+	L-	M-	L-	L-	L+	L-
Murray River at Doctors Point (409017)	M	L0	H+	H+	M-	M-	M-	L0	H+	H+	M-	M-	M-
Murray River d/s Yarrawonga	VH	H-	H+	H+	M-	M-	L-	H-	H+	H+	H-	H-	M-
Murray River at Echuca (409200A)*	H	H+	M-	H-	L-	L-	L-	H+	M-	H-	L-	L-	L-
Murray River at Torrumbarry (409207B)	VH	H+	M-	H-	L-	L-	L-	H+	H-	H-	M-	M-	M-
Murray River at d/s Wakool Junction (414200	M	L0	M-	M-	M-	M-	M-	L0	M-	M-	M-	M-	M-
Murray River at Euston (414203)	H	L0	H-	H-	M-	M-	M-	L0	H-	H-	M-	M-	M-

Murray River at Wentworth (425010)*	H	L0	H-	H-	M-	M-	M-	L0	H-	H-	M-	M-	M-
Murray River at Lock 9 downstream (426506)	H	L0	H-	H-	M-	M-	M-	L0	H-	H-	M-	M-	M-
Murray River Flow to South Australia (426510)	M	H-	H-	H-	L-	L-	L-	H-	H-	H-	L-	L-	L-
Edward River at Toonalook (409047)	VH	H+	H+	H+	M-	M-	L-	H+	H+	H+	H-	H-	M-
Edward River at Deniliquin (409003)	VH	L0	H+	H+	H-	M-	M-	M0	H+	H+	H-	H-	H-
Edward River d/s Stevens Weir (409023)	H	L0	H-	H+	H-	M-	M-	L0	H-	H+	H-	M-	M-
Edward River at Leiwah (409035)	H	H+	H+	M+	L-	M-	L-	H+	H+	M+	L-	M-	L-
Wakool River at Offtake Regulator (409019)	VH	H-	H-	H-	H-	M-	L-	H-	H-	H-	H-	H-	M-
Wakool River at Wakool / Barham Rd (409045)*	VH	H-	H-	H-	H-	M-	L-	H-	H-	H-	H-	H-	M-
Wakool River at Gee Gee Bridge [No. 2] (409062)*	VH	H-	H-	H-	H-	M-	L-	H-	H-	H-	H-	H-	M-
Wakool River at Stoney Crossing (409013)	H	L0	H+	H+	M-	M-	M-	L0	H+	H+	M-	M-	M-
Wakool River at Kyalite (409034)	H	L0	H+	M+	H-	M-	M-	L0	H+	M+	H-	M-	M-
Yallakool Creek at Offtake (409020)	VH	H-	H+	H-	H-	M-	L-	H-	H+	H-	H-	H-	M-

Colligen Creek at below Regulator (409024)	VH	H^-	H^+	H^-	M^-	M^-	L^-	H^-	H^+	H^-	H^-	H^-	M^-
Niemur River at Barnham / Moulamein Rd (409048)*	H	H^-	H^+	H^-	M^-	M^-	L^-	H^-	H^+	H^-	M^-	M^-	L^-
Bullatale Creek u/s Edward R (409075)*	H	H^+	H^+	H^+	M^-	M^-	L^-	H^+	H^+	H^+	M^-	M^-	L^-
Gulpa Creek at offtake (409030)	VH	H^+	H^+	M^-	L^-	L^+	L^0	H^+	H^+	H^-	M^-	M^-	M^0

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

* Where likelihood information was unavailable a qualitative approach determined the likelihood for that flow characteristic. This was based on expert opinion and likelihood from the nearest gauge was used

Table 4-13. Risk of insufficient water for the environment and capacity to meet EWRs in the Menindee Lakes [E(W)].

Regulated river reach	Consequence	Likelihood						Overall risk rating - E(W)					
		Overbank 1 (low level lake fill)	Overbank 2 (mid level lake fill)	Overbank 3 (high level lake fill)	Overbank 4 (very high level lake fill)	Drawdown (falls)	Filling (rises)	Overbank 1 (low level lake fill)	Overbank 2 (mid level lake fill)	Overbank 3 (high level lake fill)	Overbank 4 (very high level lake fill)	Drawdown (rate and duration of falls)	Filling (rate and duration of rises)
Baseline (development as of 2009) compared to 2,800 GL scenario													
Lake Cawndilla	H	M^{-}	M^{-}	M^{-}	M^{-}	M^{+}	M^{+}	M^{-*}	M^{-*}	M^{-*}	M^{-*}	M^{-**}	M^{-}
Lake Menindee	H	M^{-}	M^{-}	M^{-}	M^{-}	M^{-}	M^{-}	M^{-*}	M^{-*}	M^{-*}	M^{-*}	M^{-**}	M^{-}
Lake Wetherell	VH	H^{-}	L^{+}	L^{-}	H^{-}	L^{+}	L^{-}	H^{-*}	M^{+}	M^{-*}	H^{-*}	M^{+}	M^{-}

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

$^{+}$ increase from baseline (2009 development) condition ; $^{-}$ decrease from baseline (2009 development) condition; ^{0} no change from baseline (2009 development) condition

* represents a decrease in the duration and number of days below the specific EWR (i.e. below a specific lake volume). This actually represents an increase in the likelihood of achieving the EWRs and is not considered an actual risk.

** represents a decrease in the average rate of fall and is not considered an actual risk.

Table 4-14. Risk of insufficient water for the environment and capacity to meet EWRs in the unregulated water sources of the NSW Murray and Lower Darling 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
Albury	L	L^0	H^-	L^-	L^0	L^0	L^0	L^0	M^-	L^-	L^0	L^0	L^0
Dora Dora	L	L^0	L^0	L^0	L^0	L^0	L^0	L^0	L^0	L^0	L^0	L^0	L^0
Hume	M	L^0	M^-	L^-	L^0	L^0	L^0	L^0	M^-	L^-	L^0	L^0	L^0
Indi**	L	L^-	L^-	L^-	L^-	L^-	L^-	L^0	L^-	L^-	L^-	L^-	L^-
Jingellic**	M	L^0	L^-	L^-	L^0	L^0	L^0	L^0	L^-	L^-	L^0	L^0	L^0
Lower Wangamong	L	L^0	L^0	L^0	L^0	L^0	L^0	L^0	L^0	L^0	L^0	L^0	L^0
Majors	L	L^0	L^-	L^-	L^-	L^0	L^0	L^0	L^-	L^-	L^-	L^0	L^0
Mannus**	M	H^+	L^-	L^-	L^-	L^0	L^0	H^+	L^-	L^-	L^-	L^0	L^0
Maragle**	L	M^+	L^-	L^-	L^0	L^0	L^0	L^+	L^-	L^-	L^0	L^0	L^0
Ournie Welaregang	L	L^0	L^-	L^-	L^0	L^0	L^0	L^0	L^-	L^-	L^0	L^0	L^0
Swampy Plain	M	L^0	H^+	H^+	M^-	M^-	M^-	L^0	H^+	H^+	M^-	M^-	M^-
Tooma	M	H^+	L^-	L^-	L^0	L^0	L^0	H^+	L^-	L^-	L^0	L^0	L^0
Tumbarumba	VL	H^+	L^-	L^-	L^0	L^0	L^0	L^+	L^-	L^-	L^0	L^0	L^0
Upper Murray	M	L^0	H^+	H^+	L^-	L^-	L^-	L^0	H^+	H^+	L^-	L^-	L^-
Murray below Mulwala*	H	L^0	L^0	L^0	L^0	L^0	L^0	L^0	L^0	L^0	L^0	L^0	L^0
Lower Murray – Darling*	M	L^0	L^0	L^0	L^0	L^0	L^0	L^0	L^0	L^0	L^0	L^0	L^0

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

* Where likelihood information was unavailable a qualitative approach determined the likelihood for that flow characteristic. This was based on expert opinion and likelihood from the nearest gauge was used

** refers to the unregulated water source modelled with CtP implemented

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 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 provides 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.

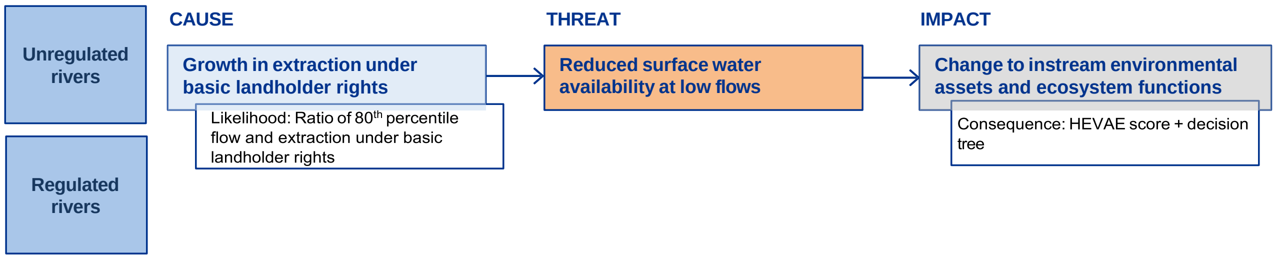


Figure 4-7. Impact pathway showing risk of growth in BLR reducing water available for the environment.

4.4.1. Determining the likelihood rating

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 the regulated Murray River, and a 'nil' likelihood has been assigned to this regulated river (Table 4-17 and Table 4-18Table 4-19). The 'nil' likelihood rating was assigned to all components of the flow regime (all EWRs; Table 4-5).

In contrast, the Lower Darling regulated system is more variable. The ability to manage BLR requirements from Menindee Lakes is often not possible. In dryer years, BLR may be accessing water after a cease-to-flow (EWR: CF) event when only refuge pools remain. However, the *Water Management Act 2000* lists BLR second two environmental needs. For this reason, the likelihood was considered 'low' in the Lower Darling.

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: BF, VF, CF; 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 4-15. The likelihood results for water sources in the unregulated NSW Murray and Lower Darling system are shown in Table 4-16.

Table 4-15. 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 $\leq$1

		i.e. extraction is equal to 100% or more of 80th percentile flow Intermittent streams (80th percentile flow is zero)

Table 4-16. Likelihood results for unregulated water sources in the NSW Murray and Lower Darling WRPA.

Unregulated water source	Likelihood rating
Albury	Low
Dora Dora	Low
Hume	Low
Indi	Low
Jingellic	Low
Lower Wangamong	Low
Majors	Low
Mannus	Low
Maragle	Low
Ournie Welaregang	Low
Swampy Plain	Low
Tooma	Low
Tumbarumba	Low
Upper Murray	High
Murray Below Mulwala	Low
Lower Murray Darling	Low

* Where likelihood information was unavailable a qualitative approach determined the likelihood for that flow characteristic. This was based on expert opinion and likelihood from the nearest gauge was used.

4.4.2. Existing water management actions & 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 NSW Murray and Lower Darling WRPA is provided in Table 4-17.

Table 4-17. 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 4-16) for the NSW Murray and Lower Darling regulated and unregulated water sources results in the overall risk levels to ecological assets and functions as shown in Table 4-18 and Table 4-19.

Table 4-18 Risk of increased BLR extraction impacting on water available for the environment in the regulated water source of the NSW Murray and Lower Darling WRPA [E(BLR)]

	Consequence	Likelihood	Overall risk rating - E(BLR)
Lower Darling regulated river water source	Low to Very High	Nil	Nil
NSW Murray regulated river water source	Medium to Very High	Nil	Nil

Table 4-19. Risk of increased BLR extraction impacting on water available for the environment in the unregulated water sources of the NSW Murray and Lower Darling WRPA [E(BLR)].

Risk factor/source	Consequence	Likelihood	Overall risk rating - E(BLR)
Albury	Low	Low	Low
Dora Dora	Low	Low	Low
Hume	Medium	Low	Low
Indi	Low	Low	Low
Jingellic	Medium	Low	Low
Lower Wangamong	Low	Low	Low

Majors	Low	Low	Low
Mannus	Medium	Low	Low
Maragle	Low	Low	Low
Ournie Welaregang	Low	Low	Low
Swampy Plain	Medium	Low	Low
Tooma	Medium	Low	Low
Tumbarumba	Very Low	Low	Low
Upper Murray	High	High	High
Murray Below Mulwala	High	Low	Low
Lower Murray Darling	Medium	Low	Low

Key: L = Low; M = Medium; H = High

* Where likelihood information was unavailable a qualitative approach determined the likelihood for that flow characteristic. This was based on expert opinion and likelihood from the nearest gauge was used.

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

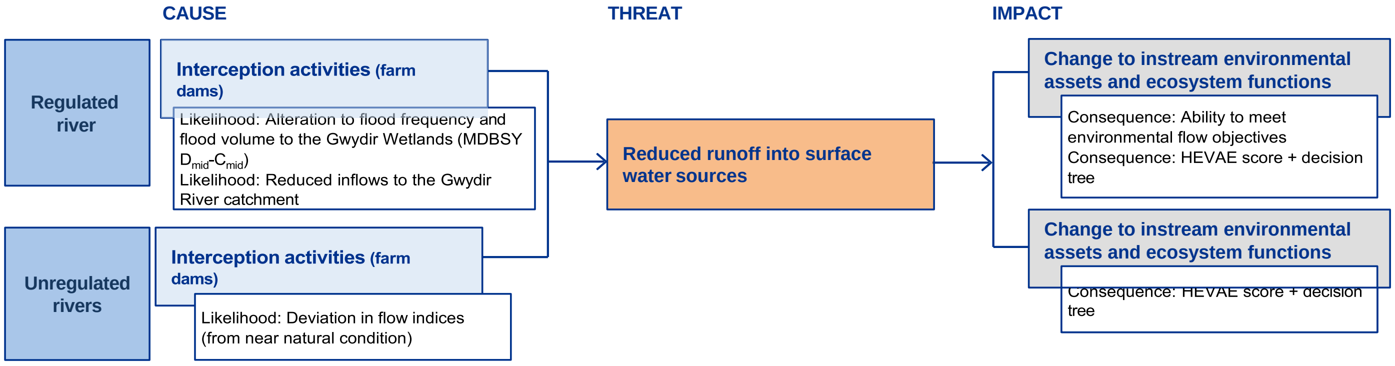


Figure 4-8 Impact pathway showing risk of growth in farm dams reducing water available for the environment

4.5.1.1. Assigning a consequence score

Regulated river water source

Geoscience Australia mapped farm dams in the MDB in 2006 (Geosciences Australia 2007 in CSIRO 2008b). 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.

In assigning a consequence level to farm dams and plantations, 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 (NOW 2010) and SKM (2009) 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 SKM (2009) specified environmental flow indicators in the WRPA, as listed below.

Environmental asset - River Murray Channel

Major objectives for the River Murray Channel are to increase the frequency of higher flows in spring that are ecologically significant, and overcome barriers to migration of native fish species (MDBC, 2006). Most of these objectives are based on increasing variability in the flow regime, preventing unseasonal flooding, restoring floodplain health and preventing algal blooms (SKM, 2009). A summary of the environmental objectives, environmental indicators and flow events reported by SKM (2009) are provided in Table 4-20.

Table 4-20. Environmental flow indicators used in the SKM Murray risk assessment for the River Murray Channel (Source: SKM 2009).

Ecological objective	Environmental flow indicator
Prevention of cyanobacteria problems in the Alert Level 3 range (> 15,000 cells/ml)	River flows should not drop below 4,000 ML/day for periods exceeding 1 week for weir pools in the River Murray between Torrumbarry and Wentworth during the summer-autumn period (Nov – April)
Provide environmental flow requirements to the main channel	High flow (40,000 ML/day) for 8 consecutive weeks on average, every second year in late spring at the South Australia / Victoria Border

Environmental asset - Barmah-Millewa Forest

The major ecological objectives for this site focus on the provision of drought refuge and colonial breeding habitat for waterbirds, as well as the preservation of diverse vegetation communities such as Moira Grass, Giant Rush and Red-gum Forest and Woodland in an ecological healthy state. A summary of the environmental objectives, environmental indicators and flow events reported by SKM (2009) are provided in Table 4-21.

Table 4-21. Environmental flow indicators used in the SKM Murray risk assessment for the Barmah-Millewa Forest (Source: SKM 2009).

Flow event description	Flow event definition	Indicators reported
Beneficial flood volumes	Flows exceeding 18.3 GL/day for 60 days August – December at Yarrawonga Weir	Average period between flow event Maximum period between flow event Average flood volume per year Average flood volume per event

Environmental asset - Gunbower-Koondrook-Perricoota Forest

The MDBSY project (CSIRO 2008b) used one flow event description and associated flow event definition to characterise environmental water requirements for the Gunbower-Koondrook-Perricoota Forest (Table 4-22). This flow recommendation is based on the objectives and triggers defined in the Living Murray Environmental watering Plan 2005-2006 (MDBC, 2004) for this site, using a duration and flow exceedance threshold recommended by the MDBC (SKM, 2009). A summary of the environmental objectives, environmental indicators and flow events reported by SKM (2009) are provided in Table 4-22.

Table 4-22. Environmental flow indicators used in the SKM Murray risk assessment for the Gunbower-Koondrook-Perricoota Forest (Source: SKM 2009).

Flow event description	Flow event definition	Indicators reported
Beneficial flood volumes	Flows exceeding 30 GL/day for 30 days August – January at Torrumbarry Weir	Average period between flow event Maximum period between flow event Average flood volume per year Average flood volume per event

Environmental asset - Darling Anabranch Lakes

The MDBSY project (CSIRO 2008b) used one flow event description and associated flow event definition to characterise environmental water requirements for the Lower Darling River and associated Darling Anabranch Lakes (SKM 2009) (Table 4-23). This flow threshold is based on the commence-to-flow threshold for the offtake south of Menindee. However, SKM (2009) note that the hydrology of the Lakes system is poorly understood (CSIRO 2008b), with little information to assist with objective setting in their risk assessment, and therefore, it is unclear what the implications of these flows are for the inundation of the Anabranch Lakes (SKM, 2009).

Table 4-23. Environmental flow indicators used in the SKM Murray risk assessment for the Darling Anabranch Lakes (Source: SKM 2009).

Flow event description	Flow event definition	Indicators reported
Beneficial spring-summer flood	Flows above 12 GL/day for 14 days August – January at Weir 32	Average period between flow event Maximum period between flow event Average flood volume per year Average flood volume per event

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 4-26).

The consequence of meeting all objectives was then classified based on level of objectives being met for the River Murray Channel, Barmah-Millewa Forest, Gunbower-Koondrook-Perricoota Forest and the Darling Anabranch Lakes (SKM 2009). The consequence scores for these assets are listed in Table 4-24.

Regulated rivers

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 and shown in Table 4-24.

Table 4-24. Consequence results in the River Murray Channel, Barmah-Millewa Forest, Gunbower-Koondrook-Perricoota Forest, Darling Anabranch Lakes and Regulated river water sources as a result of interception from farm dams.

Environmental assets	Consequence
River Murray Channel	Negligible*
Barmah-Millewa Forest	Negligible*
Gunbower-Koondrook-Perricoota Forest	Negligible*
Darling Anabranch Lakes	Negligible
Lower Darling regulated river water source	Medium
NSW Murray regulated river water source	Medium – Very High

Reference: SKM 2009

*SKM 2009 defined the consequence as 'none' for the annotated assets, which meant that no measurable change was expected in the ability to achieve objectives. This has been altered to 'negligible' for this report to maintain consistency with the SKM (2008) risk matrix

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 4-24). The SKM (2011) assessment of the hydrological impacts of farm dams identified the following four gauges (Table 4-25).

Table 4-25. Consequence results for environmental assets in the unregulated water sources in the NSW Murray and Lower Darling WRPA.

Gauging Station	Consequence Rating (HEVAE consequence score)
Bowna Creek at Yambla 401015	Low
Jingellic Creek at Jingellic 401013	Low
Maragle Creek at Maragle 401009	Low
Tooma River at Pinegrove 401014	Medium

4.5.1.2. Determining the likelihood rating

Regulated river water source

Environmental assets

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 4-26). The farm dam component of this impact was estimated at 50% of the total (NOW 2010).

Table 4-26. 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	
C_{dry}	2nd driest of 45 estimates of future climate, and 2004/5 levels of development	When compared to A0 climate change risk determined
C_{mid}	Median of 45 estimates of future climate, and 2004/5 levels of development	When compared to A0 climate change risk determined
C_{wet}	2nd wettest of 45 estimates of future climate, and 2004/5 levels of development	When compared to A0 climate change risk determined
D_{dry}	C_{dry} with projected 2030 levels of groundwater usage, and increases in farm dams and plantation forestry	When compared to C_{dry} development risk (farm dams and plantations) determined

		When compared to A0 cumulative risk (climate change + development) determined
D_{mid}	C_{mid} with projected 2030 levels of groundwater usage, and increases in farm dams and plantation forestry	When compared to C_{mid} development risk (farm dams and plantations) determined When compared to A0 cumulative risk (climate change + development) determined
D_{wet}	C_{wet} with projected 2030 levels of groundwater usage, and increases in farm dams and plantation forestry	When compared to C_{mid} 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 NSW Murray and Lower Darling WRPA, are described in Table 4-20– Table 4-23. Likelihoods are therefore the chance that a given flow indicator would be reported under a given climate scenario. For example, if there was less than 1 % chance that a flow indicator would be recorded in a given climate scenario, the likelihood would be classed as “rare” (Table 4-27).

Table 4-27. Likelihood metrics selected for modelled scenarios in the NSW Murray and Lower Darling Regulated River Water Source in the MLD WRPA (SKM 2008).

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
Probable	Would occur at some time	66-99
Almost Certain	Expected to occur in most circumstances	>99
Reference: SKM 2008		

As stated, the likelihood rating was based on the differences between the MDBSY $D_{mid} – C_{mid}$ scenario. The likelihood rating for the River Murray Channel, the Koondrook-Perricoota Forest, the Barmah-Millewa Forest and the Darling Anabranch lakes from interception by farm dams was assessed as possible (Table 4-28).

Table 4-28. Likelihood results for modelled scenarios in the River Murray Channel, Barmah-Millewa Forest, Gunbower-Koondrook-Perricoota Forest and Darling Anabranch Lakes as a result of interception from farm dams.

Environmental asset	Likelihood
River Murray Channel	Possible

Barmah-Millewa Forest	Possible
Gunbower-Koondrook-Perricoota Forest	Possible
Darling Anabranch Lakes	Possible
Reference: NOW 2010, SKM 2009	

Regulated rivers

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 regulated Lower Darling River (NOW 2010) and Murray River (CSIRO 2008b) due to farm dams were used as likelihood ratings for the regulated water sources. These estimates were calculated at the valley scale and were used as the likelihood metric for each regulated water source (Table 4-29). The effect of farm dams on runoff is greatest on low flows and high flows (SKM 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 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: LFs and OBs, Table 4-5).

Table 4-29 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

Lower Darling River

Likelihood ratings for the regulated Lower Darling (based of Darling River reductions) due to farm dams were based on NOW 2010. In 2008 the volume of in-stream farm dams in the Darling River was estimated at 4.6 GL with a projected growth in farm dams of 13.2 GL in upstream catchments by 2030 (NOW 2010). This equates to a reduction of inflows of 0.2% as a result of farm dam interception, depending on the climatic scenario adopted (NOW 2010).

Murray River

Likelihood ratings for the regulated Murray River (based of Murray River channel reductions) due to farm dams were based on CSIRO 2008. As of 2008, the estimated farm dam storage volume was 70GL with a 10.9GL (12%) increase by 2030 which equates to a reduction in annual runoff by less than 1 percent (CSIRO 2008b). Furthermore, river regulation and Planned Environmental Water rules within the NSW Murray and Lower Darling regulated WSP substantially reduce any effect of farm dams on river flows.

Based on the estimates of reduced inflows, all regulated water sources were assessed as having a very low likelihood of reduced flows due to farm dams (Table 4-30). The 'very low' likelihood rating was assigned to high flows.

Table 4-30 Likelihood results for NSW Murray and Lower Darling regulated river water sources

Regulated river reach	Likelihood

Lower Darling regulated river water source	Very Low
NSW Murray regulated river water source	Very Low

Reference: NOW 2010, CSIRO 2008b

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 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 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: BF, VF and CF, 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: BF, VF and CF, 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: LF and OB, Table 4-5)

These indices were selected as the metrics to describe the likelihood in unregulated water sources in the NSW Murray and Lower Darling WRPA.

Likelihood category definitions are defined by the extent of deviation from the near-natural condition (Table 4-31). Likelihood results are provided in Table 4-32 for four flow gauges used in the hydrological assessment (SKM 2011) that are within the NSW Murray and Lower Darling WRPA.

Table 4-31. 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 4-32. Likelihood results for risk to water for the environment in unregulated water sources in the NSW Murray and Lower Darling WRPA due to interception activities.

Gauging Station	Likelihood		
	CV	LF Q_{90}	HF Q_{10}
Bowna Creek at Yambla 401015	Low	Low	Low
Jingellic Creek at Jingellic 401013	Low	Low	Low
Maragle Creek at Maragle 401009	Low	Low	Low
Tooma River at Pinegrove 401014	Low	Low	Low

Reference: SKM (2011)

4.5.1.3. Existing water management actions & 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

Regulated river water source

Environmental assets

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 4-33.

Table 4-33. Matrix used to determine risk outcomes of insufficient water available for the environment from potential interception activities in the NSW Murray and Lower Darling Regulated River Water Source, adapted from CSIRO (2008a).

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

Combining the risk consequence and likelihood rating (Table 4-24 and Table 4-28) results in a low overall risk level to the NSW Murray and Lower Darling regulated river environmental assets (Table 4-34).

Table 4-34. Risks of insufficient water available for the environment in the River Murray Channel, Barmah-Millewa Forest, Gunbower-Koondrook-Perricoota Forest and Darling Anabranch Lakes as a result of growth in interception by farm dams [E(I-FD)].

Environmental asset	Consequence	Likelihood	Risk level - E(I-FD)
River Murray Channel	Negligible	Possible	Low
Barmah-Millewa Forest	Negligible	Possible	Low
Gunbower-Koondrook-Perricoota Forest	Negligible	Possible	Low
Darling Anabranch Lakes	Negligible	Possible	Low

Reference: NOW 2010, SKM 2009

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 NSW Murray and Lower Darling regulated water sources is provided in Table 4-35.

Table 4-35 Matrix used to determine risk outcomes of insufficient water available for the environment from potential interception activities in NSW MLD 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 NSW Murray and Lower Darling WRPA from interception due to farm dams (Table 4-36).

Table 4-36 Risks of insufficient water available for the environment in the NSW Murray and Lower Darling Regulated water source as a result of growth in interception by farm dams [E(I-FD)]

Water source	Consequence	Likelihood	Risk level - E(I-FD)
Lower Darling regulated river water source	Low – Very High	Very Low	Low
NSW Murray regulated river water source	Medium – Very High	Very Low	Low

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 NSW Murray and Lower Darling unregulated water sources is provided in Table 4-37.

Table 4-37. Matrix used to determine risk outcomes of insufficient water available for the environment from potential interception activities in unregulated water sources in the NSW Murray and Lower Darling 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 4-25 and Table 4-32) results in a low risk level to ecological assets and functions in unregulated water sources in the NSW Murray and Lower Darling WRPA (Table 4-38) from interception due to farm dams.

Table 4-38. Risks of insufficient water available for the environment in unregulated water sources in the NSW Murray and Lower Darling 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}
Bowna Creek at Yambla 401015	Low	Low	Low	Low	Low	Low	Low
Jingellic Creek at Jingellic 401013	Low	Low	Low	Low	Low	Low	Low
Maragle Creek at Maragle 401009	Low	Low	Low	Low	Low	Low	Low
Tooma River at Pinegrove 401014	Medium	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; and
- 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.

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

Regulated river water source

The consequence scores used in the assessment of the impact of plantation forestry on relevant environmental assets associated with the regulated rivers were taken from NOW 2010 and SKM 2009. The consequence was determined to be ‘negligible’ (Table 4-24).

Unregulated river water sources

Consequence scores for unregulated water sources were determined using the HEVAE instream values listed in Table 4-3. However, the area of commercial forestry plantations in the upper Murray catchment is projected to increase by 33,000 ha (62%) by around 2030, which is the largest projected increase of any sub-catchment in the Murray-Darling Basin (SKM 2008). The current plantation coverage in the lower Murray Darling sub-catchment, combined with projected increase by 2030, is less than 0.2%. Because the potential risk is concentrated in the upper Murray area, the unregulated water sources were divided into upper Murray and lower Murray – Darling, including mid-Murray, regions. Every consequence score in the Upper Murray water sources was examined and the highest consequence score was selected. The combined consequence used for upper Murray unregulated water sources was medium.

Table 4-39. Consequence results in the River Murray Channel, Barmah-Millewa Forest, Gunbower-Koondrook-Perricoota Forest, Darling Anabranch Lakes, Regulated river and upper Murray unregulated water sources as a result of interception from commercial plantations.

Environmental assets	Consequence
River Murray Channel	Negligible[1]
Barmah-Millewa Forest	Negligible[1]
Gunbower-Koondrook-Perricoota Forest	Negligible[1]
Darling Anabranch Lakes	Negligible[1]
Lower Darling regulated river water source	Negligible[1]
NSW Murray regulated river water source	Negligible[1]
Upper Murray unregulated water sources (upstream of Hume Dam)	Medium[2]

[1]Reference: SKM 2009. SKM 2009 defined the consequence as ‘none’ for the annotated assets, which meant that no measurable change was expected in the ability to achieve objectives. This has been altered to ‘negligible’ for this report to maintain consistency with the SKM (2008) risk matrix

[2]Based on the highest HEVAE consequence ratings in upper Murray unregulated water sources (Table 4-3)

4.5.2.2. Determining the likelihood rating

Regulated and unregulated river water sources

Substantial increases in commercial plantation growth are predicted in the upper Murray sub-catchment, so the impacts may be significant at this scale. However, the impact of projected commercial forestry plantation development on the regional average annual runoff was also estimated as ‘Probable’ for the River Murray Channel, the Koondrook-Perricoota Forest, the Barmah-Millewa Forest and the Darling Anabranch lakes (SKM 2009). Therefore, a ‘Probable’ likelihood was applied to all regulated and unregulated water sources with the exception of the Lower Darling. The Lower Darling has negligible plantation forestry and was therefore assessed as ‘rare’ (Table 4-28).

Table 4-40. Likelihood results for modelled scenarios in the River Murray Channel, Barmah-Millewa Forest, Gunbower-Koondrook-Perricoota Forest, Darling Anabranch Lakes, regulated river and unregulated river water sources as a result of interception from plantation forests [E(I-PF)]

Environmental asset	Likelihood
River Murray Channel	Probable

Barmah-Millewa Forest	Probable
Gunbower-Koondrook-Perricoota Forest	Probable
Darling Anabranch Lakes	Probable
Lower Darling regulated river water source	Rare
NSW Murray regulated river water source	Probable
All unregulated water sources	Probable

Reference: SKM 2009

4.5.2.3. Existing water management actions & mechanisms

The NSW regulatory approach including compliance to plantation forests is described in DWE (2009). 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 NSW Murray and Lower Darling Surface WRPA is provided in Table 4-41. The results of the risk assessment are presented in Table 4-42. The results show that on a WRPA scale, the risk from growth in plantation forestry is medium or high in the Murray catchment and low in the Lower Darling.

Table 4-41. Matrix used to determine risk outcomes of insufficient water available for the environment from potential plantation forestry interception activities in the NSW Murray and Lower Darling regulated and unregulated water sources, adapted from CSIRO (2008a).

			Likelihood of insufficient water availability				
	Regulated	Unregulated	Rare	Unlikely	Possible	Probable	Almost Certain
Consequence Regulated: %change in water use Unregulated: HEVAE	Negligible	Very Low	Low	Low	Low	Low	Medium
	Minor	Low	Low	Low	Medium	Medium	High
	Moderate	Medium	Low	Medium	Medium	High	High
	Major	High	Medium	Medium	High	High	High
	Severe	Very High	Medium	High	High	High	High

Table 4-42. Risks of insufficient water available for the environment in the River Murray Channel, Barmah-Millewa Forest, Gunbower-Koondrook-Perricoota Forest, Darling Anabranch Lakes, regulated and unregulated water sources as a result of growth in interception by plantation forestry [E(I-PF)].

Environmental asset	Consequence	Likelihood	Risk level - E(I-PF)

River Murray Channel	Negligible*	Probable	Low
Barmah-Millewa Forest	Negligible*	Probable	Low
Gunbower-Koondrook-Perricoota Forest	Negligible*	Probable	Low
Darling Anabranch Lakes	Negligible*	Probable	Low
Lower Darling regulated river water source	Negligible*	Rare	Low
NSW Murray regulated river water source	Negligible*	Probable	Low
Upper Murray unregulated water sources	Medium	Probable	High

Reference: SKM 2009

*SKM 2009 defined the consequence as 'none' for the annotated assets, which meant that no measurable change was expected in the ability to achieve objectives. This has been altered to 'negligible' for this report to maintain consistency with the SKM (2008) risk matrix

4.5.3. Mining [E(I-M)]

Mining activities in NSW must go through stringent assessment and approval processes. Any new mining project, or the expansion of an existing mining project, requires approval under the NSW *Environmental Planning and Assessment Act 1979*, and, depending on their location and the value of capital investment, may require approval from the Minister for Planning. Coal seam gas (CSG) exploration and commercialisation must be consistent with the CSG regulations and exclusion zones that apply in NSW.

All 'take' for mining operations, including water required for operations and processing and intercepted water, must be accounted for by appropriate NSW water access licences acquired within the affected surface or groundwater source. This includes any direct or indirect take from surface waters.

Mining activities in the NSW Murray and Lower Darling WRPA currently comprise of less than one percent of the total catchment area (ABARES 2017). There are currently two mineral sand mines located in the Lower Darling catchment and Broken Hill, located on the western edge of the WRPA, continues to mine metal ore. All of these are approximately 10 km or more from the nearest significant waterway (Australian Mining 2015). No commercial coal or coal seam gas extraction has occurred or is currently occurring in the WRPA.

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).

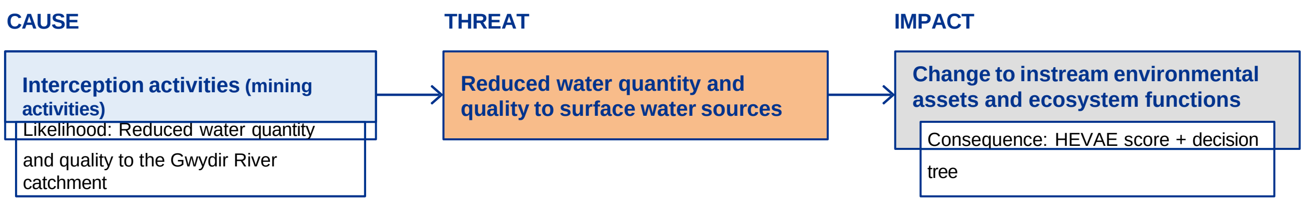


Figure 4-10 Impact pathway showing risk of mining activities reducing water quantity and quantity for the environment

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 licensing 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.

The NSW Murray and Lower Darling subregion does not have any significant areas of mining nor growth in mining (NSW Resources and Geoscience (2019). 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 *Darling Alluvium Risk Assessment* and the *Murray Alluvium Risk Assessment.*.

The risk outcomes are summarised in Table 4-43 below.

Table 4-43 Risks of insufficient water available for the environment in regulated and unregulated water sources in the NSW Murray and Lower Darling 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
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

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.

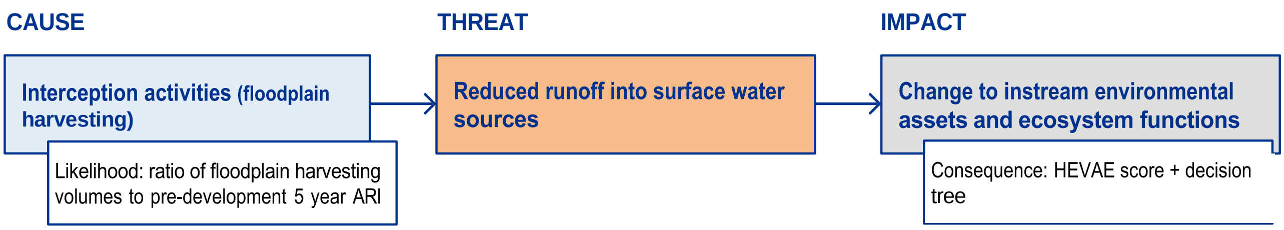


Figure 4-11 Impact pathway showing risk of growth in floodplain harvesting reducing water available for the environment

The *NSW Floodplain Harvesting Policy* 2013 is currently being implemented in five northern Basin valleys through the NSW Healthy Floodplains Project. These valleys were prioritised because surveys of current and predicted floodplain harvesting activities indicated that regulation should be prioritised. In areas where the pressures from floodplain harvesting remain minor or absent (i.e. the southern Basin), the Policy will be implemented in due course.

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 for the Murray River catchment and a consequence score of 'medium' was used for the Lower Darling catchment. In addition, there are significant floodplain wetlands within the WRPA (e.g. Koondrook-Perricoota Forest) 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

Some unregulated licences in the NSW Murray and Lower Darling WRPA allow for the taking of flows from undeclared floodplains. An analysis of existing structures suggests that this practice is minimal or not occurring. Further, the practice is unlikely to grow because of regional geomorphology and reliable supply from regulated water sources. Analyses also suggest that supplementary access licences, which have been a major driver behind the growth in storage facilities in the northern Basin, are unlikely to contribute to floodplain harvesting in this WRPA.

NSW will continue to monitor for any growth in farm storages, including in the southern Basin, and will review the information as the Floodplain Harvesting Policy 2013 is implemented.

Given that there is no material floodplain harvesting activity occurring in the NSW Murray and Lower Darling WRPA and the risk of future growth in this area is very low, we have defined the likelihood as 'nil'. The likelihood metrics are defined in Table 4-44. Table 4-44 Likelihood metrics for floodplain harvesting

Likelihood metric	Metric category	Metric category definition
Flow Deviation	Nil	No material FPH occurring
	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 (DPI Water 2017) are converting this form of historical take into a licensable right. This form of take will be managed under the Floodplain licensing framework. Due to the lack of material FPH and very low growth in this WRPA, the Healthy Floodplains program will not be applied to the NSW Murray and Lower Darling, so there will not be floodplain harvesting entitlements established.

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 NSW Murray and Lower Darling Surface WRPA is provided in Table 4-46.

Table 4-45. Risk matrix to determine risk outcomes of insufficient water for the environment and capacity to meet EWRs.

		Likelihood (of hydrological alternation)			
		Nil	Low	Medium	High
Consequen	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

Table 4-46 Risks of insufficient water available for the environment in regulated and unregulated water sources in the NSW Murray and Lower Darling Surface WRPA as a result of floodplain harvesting activities [E(I-FH)].

	Consequence	Likelihood	Overall risk rating - E(I-FH)
NSW Murray water sources	Very High	Nil	Nil
Lower Darling water source	Medium	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 available for the environment in the NSW Murray and Lower Darling WRPA.

The likelihood is described as the change in frequency of flow indicators, while the consequence is assessed as the loss of annual water diversions for environmental entitlements.

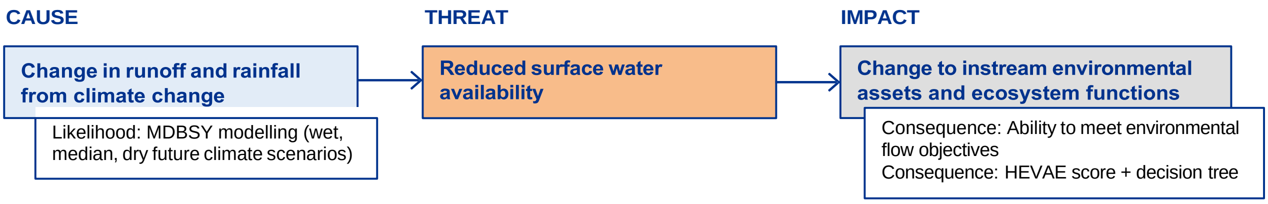


Figure 4-12. Impact pathway showing how change in climate can impact on the availability of water for the environment.

4.6.1. Assigning a consequence rating

Regulated river water source

Environmental assets

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 dry, median and wet climate change scenarios (scenario type C), these were compared to scenario A0 (Table 4-26) (NOW 2010).

The NSW environmental assets assessed in the MDBSY Project were the River Murray Channel, Barmah-Millewa Forest, Gunbower-Koondrook-Perricoota Forest, and the Lower Darling River and associated Anabranches. The consequence scores for these assets are provided below (Table 4-47). Consequence levels were defined by the magnitude of change and were set by experienced consultants at levels considered to be 'reasonable'. For the NSW Murray, two consequence options were provided, without precautionary principle and with the precautionary principle. In applying the precautionary principle, consequences have been reclassified as more severe due to uncertainty around residual values of the asset and the ecological response to changes in hydrology (SKM 2009). The consequence options with the precautionary principle were used for this assessment of the NSW Murray and Lower Darling WRPA.

Table 4-47. Consequence results for key environmental assets in the NSW Murray and Lower Darling WRPA.

Environmental asset	Consequence		
	Dry climate change scenario	**Median climate change scenario**	**Wet climate change scenario**
River Murray Channel	Severe	Severe	Negligible
Barmah-Millewa Forest	Severe	Severe	Severe
Gunbower-Koondrook-Perricoota Forest	Severe	Severe	Severe
Darling Anabranch Lakes	Severe	Severe	Negligible

Reference: SKM (2009)

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.

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 4-2.

4.6.2. Determining the likelihood rating

Regulated river water source

Environmental assets

As discussed earlier in Section 4.5.1, customised hydrological indicators were developed in the MDBSY Project for the NSW Murray and Lower Darling WRPA (CSIRO 2008b). Comparing MDBSY Project C scenarios to the 2004/05 (A0 scenario) determines likelihood of specific flow indicator events occurring under the three different climate projections (wet, dry, median) (Table 4-48). Also as discussed in Section 4.5.1, likelihood rankings are provided in Table 4-49. Also as discussed in Section 4.5.1, likelihood rankings were adapted from the SKM (2008) guidelines for assessing risks to shared water resources in the Murray-Darling Basin, 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: LFs, NFs and OBs; Table 4-5).

Table 4-48. Data used to assess risk likelihood from climate change to key environmental assets in the NSW Murray and Lower Darling WRPA (CSIRO 2008b). Note that data was not available for the River Murray channel environmental asset.

Environmental flow indicator	A0	C_{dry} (% change from A0)	C_{mid} (% change from A0)	C_{wet} (% change from A0)
Barmah-Millewa Forest				
Event = flows exceeding 18.3 GL/day for 60 days Aug–Dec at Yarrawonga Weir				
Maximum period (years) between events	1.8 yrs	40%	13%	-1%
Average period between events	4.7 yrs	219%	95%	0%
Average event volume per event	1217 GL	-93%	-49%	10%
Average event volume per year	1947 GL	-91%	-43%	9%
Gunbower-Koondrook-Perricoota Forest				
Event = flows exceeding 30 GL/day for 30 days Aug–Jan at Torrumbarry Weir				
Maximum period (years) between events	1.7 yrs	35%	15%	1%
Average period between events	4.6 yrs	228%	77%	0%
Average event volume per event	680 GL	-96%	-52%	-6%
Average event volume per year	1016 GL	-94%	-46%	-6%
Darling Anabranch Lakes				
Event = flows above 12 GL/day for 14 days Aug–Jan at Weir 32				
Maximum period (years) between events	2.7 yrs	7%	4%	-4%
Average period between events	9.2 yrs	26%	26%	-17%
Average event volume per event	211 GL	-51%	-28%	73%
Average event volume per year	513 GL	-25%	-25%	66%

Reference: CSIRO 2008b

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 4-49. Likelihood results for key environmental assets in the receiving insufficient flows from the regulated NSW Murray and Lower Darling WRPA.

Environmental asset	Likelihood		
	Dry climate change scenario	**Median climate change scenario**	**Wet climate change scenario**
River Murray Channel	Almost certain	Possible	Unlikely
Barmah-Millewa Forest	Almost certain	Possible	Unlikely
Gunbower-Koondrook-Perricoota Forest	Almost certain	Possible	Unlikely
Darling Anabranch Lakes	Almost certain	Possible	Unlikely

Reference: SKM (2009)

N/A = data was not available

Regulated rivers

In the NSW Murray and Lower Darling valley, there was no direct assessment of climate change impacts on surface water flows in the regulated Murray and Lower Darling rivers (SKM 2009). Therefore, the three climate change scenarios (dry, median, wet) were used to define likelihood ratings (Table 4-50 and Table 4-51). 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 4-50. Impacts of climate change scenarios on mean annual runoff and rainfall.

Scenario	Change to mean annual rainfall (%)	Change to mean annual runoff (%)
C_{dry}	-19	-37
C_{mid}	-3	-10
C_{wet}	+6	+7

According to the MDBSY Project, the wet scenario climate change is predicted to increase mean annual runoff by 31%, but there is a predicted 28% and 9% reduction in inflows for the dry and median climate change scenarios respectively.

Table 4-51 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

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 & 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

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). The resulting change in average annual rainfall and runoff is presented in Table 4-50.

Environmental assets

As discussed in Section 4.5.1, the risk matrix used to determine the risk rating of flow alteration from change in climate impacting the availability of water for the Murray and Lower Darling environmental assets 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 River Murray Channel, Koondrook-Perricoota Forest, the Barmah-Millewa Forest and Darling Anabranch Lakes is provided in Table 4-52.

Table 4-52. Matrix used to determine risk of insufficient water available for environmental assets from potential change in climate adapted from CSIRO (2008a).

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

	Severe	Medium	High	High	High	High

Combining the risk consequence and likelihood ratings (Table 4-47 and Table 4-49) results in the overall risk levels to the ecological assets and functions of the River Murray Channel, Barmah-Millewa Forest, Gunbower-Koondrook-Perricoota Forest, and Lower Darling River and associated Darling Anabranch Lakes as shown in Table 4-53. The risk assessment determined a high risk to all assets under the wet, medium and dry scenarios.

Table 4-53. Risks of insufficient water available for the environment in the for key environmental assets in the NSW Murray and Lower Darling WRPA as a result of change in climate [E(CC)].

Environmental asset/Climate scenario	Consequence	Likelihood	Risk level - E(CC)
River Murray Channel			
Wet climate change scenario	Negligible	Unlikely	Medium
Median climate change scenario	Severe	Possible	High
Dry climate change scenario	Severe	Almost Certain	High
Barmah-Millewa Forest			
Wet climate change scenario	Severe	Unlikely	High
Median climate change scenario	Severe	Possible	High
Dry climate change scenario	Severe	Almost Certain	High
Gunbower-Koondrook-Perricoota Forest			
Wet climate change scenario	Severe	Unlikely	High
Median climate change scenario	Severe	Possible	High
Dry climate change scenario	Severe	Almost Certain	High
Darling Anabranch Lakes			
Wet climate change scenario	Negligible	Unlikely	Medium
Median climate change scenario	Severe	Possible	High
Dry climate change scenario	Severe	Almost Certain	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 4-54.

Table 4-54 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 (HEVAE consequ	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 the majority of regulated river reaches having a 'medium or 'high' risk level due to climate change (

Table 4-55).

Table 4-55 Risks of insufficient water available for the environment in regulated river sections in the NSW Murray and Lower Darling Surface WRPA as a result of climate change [E(CC)].

Regulated river reach	Consequence	Likelihood	Overall risk rating - E(CC)
Darling River at Menindee u/s Weir 32 (425012)	M	M	M
Darling River at Burtundy (425007)	M	M	M
Great Darling Anabranch at outlet Lake Cawndilla (425014)	L	M	L
Great Darling Anabranch at Redbank Ck d/s Packers Crossing (425019)	L	M	L
Murray River at Doctors Point (409017)	M	M	M
Murray River d/s Yarrawonga Weir (409025)	VH	M	H
Murray River at Echuca (409200A)	H	M	M
Murray River at Torrumbarry (409207B)	VH	M	H
Murray River at d/s Wakool Junction (414200	M	M	M
Murray River at Euston (414203)	H	M	M
Murray River at Wentworth (425010)	H	M	M
Murray River at Lock 9 downstream (426506)	H	M	M
Murray River Flow to South Australia (426510)	M	M	M
Edward River at Toonalook (409047)	VH	M	H
Edward River at Deniliquin (409003)	VH	M	H
Edward River d/s Stevens Weir (409023)	H	M	M
Edward River at Leiwah (409035)	H	M	M
Wakool River at Offtake Regulator (409019)	VH	M	H
Wakool River at Wakool / Barham Rd (409045)	VH	M	H
Wakool River at Gee Gee Bridge [No. 2] (409062)	VH	M	H
Wakool River at Stoney Crossing (409013)	H	M	M

Wakool River at Kyalite (409034)	H	M	M
Yallakool Creek at Offtake (409020)	VH	M	H
Colligen Creek at below Regulator (409024)	VH	M	H
Niemur River at Barnham / Moulamein Rd (409048)	H	M	M
Bullatale Creek u/s Edward R (409075)	H	M	M
Gulpa Creek at offtake (409030)	VH	M	H

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

Unregulated 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 4-54.

Combining the unregulated risk consequence (Table 4-3) and 'medium' likelihood ratings resulted in the majority of water sources having 'low' or 'medium' risk ratings (Table 4-56).

Table 4-56 Risks of insufficient water available for the environment in unregulated river sections in the NSW Murray and Lower Darling Surface WRPA as a result of climate change [E(CC)].

Unregulated water source	Consequence	Likelihood	Overall risk rating – E(CC)
Albury	L	M	L
Dora Dora	L	M	L
Hume	M	M	M
Indi	L	M	L
Jingellic	M	M	M
Lower Wangamong	L	M	M
Majors	L	M	L
Mannus	M	M	M
Maragle	L	M	L
Ournie Welaregang	L	M	L
Swampy Plain	M	M	M
Tooma	M	M	M
Tumbarumba	VL	M	L
Upper Murray	M	M	M
Murray below Mulwala	H	M	H
Lower Murray – Darling	M	M	M

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 NSW Murray and Lower Darling Regulated WSP and the Murray unregulated and Lower Darling unregulated WSP described in section 4.1 of the NSW Murray and Lower Darling 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 (Water) ecohydrology specialist expert opinion. There are potential risks to environmental assets and functions in the NSW Murray and Lower Darling 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 NSW Murray and Lower Darling Surface WRP area was ‘medium’, and the consequence of the impact from pest species was ‘high’. Using the risk matrix set out in Table 4-11, the overall risk rating was ‘medium’ (Table 5-1).

Table 5-1 Risk to environmental assets and functions within the NSW Murray and Lower Darling Surface WRPA due to pest plants and animals.

Water source	Consequence	Likelihood	Overall risk rating
NSW Murray and Lower Darling Surface WRP area water sources	High	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 WQM Plan for the NSW Murray and Lower Darling WRPA has been prepared to meet the requirements of the Basin Plan. The WQM Plan is supplemented by a number of other documents including:

- The Incident Response Guide
- Salinity Technical Report
- Surface Water Quality Technical Report.

Water quality problems occurring within the NSW Murray and Lower Darling catchments 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 & mechanisms

The WMA sets a principle sets a requirement that water quality of all water sources should be protected and, wherever possible, enhanced. Key objectives within NSW Basin 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 benefit 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.
- Pass tributary inflows through to the Murray Water Source. The protection of small freshes is important for flushing and turning over stratified pools, and to maintain a supply of domestic and stock rights and native title rights to users on the system.
- Protect supplementary water events from extraction by users. This protects important rises in the water level and natural flow variability, preserves a significant portion of natural tributary flows for river health and maintains wetland and floodplain inundation.
- Releases from the Lower Darling Allowance to suppress algal blooms in the Lower Darling River watercourse.
- Minimum daily flows from Weir 32 in the Lower Darling River.
- 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 WQM Plan, Salinity Technical Report and the Surface Water Quality Technical Report.

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 of 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 NSW Murray and Lower Darling WRPA.

This risk assessment focuses both cold water pollution (CWP), (see Preece ,2004: - *Cold water pollution below dams in NSW*), and warm water pollution (WWP). Hume and Khancoban Dam are the two main large storages likely to cause CWP or WWP in the NSW Murray and Lower Darling Surface WRPA. The impact of CWP and WWP on water-dependent ecosystems is only applicable to the regulated NSW Murray River only.

Water temperature influences many biological processes. The release of cold or warm water from Hume Dam into the regulated Murray River and from Khancoban Dam into the regulated Swampy Plain River can impact on ecosystem function and condition of ecological assets by altering thermal regimes in the regulated rivers downstream of these storages. Changed water temperatures influences growth rates and metabolism of in-stream plants, animals and algae. Temperature can also trigger spawning, breeding and migration patterns of many aquatic animals.

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

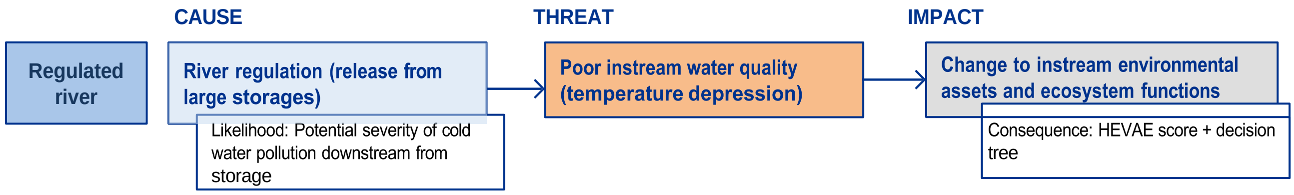


Figure 6-1 Impact pathway showing impact of cold water pollution on ecological functions and assets

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 NSW Murray and Lower Darling catchment (DPI Water 2016).

Cold water pollution (defined as more than 5˚C peak depression) from the Hume and Khancoban Dams is a result of the discharge outlet being below the thermocline resulting in water temperatures below natural during spring and summer months. Transfers of colder water from Island Bend Pondage, Lake Eucumbene and Jindabyne into a relatively shallow dam (median depth 4.6 m) in Khancoban can also influence the degree of CWP (Preece 2004). Khancoban Dam has a 50th percentile exceedance flow immediately below the Dam into Swampy Plain River, which according to DLWC (1998a) is approximately 20 % of the storage volume; suggesting that there is little retention time in the storage for atmospheric heating to occur. In the Hume dam, large volumes of water released for irrigation and South Australian water entitlements. In the regulated Murray River, this means that thermal modification can persist along the 200 km between the Hume Dam and Lake Mulwala (Preece, 2004; Sherman 2005). This large thermal inertia is also the cause for warm water pollution during winter months. The large volumes in Hume Dam and Khancoban Dam during winter can store more heat than the nearby river and then release this warmer water into the downstream river, causing WWP.

The same consequence scores as determined in Section 4.2.3 (regulated only) are used to assess risks due to water temperatures falling outside natural ranges due to releases from major storages. As HEVAE scoring for this length of the regulated river is all very high, it has been assessed as one reach only.

6.3.2. Determining the likelihood rating

Cold water pollution

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 (<1000 ML/d)
	Medium	Moderate CWP Deep intake (≥10 m) and smaller discharge (>5 and <1000 ML/d)
	High	Severe CWP Deep intake (≥10 m) and large discharge (≥1000 ML/d)

Reference: Preece, 2004

In Khancoban Dam, the combination of cold water inflows and short retention times results in discharge temperatures out of Khancoban which are markedly colder than natural (Preece 2004). Whilst the Hume Dam does not suffer the extreme thermal pollution levels that other NSW storages do (>8 ˚C changes from peak depression), it does still achieve a 'high' likelihood ranking due to the large volumes of water that are discharged during the Spring and Summer months with maximum temperatures 5 ˚C - 7 ˚C lower than the surface of the storage (Preece 2004). The thermocline is typically positioned between 9 and 15 m below the water surface (Preece 2004).

Hume Dam has two sets of intake, one at a depth of 23 to 30 m below full supply level, and the other at 30 to 34 m below full supply level. Historical discharge data shows that the median spring discharge is approximately 15,000 ML/day, whilst the median summer discharge is 20,000 ML/day acknowledging that there is considerable variation from year to year depending on rainfall (Preece 2004). Minimum releases from the storage in winter are in the order of 600 ML/day (Preece 2004).

Khancoban Dam has a regulating gate within the spillway structure with a crest approximately 12 m below the full supply level. The 50th percentile exceedance flow is approximately 4,000 ML/day. Based on the above criteria, Hume and Khancoban Dams have high likelihood for causing CWP.

Warm water pollution

The likelihood for warm water pollution was determined by assessing the maximum difference between monthly median water temperatures downstream of Hume Dam during winter (July) to the 80th percentile mean monthly temperature of reference sites (Table 6-2). The monthly 80th percentiles were calculated using the hourly water temperature data from the upstream Murray River at Jingellic continuous water temperature station (DPI Water 2016). The monthly median temperature downstream of Hume Dam was calculated using the hourly water temperature data from the Murray River at Heywoods (409016) gauging station. This site is approximately 1.2 km below the outlet of Hume Dam. The maximum difference is 3-4˚C warmer and therefore the likelihood was rated as 'medium'.

Warm water pollution was not assessed for Khancoban Dam in the water quality technical report for this WRPA (DPI Water 2016). However, Pope and Nolan (2018) did assess water temperatures upstream and downstream of Khancoban Dam. Mean monthly water temperatures were less than 2˚C warmer during April – July. Therefore, the likelihood of WWP released from Khancoban Dam was 'low' (Table 6-2).

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 the regulated river below Hume or Khancoban Dam and reference sites
	Medium	2 °C – 4 °C maximum difference of mean monthly temperatures in winter (July) between the regulated river below Hume or Khancoban Dam and reference sites
	High	≥ 6 °C maximum difference of mean monthly temperatures in winter (July) between the regulated river below Hume or Khancoban Dam and reference sites

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 NSW Murray and Lower Darling WRPA is provided in Table 6-3.

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

		Likelihood (of instream structure having the potential to cause CWP)		
		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

Cold water pollution

Combining the risk consequence and likelihood ratings (Table 4-2 and Table 6-3) for the NSW Murray and Lower Darling regulated rivers results in an overall 'high' risk from CWP to ecological assets and functions (Table 6-4). For Khancoban Dam, this extends from the dam through Swampy Plain River into the Murray River. For Hume Dam, this risk extends from the dam downstream to Lake Mulwala, as shown in Table 6-4.

Warm water pollution

Combining the risk consequence and likelihood ratings (Table 4-2 and Table 6-3) for the NSW Murray and Lower Darling regulated rivers results in a 'low' risk below Khancoban Dam and a 'medium' risk below Hume dam from WWP to ecological assets and functions (Table 6-4). For Khancoban Dam, this extends from the dam through Swampy Plain River to the Murray River confluence. For Hume Dam, this risk is assessed directly downstream of the dam only, as shown in Table 6-4.

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

Regulated river reach	Consequence rating	Likelihood rating	Risk rating - E(WQ-CWP)
E(WQ-CWP)			
Hume Dam (Murray River up to 200 km downstream of dam to Lake Mulwala)	High	High	High
Khancoban Dam (Murray River up to 120 km downstream of dam)	Medium	High	High
E(WQ-WWP)			
Hume Dam (Murray River directly downstream of Hume Dam)	High	Medium	Medium
Khancoban Dam (Swampy Plain River from Khancoban Dam to the Murray River confluence)	Medium	Low	Low

6.4. Risks due to turbidity, TP, TN, pH & DO

Elevated levels of suspended matter and nutrients and 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.

Changes to land use and natural river flows are the main causes of poor water quality within the NSW Murray and Lower Darling WRPA. Turbidity and 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 (DPI Water 2016). Harmful algal blooms are rare in the middle and upper NSW Murray Rivers, but can be found in the Hume Dam in warmer months, as well as in Menindee Lakes, the lower Darling River and the lower part of the Murray River (DPI Water 2016).

Dissolved oxygen is influenced by organic carbon concentrations, nutrient concentrations and temperature, particularly during low and cease to flow periods. In the Murray Rivers dissolved oxygen is mostly within the target range; however, it can be wildly unpredictable in the Darling River and frequently outside the target range in periods of low flow. 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.

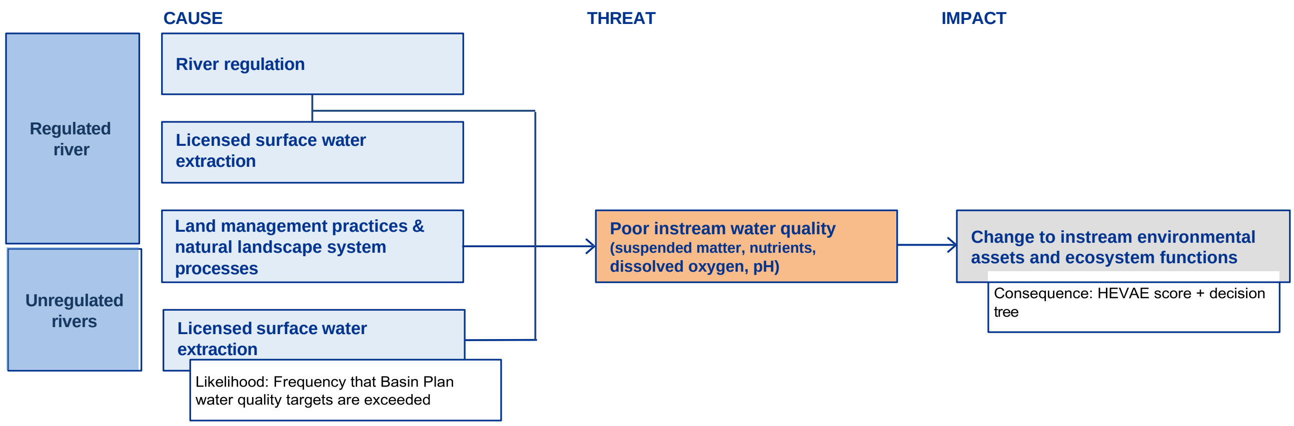


Figure 6-3. Impact pathway showing impact of water quality degradation (increased turbidity, TP, TN, pH & DO) on ecological functions and assets.

6.4.1. Assigning a consequence rating

There are 14 Department of Planning and Environment-Water water quality monitoring sites in the NSW Murray and Lower Darling WRPA 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; Appendix B) 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.

Regulated river water source

Table 6-5. Consequence results for reaches of the NSW Murray and Lower Darling regulated river in the NSW Murray and Lower Darling WRPA.

Regulated river reach	Consequence Rating
425012 Darling River at upstream of Weir 32	Medium
425007 Darling River at Burtundy	Medium
409025 Murray River downstream of Yarrawonga Weir	Medium
414209Murray River upstream Euston Weir	High
42610001 Murray River at Lock 8	Medium
409005 Murray River at Barham	Very High
414206 Murray River at Merebin Pump Station	High
409003 Edward River at Deniliquin	High
409034 Wakool River at Kyalite	High
409013 Wakool River at Stoney Crossing	High

Unregulated water sources

Table 6-6. Consequence ratings in unregulated reaches in the NSW Murray and Lower Darling WRPA.

River reach	Consequence Rating
409001 Murray River at Albury	Medium
401556 Murray River at Indi	Low
401201 Murray River at Jingellic	Medium
401003 Tooma River at Warbrook	Medium

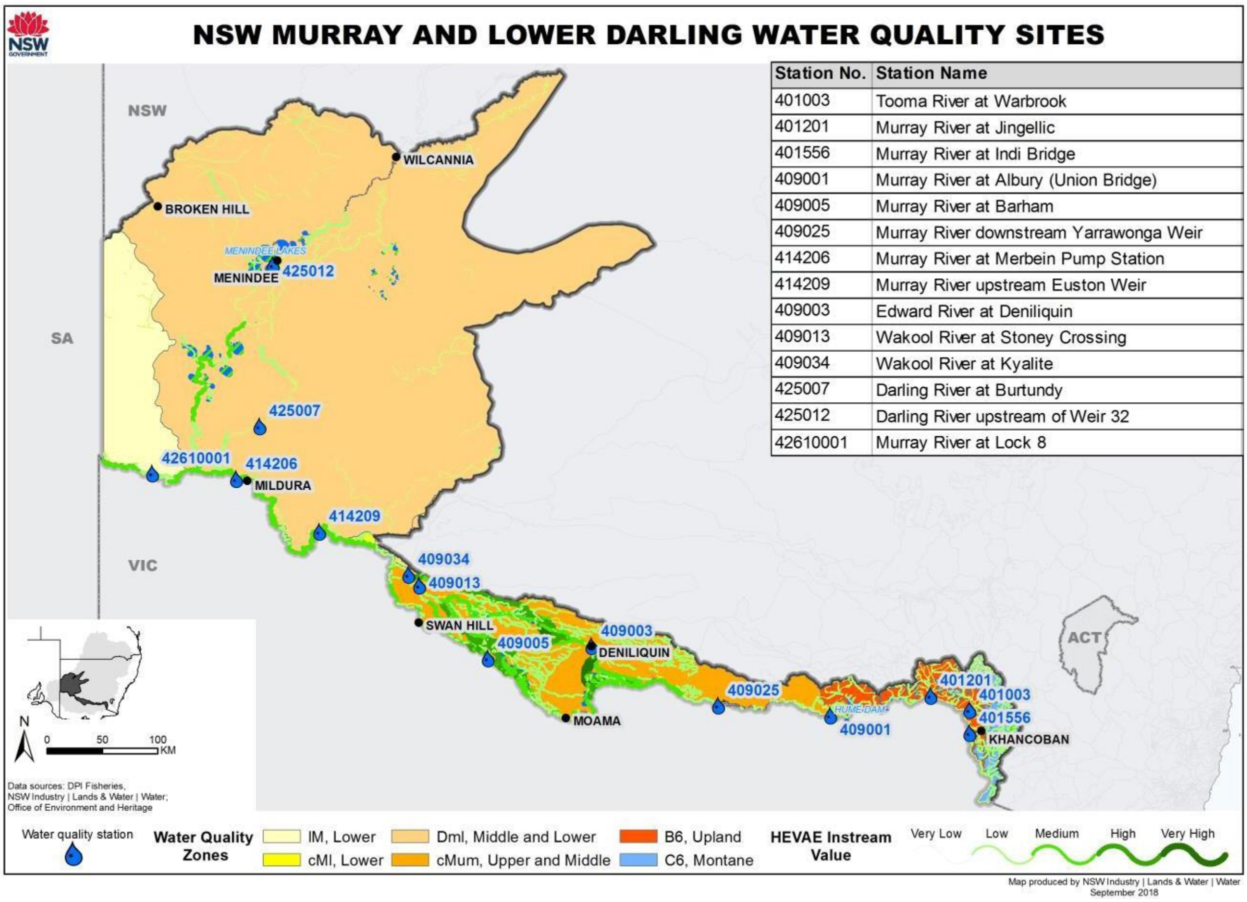


Figure 6-4. Water quality monitoring sites used to determine water quality target application zones for water-dependent ecosystems (Schedule 11 of the Basin Plan).

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 - 2014/15.

Schedule 11 water quality target values used for this risk assessment were for 'other water-dependent ecosystems' in the Montane; Upland; Upper, Central and Middle Murray; Lower Central Murray; Middle and Lower Darling; and Lower Murray zones (C6, B6, cMum, cMl, Dml, and lM 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	C6 & B6 (includes Mitta Mitta and Upper Murray; Montane zone)	5	25	150	>9mg/L; or 95-110%	6.4-7.7
	cMum (includes Murray WRPA; Upper and Middle zones)	15	40	500	>7.7 mg/L; or 90-110%	6.5-7.5
	cMl (includes Central Murray; Lower)	35	80	700	>8.0 mg/L; or 90-110%	6.8-8.0
	Dml (includes Darling WRPA; Middle and Lower zones)	50	50	500	85-110%	6.5-8.0
	IM (includes Lower Murray)	50	100	1000	85-110%	6.5-9.0

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 NSW Murray and Lower Darling 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.

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
425012 Darling River at upstream of Weir 32	High	Medium	Medium	Low	Medium
425007 Darling River at Burtundy	High	Medium	Medium	Medium	Medium
409025 Murray River downstream of Yarrawonga Weir	Low	Low	Low	Low	Low
414209 Murray River upstream Euston Weir	Medium	Medium	Low	Low	Low
42610001 Murray River at Lock 8	High	Medium-Low	Medium	Low	Low
409005 Murray River at Barham	High	Medium	Medium	Low	Low
414206 Murray River at Merebin Pump Station	Low	Low	Low	Low	Low
409003 Edward River at Deniliquin	High	Medium	Low	Low	Low
409034 Wakool River at Kyalite	High	Medium	Medium	Low	Medium
409013 Wakool River at Stoney Crossing	High	Medium	Medium	Low	Medium

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
409001 Murray River at Albury	Low	Low	Low	Low	Medium
401556 Murray River at Indi	Low	Low	Low	Low	Low
401201 Murray River at Jingellic	Medium	Low	Low	Low	Low
401003 Tooma River at Warbrook	High	Medium	Medium	Low	Low

6.4.3. Risk outcomes

The risk matrix used to determine the risk to the health of water-dependent ecosystems due 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 NSW Murray and Lower Darling 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.

There was a low risk to water dependent ecosystems from poor water quality on the lower Darling River. On the Murray River there were mostly low to medium risk to water dependent ecosystems. The exception was in the middle Murray where there was a high risk from increased levels of turbidity. There were medium risks in the upper, middle and lower Murray from elevated levels of turbidity and total phosphorus and nitrogen. There was a medium risk from low levels of dissolved oxygen in the Murray River. This does not include the potential for blackwater events that have occurred in the past in the middle Murray (Whitworth et al. 2012).

Regulated river water source

Table 6-12. Risks of exceeding water quality targets impacting the heath of water-dependent ecosystems in the regulated reaches of the NSW Murray and Lower Darling WRPA [E(WQ)].

Regulated river reach	Consequence	Turbidity Likelihood	Turbidity Overall risk rating	Total phosphorus Likelihood	Total phosphorus Overall risk rating	Total nitrogen Likelihood	Total nitrogen Overall risk rating	pH Likelihood	pH Overall risk rating	DO Likelihood	DO Overall risk rating
425012 Darling River at upstream of Weir 32	M	High	High	Medium	Medium	Medium	Medium	Low	Low	Medium	Medium
425007 Darling River at Burtundy	M	High	High	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium
409025 Murray River downstream of Yarrawonga Weir	M	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
414209 Murray River upstream Euston Weir	H	Medium	Medium	Medium	Medium	Low	Low	Low	Low	Low	Low
42610001 Murray River at Lock 8	M	High	High	Medium	Medium	Medium	Medium	Low	Low	Low	Low
409005 Murray River at Barham	VH	High	High	Medium	High	Medium	High	Low	Medium	Low	Medium
414206 Murray River at Merebin Pump Station	H	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
409003 Edward River at Deniliquin	H	High	High	Medium	Medium	Low	Low	Low	Low	Low	Low
409034 Wakool River at Kyalite	H	High	High	Medium	Medium	Medium	Medium	Low	Low	Medium	Medium
409013 Wakool River at Stoney Crossing	H	High	High	Medium	Medium	Medium	Medium	Low	Low	Medium	Medium

Unregulated water sources

Table 6-13. Risks of exceeding water quality targets impacting the heath of water-dependent ecosystems in the unregulated water sources of the NSW Murray and Lower Darling 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
409001 Murray River at Albury	M	Low	Low	Low	Low	Low	Low	Low	Low	Medium	Medium
401556 Murray River at Indi	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
401201 Murray River at Jingellic	M	Medium	Medium	Low	Low	Low	Low	Low	Low	Low	Low
401003 Tooma River at Warbrook	M	High	High	Medium	Medium	Medium	Medium	Low	Low	Low	Low

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.

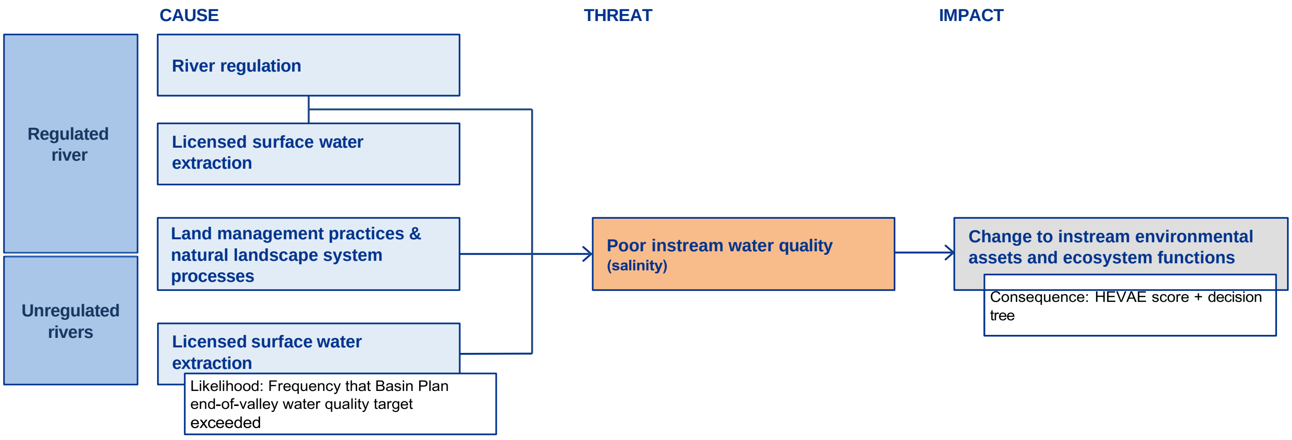


Figure 6-5. Impact pathway showing impact of elevated levels of instream salinity on ecological functions and assets in the NSW Murray and Lower Darling WRPA.

6.5.1. Assigning a consequence rating

The same consequence rating as applied in Section 5.4.1 was used. The Basin Plan stipulates that end-of-valley salinity targets be used for water dependent ecosystems. The Barwon-Darling reporting site is at Wilcannia, which is located upstream of this WRPA. There is no salinity target listed for the NSW Murray River. For this reason the flow to South Australia target has been used.

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 is based on continuous electrical conductivity data for the period 2010/11 to 2014/15.

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 NSW Murray and Lower Darling WRPA.

Likelihood metric	Metric category	Metric category definition
Number of years the annual 80th percentile salinity exceeds the end-of-valley target of 453 µS/cm in the Darling River and	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

412 µS/cm in the NSW Murray River	High	The annual 80th percentile exceeds the end-of-valley 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.

There is a medium risk to water dependent ecosystems from salinity in the lower Murray River. The highest values across the 5 year period at Murray River at Lock 8 were 572 µS/cm. There was high likelihood that salinity would exceed the target on the Lower Darling River, however the consequence at site was low and therefore classed as medium risk.

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

The annual 80th percentile in the Darling River at Burtundy exceeded the end-of-valley target three out of five years between 2010 and 2015, resulting in a medium likelihood score. Combining the medium risk consequence (Table 6-5) and medium likelihood rating results in a medium overall risk rating Table 6-16) of the salinity target being exceeded in the Darling River at Burtundy.

There is a low risk to water dependent ecosystems from salinity in the lower Murray. The annual 80th percentile in the Murray River downstream of Rufus River did not exceed the flow to South Australia electrical conductivity target between 2010 and 2015. Combining the medium risk consequence and low likelihood rating resulted in a low overall risk rating (Table 6-16).

Table 6-16. Risks of elevated levels of instream salinity impacting the heath of water-dependent ecosystems in the regulated system of the NSW Murray and Lower Darling WRPA [E(WQ-S)].

Regulated river reach	Consequence rating	Likelihood rating	Risk rating - E(WQ-S)
425012 Darling River at Menindee Weir 32	Medium	High	High
425007 Darling River at Burtundy	Medium	Medium	Medium
409003 Edward River at Deniliquin	High	Low	Low
409005 Murray River at Barham	Very High	Low	Medium
409025 Murray River d/s Yarrawonga Weir	Medium	Low	Low

426200 Murray River downstream of Rufus River	Medium	Low	Low
4261001 Murray River at Lock 8	Medium	High	High

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 licensing 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 6-6 is 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.

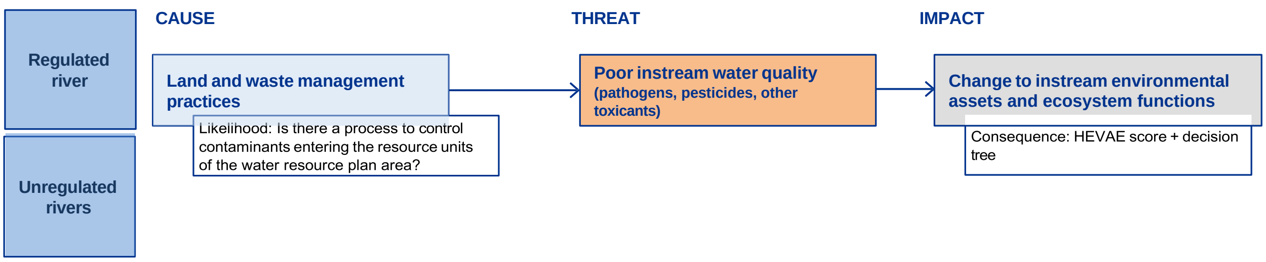


Figure 6-6. Impact pathway showing how risk of poor water quality (pathogens, pesticides and other toxic contaminants) can impact on ecological assets and functions.

6.6.1. Assigning a consequence rating

Risk consequence was determined using the HEVAE instream value scoring (Table 4-2 and Table 4-3). The consequence decision support tree (Section 9.5) 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 significantly, a ‘very high’ consequence for the Murray water sources and a ‘medium’ consequence for the Lower Darling water sources were used in determining the risk outcomes. The ‘very high’ and ‘medium’ consequence scores 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. Licensed 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 NSW Murray and Lower Darling 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 likelihood (Table 6-17) and consequence rating using the risk matrix Table 6-18 results in the overall risk (Table 6-19) of surface water contamination from land and waste management practices as ‘medium’ in all NSW Murray regulated and unregulated resource units. The risk rating for all Lower Darling regulated and unregulated resource units was ‘low’.

Table 6-18. Risks matrix to determine risk outcomes of the 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

Table 6-19. Risks of the impact of pathogens and toxicants on water dependent ecosystems in the regulated and unregulated water sources of the NSW Murray and Lower Darling WRPA [E(WQ-PT)].

Water resource unit	Consequence rating	Likelihood rating	Risk rating - E(WQ-S)
Lower Darling regulated and unregulated water sources	Medium	Low	Low
NSW Murray regulated and unregulated water sources	Very High	Low	Medium

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 NSW Murray and Lower Darling WRPA. Land use within the NSW Murray and Lower Darling catchment is predominantly agricultural including: livestock grazing, forestry, dryland cropping and irrigated cropping; and conservation, with much of the Upper Murray designated as National Parkland (Burrell et al., 2015).

7.2. Existing water management actions & mechanisms

As discussed in Chapter 5.2 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. For more information 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 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 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.

The sodium adsorption ratio (SAR) is another indicator of the suitability of water for irrigation. Irrigation water with a high SAR may lead to soil degradation. The Basin Plan also sets a target for the SAR for irrigation water. The target value is the value which, if exceeded, could cause soil degradation when that water is applied to land. This risk is not addressed in this assessment as adequate data is not yet available.

The impact pathway is shown in Table 7-1 and demonstrates the threat to water used for irrigation driven by elevated levels of instream salinity in the NSW Murray and Lower Darling WRPA. The consequence is described by the water salinity rating of irrigation water. Likelihood is described by the frequency that Basin Plan salinity targets for irrigation are exceeded.

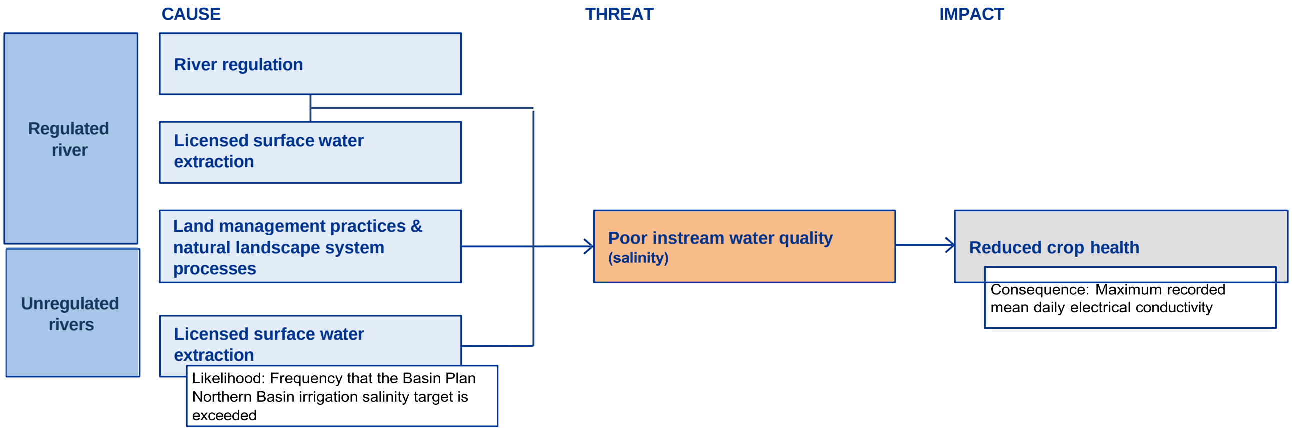


Figure 7-1. Impact pathway showing elevated salinity levels causing water to be unsuitable for irrigation.

This risk assessment has also had regard to water being unsuitable for other users 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 6.5.3). 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

Elevated levels of instream salinity can be driven by a number of causes. Consequence is described by the water salinity rating of irrigation water (ANZECC and ARMCANZ (2000), Chapter 9 Table 9.2.5). A single irrigation event of highly saline water can cause crop damage. Therefore, the consequence metric is the maximum mean daily electrical conductivity recorded between 2005/06 – 2014/15.

There are two Irrigation Corporations, two Private Irrigation Districts and eight Private Water Trusts operating in the Murray Lower Darling WRPA. Table 7-1 lists the irrigation infrastructure operators and the closest continuous electrical conductivity gauging station to the water offtake points.

Consequence categories are defined by different water salinity rating and the sensitivity of different crops to saline irrigation water (Table 7-2). All sites had a low consequence rating except for the Darling River at Wentworth which had a medium score (Table 7-3) and is the closest site to Pomona Irrigation Trust.

Table 7-1.List of Irrigation Infrastructure Operators and relevant continuous electrical conductivity monitoring stations in the NSW Murray and Lower Darling.

Irrigation Operators	Offtake location	Electrical conductivity monitoring station
Murray Irrigation Limited	Mulwala Canal offtake from Murray River at Lake Mulwala (Yarrawonga Weir)	409025 Murray River downstream Yarrawonga Weir
	Wakool Canal Offtake from Colligen Creek via the Edward River	409023 Edward River downstream Stevens Weir
Western Murray Irrigation limited	Buronga pumping station on Murray River Curlwaa pumping station on Murray River Coomealla pumping station on Murray River	414216 Murray River downstream Mildura Weir (VIC) 414217 Murray River at Curlwaa (VIC)

Moira Private Irrigation District	Murray River upstream of Barmah. Diversion channel at Moira Lake.	409215 Murray River at Barmah (VIC)
West Corurgan Private Irrigation District	West Corurgan Canal offtake from the Murray River between Corowa and Lake Mulwala	409002 Murray River at Corowa
Bama Irrigation Trust	Murray River near Moama	409215 Murray River at Barmah (VIC)
Bringan Irrigation Trust	Murray River near Barham	409005 Murray River at Barham
Bullatale Creek Waters Trust	Murray River west of Tocumwal	409202 Murray River at Tocumwal (VIC)
Bungunyah Koraleigh Irrigation Trust	Murray River near Koraleigh, upstream of Tooleybuck	409204 Murray River at Swan Hill (VIC)
Glenview Irrigation Trust	Murray River near Barham	409005 Murray River at Barham
Goodnight Irrigation Trust	Murray River near Goodnight, downstream of Tooleybuck and upstream of Wakool junction	409204 Murray River at Swan Hill (VIC)
Pomona Irrigation Trust (Pomona Water)	Darling River upstream of Wentworth. Located in the Lock 10 weir pool.	425017 Darling River at Wentworth (VIC)
West Cadell Irrigation Trust	Murray River near Moama	409215 Murray River at Barmah (VIC)

Table 7-2. Consequence metrics for risk to irrigation water due to elevated salinity level.

Consequence metric	Metric category	Metric category definition
Maximum mean daily electrical conductivity recorded between 2005/06 – 2014/15	Low	Maximum mean daily EC over 10 years <1300 µS/cm Very low to low salinity rating
	Medium	Maximum mean daily EC over 10 years 1300 - 5200 µS/cm Medium to high salinity rating
	High	Maximum mean daily EC over 10 years >5200 µS/cm Very High to extreme salinity rating

Reference: ANZECC and ARMCANZ 2000, Chapter 9 Table 9.2.5

Table 7-3. Consequence results for risk due to high salinity levels to irrigation water.

River reach	Consequence
409002 Murray River at Corowa	Low
409025 Murray River downstream Yarrawonga Weir	Low
409202 Murray River at Tocumwal	Low
409005 Murray River at Barham	Low

409023 Edward River downstream of Stevens Weir	Low
409215 Murray River at Barmah (VIC)	Low
409204 Murray River at Swan Hill	Low
414216 Murray River downstream Mildura Weir	Low
414217 Murray River at Curlwaa	Low
425017 Darling River at Wentworth	Medium

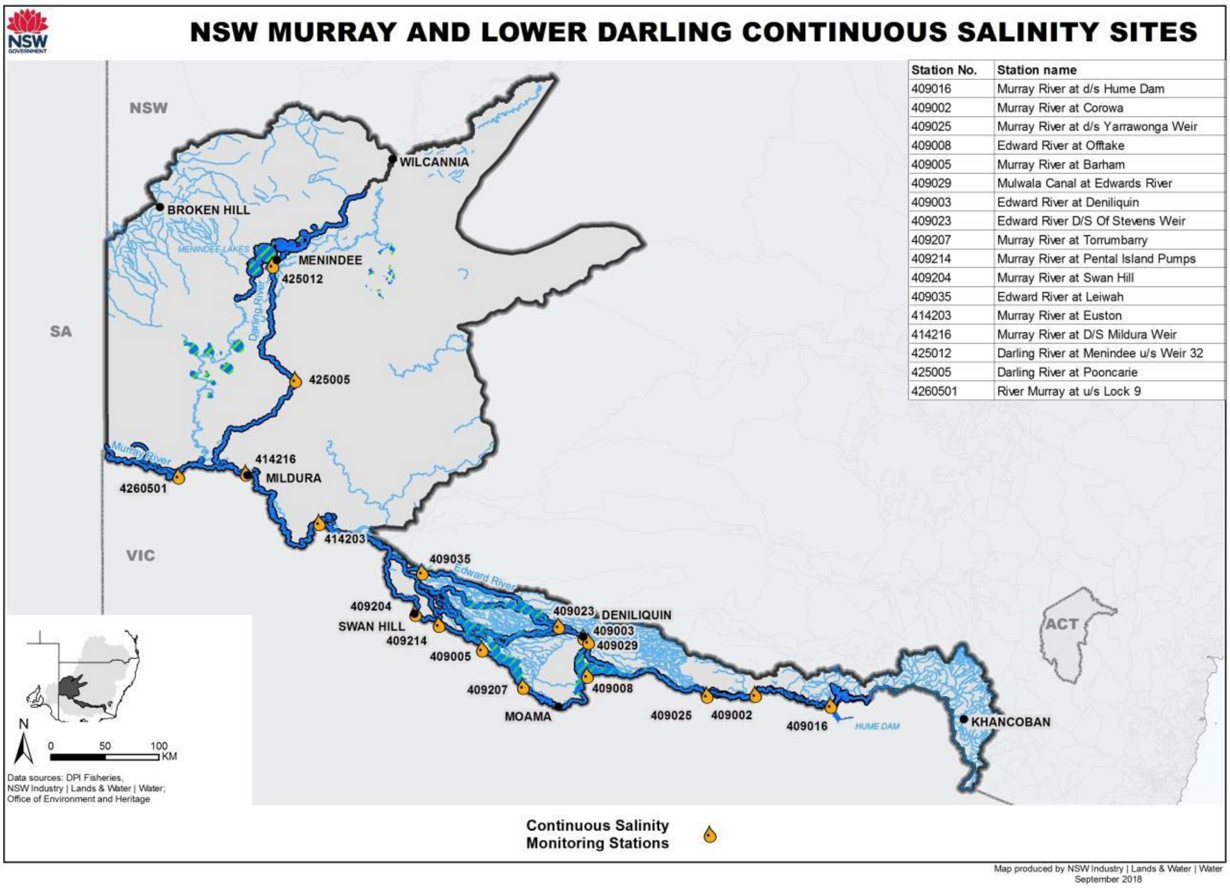


Figure 7-2. Monitoring stations used to determine the risk of elevated salinity to irrigation use.

7.3.2. Determining the likelihood rating

A target value of 833 µS/cm is set for the WRPA. This target value should not be exceeded 95 % of the time over a 10 year period (i.e. that the 95th percentile must be less than 833 µS/cm).

The likelihood is described by the number of years that the annual 95th percentile of daily means of electrical conductivity exceeds the irrigation salinity target over the ten year period of 2004/05 to 2014/15.

Salinity was measured as real time data at the three monitoring stations identified above (Table 7-2). These sites are considered representative of areas of significant irrigation.

Likelihood categories are defined by different water salinity rating and the sensitivity of different crops to saline irrigation water (Table 7-4). Likelihood ratings for the three monitoring stations are provided in Table 7-5.

Table 7-4. Likelihood metrics for elevated salinity levels in the NSW Murray and Lower Darling WRPA.

Likelihood metric	Metric category	Metric category definition[1]
Annual 95th percentile of daily mean electrical conductivity recorded between 2005/06 – 2014/15	Low	Annual 95th percentile of daily EC mean never exceeds the irrigation salinity target for the 10 year period
	Medium	Annual 95th percentile of daily EC mean exceeds the irrigation salinity target for at least 1 year but no more than 4 years over the 10 year period
	High	Annual 95th percentile of daily EC mean exceeds the irrigation salinity target for more than 4 years over the 10 year period

Table 7-5. Likelihood results for risk due to high salinity levels in irrigation water in the NSW Murray and Lower Darling WRPA.

River reach	Likelihood
409002 Murray River at Corowa	Low
409025 Murray River downstream Yarrawonga Weir	Low
409202 Murray River at Tocumwal	Low
409005 Murray River at Barham	Low
409023 Edward River downstream of Stevens Weir	Low
409215 Murray River at Barmah (VIC)	Low
409204 Murray River at Swan Hill	Low
414216 Murray River downstream Mildura Weir	Low
414217 Murray River at Curlwaa	Low
425017 Darling River at Wentworth	Low

7.3.3. Risk outcomes

The risk matrix used to determine the risk to irrigation water from elevated salinity used for irrigation purposes in the NSW Murray and Lower Darling WRPA is provided in Table 7-6.

Table 7-6. Risk matrix to determine risk outcomes of elevated salinity levels on irrigation water.

Consequence (Maximum EC value)		Likelihood (of salinity water quality target being exceeded)		
		Low	Medium	High
	Low	Low	Low	Medium
	Medium	Low	Medium	High
	Very High	Medium	High	High

Combining the risk consequence and likelihood ratings (Table 7-3 and Table 7-5) results in the overall risk as low for instream salinity impacting irrigation water (Table 7-7).

Table 7-7. Risks of elevated levels of instream salinity impacting on irrigation water in the NSW Murray and Lower Darling WRPA [O(WQ-S)].

Regulated river reach	Consequence rating	Likelihood rating	Risk rating – O(WQ-S)
409002 Murray River at Corowa	Low	Low	Low
409025 Murray River downstream Yarrawonga Weir	Low	Low	Low
409202 Murray River at Tocumwal	Low	Low	Low
409005 Murray River at Barham	Low	Low	Low
409023 Edward River downstream of Stevens Weir	Low	Low	Low
409215 Murray River at Barmah (VIC)	Low	Low	Low
409204 Murray River at Swan Hill	Low	Low	Low
414216 Murray River downstream Mildura Weir	Low	Low	Low
414217 Murray River at Curlwaa	Low	Low	Low
425017 Darling River at Wentworth	Medium	Low	Low

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 were 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 7-3 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.

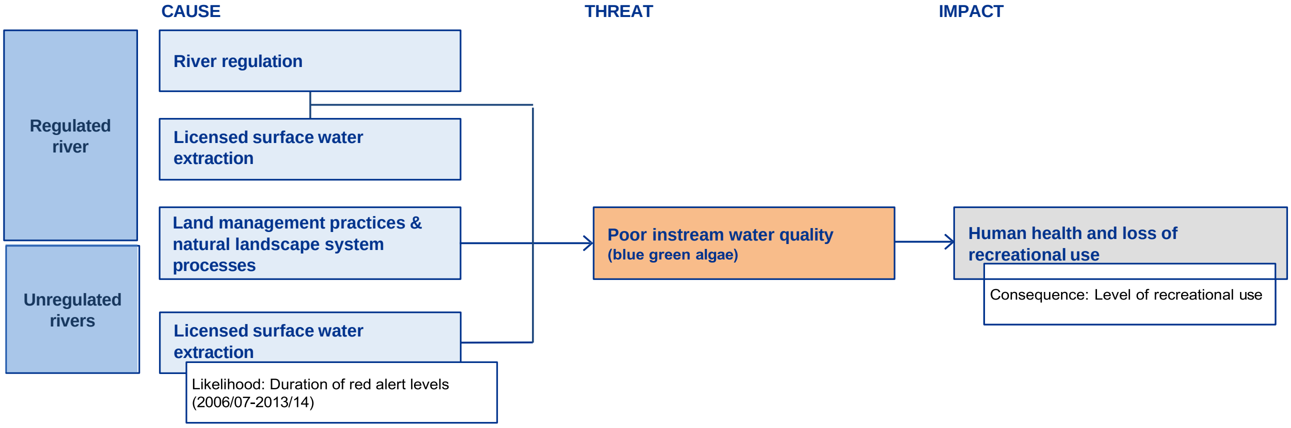


Figure 7-3. Impact pathway showing risk to recreation water quality and human health from blue-green algae.

7.4.1. Existing water management actions & 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 7-4. 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.

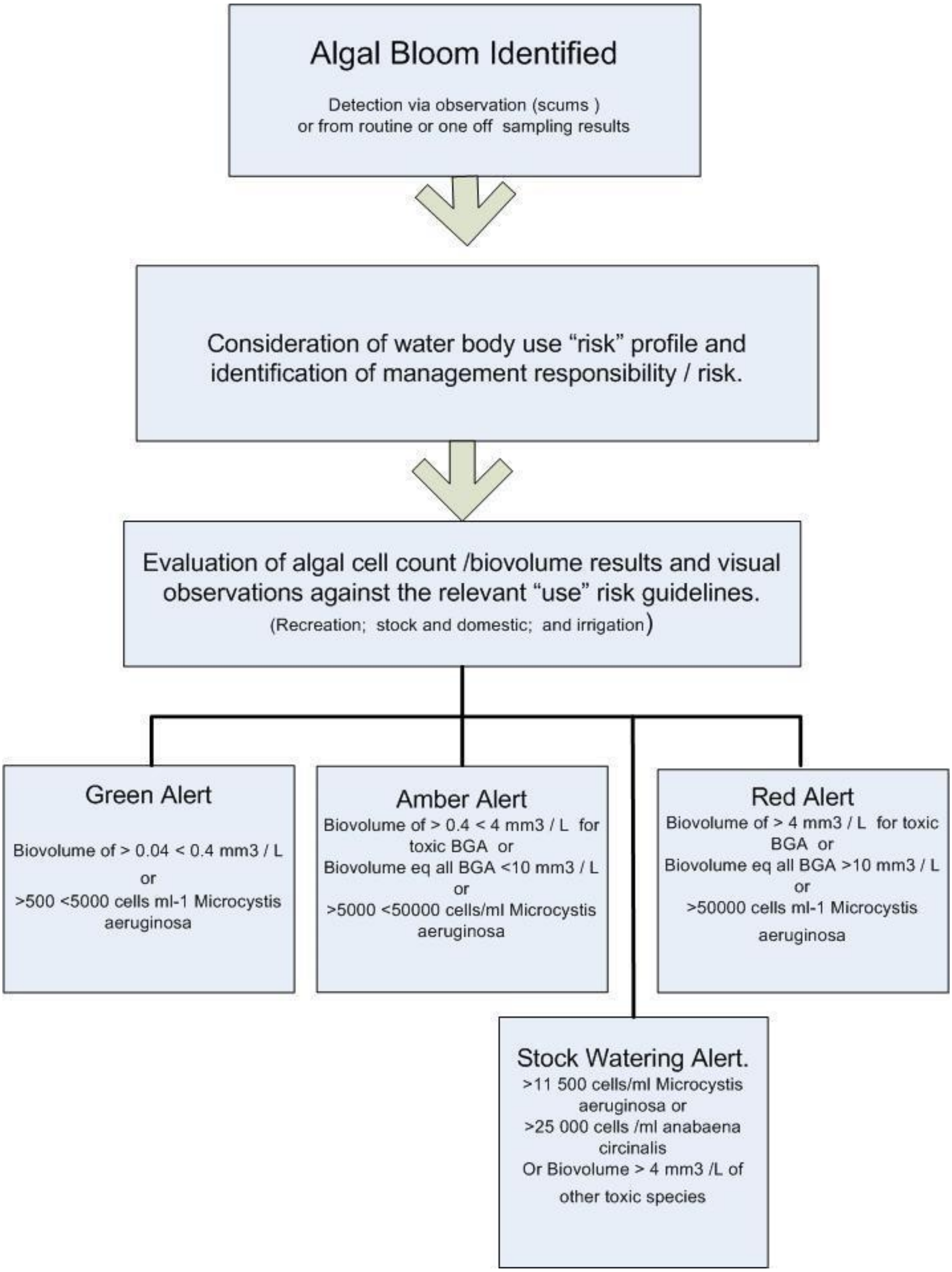


Figure 7-4. Conceptual outline of how algal alert levels are used in NSW.

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 7-8). Consequence ratings are provided in Table 7-9.

Table 7-8. Consequence metrics for risk to water used for recreational uses due to blue-green algae in the NSW Murray and Lower Darling 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 7-9. Consequence results for risk to recreational water users in the NSW Murray and Lower Darling WRPA.

River reach	Consequence
Copi Hollow	Low
Lake Pamamaroo	Low
Lake Wetherell	Low
Lake Menindee	Low
Lake Cawndilla	Low
Darling River at Menindee	Low
Darling River at Weir 32	Low
Darling River at Tolarno	Low
Darling River at Menincourt	Low
Darling River at Pooncarie	Low
Darling River at Tulney Point	Low
Darling River at Burtundy	Low
Darling River at Ellerslie	Low
Darling River at Tapio	Low
Lake Victoria outlet regulator	Low
Murray River at Lock 8	Low
Murray River at Fort Courage	Low
Murray River at Curlwaa	Low
Murray River at Merbein	Low
Murray River at Buronga	Low

Murray River at Mount Dispersion	Low
Murray River at Euston	Low
Lake Benanee Rec Area	Low
Murray River at Tooleybuc	Low
Murray River at Murray Downs	Low
Murray River at Barham	Low
Murray River at Moama	Low
Murray River at Picnic Point	Low
Murray River at Tocumwal	Low
Murray River at Cobram	Low
Murray River downstream of Yarrawonga	Low
Mulwala Canal offtake	Low
Lake Mulwala	Low
Murray River at Corowa	Low
Murray River at Albury	Low
Lake Hume	Low
Wakool River at Wakool-Barham Road	Low
Wakool River at Kyalite	Low
Gulpa Creek at Mathoura	Low
Edward River at Deniliquin	Low
Edward River at Old Morago	Low
Edward River at Moulamein	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 bio volume 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 7-10). Likelihood ratings are provided in Table 7-11.

Table 7-10. Likelihood metrics for risks from blue-green algae in the NSW Murray and Lower Darling WRPA.

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

Table 7-11. Likelihood results for risk due to blue-green algae.

River reach	Likelihood
Copi Hollow	Low
Lake Pamamaroo	High
Lake Wetherell	High
Lake Menindee	Medium
Lake Cawndilla	Medium
Darling River at Menindee	Medium
Darling River at Weir 32	Medium
Darling River at Tolarno	Low
Darling River at Menincourt	Low
Darling River at Pooncarie	Low
Darling River at Tulney Point	Low
Darling River at Burtundy	Low
Darling River at Ellerslie	Low
Darling River at Tapio	Low
Lake Victoria outlet regulator	Low
Murray River at Lock 8	Low
Murray River at Fort Courage	Low
Murray River at Curlwaa	Low
Murray River at Merbein	Low
Murray River at Buronga	Low
Murray River at Mount Dispersion	Low
Murray River at Euston	Low

Lake Benanee Rec Area	Low
Murray River at Tooleybuc	Low
Murray River at Murray Downs	Low
Murray River at Barham	Low
Murray River at Moama	Low
Murray River at Picnic Point	Low
Murray River at Tocumwal	Low
Murray River at Cobram	Low
Murray River downstream of Yarrawonga	Low
Mulwala Canal offtake	Low
Lake Mulwala	Low
Murray River at Corowa	Medium
Murray River at Albury	Low
Lake Hume	High
Wakool River at Wakool-Barham Road	Low
Wakool River at Kyalite	Low
Gulpa Creek at Mathoura	Low
Edward River at Deniliquin	Low
Edward River at Old Morago	Low
Edward River at Moulamein	Low

7.4.4. Risk outcomes

The risk matrix used to determine the risk to recreational water users from blue-green algae in the NSW Murray and Lower Darling WRPA is provided in Table 7-12.

Table 7-12. 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
	High	Medium	High	High

Combining the risk consequence and likelihood ratings (Table 7-9 and Table 7-11) results in low risk for the majority of water sources in the NSW Murray and Lower Darling water sources (Table 7-13). There is a medium risk at Lake Pamamaroo, Lake Wetherell and Lake Hume.

Table 7-13. Risks from blue-green algae to recreational water uses in the NSW Murray and Lower Darling WRPA [O(WQ-BGA)].

Regulated river reach	Consequence rating	Likelihood rating	Risk rating – O(WQ-BGA)
Copi Hollow	Low	Low	Low
Lake Pamamaroo	Low	High	Medium
Lake Wetherell	Low	High	Medium
Lake Menindee	Low	Medium	Low
Lake Cawndilla	Low	Medium	Low
Darling River at Menindee	Low	Medium	Low
Darling River at Weir 32	Low	Medium	Low
Darling River at Tolarno	Low	Low	Low
Darling River at Menincourt	Low	Low	Low
Darling River at Pooncarie	Low	Low	Low
Darling River at Tulney Point	Low	Low	Low
Darling River at Burtundy	Low	Low	Low
Darling River at Ellerslie	Low	Low	Low
Darling River at Tapio	Low	Low	Low
Lake Victoria outlet regulator	Low	Low	Low

Murray River at Lock 8	Low	Low	Low
Murray River at Fort Courage	Low	Low	Low
Murray River at Curlwaa	Low	Low	Low
Murray River at Merbein	Low	Low	Low
Murray River at Buronga	Low	Low	Low
Murray River at Mount Dispersion	Low	Low	Low
Murray River at Euston	Low	Low	Low
Lake Benanee Rec Area	Low	Low	Low
Murray River at Tooleybuc	Low	Low	Low
Murray River at Murray Downs	Low	Low	Low
Murray River at Barham	Low	Low	Low
Murray River at Moama	Low	Low	Low
Murray River at Picnic Point	Low	Low	Low
Murray River at Tocumwal	Low	Low	Low
Murray River at Cobram	Low	Low	Low
Murray River downstream of Yarrawonga	Low	Low	Low
Mulwala Canal offtake	Low	Low	Low
Lake Mulwala	Low	Low	Low
Murray River at Corowa	Low	Medium	Low
Murray River at Albury	Low	Low	Low
Lake Hume	Low	High	Medium
Wakool River at Wakool-Barham Road	Low	Low	Low
Wakool River at Kyalite	Low	Low	Low
Gulpa Creek at Mathoura	Low	Low	Low
Edward River at Deniliquin	Low	Low	Low
Edward River at Old Morago	Low	Low	Low
Edward River at Moulamein	Low	Low	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 NSW Murray and Lower Darling WRPA:

- Albury City Council
- Balranald Shire Council
- Berrigan Shire Council
- Broken Hill City Council
- Central-Darling Shire Council
- Corowa Shire Council
- Greater Hume Shire
- Murray Shire Council
- Tumbarumba Shire Council
- Wakool Shire Council
- Wentworth 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(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 are shown in Figure 7-1 and 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 farm dams in the NSW Murray and Lower Darling valley was estimated at 66 GL (CSIRO 2008a). The MDBSY Project estimated growth rate of 0.6% for the entire Basin was applied to the 2008 NSW Murray and Lower Darling valley estimated volume, yielding a predicted increase of 10.2 GL.

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 pathway (Figure 8-1) demonstrates how the threat of flow alteration driven by farm dam interception 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.

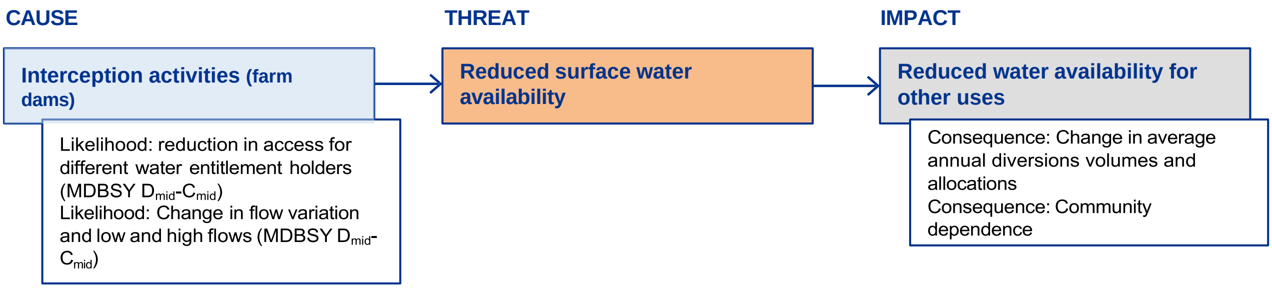


Figure 8-1 Impact pathway showing impact of farm dams on water available for other uses

8.2.1.1. Assigning a consequence score

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).

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 in 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**
NSW Murray high security	N/A	0.9%	N/A
NSW Murray general security	N/A	0.9%	N/A
NSW Murray supplementary	1.0%	N/A	N/A
NSW Murray conveyance	N/A	N/A	N/A
Lower Darling cap diversions	0.4%	N/A	N/A

Reference: SKM 2009
N/A = This metric was not applicable for this type of water access licence

Table 8-3. Consequence results for 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**
NSW Murray high security	N/A	Negligible	N/A
NSW Murray general security	N/A	Negligible	N/A
NSW Murray supplementary	Minor	N/A	N/A
NSW Murray conveyance	N/A	N/A	N/A
Lower Darling cap diversions	Negligible	N/A	N/A

Reference: SKM 2009
N/A = This metric was not applicable for this type of water access licence

8.2.1.2. Determining the likelihood rating

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 4-27). 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 categories identified by SKM (2008) have been adopted for this risk assessment (Table 4-27-Table 4-31). 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 due to farm dam interception in the regulated NSW Murray and Lower Darling River. Likelihood metric estimates the likelihood of insufficient water access.

Water access entitlement holder	Likelihood
NSW Murray high security	Possible
NSW Murray general security	Possible
NSW Murray supplementary	Possible
NSW Murray conveyance	Possible
Lower Darling cap diversions	Possible

Reference: SKM 2009

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). Only a number of unregulated water sources were assessed by this study, they include the Bowna, Jingellic, Maragle and Tooma water sources.

The likelihood method and ratings used for unregulated water sources are listed in Table 4-31 and Table 4-32.

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 4.5.1. 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 4.5.1 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

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 regulated NSW Murray and Lower Darling WRPA is provided in Table 8-5.

Table 8-5. Matrix used to determine risk from potential interception activities to other users in the NSW Murray and Lower Darling regulated water sources.

		Likelihood of insufficient water access				
		Rare	Unlikely	Possible	Probable	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 in the NSW Murray and Lower Darling regulated river as ‘low’ for all types of water access licences (Table 8-6).

Table 8-6. Risks of insufficient water available for different categories of water access licences in the NSW Murray and Lower Darling 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)
NSW Murray high security	Negligible	Possible	Low
NSW Murray general security	Negligible	Possible	Low
NSW Murray supplementary	Minor	Possible	Low
NSW Murray conveyance	N/A	Possible	N/A
Lower Darling cap diversions	Negligible	Possible	Low

Reference: CSIRO 2008b, SKM 2009
N/A = This metric was not applicable for this type of water access licence

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 NSW Murray and Lower Darling 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 NSW Murray and Lower Darling 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 NSW Murray and Lower Darling unregulated river (Table 8-8).

Table 8-8 Risks of insufficient water available for other users in unregulated water sources in the NSW Murray and Lower Darling 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}
Bowna Creek at Yambla 401015	L	L	L	L	L	L	L
Jingellic Creek at Jingellic 401013	L	L	L	L	L	L	L
Maragle Creek at Maragle 401009	M	L	L	L	L	L	L
Tooma River at Pinegrove 401014	M	L	L	L	L	L	L

CV = variation index annual; HF Q_{10} = high flow index; LF Q_{90} = low flow index
* Community dependence on water use

8.2.2. Commercial plantations [O(I-PF)]

Afforestation is defined as the large-scale planting of trees for timber production, carbon offsetting, land conservation or other environmental purposes. The area of commercial forestry plantations in the NSW Murray and Lower Darling is projected to increase by 33,000 ha (62%) by around 2030(CSIRO, 2008b). For more information, refer to section 4.5.2.

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

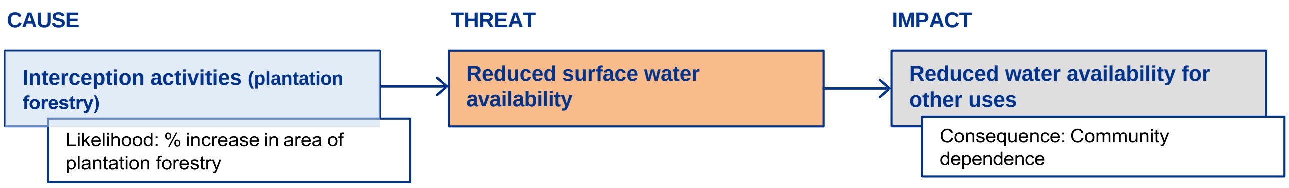


Figure 8-2 Impact pathway showing impact of commercial plantations on water available for other uses.

8.2.2.1. Assigning a consequence score

Regulated river water source

In assigning a consequence level to plantations, 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 NOW (2010) and SKM (2009) adopted indicators that were based on information readily available in the MDBSY reports (CSIRO 2008a, CSIRO 2008b). Further information on this approach is provided in Section 4.5.2.1.

Consequence thresholds (Table 8-1) and data used to assess consequence is presented in Table 8-9 and results are provided in

Table 8-10. Where there was a ‘none’ consequence given to a water access category by SKM (2009), a consequence of ‘nil’ was applied.

Table 8-9. Data used to assess consequences to different types of water access licences in the regulated river due to interception by plantation forestry.

Water access licence type	Consequence		
	% change in average annual diversions	**% change years with 100% allocation**	**% change in years with 0% allocation**
NSW Murray high security	N/A	0.4%	N/A
NSW Murray general security	N/A	0.4%	N/A
NSW Murray supplementary	0.4%	N/A	N/A
NSW Murray conveyance	N/A	N/A	N/A
Lower Darling cap diversions	N/A	N/A	N/A

Reference: SKM 2009
N/A = This metric was not applicable for this type of water access licence

Table 8-10. Consequence results for different types of water access licences in the regulated river due to interception by plantation forestry.

Water access licence type	Consequence		
	% change in average annual diversions	**% change years with 100% allocation**	**% change in years with 0% allocation**
NSW Murray high security	N/A	Negligible	N/A
NSW Murray general security	N/A	Negligible	N/A
NSW Murray supplementary	Negligible	N/A	N/A
NSW Murray conveyance	Nil	Nil	Nil
Lower Darling cap diversions	Nil	Nil	Nil

Reference: SKM 2009

N/A = This metric was not applicable for this type of water access licence

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). The majority of unregulated water sources in the Murray catchment were medium or low dependency. A conservative estimate of 'medium' was used to represent all Murray unregulated water sources. In the Lower Darling, dependency on unregulated water sources was 'low'.

8.2.2.2. Assigning a likelihood score

Regulated river water source

Likelihood ratings were based on the SKM (2009) risk assessment and SKM (2008) which define the overall change that the scenario will have the assessed impact. The approach is outlined in Section 4.5.2.2 and Table 4-27. Likelihood was 'probable' for all water access entitlements (Table 8-11).

Table 8-11. Likelihood results for different types of water access licences due to plantation forestry interception in the regulated NSW Murray and Lower Darling River. Likelihood metric estimates the likelihood of insufficient water access.

Water access entitlement holder	Likelihood
NSW Murray high security	Probable
NSW Murray general security	Probable
NSW Murray supplementary	Probable
NSW Murray conveyance	Probable
Lower Darling cap diversions	Probable

Reference: SKM 2009

Unregulated river water source

As outlined in Section 4.5.2.2, growth in plantation forestry is likely to be small across the WRPA, but potentially significant in specific water sources. As the MDBSY and SKM reports did not report against unregulated water sources, a 'probable' likelihood was applied to all unregulated water sources with the exception of the Lower Darling. This likelihood reflects the likelihood applied to regulated water users and provides a conservative estimate for unregulated water users in the NSW Murray catchment. The Lower Darling has negligible plantation forestry and was therefore assessed as 'rare' (Table 4-28).

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

8.2.2.3. Risk outcomes

The combined consequence and likelihood ratings using the risk matrix outlined in Section 4.5.2.4 (Table 4-41) are presented in Table 8-12. For regulated water users, the risk level is 'medium' although the consequence was negligible. The risk level for Murray unregulated water users is 'low' in the lower Murray-Darling and mid-Murray and 'high' in the upper Murray.

Table 8-12 Risks of insufficient water available for other water users in regulated and unregulated water sources in the NSW Murray and Lower Darling Surface WRPA as a result of plantation forests [O(I-PF)].

	Consequence	Likelihood	Overall risk rating - O(I-PF)
NSW Murray high security	Negligible	Probable	Low
NSW Murray general security	Negligible	Probable	Low
NSW Murray supplementary	Negligible	Probable	Low
NSW Murray conveyance	Nil	Probable	Nil
Lower Darling cap diversions	Nil	Probable	Nil
Upper Murray unregulated water sources	Medium	Probable	High
Lower Murray-Darling and mid-Murray unregulated water sources	Low	Rare	Low

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

Mining activities in the NSW Murray and Lower Darling catchment currently comprise of less than one percent of the total catchment area (DoI Water 2018). There are currently no coal mines operating in the NSW Murray and Lower Darling catchment; there is limited published information available on the distribution and properties of the resources in the NSW Murray and Lower Darling (Murray CMA, 2013). Additionally, no commercial coal seam gas extraction has occurred or is currently occurring in the NSW Murray and Lower Darling catchment.

The impact pathway for mining activities impacting on water availability for other uses is described in Figure 8-3.

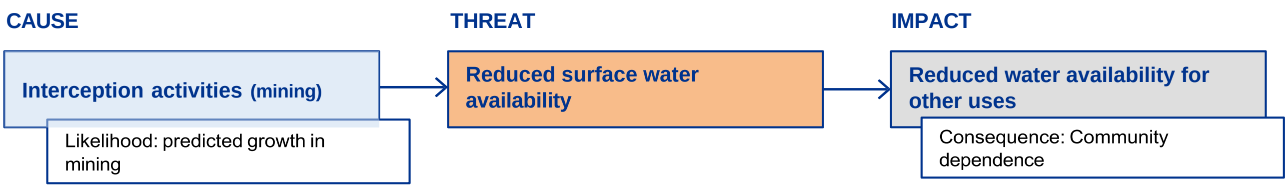


Figure 8-3 Impact pathway showing impact of mining on water available for other uses.

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 licensing 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.

The NSW Murray and Lower Darling subregion does not have any significant areas of mining nor growth in mining (NSW Resources and Geoscience (2019). Therefore, the risk of mining causing impacts to structural integrity that lead to reduced surface water for other water users is '**low**'. Note that risks to the structural integrity of groundwater systems are assessed as part of the *Darling Alluvium Risk Assessment* and the *Murray Alluvium Risk Assessment.*.

Table 8-13 Risks of insufficient water available for other water users in regulated and unregulated water sources in the NSW Murray and Lower Darling 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 (DPI Water 2017) are converting this form of take into a licensable right. Floodplain harvesting activities in the NSW Murray and Lower Darling catchment are described in Section 4.5.4.

8.2.4.1. Assigning a consequence score

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

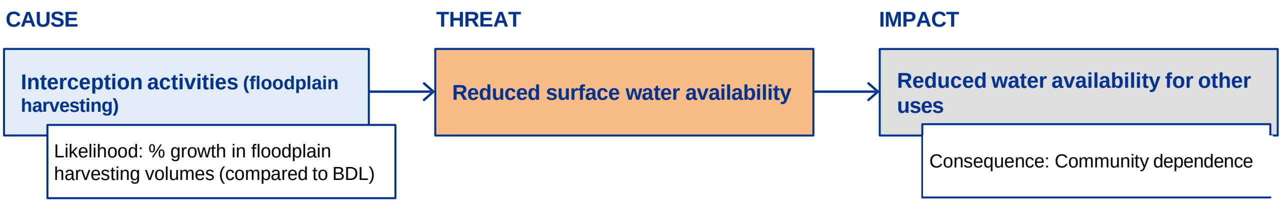


Figure 8-4 Impact pathway showing impact of floodplain harvesting on water available for other uses.

Unregulated river water sources

The consequence scores for each unregulated water source are based on community dependence on water use within each water source (NOW 2011). The majority of unregulated water sources in the Murray catchment were medium or low dependency. A conservative estimate of 'medium' was used to represent all Murray unregulated water sources. In the Lower Darling, dependency on unregulated water sources was 'low'.

8.2.4.2. 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). There is no material floodplain harvesting activity occurring in the NSW Murray and Lower Darling WRPA and the risk of future growth in this area is very low due to the absence of on farm storage facilities and the lack of supplementary access entitlements that have been a key driver for the development of on farm storage facilities in northern basin valleys. Therefore, we have defined the likelihood as 'nil' for both unregulated and regulated water sources. The likelihood metrics are defined in Table 4-44.

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 8-14.

Table 8-14 Risk matrix to determine risk outcomes of increased floodplain harvesting to other water users.

		Likelihood (% growth in FPH)		
		Low	Medium	High
Consequence (community dependence)	Low	Low	Low	Medium
	Medium	Low	Medium	High
	High	Medium	High	High

Combining the consequence and likelihood ratings resulted in 'nil' overall risk level to other water users in the regulated water source and in the unregulated water sources (Table 8-15).

Table 8-15 Risks of insufficient water available for other water users in regulated and unregulated water sources in the NSW Murray and Lower Darling Surface WRPA as a result of floodplain harvesting [O(I-FH)].

Water source	Consequence	Likelihood	Overall risk rating - O(I-M)
Regulated river water source	High	Nil	Nil
Murray unregulated river water sources	Medium	Nil	Nil
Lower Darling unregulated river water sources	Low	Nil	Nil

8.3. Risk to other water users due to climate change [O(CC)]

As discussed in section 4.6, there has been 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.

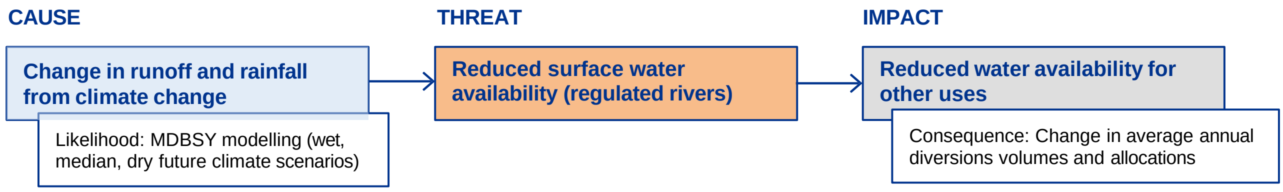


Figure 8-5. Impact pathway showing impact of change in climate on ability to meet other water user's water requirements.

8.3.1. Assigning a consequence rating

Regulated river water source

In assigning a consequence level from climate change, the approach undertaken by the NSW Office of Water (NOW 2010) was applied in this current risk assessment. This approach 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 MDBSY reports covered a range of possible 2030 climate scenarios (CSIRO 2008a, CSIRO 2008b). 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 NSW Office of Water (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 NSW report, *Assessment of Risk to NSW Murray-Darling Basin Shared Water Resources - 2008* (NOW 2010, SKM 2009) and shown in Table 8-2. Data used to assess consequence is presented in Table 8-16; results are provided in Table 8-17.

Table 8-16. Data used to assess consequences to different types of water access licences in the NSW Murray and Lower Darling regulated river due to climate change.

Water access licence type	% change in years with 100% allocation
Wet climate change scenario	
NSW Murray high security	N/A
NSW Murray general security	N/A
NSW Murray supplementary	-5%
NSW Murray conveyance	N/A
Lower Darling cap diversions	N/A
Median climate change scenario	
NSW Murray high security	-16%
NSW Murray general security	-17%

NSW Murray supplementary	-14%
NSW Murray conveyance	-6%
Lower Darling cap diversions	-7%
Dry climate change scenario	
NSW Murray high security	-59%
NSW Murray general security	-60%
NSW Murray supplementary	-55%
NSW Murray conveyance	-19%
Lower Darling cap diversions	-29%

Reference: SKM 2009
N/A = data not available

Table 8-17. Consequence results for different types of water access licences in the NSW Murray and Lower Darling regulated river.

Water access licence type	Consequence
Wet climate change scenario	
NSW Murray high security	Negligible*
NSW Murray general security	Minor
NSW Murray supplementary	Minor
NSW Murray conveyance	Negligible*
Lower Darling cap diversions	Negligible*
Median climate change scenario	
NSW Murray high security	Moderate
NSW Murray general security	Moderate
NSW Murray supplementary	Moderate
NSW Murray conveyance	Minor
Lower Darling cap diversions	Minor
Dry climate change scenario	
NSW Murray high security	Severe
NSW Murray general security	Severe
NSW Murray supplementary	Major
NSW Murray conveyance	Moderate

Lower Darling cap diversions	Major

Reference: SKM 2009

N/A = no data available

*SKM (2009) defined the consequence as ‘none’ for this licence class, which meant that no measurable change was expected. This has been altered to ‘negligible’ for this report to maintain consistency with the SKM (2008) risk matrix

Unregulated river water source

The consequence scores for each unregulated water source are based on community dependence on water use within each water source (NOW 2011). The majority of unregulated water sources in the Murray catchment were medium or low dependency. Consequence outcomes for each water source are provided below (Table 8-18).

Table 8-18. Consequence results for other water users in unregulated water sources of the NSW Murray and Lower Darling Surface WRPA.

Unregulated water source	Consequence (community dependence)
Albury	M
Dora Dora	L
Hume	L
Indi	M
Jingellic	L
Lower Wangamong	L
Majors	L
Mannus	H
Maragle	M
Ournie Welaregang	L
Swampy Plain	M
Tooma	M
Tumbarumba	M
Upper Murray	M
Murray Below Mulwala	M
Lower Murray Darling	L

Reference: NOW 2011

8.3.2. Determining the likelihood rating

Regulated river water source

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 4-49). Likelihood rankings are provided in Table 8-19.

Table 8-19. Likelihood results for different types of water access licences in the NSW Murray and Lower Darling regulated river under different climate change scenarios. Likelihood metric estimates the likelihood of insufficient water access.

Water access licence type	Likelihood
Wet climate change scenario	
NSW Murray high security	Rare
NSW Murray general security	Rare
NSW Murray supplementary	Rare
NSW Murray conveyance	Rare
Lower Darling cap diversions	Rare
Median climate change scenario	
NSW Murray high security	Possible
NSW Murray general security	Possible
NSW Murray supplementary	Possible
NSW Murray conveyance	Possible
Lower Darling cap diversions	Possible
Dry climate change scenario	
NSW Murray high security	Probable
NSW Murray general security	Probable
NSW Murray supplementary	Probable
NSW Murray conveyance	Probable
Lower Darling cap diversions	Probable

Reference: SKM 2009

Unregulated river water source

The three climate change scenarios outlined in Table 4-50 and Table 4-51 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. The change to mean annual runoff under this scenario was estimated to be a 37% reduction. Therefore, a ‘medium’ likelihood category was assigned to all water sources.

8.3.3. Risk outcomes

Regulated river water source

As discussed earlier, the wet climate change scenario is predicted to increase mean annual runoff by 7%, but there is a predicted 37% and 10% reduction in inflows for the dry and median climate change scenarios respectively, see section 4.6. The risk matrix used to determine the risk rating of flow alteration from change in climate impacting the availability of water for other uses in the NSW Murray and Lower Darling regulated river is provided in Table 8-20.

Table 8-20. Matrix used to determine risk from potential change in climate.

Consequence (%change in water use)		Likelihood of 2030 projected hydrologic change from baseline (insufficient water access, modelled C runs)				
		Rare	Unlikely	Possible	Probable	Almost Certain
	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 8-17 and Table 8-19) results in the overall risk levels to other users from climate change are shown in Table 8-21. The risk assessment determined a ‘low’ risk under the wet scenario and a mixture of ‘low’ and ‘medium’ risks under a median scenario. Under a dry climate change scenario, NSW Murray general security, NSW Murray high security, NSW Murray conveyance and Lower Darling cap diversions are at ‘high’ risk of a reduction in inflows.

Table 8-21. Risks to different types of water access licences in the NSW Murray and Lower Darling regulated river under different climate change scenarios [O(CC)].

Water access licence type	Consequence	Likelihood	Risk level – O(CC)
Wet climate change scenario			
NSW Murray high security	Negligible	Rare	Low
NSW Murray general security	Minor	Rare	Low
NSW Murray supplementary	Minor	Rare	Low
NSW Murray conveyance	Negligible	Rare	Low
Lower Darling cap diversions	Negligible	Rare	Low
Median climate change scenario			
NSW Murray high security	Moderate	Possible	Medium
NSW Murray general security	Moderate	Possible	Medium
NSW Murray supplementary	Moderate	Possible	Medium
NSW Murray conveyance	Minor	Possible	Low
Lower Darling cap diversions	Minor	Possible	Low
Dry climate change scenario			

NSW Murray high security	Severe	Probable	High
NSW Murray general security	Severe	Probable	High
NSW Murray supplementary	Major	Probable	High
NSW Murray conveyance	Moderate	Probable	High
Lower Darling cap diversions	Major	Probable	High

Reference: NOW 2010

Unregulated river water source

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 4-54. Combining the unregulated consequence (Table 8-18) and likelihood outcomes results in 'medium' and 'low' risks to a number of unregulated water sources (Table 8-22).

Table 8-22 Risks of insufficient water available for other water users in unregulated river sections in the NSW Murray and Lower Darling Surface WRPA as a result of climate change [O(CC)]

Unregulated water source	Consequence (community dependence)	Likelihood	Overall risk rating – O(CC)
Albury	M	M	Medium
Dora Dora	L	M	Low
Hume	L	M	Low
Indi	M	M	Medium
Jingellic	L	M	Low
Lower Wangamong	L	M	Low
Majors	L	M	Low
Mannus	H	M	Medium
Maragle	M	M	Medium
Ournie Welaregang	L	M	Low
Swampy Plain	M	M	Medium
Tooma	M	M	Medium
Tumbarumba	M	M	Medium
Upper Murray	M	M	Medium
Murray Below Mulwala	M	M	Medium
Lower Murray Darling	L	M	Low

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 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 4.4.

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 NSW Murray and Lower Darling WRPA.

8.4.1. Assigning a consequence rating

Regulated river water source

For regulated reaches, a ‘High’ consequence (i.e. high community dependence) was assigned to all reaches.

Unregulated river water source

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 8-23. Consequence ratings are shown in Table 8-24. 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 8-23. Consequence metrics for increased extraction by BLR in unregulated water sources in the NSW Murray and Lower Darling 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
Data source: NSW Water Register; https://waterregister.waternsw.com.au/water-register-frame		

Table 8-24. Consequence ratings for increased extraction by BLR in unregulated water sources in the NSW Murray and Lower Darling WRPA.

Water source	Consequence rating
Albury	Low
Dora Dora	Low
Hume	Low
Indi	Low
Jingellic	Low
Lower Murray Darling	High
Lower Wangamong	Low
Majors	Low
Mannus	Low
Maragle	Low
Murray below Mulwala	High
Ournie Welaregang	Low
Swampy Plain	Low
Tooma	Low
Tumbarumba	Low
Upper Murray River	Low
N/A = no data available	

8.4.2. Determine the likelihood rating

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. In extremely dry periods, BLR supply may be restricted due to lower than normal inflows into storages. This is extremely unlikely in the Murray River due to the large storage volumes across the catchment. However, any growth in BLR in the Lower Darling river could impact other BLR users during extreme dry events.

As there is no pathway for impact on water for other users from BLR extraction in the Murray regulated river sections, and a ‘nil’ likelihood has been assigned to the regulated Murray River. A ‘low’ likelihood was given to the regulated Lower Darling river to reflect the possibility of impacts on Lower Darling water users during extreme dry events.

Unregulated river water source

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 8-25. Consequence ratings are shown in Table 8-26.

Table 8-25. Likelihood metrics for increased extraction by BLR in unregulated water sources in the NSW Murray and Lower Darling 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
Data source: NSW Water Register; https://waterregister.waternsw.com.au/water-register-frame		

Table 8-26. Likelihood ratings for increased extraction by BLR in unregulated water sources in the NSW Murray and Lower Darling WRPA.

Water source	Likelihood rating
Albury	Low
Dora Dora	Low
Hume	Low
Indi	Low
Jingellic	Low
Lower Murray Darling	Low
Lower Wangamong	Low
Majors	Low
Mannus	Low
Maragle	Low
Murray below Mulwala	Low
Ournie Welaregang	High
Swampy Plain	Low
Tooma	Low
Tumbarumba	Low
Upper Murray River	Low
* Where likelihood information was unavailable a qualitative approach determined the likelihood for that flow characteristic. This was based on expert opinion and likelihood from the nearest gauge was used.	

8.4.3. Existing water management actions & 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

Regulated water source

Combining the consequence and likelihood outcomes results in a 'nil' risk to the NSW Murray regulated and a 'low' risk to the Lower Darling regulated water sources (Table 8-27).

Table 8-27 Risk of increased BLR extraction impacting on water available for other water users in the regulated water source of the NSW Murray and Lower Darling Surface WRPA [O(BLR)].

	Consequence	Likelihood	Overall risk rating - O(BLR)
NSW Murray regulated river water source	High	Nil	Nil
Lower Darling regulated river water source	High	Low	Low

Unregulated water source

The risk matrix used to determine the risk to water availability for other users due to growth in BLR extraction is provided in Table 8-28.

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 8-28. 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 8-24 and Table 8-26) results in the overall risk being low for all unregulated water sources in the NSW Murray and Lower Darling WRPA (Table 8-29) except for Ournie Welaregang water source, which had a medium risk level. Albury, Lower Wangamong and Majors water sources returned a ‘not applicable’ result due to the absent of data in either of the two rating categories.

Table 8-30 shows data on BLR volumes and entitlement volumes for the Ournie Welaregang water source which returned a medium risk. Ournie Welaregang water source has a high BLR estimate compared to entitlement.

There is potential in Ournie Welaregang water source for any growth in BLR to reduce water made available to entitlement holders due to the priority of access set by legislation in NSW. Although total entitlement volumes are low, as they are held by one or only a few licensees, any growth to BLR could substantially affect their entitlement.

Table 8-29. Risks of increased BLR extraction to other water users in unregulated water sources in the NSW Murray and Lower Darling WRPA [O(BLR)].

Water source	Consequence rating	Likelihood rating	Risk level – O(BLR)
Albury	Low	Low	Low
Dora Dora	Low	Low	Low
Hume	Low	Low	Low
Indi	Low	Low	Low
Jingellic	Low	Low	Low
Lower Murray Darling	High	Low	Low
Lower Wangamong	Low	Low	Low
Majors	Low	Low	Low
Mannus	Low	Low	Low
Maragle	Low	Low	Low
Murray below Mulwala	High	Low	Low
Ournie Welaregang	Low	High	Medium
Swampy Plain	Low	Low	Low
Tooma	Low	Low	Low
Tumbarumba	Low	Low	Low
Upper Murray River	Low	Low	Low

* Where likelihood information was unavailable a qualitative approach determined the likelihood for that flow characteristic. This was based on expert opinion and likelihood from the nearest gauge was used.

Table 8-30. BLR and entitlement volumes for medium and high risk water sources in the NSW Murray and Lower Darling WRPA.

Water source	BLR rights[1] (ML/yr)	Total entitlement[2] (ML/yr)	Number of WALs
Ournie Welaregang	40.3	13	3
References: *1 Water Sharing Plan for the Murray Unregulated and Alluvial Water Sources 2011 (2011)* 2 Department of Planning, Industry and Environment - Water 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(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 Table 9-1. Defining tolerable risk results (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) at the start of this document.

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 NSW Murray and Lower Darling 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 impact 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 8.2 below.

For detailed information on the application of the options and strategies applied to individual risk results see the consolidated risk table (Table 1 of the Executive Summary). 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.

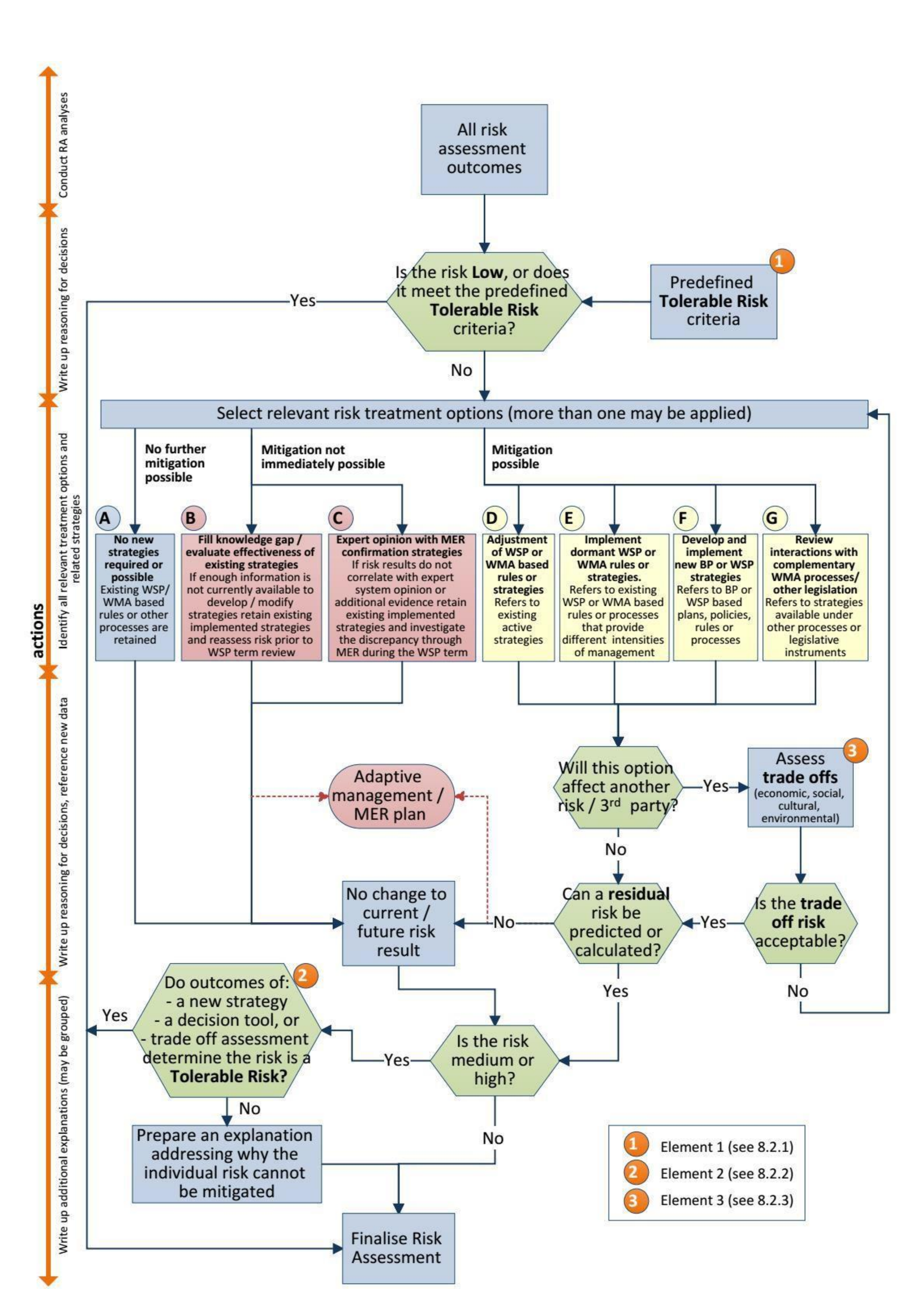


Figure 9-1. Risk treatment pathway.

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.
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 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 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 Department of Planning and Environment-Water 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 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 Murray Unregulated and Alluvial Water Sources 2011 Background Document, DPI Water 2012
Water Sharing Plan for the Lower Murray-Darling Unregulated and Alluvial Water Sources 2011 Background Document, DPI Water
Water Sharing Plan for the NSW Murray and Lower Darling Regulated Rivers Water Sources 2016 Background Document, DPI Water
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

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 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.* 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 9-3lists 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.

<table>
<tr><th>Risk</th><th>Component</th><th>Tolerable rationale</th></tr>
<tr><td rowspan="7">E(W) Risk to water available for the environment due to river regulation and licensed extraction (regulated rivers)</td><td>Zero flows</td><td>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 Hume Dam, Menindee Lakes and other major weirs. Zero flow periods will exhibit more natural patterns towards the downstream end of the water source.</td></tr>
<tr><td rowspan="2">Base flows</td><td>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 is most pronounced in reaches closest to Hume Dam and other major weirs on the regulated river system. Base flow periods will exhibit more natural patterns towards the downstream end of the water source.</td></tr>
<tr><td>There are no unregulated NSW tributaries in the river reach below Hume Dam to supplement PEW or HEW releases to order to achieve base flows. The ability to mitigate the likelihood is low, hence the risk is tolerable.</td></tr>
<tr><td rowspan="2">Fresh flows</td><td>Water ordering patterns have altered the duration and timing of freshes leading to unnaturally long events in summer and less events in winter. This impact is most pronounced in the regulated Murray River between the Hume Dam and the South Australian border.</td></tr>
<tr><td>There are no unregulated NSW tributaries in the river reach below Hume Dam to supplement PEW or HEW releases to order to achieve fresh full or over bank flows. The ability to mitigate the likelihood is low, hence the risk is tolerable.</td></tr>
<tr><td rowspan="2">Bank full flows
ARI 1.5</td><td>Water ordering patterns have altered the duration and timing of bank full events, leading to more events in summer and less events in winter. This impact is most pronounced in the regulated reaches downstream of Hume Dam.</td></tr>
<tr><td>There are no unregulated NSW tributaries in the river reach below Hume Dam or Menindee Lakes to supplement PEW or HEW releases to order to achieve bank full or over bank flows. The ability to mitigate the likelihood is low, hence the risk is tolerable.</td></tr>
</table>

Risk	Component	Tolerable rationale
		Due to release constraints in the Murray and Lower Darling regulated system the ability to mitigate ARI 1.5 flows in many regulated reaches is not possible
		If the medium or high risk result is driven by a low likelihood and but a high or very high ecological consequence. The risk is tolerable because of the low likelihood.
	Over bank flows ARI 2.5	River regulation, water ordering patterns, and third party inundation risks prevent an increase in the frequency of 2.5 ARI flows
		There are no unregulated NSW tributaries in the river reach below Hume Dam or Menindee Lakes to supplement PEW or HEW releases to order to achieve bank full or over bank flows. 2.5 year ARI flows are unlikely to be returned via discretionary or non-discretionary environmental water due to the magnitudes required. The ability to mitigate the likelihood is low, hence the risk is tolerable.
		Due to release constraints in the Murray and Lower Darling regulated system the ability to mitigate ARI 2.5 flows in many regulated reaches is not possible
		If the medium or high risk result is driven by a low likelihood and but a high or very high ecological consequence. The risk is tolerable because of the low likelihood.
	Over bank flows ARI 5	River regulation, water ordering patterns, and third party inundation risks prevent an increase in the frequency of 5 ARI flows
		There are no unregulated NSW tributaries in the river reach below Hume Dam or Menindee Lakes to supplement PEW or HEW releases to order to achieve bank full or over bank flows. 5.0 year ARI flows are unlikely to be returned via discretionary or non-discretionary environmental water due to the magnitudes required. The ability to mitigate the likelihood is low, hence the risk is tolerable.
		Due to release constraints in the Murray and Lower Darling regulated system the ability to mitigate ARI 5.0 flows in many regulated reaches is not possible
		If the medium or high risk result is driven by a low likelihood and but a high or very high ecological consequence. The risk is tolerable because of the low likelihood.

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 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 F. 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).
	WRPs are cost neutral for NSW licence holders

Delivering WRP Plans for NSW Roadmap 2016-2019	Development of WRPs minimises change to NSW WSPs within their initial ten 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 Strategic use of the Lower Darling Environmental Water Allowance (the Lower Darling Allowance), or the Barmah-Millewa Allowance (BMA), or the Barmah-Millewa Overdraw (BMO), or the Murray Additional Environmental Allowance (Murray AEA), or River Murray Increased Flows (RMIF) and held environmental water licences as described in the LTWP and Annual Environmental Water Plans	Risk: Risk to the environment and risk to the capacity to meet environmental water requirements from insufficient water. Risk driver addressed: Reduced frequency, duration, magnitude and altered seasonality of freshes and over bank flows the regulated river. Locations: Regulated rivers and downstream unregulated water sources Benefits: Improved pattern of freshes and possibly overbank flows (location dependent) through improved environmental water management.
N3 Improve environmental water delivery by implementing the Constraints Management and Supply Projects within the Murray and Lower Darling key focus areas	Risk: Risk to the environment and risk to the capacity to meet environmental water requirements from insufficient water and inability to deliver EWRs. Risk driver addressed: Reduced frequency, duration, magnitude and altered seasonality of freshes and over bank flows in the regulated river. Locations: Regulated rivers and downstream unregulated water sources Benefits: Improved hydrograph, pattern of freshes and possibly overbank flows (location dependent) through improved environmental water delivery.
N4 Protection of environmental water from extraction by implementing the prerequisite policy measures into the WSP	Risk: Risk to the environment and risk to the capacity to meet environmental water requirements from loss of return flows and less effective water delivery. Risk driver addressed: Reduced frequency, duration, magnitude and altered seasonality of freshes and over bank flows the regulated river. Locations: Regulated rivers and downstream unregulated water sources Benefits: Improved discretionary water accounting and delivery for freshes and possibly overbank flows (location dependent) through improved environmental water protection. This strategy applies to the NSW Murray River Source only.
N5 Investigate opportunities to implement Weir Pool Manipulation in the Murray River	Risk: Risk to the environment and risk to the capacity to meet environmental water requirements from lack of flow variability in weir pools. Risk driver addressed: Reduced variability in velocity within weir pools. Locations: Weir pools on regulated rivers. Benefits: Improved habitat variability within weir pools.

Mechanism	Description
N6 Strategic use of the Lower Darling River Flow Restart Allowance	Risk: Deteriorated water quality in the Lower Darling after a period of no flow (10 consecutive days) requires sufficient volumes to 'restart the river'. Risk driver addressed: Risk to the environment and water users due to the inability to return base flows of sufficient water quality to the Lower Darling river after a no flow period of 10 or more days. Locations: Lower Darling River from Weir 32 to Burtundy Benefits: Improved water quality after a cease to flow event

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
K1 Improve knowledge used to assess risk in unregulated sections of the WRP area.	N8 Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies 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. *Note: N8 may also be used in conjunction with N9*
K2 Improve knowledge of effectiveness of existing strategies	N9 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. In this WRP area those water sources are: Tooma, Mannus, Hume and Albury *Note: where N9 applies, N8 also applies*
K3 Improve knowledge and develop new strategies	N10 No current mechanism available. Further knowledge required to improve strategies. The risk assessment defines the risk as not tolerable, however no current strategies exist and require further development. In this WRP area those water sources are: Darling River @ below Menindee, Darling Burtundy, and Great Darling Anabranch @ Redbank

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 NSW Murray and Lower Darling Long-term Water Plan Technical Report (Department of Planning, Industry and Environment-Conservation and Biodiversity 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.

Strategies	Water management actions and mechanisms / supporting activities	RTO	Associated management plan or instrument	Relevant risks & 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 Lower Murray into South Australia and connectivity between the Lower Darling and the NSW Murray Watercourse 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	D A F	*Water Sharing Plan for the New South Wales Murray and Lower Darling Regulated Rivers Water Sources 2016* *Water Sharing Plan for the Murray Unregulated River Water Sources 2011* *Water Sharing Plan for the Lower Murray-Darling Unregulated River Water Source 2011* NSW Murray and Lower Darling Water Resource Plan	**E(W)** Z, BF, F, BKF1.5, OB1, OB2, OB2.5, OB3, OB4, OB5, D, F **EWR ref.** LTWP CF1, LTWP VF1, LTWP BF1, LTWP BF2, LTWP BF3, LTWP NFF1, LTWP WP1, LTWP WP2, LTWP SF1, LTWP SF2, LTWP LF1, LTWP LF2, LTWP LF3,	**4.03(3)** **(a)(iii)** **(a)(iv)** **(c)** **(f)** **Ch. 10 Part 3, Part 8 Part 10**	**WSP** 1-4
	E3 Require all take to be licensed except for BLR. E4 Extraction limits for individual extractors and associated accounting provisions to manage extraction at the extraction point.	A	*Water Sharing Plan for the New South Wales Murray and Lower Darling Regulated Rivers Water Sources 2016* *Water Sharing Plan for the Murray Unregulated River Water Sources 2011* *Water Sharing Plan for the Lower Murray-Darling Unregulated River Water Source 2011*			

Strategies	Water management actions and mechanisms / supporting activities	RTO	Associated management plan or instrument	Relevant risks & EWR ref	Relevant BP clauses	Relevant objectives
	E5 Compliance with individual extraction limits	D	Water Take Measurement and Metering Policy	LTWP LF4, LTWP OB1, LTWP OB2, LTWP OB3, LTWP OB4, LTWP OB5, LTWP OB6, LTWP OB7, LTWP OB8		
	E6 Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage entitlement growth. E7 Prohibit trade between surface water and groundwater sources.	A	*Water Sharing Plan for the New South Wales Murray and Lower Darling Regulated Rivers Water Sources 2016* *Water Sharing Plan for the Murray Unregulated River Water Sources 2011* *Water Sharing Plan for the Lower Murray-Darling Unregulated River Water Source 2011*			
2 Protect a portion of high flow events in the Lower Darling and Murray 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, * allow flows to pass through to the South Australian River Murray WRP (SW6) area. This strategy provides connectivity between WRP areas and facilitates fish movement and recruitment.	E8 Supplementary access to natural flow events may be permitted once flows are in excess of those required by the WSP	A	*Water Sharing Plan for the New South Wales Murray and Lower Darling Regulated Rivers Water Sources 2016*	**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 BF3, LTWP NFF1, LTWP WP1, LTWP WP2, LTWP SF1, LTWP SF2, LTWP LF1, LTWP LF2, LTWP LF3,	**4.03(3)** **(a)(i)** **(a)(ii)** **(a)(iv)** **(c)** **(d)** **Ch. 10 Part 6 Part 7**	**WSP** 1-4

Strategies	Water management actions and mechanisms / supporting activities	RTO	Associated management plan or instrument	Relevant risks & EWR ref	Relevant BP clauses	Relevant objectives
				LTWP LF4, LTWP OB1, LTWP OB2, LTWP OB3, LTWP OB4, LTWP OB5, LTWP OB6, LTWP OB7, LTWP OB8		
3 Provide discretionary environmental watering events in the regulated river and downstream unregulated river sections of the WRP area. This strategy offsets some effects of river regulation on the environment and aims to: * protect refuge pools during dry periods, * facilitate fish recruitment and movement, * wet benches, banks and wetlands to facilitate vegetation growth and recruitment, * mobilise carbon and nutrients from channels, river benches and wetlands in the NSW Murray and Lower Darling regulated water source, * reduce prolonged accumulation of organic material on floodplains.	E8 Supplementary access to natural flow events may be permitted once flows are in excess of those required by the WSP.	A	*Water Sharing Plan for the New South Wales Murray and Lower Darling Regulated Rivers Water Sources 2016* NSW Murray and Lower Darling Long Term Water Plan	**E(W)** Z, BF, F, BKF1.5, OB1, OB2, OB2.5, OB3, OB4, OB5, D, F **E(WQ)** TP TN **EWR ref.** LTWP CF1, LTWP VF1, LTWP BF1, LTWP BF2, LTWP BF3, LTWP NFF1, LTWP WP1, LTWP WP2, LTWP SF1, LTWP SF2, LTWP LF1, LTWP LF2,	**4.03(3) (a)(i) (a)(ii) (a)(iv) (c)** **Ch. 10 Part 6 Part 7**	**WSP** 1-4
	E9 Strategic use of one or more of the Barmah-Millewa Allowance (BMA), Barmah-Millewa Overdraw (BMO), Murray Additional Environmental Allowance (Murray AEA), or the Lower Darling Environmental Water Allowance (the Lower Darling Allowance) as described in the WSP. N2 Strategic use of one or more of the Barmah-Millewa Allowance (BMA), Barmah-Millewa Overdraw (BMO), Murray Additional Environmental Allowance (Murray AEA), River Murray Increased Flows (RMIF) or the Lower Darling Environmental Water Allowance (the Lower Darling Allowance) and held environmental water licences as described in the	 A	*Water Sharing Plan for the New South Wales Murray and Lower Darling Regulated Rivers Water Sources 2016* NSW Murray and Lower Darling Annual Environmental Water Plans NSW Murray and Lower Darling Long Term Water Plan			

Strategies	Water management actions and mechanisms / supporting activities	RTO	Associated management plan or instrument	Relevant risks & EWR ref	Relevant BP clauses	Relevant objectives
	LTWP and Annual Environmental Water Plans			LTWP LF3, LTWP LF4, LTWP OB1, LTWP OB2, LTWP OB3, LTWP OB4, LTWP OB5, LTWP OB6, LTWP OB7, LTWP OB8		
	N3 Protection of environmental water from extraction by implementing the prerequisite policy measures into the WSP.	F	Pre-requisite Policy Measures Implementation Plan			
	N4 Improve environmental water delivery by implementing the ConstraintsManagement Strategies withinthe Murray and Lower Darling key focus areas	F	Sustainable Diversion Limit Adjustment Mechanism Constraints Management Strategy 2013 to 2024			
4 Manage environmental water to meet flow targets specified in the NSW Murray and Lower Darling LTWP. This strategy aims to improve environmental water management in the WRP area.	N3 Protection of environmental water from extraction by implementing the prerequisite policy measures into the WSP.	F	*Water Sharing Plan for the New South Wales Murray and Lower Darling Regulated Rivers Water Sources 2016*	**E(W)** Z, BF, F, BKF1.5, OB2.5, OB5 **EWR ref.** LTWP CF1, LTWP VF1, LTWP BF1, LTWP BF2, LTWP BF3, LTWP NFF1, LTWP WP1, LTWP WP2, LTWP SF1, LTWP SF2, LTWP LF1, LTWP LF2, LTWP LF3, LTWP LF4, LTWP OB1, LTWP OB2,	**4.03(3) (a)(i) (a)(iv) (c)** **Ch. 10 Part 6**	**WSP** 4
		F	Pre-requisite Policy Measures Implementation Plan			
	E8 Supplementary access to natural flow events may be permitted once flows are in excess of those required by the WSP.	A	*Water Sharing Plan for the New South Wales Murray and Lower Darling Regulated Rivers Water Sources 2016*			
	E10 Coordinate release of one or more of the Barmah-Millewa Allowance, Barmah-Millewa Overdraw, Murray Additional Environmental Allowance, River Murray Increased Flows (RMIF) or the Lower Darling Environmental Water Allowance (the Lower Darling Allowance) and held environmental water with natural flow events.	A	*Water Sharing Plan for the New South Wales Murray and Lower Darling Regulated Rivers Water Sources 2016* NSW Murray and Lower Darling Annual Environmental Water Plans NSW Murray and Lower Darling Long Term Water Plan			

Strategies	Water management actions and mechanisms / supporting activities	RTO	Associated management plan or instrument	Relevant risks & EWR ref	Relevant BP clauses	Relevant objectives
	N4 Improve environmental water delivery by implementing the ConstraintsManagement Strategies withinthe Murray and Lower Darling key focus areas	F	Sustainable Diversion Limit Adjustment Mechanism Constraints Management Strategy 2013 to 2024	LTWP OB3, LTWP OB4, LTWP OB5, LTWP OB6, LTWP OB7, LTWP OB8		
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 replenishment flows may provide incidental environmental benefit in line with this strategy.*	E11 Cease-to-pump rules for streams, in-stream pools and off-river pools.	A	*Water Sharing Plan for the New South Wales Murray and Lower Darling Regulated Rivers Water Sources 2016*	**E(W)** Z, BF, F **EWR ref.** LTWP CF1, LTWP VF1, LTWP BF1, LTWP BF2, LTWP BF3, LTWP NFF1, LTWP WP1, LTWP WP2, LTWP SF1, LTWP SF2	**4.03(3)** **(a)(i)** **(a)(ii)** **(a)(iv)** **(c)** **(d)** **Ch. 10 Part 4, Part 6**	**WSP** 1-4
	E9 Strategic use of one or more of the Barmah-Millewa Allowance (BMA), Barmah-Millewa Overdraw (BMO), Murray Additional Environmental Allowance (Murray AEA), or the Lower Darling Environmental Water Allowance (the Lower Darling Allowance) as described in the WSP.	A	*Water Sharing Plan for the New South Wales Murray and Lower Darling Regulated Rivers Water Sources 2016* NSW Murray and Lower Darling Annual Environmental Water Plans NSW Murray and Lower Darling Long Term Water Plan			
	N2 Strategic use of one or more of the Barmah-Millewa Allowance (BMA), Barmah-Millewa Overdraw (BMO), Murray Additional Environmental Allowance (Murray AEA), River Murray Increased Flows (RMIF) or the Lower Darling Environmental Water Allowance (the Lower Darling Allowance) and held environmental water licences as described in the LTWP and Annual Environmental Water Plans N7 Strategic use of the Lower Darling River Flow Restart Allowance	F				
	Note: Complimentary groundwater actions and mechanisms are identified	F	Darling Alluvium (GW7), the Murray Alluvium (GW8), NSW Murray-Darling			

Strategies	Water management actions and mechanisms / supporting activities	RTO	Associated management plan or instrument	Relevant risks & EWR ref	Relevant BP clauses	Relevant objectives
	in the Darling Alluvium (GW7), the Murray Alluvium (GW8), NSW Murray-Darling Basin Porous Rock (GW6) and the NSW Murray-Darling Basin Fractured Rock (GW11) WRPAs		Basin Porous Rock (GW6), and the NSW Murray-Darling Basin Fractured Rock (GW11) Water Resource Plans			
6 Protect pools in streams, wetlands, lagoons and floodplains within the WRP area during dry periods. This strategy offsets impacts of water extraction from pools and aims to maintain natural rates of drying to protect water quality, and provide refugial habitat for fish, frogs and other water-dependent biota.	E11 Cease-to-pump rules for streams, in-stream pools and off-river pools.	A	*Water Sharing Plan for the Murray Unregulated River Water Sources 2011* *Water Sharing Plan for the Lower Murray-Darling Unregulated River Water Source 2011*	**E(W)** Z, BF, F **E(WQ)** all **EWR ref.** LTWP CF1, LTWP VF1, LTWP BF1, LTWP BF2, LTWP BF3, LTWP NFF1, LTWP WP1, LTWP WP2, LTWP SF1, LTWP SF2	**4.03(3)** **(a)(i)** **(a)(ii)** **(a)(iv)** **(c)** **Ch. 10 Part 4 Part 6 Part 7**	**WSP** 1-4
	E12 Authorised in-river dam construction, operation, and passing flow requirements as specified on the dam approval.	A				
	E9 Strategic use of one or more of the Barmah-Millewa Allowance (BMA), Barmah-Millewa Overdraw (BMO), Murray Additional Environmental Allowance (Murray AEA), or the Lower Darling Environmental Water Allowance (the Lower Darling Allowance) as described in the WSP.	A	*Water Sharing Plan for the NSW Murray and Lower Darling Regulated Rivers Water Sources 2016*			
7 Protect important lagoons and wetlands within the WRP area. This strategy aims to limit extraction induced declines in water quality and condition of: * wetlands listed under the Ramsar Convention and other significant wetlands, refuge pools and lagoons in the WRP area	E13 Prohibit new works on significant identified lagoons, wetlands and uplandwetlands listed in the *Water Sharing Plan for the Lower Murray-Darling Unregulated River Water Source 2011*.	A	*Water Sharing Plan for the Murray Unregulated River Water Sources 2011* *Water Sharing Plan for the Lower Murray-Darling Unregulated River Water Source 2011*	**E(W)** Z, BF, F **E(WQ)** all **EWR ref.** LTWP CF1, LTWP VF1, LTWP BF1, LTWP BF2, LTWP BF3, LTWP	**4.03(3)** **(a)(i)** **(a)(ii)** **(a)(iv)** **(c)** **Ch 10 Part 4 Part 6 Part 7**	**WSP** 1-4
	E11 Cease-to-pump rules for streams, in-stream pools and off-river pools.	A				
	E14 Restrict construction of in-river dams on 3rd order or higher streams.	A				

Strategies	Water management actions and mechanisms / supporting activities	RTO	Associated management plan or instrument	Relevant risks & EWR ref	Relevant BP clauses	Relevant objectives
	E6 Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage entitlement growth.	A		NFF1, LTWP WP1, LTWP WP2, LTWP SF1, LTWP SF2		
	E9 Strategic use of one or more of the Barmah-Millewa Allowance (BMA), Barmah-Millewa Overdraw (BMO), Murray Additional Environmental Allowance (Murray AEA), or the Lower Darling Environmental Water Allowance (the Lower Darling Allowance) as described in the WSP.	A	*Water Sharing Plan for the New South Wales Murray and Lower Darling Regulated Rivers Water Sources 2016* NSW Murray and Lower Darling Long Term Water Plan NSW Murray and Lower Darling Annual Environmental Water Plans			
	N2 Strategic use of one or more of the Barmah-Millewa Allowance (BMA), Barmah-Millewa Overdraw (BMO), Murray Additional Environmental Allowance (Murray AEA), or the Lower Darling Environmental Water Allowance (the Lower Darling Allowance) and held environmental water licences as described in the LTWP and Annual Environmental Water Plans	F				
8 Protect tributary flows within the WRP area as they move from the unregulated water source into the regulated river water source. This strategy protects connectivity within the WRP area and facilitates: *fish dispersal and carbon and nutrient transport	E11 Cease-to-pump rules for streams, in-stream pools and off-river pools.	A	*Water Sharing Plan for the Murray Unregulated River Water Sources 2011* *Water Sharing Plan for the Lower Murray-Darling Unregulated River Water Source 2011*	**E(W)** Z, BF **E(WQ-CWP)** **EWR ref.** LTWP CF1, LTWP VF1, LTWP BF1, LTWP BF2, LTWP BF3,	**4.03(3)** **(a)(i)** **(a)(ii)** **(a)(iv)** **(c)** **Ch. 10 Part 6 Part 7**	**WSP** 1-4
	E8 Supplementary access to natural flow events may be permitted once flows are in excess of those required by the WSP.	A	*Water Sharing Plan for the New South Wales Murray and Lower Darling Regulated Rivers Water Sources 2016*			

Strategies	Water management actions and mechanisms / supporting activities	RTO	Associated management plan or instrument	Relevant risks & EWR ref	Relevant BP clauses	Relevant objectives
				LTWP NFF1,		
9 Protect the regulated river sections of the WRP area from rapid increases and decreases in flow following releases from Hume Dam and Menindee Lakes. This strategy protects the integrity of river banks and assists in the management of suspended sediment loads.	E15 Rates of change to storage release protocol.	A	*Water Sharing Plan for the New South Wales Murray and Lower Darling Regulated Rivers Water Sources 2016* WaterNSW Hume Dam and Menindee Lakes Water Supply Work Approval	E(WQ) Turbidity	4.03(3) (a)(ii) (a)(iv) (c) Ch. 10 Part 7	WSP 3
10 Recognise the contribution of Hume Dam and Menindee Lakes 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 of CWP or poor WQ, * facilitate the dilution of saline surface waters. *Note: all releases made from Hume Dam contribute to the achievement of this aspect of the strategy. Releases made from Menindee Lakes contribute to reducing poor WQ and facilitating dilution of saline surface waters.*	E8 Supplementary access to natural flow events may be permitted once flows are in excess of those required by the WSP.	A	*Water Sharing Plan for the New South Wales Murray and Lower Darling Regulated Rivers Water Sources 2016*	E(WQ-S) E(WQ-CWP) E(WQ)	4.03(3) (a)(i) (a)(ii) (a)(iv) (c) (d) Ch. 10 Part 6 Part 7	WSP 3
	E9 Strategic use of one or more of the Barmah-Millewa Allowance (BMA), Barmah-Millewa Overdraw (BMO), Murray Additional Environmental Allowance (Murray AEA), or the Lower Darling Environmental Water Allowance (the Lower Darling Allowance) as described in the WSP.	A	*Water Sharing Plan for the New South Wales Murray and Lower Darling Regulated Rivers Water Sources 2016* NSW Murray and Lower Darling Long Term Water Plan NSW Murray and Lower Darling Annual Environmental Water Plans			
	N2 Strategic use of one or more of the Barmah-Millewa Allowance (BMA), Barmah-Millewa Overdraw (BMO), Murray Additional Environmental Allowance (Murray AEA), River Murray Increased Flows (RMIF) or the Lower Darling Environmental Water Allowance (the Lower Darling Allowance) and held environmental water licences as described in the	F				

Strategies	Water management actions and mechanisms / supporting activities	RTO	Associated management plan or instrument	Relevant risks & EWR ref	Relevant BP clauses	Relevant objectives
	LTWP and Annual Environmental Water Plans					
	E16 Improve dam infrastructure and its management so that water releases are more closely matched to Murray River ambient temperatures.	A	NSW Cold Water Pollution Strategy			
11 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 NSW Murray and Lower Darling WRP area Basin Salinity Management Strategy	**E(WQ-S)** **E(WQ-CWP)** **E(WQ)** **O(WQ-BGA)**	**4.03(3) (a)(ii)** **Ch. 10 Part 7**	**WSP** 1-4
12 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.	E17 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. E23 Ongoing monitoring of potential growth in number of farm dams within medium and high risk water sources	A	*Water Sharing Plan for the Murray Unregulated River Water Sources 2011* *Water Sharing Plan for the Lower Murray-DarlingUnregulated River Water Source 2011* 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**
13 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.	E18 Plantation forestry interception managed under the Plantation forestry policy (in prep), Plantations and Reafforestation Act 1999 and the Plantation and Reafforestation (Code) Regulation 2001.	A	Plantation forestry policy (in prep) Plantations and Reafforestation Act 1999 (PRA) Plantations and Reafforestation (Code) Regulation 2001	**E(I-PF)** **O(I-PF)**	**4.03(3) (a)(iv) (c) (h)(i)** **Ch. 10 Part 5**	**N/A**
	E19 Ongoing risk monitoring to determine impact of future expansion	B				

Strategies	Water management actions and mechanisms / supporting activities	RTO	Associated management plan or instrument	Relevant risks & EWR ref	Relevant BP clauses	Relevant objectives
	of forest plantations at local and regional scales.		NSW Murray and Lower Darling Monitoring, Evaluation and Reporting Plan			
14 Protect the environment and water usersfromchanges 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. **E24** Review and update climate change models when new data is available. **N1** Sustainable Diversion Limits.	**D** **F**	*Water Sharing Plan for the New South Wales Murray and Lower Darling Regulated Rivers Water Sources 2016* *Water Sharing Plan for the Murray Unregulated River Water Sources 2011* *Water Sharing Plan for the Lower Murray-Darling Unregulated River Water Source 2011* NSW Murray and Lower Darling Water Resource Plan *Draft Murray Regional Water Strategy 2021* *Draft Western Regional Water Strategy 2021* *Draft NSW State Water Strategy 2021* *Murray-lower Darling Incident Response Guide (included as a schedule in the NSW Murray and Lower Darling WRP)*	**E(CC)** **O(CC)**	**4.03(3)** **(a)(iv)** **(c)** **(g)(iii)** **(h)(ii)** **(h)(iii)** **Ch. 10 Part 3**	**N/A**
15 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.	**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.	**D** **F**	*Water Sharing Plan for the New South Wales Murray and Lower Darling Regulated Rivers Water Sources 2016* *Water Sharing Plan for the Murray Unregulated River Water Sources 2011* *Water Sharing Plan for the Lower Murray-Darling Unregulated River Water Source 2011*	**E(BLR)**	**4.03(3)** **(a)(iv)** **(c)** **h(ii)** **Ch 10 Part 3**	**N/A**

Strategies	Water management actions and mechanisms / supporting activities	RTO	Associated management plan or instrument	Relevant risks & EWR ref	Relevant BP clauses	Relevant objectives
			NSW Murray and Lower Darling Water Resource Plan			
16 Protect licensed 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, related mechanisms are not currently active in the NSW Murray and Lower Darling WRPA.*	E20 Restrict BLR access through the establishment of mandatory guidelines under the WMA s. 52(2) and S. 336B. E21 Temporarily restrict access under the WMA s. 324 when there are water shortages. E22 Minister may limit growth in BLR when a land holding is subdivided and there is high hydrological stress on the river or aquifer	A	*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**
17 Improve knowledge used to assess riskinunregulated sections of the WRP area.	N8 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	NSW Murray and Lower Darling Surface Water Monitoring, Evaluation and Reporting Plan.	**E(W)** unregulated Z, BF, F **EWR ref.** LTWP CF1, LTWP VF1, LTWP BF1, LTWP BF2, LTWP BF3, LTWP NFF1, LTWP WP1, LTWP WP2, LTWP SF1, LTWP SF2	**4.03(3) (c) 4.03(3)(i)(i) 4.03(3)(i)(ii)**	**N/A**
18 Improve knowledge of effectiveness of existing strategies.	N9 Reviews resulting from application of risk treatment option B Fill	B	NSW Murray and Lower Darling Surface Water Monitoring, Evaluation and Reporting Plan.	**E(W)** unregulated Z, BF, F	**4.03(3) (b) (c)**	**N/A**

Strategies	Water management actions and mechanisms / supporting activities	RTO	Associated management plan or instrument	Relevant risks & EWR ref	Relevant BP clauses	Relevant objectives
	knowledge gap / evaluate effectiveness of existing strategies.			**EWR ref.** LTWP CF1, LTWP VF1, LTWP BF1, LTWP BF2, LTWP BF3, LTWP NFF1, LTWP WP1, LTWP WP2, LTWP SF1, LTWP SF2	**(e)** **(g)** **4.03(3)(i)(i)** **4.03(3)(i)(ii)**	

Table 9-8. Abbreviations used in Table 8 7.

Abbreviation	Explanation
RTO	Risk treatment option refer to Figure 8-1.
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
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)	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)
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
E(BLR)	Risks to water available for the environment from extraction by basic landholder rights
Z	Zero flows
BF	Base flows
F	Fresh flows
BKF1.5	Bank full flows, average recurrence interval 1.5 years
OB1	Low level Lake fill
OB2	Mid level lake fill
OB2.5	Over bank flows, average recurrence interval 2.5 years
OB3	High level lake fill
OB4	Very high level lake fill
OB5	Over bank flows, average recurrence interval 5 years
D	Lake drawdown (falls)
F	Lake filling (rises)
LTWP CF1	Cease-to-flow, no greater than modelled natural maximum inter-flow period

Abbreviation	Explanation	
LTWP VF1	Very-low flow, no greater than modelled natural maximum inter-flow period	
LTWP BF1	Base flow, As required during dry periods maximum inter-flow. 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 BF2	Base flow, 2 year maximum inter-flow period. 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 BF3	Base flow, 3 year maximum inter-flow period. 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 WP1	Weir pool drawdown	
LTWP WP2	Weir pool raising	
LTWP NFF1	Nesting flow	
LTWP SF1	Small fresh, 1 year maximum inter-flow period	
LTWP SF2	Small fresh, 2 years maximum inter-flow period	
LTWP LF1	Large fresh, 2 years maximum inter-flow period	
LTWP LF2	Large Fresh, 4 years maximum inter-flow period	
LTWP LF3	Large Fresh	
LTWP BK1	Bank full, 2 years maximum inter-flow period	
LTWP BK2	Bank full, 4 years maximum inter-flow period	
LTWP OB1	Over bank, 2 years maximum inter-flow period / Or low level Lake filling event	
LTWP OB2	Over bank, 3–5 years maximum inter-flow period / Or mid level Lake filling event	
LTWP OB3	Over bank, 4 years maximum inter-flow period / Or high level Lake filling event	
LTWP OB4	Over bank, 5 years maximum inter-flow period / Or very high level Lake filling event	
LTWP OB5	Over bank, 5 years maximum inter-flow period	
LTWP OB6	Over bank, 5 years maximum inter-flow period	
LTWP OB7	Over bank, 7 years maximum inter-flow period	
LTWP OB8	Over bank, 7 years maximum inter-flow period	
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

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 is 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 NSW Murray and Lower Darling Water Resource Plan Area risk assessment.

#	Metric	Data Description	Report Reference	Relevant risk #		Data source/s	Reference	Time period	Data confidenc	Reasoning
1	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.
2	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: Department of Planning, Industry and Environment Water IQQM (Integrated Quantity Quality Model) used for both MDBA & Department of Planning and Environment Water sites. 4. MDBA modelling report appendix - 2800 GL scenario - 847	**Regulated River Hydrologic Sites**: • Darling River at Menindee u/s weir 32 (425012) • Darling River at Burtundy (425007) • Great Darling Anabranch at outlet Lake Cawndilla (425014)* • Great Darling Anabranch at Redbank Ck d/s Packers Crossing (425019) • Murray River at Doctors Point (409017) • Murray River d/s Yarrawonga Weir (409025) • Murray River at Echuca (409200A)* • Murray River at Torrumbarry (409207B) • Murray River at d/s Wakool Junction (414200) • Murray River at Euston (414203) • Murray River at Wentworth (425010) • Murray River at Lock 9 downstream (426506) • Murray River Flow to South Australia (426510) • Edward River at Toonalook (409047) • Edward River at Deniliquin (409003) • Edward River d/s Stevens Weir (409023) • Edward River at Leiwah (409035) • Wakool River at Offtake Regulator (409019) • Wakool River at Wakool/Barham Rd (409045)* • Wakool River at Gee Gee Bridge (No.2) (409062)* • Wakool River at Stoney Crossing (409013) • Wakool River at Kyalite (409034) • Yallakool Creek at Offtake (409020) • Colligen Creek at below Regulator (409024) • Niemur River at Barham/Moulamein Rd (409048)* • Bullatale Creek u/s Edward R (409075)* • Gulpa Creek at Offtake (409030)	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).
3	Hydrological modelling - unregulated water sources	Flow Metrics (hydrological alteration): 2800 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 Department of Planning, Industry and Environment Water IQQM.	**Unregulated River hydrologic Sites:** Murray River at Walwa, Jingellic Creek at Jingellic, Bowna Creek at Yambla, Mannus Creek at Tooma, Maragle Creek at Maragle, Tumbarumba Creek at Tooma, Welumba Creek at the square, Tooma River at Pinegrove, Swampy Plain River at Khancoban, Murray River at Biggara.	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 confidenc	Reasoning
4	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 Department of Planning, Industry and Environment Water 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:** Murray River at Brentwood Park, Welumba Creek at the square, Maragle Creek at Maragle, Tumbarumba Creek at Tumbarumba No. 2, Mannus Creek at Tooma, Jingellic Creek at Jingellic, Bowna Creek at Yambla, Murray River at Walwa		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)
5	Pest plants and animals	Qualitative assessment	5			Expert opinion	none	Not apllicable (N/A)	Low	Qualitative assessment based on NSW Department of Planning and Environment (Water) ecohydrology specialist expert opinion
6	Risk from climate change – estimated for regulated and unregulated water sources	Extrapolation of CSIRO MDBSY Project	4.6.4	E(CC)	likelihood	1. NOW (2010), Assessment of risk to NSW Murray-Darling Basin shared water resources – 2008, NSW Office of Water, Sydney. 2. CSIRO (2008a), 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. 4. SKM (2009) Murray Darling Basin Risk Assessment: Murray Region Technical Assessment. Report by Sinclair Knight Merz for the Murray Darling Basin Authority	River Murray Channel Barmah-Millewa Forest Gunbower-Koondrook-Perricoota Forest Darling Anabranch Lakes Other regulated water sources All unregulated water sources		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(I-FH)	likelihood	DPI-Water modelling			low	Preliminary modelling, indicative only. Modelled estimate is for the WRP Area, no finer scale available

#	Metric	Data Description	Report Reference	Relevant risk #		Data source/s	Reference	Time period	Data confidenc	Reasoning
7	High ecological value aquatic ecosystems	HEVAE (high ecological value aquatic ecosystem) - Identifying environmental assets and ecosystems functions	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	E(W) E(BLR) E(I-FD) (E(I-PF) E(I-FH) E(CC) E(WQ-CWP) E(WQ) E(WQ-S)	Consequence	1. HEVAE data based on the following sources: Table 1: Data sources used in each of the criteria **Criteria** — **Data Sources** **Base layer in all criteria**: • River Styles® (DPI Water) • Geofabric data layer (BOM) • IBRA Subregions layer (OEH) **Diversity**: • Fish diversity data (DPI Fisheries) • AUSRIVAS macroinvertebrate data (OEH) **Distinctiveness**: • Threatened species, populations and communities (recorded, known and predicted data) (OEH and DPI Fisheries) • Rare River Styles® (DPI Water) **Vital Habitat**: • Riparian Woody Extent raster dataset (DECC 2008) • River Styles® recovery potential (DPI Water) **Naturalness**: • 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) 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.	1. Healey et al. 2018. 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.	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.	High	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 NSW MLD Catchment. This information is used in helping determine consequence outcomes in the HEVAE process. **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)

#	Metric	Data Description	Report Reference	Relevant risk #		Data source/s	Reference	Time period	Data confidenc	Reasoning
8	**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. *Water 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.
9	Cold water and warm water pollution	Real-time gauge based monitoring	6.3.2	E(WQ-CWP)	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. Pope, E. and Nolan, A. (2018) Data versus desktop: an assessment of the severity of cold water pollution in the Swampy Plain and Murray Rivers below Khancoban Dam. Snowy Hydro Limited, Cooma NSW Australia.	Hume Dam (Murray River 200 km downstream of dam) Khancoban Dam (120 km downstream of dam in the Swampy Plain River and then the Murray River)	From March 2012 to January 2016.	High	Based on Real-time data.
10	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	• 401003 Tooma River at Warbrook • 401201 Murray River at Jingellic • 401556 Murray River at Indi Bridge • 409001 Murray River at Albury • 409005 Murray River at Barham • 409025 Murray River downstream Yarrawonga Weir • 414206 Murray River at Merbein Pump Station • 414209 Murray River upstream Euston Weir • 409003 Edward River at Deniliquin • 409013 Wakool River at Stoney Crossing • 409034 Wakool River at Kyalite • 425007 Darling River at Burtundy • 425012 Darling River upstream Weir 32 • 42610001 Murray River at Lock 8	2010/11 - 2014/15 (5-year period)	High	Based on Real-time data.
11	Levels of instream salinity	Real-time gauge based monitoring	7.5.2	E(WQ-S)	Likelihood	1. WaterNSW water quality monitoring stations	• 425012 Darling River at Menindee Weir 32 • 409003 Edward River at Deniliquin • 409005 Murray River at Barham • 409025 Murray River d/s Yarrawonga Weir • 4261001 Murray River at Lock 8	2010/11 - 2014/15 (5-year period)	High	Based on Real-time data.
Water quality for other uses										

#	Metric	Data Description	Report Reference	Relevant risk #		Data source/s	Reference	Time period	Data confidenc	Reasoning
12	**Water quality**		7. Risk to other water uses due to unsuitable water quality	O(WQ) O(WQ-BGA) O(WQ-S)						
13	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	• 409016 Murray River at d/s Hume Dam* • 409002 Murray River at Corowa* • 409025 Murray River at d/s Yarrawonga Weir# • 409008 Edward River at Offtake • 409005 Murray River at Barham • 409029 Mulwala Canal at Edwards River • 409003 Edward River at Deniliquin • 409023 Edward River at D/S Of Stevens Weir • 409207 Murray River at Torrumbarry • 409005 Murray River at Barham • 409214 Murray River at Pental Island Pumps • 409204 Murray River at Swan Hill • 409035 Edward River at Leiwah • 414203 Murray River at Euston • 414216 Murray River at D/S Mildura Weir • 425012 Darling River at Menindee u/s Weir 32 • 425005 Darling River at Pooncarie • A4260501 River Murray at u/s Lock 9	2010/11 - 2014/15 (5-year period)	High	Based on Real-time data.
14	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	As above	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 confidenc	Reasoning
15	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	• Copi Hollow • Lake Pamamaroo • Lake Wetherell • Lake Menindee • Lake Cawndilla • Darling River at Menindee • Darling River at Weir 32 • Darling River at Tolarno • Darling River at Menincourt • Darling River at Pooncarie • Darling River at Tulney Point • Darling River at Burtundy • Darling River at Ellerslie • Darling River at Tapio • Lake Victoria outlet regulator • Murray River at Lock 8 • Murray River at Fort Courage • Murray River at Curlwaa • Murray River at Merbein • Murray River at Buronga • Murray River at Mount Dispersion • Murray River at Euston • Lake Benanee Rec Area • Murray River at Tooleybuc • Murray River at Murray Downs • Murray River at Barham • Murray River at Moama • Murray River at Picnic Point • Murray River at Tocumwal • Murray River at Cobram • Murray River downstream of Yarrawonga • Mulwala Canal offtake • Lake Mulwala • Murray River at Corowa • Murray River at Albury • Lake Hume • Wakool River at Wakool-Barham Road • Wakool River at Kyalite • Gulpa Creek at Mathoura • Edward River at Deniliquin • Edward River at Old Morago • Edward River at Moulamein		Moderate	

#	Metric	Data Description	Report Reference	Relevant risk #		Data source/s	Reference	Time period	Data confidenc	Reasoning
16	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	As above	Based on 2006 - 2014	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).
17	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.
18	Indigenous & Socio-economic		7.6 & 8.5	O		Placeholder.		N/A	N/A	Cultural requirements addressed in a separate document. Socio-economic not assessed due to lack of data.
Interception Activities										
19	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 (2008a), 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. CSIRO (2008b), Water availability in the Murray. A report to the Australian Government from the CSIRO Murray-Darling Basin Sustainable Yields Project. CSIRO, Canberra. 217pp. 3. 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. 4. SKM (2009) Murray Darling Basin Risk Assessment: Murray Region Technical Assessment. Report by Sinclair Knight Merz for the Murray Darling Basin Authority			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 confidenc	Reasoning
20	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 (2008a), 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. SKM (2009) Murray Darling Basin Risk Assessment: Murray Region Technical Assessment. Report by Sinclair Knight Merz for the Murray Darling Basin Authority.	NSW Murray high security NSW Murray general security NSW Murray supplementary NSW Murray conveyance Lower Darling cap diversions River Murray Channel Barmah-Millewa Forest Gunbower-Koondrook-Perricoota Forest Darling Anabranch Lakes	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 License).
21	Ability to meet environmental flow objectives		4.5.1.1	E(I-FD)	Consequence		River Murray Channel Barmah-Millewa Forest Gunbower-Koondrook-Perricoota Forest Darling Anabranch Lakes		Moderate / High	
22	Change in average annual diversions and allocations for licence holders		8.2.1.1	O(I-FD)	Consequence		NSW Murray high security NSW Murray general security NSW Murray supplementary NSW Murray conveyance Lower Darling cap diversions		Moderate / High	

#	Metric	Data Description	Report Reference	Relevant risk #		Data source/s	Reference	Time period	Data confidenc	Reasoning
21	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 (2008a), 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 6. SKM (2009) Murray Darling Basin Risk Assessment: Murray Region Technical Assessment. Report by Sinclair Knight Merz for the Murray Darling Basin Authority	Tooma River at Pinegrove, Maragle Creek at Maragle, Jingellic Creek at Jingellic, Bowna Creek at Yambla	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. Licensed from the MDBA under a Creative Commons Attribution 4.0 License).
22	HEVAE (see 4 above)	See 4 above	4.5.1.1	E(I-FD)	Consequence	See 5 above	Tooma River at Pinegrove, Maragle Creek at Maragle, Jingellic Creek at Jingellic, Bowna Creek at Yambla	See 5 above	See 5 above	See 5 above.
23	Growth in plantation forestry	Farm dam and plantation impacts on streamflow estimated using the SIMHYD rainfall-runoff model; this data was adapted to fit into river	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 (2008a), 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 5. SKM (2009) Murray Darling Basin Risk Assessment: Murray Region Technical Assessment. Report by Sinclair Knight Merz for the Murray Darling Basin Authority	NSW Murray high security NSW Murray general security NSW Murray supplementary NSW Murray conveyance Lower Darling cap diversions River Murray Channel Barmah-Millewa Forest Gunbower-Koondrook-Perricoota Forest Darling Anabranch Lakes	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

#	Metric	Data Description	Report Reference	Relevant risk #		Data source/s	Reference	Time period	Data confidenc	Reasoning
24	Ability to meet environmental flow objectives	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	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 (2008a), 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. SKM (2009) Murray Darling Basin Risk Assessment: Murray Region Technical Assessment. Report by Sinclair Knight Merz for the Murray Darling Basin Authority	River Murray Channel Barmah-Millewa Forest Gunbower-Koondrook-Perricoota Forest Darling Anabranch Lakes			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).
25	Change in average annual diversions and allocations for licence holders		8.2.2	O(I-PF)	Consequence		NSW Murray high security NSW Murray general security NSW Murray supplementary NSW Murray conveyance Lower Darling cap diversions			
26	Mining area and growth	Mining area, type and growth	4.5.3 8.2.3			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. NSW Resources and Geoscience (2019).		2014 Current	Modera te/	
27	Floodplain harvesting	N/A	4.5.4 (environment) 8.2.4 (Other uses)			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 licensing 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 License).
28	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	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 (2008a), 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. 4. SKM (2009) Murray Darling Basin Risk Assessment: Murray Region Technical Assessment. Report by Sinclair Knight Merz for the Murray Darling Basin Authority	NSW Murray high security NSW Murray general security NSW Murray supplementary NSW Murray conveyance Lower Darling cap diversions River Murray Channel Koondrook-Perricoota Forest Darling Anabranch Lakes	The average rainfall during the calibration period 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

#	Metric	Data Description	Report Reference	Relevant risk #		Data source/s	Reference	Time period	Data confidenc	Reasoning
29	Ability to meet environmental flow objectives	variables based on different scaling of the historical 1895 - 2006 climate sequence (Van Dijk et al. 2008).	4.6.1	E(CC)	Consequence		Lower Darling cap diversions River Murray Channel Koondrook-Perricoota Forest Darling Anabranch Lakes			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).
30	Change in average annual diversions and allocations for licence holders		8.4.1	O(CC)	Consequence		NSW Murray high security NSW Murray general security NSW Murray supplementary NSW Murray conveyance			
Growth in basic landholder rights										

#	Metric	Data Description	Report Reference	Relevant risk #		Data source/s	Reference	Time period	Data confidenc	Reasoning
31	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	Water sources: Indi, Swampy Plain, Upper Murray River, Tooma, Maragle, Tumbarumba, Mannus, Ournie Welaregang, Jingellic, Dora Dora, Hume, Albury, Majors, Lower Wangamong, Murray Below Mulwala, Lower Murray Darling		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)
32	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.	Water sources: Indi, Swampy Plain, Upper Murray River, Tooma, Maragle, Tumbarumba, Mannus, Ournie Welaregang, Jingellic, Dora Dora, Hume, Albury, Majors, Lower Wangamong, Murray Below Mulwala, Lower Murray Darling		High	
33	Volume of entitlement	Volume of entitlement (2015)	8.4.1	O(BLR)	Consequence	1. NSW Water Register			High	

LIST OF THREATENED SPECIES OF NSW MURRAY LOWER DARLING CATCHMENT

Common Name	Scientific Name	Distinctiveness Parameter	NSW Status	Commonwealth listing	Flow sensitivity Weighting	Status Weights	Layers from NSW Department of Planning and Environment Conservation and Biodiversity & DPI Fisheries
eel-tailed catfish	*Tandanus tandanus*	EP	Endangered Population	not listed	4	3	Known & predicted
olive perchlet	*Ambassis agassizii*	EP	Endangered Populations	not listed	4	3	Known & predicted
silver perch	*Bidyanus bidyanus*	Fish	Vulnerable	Critically endangered	4	4	Known & predicted
Macquarie perch	*Macquarie perch*	Fish	Endangered	Endangered	4	4	Known & predicted
golden perch	*Macquaria ambigua*	Fish	Recreationally important	not listed	N/A	N/A	Known
purple spotted gudgeon	*Mogurnda adspersa*	Fish	Endangered Population	not listed	4	3	Known & predicted
Murray cod	*Maccullochella peelii*	Fish	not listed	Vulnerable	4	2	Known & predicted
Murray hardyhead	*Craterocephalus fluviatil*	Fish	Critically endangered	Endangered	4	4	Known & predicted
southern pygmy perch	*Nannoperca australis*	Fish	Endangered	Not listed	4	3	Known & predicted
trout cod	*Maccullochella macquari*	Fish	Endangered	Endangered	4	3	Known & predicted
flathead galaxia	*Galaxias rostratus*	Fish	Critically endangered	Endangered	4	3	Known & predicted

LIST OF THREATENED SPECIES OF NSW MURRAY LOWER DARLING CATCHMENT							
Common Name	**Scientific Name**	**Distinctiveness Parameter**	**NSW Status**	**Commonwealth listing**	**Flow sensitivity Weighting**	**Status Weights**	**Layers from NSW Department of Planning and Environment Conservation and Biodiversity & DPI Fisheries**
Murray crayfish	*Euastacus armatus*	Crustacean	Vulnerable		4	2	Known & predicted
Booroolong frog	*Litoria booroolongensis*	Frog	Endangered	Endangered	4	3	Known & predicted
alpine Tree frog	*Litoria verreauxii alpina*	Frog	Endangered	Vulnerable	4	3	Known & predicted
southern bell frog	*Litoria raniformis*	Frog	Endangered	Vulnerable	4	3	Known & predicted
spotted Tree frog	*Litoria spenceri*	Frog	Critically endangered	Endangered	4	4	Known & predicted
yellow-spotted tree frog	*Litoria castanea*	Frog	Critically endangered	Endangered	4	4	Known & predicted
Lowland Darling River aquatic ecological community		EEC	Endangered Ecological Community	not listed	4	3	from DPI and EEC layer available on the EDB
Montane peatlands and swamps of the Australian Alps bioregions		EEC	Endangered Ecological Community	Endangered	4	3	
NSW Lower Murray River EEC		EEC	Endangered Ecological Community		4	3	
Sloane's Froglet	*Crinia sloanei*	Frog	Vulnerable	not listed	3	2	Known & predicted
painted burrowing frog	*Neobatrachus pictus*	Frog	Endangered	Not listed	3	3	Known & predicted
Menindee nightshade	*Solanum karsense*	Plant	Vulnerable	Vulnerable	3	2	
western water-starwort	*Callitriche cyclocarpa*	Plant	Vulnerable	Not listed	3	2	
Australian painted snipe	*Rostratula australis*	Bird	Endangered	Endangered	2	3	Known & predicted
blue-billed duck	*Oxyura australis*	Bird	Vulnerable	not listed	2	2	Known
Brolga	*Grus rubicunda*	Bird	Vulnerable	not listed	2	2	Known
freckled duck	*Stictonetta naevosa*	Bird	Vulnerable	not listed	2	2	Known & predicted
magpie goose	*Anseranas semipalmata*	Bird	Vulnerable	not listed	2	2	Known
Australasian bittern	*Botaurus poiciloptilus*	Bird	Endangered	Endangered	2	3	
black-tailed godwit	*Limosa limosa*	Bird	Vulnerable	Not listed	2	2	
curlew sandpiper	*Calidris ferruginea*	Bird	Endangered	Not listed	2	3	
southern corroboree frog	*Pseudophryne corroboree*	Frog	Critically Endangered	Critically Endangered	2	4	Known & predicted
southern myotis bat	*Myotis macropus*	Bat	Vulnerable	Not listed	2	2	
winged peppercress	*Lepidium monoplocoides*	Plant	Endangered	Endangered	2	3	
Australian pillwort	*Pilularia novae-hollandiae*	Plant	Endangered	Not listed	1	3	
floating swamp wallaby grass	*Amphibromus fluitans*	Plant	Vulnerable	Vulnerable	1	2	
spike rush	*Eleocharis obicis*	Plant	Vulnerable	Vulnerable	1	2	
square raspwort	*Haloragis exalta subsp exalta*	Plant	Vulnerable	Vulnerable	1	2	

Appendix B - HEVAE alignment with Schedules 8 & 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 Park 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 is 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®)

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 et al. (2018)	

Table B-2.Alignment of Schedule 9 Key ecosystem function criteria with HEVAE criteria.

<table>
<tr><th>Key ecosystem function criteria (Schedule 9)</th><th>HEVAE or risk assessment criteria/associated attributes</th></tr>
<tr><td>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.</td><td rowspan="4">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 is 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.</td></tr>
<tr><td>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.</td></tr>
<tr><td>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.</td></tr>
<tr><td>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:</td></tr>
</table>

(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

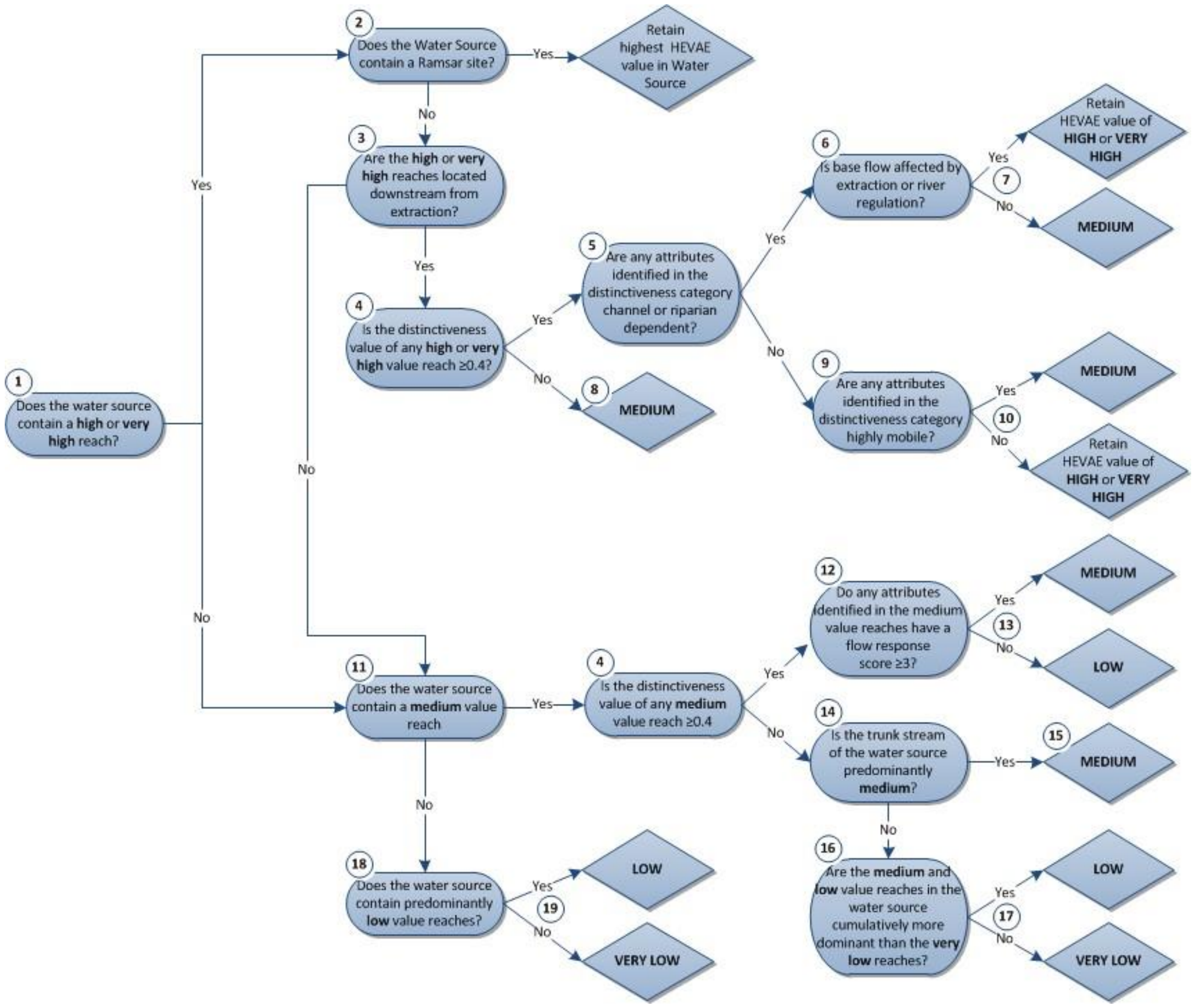

Figure C-1. Consequence decision tree used to convert HEVAE scores to a consequence rank.

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.

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. • It is assumed there is little reliance on habitats in these reaches by freshwater-dependent flora and fauna.

Appendix D - Threatened fish species & 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 NSW Murray and Lower Darling 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.

Results show a significant spread of threatened fish species or endangered populations within the NSW Murray and Lower Darling WRPA. The regulated river had known and predicted records of silver perch, Murray cod, eel-tailed catfish, trout cod, flathead galaxias, golden perch, southern pygmy perch, Macquarie perch and Murray crayfish. The fish diversity was highest in the mid-Murray reach which includes the Barmah-Millewa Forest, Edward-Wakool system, Koondrook-Perricoota Forest. Known and predicted records of silver perch, Murray cod, eel-tailed catfish, southern pygmy perch, Macquarie perch, Murray crayfish were located in a number of unregulated water sources. Flathead galaxias was only predicted to occur in a number of unregulated water sources.

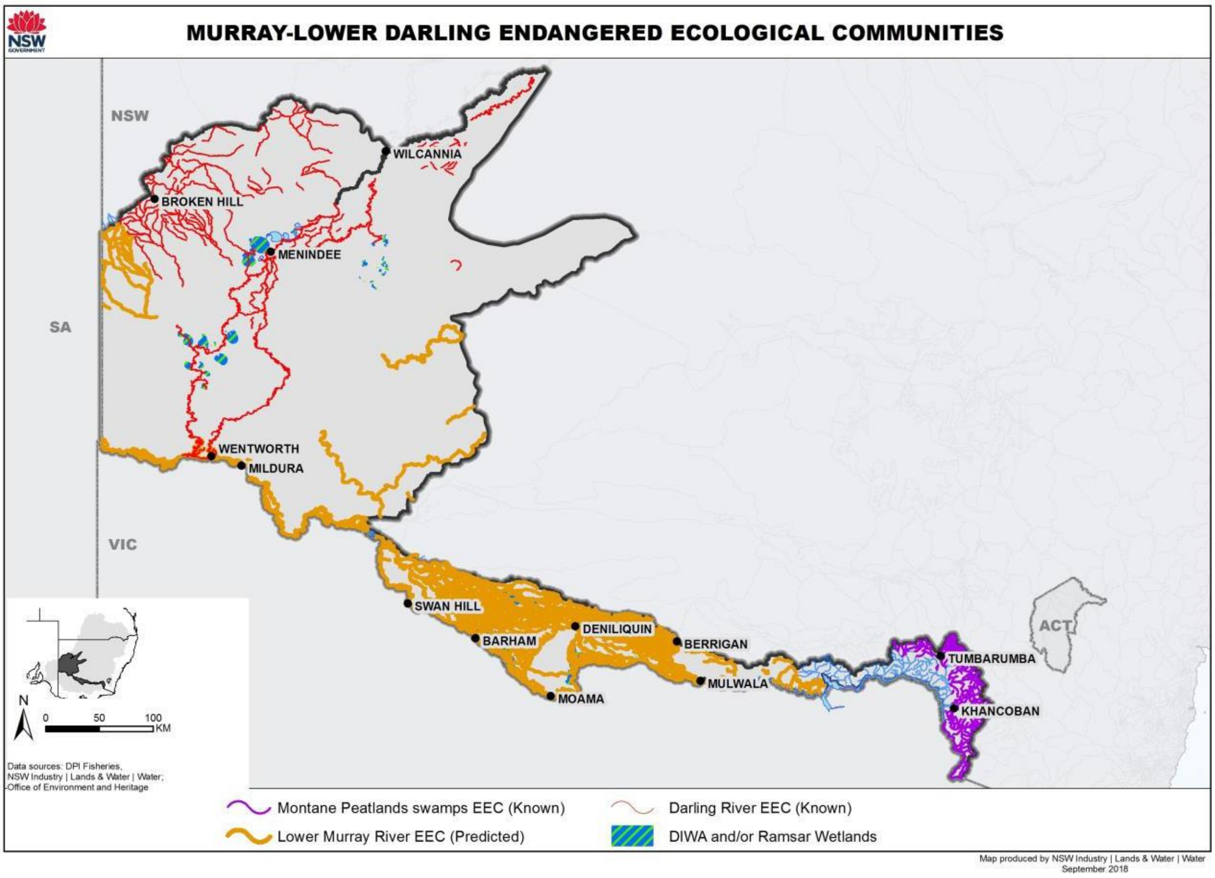

Figure D-1. Distribution of Endangered Ecological Communities in the NSW Murray and Lower Darling WRPA.

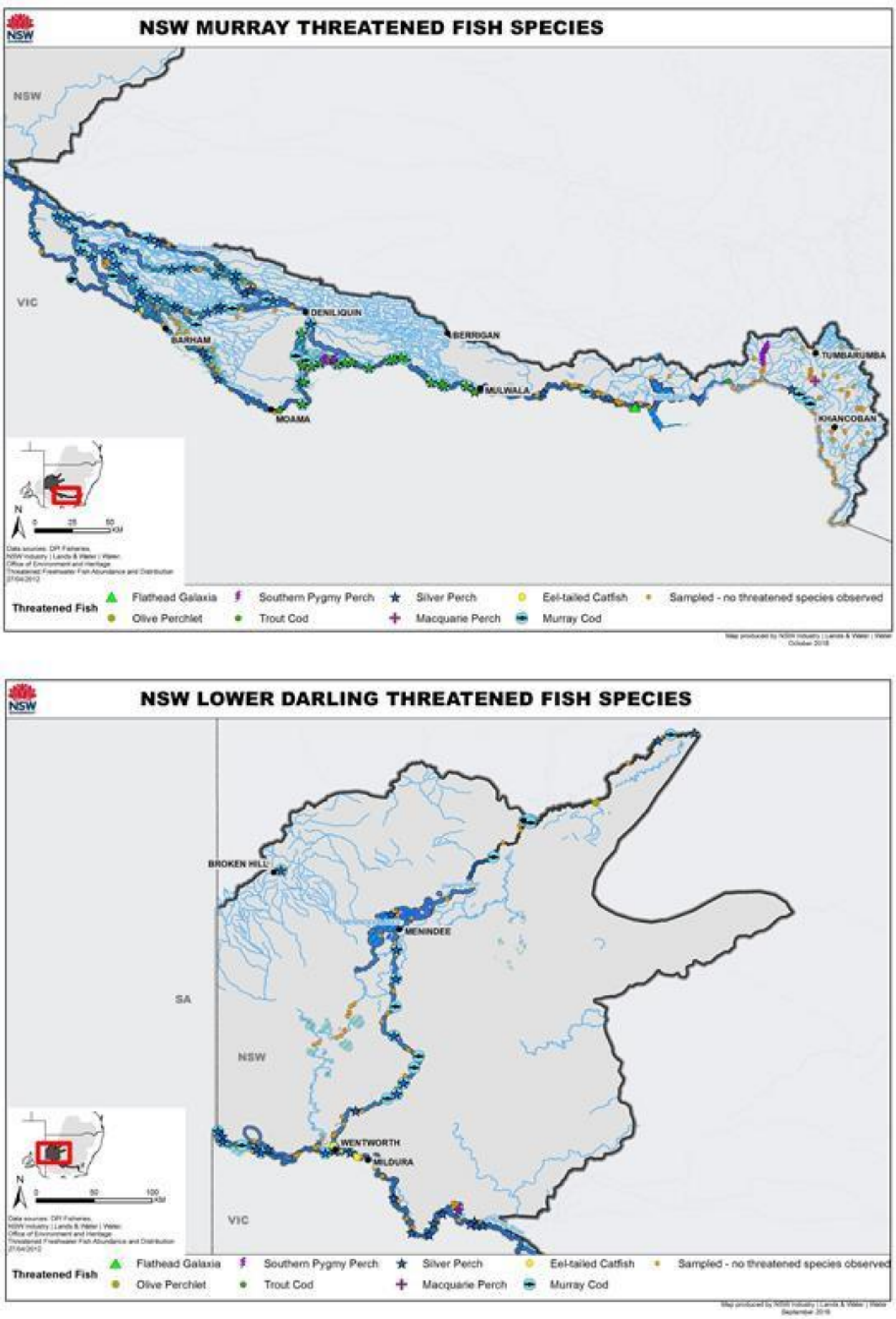

Figure D-2. Distribution of threatened fish species within the NSW Murray and Lower Darling WRPA.

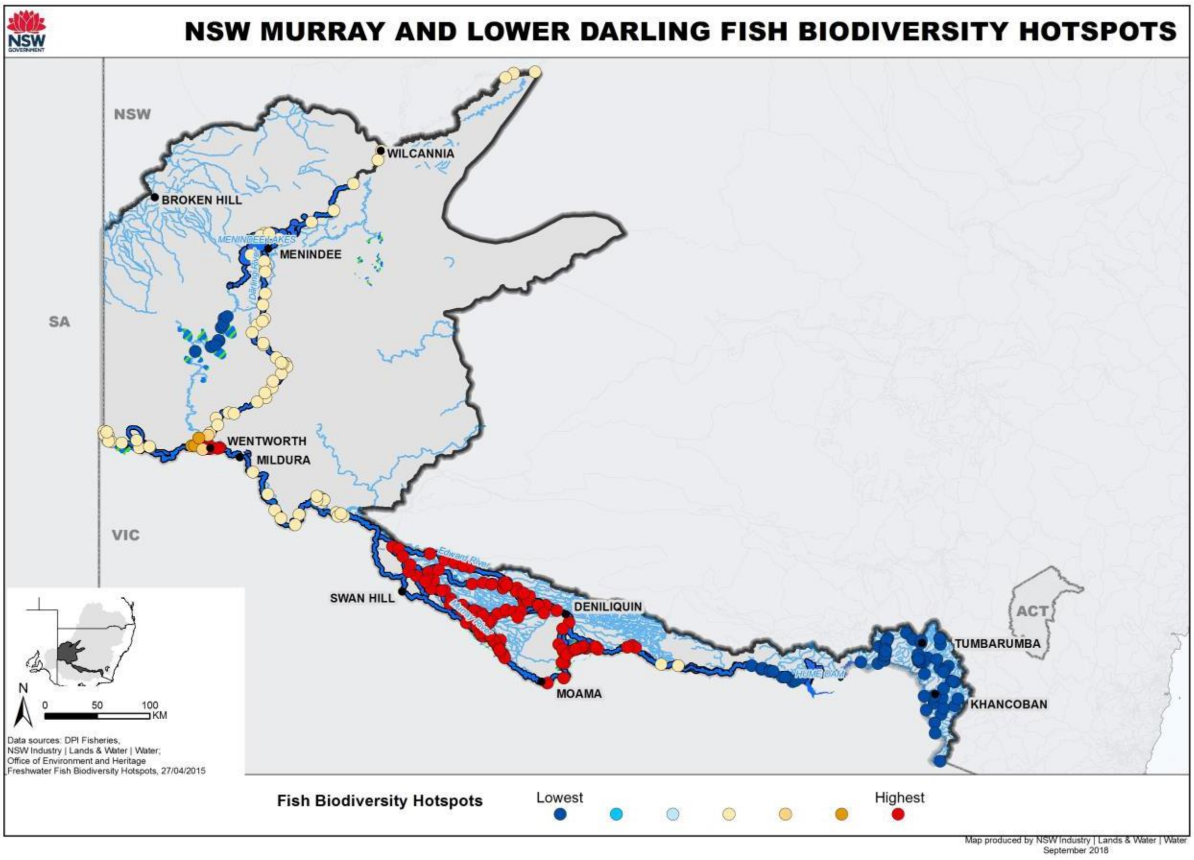

Figure D-3. Fish biodiversity hotspots in the NSW Murray and Lower Darling WRPA.

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 NSW Murray and Lower Darling WRPA are shown in the figures below.

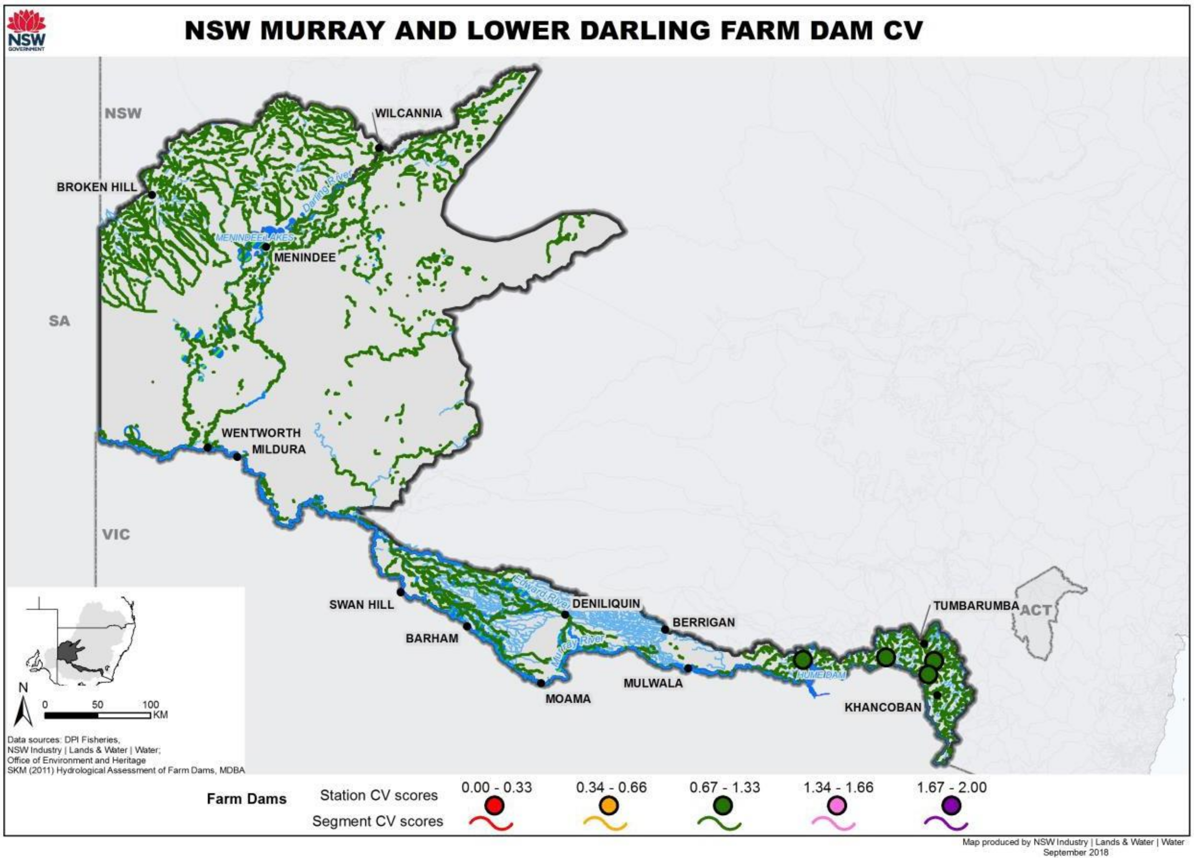

Figure E-1. Flow variation index (CV) results for farm dams in the NSW Murray and Lower Darling WRPA (SKM 2011).

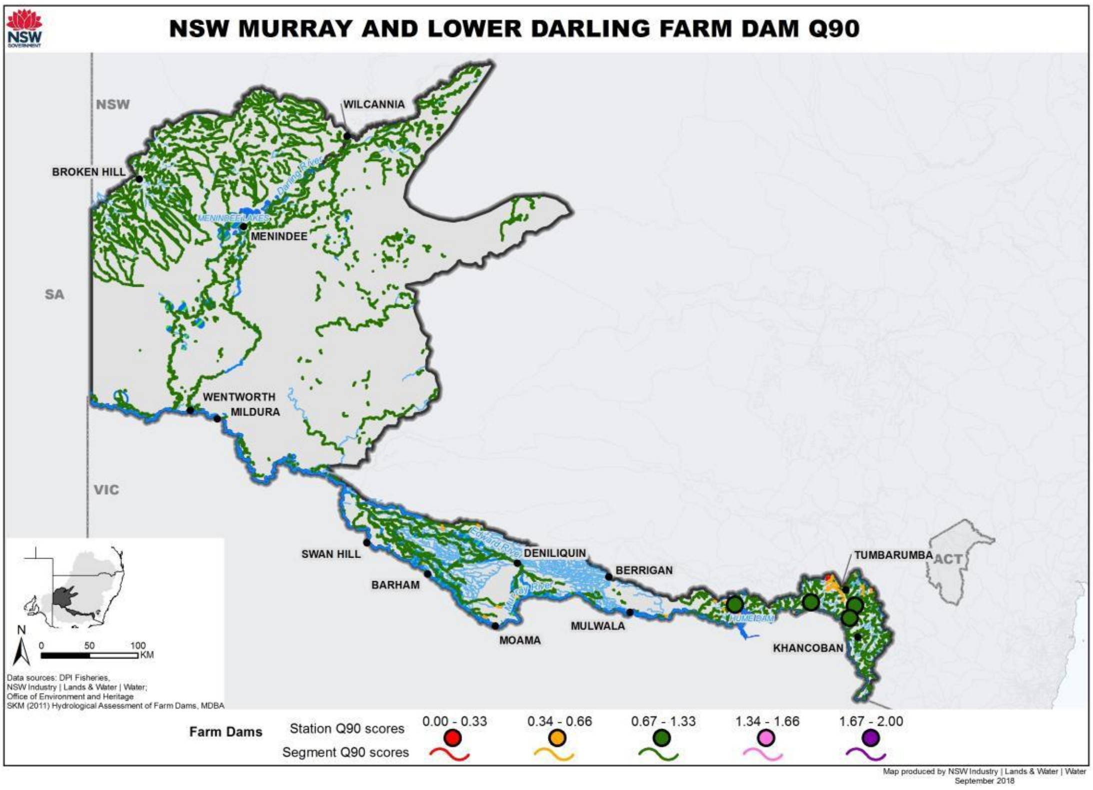

Figure E-2. Results for the Q90 low flow metric for farm dams in the NSW Murray and Lower Darling WRPA (SKM 2011).

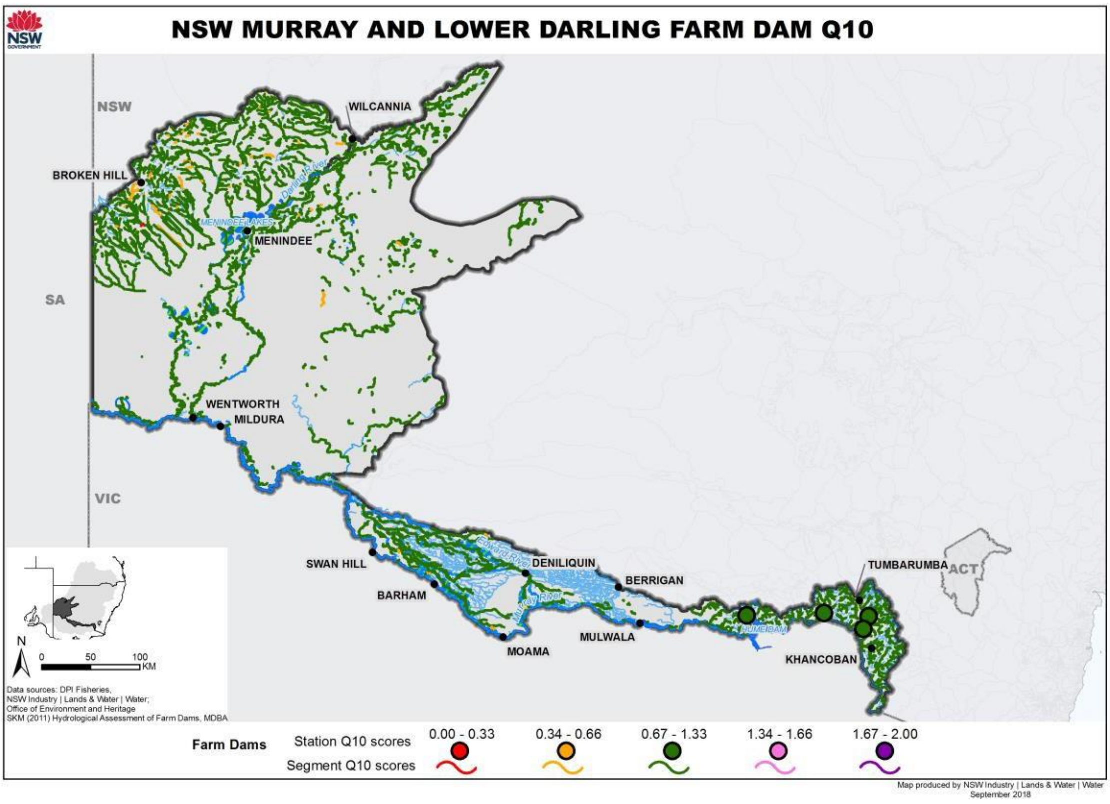

Figure E-3. Results for the Q10 high flow metric for farm dams in the NSW Murray and Lower Darling WRPA (SKM 2011).

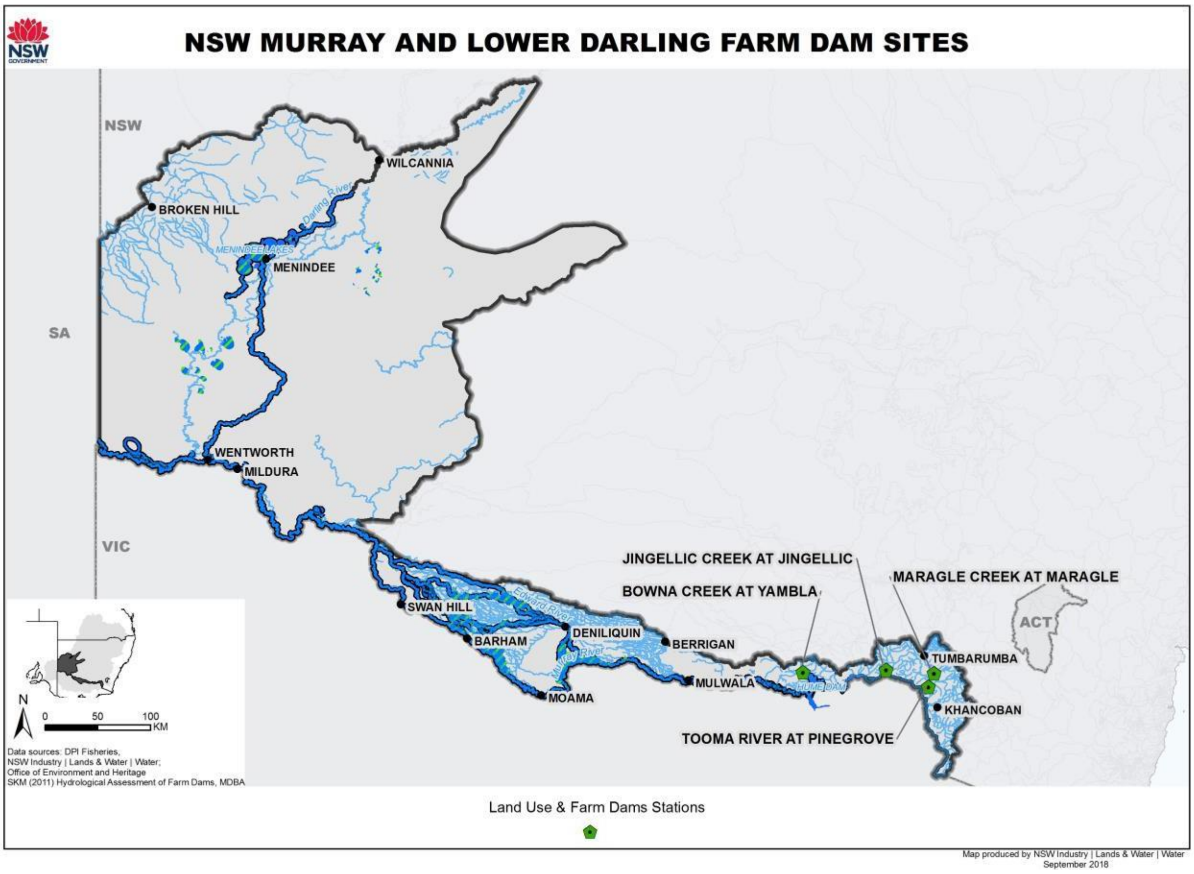

Figure E-2. Location of land use and farm dam stations in the NSW Murray and Lower Darling WRPA (MDBA 2011).

Appendix F - Unregulated rivers tolerable risk decision tool

This appendix relates to Figure 8-1 Risk treatment pathway (in particular element 2 and risk treatment option C), associated text in section 8.2.2.1, and strategy 18 in Table 8 6 Knowledge strategies.

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.

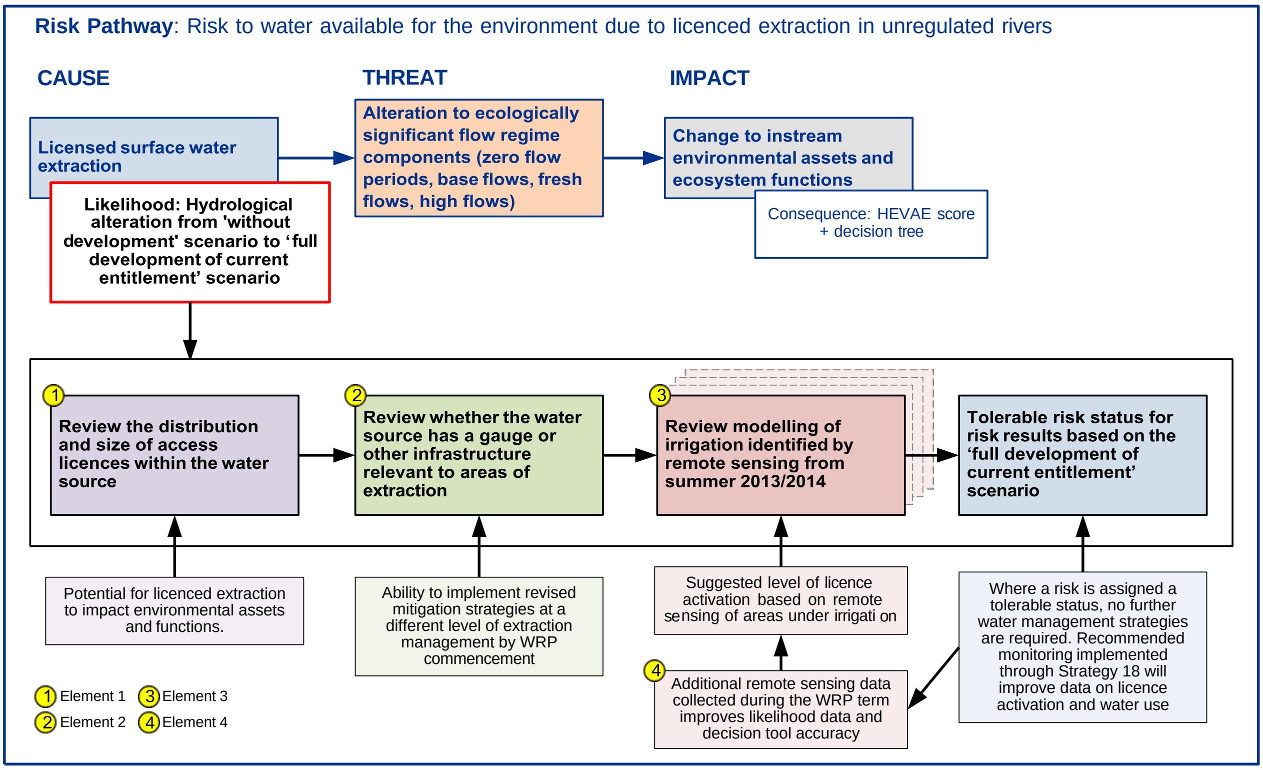

Figure F-1. Overview of decision tool.

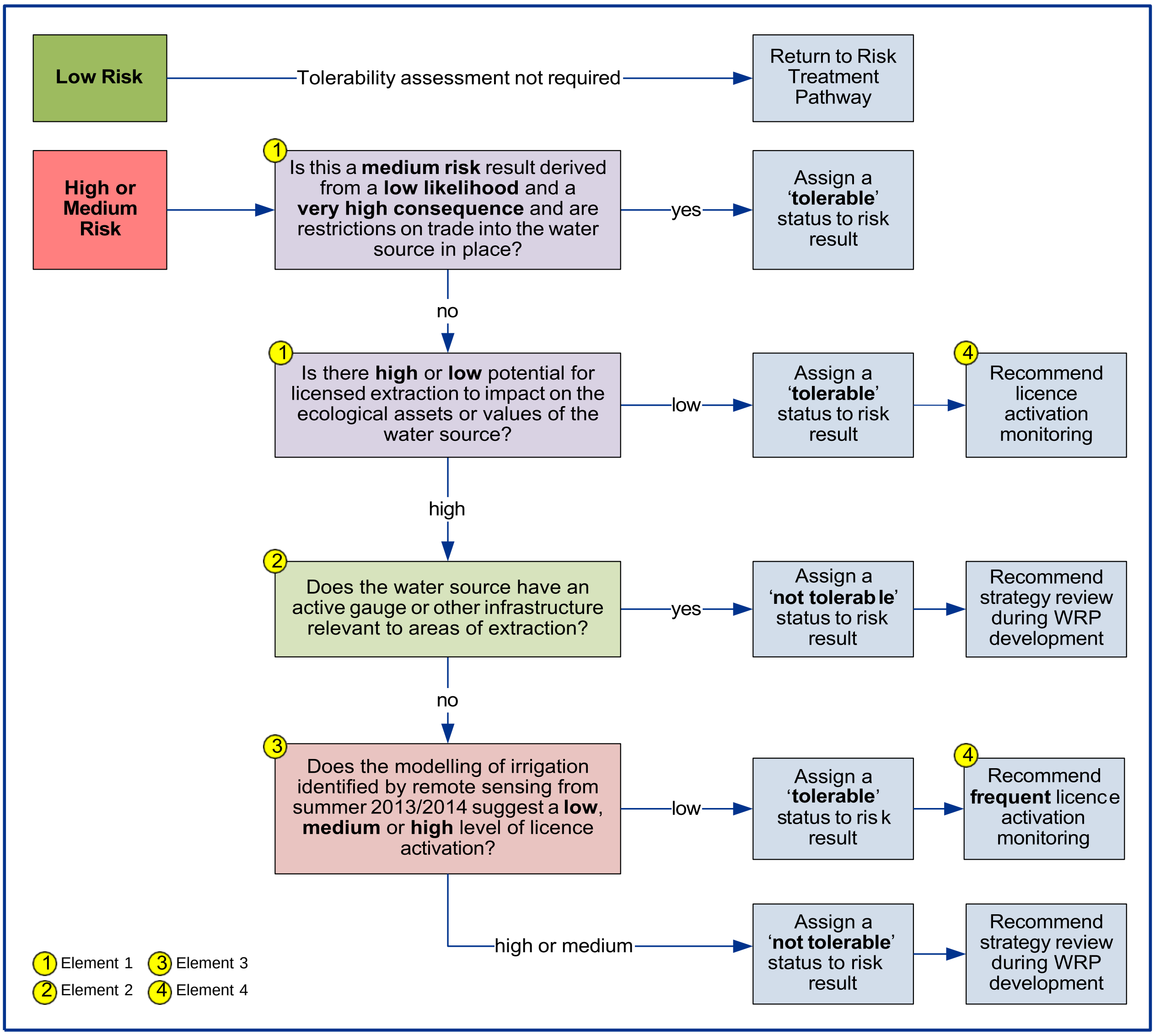

Figure F-2. Decision tree used as a guide to apply elements of the unregulated rivers tolerable risk decision tool.

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 system's structure

[1] An access licence must be linked to at least one pump (water supply work) for extraction to be possible.

(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).

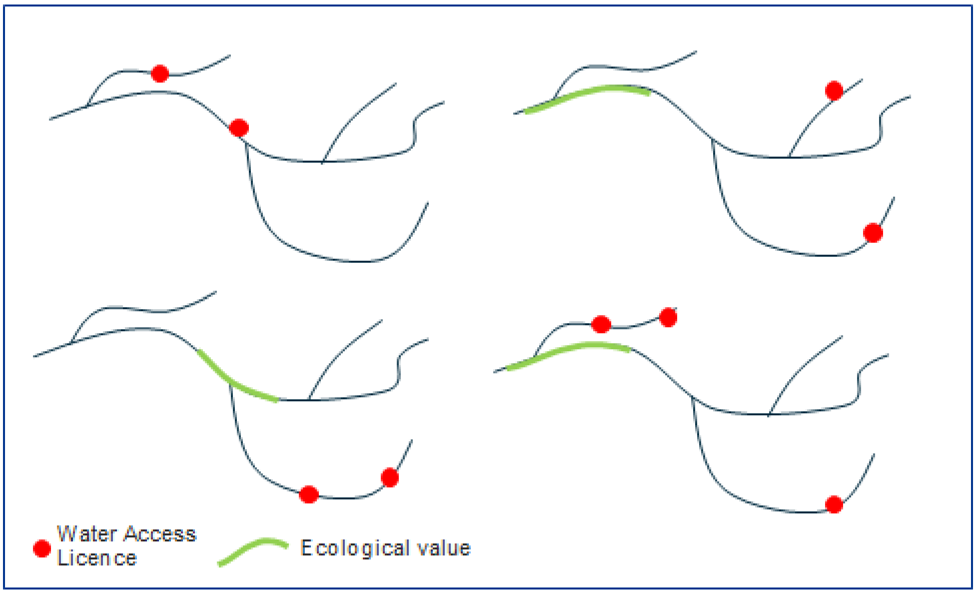

Figure F-3. Examples of the distribution of insignificant entitlement distribution.

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 2013/2014 to suggest a level of access licence activation. 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 & 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.

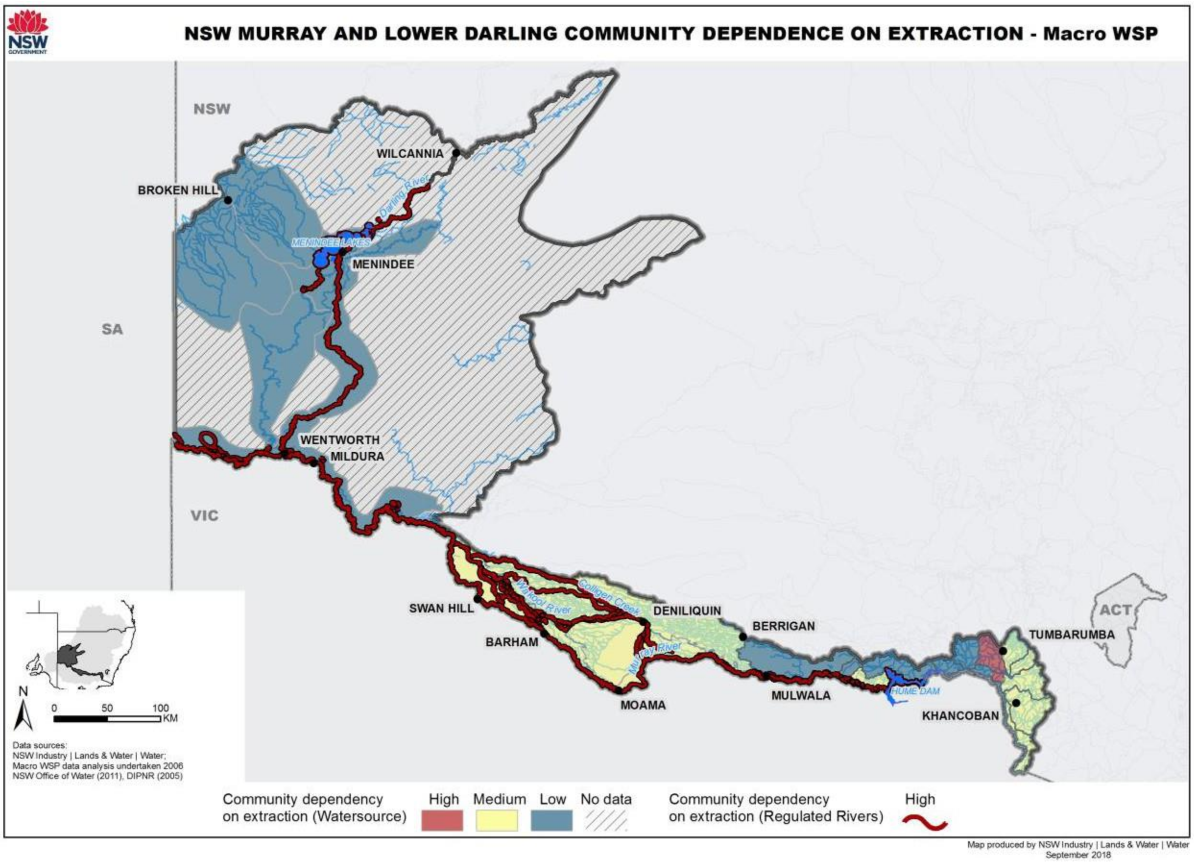

Figure G-1. Community dependency on extraction.

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 Department of Planning and Environment-Water 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 (Department of Planning and Environment-Conservation and Biodiversity 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 NSW Murray and Lower Darling 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).

NSW Department of Primary Industries (DPI 2015) report the extent of cold water pollution from Copeton Dam (as defined by a greater than 5 °C peak depression) has yet to be quantified, but it is estimated by Lugg (1999) to extend over 200 km downstream of the dam wall. 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 NSW Murray and Lower Darling WRPA (DPI 2015).

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 Copeton 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 (DPI 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 (DPI 2015); and
- Disrupting downstream movement of adults and impeding larval drift (Jones & Stuart 2004; DPI 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 Department of Planning and Environment - Conservation and Biodiversity 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 over 200 barriers to fish passage in the NSW Murray and Lower Darling WRPA (DPI 2015) 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 (DPI 2015) and likely to be a considerable constraint to the success of strategies. DPI Fisheries have identified 20 barriers which are considered to be high priority for mitigation action. These barriers are identified in the summaries presented in Volume 2 and are considered potential constraints to the success of hydrological risk mitigation strategies.

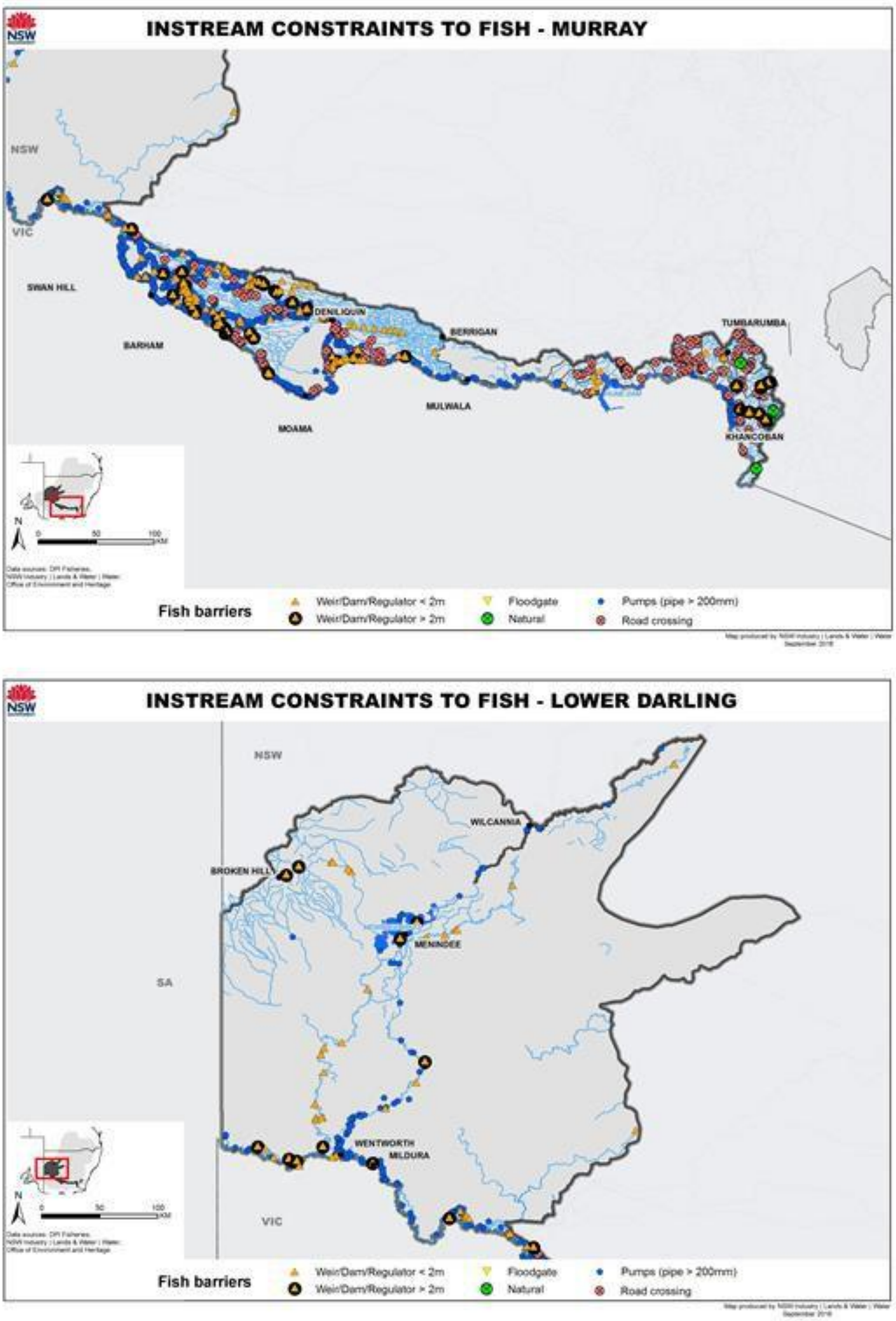

Figure G-2. Instream constraints to fish in the NSW Murray and Lower Darling WRPA (adapted from DPI 2015).

Water diversion

NSW Department of Primary Industries (DPI 2015) cite that 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 NSW Murray and Lower Darling WRPA, it is reported that there are over 300 pump offtakes with a diameter greater than 200 mm (Figure 23) (DPI 2015). There is some suggestion that irrigation pump offtakes, with a diameter greater than 200 mm, influence the entrainment of freshwater fish (DPI 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 NSW Murray and Lower Darling WRPA during peak extraction times. In addition to this, NSW Department of Primary Industries (DPI 2015) report there are over 100 diversion channels that capture over bank flows in key fish habitats, significantly influencing an important flow component in the system with the potential to impact native fish populations.

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 2006), 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 NSW Murray and Lower Darling 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).

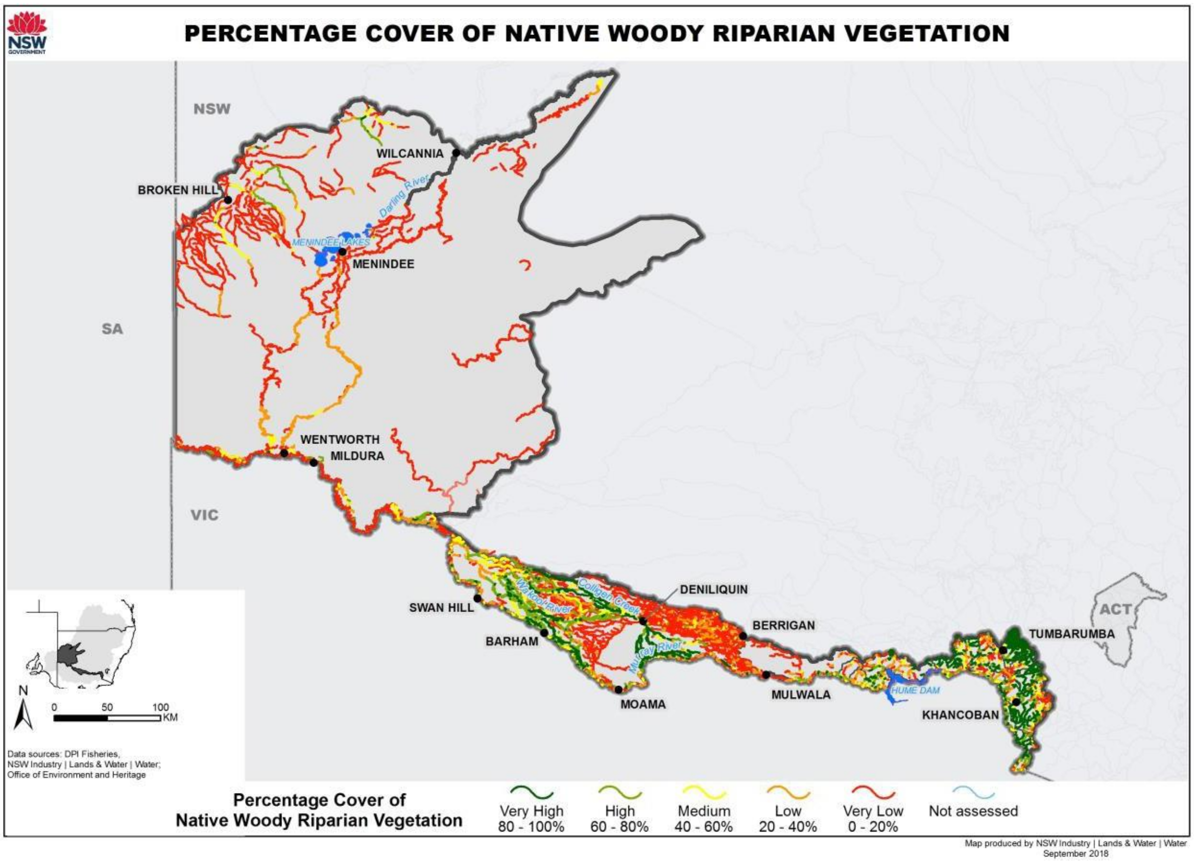

Figure G-3. Percent cover categories of native woody riparian vegetation in the NSW Murray and Lower Darling WRPA.

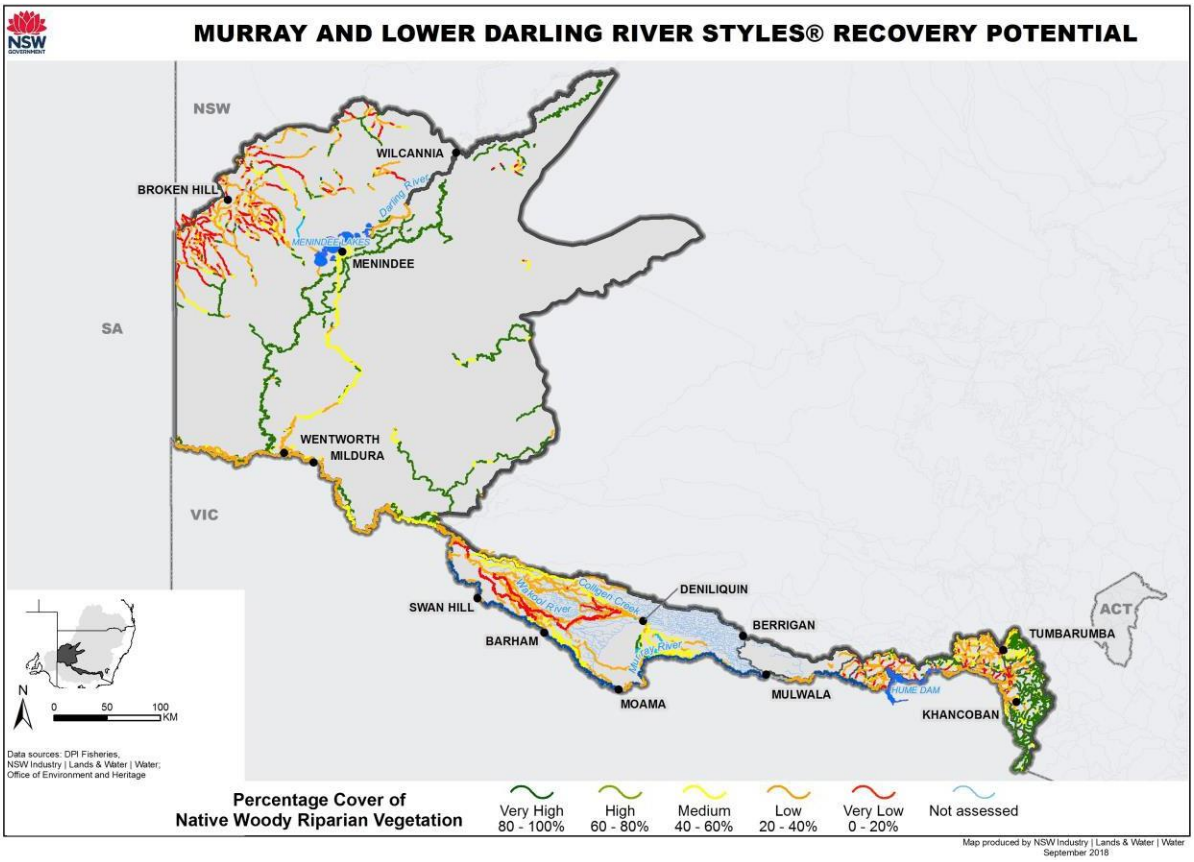

Figure G-4. Geomorphic recovery potential in streams in the NSW Murray and Lower Darling WRPA.

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 Department of Planning and Environment-Water, 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).

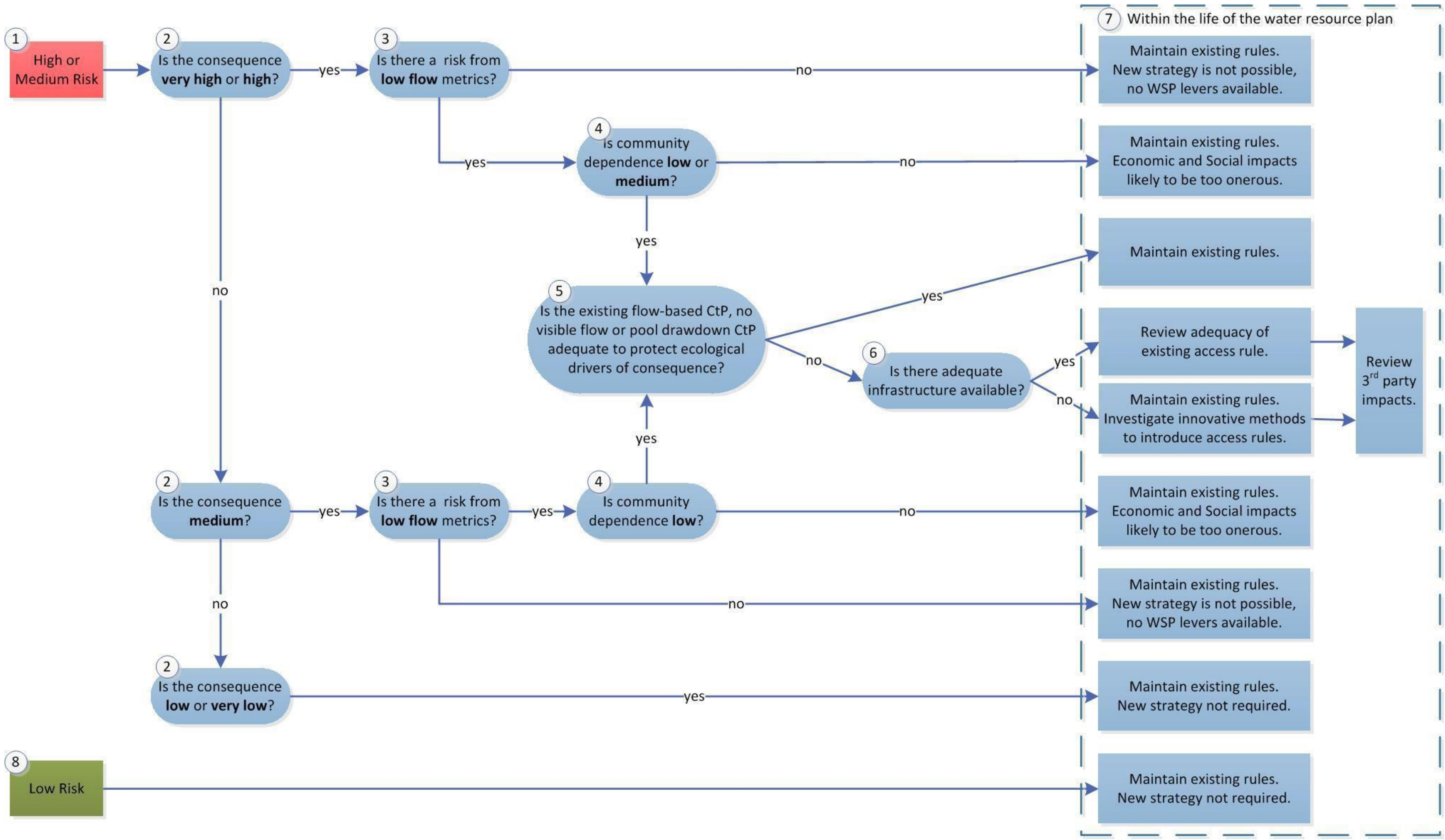

Figure G-5. Decision tree used as a guide for developing strategies in unregulated water sources.

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.

Decision tree annotation	Rationale
	• 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. • 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: - An assessment of any monitoring of the rules during the life of the previous State-based WSP, - There is existing evidence that indicates connectivity and water quality are managed through the CtP measures, - 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: - 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. - 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. - 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.

Decision tree annotation	Rationale
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 Department of Planning and Environment-Conservation and Biodiversity 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
Investigate options for optimising irrigation releases with the aim of achieving a more natural hydrograph in the low flow season The aim of this strategy would be to improve baseflow variability in the regulated river(s) by increasing the frequency of low flow periods during the natural low flow season. One option for achieving this would be co-ordinating and aggregating irrigation water orders so that the orders are delivered in 'pulses' that are separated by periods of lower flows. Implementation of this strategy may be constrained because irrigation releases need to meet the fundamental requirements for basic landholder rights, delivery constraints (e.g. the Barmah choke) and irrigation orders, however all options will be developed with these constraints in mind.	Murray regulated river reaches below Hume Dam and Y
Reduce the risk to baseflow and fresh frequencies by introducing seasonal patterns to mimic natural flow events This strategy aims to improve the naturalness of flows in the regulated river(s) by attempting to mimic the rising and falling limbs of a natural flow event. This draft strategy will investigate whether the risk associated with a reduced frequency of freshes during winter and early spring can be mitigated with EWA water releases, cued by natural inflow events into dams/weirs, which could be used to restore winter/spring freshes.	All regulated river reaches with Medium or High risk to base and fresh flows within the MLD
Investigate potential to introduce winter rainfall and snowmelt releases to mimic winter and spring flows to the Hume-Yarrawonga reach of the Murray River The aim of this strategy would be to investigate the feasibility of providing a scaled stimulus flow(s) mimicking the natural rainfall-snowmelt triggered high flows once experienced in this river reach. Investigate the ability to scale	All regulated river reaches between Hume Dam and Yarrawonga Weir

Draft Strategy Details	Relevant River Reaches
downstream releases from Hume dam based on upstream inflows into Hume dam or a nearby analogue tributary .	
Reduce the risk to zero flows and base flows by prohibiting or reviewing trade into high and medium risk water sources The current water sharing plan for the unregulated water sources for the Murray-Lower Darling does not allow trade into the medium and high risk water sources. The adequacy of this mechanism in controlling risk will be assessed over the term of the plan.	Tooma, Albury, Hume, Mannus, Maragle
Reduce the risk to zero flows and baseflows by reviewing low flow access rules This strategy will involve undertaking science over the term of the plan to establish the flow-ecology relationships in medium and high risk water sources to confirm (or otherwise) the risk. The results of this science will then be assessed against economic and social metrics to determine the adequacy of the current low flow access rules.	Tooma, Albury, Hume, Mannus

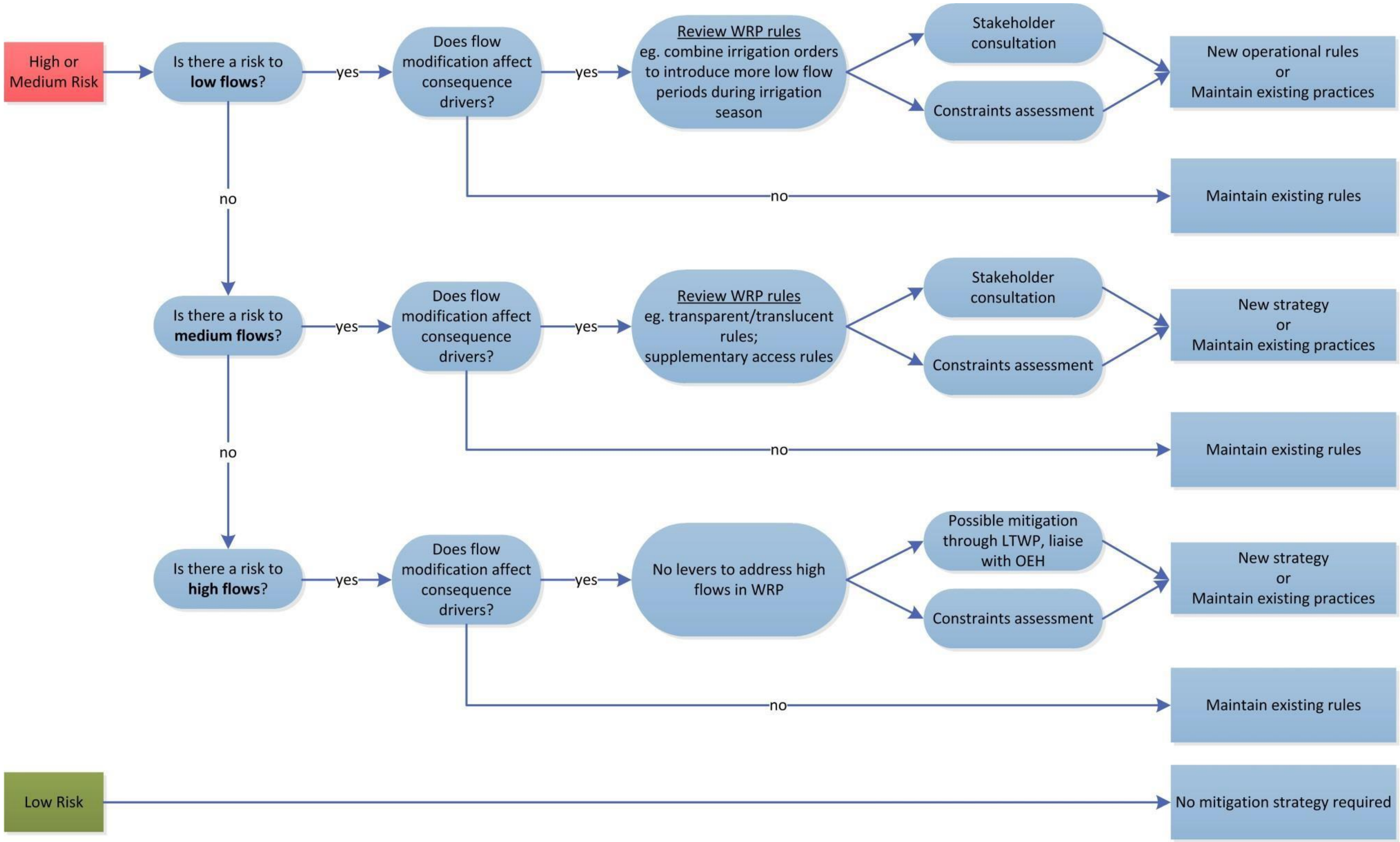

Figure G-6. Decision tree used as a guide for developing strategies in regulated water sources.

Appendix H - Risk assessment definitions