BASIN PLAN IMPLEMENTATION

Schedule D

Published by NSW Department of Planning, and Environment

dpie.nsw.gov.au

Title:

Subtitle: Schedule D

First published: December 2019

Department reference number: INT20/373662

NOTE: On 1 July 2019, NSW Department of Industry became part of NSW Department of Planning and Environment. Any references to Department of Industry in this document, except where made in a historical context, can be taken to refer to Department of Planning and Environment.

Acknowledgements

The maps in this report contain data sourced from:

Murray–Darling Basin Authority

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NSW Department of Primary Industries—Water

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

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NSW Department of Primary Industries—Fisheries, Fish Barrier database

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Executive Summary

The *Basin Plan 2012* (Basin Plan) requires NSW to prepare Water Resource Plans (WRP). The Risk Assessment for the Barwon-Darling Watercourse Resource Plan Area (SW12) (Barwon-Darling WRPA) 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 Barwon-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.

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

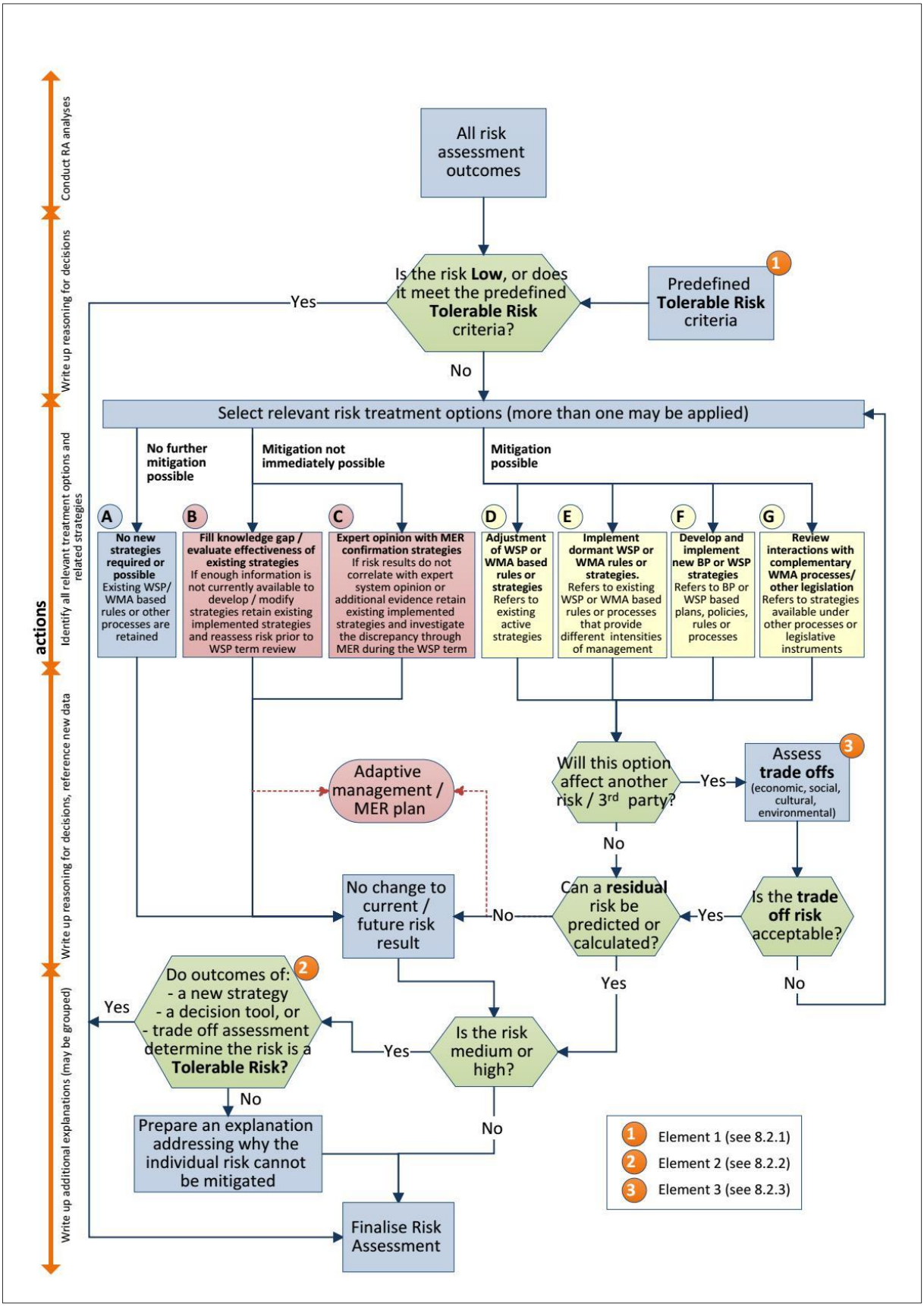

Figure 1 Risk treatment pathway

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 Summary of strategies to address risk 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 Rating	Explanation of tolerable risk application OR Explanation of why risk cannot be addressed (refer to Table 9-3)	Monitoring and evaluation
Risk assessment							**Risk treatment pathway**						
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 A **Nil** risk rating is used when the potential risk driver does not occur in the WRPA		**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 BARWON-DARLING SURFACE WRPA DUE TO CONNECTIVITY WITH THE DOWNSTREAM MURRAY-LOWER DARLING WATERCOURSE WRPA AND UPSTREAM GWYDIR, NAMOI, MACQUARIE-CASTLEREAGH AND INTERSECTING STREAMS										
Water Source Type	**Consequence**	**Likelihood**	**Risk Rating**	**Data confidence (Consequence / Likelihood)**	**Risk treatment option**	**Strategies**	**New Critical Mechanisms**	**Tolerable Risk Rating**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring & Evaluation**
Unregulated	M	L	L	H/H	N/A	None required. Risk is low	N/A	N/A	N/A	No MER planned
Current Critical Mechanisms Environmental flow rules described in WRP Section 4.2										

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

SECTION 4.3 RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT & CAPACITY TO MEET EWRS E(W)] - UNREGULATED WATER SOURCES													
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**
Section 1: Mungindi to Walgett (422003)	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 E4 - Trade limits or prohibitions between surface water plan areas, water sources, and river Sections to manage entitlement growth. E5 - Prohibit trade between surface water and groundwater sources. E6 - Cease / commence to pump rules for streams. E7 - Cease / commence to pump rules for in-stream pools. E9 – Implement Total Daily Extraction Limits (TDELs) and Individual Daily Extraction Limits (IDELs) (not currently in operation) E10 - Implement flow targets from the former Interim Unregulated Flow Management Plan for the North West (North West Plan) into the New WSP. E16 - Authorised in-river dam construction, operation, and passing flow requirements as specified on the dam approval. E18 - Prohibit trade onto a water supply work within a natural pool, lagoon or lake that is not in a river or in a floodplain or flood-runner	VH	H-	H-	H/H	N/A	E; F(i)	1 Limit consumptive water extractions in the WRP area to the predefined share of available water. 2 Protect a portion of natural flow events in the Barwon-Darling WRP area to enable longitudinal hydrologic connectivity within the WRP area and with the downstream NSW Murray and Lower Darling WRP area and inflowing tributaries 3 Protect a portion of natural flows to maintain hydrological connectivity between this water source and riparian zones, wetlands and floodplains connected to this water source. 4 Manage environmental water to meet flow targets specified in the Barwon-Darling LTWP. 5 Contribute to critical environmental and water quality events in downstream water sources. 6 Protect low flow habitats from accelerated rates of drying. **7** Protect pools in streams, wetlands, lagoons and floodplains within the WRP area during dry periods. 14 Improve knowledge used to assess risk in unregulated sections of the WRP area. 15 Improve knowledge of effectiveness of existing strategies	N1 Sustainable Diversion Limits Sustainable Diversion Limits N2 Implementation of a first flush rule to manage the resumptions of flows after a cease to flow period (proposed new active management option) N3 Protection of Held Environmental Water through water take restrictions (proposed new active management option) N4 Investigate and implement water/flow protection measures to improve northern hydrological connectivity between Northern Basin catchments (proposed new active management option) N5 Strategic use of held environmental water licences as guided by the LTWP N6 Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies N7 Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies	Not Tolerable	Risks are intolerable (Not tolerable). The hydrologic (likelihood) model for the Barwon-Darling is based on surveyed use of water (not full development). Therefore the impacts on the hydrograph are not potential impacts, but reasonable estimates of real impacts. This suggests that Key Ecosystem Assets and Functions are likely to be impacted by medium and high simulated changes, which are reflected in the risks associated with the flow metric.	MER planned for WSP objectives
Section 1: Mungindi to Walgett (422003)	Base-flow or Low Flows		VH	L+	M+	H/H	N/A				Not Tolerable	Risks are intolerable (Not tolerable). The hydrologic (likelihood) model for the Barwon-Darling is based on surveyed use of water (not full development). Therefore the impacts on the hydrograph are not potential impacts, but reasonable estimates of real impacts. This suggests that Key Ecosystem Assets and Functions are likely to be impacted by medium and high simulated changes, which are reflected in the risks associated with the flow metric.	MER planned for WSP objectives
Section 1: Mungindi to Walgett (422003)	Fresh Flows		VH	M-	H-	H/H	N/A				Not Tolerable	Risks are intolerable (Not tolerable). The hydrologic (likelihood) model for the Barwon-Darling is based on surveyed use of water (not full development). Therefore the impacts on the hydrograph are not potential impacts, but reasonable estimates of real impacts. This suggests that Key Ecosystem Assets and Functions are likely to be impacted by medium and high simulated changes, which are reflected in the risks associated with the flow metric.	MER planned for WSP objectives
Section 1: Mungindi to Walgett (422003)	High and Infrequent Flows - Bank Full 1.5 years ARI		VH	M-	H-	H/H	N/A				Not Tolerable	Risks are intolerable (Not tolerable). The hydrologic (likelihood) model for the Barwon-Darling is based on surveyed use of water (not full development). Therefore the impacts on the hydrograph are not potential impacts, but reasonable estimates of real impacts. This suggests that Key Ecosystem Assets and Functions are likely to be impacted by medium and high simulated changes, which are reflected in the risks associated with the flow metric.	MER planned for WSP objectives
Section 1: Mungindi to Walgett (422003)	High and Infrequent Flows - Over Bank 2.5 years ARI		VH	M-	H-	H/H	N/A				Not Tolerable	Risks are intolerable (Not tolerable). The hydrologic (likelihood) model for the Barwon-Darling is based on surveyed use of water (not full development). Therefore the impacts on the hydrograph are not potential impacts, but reasonable estimates of real impacts. This suggests that Key Ecosystem Assets and Functions are likely to be impacted by medium and high simulated changes, which are reflected in the risks associated with the flow metric.	MER planned for WSP objectives
Section 1: Mungindi to Walgett (422003)	High and Infrequent Flows - Over Bank 5.0 years ARI		VH	M-	H-	H/H	N/A				Not Tolerable	Risks are intolerable (Not tolerable). The hydrologic (likelihood) model for the Barwon-Darling is based on surveyed use of water (not full development). Therefore the impacts on the hydrograph are not potential impacts, but reasonable estimates of real impacts. This suggests that Key Ecosystem Assets and Functions are likely to be impacted by medium and high simulated changes, which are reflected in the risks associated with the flow metric.	MER planned for WSP objectives

SECTION 4.3 RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT & CAPACITY TO MEET EWRS E(W)] - UNREGULATED WATER SOURCES													
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**
Section 2: Walgett to Brewarrina (422027)	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 E4 - Trade limits or prohibitions between surface water plan areas, water sources, and river Sections to manage entitlement growth. E5 - Prohibit trade between surface water and groundwater sources. E6 - Cease / commence to pump rules for streams. E7 - Cease / commence to pump rules for in-stream pools. E9 – Implement Total Daily Extraction Limits (TDELs) and Individual Daily Extraction Limits (IDELs) (not currently in operation) E10 - Implement flow targets from the former Interim Unregulated Flow Management Plan for the North West (North West Plan) into the New WSP. E16 - Authorised in-river dam construction, operation, and passing flow requirements as specified on the dam approval. E18 - Prohibit trade onto a water supply work within a natural pool, lagoon or lake that is not in	H	L^{o}	L^{o}	H/H	N/A	E; F(i)	1 Limit consumptive water extractions in the WRP area to the predefined share of available water. 2 Protect a portion of natural flow events in the Barwon-Darling WRP area to enable longitudinal hydrologic connectivity within the WRP area and with the downstream NSW Murray and Lower Darling WRP area and inflowing tributaries 3 Protect a portion of natural flows to maintain hydrological connectivity between this water source and riparian zones, wetlands and floodplains connected to this water source. 4 Manage environmental water to meet flow targets specified in the Barwon-Darling LTWP. 5 Contribute to critical environmental and water quality events in downstream water sources. 6 Protect low flow habitats from accelerated rates of drying. **7** Protect pools in streams, wetlands, lagoons and floodplains within the WRP area during dry periods. 14 Improve knowledge used to assess risk in unregulated sections of the WRP area. 15 Improve knowledge of effectiveness of existing strategies	None required – risks are low	N/A		
Section 2: Walgett to Brewarrina (422027)	Base-flow or Low Flows		H	M-	M-	H/H	N/A			N1 Sustainable Diversion Limits Sustainable Diversion Limits N2 Implementation of a first flush rule to manage the resumptions of flows after a cease to flow period (proposed new active management option) N3 Protection of Held Environmental Water through water take restrictions (proposed new active management option) N4 Investigate and implement water/flow protection measures to improve northern hydrological connectivity between Northern Basin catchments (proposed new active management option)	Not Tolerable	Risks are intolerable (Not tolerable). The hydrologic (likelihood) model for the Barwon-Darling is based on surveyed use of water (not full development). Therefore the impacts on the hydrograph are not potential impacts, but reasonable estimates of real impacts. This suggests that Key Ecosystem Assets and Functions are likely to be impacted by medium and high simulated changes, which are reflected in the risks associated with the flow metric.	MER planned for WSP objectives
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Section 3: Brewarrina to Bourke (425003)	Base-flow or Low Flows		VH	L-	M-	H/H	N/A				Not Tolerable	Risks are intolerable (Not tolerable). The hydrologic (likelihood) model for the Barwon-Darling is based on surveyed use of water (not full development). Therefore the impacts on the hydrograph are not potential impacts, but reasonable estimates of real impacts. This suggests that Key Ecosystem Assets and Functions are likely to be impacted by medium and high simulated changes, which are reflected in the risks associated with the flow metric.	MER planned for WSP objectives
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Section 3: Brewarrina to Bourke (425003)	High and Infrequent Flows - Bank Full 1.5 years ARI		VH	M-	H-	H/H	N/A				Not Tolerable	Risks are intolerable (Not tolerable). The hydrologic (likelihood) model for the Barwon-Darling is based on surveyed use of water (not full development). Therefore the impacts on the hydrograph are not potential impacts, but reasonable estimates of real impacts. This suggests that Key Ecosystem Assets and Functions are likely to be impacted by medium and high simulated changes, which are reflected in the risks associated with the flow metric.	MER planned for WSP objectives
Section 3: Brewarrina to Bourke (425003)	High and Infrequent Flows - Over Bank 2.5 years ARI		VH	M-	H-	H/H	N/A				Not Tolerable	Risks are intolerable (Not tolerable). The hydrologic (likelihood) model for the Barwon-Darling is based on surveyed use of water (not full development). Therefore the impacts on the hydrograph are not potential impacts, but reasonable estimates of real impacts. This suggests that Key Ecosystem Assets and Functions are likely to be impacted by medium and high simulated changes, which are reflected in the risks associated with the flow metric.	MER planned for WSP objectives

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

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
Section 3: Brewarrina to Bourke (425003)	High and Infrequent Flows - Over Bank 5.0 years ARI	E18 - Prohibit trade onto a water supply work within a natural pool, lagoon or lake that is not in a river or in a floodplain or flood-runner	VH	M-	H-	H/H	N/A		15 Improve knowledge of effectiveness of existing strategies	MER confirmation strategies N7 Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies	Not Tolerable	Risks are intolerable (Not tolerable). The hydrologic (likelihood) model for the Barwon-Darling is based on surveyed use of water (not full development). Therefore the impacts on the hydrograph are not potential impacts, but reasonable estimates of real impacts. This suggests that Key Ecosystem Assets and Functions are likely to be impacted by medium and high simulated changes, which are reflected in the risks associated with the flow metric.	MER planned for WSP objectives
Section 4a: Bourke to Louth (425004)	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 E4 - Trade limits or prohibitions between surface water plan areas, water sources, and river Sections to manage entitlement growth. E5 - Prohibit trade between surface water and groundwater sources. E6 - Cease / commence to pump rules for streams. E7 - Cease / commence to pump rules for in-stream pools. E9 – Implement Total Daily Extraction Limits (TDELs) and Individual Daily Extraction Limits (IDELs) (not currently in operation) E10 - Implement flow targets from the former Interim Unregulated Flow Management Plan for the North West (North West Plan) into the New WSP. E16 - Authorised in-river dam construction, operation, and passing flow requirements as specified on the dam approval. E18 - Prohibit trade onto a water supply work within a natural pool, lagoon or lake that is not in a river or in a floodplain or flood-runner	H	H-	H-	H/H	N/A	E; F(ii)	1 Limit consumptive water extractions in the WRP area to the predefined share of available water. 2 Protect a portion of natural flow events in the Barwon-Darling WRP area to enable longitudinal hydrologic connectivity within the WRP area and with the downstream NSW Murray and Lower Darling WRP area and inflowing tributaries 3 Protect a portion of natural flows to maintain hydrological connectivity between this water source and riparian zones, wetlands and floodplains connected to this water source. 4 Manage environmental water to meet flow targets specified in the Barwon-Darling LTWP. 5 Contribute to critical environmental and water quality events in downstream water sources. 6 Protect low flow habitats from accelerated rates of drying. **7** Protect pools in streams, wetlands, lagoons and floodplains within the WRP area during dry periods. 14 Improve knowledge used to assess risk in unregulated sections of the WRP area. 15 Improve knowledge of effectiveness of existing strategies	N1 Sustainable Diversion Limits Sustainable Diversion Limits N2 Implementation of a first flush rule to manage the resumptions of flows after a cease to flow period (proposed new active management option) N3 Protection of Held Environmental Water through water take restrictions (proposed new active management option) N4 Investigate and implement water/flow protection measures to improve northern hydrological connectivity between Northern Basin catchments (proposed new active management option) N5 Strategic use of held environmental water licences as guided by the LTWP N6 Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies N7 Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies	Not Tolerable	Risks are intolerable (Not tolerable). The hydrologic (likelihood) model for the Barwon-Darling is based on surveyed use of water (not full development). Therefore the impacts on the hydrograph are not potential impacts, but reasonable estimates of real impacts. This suggests that Key Ecosystem Assets and Functions are likely to be impacted by medium and high simulated changes, which are reflected in the risks associated with the flow metric.	MER planned for WSP objectives
Section 4a: Bourke to Louth (425004)	Base-flow or Low Flows		H	M-	M-	H/H	N/A				Not Tolerable	Risks are intolerable (Not tolerable). The hydrologic (likelihood) model for the Barwon-Darling is based on surveyed use of water (not full development). Therefore the impacts on the hydrograph are not potential impacts, but reasonable estimates of real impacts. This suggests that Key Ecosystem Assets and Functions are likely to be impacted by medium and high simulated changes, which are reflected in the risks associated with the flow metric.	MER planned for WSP objectives
Section 4a: Bourke to Louth (425004)	Fresh Flows		H	M-	M-	H/H	N/A				Not Tolerable	Risks are intolerable (Not tolerable). The hydrologic (likelihood) model for the Barwon-Darling is based on surveyed use of water (not full development). Therefore the impacts on the hydrograph are not potential impacts, but reasonable estimates of real impacts. This suggests that Key Ecosystem Assets and Functions are likely to be impacted by medium and high simulated changes, which are reflected in the risks associated with the flow metric.	MER planned for WSP objectives
Section 4a: Bourke to Louth (425004)	High and Infrequent Flows - Bank Full 1.5 years ARI		H	M-	M-	H/H	N/A				Not Tolerable	Risks are intolerable (Not tolerable). The hydrologic (likelihood) model for the Barwon-Darling is based on surveyed use of water (not full development). Therefore the impacts on the hydrograph are not potential impacts, but reasonable estimates of real impacts. This suggests that Key Ecosystem Assets and Functions are likely to be impacted by medium and high simulated changes, which are reflected in the risks associated with the flow metric.	MER planned for WSP objectives
Section 4a: Bourke to Louth (425004)	High and Infrequent Flows - Over Bank 2.5 years ARI		H	M-	M-	H/H	N/A				Not Tolerable	Risks are intolerable (Not tolerable). The hydrologic (likelihood) model for the Barwon-Darling is based on surveyed use of water (not full development). Therefore the impacts on the hydrograph are not potential impacts, but reasonable estimates of real impacts. This suggests that Key Ecosystem Assets and Functions are likely to be impacted by medium and high simulated changes, which are reflected in the risks associated with the flow metric.	MER planned for WSP objectives
Section 4a: Bourke to Louth (425004)	High and Infrequent Flows - Over Bank 5.0 years ARI		H	M-	M-	H/H	N/A				Not Tolerable	Risks are intolerable (Not tolerable). The hydrologic (likelihood) model for the Barwon-Darling is based on surveyed use of water (not full development). Therefore the impacts on the hydrograph are not potential impacts, but reasonable estimates of real impacts. This suggests that Key Ecosystem Assets and Functions are likely to be impacted by medium and high simulated changes, which are reflected in the risks associated with the flow metric.	MER planned for WSP objectives

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

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
Section 4b: Louth to Wilcannia (425008)	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 E4 - Trade limits or prohibitions between surface water plan areas, water sources, and river Sections to manage entitlement growth. E5 - Prohibit trade between surface water and groundwater sources. E6 - Cease / commence to pump rules for streams. E7 - Cease / commence to pump rules for in-stream pools. E9 – Implement Total Daily Extraction Limits (TDELs) and Individual Daily Extraction Limits (IDELs) (not currently in operation) E10 - Implement flow targets from the former Interim Unregulated Flow Management Plan for the North West (North West Plan) into the New WSP. E16 - Authorised in-river dam construction, operation, and passing flow requirements as specified on the dam approval. E18 - Prohibit trade onto a water supply work within a natural pool, lagoon or lake that is not in a river or in a floodplain or flood-runner	H	H-	H-	H/H	N/A	E; F(ii)	1 Limit consumptive water extractions in the WRP area to the predefined share of available water. 2 Protect a portion of natural flow events in the Barwon-Darling WRP area to enable longitudinal hydrologic connectivity within the WRP area and with the downstream NSW Murray and Lower Darling WRP area and inflowing tributaries 3 Protect a portion of natural flows to maintain hydrological connectivity between this water source and riparian zones, wetlands and floodplains connected to this water source. 4 Manage environmental water to meet flow targets specified in the Barwon-Darling LTWP. 5 Contribute to critical environmental and water quality events in downstream water sources. 6 Protect low flow habitats from accelerated rates of drying. **7** Protect pools in streams, wetlands, lagoons and floodplains within the WRP area during dry periods. 14 Improve knowledge used to assess risk in unregulated sections of the WRP area. 15 Improve knowledge of effectiveness of existing strategies	N/A N1 Sustainable Diversion Limits Sustainable Diversion Limits N2 Implementation of a first flush rule to manage the resumptions of flows after a cease to flow period (proposed new active management option) N3 Protection of Held Environmental Water through water take restrictions (proposed new active management option) N4 Investigate and implement water/flow protection measures to improve northern hydrological connectivity between Northern Basin catchments (proposed new active management option) N5 Strategic use of held environmental water licences as guided by the LTWP N6 Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies N7 Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies	Not Tolerable	Risks are intolerable (Not tolerable). The hydrologic (likelihood) model for the Barwon-Darling is based on surveyed use of water (not full development). Therefore the impacts on the hydrograph are not potential impacts, but reasonable estimates of real impacts. This suggests that Key Ecosystem Assets and Functions are likely to be impacted by medium and high simulated changes, which are reflected in the risks associated with the flow metric.	MER planned for WSP objectives
Section 4b: Louth to Wilcannia (425008)	Base-flow or Low Flows		H	M-	M-	H/H	N/A				Not Tolerable	Risks are intolerable (Not tolerable). The hydrologic (likelihood) model for the Barwon-Darling is based on surveyed use of water (not full development). Therefore the impacts on the hydrograph are not potential impacts, but reasonable estimates of real impacts. This suggests that Key Ecosystem Assets and Functions are likely to be impacted by medium and high simulated changes, which are reflected in the risks associated with the flow metric.	MER planned for WSP objectives
Section 4b: Louth to Wilcannia (425008)	Fresh Flows		H	M-	M-	H/H	N/A				Not Tolerable	Risks are intolerable (Not tolerable). The hydrologic (likelihood) model for the Barwon-Darling is based on surveyed use of water (not full development). Therefore the impacts on the hydrograph are not potential impacts, but reasonable estimates of real impacts. This suggests that Key Ecosystem Assets and Functions are likely to be impacted by medium and high simulated changes, which are reflected in the risks associated with the flow metric.	MER planned for WSP objectives
Section 4b: Louth to Wilcannia (425008)	High and Infrequent Flows - Bank Full 1.5 years ARI		H	M-	M-	H/H	N/A				Not Tolerable	Risks are intolerable (Not tolerable). The hydrologic (likelihood) model for the Barwon-Darling is based on surveyed use of water (not full development). Therefore the impacts on the hydrograph are not potential impacts, but reasonable estimates of real impacts. This suggests that Key Ecosystem Assets and Functions are likely to be impacted by medium and high simulated changes, which are reflected in the risks associated with the flow metric.	MER planned for WSP objectives
Section 4b: Louth to Wilcannia (425008)	High and Infrequent Flows - Over Bank 2.5 years ARI		H	L-	L-	H/H	N/A			None required – risks are low	N/A		
Section 4b: Louth to Wilcannia (425008)	High and Infrequent Flows - Over Bank 5.0 years ARI		H	L-	L-	H/H	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**
Section 1: Mungindi to Walgett (422003)	BLR (D&S) extraction	VH	L	M	H/M	A	12 Protect the environment from changes in flow attributable to growth in BLR extractive use.	N1 Sustainable diversion limits	M	See below.	MER planned for WSP objectives
Section 2: Walgett to Brewarrina (422027)	BLR (D&S) extraction	H	L	L	H/M	N/A	None required, low risk		N/A	See below.	
Section 3: Brewarrina to Bourke (425003)	BLR (D&S) extraction	VH	L	M	H/M	A	12 Protect the environment from changes in flow attributable to growth in BLR extractive use.	N1 Sustainable diversion limits	M	See below.	MER planned for WSP objectives
Section 4a: Bourke to Louth (425004)	BLR (D&S) extraction	H	L	L	H/M	N/A	None required, low risk		N/A	N/A	
Section 4b: Louth to Wilcannia (425008)	BLR (D&S) extraction	H	L	L	H/M	N/A	None required, low risk		N/A	N/A	

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

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

SECTION 4.5.1 RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT FROM INTERCEPTION ACTIVITIES [E(I-FD)]												
Risk	**Water Source Type**	**Location, Reach, or Extraction Type within WRP Area**	**Flow or Extraction Characteristic**	**Consequence**	**Likelihood**	**Risk Rating**	**Data confidence (Consequence / Likelihood)**	**Risk treatment option**	**Strategies**	**New Critical Mechanisms**	**Tolerable risk level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and Evaluation**
Section 1 (Mungindi to Walgett)	Unregulated	All gauges outside and upstream of WSP area	Variation Annual Index CV	VH	L	M	H/L	A	**9** Protect stream flow from reduced runoff attributable to farm dam interception.	E21 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.	M	Risk is driven by very high consequence, but likelihood is low Farm dams that capture runoff into them as a basic right are permitted in NSW, and permitted under the Basin Plan. Farm dams that capture more than 10% of runoff on their properties are required to be licensed and extraction must also comply with the SDL of the resource unit. However, properties located in the Western Division of NSW are permitted to capture 100% of their runoff into a dam or dams including those on a minor stream without a licence being required.	E29 Ongoing monitoring of potential growth in number of farm dams within medium and high risk water sources
Section 1 (Mungindi to Walgett)	Unregulated	All gauges outside and upstream of WSP area	Low Flow Index Q90	VH	L	M	H/L	A	**9** Protect stream flow from reduced runoff attributable to farm dam interception	E21 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	M	Risk is driven by very high consequence, but likelihood is low Farm dams that capture runoff into them as a basic right are permitted in NSW, and permitted under the Basin Plan. Farm dams that capture more than 10% of runoff on their properties are required to be licensed and extraction must also comply with the SDL of the resource unit. However, properties located in the Western Division of NSW are permitted to capture 100% of their runoff into a dam or dams including those on a minor stream without a licence being required.	E29 Ongoing monitoring of potential growth in number of farm dams within medium and high risk water sources.
Section 1 (Mungindi to Walgett)	Unregulated	All gauges outside and upstream of WSP area	High Flow Index Q10	VH	L	M	H/L	A	**9** Protect stream flow from reduced runoff attributable to farm dam interception	E21 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	M	Risk is driven by very high consequence, but likelihood is low Farm dams that capture runoff into them as a basic right are permitted in NSW, and permitted under the Basin Plan. Farm dams that capture more than 10% of runoff on their properties are required to be licensed and extraction must also comply with the SDL of the resource unit. However, properties located in the Western Division of NSW are permitted to capture 100% of their runoff into a dam or dams including those on a minor stream without a licence being required.	E29 Ongoing monitoring of potential growth in number of farm dams within medium and high risk water sources

SECTION 4.5.1 RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT FROM INTERCEPTION ACTIVITIES [E(I-FD)]													
Risk	**Water Source Type**	**Location, Reach, or Extraction Type within WRP Area**	**Flow or Extraction Characteristic**	**Consequence**	**Likelihood**	**Risk Rating**	**Data confidence (Consequence / Likelihood)**	**Risk treatment option**	**Strategies**	**New Critical Mechanisms**	**Tolerable risk level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and Evaluation**
Section 2 (Walgett to Brewarrina)	Unregulated	All gauges outside and upstream of WSP area	Variation Annual Index CV	H	L	L	H/L	N/A	None required. Risk is low		N/A	N/A	
Section 2 (Walgett to Brewarrina)	Unregulated	All gauges outside and upstream of WSP area	Low Flow Index Q90	H	L	L	H/L	N/A	None required. Risk is low		N/A	N/A	
Section 2 (Walgett to Brewarrina)	Unregulated	All gauges outside and upstream of WSP area	High Flow Index Q10	H	L	L	H/L	N/A	None required. Risk is low		N/A	N/A	
Section 3 (Brewarrina to Bourke)	Unregulated	All gauges outside and upstream of WSP area	Variation Annual Index CV	VH	L	M	H/L	A	**9** Protect stream flow from reduced runoff attributable to farm dam interception	E21 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	M	Risk is driven by very high consequence, but likelihood is low Farm dams that capture runoff into them as a basic right are permitted in NSW, and permitted under the Basin Plan. Farm dams that capture more than 10% of runoff on their properties are required to be licensed and extraction must also comply with the SDL of the resource unit.	E29 Ongoing monitoring of potential growth in number of farm dams within medium and high risk water sources
Section 3 (Brewarrina to Bourke)	Unregulated	All gauges outside and upstream of WSP area	Low Flow Index Q90	VH	L	M	H/L	A	**9** Protect stream flow from reduced runoff attributable to farm dam interception	E21 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	M	Risk is driven by very high consequence, but likelihood is low Farm dams that capture runoff into them as a basic right are permitted in NSW, and permitted under the Basin Plan. Farm dams that capture more than 10% of runoff on their properties are required to be licensed and extraction must also comply with the SDL of the resource unit.	E29 Ongoing monitoring of potential growth in number of farm dams within medium and high risk water sources
Section 3 (Brewarrina to Bourke)	Unregulated	All gauges outside and upstream of WSP area	High Flow Index Q10	VH	L	M	H/L	A	**9** Protect stream flow from reduced runoff attributable to farm dam interception	E21 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	M	Risk is driven by very high consequence, but likelihood is low Farm dams that capture runoff into them as a basic right are permitted in NSW, and permitted under the Basin Plan. Farm dams that capture more than 10% of runoff on their properties are required to be licensed and extraction must also comply with the SDL of the resource unit.	E29 Ongoing monitoring of potential growth in number of farm dams within medium and high risk water sources
Section 4a (Bourke to Louth)	Unregulated	All gauges outside and upstream of WSP area	Variation Annual Index CV	H	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	

SECTION 4.5.1 RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT FROM INTERCEPTION ACTIVITIES [E(I-FD)]													
Risk	**Water Source Type**	**Location, Reach, or Extraction Type within WRP Area**	**Flow or Extraction Characteristic**	**Consequence**	**Likelihood**	**Risk Rating**	**Data confidence (Consequence / Likelihood)**	**Risk treatment option**	**Strategies**	**New Critical Mechanisms**	**Tolerable risk level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and Evaluation**
Section 4a (Bourke to Louth)	Unregulated	All gauges outside and upstream of WSP area	Low Flow Index Q90	H	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	
Section 4a (Bourke to Louth)	Unregulated	All gauges outside and upstream of WSP area	High Flow Index Q10	H	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	
Section 4b (Louth to Wilcannia)	Unregulated	All gauges outside and upstream of WSP area	Variation Annual Index CV	H	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	
Section 4b (Louth to Wilcannia)	Unregulated	All gauges outside and upstream of WSP area	Low Flow Index Q90	H	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	
Section 4b (Louth to Wilcannia)	Unregulated	All gauges outside and upstream of WSP area	High Flow Index Q10	H	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	
Current Critical Mechanisms - E(I-FD) E21 Require farm dams with a capacity above the maximum harvestable right dam capacity (MHRDC) to be licensed and comply with extraction limits as described in Strategy 1 (E1 Reserve all water above the long-term average annual extraction limit (LTAAEL) for the environment as PEW (defined and managed by the listed WSPs) & E2 Available Water Determinations (AWD) adjust extractive use according to water availability)													
New Strategy: None required. Risks are low. Refer to MER. N/A no data available or not applicable													

SECTION 4.5.2 RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT FROM INTERCEPTION ACTIVITIES [E(I-PF)]											
Risk	**Water Source Type**	**Consequence**	**Likelihood**	**Risk Rating**	**Data confidence (Consequence / Likelihood)**	**Risk treatment option**	**Strategies**	**New Critical Mechanisms**	**Tolerable risk level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and Evaluation**
Risk to water available for the environment from plantation forestry E(I-PF)	Unregulated	H_VH	Nil	Nil	H/M	N/A	None required. Risk is nil		N/A	N/A	
Current Critical Mechanisms - E(I-PF) E22 Plantation forestry interception is considered lnil risk therefore no mechanisms have been implemented under the WM Act. E23 Ongoing risk monitoring to determine impact of future expansion of forest plantations at local and regional scales											

SECTION 4.5.3 RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT FROM INTERCEPTION ACTIVITIES [E(I-M)]									
Risk	**Water Source Type**	**Risk Rating**	**Data confidence (Consequence / Likelihood)**	**Risk treatment option**	**Strategies**	**New Critical Mechanisms**	**Tolerable risk level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and Evaluation**
Reduced water quantity available for the environment caused by mining E(I-M)	Unregulated	Nil	M/M	N/A	None required.		N/A	Risk is nil due to absence of mining	
Poor water quality for the environment caused by mining E(I-M)	Unregulated	L	M/M	N/A	None required. Risk is low		N/A	Risk is low due to absence of mining	
Damage to structural integrity caused by mining E(I-M)	Unregulated	L	M/M	N/A	None required. Risk is low		N/A	Risk is low due to absence of mining	
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)	Unregulated	VH	L	M	H/M	A B	16 Protect the environment and other users from changes in flow attributable to growth in Floodplain harvesting	N7 - Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies.	M	Risk is tolerable. See section 5.7.4 of the water resource plan for current management actions and mechanisms. Floodplain Harvesting Policy and Healthy Floodplains Projects mitigate risk	MER for N7
Current Critical Mechanisms - E(I-FH) The Floodplain Harvesting Policy and Healthy Floodplains Projects are converting this form of take into a licensable right. This form of take will be managed under the Floodplain licencing framework.											

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

Risk	Location, Reach, or Extraction Type within WRP Area	Climate Change Scenario (MDBSY)	Current Critical Mechanisms	Consequence	Likelihood	Risk Rating	Data confidence (Consequence / 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
drown-out flow at Bourke Weir	Weir at Bourke on the Darling River	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. E30 Review and update climate change models when new data is available	Moderate	Possible	M	L/M	F	11 Protect the environment and water users from changes in flow attributable to climate change.	N1 Sustainable Diversion Limits N5 Strategic use of held environmental water licences as guided by the LTWP N3 Protection of Held Environmental Water through water take restrictions (proposed new active management option)	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.	
drown-out flow at Bourke Weir	Weir at Bourke on the Darling River	Median climate change scenario		Major	Possible	H	L/M	F			H		
drown-out flow at Bourke Weir	Weir at Bourke on the Darling River	Dry climate change scenario		Severe	Likely	H	L/M	F			H		
Risk to water available for the environment in unregulated river sections as a result of climate change E(CC)	Section 1 (Mungindi to Walgett)			VH	M	H	L/M	F			H		
	Section 2 (Walgett to Brewarrina)			H	M	M	L/M	F			M		
	Section 3 (Brewarrina to Bourke)			VH	M	H	L/M	F			H		
	Section 4a (Bourke to Louth)			H	M	M	L/M	F			M		
	Section 4b (Louth to Wilcannia)			H	M	M	L/M	F			M		

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

SECTION 6.4, 6.5, 6.6 RISKS TO THE HEALTH OF WATER DEPENDENT ECOSYSTEMS FROM POOR WATER QUALITY [E(WQ), (E(WQ-CWP)], [E(WQ-S)], [E(WQ-PT)]														
Risk Code	**Water Source Type**	**Location, Reach, or Extraction Type within WRP Area**	**Water Quality Characteristic**	**Current Critical Mechanisms**	**Consequence**	**Likelihood**	**Risk Rating**	**Data confidence (Consequence / Likelihood)**	**Risk treatment option**	**Strategies**	**New Critical Mechanisms**	**Tolerable Risk Level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and Evaluation**
										The primary strategy for addressing risks associated with water quality is the implementation of the Water Quality Management Plan for Barwon-Darling WRPA. Additional actions and mechanisms relevant to the WRP are listed below.				**WQ** 1, 2, 3, 4, 5, 6, 7
E(WQ)	Unregulated	416001 Barwon River at Mungindi	Turbidity	E6 Cease / commence to pump rules for streams E7 Cease / commence to pump rules for in-stream pools E9 Implement Total Daily Extraction Limits (TDELs) and Individual Daily Extraction Limits (IDELs) (not currently in operation) E10 Implement flow targets within the former Interim Unregulated Flow Management Plan for the North West (North West Plan) into the New WSP	H	L	L	M/H	F	Refer to WQM Plan		Refer to WQM Plan.		
E(WQ)	Unregulated	416001 Barwon River at Mungindi	Total Phosphorus	E6 Cease / commence to pump rules for streams E7 Cease / commence to pump rules for in-stream pools E9 Implement Total Daily Extraction Limits (TDELs) and Individual Daily Extraction Limits (IDELs) (not currently in operation) E10 Implement flow targets within the former Interim Unregulated Flow Management Plan for the North West (North West Plan) into the New WSP	H	L	L	M/H	F	Refer to WQM Plan		Refer to WQM Plan.		

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E(WQ)	Unregulated	416001 Barwon River at Mungindi	pH	E6 Cease / commence to pump rules for streams E7 Cease / commence to pump rules for in-stream pools E9 Implement Total Daily Extraction Limits (TDELs) and Individual Daily Extraction Limits (IDELs) E10 Implement flow targets within(not currently in operation) the former Interim Unregulated Flow Management Plan for the North West (North West Plan) into the New WSP	H	L	L	M/H	F	Refer to WQM Plan		Refer to WQM Plan.		
E(WQ)	Unregulated	416001 Barwon River at Mungindi	Dissolved Oxygen	E6 Cease / commence to pump rules for streams E7 Cease / commence to pump rules for in-stream pools E9 Implement Total Daily Extraction Limits (TDELs) and Individual Daily Extraction Limits (IDELs) (not currently in operation) E10 Implement flow targets within the former Interim Unregulated Flow Management Plan for the North West (North West Plan) into the New WSP	H	L	L	M/H	F	Refer to WQM Plan		Refer to WQM Plan.		
E(WQ)	Unregulated	422003 Barwon River at Collarenebri	Turbidity	E6 Cease / commence to pump rules for streams E7 Cease / commence to pump rules for in-stream pools E9 Implement Total Daily Extraction Limits (TDELs) and Individual Daily Extraction Limits (IDELs) (not currently in operation) E10 Implement flow targets within the former Interim Unregulated Flow Management Plan for the North West (North West Plan) into the New WSP E16 Authorised in-river dam construction, operation, and passing flow requirements as specified on the dam approval. E18 Prohibit trade onto a water supply work within a natural pool, lagoon or lake that is not in a river or in a floodplain or flood-runner	VH	L	M	M/H	F	Refer to WQM Plan 2 Protect a portion of natural flow events in the Barwon-Darling WRP area to enable longitudinal hydrologic connectivity within the WRP area and with the Barwon-Darling WRP area. 3 Protect a portion of natural flows to maintain hydrological connectivity between this water source and riparian zones, wetlands and floodplains connected to this water source. **7** Protect pools in streams, wetlands, lagoons and floodplains within the WRP area during dry periods. **8** Implement the WQM Plan for the WRP area.	N2 Implementation of a first flush rule to manage the resumptions of flows after a cease to flow period (proposed new active management option) N3 Protection of Held Environmental Water through water take restrictions (proposed new active management option) N4 Investigate and implement water/flow protection measures to improve northern hydrological connectivity between Northern Basin catchments (proposed new active management option) N5 Strategic use of held environmental water licences as guided by the LTWP.	Refer to WQM Plan.		

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E(WQ)	Unregulated	422003 Barwon River at Collarenebri	Total Nitrogen	E6 Cease / commence to pump rules for streams E7 Cease / commence to pump rules for in-stream pools E9 Implement Total Daily Extraction Limits (TDELs) and Individual Daily Extraction Limits (IDELs) (not currently in operation) E10 Implement flow targets within the former Interim Unregulated Flow Management Plan for the North West (North West Plan) into the New WSP E16 Authorised in-river dam construction, operation, and passing flow requirements as specified on the dam approval. E18 Prohibit trade onto a water supply work within a natural pool, lagoon or lake that is not in a river or in a floodplain or flood-runner	VH	M	H	M/H	F	Refer to WQM Plan 2 Protect a portion of natural flow events in the Barwon-Darling WRP area to enable longitudinal hydrologic connectivity within the WRP area and with the Barwon-Darling WRP area. 3 Protect a portion of natural flows to maintain hydrological connectivity between this water source and riparian zones, wetlands and floodplains connected to this water source. **7** Protect pools in streams, wetlands, lagoons and floodplains within the WRP area during dry periods.	N2 Implementation of a first flush rule to manage the resumptions of flows after a cease to flow period (proposed new active management option) N3 Protection of Held Environmental Water through water take restrictions (proposed new active management option) N4 Investigate and implement water/flow protection measures to improve northern hydrological connectivity between Northern Basin catchments (proposed new active management option)	Refer to WQM Plan.		

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E(WQ)	Unregulated	422002 Barwon River at Brewarrina	pH	E6 Cease / commence to pump rules for streams E7 Cease / commence to pump rules for in-stream pools E9 Implement Total Daily Extraction Limits (TDELs) and Individual Daily Extraction Limits (IDELs) (not currently in operation) E10 Implement flow targets within the former Interim Unregulated Flow Management Plan for the North West (North West Plan) into the New WSP E16 Authorised in-river dam construction, operation, and passing flow requirements as specified on the dam approval. E18 Prohibit trade onto a water supply work within a natural pool, lagoon or lake that is not in a river or in a floodplain or flood-runner	VH	L	M	M/H	F	Refer to WQM Plan 2 Protect a portion of natural flow events in the Barwon-Darling WRP area to enable longitudinal hydrologic connectivity within the WRP area and with the Barwon-Darling WRP area. 3 Protect a portion of natural flows to maintain hydrological connectivity between this water source and riparian zones, wetlands and floodplains connected to this water source. **7** Protect pools in streams, wetlands, lagoons and floodplains within the WRP area during dry periods. **8** Implement the WQM Plan for the WRP area.		Refer to WQM Plan.		
E(WQ)	Unregulated	422002 Barwon River at Brewarrina	Dissolved Oxygen	E6 Cease / commence to pump rules for streams E7 Cease / commence to pump rules for in-stream pools E9 Implement Total Daily Extraction Limits (TDELs) and Individual Daily Extraction Limits (IDELs) (not currently in operation) E10 Implement flow targets within the former Interim Unregulated Flow Management Plan for the North West (North West Plan) into the New WSP E16 Authorised in-river dam construction, operation, and passing flow requirements as specified on the dam approval. E18 Prohibit trade onto a water supply work within a natural pool, lagoon or lake that is not in a river or in a floodplain or flood-runner	VH	L	M	M/H	F	Refer to WQM Plan 2 Protect a portion of natural flow events in the Barwon-Darling WRP area to enable longitudinal hydrologic connectivity within the WRP area and with the Barwon-Darling WRP area. 3 Protect a portion of natural flows to maintain hydrological connectivity between this water source and		Refer to WQM Plan.		

SECTION 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-S)], [E(WQ-PT)]															
Risk Code	**Water Source Type**	**Location, Reach, or Extraction Type within WRP Area**	**Water Quality Characteristic**	**Current Critical Mechanisms**	**Consequence**	**Likelihood**	**Risk Rating**	**Data confidence (Consequence / Likelihood)**	**Risk treatment option**	**Strategies**	**New Critical Mechanisms**	**Tolerable Risk Level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and Evaluation**
										The primary strategy for addressing risks associated with water quality is the implementation of the Water Quality Management Plan for Barwon-Darling WRPA. Additional actions and mechanisms relevant to the WRP are listed below.				**WQ** 1, 2, 3, 4, 5, 6, 7
										riparian zones, wetlands and floodplains connected to this water source. **7** Protect pools in streams, wetlands, lagoons and floodplains within the WRP area during dry periods. **8** Implement the WQM Plan for the WRP area.				
E(WQ)	Unregulated	425003 Darling River at Bourke	Turbidity	E6 Cease / commence to pump rules for streams E7 Cease / commence to pump rules for in-stream pools E9 Implement Total Daily Extraction Limits (TDELs) and Individual Daily Extraction Limits (IDELs) (not currently in operation) E10 Implement flow targets within the former Interim Unregulated Flow Management Plan for the North West (North West Plan) into the New WSP E16 Authorised in-river dam construction, operation, and passing flow requirements as specified on the dam approval. E18 Prohibit trade onto a water supply work within a natural pool, lagoon or lake that is not in a river or in a floodplain or flood-runner	H	H	H	M/H	F	Refer to WQM Plan 2 Protect a portion of natural flow events in the Barwon-Darling WRP area to enable longitudinal hydrologic connectivity within the WRP area and with the Barwon-Darling WRP area. 3 Protect a portion of natural flows to maintain hydrological connectivity between this water source and riparian zones, wetlands and floodplains connected to this water source. **7** Protect pools in streams, wetlands, lagoons and floodplains within the WRP area during dry periods. **8** Implement the WQM Plan for the WRP area.		Refer to WQM Plan.		
E(WQ)	Unregulated	425003 Darling River at Bourke	Total Phosphorus	E6 Cease / commence to pump rules for streams E7 Cease / commence to pump rules for in-stream pools E9 Implement Total Daily Extraction Limits (TDELs) and Individual Daily Extraction Limits (IDELs) (not currently in operation) E10 Implement flow targets within the former Interim Unregulated Flow Management Plan for the North West (North West Plan) into the New WSP	H	H	H	M/H	F	Refer to WQM Plan		Refer to WQM Plan.		

SECTION 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-S)], [E(WQ-PT)]															
Risk Code	**Water Source Type**	**Location, Reach, or Extraction Type within WRP Area**	**Water Quality Characteristic**	**Current Critical Mechanisms**	**Consequence**	**Likelihood**	**Risk Rating**	**Data confidence (Consequence / Likelihood)**	**Risk treatment option**	**Strategies**	**New Critical Mechanisms**	**Tolerable Risk Level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and Evaluation**
										The primary strategy for addressing risks associated with water quality is the implementation of the Water Quality Management Plan for Barwon-Darling WRPA. Additional actions and mechanisms relevant to the WRP are listed below.				**WQ** 1, 2, 3, 4, 5, 6, 7
E(WQ)	Unregulated	425003 Darling River at Bourke	Total Nitrogen	E6 Cease / commence to pump rules for streams E7 Cease / commence to pump rules for in-stream pools E9 Implement Total Daily Extraction Limits (TDELs) and Individual Daily Extraction Limits (IDELs) (not currently in operation) E10 Implement flow targets within the former Interim Unregulated Flow Management Plan for the North West (North West Plan) into the New WSP	H	H	H	M/H	F	Refer to WQM Plan		Refer to WQM Plan.		
E(WQ)	Unregulated	425003 Darling River at Bourke	pH	E6 Cease / commence to pump rules for streams E7 Cease / commence to pump rules for in-stream pools E9 Implement Total Daily Extraction Limits (TDELs) and Individual Daily Extraction Limits (IDELs) (not currently in operation) E10 Implement flow targets within the former Interim Unregulated Flow Management Plan for the North West (North West Plan) into the New WSP.	H	M	M	M/H	F	Refer to WQM Plan		Refer to WQM Plan.		
E(WQ)	Unregulated	425003 Darling River at Bourke	Dissolved Oxygen	E6 Cease / commence to pump rules for streams E7 Cease / commence to pump rules for in-stream pools E9 Implement Total Daily Extraction Limits (TDELs) and Individual Daily Extraction Limits (IDELs) (not currently in operation) E10 Implement flow targets within the former Interim Unregulated Flow Management Plan for the North West (North West Plan) into the New WSP E16 Authorised in-river dam construction, operation, and passing flow requirements as specified on the dam approval. E18 Prohibit trade onto a water supply work within a natural pool, lagoon or lake that is not in a river or in a floodplain or flood-runner	H	M	M	M/H	F	Refer to WQM Plan 2 Protect a portion of natural flow events in the Barwon-Darling WRP area to enable longitudinal hydrologic connectivity within the WRP area and with the Barwon-Darling WRP area. 3 Protect a portion of natural flows to maintain hydrological connectivity between this water source and riparian zones, wetlands and floodplains connected to this water source. **7** Protect pools in streams, wetlands, lagoons and floodplains within the WRP area during dry periods. **8** Implement the WQM Plan for the WRP area.		Refer to WQM Plan.		

SECTION 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-S)], [E(WQ-PT)]															
Risk Code	**Water Source Type**	**Location, Reach, or Extraction Type within WRP Area**	**Water Quality Characteristic**	**Current Critical Mechanisms**	**Consequence**	**Likelihood**	**Risk Rating**	**Data confidence (Consequence / Likelihood)**	**Risk treatment option**	**Strategies**	**New Critical Mechanisms**	**Tolerable Risk Level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and Evaluation**
										The primary strategy for addressing risks associated with water quality is the implementation of the Water Quality Management Plan for Barwon-Darling WRPA. Additional actions and mechanisms relevant to the WRP are listed below.				**WQ** 1, 2, 3, 4, 5, 6, 7
E(WQ)	Unregulated	425004 Darling River at Louth	Turbidity	E6 Cease / commence to pump rules for streams E7 Cease / commence to pump rules for in-stream pools E9 Implement Total Daily Extraction Limits (TDELs) and Individual Daily Extraction Limits (IDELs) (not currently in operation) E10 Implement flow targets within the former Interim Unregulated Flow Management Plan for the North West (North West Plan) into the New WSP E16 Authorised in-river dam construction, operation, and passing flow requirements as specified on the dam approval. E18 Prohibit trade onto a water supply work within a natural pool, lagoon or lake that is not in a river or in a floodplain or flood-runner	M	H	H	M/H	F	Refer to WQM Plan 2 Protect a portion of natural flow events in the Barwon-Darling WRP area to enable longitudinal hydrologic connectivity within the WRP area and with the Barwon-Darling WRP area. 3 Protect a portion of natural flows to maintain hydrological connectivity between this water source and riparian zones, wetlands and floodplains connected to this water source. **7** Protect pools in streams, wetlands, lagoons and floodplains within the WRP area during dry periods. **8** Implement the WQM Plan for the WRP area.		Refer to WQM Plan.		MER planned for WSP objectives and WQ 1, 2, 4, 5
E(WQ)	Unregulated	425004 Darling River at Louth	Total Phosphorus	E6 Cease / commence to pump rules for streams E7 Cease / commence to pump rules for in-stream pools E9 Implement Total Daily Extraction Limits (TDELs) and Individual Daily Extraction Limits (IDELs) (not currently in operation) E10 Implement flow targets within the former Interim Unregulated Flow Management Plan for the North West (North West Plan) into the New WSP E16 Authorised in-river dam construction, operation, and passing flow requirements as specified on the dam approval. E18 Prohibit trade onto a water supply work within a natural pool, lagoon or lake that is not in a river or in a floodplain or flood-runner	M	H	H	M/H	F	Refer to WQM Plan 2 Protect a portion of natural flow events in the Barwon-Darling WRP area to enable longitudinal hydrologic connectivity within the WRP area and with the Barwon-Darling WRP area. 3 Protect a portion of natural flows to maintain hydrological connectivity between this water source and riparian zones, wetlands and floodplains connected to this water source. **7** Protect pools in streams, wetlands, lagoons and floodplains within the	.	Refer to WQM Plan.		MER planned for WSP objectives and WQ 1, 2, 4, 5

SECTION 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-S)], [E(WQ-PT)]															
Risk Code	**Water Source Type**	**Location, Reach, or Extraction Type within WRP Area**	**Water Quality Characteristic**	**Current Critical Mechanisms**	**Consequence**	**Likelihood**	**Risk Rating**	**Data confidence (Consequence / Likelihood)**	**Risk treatment option**	**Strategies**	**New Critical Mechanisms**	**Tolerable Risk Level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and Evaluation**
										The primary strategy for addressing risks associated with water quality is the implementation of the Water Quality Management Plan for Barwon-Darling WRPA. Additional actions and mechanisms relevant to the WRP are listed below.				**WQ** 1, 2, 3, 4, 5, 6, 7
										WRP area during dry periods. **8** Implement the WQM Plan for the WRP area.				
E(WQ)	Unregulated	425004 Darling River at Louth	Total Nitrogen	E6 Cease / commence to pump rules for streams E7 Cease / commence to pump rules for in-stream pools E9 Implement Total Daily Extraction Limits (TDELs) and Individual Daily Extraction Limits (IDELs) (not currently in operation) E10 Implement flow targets within the former Interim Unregulated Flow Management Plan for the North West (North West Plan) into the New WSP E16 Authorised in-river dam construction, operation, and passing flow requirements as specified on the dam approval. E18 Prohibit trade onto a water supply work within a natural pool, lagoon or lake that is not in a river or in a floodplain or flood-runner	M	H	H	M/H	F	Refer to WQM Plan 2 Protect a portion of natural flow events in the Barwon-Darling WRP area to enable longitudinal hydrologic connectivity within the WRP area and with the Barwon-Darling WRP area. 3 Protect a portion of natural flows to maintain hydrological connectivity between this water source and riparian zones, wetlands and floodplains connected to this water source. **7** Protect pools in streams, wetlands, lagoons and floodplains within the WRP area during dry periods. **8** Implement the WQM Plan for the WRP area.		Refer to WQM Plan.		MER planned for WSP objectives and WQ 1, 2, 4, 5
E(WQ)	Unregulated	425004 Darling River at Louth	pH	E6 Cease / commence to pump rules for streams E7 Cease / commence to pump rules for in-stream pools E9 Implement Total Daily Extraction Limits (TDELs) and Individual Daily Extraction Limits (IDELs) E10 Implement flow targets within the former Interim Unregulated Flow Management Plan for the North West (North West Plan) into the New WSP	M	L	L	M/H	F	Refer to WQM Plan		Refer to WQM Plan.		

SECTION 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-S)], [E(WQ-PT)]															
Risk Code	**Water Source Type**	**Location, Reach, or Extraction Type within WRP Area**	**Water Quality Characteristic**	**Current Critical Mechanisms**	**Consequence**	**Likelihood**	**Risk Rating**	**Data confidence (Consequence / Likelihood)**	**Risk treatment option**	**Strategies**	**New Critical Mechanisms**	**Tolerable Risk Level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and Evaluation**
										The primary strategy for addressing risks associated with water quality is the implementation of the Water Quality Management Plan for Barwon-Darling WRPA. Additional actions and mechanisms relevant to the WRP are listed below.				**WQ** 1, 2, 3, 4, 5, 6, 7
E(WQ)	Unregulated	425004 Darling River at Louth	Dissolved Oxygen	E6 Cease / commence to pump rules for streams E7 Cease / commence to pump rules for in-stream pools E9 Implement Total Daily Extraction Limits (TDELs) and Individual Daily Extraction Limits (IDELs) E10 Implement flow targets within the former Interim Unregulated Flow Management Plan for the North West (North West Plan) into the New WSP	M	L	L	M/H	F	Refer to WQM Plan		Refer to WQM Plan.		MER planned for WSP objectives and WQ 1, 2, 4, 5
E(WQ)	Unregulated	425008 Darling River at Wilcannia	Turbidity	E6 Cease / commence to pump rules for streams E7 Cease / commence to pump rules for in-stream pools E9 Implement Total Daily Extraction Limits (TDELs) and Individual Daily Extraction Limits (IDELs) E10 Implement flow targets within the former Interim Unregulated Flow Management Plan for the North West (North West Plan) into the New WSP E16 Authorised in-river dam construction, operation, and passing flow requirements as specified on the dam approval. E18 Prohibit trade onto a water supply work within a natural pool, lagoon or lake that is not in a river or in a floodplain or flood-runner	M	M	M	M/H	F	Refer to WQM Plan 2 Protect a portion of natural flow events in the Barwon-Darling WRP area to enable longitudinal hydrologic connectivity within the WRP area and with the Barwon-Darling WRP area. 3 Protect a portion of natural flows to maintain hydrological connectivity between this water source and riparian zones, wetlands and floodplains connected to this water source. **7** Protect pools in streams, wetlands, lagoons and floodplains within the WRP area during dry periods. **8** Implement the WQM Plan for the WRP area.	N2 Implementation of a first flush rule to manage the resumptions of flows after a cease to flow period (proposed new active management option) N3 Protection of Held Environmental Water through water take restrictions (proposed new active management option) N4 Investigate and implement water/flow protection measures to improve northern hydrological connectivity between Northern Basin catchments (proposed new active management option) N5 Strategic use of held environmental water licences as guided by the LTWP.	Refer to WQM Plan.		MER planned for WSP objectives and WQ 1, 2, 4, 5
E(WQ)	Unregulated	425008 Darling River at Wilcannia	Total Phosphorus	E6 Cease / commence to pump rules for streams E7 Cease / commence to pump rules for in-stream pools E9 Implement Total Daily Extraction Limits (TDELs) and Individual Daily Extraction Limits (IDELs) E10 Implement flow targets within the former Interim Unregulated Flow Management Plan for the North West (North West Plan) into the New WSP E16 Authorised in-river dam construction, operation, and passing flow requirements as specified on the dam approval. E18 Prohibit trade onto a water supply work within a natural pool, lagoon or lake that is not in a river or in a floodplain or flood-runner.	M	H	H	M/H	F	Refer to WQM Plan 2 Protect a portion 2 Protect a portion of natural flow events in the Barwon-Darling WRP area to enable longitudinal hydrologic connectivity within the WRP area and with the Barwon-Darling WRP area.	N2 Implementation of a first flush rule to manage the resumptions of flows after a cease to flow period (proposed new active management option) N3 Protection of Held Environmental Water through water take restrictions (proposed new active management option)	Refer to WQM Plan.		MER planned for WSP objectives and WQ 1, 2, 4, 5

SECTION 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-S)], [E(WQ-PT)]															
Risk Code	**Water Source Type**	**Location, Reach, or Extraction Type within WRP Area**	**Water Quality Characteristic**	**Current Critical Mechanisms**	**Consequence**	**Likelihood**	**Risk Rating**	**Data confidence (Consequence / Likelihood)**	**Risk treatment option**	**Strategies**	**New Critical Mechanisms**	**Tolerable Risk Level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and Evaluation**
										The primary strategy for addressing risks associated with water quality is the implementation of the Water Quality Management Plan for Barwon-Darling WRPA. Additional actions and mechanisms relevant to the WRP are listed below.				**WQ** 1, 2, 3, 4, 5, 6, 7
										3 Protect a portion of natural flows to maintain hydrological connectivity between this water source and riparian zones, wetlands and floodplains connected to this water source. **7** Protect pools in streams, wetlands, lagoons and floodplains within the WRP area during dry periods. **8** Implement the WQM Plan for the WRP area.	N4 Investigate and implement water/flow protection measures to improve northern hydrological connectivity between Northern Basin catchments (proposed new active management option) N5 Strategic use of held environmental water licences as guided by the LTWP.			
E(WQ)	Unregulated	425008 Darling River at Wilcannia	Total Nitrogen	E6 Cease / commence to pump rules for streams E7 Cease / commence to pump rules for in-stream pools E9 Implement Total Daily Extraction Limits (TDELs) and Individual Daily Extraction Limits (IDELs) E10 Implement flow targets within the former Interim Unregulated Flow Management Plan for the North West (North West Plan) into the New WSP E16 Authorised in-river dam construction, operation, and passing flow requirements as specified on the dam approval. E18 Prohibit trade onto a water supply work within a natural pool, lagoon or lake that is not in a river or in a floodplain or flood-runner	M	H	H	M/H	F	Refer to WQM Plan 2 Protect a portion of natural flow events in the Barwon-Darling WRP area to enable longitudinal hydrologic connectivity within the WRP area and with the Barwon-Darling WRP area. 3 Protect a portion of natural flows to maintain hydrological connectivity between this water source and riparian zones, wetlands and floodplains connected to this water source. **7** Protect pools in streams, wetlands, lagoons and floodplains within the WRP area during dry periods. **8** Implement the WQM Plan for the WRP area.	N2 Implementation of a first flush rule to manage the resumptions of flows after a cease to flow period (proposed new active management option) N3 Protection of Held Environmental Water through water take restrictions (proposed new active management option) N4 Investigate and implement water/flow protection measures to improve northern hydrological connectivity between Northern Basin catchments (proposed new active management option) N5 Strategic use of held environmental water licences as guided by the LTWP.	Refer to WQM Plan.		MER planned for WSP objectives and WQ 1, 2, 4, 5

SECTION 6.4, 6.5, 6.6 RISKS TO THE HEALTH OF WATER DEPENDENT ECOSYSTEMS FROM POOR WATER QUALITY [E(WQ), (E(WQ-CWP)], [E(WQ-S)], [E(WQ-PT)]															
Risk Code	**Water Source Type**	**Location, Reach, or Extraction Type within WRP Area**	**Water Quality Characteristic**	**Current Critical Mechanisms**	**Consequence**	**Likelihood**	**Risk Rating**	**Data confidence (Consequence / Likelihood)**	**Risk treatment option**	**Strategies**	**New Critical Mechanisms**	**Tolerable Risk Level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and Evaluation**
										The primary strategy for addressing risks associated with water quality is the implementation of the Water Quality Management Plan for Barwon-Darling WRPA. Additional actions and mechanisms relevant to the WRP are listed below.				**WQ** 1, 2, 3, 4, 5, 6, 7
E(WQ)	Unregulated	425008 Darling River at Wilcannia	pH	E6 Cease / commence to pump rules for streams E7 Cease / commence to pump rules for in-stream pools E9 Implement Total Daily Extraction Limits (TDELs) and Individual Daily Extraction Limits (IDELs) E10 Implement flow targets within the former Interim Unregulated Flow Management Plan for the North West (North West Plan) into the New WSP E16 Authorised in-river dam construction, operation, and passing flow requirements as specified on the dam approval. E18 Prohibit trade onto a water supply work within a natural pool, lagoon or lake that is not in a river or in a floodplain or flood-runner	M	M	M	M/H	F	Refer to WQM Plan 2 Protect a portion of natural flow events in the Barwon-Darling WRP area to enable longitudinal hydrologic connectivity within the WRP area and with the Barwon-Darling WRP area. 3 Protect a portion of natural flows to maintain hydrological connectivity between this water source and riparian zones, wetlands and floodplains connected to this water source. **7** Protect pools in streams, wetlands, lagoons and floodplains within the WRP area during dry periods. **8** Implement the WQM Plan for the WRP area.	N2 Implementation of a first flush rule to manage the resumptions of flows after a cease to flow period (proposed new active management option) N3 Protection of Held Environmental Water through water take restrictions (proposed new active management option) N4 Investigate and implement water/flow protection measures to improve northern hydrological connectivity between Northern Basin catchments (proposed new active management option) N5 Strategic use of held environmental water licences as guided by the LTWP.	Refer to WQM Plan.		MER planned for WSP objectives and WQ 1, 2, 4, 5
E(WQ)	Unregulated	425008 Darling River at Wilcannia	Dissolved Oxygen	E6 Cease / commence to pump rules for streams E7 Cease / commence to pump rules for in-stream pools E9 Implement Total Daily Extraction Limits (TDELs) and Individual Daily Extraction Limits (IDELs) E10 Implement flow targets within the former Interim Unregulated Flow Management Plan for the North West (North West Plan) into the New WSP E16 Authorised in-river dam construction, operation, and passing flow requirements as specified on the dam approval. E18 Prohibit trade onto a water supply work within a natural pool, lagoon or lake that is not in a river or in a floodplain or flood-runner	M	M	M	M/H	F	Refer to WQM Plan 2 Protect a portion of natural flow events in the Barwon-Darling WRP area to enable longitudinal hydrologic connectivity within the WRP area and with the Barwon-Darling WRP area. 3 Protect a portion of natural flows to maintain hydrological connectivity between this water source and riparian zones,	N2 Implementation of a first flush rule to manage the resumptions of flows after a cease to flow period (proposed new active management option) N3 Protection of Held Environmental Water through water take restrictions (proposed new active management option) N4 Investigate and implement water/flow protection measures to improve northern hydrological connectivity between	Refer to WQM Plan.		MER planned for WSP objectives and WQ 1, 2, 4, 5

SECTION 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-S)], [E(WQ-PT)]															
Risk Code	**Water Source Type**	**Location, Reach, or Extraction Type within WRP Area**	**Water Quality Characteristic**	**Current Critical Mechanisms**	**Consequence**	**Likelihood**	**Risk Rating**	**Data confidence (Consequence / Likelihood)**	**Risk treatment option**	**Strategies**	**New Critical Mechanisms**	**Tolerable Risk Level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and Evaluation**
										The primary strategy for addressing risks associated with water quality is the implementation of the Water Quality Management Plan for Barwon-Darling WRPA. Additional actions and mechanisms relevant to the WRP are listed below.				**WQ** 1, 2, 3, 4, 5, 6, 7
										wetlands and floodplains connected to this water source. **7** Protect pools in streams, wetlands, lagoons and floodplains within the WRP area during dry periods. **8** Implement the WQM Plan for the WRP area.	Northern Basin catchments (proposed new active management option) N5 Strategic use of held environmental water licences as guided by the LTWP.			
E(WQ-S)	Unregulated	425008 Darling River at Wilcannia	Salinity	E6 Cease / commence to pump rules for streams E7 Cease / commence to pump rules for in-stream pools E9 Implement Total Daily Extraction Limits (TDELs) and Individual Daily Extraction Limits (IDELs) E10 Implement flow targets within the former Interim Unregulated Flow Management Plan for the North West (North West Plan) into the New WSP *Note: contributions towards flow targets are provided by the NSW Border Rivers WRP SW16, Gwydir WRP SW15 and Namoi WRP SW 14 for the purposes of BLR, environmental and water quality benefits (algal management).* E16 Authorised in-river dam construction, operation, and passing flow requirements as specified on the dam approval. E18 Prohibit trade onto a water supply work within a natural pool, lagoon or lake that is not in a river or in a floodplain or flood-runner	M	H	H	M/H	F	Refer to WQM Plan 2 Protect a portion of natural flow events in the Barwon-Darling WRP area to enable longitudinal hydrologic connectivity within the WRP area and with the Barwon-Darling WRP area. 3 Protect a portion of natural flows to maintain hydrological connectivity between this water source and riparian zones, wetlands and floodplains connected to this water source. **7** Protect pools in streams, wetlands, lagoons and floodplains within the WRP area during dry periods. **8** Implement the WQM Plan for the WRP area.	N2 Implementation of a first flush rule to manage the resumptions of flows after a cease to flow period (proposed new active management option) N3 Protection of Held Environmental Water through water take restrictions (proposed new active management option) N4 Investigate and implement water/flow protection measures to improve northern hydrological connectivity between Northern Basin catchments (proposed new active management option) N5 Strategic use of held environmental water licences as guided by the LTWP.	Refer to WQM Plan.		MER planned for WSP objectives and WQ 1, 2, 4, 5
E(WQ-CCP)	Unregulated	Barwon-Darling water sources	CWP	None required	VH	Nil	Nil	H/H	NA	Risk is Nil – none required	N/A			

SECTION 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-S)], [E(WQ-PT)]

Risk Code	Water Source Type	Location, Reach, or Extraction Type within WRP Area	Water Quality Characteristic	Current Critical Mechanisms	Consequence	Likelihood	Risk Rating	Data confidence (Consequence / Likelihood)	Risk treatment option	Strategies	New Critical Mechanisms	Tolerable Risk Level	Explanation of tolerable risk application OR Explanation of why risk cannot be addressed	Monitoring and Evaluation
										The primary strategy for addressing risks associated with water quality is the implementation of the Water Quality Management Plan for Barwon-Darling WRPA. Additional actions and mechanisms relevant to the WRP are listed below.				**WQ** 1, 2, 3, 4, 5, 6, 7
E(WQ-CCP)	Unregulated	Barwon-Darling water sources	WWP	None required	VH	Nil	Nil	H/H	NA	Risk is Nil – none required	N/A			
E(WQ-PT)	Unregulated	Barwon-Darling water sources	Pathogens and toxicants	Protection of the Environment Operations Act 1997 Local Government Act 1993 Local Government (General) Regulation 2005	VH	L	M	H/M	A	No new strategies required	NA	M	Risk is tolerable. Other legislative processes mitigate risk	

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 Barwon-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	River	Barwon River at Mungindi	Recreational Water Quality (BGA)	Refer to WQM Plan	L	L	L	H/M	F	Refer to WQM Plan		Refer to WQM Plan.		
O(WQ-BGA)	Risks to recreational water quality	River	Barwon River at Collarenebri	Recreational Water Quality (BGA)	Refer to WQM Plan	L	L	L	H/M	F	Refer to WQM Plan		Refer to WQM Plan.		
O(WQ-BGA)	Risks to recreational water quality	River	Barwon River at Dangar Bridge (Walgett)	Recreational Water Quality (BGA)	Refer to WQM Plan	L	L	L	H/M	F	Refer to WQM Plan		Refer to WQM Plan.		
O(WQ-BGA)	Risks to recreational water quality	River	Barwon River at Brewarrina	Recreational Water Quality (BGA)	Refer to WQM Plan	L	L	L	H/M	F	Refer to WQM Plan		Refer to WQM Plan.		
O(WQ-BGA)	Risks to recreational water quality	River	Darling River at Bourke	Recreational Water Quality (BGA)	Refer to WQM Plan	L	L	L	H/M	F	Refer to WQM Plan		Refer to WQM Plan.		
O(WQ-BGA)	Risks to recreational water quality	River	Darling River at Rose Isle	Recreational Water Quality (BGA)	Refer to WQM Plan	L	L	L	H/M	F	Refer to WQM Plan		Refer to WQM Plan.		

SECTION 7.4 RISKS TO OTHER WATER USERS DUE TO UNSUITABLE WATER QUALITY [O(WQ-BGA)]

Risk Code	Risk	Water Source Type	Location, Reach, or Extraction Type within WRP Area	Water Quality Characteristic	Current Critical Mechanisms	Consequence	Likelihood	Risk Rating	Data confidence (Consequence / Likelihood)	Risk treatment option	Strategies	New Critical Mechanisms	Tolerable Risk Level	Explanation of tolerable risk application OR Explanation of why risk cannot be addressed	Monitoring and Evaluation
											The primary strategy for addressing risks associated with water quality is the implementation of the Water Quality Management Plan for Barwon-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	River	Darling River at Louth	Recreational Water Quality (BGA)	Refer to WQM Plan	L	L	L	H/M	F	Refer to WQM Plan		Refer to WQM Plan.		
O(WQ-BGA)	Risks to recreational water quality	River	Darling River at Tilpa	Recreational Water Quality (BGA)	Refer to WQM Plan	L	L	L	H/M	F	Refer to WQM Plan		Refer to WQM Plan.		
O(WQ-BGA)	Risks to recreational water quality	River	Darling River at Trevallyn	Recreational Water Quality (BGA)	Refer to WQM Plan	L	M	L	H/M	F	Refer to WQM Plan		Refer to WQM Plan.		
O(WQ-BGA)	Risks to recreational water quality	River	Darling River at Wilcannia	Recreational Water Quality (BGA)	Refer to WQM Plan	L	M	L	H/M	F	Refer to WQM Plan		Refer to WQM Plan.		
O(WQ-BGA)	Risks to recreational water quality	River	Darling River at Atley	Recreational Water Quality (BGA)	Refer to WQM Plan	L	H	M	H/M	F	Refer to WQM Plan		Refer to WQM Plan.		
O(WQ-BGA)	Risks to recreational water quality	River	Darling River at Culpaulin	Recreational Water Quality (BGA)	Refer to WQM Plan	L	L	L	H/M	F	Refer to WQM Plan		Refer to WQM Plan.		

SECTION 8.2.1 RISKS TO WATER AVAILABLE FOR OTHER USES DUE TO INTERCEPTION ACTIVITY [O(I-FD)]

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 (unregregulated rivers) O(I-FD)	Unregulated	A, B and C Class	Negligible	Possible	L	M/H	N/A	None required. Risk is low.		N/A	N/A	

Current Critical Mechanisms - O(I-FD)
E21 Require farm dams with a capacity above the maximum harvestable right dam capacity (MHRDC) to be licensed and comply with extraction limits as described in Strategy 1 (E1 Reserve all water above the long-term average annual extraction limit (LTAAEL) for the environment as PEW (defined and managed by the listed WSPs) & E2 Available Water Determinations (AWD) adjust extractive use according to water availability)

N/A no data available or not applicable

SECTION 8.2.2 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)	Unregulated	L-H	Nil	Nil	H/M	N/A	None required. Risk is nil		N/A	N/A	

Current Critical Mechanisms - E(I-PF)
E22 Plantation forestry interception is considered low risk therefore no mechanisms have been implemented under the WM Act.
E23 Ongoing risk monitoring to determine impact of future expansion of forest plantations at local and regional scales

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

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

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

Risk	Water Source Type	Risk Rating	Data confidence (Consequence / Likelihood)	Risk treatment option	Strategies	New Critical Mechanisms	Tolerable risk level	Explanation of tolerable risk application OR Explanation of why risk cannot be addressed	Monitoring and Evaluation
Damage to structural integrity caused by mining O(I-M)	Unregulated	L	M/M	N/A	None required. Risk is low		N/A	N/A	

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

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

Risk	Water Source Type	Consequence	Likelihood	Risk Rating	Data confidence (Consequence / Likelihood)	Risk treatment option	Strategies	New Critical Mechanisms	Tolerable risk level	Explanation of tolerable risk application OR Explanation of why risk cannot be addressed	Monitoring and Evaluation
Risk to water available for other uses from floodplain harvesting O(I-FH)	Unregulated	H	L	M	H/M	A B	**16** Protect the environment and other users from changes in flow attributable to growth in Floodplain harvesting	N7 - Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies.	M	This medium risk result is driven by a low likelihood and a very high ecological consequence. The risk is tolerable because of the low likelihood. See section 5.7.4 of the water resource plan for current management actions and mechanisms Floodplain Harvesting Policy and Healthy Floodplains Projects mitigate risk	MER for N7

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

SECTION 8.3 RISKS TO WATER AVAILABLE FOR OTHER USES DUE TO CLIMATE CHANGE [O(CC)]												
Risk	**Location, Reach, or Extraction Type within WRP Area**	**Climate Change Scenario (MDBSY)**	**Current Critical Mechanisms**	**Consequence**	**Likelihood**	**Risk Rating**	**Data confidence (Consequence / Likelihood)**	**Risk treatment option**	**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)	A, B and C Classes	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	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)	A, B and C Classes	Median climate change scenario		Negligible	Possible	L	M/M	N/A	None required. Risk is low.		N/A		
Risk to water available for other uses due to climate change O(CC)	A, B and C Classes	Dry climate change scenario		Minor	Likely	M	M/M	N/A	11 Protect the environment and water users from changes in flow attributable to climate change.	N1 Sustainable Diversion Limits N2 Implementation of a first flush rule to manage the resumptions of flows after a cease to flow period (proposed new active management option) N3 Protection of Held Environmental Water through water take restrictions (proposed new active management option) N4 Investigate and implement water/flow protection measures to improve northern hydrological connectivity between Northern Basin catchments (proposed new active management option) N5 Strategic use of held environmental water licences as guided by the LTWP.	M	An individual licence holder's annual access to water is governed by their entitlement and climatic availability. The volume of water available to meet all competing environmental and extractive needs varies on a yearly and daily basis, depending on the weather, river flows and aquifer characteristics.	

SECTION 8.4 RISKS TO WATER AVAILABLE FOR OTHER USES DUE TO GROWTH IN BLR [O(BLR)]												
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**	**Strategy**	**New Critical Mechanisms**	**Tolerable Risk Level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and Evaluation**
Unregulated	1 (Mungindi to Walgett)	E24 - Minister may restrict BLR access through the establishment of mandatory guidelines. E25 - Minister may temporarily restrict groundwater access where it is in the public interest to do so. E26 - Minister may limit growth in BLR when a land holding is subdivided and there is high hydrological stress on the river or aquifer	H	L	L	L/L	N/A	None required. Risk is low.		NA		
Unregulated	2 (Walgett to Brewarrina)		H	L	L	L/L	N/A	None required. Risk is low.		NA		
Unregulated	3 (Brewarrina to Bourke)		H	L	L	L/L	N/A	None required. Risk is low.		N/A		
Unregulated	4a (Bourke to Louth)		H	L	L	L/L	N/A	None required. Risk is low.		N/A		
Unregulated	4b (Louth to Wilcannia)		L	L	L	L/L	N/A	None required. Risk is low.		N/A		

Current Critical Mechanisms - O(BLR):
E1 Reserve all water above the long-term average annual extraction limit (LTAAEL) for the environment as PEW (defined and managed by the listed WSPs).
E2 Available Water Determinations (AWD) adjust extractive use according to water availability.
E24 Minister may restrict BLR access through the establishment of mandatory guideline.
E26 Minister may limit growth in BLR when a land holding is subdivided and there is high hydrological stress on the river or aquifer
E25 Minister may temporarily restrict groundwater access where it is in the public interest to do so.
N/A no data available or not applicable

Consolidated Risk Maps

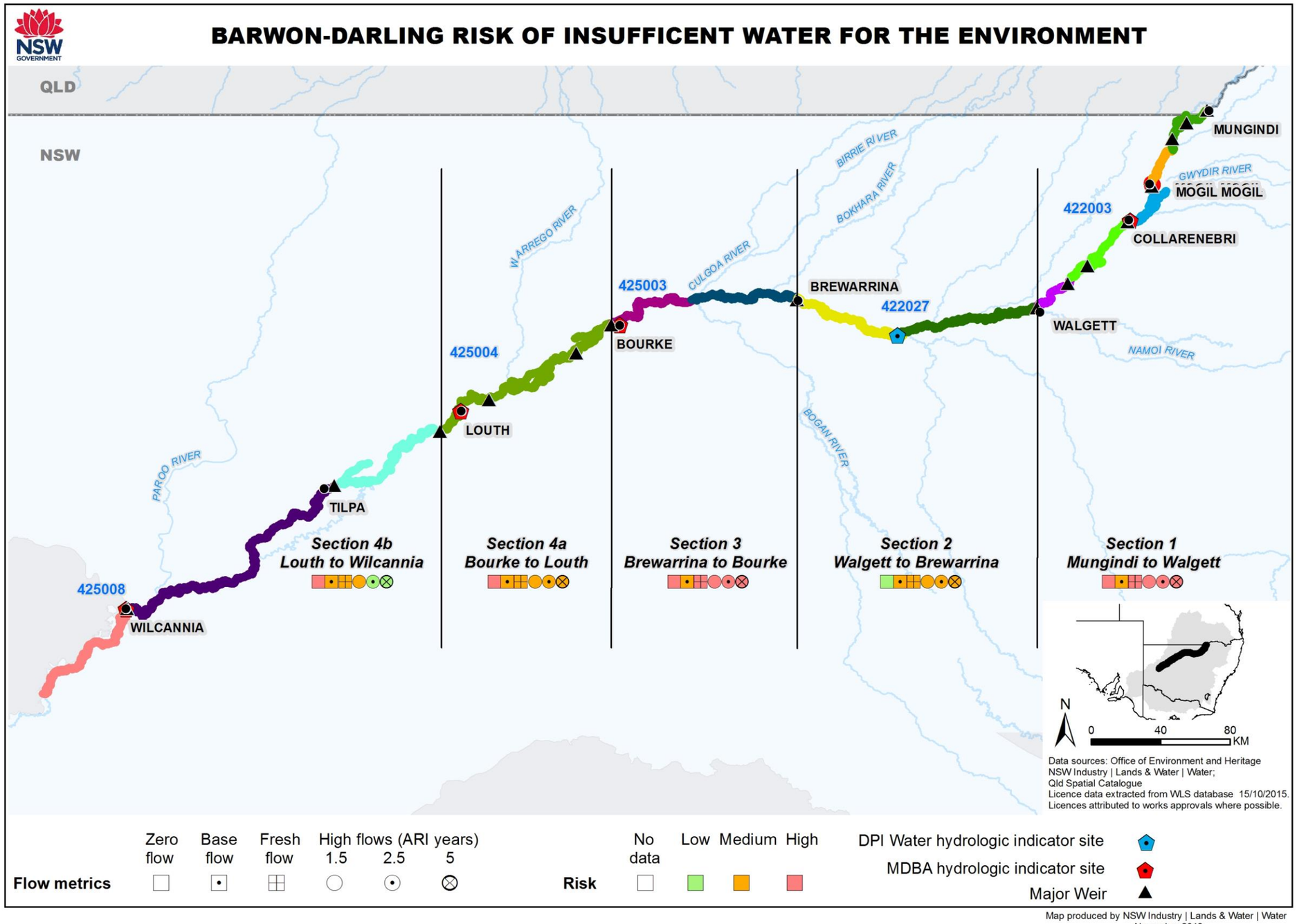

Figure 2 Consolidated risk map – Insufficient water for the environment

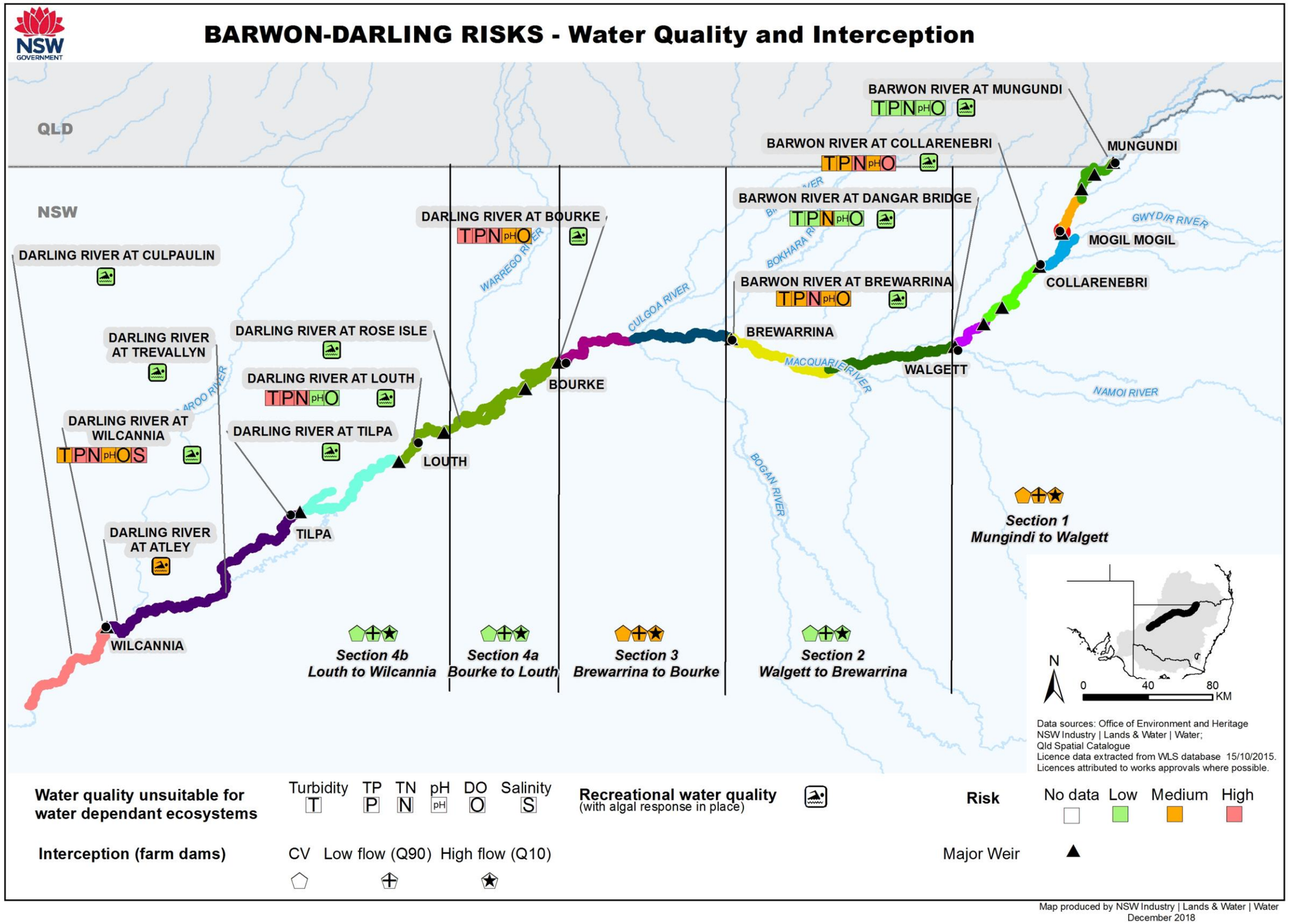

Figure 3 Consolidated risk map – Water quality, temperature and interception

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Glossary

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

O(I-PF)	Risk to water available for other uses from interception activities (plantation forestry) (regulated rivers)
O(CC)	Risk to water available for other uses from climate change (regulated rivers)
O(BLR)	Risk to water available for other uses from growth in BLR (unregulated rivers)

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.

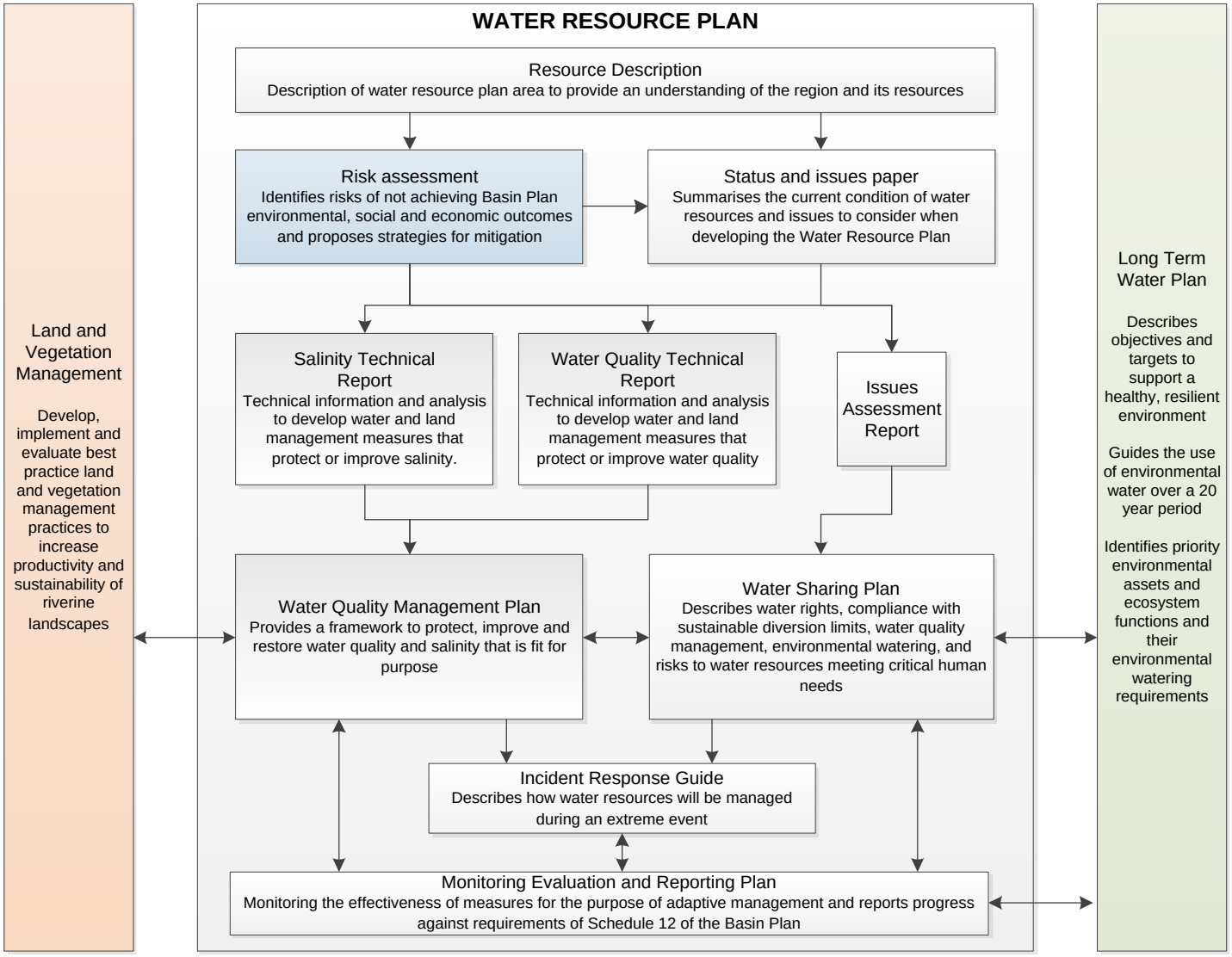


Figure 1-1 Components of the WRP

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

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

Basin Plan requirement		Location in Risk Assessment		Location in WRP
Schedule 8, Schedule 9	Criteria for identifying an environmental asset and an ecosystem function	6.3.1, 6.4.1, 6.5.1, 6.6.1	Assigning a consequence rating (HEVAE)	3.1
10.41(1), 10.41(1)(d) , 10.41(5),(6)	Risks arising from elevated levels of salinity or other types of water quality degradation	6.3	Risks due to water temperature outside natural ranges	3 3.1 3.2 6
		6.4	Risks due to turbidity, TP, TN, pH, turbidity and DO	
		6.5	Risks due to elevated levels of instream salinity	
		6.6	Risks due to pathogens and toxicants	
10.41(3)(a), 4.02(1)(b), 4.02(2)(a)(b)	Risks identified in section 4.02 Risk arising from water being of a quality unsuitable for use Water is not suitable for consumptive and other economic uses of Basin water resources Water is not suitable to maintain social, cultural, Indigenous and other public benefit values	Section 7	Risk to other water uses due to unsuitable water quality	3 3.1 3.2 6
10.41(1), 10.41(2)(d) , 10.41(5),(6)	Risks arising from elevated levels of salinity or other types of water quality degradation	7.3	Risks to irrigation water from elevated instream salinity	3 3.1 3.2 6
		7.4	Risks to water used for recreational purposes	
		7.5	Risks to water used for human consumption	
		7.6	Other values	
10.41(3)(a), 4.02(1)(b), 4.02(2)(a)(b)	Risks identified in section 4.02 Insufficient water available for consumptive and other economic uses of Basin water resources Insufficient water available to maintain social, cultural, Indigenous and other public benefit values	Section 8	Risk to water available for other uses	3 3.1 3.2 3.3
10.41(1), 10.41(2)(c), 10.23, 10.41(5),(6)	Risks arising from potential interception activities	8.1	Risks to other water users from interception activities	3 3.1 3.2 3.3
10.41(1), 10.41(5),(6)	Future risks	8.2	Risk to other water users due to climate change	3 3.1 3.2 3.3
		8.3	Risk to other water users due to growth in BLR	
		8.4	Other values	
10.41(1), 10.42 10.43	Lists the risks identified Strategies for addressing risks as having a medium or higher level of risk	Section 9	Summary of risks, tolerable discussion, revised risk tables identifying tolerable	3 3.1 3.2 3.3
		Executive Summary	Consolidated Risk Tables	
10.41(7)(8)	Description of the data and methods Description of uncertainty	Appendix A		3.1

2. NSW Basin Plan risk assessment framework overview

2.1. Introduction

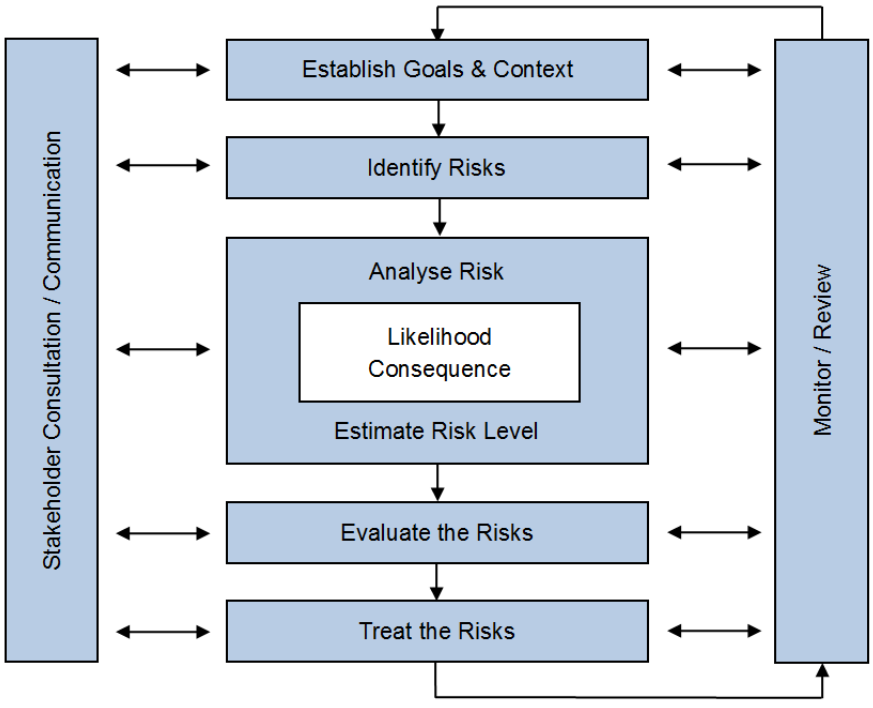
Risk-based management is not a new concept in water resource planning in NSW. Considerable work has been undertaken by State governments and under Commonwealth-level intergovernmental initiatives to design and implement risk-based water planning. The *National Water Initiative* (NWI) *Policy Guidelines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

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

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

2.2. The risk assessment framework

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



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

Figure 2-1 The NSW Basin Plan risk assessment framework

The risk assessment framework adopts a cause/threat/impact model that describes the pathway for impacts to a receptor. Adopting the cause/threat/impact pathway approach provides a systematic way to identify the full

range of factors that may lead to an impact, while also being consistent with the internationally recognised risk standard which considers both likelihood and consequence.

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

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

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

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

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

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

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

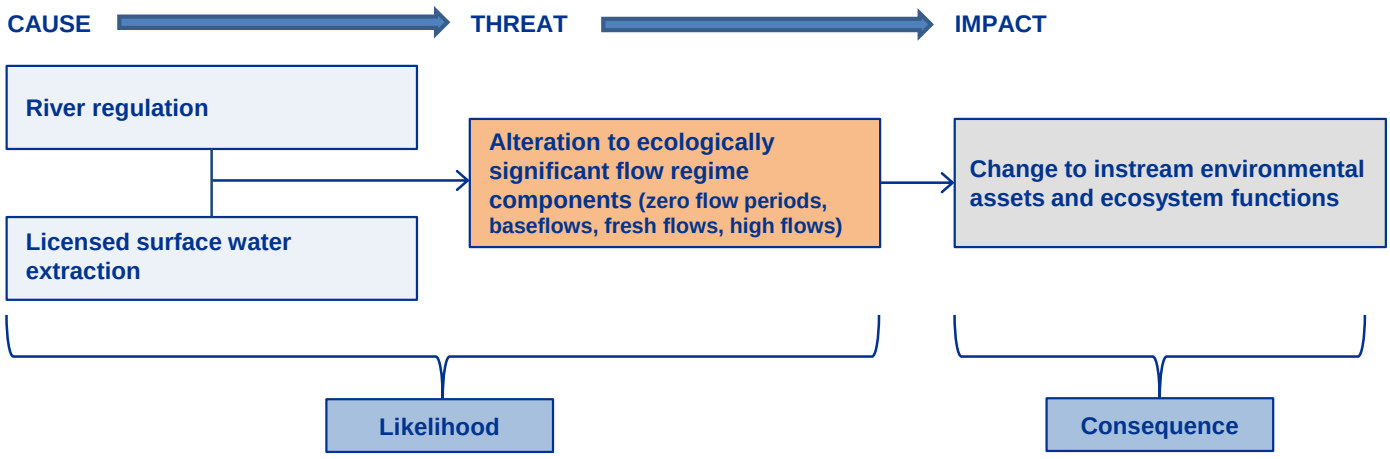


Figure 2-2 Example of an impact pathway for identifying risks to the environment associated with river regulation and licensed extraction

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

Table 2-2 The risk assessment matrix

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

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

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

2.3. Risk assessment scope

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

- The risk directly relates to a change in the water resource, which may 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 NSW *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 Barwon-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 Barwon-Darling watercourse resource plan area (SW12)

3.1. Identification of the Barwon-Darling watercourse 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 Barwon-Darling WRPA.

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

- The SDL resource unit in the Barwon-Darling WRPA is that described in section 6.02 and Schedule 2 to the Basin Plan within the Barwon-Darling WRPA, (being the Barwon-Darling surface water SDL resource unit SS19) and
- The water resources within that SDL resource unit are those described in section 6.02 and Schedule 2 to the Basin Plan within the Barwon-Darling WRPA.

3.2. Characterisation of the Barwon-Darling watercourse resource plan area

The Barwon-Darling WRPA is derived from the existing unregulated Water Sharing Plan (WSP) boundary of the gazetted Plan (NSW Office of Water 2012). This differs from the WRPA determined by the MDBA (MDBA 2016). The NSW Department of Primary Industries—Water has advised the MDBA that it intends to develop the surface water WRP for the Barwon-Darling on existing WSP boundaries. The following WRP overview and characteristics will therefore focus on the existing WSP boundary that occupies a narrow riverine corridor.

The semi-arid lowland Barwon-Darling WRPA is in north-western NSW and spans from Mungindi on the Queensland/NSW border in the north, to Lake Wetherell storage below Wilcannia in the South (Figure 3-2). The WRPA covers roughly 13 % of the MDB and produces below 3 % of river flow in the Basin (CSIRO 2008a). Major towns along the river include Mungindi, Brewarrina, Walgett, Bourke, Wilcannia and Menindee.

Further information can be found in the Barwon-Darling Watercourse Resource Plan Surface Water Resource Description report (NSW Department of Planning and Environment 2019).

The NSW Department of Planning and Environment will utilise the existing boundary of the gazetted WSP for the Barwon-Darling unregulated and alluvial water sources to develop the WRP for this area (Figure 3-1). The gazetted WSP for the area has four Sections developed for trading purposes and 14 management zones where access rules apply (NSW Office of Water 2012). Management zones are generally based on the occurrence of a weir or the confluence of a major tributary. Following discussions with our partner agencies, NSW Office of Environment and Heritage (OEH) and Department of Primary Industries—Fisheries, it was decided that the original Section 4 would be split into two separate Sections (Figure 3-2). This was to:

- enable the inclusion of gauge 425004 (Darling River at Louth), a key hydrological indicator site supporting existing modelling and environmental outcomes under the Basin Plan
- better account for the changes that may occur over the long length of the original Section 4
- better enable the risk assessment to focus on smaller assessment units
- better account for inflows from the Warrego and Paroo Rivers in separate Sections.

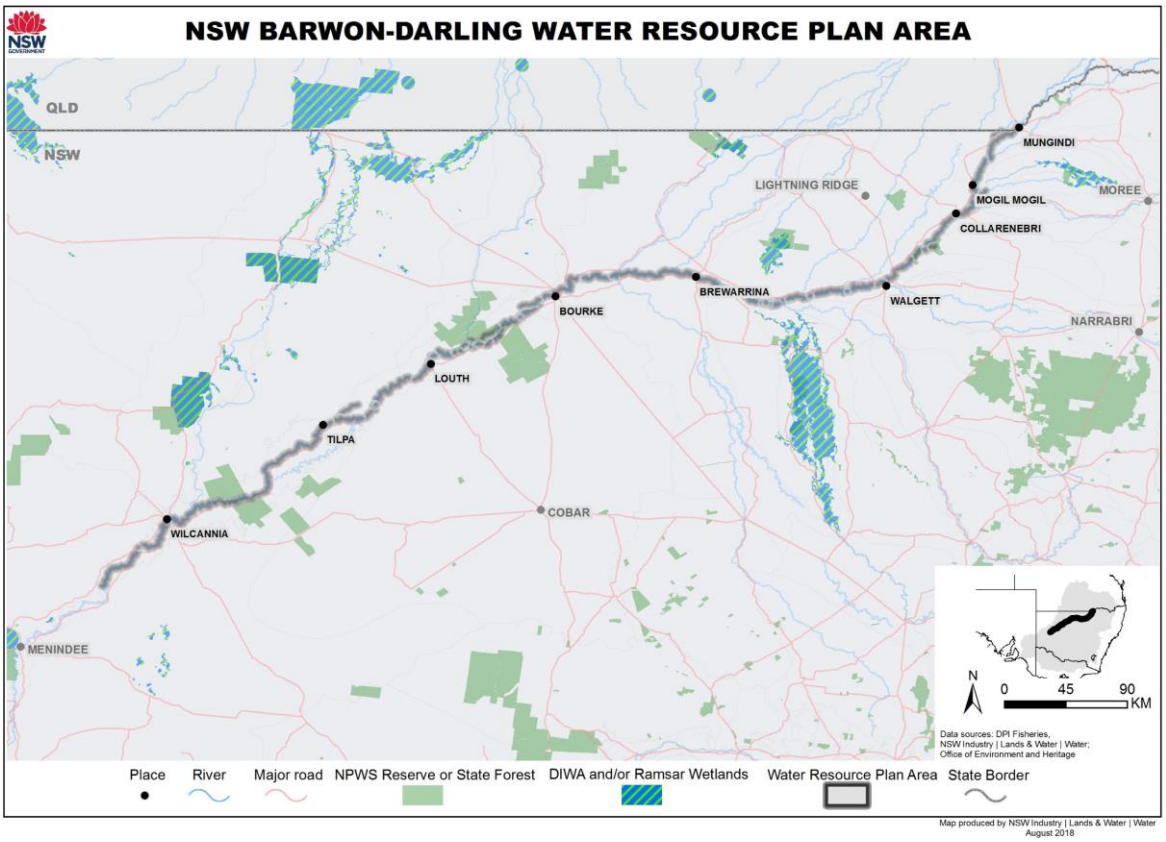


Figure 3-1 The Barwon-Darling WRPA (SW12)

The NSW government gazetted the *Water Sharing Plan for the Barwon-Darling unregulated and alluvial water sources* in 2012. During the development of this Plan, a number of stream flow characteristics were compiled on the Barwon-Darling River (NSW Office of Water 2012). This found that some of the major tributaries in the northern part of the Barwon-Darling contribute high levels of flow. At the Darling River at Menindee, inflowing tributary contributions to the long-term average flow were the Border Rivers 35 %, Namoi River 25 % and the Condamine-Culgoa rivers 20 %.

Daily river flows in the Barwon-Darling are highly variable and characterised by flood events with prolonged lower levels of flow that can occur for months or years (Green and Petrovic 2011). Between Collarenebri and Bourke, mean daily flows rise with increasing channel capacity and then decrease again downstream of Bourke, with average daily flow being 9,464 ML/day at Bourke (NSW Office of Water 2012). Based on current assessments of the range of surface water licenses that occur along the length of the Barwon-Darling WRPA, existing total entitlement is estimated to be around 190,000 ML/year. It is estimated that three percent of surface water diverted for irrigation in the MDB is from the Barwon-Darling WRPA while the area generates about 2.8 percent of total runoff in the MDB (CSIRO 2008a).

The entitlement data and volumes for the unregulated Barwon-Darling WRPA (shown in Figure 3-3 and Figure 3-4 and used for calculations in the reports), are derived at one particular time and subject to change. The licensing data shown and used in this report were obtained from the Department of Primary Industries surface water licensing database on 12 January 2016.

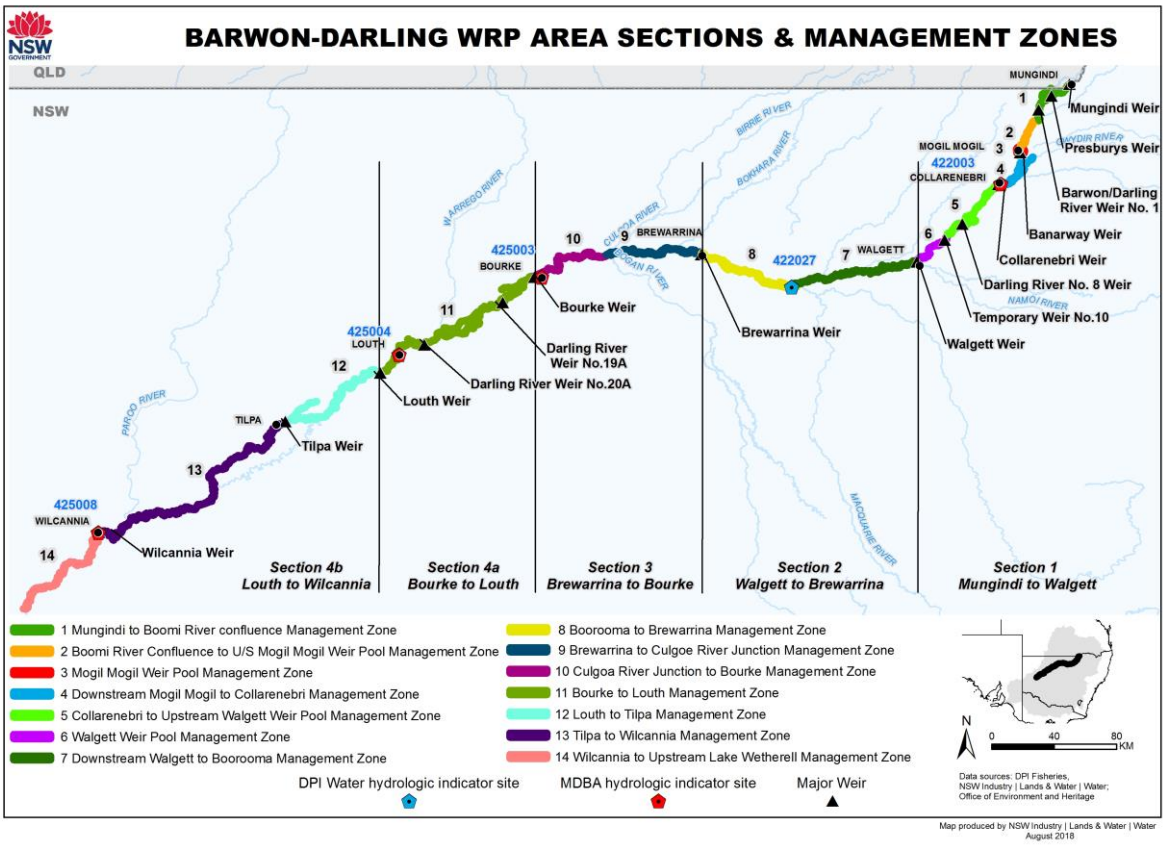


Figure 3-2 Sections and management zones of the Barwon-Darling WRPA (SW12)

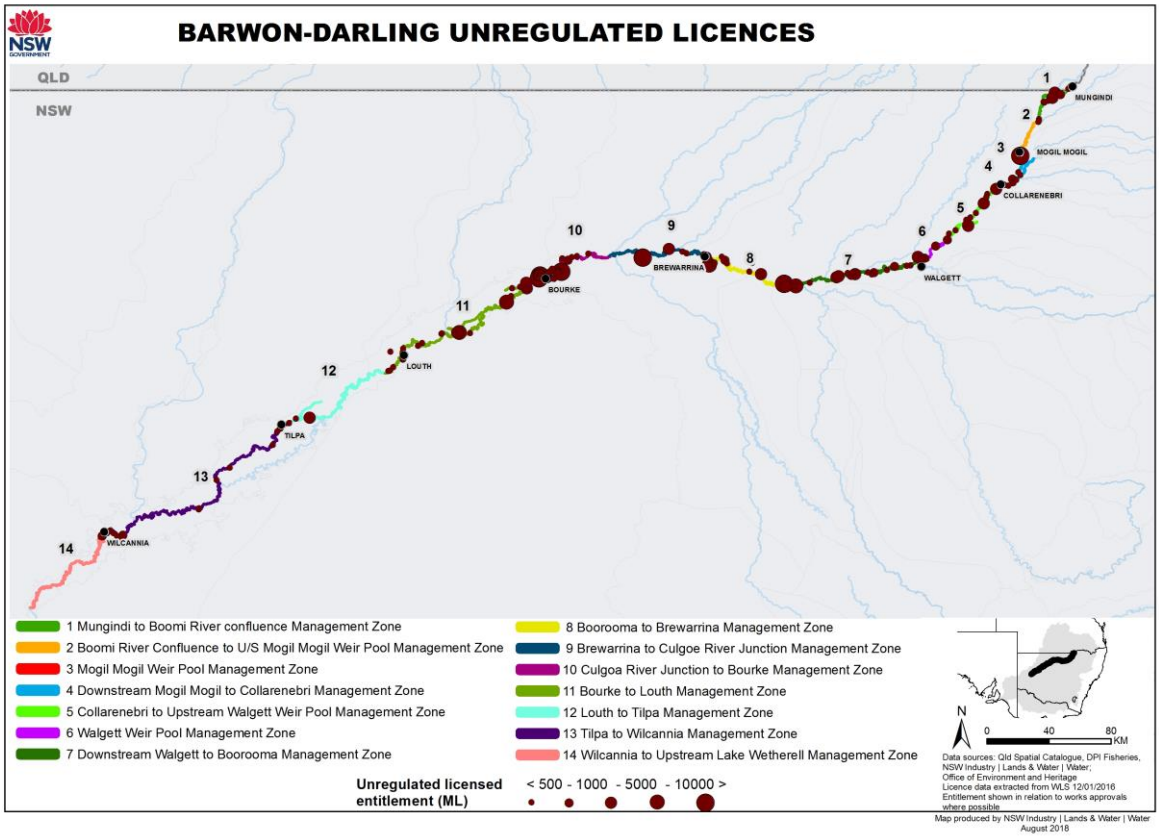


Figure 3-3 Unregulated river entitlement in the Barwon-Darling WRPA (SW12)

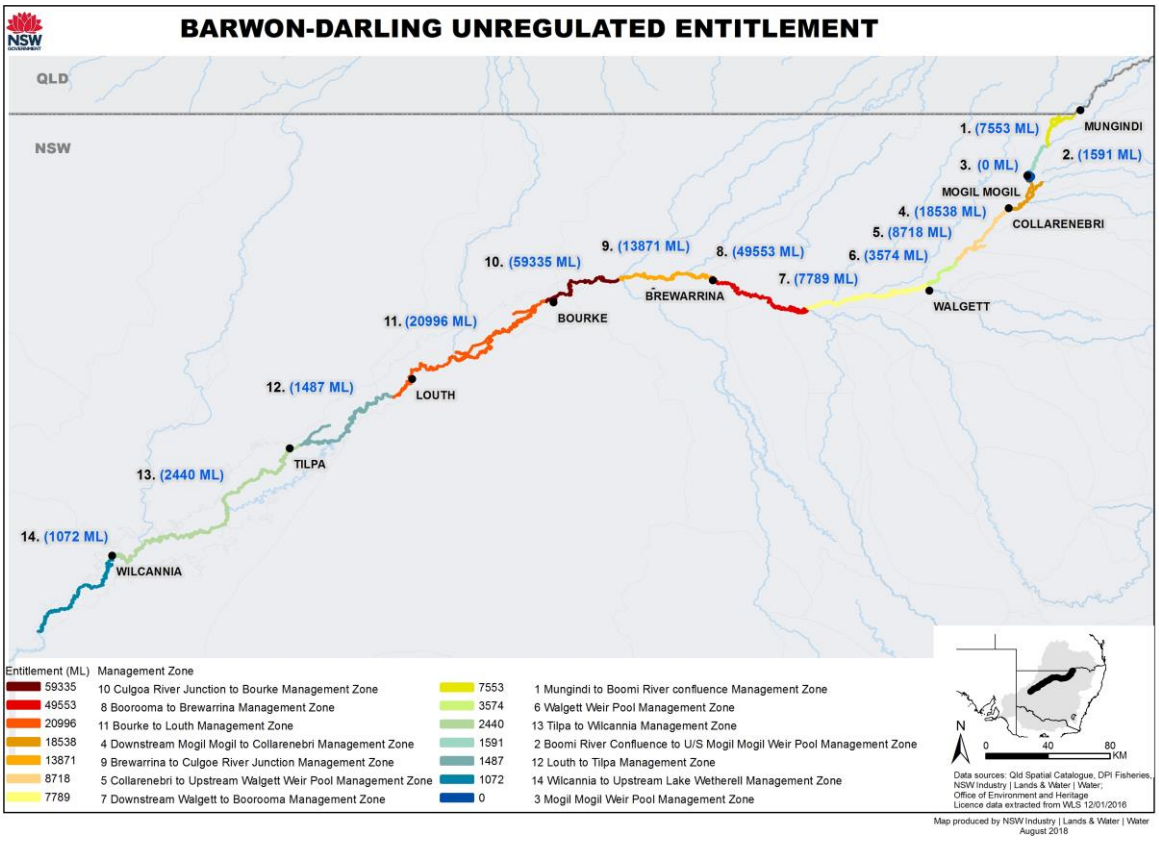


Figure 3-4 Unregulated management zones and entitlement in the Barwon-Darling WRPA (SW12)

3.3. Connectivity

The Barwon-Darling WRPA is a single SDL resource unit: the Barwon–Darling Watercourse SS19. Hydrologic connection between the Barwon-Darling and other connected regulated and unregulated surface water sources is managed according to the actions and mechanisms in the *Water Sharing Plan for the Border Rivers Regulated River Water Source 2021,* the *Water Sharing Plan for the Barwon-Darling Unregulated River Water Source 2012 and other surface water WSPs*. These are further described below.

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

3.3.1. Connectivity within the unregulated water sources of the Barwon-Darling WRPA

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 under Section 324 of the *WMA* 2000.

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 in each of the fourteen management zones and are associated with A, B and C class licenses. Within each management zone hydrologic connectivity is influenced by the cease-to- and commence-to-pump rules for each license 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 River 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. These inflows are focused at providing for the following three operational flow targets:

i) Riparian flows (basic landholder rights) 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 in 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 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, and at times, the downstream NSW Murray and Lower Darling WRPA (SW8).

3.3.2. Connectivity with other WRP areas

Surface water to surface water

Downstream WRPAs

For the purposes of sections 10.05 and 10.27 of the Basin Plan, the Barwon-Darling WRPA (SW12) is considered to have significant hydrological connection with the downstream surface water NSW Murray and Lower Darling WRPA (SW8).

Connectivity between the upstream Barwon-Darling WRPA and the downstream 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 Source 2012* and the Section 324 Order of the NSW *Water Management*

Act that can restrict extraction of surface water. The current WSP rules enable restrictions to be put in place to meet flow targets in the *Interim Unregulated Flow Management Plan for the North-West.* Additionally, the proposed new active management options described in 3.3.1 above, have the potential to enable varying degrees of connectivity with the downstream WRPA.

The processes described here are not formally intended to protect connectivity with the lower Darling River (Part 8 Division 2 of the *Water Sharing Plan for the Barwon-Darling Unregulated Water Source 2012)*. However, they may have the associated benefit of enabling this to occur.

The proposed new active management of environmental water described in Section 3.3.1 may also provide for connectivity with the downstream WRPA.

Any potential risks to the downstream lower Darling River Watercourse from water management related activities in the Barwon-Darling Surface Water Resource Plan area are considered in the NSW Murray and Lower Darling Watercourse WRPA (SW8) Risk Assessment.

The following is a qualitative assessment based on Department of Industry ecohydrology specialist expert opinion. There are potential risks to environmental assets and functions in the Barwon-Darling Surface WRP from the NSW Murray and Lower Darling Watercourse WRPA (SW8). 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 Barwon-Darling Surface WRP area was 'low' given the river systems have long-term existing hydrologic connectivity and invasive species that exist in other areas of the MDB, in particular the NSW Murray and Lower Darling surface water WRPA, are already established in the Barwon-Darling WRPA. A medium has been assigned to the consequence ranking. This is a conservative middle-ground that allows a pragmatic assessment of the risk in the absence of data. Using the risk matrix Table 4-7 the overall risk rating was '**low**' (Table 3-1)

Table 3-1 Risk to environmental assets and functions within the unregulated Barwon-Darling Surface WRPA due to connectivity with NSW Murray and Lower Darling Watercourse WRPA

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

As potential (new) invasive species have not been identified and impacts have not been quantified, it is not possible to take a qualitative approach to the assessment of consequence. Invasive species have a recognised potential to impact on priority environmental assets (PEAs) and priority ecosystem functions (PEFs). Currently, invasive fish species are listed as a Key Threatening Process under NSW DPI Fisheries legislation (NSW DPI 2019). Management of invasive species is currently outside of the scope of the WRP.

Upstream Border Rivers, Gwydir, Namoi, Macquarie-Castlereagh and Intersecting Streams WRPAs

Any potential risks to the Barwon-Darling WRPA (SW12) from water management-related activities in the Border Rivers WRPA are considered in the Barwon-Darling WRPA (SW12) Risk Assessment.

Connectivity between the upstream water resource units of the *Border Rivers* WRPA and the Barwon-Darling WRPA is managed via a number of planned environmental water rules (PEW). The *Water Sharing Plan for the Border Rivers Regulated River Water Source 2021* restricts supplementary access of natural flows to a maximum of 75 % of the volume announced as described in the NSW-Queensland Intergovernmental Agreement (IGA) 2008 (NSW-Qld 2008). This rule protects the remaining portion of the natural flow from extraction by supplementary water access licence holders and helps deliver flows to the Barwon-Darling.

There is also an end-of-system flow rule that stipulates from 1st September of each year to 31st March of each following year, the States must not extract that portion of natural inflows to the Border Rivers that would result in a flow over the weir in the Barwon River at Mungindi of up to 100 ML/day. Consumptive water extractions are also limited to a predefined long-term average annual extraction limit (LTAAEL) based on 60 % of the long-term annual flows measured at Mungindi. All end-of-system flow rules at Mungindi and the supplementary flow rules (also known as uncontrolled flows) are defined by the NSW-Queensland IGA for water management in the Border Rivers. The IGA also manages cross border hydrologic connectivity with the Queensland Border Rivers Surface Water WRPA (SW17) to enable the end of system flow target at Mungindi.

Connectivity between the Gwydir, Namoi, and Macquarie-Castlereagh WRPAs is also managed via flow targets described in the *Interim Unregulated Flow Management Plan for the North-West* (DWR 1992). More details on these flow targets are provided in Section 3.3.1. It is the restriction of access to supplementary flows (off-allocation) in these upstream WRPAs that may enable hydrologic connectivity through the provisions in the former Interim Flow Plan coupled with a section 324 order being enacted by the Minister. This rule recognises the significant connectivity between the water resources and aims to manage access when extractions have the highest likelihood of impacting the connectivity relationship. Although the flow targets have been set to provide for the hydrologic connectivity in the Barwon-Darling WRPA, the upstream restrictions of access to supplementary flows may provide for improved connectivity within these WRPAs also.

There are no formal water management activities or processes that enable hydrologic connectivity between the Barwon-Darling Watercourse WRPA (SW12) and the upstream Intersecting Streams WRPA (SW17). However, the proposed active management of environmental water and considerations around improved hydrologic connectivity across the Northern Basin described in Section 3.3.1 may also provide for connectivity between these two WRPAs. An example of such an outcome would be that after a prolonged period of no river flows, environmental water and/or fresh events originating in Queensland intersecting tributaries may be protected from extraction as they move in the Barwon-Darling WRPA. There is also the potential for a range of amendment provisions within the existing *Water Sharing Plan for the Intersecting Streams Unregulated Water Sources 2011* to be enacted and these may also provide for hydrologic connectivity between this WRPA and the Barwon-Darling.

The following is a qualitative assessment based on Department of Industry ecohydrology specialist expert opinion. There are potential risks to environmental assets and functions in the Barwon-Darling WRP from the upstream NSW Border Rivers (SW16), Gwydir (SW15), Namoi (SW14), Macquarie-Castlereagh (SW11), and Intersecting Streams Watercourse (SW13) WRPAs. Most of these upstream WRPAs have connected regulated and unregulated rivers with the Barwon-Darling WRPA, except for the Intersecting Streams WRPA which is an unregulated system. 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 Barwon-Darling Surface WRP area was ‘low’ given the river systems have long-term existing hydrologic connectivity and invasive species that exist in other areas of the MDB, in particular all of the upstream surface water WRPAs, are already established in the Barwon-Darling WRPA. A medium has been assigned to the consequence ranking. This is a conservative middle-ground that allows a pragmatic assessment of the risk in the absence of data. Using the risk matrix Table 4-7 the overall risk rating was ‘**low**’ (Table 3-2).

Table 3-2 Risk to environmental assets and functions within the Barwon-Darling Surface WRPA due to connectivity with Border Rivers, Gwydir, Namoi, Macquarie-Castlereagh, and Intersecting Streams Watercourse WRPAs.

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

Surface water to groundwater

The Barwon-Darling Watercourse resource unit (SS19) overlies a number of groundwater resource units (Table 3-4). There is connectivity with the Upper Darling Alluvium from Bourke downstream to the end of the Barwon-Darling Watercourse resource unit. From a water management perspective, the Barwon-Darling is considered less highly connected to the Upper Darling Alluvium and groundwater is managed independently from the river. During large river flow events, the river recharges the shallow aquifer system giving rise to the freshwater lens present in the near-river aquifer.

During low river flow conditions, depending on geology and topography, the aquifer discharges into the river at some locations. The Bourke Salt Interception Scheme located downstream of Bourke reduces the influx of saline groundwater into the Darling River and provides in-stream water quality benefits downstream of the site. In this area a strong upward pressure gradient causes saline groundwater to enter the Darling River when river levels are low. The volume of saline inflows increase substantially as low flow conditions persist. Production bores in the intermediate aquifer divert saline groundwater away from the river.

There is minimal data on the connection of surface water with the NSW GAB Shallow SDL resource units although the level of connection is expected to be low. River derived groundwater recharge would be minor due to the low permeability of the river bed sediments. The river recharge to the underlying GAB resource units would not be influenced by surface water extraction due to the anticipated depth of the water table below the river bed level.

The Barwon-Darling Watercourse resource unit also overlies the Lachlan Fold Belt and Kanmantoo Fold Belt. These groundwater resource units are fractured rock systems that have very different geological characteristics with permeabilities generally orders of magnitude lower than the river bed, associated alluvium and GAB sediments and are not considered to be hydraulically connected in a resource management sense to either the Barwon Darling Watercourse or associated groundwater resource units.

This plan does not directly link groundwater extraction to surface water access from the overlying river. The level of impact on the hydraulic relationships and properties between the river and groundwater systems was considered in setting both water sharing plan LTAAELs and the SDLs for the described SDL resource units. The management of extraction to these limits will ensure these hydraulic relationships are maintained to the acceptable level of impacts determined during that assessment.

Any potential risks to surface water / groundwater hydraulic relationships as a result of ground water extraction are considered in the Risk Assessment for the Darling Alluvial WRPA (GW7) (NSW DPIE 2019a), Risk Assessment for the NSW GAB Shallow WRPA (NSW DPIE 2019b), Risk Assessment for the Namoi Alluvium (NSW DPIE 2019c) and the Risk Assessment for the NSW Fractured Rock WRPA (NSW DPIE, 2019d). Refer to sections 3.3.2 and 6.2.2.2 of those reports.

Significant groundwater drawdown can potentially cause sediment compaction of the fine grained sediments in groundwater systems. If there are a high proportion of compressible sediments this vertical compaction may result in subsidence of the land surface. This risk is assessed in section 4.6 of the previously mentioned groundwater risk assessments.

The protection of the environmental water provisions under section 4.2 of the WRP ensures that the PEW in the WRP area is protected. Therefore the volume of water available as groundwater recharge throughout the Barwon-Darling surface WRP is protected and the likelihood rating is ‘low’. The consequence of reduced groundwater recharge was assessed as ‘medium’. Using the risk matrix outlined in Table 4-7, the likelihood and consequence metrics result in a ‘**low**’ risk rating for both unregulated water sources (Table 3-3

Table 3-3 Risk of insufficient surface water impacting on groundwater priority assets and functions in unregulated water sources in the Barwon-Darling surface WRPA

	Consequence	Likelihood	Overall risk rating

Unregulated river water sources	Medium	Low	Low

Table 3-4 Barwon-Darling Watercourse SDL resource unit and adjacent SDL resource units

SDLRU	Adjacent SDLRU	Adjacent WRP / non Basin WSP
Barwon Darling Watercourse SS19	Intersecting Streams SS17	Intersecting Streams WRP SW13
	Lower Darling SS18	NSW Murray and Lower Darling WRP SW8
	Macquarie–Castlereagh SS20	Macquarie–Castlereagh WRP SW11
	Namoi SS21	Namoi WRP SW14
	Gwydir SS22	Gwydir WRP SW15
	NSW Border Rivers SS23	NSW Border Rivers WRP SW16
	QLD Border Rivers SS24	QLD Border Rivers WRP SW17
	Kanmantoo Fold Belt MDB GS19	NSW MDB Fractured Rock WRP GW11
	Lachlan Fold Belt MDB GS20	NSW MDB Fractured Rock WRP GW11
	Lower Namoi Alluvium GS29	Namoi Alluvium WRP GW14
	NSW GAB Surat Shallow GS34	NSW Great Artesian Basin Shallow WRP GW13
	NSW GAB Warrego Shallow GS35	NSW Great Artesian Basin Shallow WRP GW13
	Upper Darling Alluvium GS42	Darling Alluvium GW7

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, commercial plantations, mining and floodplain harvesting)
- Climate change.

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

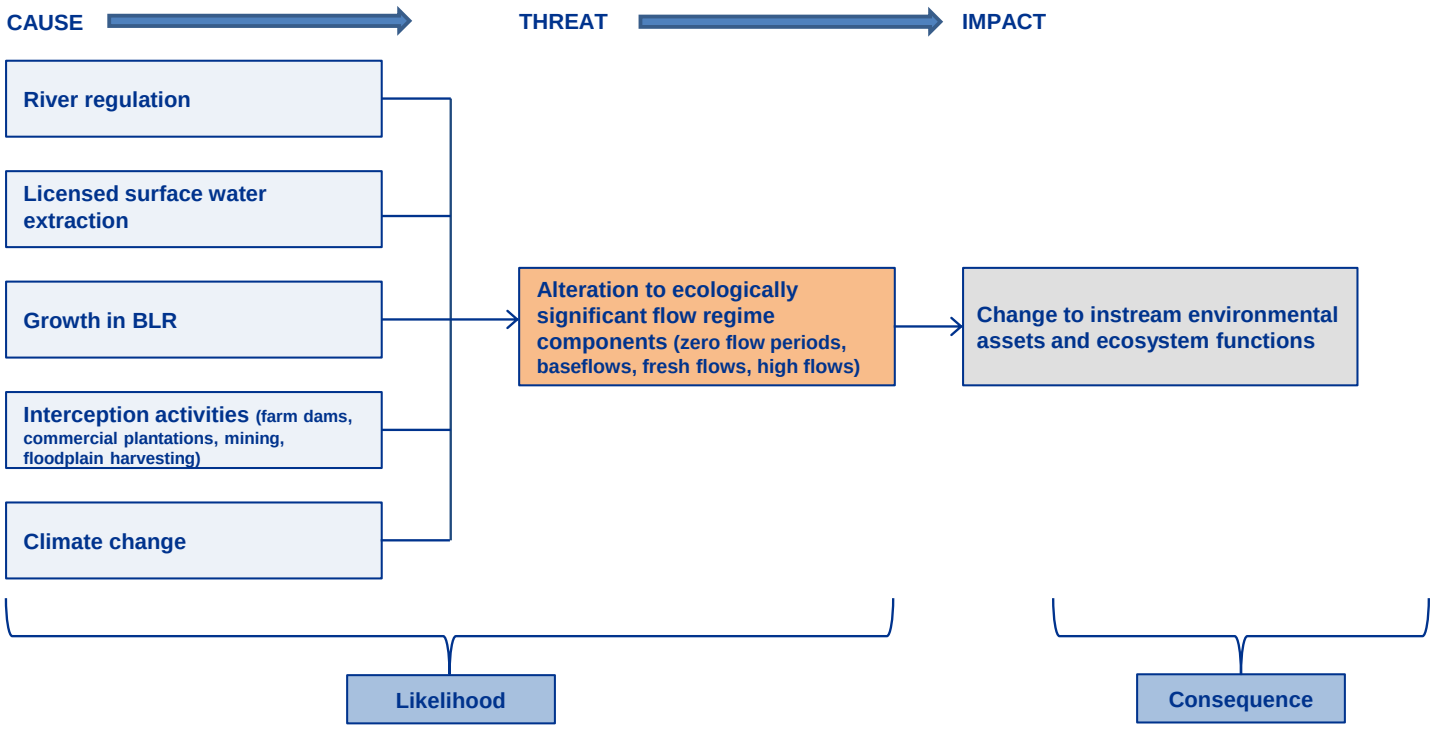


Figure 4-1 Risk pathways for risks of insufficient water for the environment and capacity to meet environmental watering requirements

4.2. Assigning a consequence rating

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

HEVAE scores were derived from the National Aquatic Ecosystems Toolkit Module 3, guidelines developed by the Aquatic Ecosystems Task Group for the Department of Sustainability, Environment, Water Population and Communities (Aquatic Ecosystems Task Group 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.

The Barwon-Darling River water source was broken into sections that represent the existing trading zones already established in the current unregulated WSP for this area. However, one key difference is that the original Section 4 was separated into two new zones at Louth (gauge 425004) (Figure 4-2, Chapter 3.2). This new separation allowed for the better consideration of modelled hydrologic outcomes for each of the flow metrics described above (Chapter 4.3.1) and how the risk from changes to flow influenced key environmental assets and ecosystem functions within these Sections.

A consequence score was 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. The hydrologic models simulated flow at a specific point (hydrologic indicator) in the Barwon-Darling River system at the described streamflow gauging stations. The sites represent specific points where flow models were simulated in the Barwon-Darling WRPA at selected streamflow gauging stations. Sites were either developed by the MDBA (2012) or where required, additional NSW Department of Primary Industries—Water hydrologic sites were used (refer to section 3.2.2). While these simulated flows are for specific points in the system, they are representative of the flows upstream and downstream of that point in the system. The reaches represented by the hydrologic indicator points were selected by identifying where significant tributaries, or effluents, upstream and downstream of the point change the hydrology significantly.

Along the Barwon-Darling WRPA, five hydrologic indicator sites were selected with four of these (422003, 425003, 425004 and 425008) also used as key hydrologic indicator sites by the MDBA (MDBA 2012). Gauge 422027 was used instead of the MDBA gauge 422001 in Section 3 (Figure 4-2) as this better represented the contributing flows from the Macquarie River. Modelled outcomes for this new gauge were obtained using the same modelled processes undertaken by the MDBA. The consequence scores were determined for the five Sections shown in Figure 4-2.

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

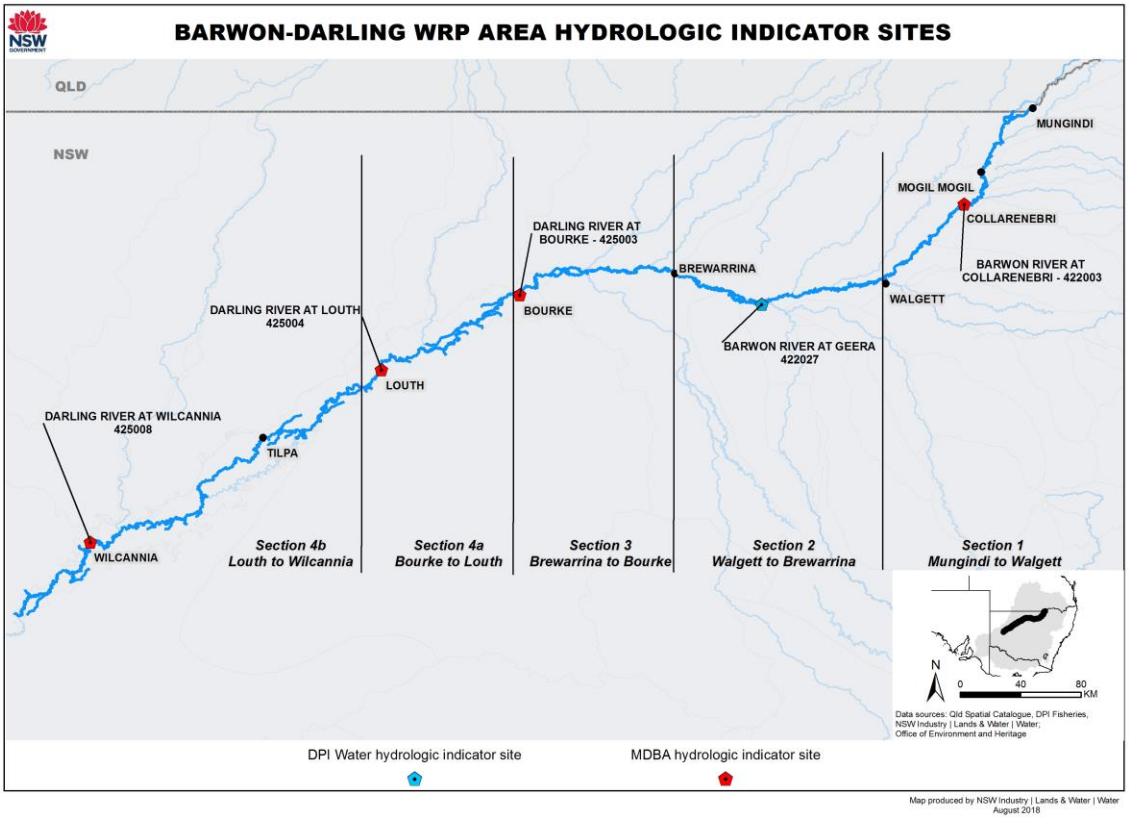


Figure 4-2 Location of unregulated flow gauges and the MDBA hydrologic indicator sites used for generating flow sequences in unregulated river Sections of the Barwon-Darling WRPA.

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. 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 Office of Environment and Heritage (OEH) to identify environmental assets and functions for the Long Term Water Plan (LTWP).

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

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

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

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

During the development of macro WSPs in NSW, specific weightings were linked to the flow sensitivity of in-stream flow dependent threatened species, populations and communities (Table 4-1) (NSW Office of Water 2011; DIPNR 2005). The weightings for each species were agreed upon through discussions with participating NSW agencies with consideration to threatened species legislative requirements including 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 received a flow sensitivity weighting of 4.

A standardised HEVAE method was applied to every MDB risk assessment (Healey et al. 2018). However, the Barwon-Darling assessment differs from the standard HEVAE method in that the fish diversity data provided by NSW Department of Primary Industries—Fisheries was based on the regional boundaries of the now-defunct Western Catchment Management Authority (CMA), rather than the existing WSP boundary. The implications of using data with different boundaries was examined and found insignificant as the highest fish diversity was found to occur in the Barwon-Darling river system. Furthermore, the vital habitat layer only accounted for large woody debris (LWD) and dissolved organic carbon (DOC) as there are no Ramsar or DIWA (Directory of Important Wetlands in Australia) wetlands in the Barwon-Darling WRPA.

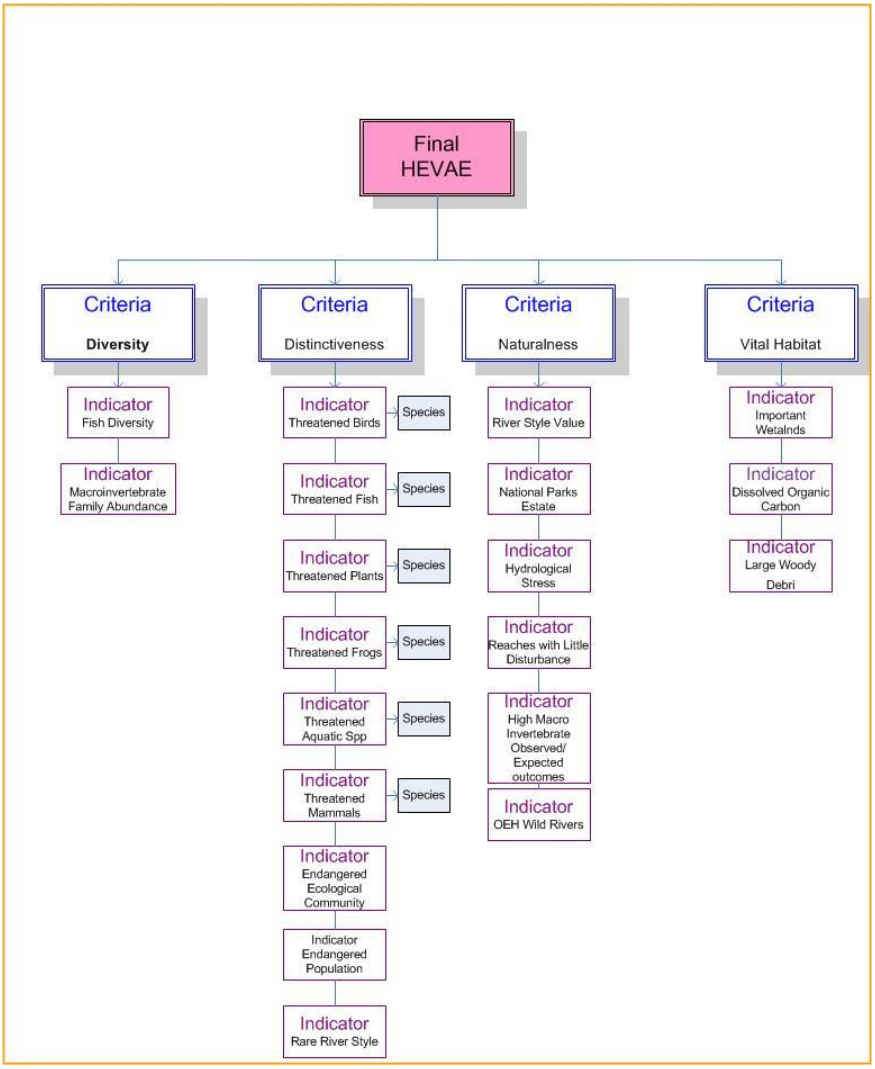


Figure 4-3 The four HEVAE criteria and associated attributes used in assessing HEVAE in NSW

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

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

4.2.2. Consequence decision tree

The risk assessment includes consideration of the location and magnitude of extraction pressure on instream ecological functions and assets 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 are used 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) are not used in the HEVAE model 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

Fish data from the MDB Sustainable Rivers Audit (Davies et al. 2012) and other sources were analysed by NSW Department of Primary Industries—Fisheries to assess the distribution of threatened fish species and to identify areas of relative high fish biodiversity in the Barwon-Darling WRPA. These data are included in the HEVAE assessment (results are provided in Appendix D).

Unregulated river Section in the Barwon-Darling WRPA have very high consequence scores in Sections 1 and 3 with high consequence scores in all other Sections (Table 4-2). Key factors influencing the consequence outcomes are:

- Threatened fish site-based records in every river Section (see Appendix D)
- Endangered ecological communities known or predicted to occur along every river Section (Appendix D)
- Highest fish diversity scores in river Section 3 with high fish diversity scores across all other Sections (Appendix D)
- High to very high Naturalness scores in every river Section (Figure 4-4).

Table 4-2 Consequence results for the unregulated water sources in the Barwon-Darling WRPA

Unregulated water source	Consequence Rating (HEVAE consequence score)
Section 1 (Mungindi to Walgett)	Very High (VH)
Section 2 (Walgett to Brewarrina)	High (H)
Section 3 (Brewarrina to Bourke)	Very High (VH)
Section 4a (Bourke to Louth)	High (H)
Section 4b (Louth to Wilcannia)	High (H)
Reference: Healey et al. 2018.	

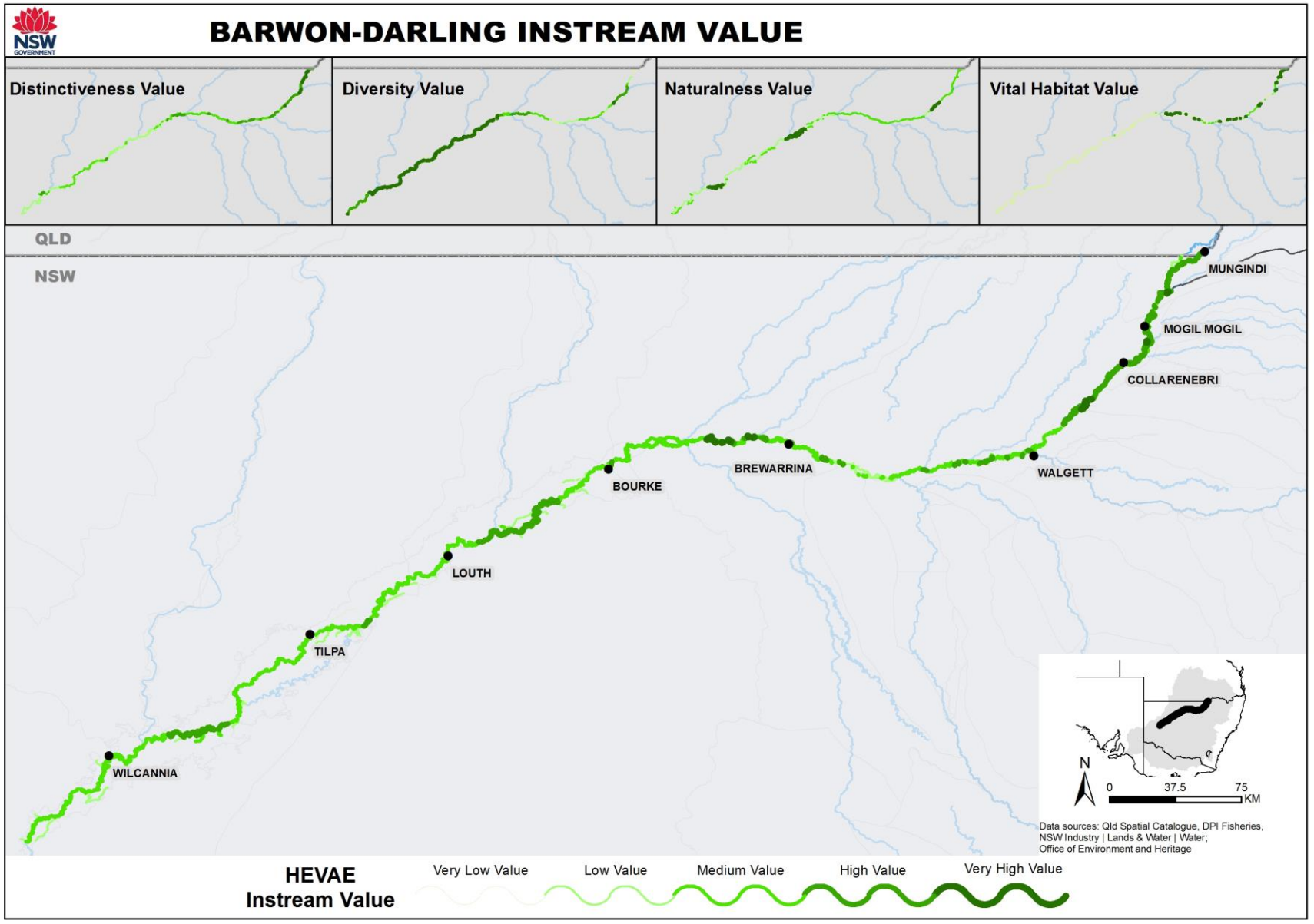


Figure 4-4 HEVAE scoring of instream values in the Barwon-Darling WRPA

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 affect 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 in Figure 4-5 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.

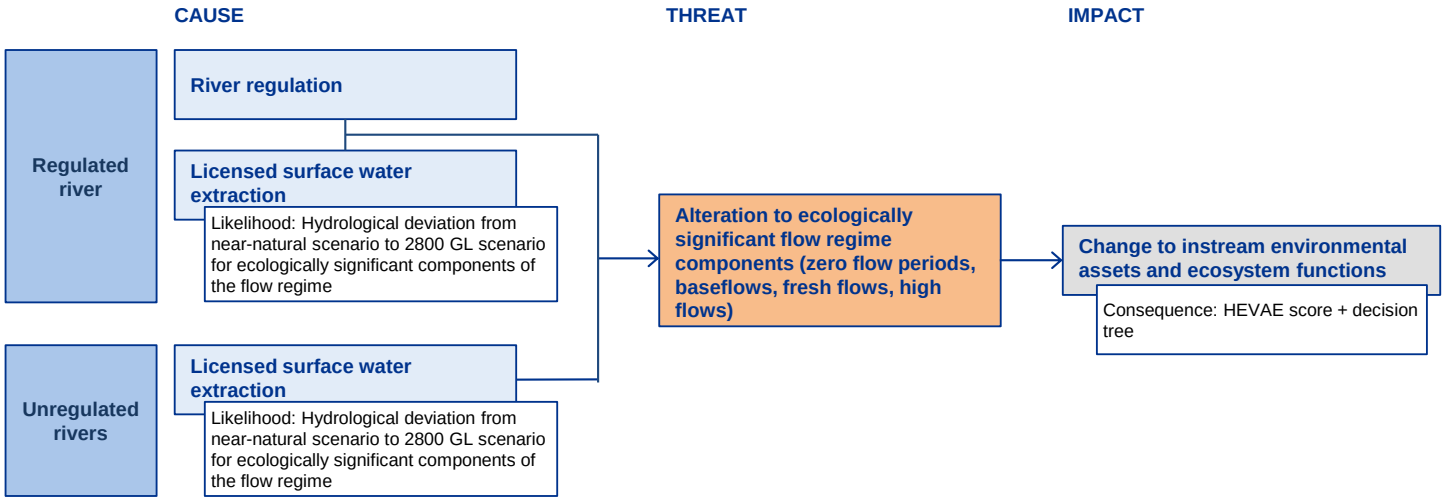


Figure 4-5 Impact pathway showing impact of river regulation and licensed extraction on water available for the environment

4.3.1. Determining the likelihood rating

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

This risk assessment process has identified key features of flow regimes which have impacts on key ecosystem functions and assets identified by the MDBA (2010) and Alluvium (2010). These key flow components and their features are summarised in Table 4-3.

Table 4-3 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.
Large and infrequent flows (BKF and OB)	Large flow events occur on an average recurrence interval (ARI) of greater than a year. These flow events are distinct from base flows and freshes because they can generate bank full and over bank flows. Bank full flows are regarded as important for maintaining river geomorphology, and are often termed the "channel forming" flows, as they help define and maintain channel dimensions such as width, depth and slope, and in-channel habitats such as benches and bars. High flows and freshes also act as a natural disturbance in river systems, helping to remove vegetation, aquatic plants and organic matter and resetting successional processes. Over bank flows deliver water, sediment and dissolved material, including plant nutrients, to the floodplain and provide temporary access to floodplain aquatic habitats. Water returning from the floodplain to the channel may carry carbon in the form of dissolved carbon and organic detritus, micro-organisms and small plankton animals. All are generated by the productive floodplain ecosystem and supported by inputs of water from the channel.
Reference: MDBA 2010, 2012; Alluvium 2010, Chessman et al. 2006a	

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

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

Hydrological alteration metrics were chosen to reflect the key ecological features of flow regimes described in Table 4-3. These metrics indicate change to the following flow components:

- Zero flow periods (or cease to flow events) (Z)
- Base flows (BF)
- Freshes (F)
- High flows 1.5 year average recurrence interval (ARI) (BK1.5)
- High flows 2.5 year ARI (OB2.5)
- High flows 5.0 year ARI (OB5).

Differences in channel morphology along a river may mean that a high flow event could result in over bank flows on one reach but not others. The ARI events used in this risk assessment are therefore considered to be

broadly indicative of a river section's likelihood. The specific ARI that might be needed, for instance, to inundate a particular wetland, will be addressed in the Barwon-Darling 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 Barwon-Darling WRPA in the LTWP developed by NSW DPIE (2019d; Table 10) and are based on seven flow components. Within each flow component, flow types have been assigned based on the timing, duration and frequency of flow required to support environmental assets and ecosystem functions.

This risk assessment was completed prior to EWRs being developed for the Barwon-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 4-4. 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 Barwon-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 4-4 Alignment of EWRs of the LTWP and flow components assessed in the Barwon-Darling WRPA risk assessment

Long Term Water Plan (DPIE)[1]						Barwon-Darling WRPA risk assessment (Department of Planning and Environment)	
Flow component[1]	EWR reference	Maximum inter-flow period	Ideal EWR			Flow component assessed (section 4.3)	How this risk assessment considers the EWR
			Timing	Duration	Frequency		
Cease-to-flow	CTF1	N/A	In line with low flow season	In line with natural, unless key refuges endangered	No greater than natural	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	No greater than natural	Any time	No less than natural	No less than natural	Base flow (BF)	Metrics used to calculate likelihood of base flow components included identifying low flows during 'wet' and 'dry' seasons. The dry season calculation is equivalent to very low flows (approximately 90-95 %ile)
"Base flow"[2]	BF1	No less than natural	Any time	No less than natural	No less than natural	Any time	Metrics used to calculate likelihood of base flow components included identifying low flows during 'wet' and 'dry' seasons. Likelihoods were generally calculated on flows between the 80-95%ile, depending on which percentile most accurately described low flows in the water source.
"Base flow"[2]	BF2	2 years	September to March	No less than natural	5–10 years in 10 (75% of years)	Fresh (F)	Metrics used to calculate likelihood of fresh flow components included identifying 20 %ile flows during 'wet' and 'dry' seasons and would capture alterations to the BF2 flows.
Small fresh	SF1	1 year	Anytime – but ideally October to April	10 days minimum	Annual (100% of years)	Fresh/ARI 1.5 (F, BKF1.5)	Metrics used to calculate likelihood of fresh flow (20 %ile during wet/dry periods) and ARI 1.5 would capture most of the SF1 flows.
Small fresh	SF2	2 years	October to April	14 days minimum	5–10 years in 10 (75% of years)	ARI 1.5 (BKF1.5)	Metrics used to calculate likelihood of ARI 1.5 flow component identifies changes to SF2.
Large fresh	LF1	2 years	Anytime, but ideally July to September	15 days minimum	5–10 years in 10 (75% of years)	ARI 1.5 (BKF1.5)	Metrics used to calculate likelihood of ARI 1.5 flow component identifies changes to LF1.

Long Term Water Plan (DPIE)[1]						Barwon-Darling WRPA risk assessment (Department of Planning and Environment)	
Flow component[1]	EWR reference	Maximum inter-flow period	Ideal EWR			Flow component assessed (section 4.3)	How this risk assessment considers the EWR
			Timing	Duration	Frequency		
Large Fresh	LF2	2 years	October to April	15 days minimum	3–5 years in 10 (42% of years)	ARI 2.5 (BKF2.5)	Metrics used to calculate likelihood of ARI 2.5 flow component identifies changes to LF2.
Bankfull	BK 1	4 years	Any time	3 days minimum	5 in 10 years (50% of years)	ARI 1.5 (BKF1.5)	Metrics used to calculate likelihood of ARI 1.5 flow component identifies changes to BK1.
Small overbank or greater	OB1	4 years	Any time	3 days minimum	2 to 4 years in 10 (30% of years)	ARI 2.5 (OB2.5)	Metrics used to calculate likelihood of ARI 2.5 flow component identifies changes to OB1
Medium overbank or greater	OB2	7 years	Any time	1 day minimum	2 to 3 years in 10 (25% of years)	ARI 5 (OB5)	Metrics used to calculate likelihood of ARI 5 flow component identifies changes to OB2
Large overbank or greater	OB3	10 years	Any time	1 day minimum	1–2 years in 10 (12% of years)	ARI 5 (OB5)	Metrics used to calculate likelihood of ARI 5 flow component identifies changes to OB3

[1] Table 7, NSW DPIE (2019e). 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.

For the majority of unregulated water sources that were assessed in WRP risk assessments, single reach IQQM models were used to derive flow sequences, where extraction at full development of unregulated entitlement and flow were simulated to determine the hydrologic alteration. However, the Barwon-Darling unregulated WRPA is different to other unregulated water sources in NSW. For each of the five Sections of the Barwon-Darling unregulated river, IQQM models were used to derive the flow sequences required to quantify the hydrologic alteration metrics at each hydrologic indicator site (Figure 3-2). The NSW IQQM data was provided to the MDBA and then used to fit the Barwon-Darling MDBA modelling needs for four indicator sites (Figure 6) along the Barwon-Darling WRPA (MDBA 2012). Another hydrologic indicator site, gauge 422027 (Barwon River at Gerra) was included as a separate NSW Department of Primary Industries—Water hydrologic indicator site. At this site, NSW Department of Primary Industries—Water calculated the hydrologic alteration metrics from flow sequences generated by the MDBA using a NSW Department of Planning

and Environment unregulated river IQQM model to run simulations to determine the 2800GL volume that needed to be acquired. The three irrigation license classes (A Class, B Class and C Class licences) are included in baseline condition model runs (MDBA 2012).

Similar to regulated systems, likelihood category definitions are defined based on the extent of deviation from the near-natural condition (Table 4-5).

Table 4-5 Likelihood metrics for risk of insufficient water available for the environment and risk to EWRs in unregulated water sources in the Barwon-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 Barwon-Darling water source are shown in Table 4-6.

Table 4-6 Likelihood results for unregulated water sources in the Barwon-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
Section 1 (Mungindi to Walgett)	H^-	L^{+*}	M-	M^-	M^-	M^-
Section 2 (Walgett to Brewarrina)	L^0	M^-	M^{-*}	M^-	M^-	M^-
Section 3 (Brewarrina to Bourke)	H^-	L^{-*}	M^-	M^-	M^-	M^-
Section 4a (Bourke to Louth)	H^-	M^-	M^-	M^-	M^-	M^-
Section 4b (Louth to Wilcannia)	H^-	M^-	M^{-*}	M^-	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 * Indicates some metrics increase and some decrease, but there could be an overall increase or decrease.						
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 Barwon-Darling WRPA. These mechanisms are provided for under the *Water Management Act 2000* and through specific rules within the unregulated water sharing plan.

The NSW Water Sharing Plan for the *Barwon-Darling Unregulated Water Sources 2012* has the following actions and mechanisms to provide water for the environment:

- All water above the long term average annual extraction limit reserved for planned environmental water.
- Cease to pump rules, commence to pump rules and flow rates/levels that provide protection during dry times.
- Cease to pump rules applied to aquifer access licences that extract groundwater that is highly connected to the unregulated surface water.
- Total and Individual Daily Extraction Limits (TDELs and IDELs) with one of the aims to keep the river flows above the cease to pump than otherwise would normally occur (note that IDELs and TDELs have not yet been implemented since the current WSP was gazetted but will likely occur in the remake of the Plan to meet Basin Planning requirements)
- Rules for granting and amending water supply works approvals 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 take from in-river dam pools based on type of construction and ability to pass of flows per specifications on water use approval

The 2800 GL scenario modelling (MDBA 2012) included a water recovery volume in the Barwon-Darling of 20 GL/yr (Long Term Cap Equivalent). This represents the volume of water already recovered in the Barwon-Darling WRPA.

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 4-7.

Table 4-7 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

Unregulated water sources

The results of the risk analysis for key ecosystem assets and functions in unregulated water sources are provided in Table 4-8. Risk outcomes were determined for each of the five Sections (see Chapter 3.2 and Figure 3-2). River Sections 1 to 3 generally had medium or high risk outcomes across the majority of flow metrics (Table 4-8), the exception being Section 2 (Walgett to Brewarrina) where a low risk for zero flow periods was determined. This is likely due to the influence of a constant low flow input from the Macquarie River preventing the natural occurrence of zero flow periods being reached as the river flows into this Section of the Barwon-Darling River.

In Sections 1 and 3, risk to instream values from alteration to fresh flows and all ARI's were found to be high. In Sections 4a and 4b, a high level of risk was determined for zero flow periods, a medium risk for base flows freshes and 1.5 ARI overbank flows. However in 4b, low levels of risk were determined for the 2.5 and 5.0 ARI over-bank flows, whereas these were medium risk in section 4a (Table 4-8).

Table 4-8 Risk of insufficient water for the environment and capacity to meet EWRs in the unregulated Barwon-Darling WRPA [E(W)]

Unregulated 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
Section 1 (Mungindi to Walgett)	VH	H^{-}	L^{+}*	M^{-}	M^{-}	M^{-}	M^{-}	H-	M+*	H-	H-	H-	H-
Section 2 (Walgett to Brewarrina)	H	L^{0}	M^{-}	M^{-}*	M^{-}	M^{-}	M^{-}	L0	M-	M-*	M-	M-	M-
Section 3 (Brewarrina to Bourke)	VH	H^{-}	L^{-}*	M^{-}	M^{-}	M^{-}	M^{-}	H-	M-*	H-	H-	H-	H-
Section 4a (Bourke to Louth)	H	H^{-}	M^{-}	M^{-}	M^{-}	M^{-}	M^{-}	H-	M-	M-*	M-	M-	M-
Section 4b (Louth to Wilcannia)	H	H^{-}	M^{-}	M^{-}*	M^{-}	L^{-}	L^{-}	H-	M-	M-*	M-	L-	L-

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

$^{-}$ indicates a decrease in the metrics (less flow, except zero flow periods more flow)

$^{+}$ indicates an increase in the metrics (more flow, except zero flow periods less flow)

* indicates some metrics increase and some decrease, but there could be an overall increase or decrease

^{0} indicates no change in the metrics (in the case of gauge 422027 zero flows periods are estimated not to occur naturally due to a constant flow from the Macquarie River)

Consequence ratings are (VL) Very Low, (L) Low, (M) Medium, (H) High, and (VH) Very High.

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 (NSW Office of Water 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 (NSW Office of Water 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 in may reduce the water available for the environment, as shown in the impact pathway below (Figure 4-6). 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 4-6 Impact pathway showing risk of growth in BLR reducing water available for the environment

4.4.1. Determining the likelihood rating

The nature of BLR extraction cannot impact upon medium to high flows, and therefore has a 'nil' risk on these components of the flow regime. The assessment of risks of BLR extraction impacting on the environment are relevant to base flows, very-low flows and cease-to-flows (EWRs: BF1, VLF1, CTF1; Table 4-4). The likelihood

of growth in BLR causing a reduction in water available for the environment 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 4-9. The likelihood results for water sources in the unregulated Barwon-Darling are shown in Table 4-10.

Table 4-9 Likelihood metrics for risk of growth in BLR in unregulated water sources

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

Table 4-10 Likelihood results for unregulated water sources in the Barwon-Darling WRPA

Unregulated water source	Likelihood rating
1 (Mungindi to Walgett)	Low
2 (Walgett to Brewarrina)	Low
3 (Brewarrina to Bourke)	Low
4a (Bourke to Louth)	Low
4b (Louth to Wilcannia)	Low

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 Barwon-Darling WRPA is provided in Table 4-11.

Table 4-11 Risk matrix to determine risk outcomes of increased BLR extraction impacting on water available for the environment

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

Combining the risk consequence and likelihood ratings (Table 4-2 and Table 4-10) for the Barwon-Darling unregulated water sources resulted in the overall risk levels to ecological assets and functions as shown in Table 4-12. Two of the five Sections in the Barwon-Darling WRPA were determined to have medium risk of insufficient water in pools.

The estimates of BLR used to determine the risk for each Section could likely be an artefact of the method used because a single estimate for BLR was determined for the whole of the Barwon-Darling WRP area. This one figure was apportioned to each of the five Sections based on the proportion of licenced entitlement in each Section. It was assumed that the higher the proportion of licensed entitlement, the higher the BLR that may occur.

Table 4-12 Risk of increased BLR extraction impacting on water available for the environment in the unregulated water sources of the Barwon-Darling WRPA [E(BLR)]

Risk factor/source	Consequence	Likelihood	Overall risk rating - E(BLR)
Section 1 (Mungindi to Walgett)	Very High	Low	Medium
Section 2 (Walgett to Brewarrina)	High	Low	Low
Section 3 (Brewarrina to Bourke)	Very High	Low	Medium
Section 4a (Bourke to Louth)	High	Low	Low
Section 4b (Louth to Wilcannia)	High	Low	Low
Key: L = Low; M = Medium; H = High			

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

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

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

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

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

The impact pathways demonstrate 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 Barwon-Darling WRPA, interception activities linked to the unregulated river pathway described in each section are the potential cause that can influence interception threats and impacts.

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 harvestable right dam capacity (MHRDC) is the total dam capacity allowed under the harvestable right and takes into account rainfall and variations in rainfall pattern.

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 4-7).

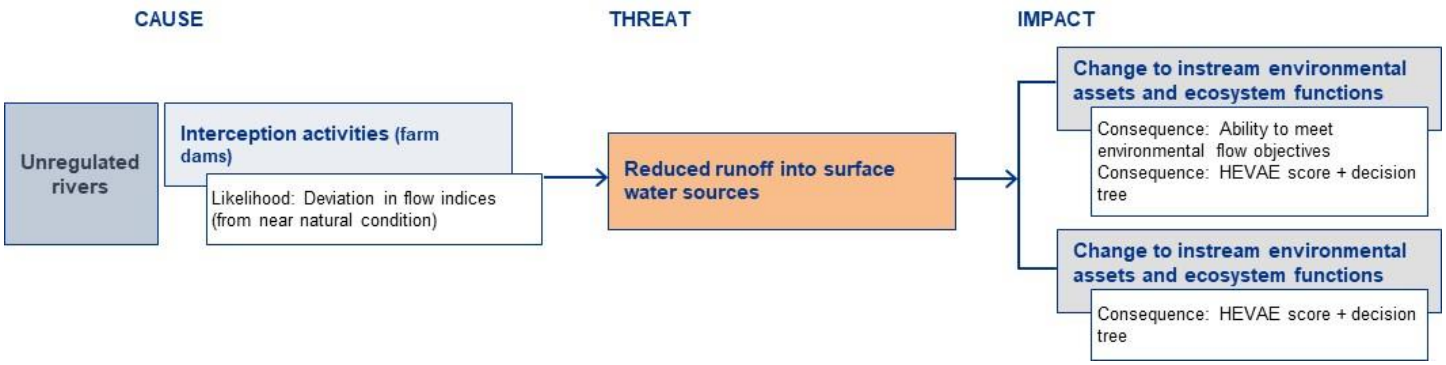


Figure 4-7 Impact pathway showing impact of interception activities on ecological functions and assets

4.5.1.1. Assigning a consequence rating score

Consequence scores for the unregulated water sources were determined using the HEVAE instream value spatial data (Section 4.2) for the Barwon-Darling WRPA. The highest HEVAE (instream) value was determined for each of the five river Sections in the Barwon-Darling WRPA (Figure 3-2) and used to indicate the consequence rating in each of these Sections (Table 4-13).

Table 4-13 Consequence results for the unregulated water sources in the Barwon-Darling WRPA

Gauging Station	Consequence Rating (HEVAE consequence score)
Section 1 (Mungindi to Walgett)	Very High
Section 2 (Walgett to Brewarrina)	High
Section 3 (Brewarrina to Bourke)	Very High
Section 4a (Bourke to Louth)	High
Section 4b (Louth to Wilcannia)	High
Reference: Healey et al. 2018.	

4.5.1.2. Determining the likelihood rating

The MDBSY Project (CSIRO 2008a; CSIRO 2008b) did not assess unregulated rivers; therefore the SKM (2011) assessment of the hydrological impacts of farm dams in the MDB was used to describe likelihood. This study assessed the impact of existing farm dams at a detailed regional scale and fits into the hydrology theme of the Sustainable Rivers Audit 2 (SRA2) (Davies et al. 2012). The assessment undertook a sensitivity analysis on the results of the SRA hydrology metrics to identify those most sensitive to farm dams. Sixteen flow stress indices were calculated across 162 study catchments using catchments and flow gauges that met a set of criteria, including a record of at least 15 years of gauged stream flow 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 2010) were the:

- low flow (LF) index had the greatest sensitivity to farm dams, consistent with other studies that note that farm dams tend to take a greater proportion of available flow during low flow periods (EWRs: BF1, BF2, VLF1, CTF1; Table 4-4):
- annual variation index (CV) (the ratio of coefficient of variation of flow in reference and current regime) was moderately affected by farm dams, possibly because flow variability was increased as low flows are made lower by farm dams (EWRs: BF1, BF2, VLF1, CTF1; Table 4-4):
- high flow (HF) index was moderately affected, possibly because farm dams can delay the onset of high flows at the start of winter in highly developed catchments (EWRs: LF1-2, OB1-5; Table 4-4):

These indices were selected as the metrics to describe the likelihood in unregulated water sources in the Barwon-Darling WRPA. However, the MDBSY farm dam assessment did not identify any significant dams or gauging stations within the Barwon-Darling water source (Figure 4-8). Given that most of the Barwon-Darling WRPA inflows are received from connected WRPAs, we assessed the risk of interception activities impacting on those tributary inflows. The cumulative impact of these contributing stream segments was used to assess likelihood in each of the Barwon-Darling management zones in Table 4-10.

In some instances, the dams and gauges on contributing streams were more than 100km from the Barwon-Darling River itself, which introduces some uncertainty into this assessment. The outcomes are therefore rated as a low data confidence in Appendix A. The results are presented below for each likelihood metric, scored according to departure from the reference:

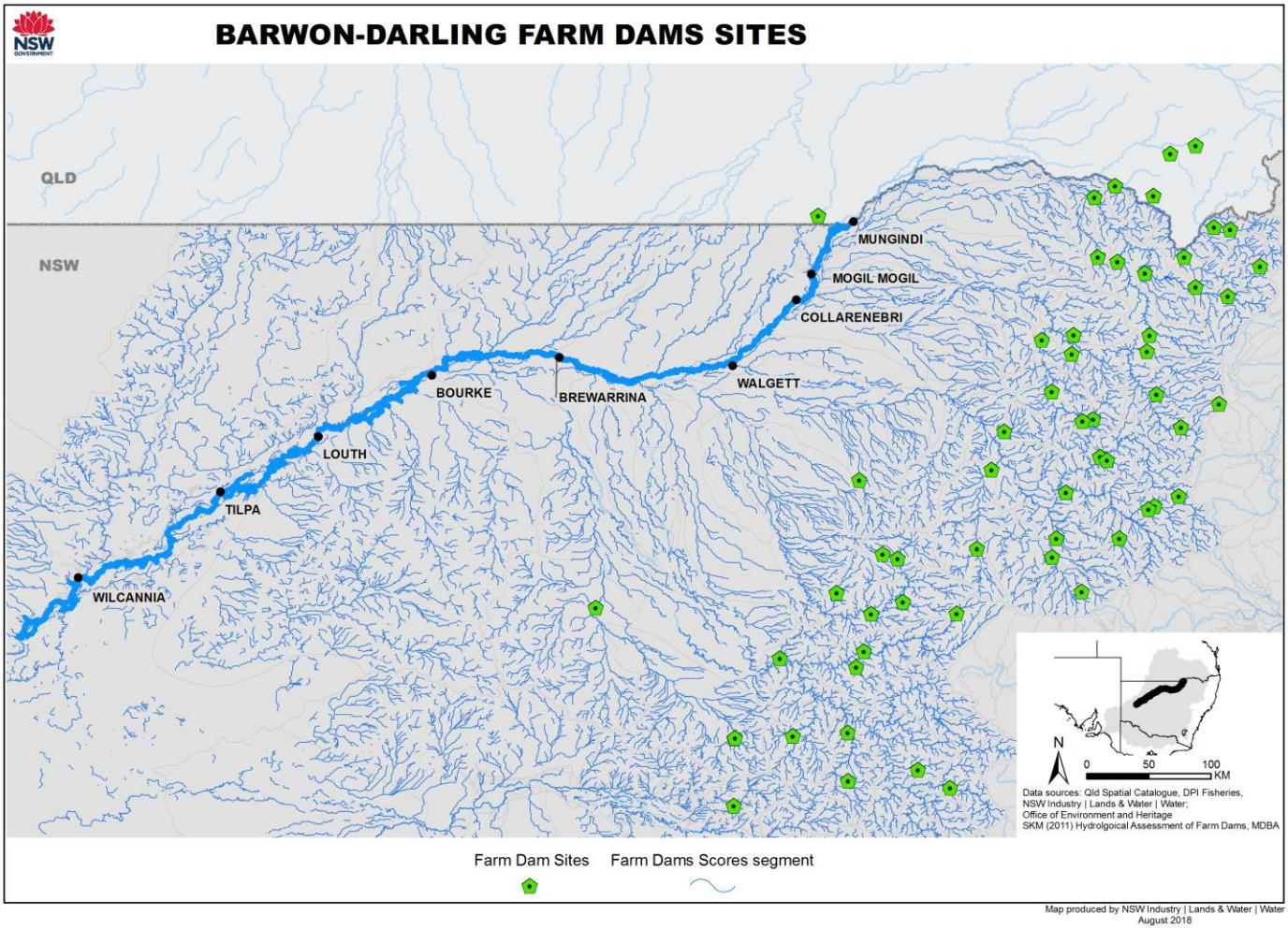


Figure 4-8 Location of land use and farm dams in tributary streams, and stream segments for farm dams near the Barwon-Darling WRPA (Source SKM 2011).

Likelihood category definitions are defined by the extent of deviation from the near-natural condition (Table 4-14). Likelihood results are provided in Table 4-15 for five river sections used in the risk assessment within the Barwon-Darling WRPA. Maps showing results of indices and metrics used to assess the likelihood of farm dams intercepting surface flows in unregulated water sources in the Barwon-Darling WRPA are provided in Appendix E.

Table 4-14 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: NSW Office of Water (2010)		

Table 4-15 Likelihood results for risk to water for the environment in unregulated water sources in the Barwon-Darling WRPA due to interception activities

Gauging Station	Likelihood		
	CV	LF Q_{90}	HF Q_{10}
Section 1 (Mungindi to Walgett)	Low	Low	Low
Section 2 (Walgett to Brewarrina)	Low	Low	Low
Section 3 (Brewarrina to Bourke)	Low	Low	Low
Section 4a (Bourke to Louth)	Low	Low	Low
Section 4b (Louth to Wilcannia)	Low	Low	Low

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

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 Barwon-Darling unregulated water sources is provided in Table 4-16.

Table 4-16 Matrix used to determine risk outcomes of insufficient water available for the environment from potential interception activities in unregulated water sources in the Barwon-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 4-13 and Table 4-15) results in a low risk level to ecological assets and functions from interception due to farm dams in unregulated water sources in Sections 2, 4a and 4b and a medium risk level in Sections 1 and 3 of the Barwon-Darling WRPA (Table 4-17). As mentioned above, the confidence in the likelihood input data is low and this reduces the confidence in the risk outcomes from farm dams impacting on the availability of water for the environment.

Table 4-17 Risks of insufficient water available for the environment in unregulated water sources in the Barwon-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}
Section 1 (Mungindi to Walgett)	Very High	Low	Low	Low	Medium	Medium	Medium
Section 2 (Walgett to Brewarrina)	High	Low	Low	Low	Low	Low	Low
Section 3 (Brewarrina to Bourke)	Very High	Low	Low	Low	Medium	Medium	Medium
Section 4a (Bourke to Louth)	High	Low	Low	Low	Low	Low	Low
Section 4b (Louth to Wilcannia)	High	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 also increase evapotranspiration and therefore reduce water yield (SMEC 2010).

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

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

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

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

As part of the MDBSY Project (CSIRO 2008b), 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.

Softwood and hardwood plantation forestry is not viable in the small and narrow semi-arid area of the Barwon-Darling WRPA. There are no commercial forestry plantations known to occur in the region and none likely to occur in the future (CSIRO 2008a). Further assessment of the NSW ACLUMP land-use data (year of mapping: 1999-2006) (ABARES 2011) indicated that the plantation forestry that occurs in this WRPA is related to conservation areas and not commercial forestry practices.

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

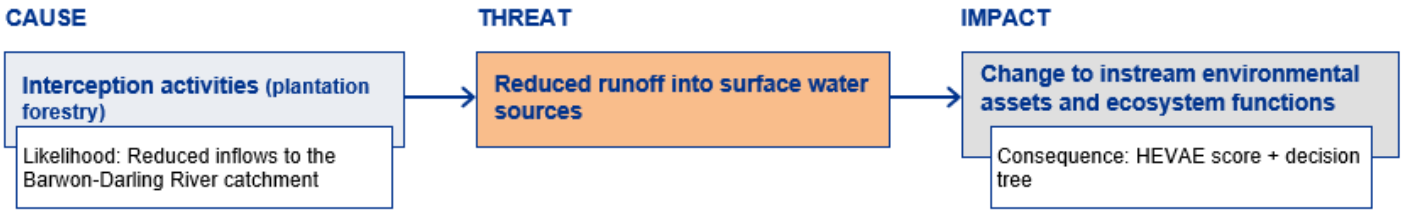


Figure 4-9 Impact pathway showing risk of growth in plantation forests reducing water available for the environment

4.5.2.1. Assigning a consequence score

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

4.5.2.2. Determining the likelihood rating

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

Where there is no projected growth in commercial plantations there is no pathway for additional future impact and a 'nil' category was assigned to unregulated water source (Table 4-18 and Table 4-19).

4.5.2.3. Existing water management actions & mechanisms

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

4.5.2.4. Risk outcomes

The risk matrix used to determine the risk of commercial plantations impacting the availability of water to the environment in the unregulated water sources in the Barwon-Darling Surface WRPA is provided in Table 4-18

Table 4-18 Risk matrix to determine risk outcomes of increased commercial plantations impacting on water available for the environment

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

Combining the risk consequence (Table 4-2) and the likelihood rating of 'nil', the overall risk levels to ecological assets and functions have been assessed as 'Nil' (Table 4-19).

Table 4-19 Risks of insufficient water available for the environment in regulated and unregulated water sources in the Barwon-Darling River Surface WRPA as a result of plantation forests [E(I-PF)]

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

4.5.3. Mining [E(I-M)]

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

Mining 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 4.5.3.5).

There are currently no operating mining activities in the Barwon-Darling WRPA (ABARES 2011, MinView https://minview.geoscience.nsw.gov.au). Additionally, no commercial coal seam gas extraction has occurred or is currently occurring in the WRP area.

4.5.3.5. 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.

4.5.3.6. Risk outcomes

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

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

The Barwon-Darling region did not identify any significant areas of mining nor growth in mining (https://minview.geoscience.nsw.gov.au). 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.*

Table 4-20 Risks of insufficient water available for the environment in regulated and unregulated water sources in the Barwon-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	Unregulated river water sources	Nil
Reduced water quality	Unregulated river water sources	Low
Structural integrity	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 4-10.

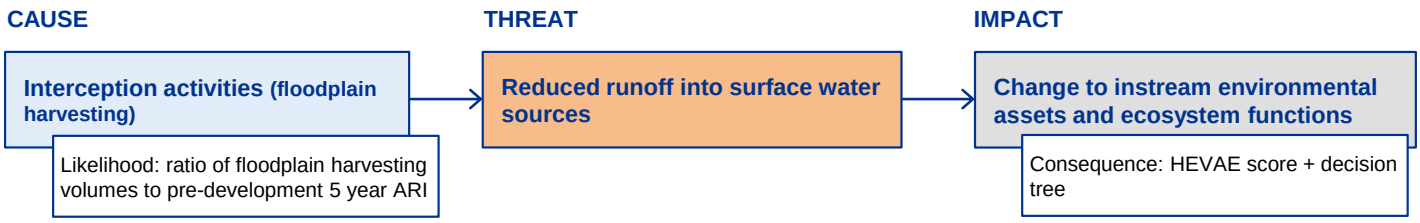


Figure 4-10 Impact pathway showing risk of growth in floodplain harvesting reducing water available for the environment

4.5.4.1. Assigning a consequence score

The consequence scores used in the assessment of the impact of floodplain harvesting on ecological assets and functions within unregulated water sources were determined using the HEVAE instream (consequence) values listed in Table 4-2 and Table 4-8. 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 'high' to 'very high', a 'very high', consequence was used in determining the risk outcomes. In addition, there are floodplain areas that could be impacted by floodplain harvesting, hence the adoption of a 'very high' consequence score. The 'very high' consequence score also ensures that a conservative estimate of risk is undertaken.

4.5.4.2. Determining the likelihood rating

The likelihood was calculated by comparing the current estimate of total volume of floodplain harvesting (FPH) diversions, including tributaries, to the volume of the pre-development 5 year ARI flood event (measured as %)

in the Barwon River at Dangar Bridge (gauge no. 422001). This does not include the impact of floodplain harvesting in Queensland on ARI 5 flow volumes. The data used for the likelihood rating are preliminary estimates from the Water Modelling team within DOI –Water, and should be considered as indicative only. The likelihood metrics are defined in Table 4-21.

Table 4-21 Likelihood metrics for floodplain harvesting

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

The proportion of FPH volume to 5 year ARI flood volume in the Barwon-Darling River WRP area was estimated to be 14%. Therefore, a 'low' likelihood rating was assigned.

4.5.4.3. Existing water management actions and mechanisms

Floodplain harvesting is identified in the Basin Plan as a potential interception activity. See section 5.7.4 of the water resource plan for current management actions and mechanisms. In NSW, the Floodplain Harvesting Policy and Healthy Floodplains Projects are converting this form of take into a licensable right. This form of take will be managed under the Floodplain licencing framework.

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 Barwon-Darling Surface WRPA is provided in Table 4-22.

Table 4-22 Risks of insufficient water available for the environment in regulated and unregulated water sources in the Barwon-Darling Surface WRPA as a result of floodplain harvesting activities [E(I-FH)]

	Consequence	Likelihood	Overall risk rating - E(I-FH)
Barwon-Darling River water sources	Very High	Low	Medium

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 4-11 and demonstrates how change in climate can alter patterns and volumes of surface runoff impacting water available for the environment in the Barwon-Darling WRPA.

The likelihood is described as the change in frequency of flow indicators at Bourke Weir (NSW Office of Water 2010), while the consequence is assessed as the loss of annual water diversions for environmental entitlements.

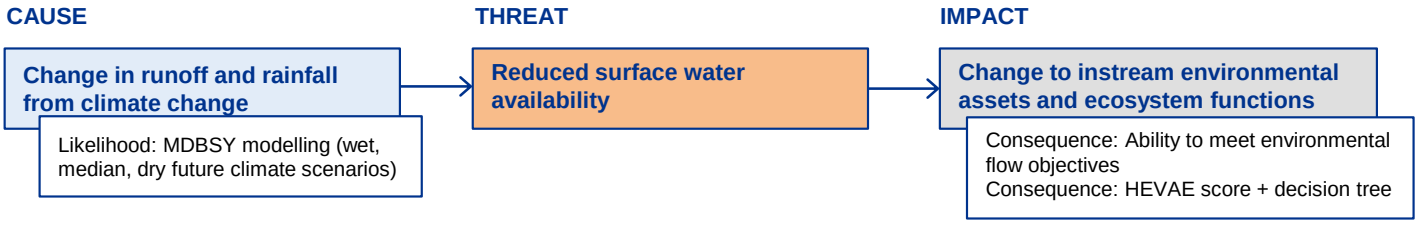


Figure 4-11 Impact pathway showing how change in climate can impact on the availability of water for the environment

4.6.1. Assigning a consequence rating

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 4-24) (NSW Office of Water 2010).

The Barwon-Darling environmental asset that was assessed by the MDBSY Project was the drown-out flow at Bourke Weir. A flow of 10 GL/day was considered to be sufficient to cause drown-out and provide effective fish passage (CSIRO 2008a). The consequence scores for this asset are provided below (Table 4-23). Consequence levels were defined by the magnitude of change and were set by experienced consultants at levels considered to be ‘reasonable’.

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

Table 4-23 Consequence results for Barwon-Darling environmental assets receiving flows in the Barwon-Darling WRPA

Environmental asset	Consequence		
	Dry climate change scenario	Median climate change scenario	Wet climate change scenario
Bourke Weir drown-out flow	Severe	Major	Moderate
Reference: NSW Office of Water (2010)			

4.6.2. Determining the likelihood rating

As discussed earlier in Section 4.5.1.2, customised hydrological indicators were developed in the MDBSY Project for the Barwon-Darling asset, Bourke Weir (CSIRO 2008a). Comparing MDBSY Project C scenarios to the 2004/05 (A0 scenario) determines the likelihood of specific flow indicators being recorded under the three different climate projections (wet, dry, median) (Table 4-24). Also as discussed in Section 4.5.1.2, likelihood rankings were adapted from the SKM (2008) guidelines for assessing risks to shared water resources in the Murray-Darling Basin (Table 4-25), which defined likelihood differently to how it has been defined in the majority of this risk assessment (Section 2.2).

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 4-4).

Table 4-24 Data used to assess risk likelihood to the Barwon-Darling environmental assets from change in climate (CSIRO 2008a)

Environmental flow indicator	A0	C_{dry} (% change from A0)	C_{mid} (% change from A0)	C_{wet} (% change from A0)
Average period between flow events exceeding 10 GL/day at Bourke Weir	0.3 years	66	18	-24
Maximum period (years) between flow events exceeding 10 GL/day at Bourke Weir	1.8 years	66	1	-10
Average excess volume per event above 10 GL/day at Bourke Weir	984 GL	-10	2	28
Average excess volume per year above 10 GL/day at Bourke Weir	2,802 GL	-44	-13	61
Reference: CSIRO 2008a				
A0: historical climate, 2004/2005 level of development and water management arrangements C_{dry}: 2004/2005 levels of development; dry climate change projections for 2030 C_{mid}: 2004/2005 levels of development; median climate change projections for 2030 C_{wet}: 2004/2005 levels of development; wet climate change projections for 2030				

Table 4-25 Likelihood results for the Barwon-Darling environmental assets receiving insufficient flows in the Barwon-Darling WRPA (adapted from CSIRO 2008a)

Environmental asset	Likelihood		
	Dry climate change scenario	Median climate change scenario	Wet climate change scenario
Drown-out flows at Bourke Weir	Likely	Possible	Possible
Reference: NSW Office of Water (2010)			

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

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 (NSW Office of Water 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 (NSW Office of Water 2010). The resulting change in average annual rainfall and runoff is presented in Table 4-26.

Table 4-26 Impacts of climate change scenarios on mean annual runoff and rainfall

Scenario	Change to mean annual rainfall (%)	Change to mean annual runoff (%)
C_{dry}	-10	-28
C_{mid}	-1	-9
C_{wet}	12	31

According to the MDBSY Project (CSIRO 2008a), wet scenario climate change is predicted to increase mean annual runoff in the Barwon-Darling WRPA by 31 %, but there is a predicted 28 % and 9 % reduction in inflows for the dry and median climate change scenarios respectively.

As mentioned in Section 4.5.1.2, the risk matrix used to determine the risk rating of flow alteration from change in climate impacting the availability of water for the Barwon-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 adapted risk matrix is provided in Table 4-27.

The risk matrix used to determine the risk rating of flow alteration from change in climate impacting the availability of water for the Barwon-Darling environmental assets is provided in Table 4-27.

Table 4-27 Matrix used to determine risk of insufficient water available for the environment from potential change in climate

		Likelihood of insufficient water availability				
		Rare	Unlikely	Possible	Likely	Almost Certain
Consequence (%change in water use)	Negligible	Low	Low	Low	Medium	Medium
	Minor	Low	Low	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 4-23 and Table 4-25) resulted in the overall risk levels to the Barwon-Darling ecological assets as shown in Table 4-28. The risk assessment determined a low risk to the ecological assets from the wet scenario and medium risk from the median climate change scenario. Under a dry climate change scenario, the ecological assets are at high risk of a reduction in inflows.

Table 4-28 Risks of insufficient water available for the environment in the Bourke Weir drownout as a result of change in climate [E(CC)]

Environmental asset	Climate scenario	Consequence	Likelihood	Risk level - E(CC)
drown-out flow at Bourke Weir	Wet climate change scenario	Moderate	Possible	Medium
drown-out flow at Bourke Weir	Median climate change scenario	Major	Possible	High
drown-out flow at Bourke Weir	Dry climate change scenario	Severe	Likely	High

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 4-29.

Table 4-29 Risk matrix to determine risk outcomes of insufficient water for the environment from potential change in climate in unregulated rivers

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

Combining the risk consequence and ‘medium’ likelihood ratings resulted in ‘High’ and ‘Medium” risk levels to all unregulated river reaches (Table 4-30).

Table 4-30 Risks of insufficient water available for the environment in unregulated river sections in the Barwon-Darling Surface WRPA as a result of climate change [E(CC)]

Unregulated water source	Consequence	Likelihood	Overall risk rating – E(CC)
Section 1 (Mungindi to Walgett)	VH	M	H
Section 2 (Walgett to Brewarrina)	H	M	M
Section 3 (Brewarrina to Bourke)	VH	M	H
Section 4a (Bourke to Louth)	H	M	M
Section 4b (Louth to Wilcannia)	H	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 Barwon-Darling Unregulated WSP described in section 4.2 of the Barwon-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 Industry ecohydrology specialist expert opinion. There are potential risks to environmental assets and functions in the Barwon-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 Barwon-Darling Surface WRP area was ‘medium’, and the consequence of the impact from pest species was ‘medium’. Using the risk matrix Table 4-7, the overall risk rating was ‘medium’ (Table 5-1).

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

	Consequence	Likelihood	Overall risk rating
Barwon-Darling Surface WRP area water sources	Medium	Medium	Medium

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

6.1. Background

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

The Basin Plan requires that a WRP must include a water quality management plan (WQM Plan). A separate WQM Plan for the Barwon-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 Barwon-Darling catchment are mostly caused by a combination of alteration to natural flow regimes, changes to catchment conditions both within and upstream of the WRPA and land use change (NSW Department of Industry 2018b). 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 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 unregulated system that benefit water quality. These rules include:

- Reserving 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.
- Allowance for hydrologic connectivity between the Border Rivers, Gwydir and Namoi catchments with the Barwon-Darling River to provide for fish passage across major weirs, suppress algal blooms and to meet basic landholder rights in the Barwon-Darling River watercourse.
- Provision within the *Water Management Act 2000* to enable specified replenishment flows that refill pools or waterholes in effluent systems downstream of a water source and provide water for stock and domestic purposes.
- Provision for the Minister to specify rules relating to the rates of change to releases from water storages from inflowing catchments to minimise environmental and geomorphological impacts.
- Provision to adjust available water determinations to ensure compliance with the long term average annual extraction limit.
- Provision 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 outside 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 Barwon-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).

The release of cold water or warm water pollution from dams can impact on ecosystem function and condition by causing temperature depression in regulated rivers. Water temperature influences many biological and ecosystem processes. Warmer temperatures can increase growth rates and metabolism of in-stream plants, animals and algae. Temperature influences spawning, breeding and migration patterns of many aquatic animals. The impact pathway for CWP is shown in Figure 6-1 and for WWP in Figure 6-2 .

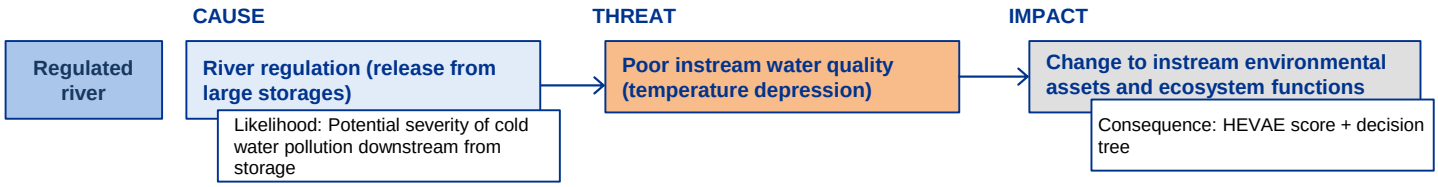


Figure 6-1 Impact pathway showing impact of cold water pollution on ecological functions and assets

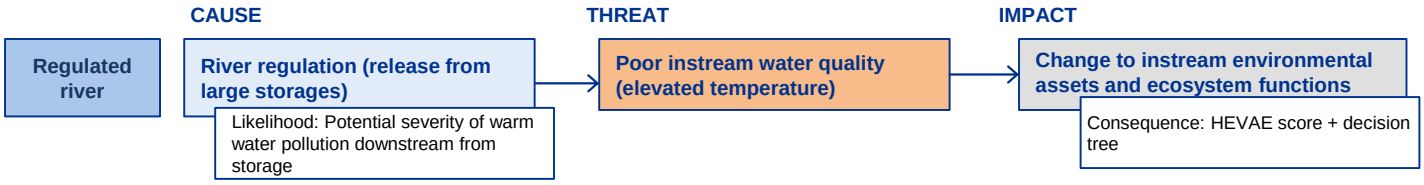


Figure 6-2 Impact pathway showing impact of warm water pollution on ecological functions and assets

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 and other fauna spawning, can reduce the growth rate of fish, and increase mortality (Lugg & Copeland 2014). If applicable to the Barwon-Darling WSP, the same consequence scores determined in Section 4.2 would have been used to assess risks due to water temperatures falling below natural ranges due to releases from major storages. The highest HEVAE value within the cold water pollution affected area of each dam would have been used as the consequence score if it was proven to be an issue within the Barwon-Darling WSP area.

6.3.2. Determining the likelihood rating

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

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

Likelihood metric	Metric category	Metric category definition
Potential severity of downstream CWP	Low	Minor CWP Shallower intake (<10 m) and smaller discharge (<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		

All significant water storages are located a considerable distance upstream and any cold or warm water pollution is unlikely to affect the Barwon-Darling WRPA. The likelihood value is therefore ‘Nil’

6.3.3. Risk outcomes

Due to the distance to any significant water storages, sites in the Barwon- Darling WRPA are assessed as having '**Nil**' risk from CWP or WWP.

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

Elevated levels of suspended matter, 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.

Pindari Dam has a major disruptive effect on water quality immediately downstream of the dam by trapping sediment, while also increasing downstream erosion through rapidly ascending and descending patterns of water release (NSW Department of Industry 2018b). Nutrient concentrations are influenced by land use, rainfall and discharge, as well as the combination of naturally occurring high concentrations of nitrogen and phosphorus in soils and erosion. Soil erosion can be exacerbated by clearing, degradation of stream banks and other land use issues. Turbidity and suspended sediment are also influenced by high flows, particularly in those reaches where bank and riparian condition is poor (NSW Department of Industry 2018b).

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

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

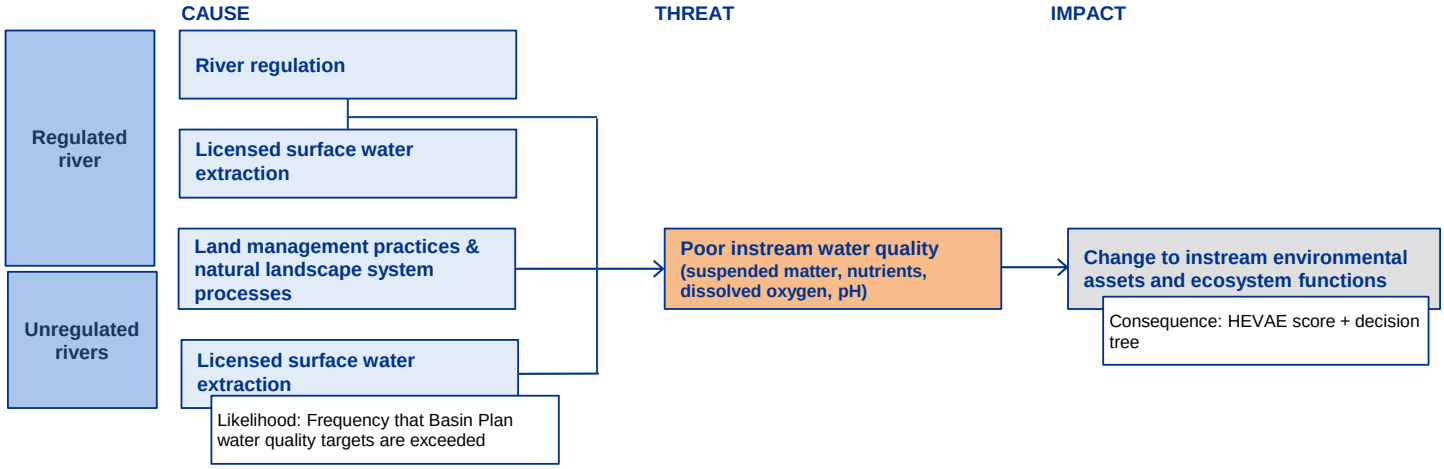


Figure 6-3 Impact pathway showing impact of water quality degradation (increased turbidity, TP, TN, pH & DO) on ecological functions and assets

6.4.1. Assigning a consequence rating

There are 13 NSW Department of Planning and Environment water quality monitoring sites in the Barwon-Darling WRPA. 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 4.2.3). The consequence decision support tree (Appendix C) was then used to define the final consequence score using the HEVAE instream values within each reach area. Consequence scores for the unregulated river Sections are shown in Table 6-2.

Table 6-2 Consequence results for reaches of the unregulated rivers in the Barwon-Darling WRPA

River reach	Consequence Rating
416001 Barwon River at Mungindi	High
422003 Barwon River at Collarenebri	Very high
422001 Barwon River at Dangar Bridge (Walgett)	High
422002 Barwon River at Brewarrina	Very high
425003 Darling River at Bourke	High
425004 Darling River at Louth	Medium
425008 Darling River at Wilcannia	Medium

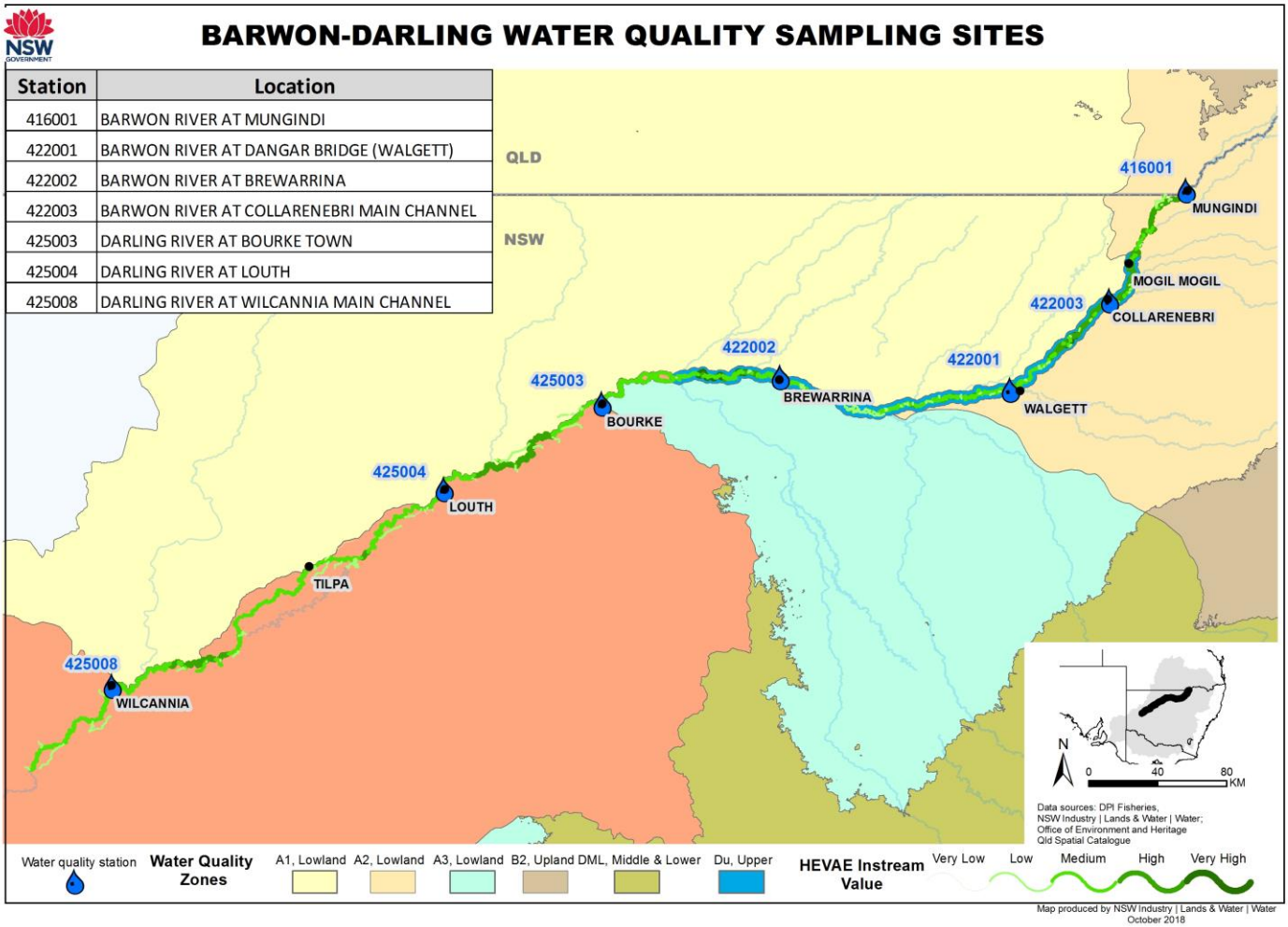


Figure 6-4 Water quality monitoring sites used to determine water quality target application zones for water-dependent ecosystems (Schedule 11 of the Basin Plan)

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 Lowland Darling upper and Darling middle and lower zones (A2, Du and Dml zones respectively) (Figure 6-4) (Table 6-3).

Table 6-3 Basin Plan (Schedule 11) water quality targets for 'other water-dependent ecosystems'

Target application zones (Target assessment)	Water-dependent ecosystem	Ecosystem Type	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)
A2 (Border Rivers, Gwydir and Namoi Valleys; lowland zone)	Declared Ramsar wetlands	Streams and rivers	75	130	490	65-110%	7.0-8.3
		Lakes and wetlands	20	10	350	90–110%	6.5–8.0
	Other water-dependent ecosystems	Streams, rivers, lakes and wetlands	200	200	1000	65-110%	7.0-8.3
Du (Darling Upper zone)	Declared Ramsar wetlands	Streams and rivers	95	150	480	80-110%	7.0-8.1
		Lakes and wetlands	20	10	350	90–110%	6.5–8.0
	Other water-dependent ecosystems	Streams, rivers, lakes and wetlands	230	250	900	80-110%	7.1-8.1
Dml (Darling valley; Middle and lower zones)	Declared Ramsar wetlands	Streams and rivers	50	50	500	85-110%	6.5-8.0
		Lakes and wetlands	20	10	350	90-110%	6.5-8.0
	Other water-dependent ecosystems	Streams, rivers, lakes and wetlands	50	50	500	85-110%	6.5-8.0

Likelihood category definitions are defined by the frequency that the water quality target is exceeded over the five year sampling period (Table 6-4). Likelihood scores for unregulated reaches are shown in Table 6-5.

Table 6-4 Likelihood metrics for risk of water quality impacting water-dependent ecosystems in the Barwon-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.

Table 6-5 Likelihood results in unregulated river reaches exceeding Basin Plan water quality targets

Unregulated river reach	Turbidity	Total phosphorus	Total nitrogen	pH	DO
416001 Barwon River at Mungindi	Low	Low	Low	Low	Low
422003 Barwon River at Collarenebri	Low	Low	Medium	Low	High
422001 Barwon River at Dangar Bridge (Walgett)	Low	Low	Medium	Low	Low
422002 Barwon River at Brewarrina	Low	Low	Medium	Low	Low
425003 Darling River at Bourke	High	High	High	Medium	Medium
425004 Darling River at Louth	High	High	High	Low	Low
425008 Darling River at Wilcannia	Medium	High	High	Medium	Medium

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 6-6.

Table 6-6 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 6-2) and likelihood ratings (Table 6-5) for the Barwon-Darling WRPA results in the overall risk levels to ecological assets and functions as shown in Table 6-7.

The highest risk to water-dependent ecosystems was found from Collarenebri through to Wilcannia (there are no water quality monitoring sites downstream of Wilcannia). The most widespread source of risk was from elevated nitrogen levels, however all variables contribute to risk levels across most of the WRPA. Mungindi was the only location not to register a medium or high risk, however Danger Bridge at Walgett also had low risks with the exception of a medium risk from elevated nitrogen levels.

Table 6-7 Risks of exceeding water quality targets impacting the health of water-dependent ecosystems in the unregulated reaches of the Barwon-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
416001 Barwon River at Mungindi	High	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
422003 Barwon River at Collarenebri	Very high	Low	Medium	Low	Medium	Medium	High	Low	Medium	High	High
422001 Barwon River at Dangar Bridge (Walgett)	High	Low	Low	Low	Low	Medium	Medium	Low	Low	Low	Low
422002 Barwon River at Brewarrina	Very high	Low	Medium	Low	Medium	Medium	High	Low	Medium	Low	Medium
425003 Darling River at Bourke	High	High	High	High	High	High	High	Medium	Medium	Medium	Medium
425004 Darling River at Louth	Medium	High	High	High	High	High	High	Low	Low	Low	Low
425008 Darling River at Wilcannia	Medium	Medium	Medium	High	High	High	High	Medium	Medium	Medium	Medium

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

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

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

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

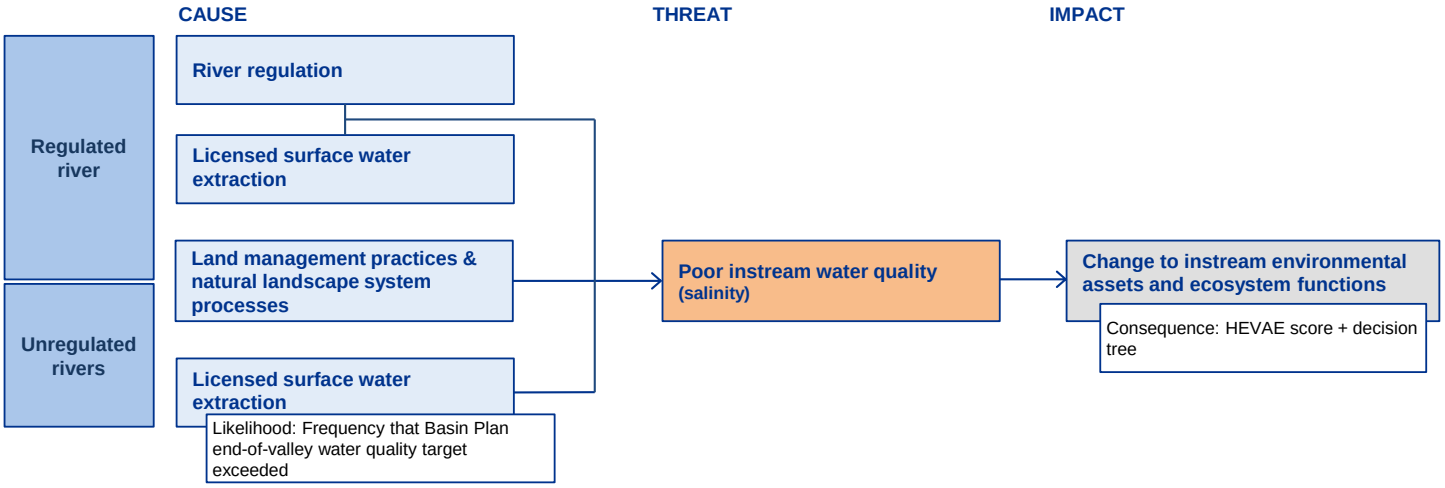


Figure 6-5 Impact pathway showing impact of elevated levels of instream salinity on ecological functions and assets in the Barwon-Darling WRPA

6.5.1. Assigning a consequence rating

The same consequence rating as applied in Section 6.4.1 was used. The end-of-valley target for the Barwon-Darling is nominated for Gauging Station 425008 (Darling River at Wilcannia) (Schedule B, Appendix 1 of the Commonwealth Water Act 2007). This station has a medium consequence rating (Table 6-2).

6.5.2. Determining the likelihood rating

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

The end-of-valley salinity targets for the Barwon-Darling WRPA, as nominated in the Basin Plan, is that the 80th percentile should not exceed 453 µS/cm.

Likelihood category definitions are defined by the frequency that the end-of-valley target is exceeded over the five year sampling period (Table 6-8).

Table 6-8 Likelihood metrics for risk to health of water-dependent ecosystems from poor water quality in the regulated reaches in the Barwon-Darling WRPA

Likelihood metric	Metric category	Metric category definition
Number of years the annual 80th percentile salinity exceeds the end-of-valley target of 330 µS/cm	Low	The annual 80th percentile exceeds the end-of-valley target no more than once between 2010/11 - 2014/15
	Medium	The annual 80th percentile exceeds the end-of-valley target at least two twice but not more than three times between 2010/11 - 2014/15
	High	The annual 80th percentile exceeds the end-of-valley target at least four times between 2010/11 - 2014/15

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

The annual 80th percentile salinity level at the Darling River at Wilcannia (425008) exceeded the salinity target four out of the five years between 2010/11 and 2014/15. Therefore this risk has a high likelihood rating.

6.5.3. Risk outcomes

The risk matrix used to determine the risk to the health of water-dependent ecosystems due to water quality targets being exceeded is provided in Table 6-9.

Table 6-9 Risk matrix to determine risk outcomes of elevated levels of instream salinity on water-dependent ecosystems

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

Combining the medium consequence (Table 6-2) and high likelihood rating (Section 6.5.2) results in a high overall risk rating (Table 6-10).

Table 6-10 Risks of elevated levels of instream salinity impacting the health of water-dependent ecosystems in the regulated system of the Barwon-Darling WRPA [E(WQ-S)]

Regulated river reach	Consequence rating	Likelihood rating	Risk rating - E(WQ-S)
425008 Darling River at Wilcannia	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 licencing and compliance activities, and
- effectiveness of measures to mitigate risk consequence such as extraction controls and water treatment activities

The pathway for impact shown in Figure 6-6 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.

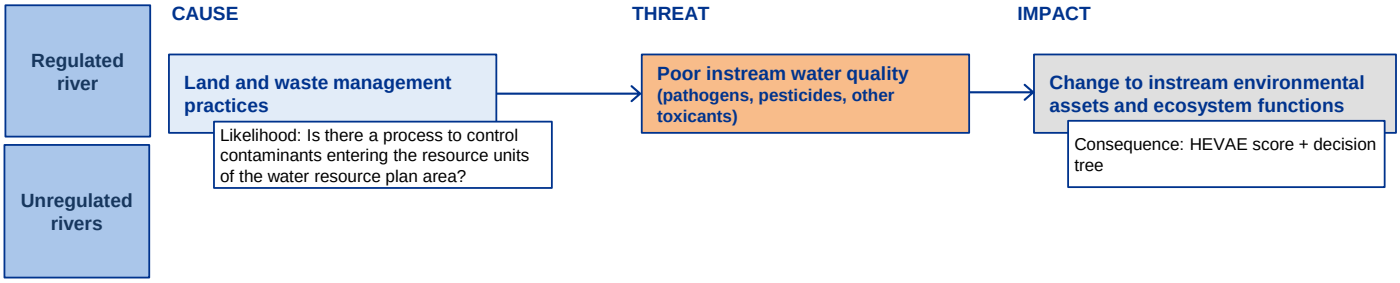


Figure 6-6. Impact pathway showing how risk of poor water quality (pathogens, pesticides and other toxic contaminants) can impact on ecological assets and functions

6.6.1. Assigning a consequence rating

Risk consequence was determined using the HEVAE instream value scoring (Section 4.2.1). The consequence decision support tree (9.5.Appendix C) was then used to define the final consequence score using the HEVAE instream values within each reach area. However, because the likelihood rating was assessed at the WRP area scale, and the consequence scores for the water sources ranged from ‘low’ to ‘very high’, a ‘very high’ consequence was used in determining the risk outcomes. The ‘very high’ consequence score ensures that a conservative estimate of risk was undertaken.

6.6.2. Determining the likelihood rating

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

In NSW the EPA and local councils implement a risk based approach to the management of potential point source contaminants under the *Protection of the Environment Operations Act 1997,* the *Local Government Act 1993* and the *Local Government (General) Regulation 2005*. The EPA is responsible for event monitoring as a result of licence compliance issues. Under the Protection of the Environment Operations Act 1997 (POEO Act), the Environment Protection Authority (EPA) uses a risk-based licensing system that aims to ensure that all environment protection licensees receive an appropriate level of regulation based on the environmental risk of the activity taking into account site specific risks. Licenced industries include sewage treatment plants and various agricultural processing activities. Licensing conditions also include a monitoring and reporting component for compliance.

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

NSW considers the EPA's risk based licensing and approval system and local councils' regulation of onsite sewage management adequately manages the major causes of water quality degradation from major contaminants entering the surface waters. Therefore, a likelihood ranking of 'low' has been applied to both regulated and unregulated water sources (Table 6-11).

Table 6-11 Likelihood metrics and categories for risk to health of water-dependent ecosystems from poor water quality (pathogens and toxicants) in the Barwon-DarlingSurface 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 6-11) and consequence rating results in the overall risk of surface water contamination from land and waste management practices as 'medium' in all resource units (Table 6-12)

Table 6-12 Risk matrix to determine risk outcomes of impact of pathogens and toxicants on water-dependent ecosystems

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

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

7.1. Background

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

7.2. Existing water management actions & mechanisms

As discussed in Chapter 5.2, a key principle of the WMA is 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 0, and the WQM Plan, Salinity Technical Report and the Surface Water Quality Technical Report.

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

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

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

Irrigation water with elevated levels of salinity can lead to potential crop damage. The Basin Plan sets water quality targets for irrigation water and for the purpose of long-term salinity planning and management (Part 4 of Chapter 9). The target for water for irrigation is for the 95th percentile of each 10 year period that ends at the end of a water accounting period. These targets apply at sites where water is extracted by an irrigation infrastructure operator (IIO) for the purpose of irrigation. In NSW, irrigation infrastructure operators are defined as a separate third party that holds a water access entitlement and delivers water to shareholders. These include NSW Irrigation Corporations, Private Irrigation Districts and Private Water Trusts. As there are no irrigation infrastructure operators that deliver services in the Barwon-Darling WRPA, the irrigation water target does not apply. However, for the purposes of long-term salinity management and planning, measures to address medium and high risk of elevated levels of salinity must be prepared having regarding to the targets in Division 4 of Part 4 of Chapter 9.

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

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

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

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

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

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

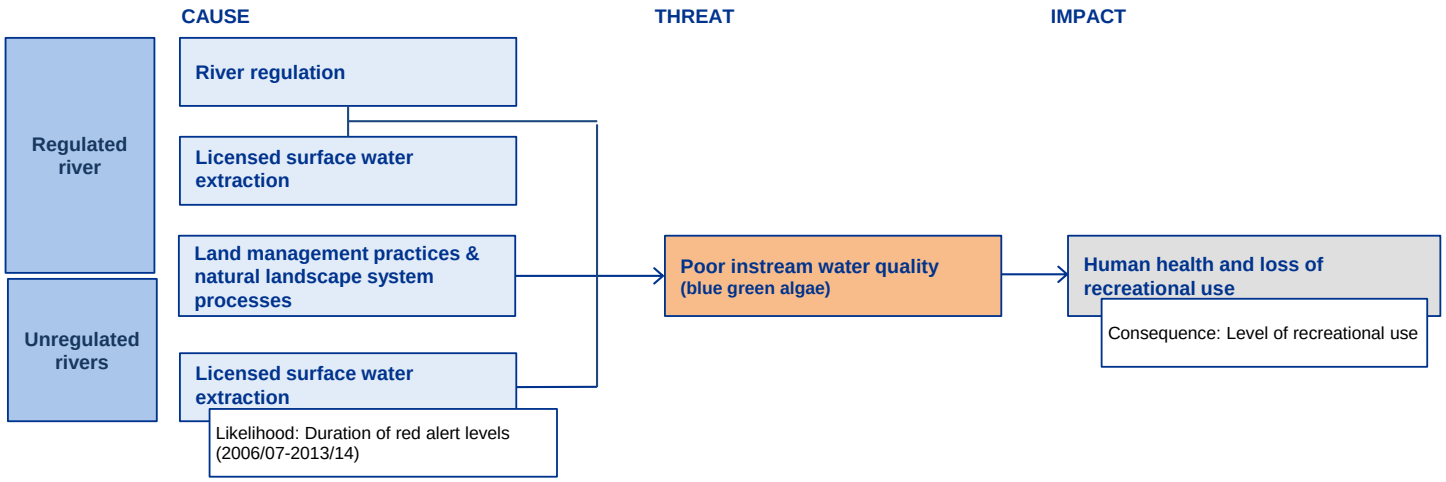


Figure 7-1 Impact pathway showing risk to recreation water quality and human health from blue-green algae

7.4.1. Existing water management actions & 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 (NSW Office of Water 2014). The objective of the guidelines is to provide a risk assessment framework to assist with effective management response to freshwater, estuarine and marine algal blooms. The guidelines aim to minimise the impact of algal blooms by providing adequate warning to the public ensuring their health and safety in recreational situations and for stock and domestic use**.**

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

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

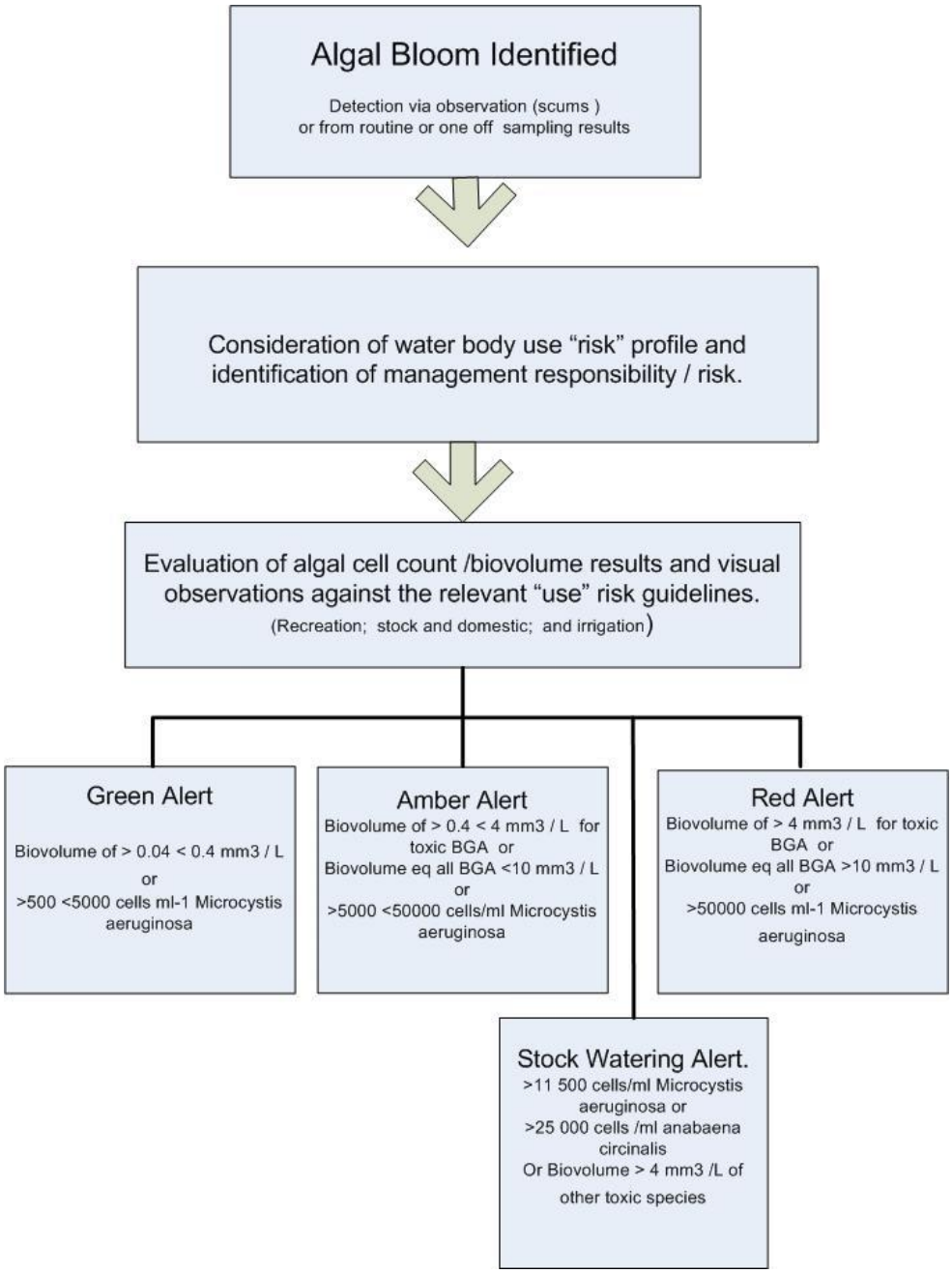


Figure 7-2 Conceptual outline of how algal alert levels are used in NSW

7.4.2. Assigning a consequence rating

Consequence is described by the degree of recreational use of the water source. Recreational usage of the three sites in the Barwon-Darling WRPA that are monitored for blue-green algae was determined during sampling to assign a use level.

Consequence categories are defined by usage levels (Table 7-1). Consequence ratings are provided in Table 7-2.

Table 7-1 Consequence metrics for risk to water used for recreational uses due to blue-green algae in the Barwon-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 7-2 Consequence results for risk to recreational water users in the Barwon-Darling WRPA

River reach	Consequence
Barwon River at Mungindi	Low
Barwon River at Collarenebri	Low
Barwon River at Dangar Bridge (Walgett)	Low
Barwon River at Brewarrina	Low
Darling River at Bourke	Low
Darling River at Rose Isle	Low
Darling River at Louth	Low
Darling River at Tilpa	Low
Darling River at Trevallyn	Low
Darling River at Wilcannia	Low
Darling River at Atley	Low
Darling River at Culpaulin	Low

7.4.3. Determining the likelihood rating

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

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

Likelihood categories are defined by length of time a red alert is in place (Table 7-3). Likelihood ratings are provided in Table 7-4.

Table 7-3 Likelihood metrics for risks from blue-green algae in the Barwon-Darling WRPA

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

Table 7-4 Likelihood results for risk due to blue-green algae

River reach	Likelihood
Barwon River at Mungindi	Low
Barwon River at Collarenebri	Low
Barwon River at Dangar Bridge (Walgett)	Low
Barwon River at Brewarrina	Low
Darling River at Bourke	Low
Darling River at Rose Isle	Low
Darling River at Louth	Low
Darling River at Tilpa	Low
Darling River at Trevallyn	Medium
Darling River at Wilcannia	Medium
Darling River at Atley	High
Darling River at Culpaulin	Low

7.4.4. Risk outcomes

The risk matrix used to determine the risk to recreational water users from blue-green algae in the Barwon-Darling WRPA is provided in Table 7-5.

Table 7-5 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 results (Table 7-2 and Table 7-4) in the overall risk as low for all monitoring sites with the exception of Darling River at Atley which registers a medium risk (Table 7-6).

Table 7-6 Risks from blue-green algae to recreational water uses in the Barwon-Darling WRPA [O(WQ-BGA)]

Regulated river reach	Consequence rating	Likelihood rating	Risk rating – O(WQ-BGA)
Barwon River at Mungindi	Low	Low	Low
Barwon River at Collarenebri	Low	Low	Low
Barwon River at Dangar Bridge (Walgett)	Low	Low	Low
Barwon River at Brewarrina	Low	Low	Low

Regulated river reach	Consequence rating	Likelihood rating	Risk rating – O(WQ-BGA)
Darling River at Bourke	Low	Low	Low
Darling River at Rose Isle	Low	Low	Low
Darling River at Louth	Low	Low	Low
Darling River at Tilpa	Low	Low	Low
Darling River at Trevallyn	Low	Medium	Low
Darling River at Wilcannia	Low	Medium	Low
Darling River at Atley	Low	High	Medium
Darling River at Culpaulin	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 Barwon-Darling WRPA:

- Bourke Shire Council
- Central-Darling Shire Council
- Walgett Shire Council
- Brewarrina 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

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 affect the water resources of a WRPA:

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

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

For the purpose of risk due to interception, NSW used 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 following section.

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.

The WMA places limits on allowable farm dam capacity as a proportion of average regional rainfall runoff, applied at the scale of each landholding. The mechanism places a limit on the total runoff that can be intercepted within a water source because even though the number of dams in a catchment can increase, dam capacity is limited to the rate of rainfall runoff relative to the size of each landholding. The combined capacity of all dams must stay within the maximum allowed under the HRO. See section 4.5.1 for more detail. The impact pathways are shown in Figure 8-1 and demonstrate how the threat of flow alteration driven by farm

dam interception activities identified in the Basin Plan can impact on water available for other users. The key threat is the interception of water that would otherwise reach a water course, thereby reducing the water available for other users in the system.

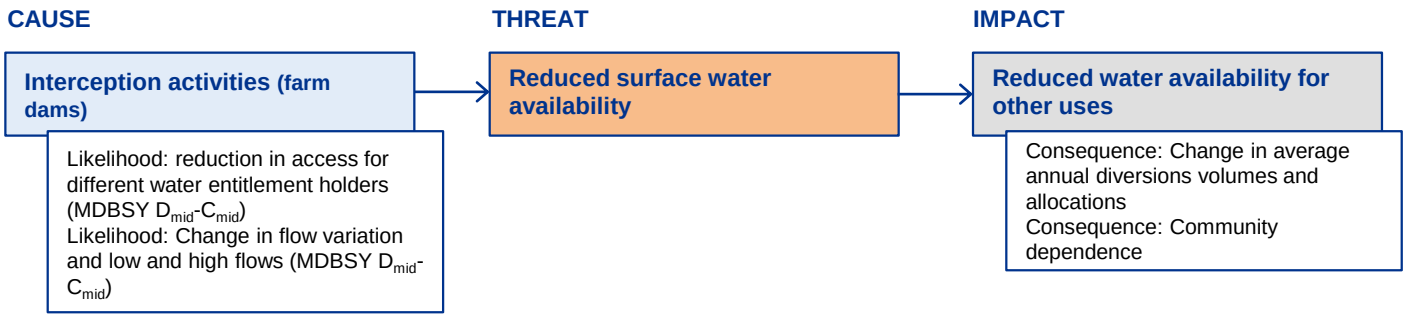


Figure 8-1 Impact pathway showing impact of farm dams on water available for other uses

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).

In assigning a consequence level to farm dams, the approach undertaken by the NSW Office of Water (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 (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:

- A Class licences, which can extract water during low flows conditions
- B and C Class licences, which can extract water during moderate and high flows.

The change in average annual diverted volumes was used to calculate consequences of interception by farm dams (Table 8-1) (NSW Office of Water 2010). Data used to assess consequence is presented in Table 8-2.

Table 8-1 Consequence thresholds for combined A,B and C Class water access licences in the Barwon-Darling WRPA

Consequence Levels	Percent Change Relative to Base Case
	Average annual diversions
Negligible	x < 1
Minor	1 ≤ x < 10
Moderate	10 ≤ x < 20
Major	20 ≤ x < 30
Severe	30 ≤ x
Reference: NSW Office of Water (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 Barwon-Darling due to interception by farm dams

Water access licence type	% change in average annual diversions	Consequence
A, B and C Classes	-0.2	Negligible

8.2.1.2. Determining the likelihood rating

For the purpose of determining likelihood for farm dams in the Barwon-Darling, likelihood was calculated by differences between MDBSY scenarios D_{mid} - C_{mid}(Table 8-3). The farm dam component of this impact was estimated at 50% of the total (NSW Office of Water 2010).

Table 8-3 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
Reference: CSIRO 2008a		

The likelihood rating for combined licence classes from interception by farm dams is provided in Table 8-4.

Table 8-4 Likelihood results for combined water access licences in the Barwon-Darling WRPA. Likelihood metric estimates the likelihood of insufficient water access.

Water access entitlement holder	Likelihood
A.B and C Classes	Possible
Reference: NSW Office of Water (2010)	

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

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 Barwon-Darling WRPA is provided in Table 8-5.

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

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

Combining the consequence and likelihood ratings (Table 8-2 and Table 8-4) resulted in the overall **'Low'** risk level to water access licences and other users in the unregulated Barwon-Darling as shown in Table 8-6.

Table 8-6 Risks of insufficient water available for different categories of water access licences in the Barwon-Darling WRPA as a result of growth in interception by farm dams [O(I-FD)]

Water access licence type	Consequence	Likelihood	Risk level – O(I-FD)
A, B and C Class	Negligible	Possible	Low
Reference: CSIRO 2008a			

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

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

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

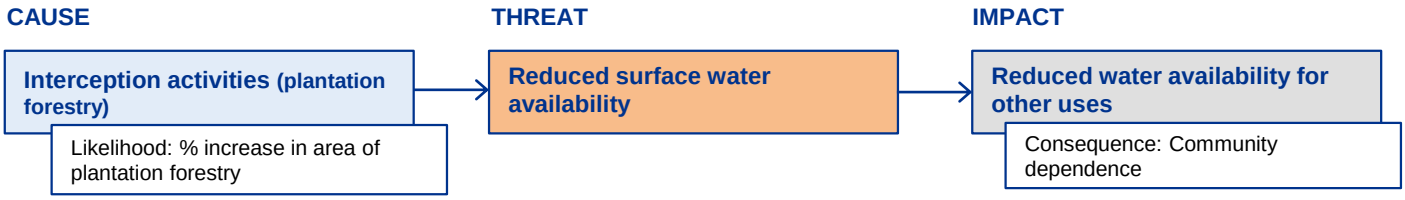


Figure 8-2 Impact pathway showing impact of commercial plantations on water available for other uses

Where there is no projected growth in commercial plantations there is no pathway for additional future impact and a 'nil' likelihood category was assigned to both regulated and unregulated water sources. The consequence scores in unregulated water sources were based on community dependence on water use (NSW Office of Water (NOW) 2011).

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

8.2.2.1. Risk outcomes

Combining the consequence (from Section 8.2.4.2) and likelihood ratings resulted in '**Nil**' overall risk levels to other water users in the Barwon-Darling river catchment (Table 8-7).

Table 8-7 Risks of insufficient water available for other water users in unregulated water sources in the Barwon-Darling Surface WRPA as a result of plantation forests [O(I-PF)]

	Consequence	Likelihood	Overall risk rating - O(I-PF)
Unregulated river water sources	High	Nil	Nil

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

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

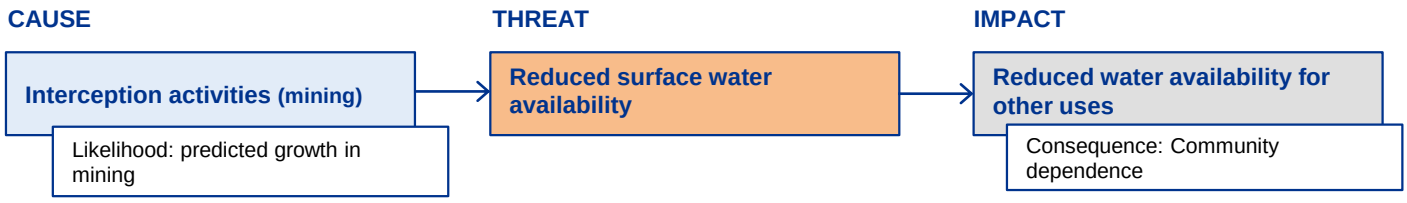


Figure 8-3 Impact pathway showing impact of mining on water available for other uses

8.2.3.1. Existing water management actions and mechanisms

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

8.2.3.2. Risk outcomes

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

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

There are no current mining activities in the Barwon-Darling WRPA (ABARES 2011). Additionally, no commercial coal seam gas extraction has occurred or is currently occurring in the WRP area. Therefore, the risk of mining causing impacts to structural integrity that lead to reduced surface water for other users is '**low**'. Note that risks to the structural integrity of groundwater systems are assessed as part of the Darling Alluvium Risk Assessment..

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

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

8.2.4. Floodplain harvesting

Floodplain harvesting is identified in the Basin Plan as a potential interception activity. See section 5.7.4 of the water resource plan for current management actions and mechanisms. In NSW, the Floodplain Harvesting Policy and Healthy Floodplains Projects are converting this form of take into a licensable right.

Floodplain harvesting activities in the Barwon-Darling catchment are described in Section 4.5.4.

8.2.4.1. Determining the likelihood rating

Growth in floodplain harvesting (FPH) was determined by comparing the current estimate of total FPH diversions compared to total FPH diversions under BDL (measured as % increase). The data used for the likelihood rating are preliminary estimates from the Water Modelling team within DOI –Water and should be considered as indicative only. The likelihood metrics are defined in Table 8-9.

Table 8-9 Likelihood metrics for floodplain harvesting

Likelihood metric	Metric category	Metric category definition
Flow Deviation	Low	< 20% increase in FPH volumes

	Medium	20-50% increase in FPH volumes
	High	> 50% increase in FPH volumes

The growth in FPH in the Barwon-Darling River WRP area was estimated to be 14%. Therefore, a 'low' likelihood rating was assigned.

8.2.4.2. Assigning a consequence score

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

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

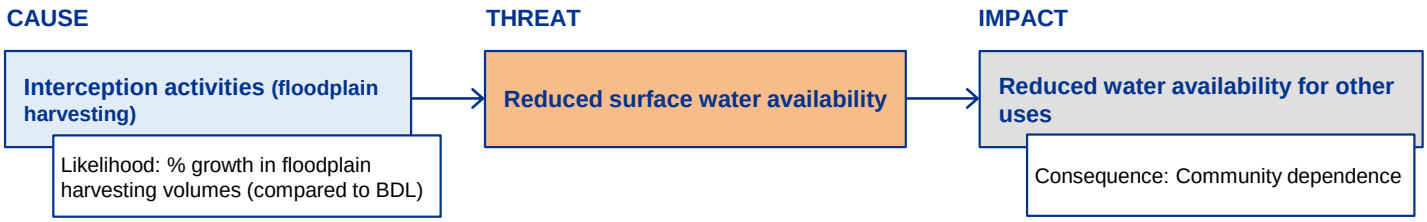


Figure 8-4 Impact pathway showing impact of floodplain harvesting on water available for other uses

8.2.4.3. Risk outcomes

The risk matrix used to determine the risk rating of flow alteration from an increase in floodplain harvesting intercepting runoff and impacting the water available to other users is provided in Table 8-10.

Table 8-10 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 '**Medium**' overall risk level to other water users in the regulated water source and 'Low' in the unregulated water sources Table 8-11.

Table 8-11 Risks of insufficient water available for other water users in unregulated water sources in the Barwon-Darling Surface WRPA as a result of floodplain harvesting [O(I-FH)]

	Consequence	Likelihood	Overall risk rating - O(I-M)
Barwon-Darling river water source	High	Low	Medium

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.

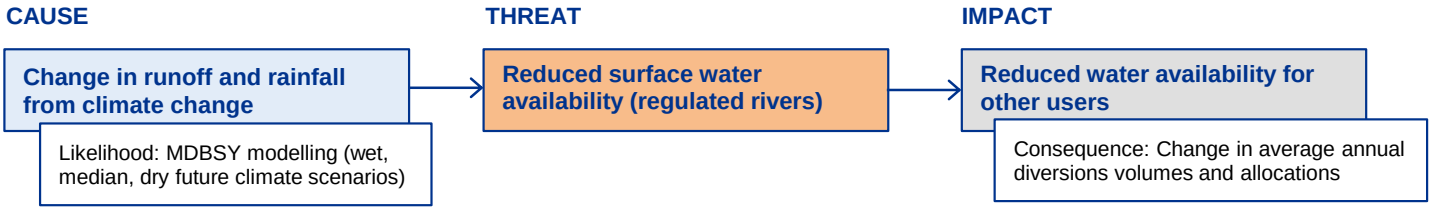


Figure 8-5 Impact pathway showing impact of change in climate on ability to meet other water user's water requirements.

8.3.1. Assigning a consequence rating

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

- A Class licences, which can extract water during low flows conditions
- B and C Class licences, which can extract water during moderate and high flows.

The change in average annual diverted volumes was used to calculate consequences of interception by farm dams (Table 8-1) (NSW Office of Water 2010).

The MDBSY reports covered a range of possible 2030 climate scenarios (CSIRO 2008). 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 (2010). The scenarios were compared against the base case to determine the percentage change to predict the level of the consequence.

Consequence levels selected for each type of water use category are located in the 2008 Risk Assessment (NSW Office of Water 2010) and shown in Table 8-1. Data used to assess consequence results are provided in Table 8-12.

Table 8-12 Consequence results for different types of water access licences in the Barwon-Darling WRPA

Climate scenario	Change in average annual diversions (%)	Consequence
Wet climate scenario	1	Negligible
Median climate scenario	2	Negligible
Dry climate scenario	-3	Minor

8.3.2. Determine the likelihood rating

Comparing MDBSY Project C scenarios to the 2004/05 outcomes (A0 scenario) determines likelihood of climate change impacting water available for other users under the three different climate projections (wet, median and dry) (Table 4-28). Likelihood rankings are provided in Table 8-13.

Table 8-13 Likelihood results for different types of water access licences in the Barwon-Darling under different climate change scenarios. Likelihood metric estimates the likelihood of insufficient water access.

Climate scenario	Likelihood
Wet climate change scenario	Possible
Median climate change scenario	Possible
Dry climate change scenario	Likely
Adapted from reference: NSW Office of Water (2010)	

8.3.3. Existing water management actions & mechanisms

Existing actions and mechanisms correspond to those identified in Section 4.6.3.

8.3.4. Risk outcomes

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 Barwon-Darling WRPA is provided in Table 8-14.

Table 8-14 Matrix used to determine risk from potential change in climate

		Likelihood of 2030 projected hydrologic change from baseline (insufficient water access, modelled C runs)				
		Rare	Unlikely	Possible	Likely	Almost Certain
Consequence (%change in water use)	Negligible	Low	Low	Low	Medium	Medium
	Minor	Low	Low	Low	Medium	High
	Moderate	Low	Low	Medium	High	High
	Major	Low	Medium	Medium	High	High
	Severe	Medium	Medium	High	High	High

Combining the risk consequence and likelihood ratings (Table 8-12 and Table 8-13) results in the overall risk levels to other users from climate change are shown in Table 8-15. The risk assessment determined a low risk under the wet and median scenario, and a medium risk under the dry scenario.

Table 8-15 Risks to different types of water access licences in the regulated Barwon-Darling under different climate change scenarios [O(CC)]

Water access licence type	Consequence	Likelihood	Risk level – O(CC)
Wet climate change scenario	Negligible	Possible	Low
Median climate change scenario	Negligible	Possible	Low
Dry climate change scenario	Minor	Likely	Medium
Reference: NSW Office of Water (2010)			

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.

The nature of water extraction under BLR means that this activity has no effect on flow regimes other than low flows in unregulated rivers. Therefore, the likelihood of impact was assessed only against low flows and risks to other parts of the flow regime are negligible

The impact pathway is shown in Figure 8-6 and demonstrates the risk to water availability for licensed water users 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 Barwon-Darling WRPA

8.4.1. Assigning a consequence rating

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 8-16. Consequence ratings are shown in Table 8-17.

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 8-16 Consequence metrics for increased extraction by BLR in unregulated water sources in the Barwon-Darling WRPA

Consequencemetric	Metric category	Metric category definition
Volume of entitlement	Low	Volume of entitlement < 5,000 ML
	Medium	Volume of entitlement 5,000 – 10,000 ML
	High	Volume of entitlement > 10,000 ML
Reference: NSW Water Register (NSW Department of Planning and Environment)		

Table 8-17 Consequence ratings for increased extraction by BLR in the Barwon-Darling WRPA

Water source	Consequence rating
1 (Mungindi to Walgett)	High
2 (Walgett to Brewarrina)	High
3 (Brewarrina to Bourke)	High
4a (Bourke to Louth)	High
4b (Louth to Wilcannia)	Low

8.4.2. Determine the likelihood rating

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 8-18. Likelihood ratings are shown in Table 8-19.

Table 8-18 Likelihood metrics for increased extraction by BLR in unregulated water sources in the Barwon-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
Reference: NSW Water Register (NSW Department of Planning and Environment)		

Table 8-19 Likelihood ratings for increased extraction by BLR in unregulated water sources in the Barwon-Darling WRPA

Water source	Likelihood rating
1 (Mungindi to Walgett)	Low
2 (Walgett to Brewarrina)	Low
3 (Brewarrina to Bourke)	Low
4a (Bourke to Louth)	Low
4b (Louth to Wilcannia)	Low

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

The risk matrix used to determine the risk to water availability for other uses due to growth in BLR extraction is provided in Table 8-20.

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 8-20 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

Growth in BLR represents a low risk in Sections 1, 2, 3, 4a and 4b (Table 8-21) indicating future growth in BLR is unlikely to occur.

The estimates of BLR for each Section could likely be an artefact of the method used. A single estimate for BLR was only ever determined for the whole of the Barwon-Darling WRP area. This one figure was apportioned to each of the five Sections based on the proportion of licenced entitlement in each Section. It was assumed that the higher the proportion of licensed entitlement, the higher the BLR that may occur.

Generally, there is a much higher volume of licensed entitlement compared to BLR estimates across all of the Sections in the Barwon-Darling.

Table 8-21 Risks of increased BLR extraction to other water users in the Barwon-Darling WRPA [O(BLR)]

Water source	Consequence rating	Likelihood rating	Risk level – O(BLR)
1 (Mungindi to Walgett)	High	Low	Low
2 (Walgett to Brewarrina)	High	Low	Low
3 (Brewarrina to Bourke)	High	Low	Low
4a (Bourke to Louth)	High	Low	Low
4b (Louth to Wilcannia)	Low	Low	Low

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 1.3.2, 1.7 and 4.6 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 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 Barwon-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 9.2.

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.

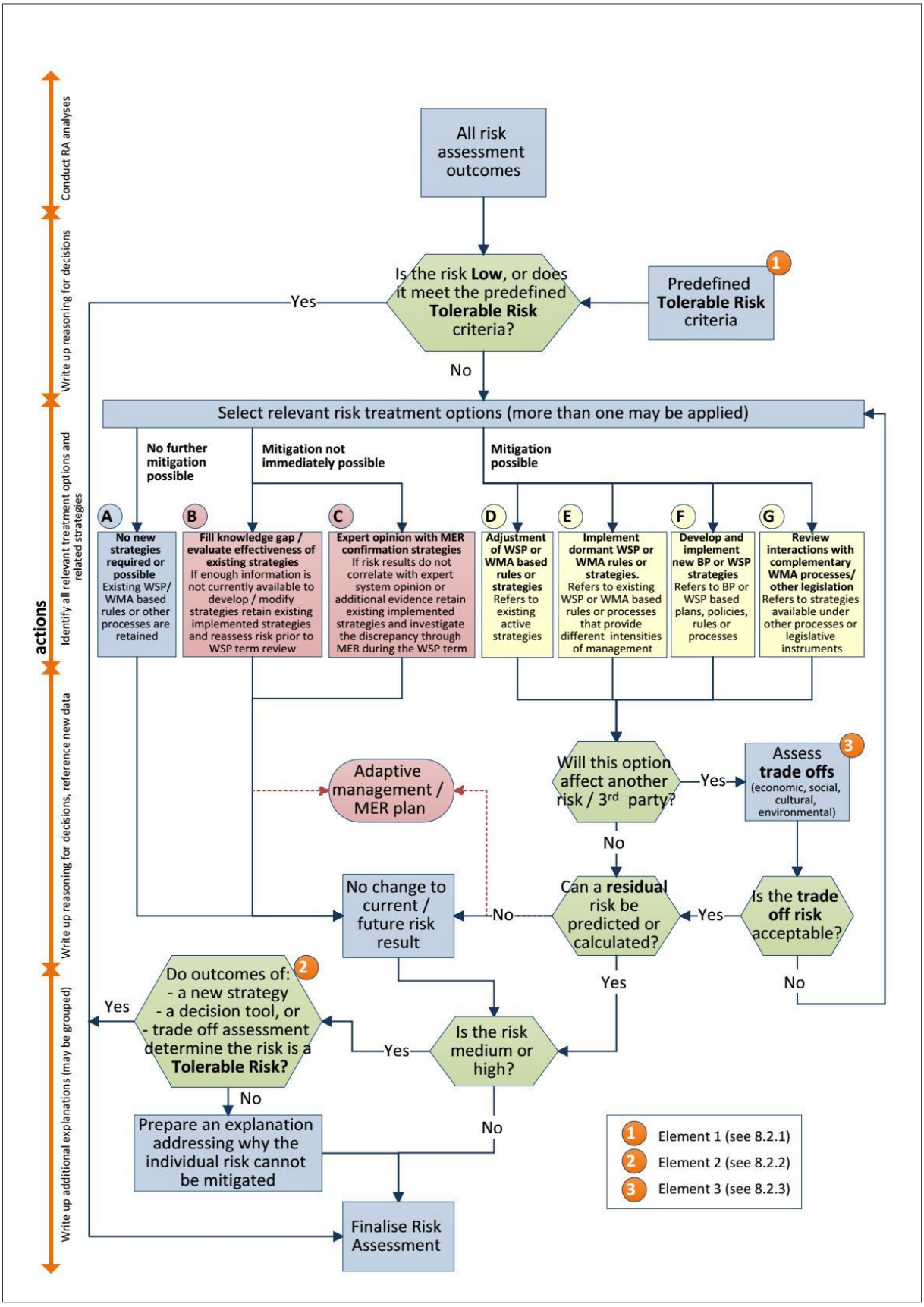


Figure 9-1 Risk treatment pathway

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 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 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 strategies	Mitigation is possible through the implementation of an existing dormant (i.e. non-implemented but available for use via WSP or WMA) 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 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 processes	The WMA covers a broad range of activities of which water sharing is one. This option focuses on reviewing linkages to WMA 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 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 NSW Department of Industry 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 (NSW Department of Primary Industries—Water 2017a) (in final draft)
Water Sharing Plan for the Barwon-Darling Unregulated and Alluvial Water Sources 2012 Background Document, NSW Office of Water (2012)
Macro water sharing plans – the approach for unregulated rivers. A report to assist community consultation, Office of Water (2011a)
Water sharing plans - Inland NSW unregulated and alluvial water sources – Overview NSW, Office of Water (2011b)
NSW Harvestable Rights Orders - *NSW Government Gazette number 40, 31 March 2006*

9.2. Tolerable risk results

A medium or high risk result does not necessarily imply that existing water management strategies require change or are inadequate. In many circumstances these risks will already have an appropriate level of management in place under the WMA 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 9-3 lists the criteria that have been used to predefine risk results as tolerable. If a risk does not appear, no predefined criteria have been identified. The consolidated risk table identifies for each river reach the tolerable status and relevant rationale for each risk result. As noted earlier, strategies relating to risks to water quality are not discussed in this chapter; refer to the WQM Plan for this material.Table 9-3. Tolerable risk result rationale

Risk	Component	Tolerable rationale
E(I-FD) Risk of insufficient water available for the environment due to growth in farm dams	CV (annual variation) LF (low flows) HF (high flows)	The total volume of water that can be collected in farm dams is controlled by the Harvestable Rights Order that applies to the relevant water source. If the threshold for allowable water capture has already been reached, no additional harvestable right is permitted a water access licence is obtained through the WSP. The medium risks identified in sections 1 and 3 driven by a very high consequence and low likelihood in the LF category. The risk is tolerable because of the low likelihood and because growth in take is controlled by the harvestable rights order.

9.2.2. Risks assessed as tolerable following application of a risk treatment option

This section refers to element 2 on the risk treatment pathway. Although risk results may arrive at this element following the application of any risk treatment option, only those where a tolerable risk has been determined are discussed.

For the Barwon-Darling WRPA, it was considered inappropriate to apply risk treatment option C or the decision tool in Appendix F, developed for other WRPAs, as the data used in this assessment is considered to reflect the real or current risk from extraction.

The medium and high risks identified in the Barwon-Darling were considered to better reflect the risk from extraction to instream values. The risk assessment model for the Barwon-Darling WRPA is based on surveyed use of water (not a full development scenario), so the impacts on the hydrograph are not potential but reasonable estimates of real impacts. This increases confidence that key ecosystem assets and functions are likely to be impacted by medium and high simulated changes.

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 WM Act 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 14 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 14.

The consolidated risk table indicates where tolerable risks have been identified for unregulated water sources. As no additional strategies have been applied to these results, they are not discussed further in this document. The table also addresses those risks this strategy has not determined to be tolerable.

9.2.3. Trade-off assessments

This section refers to element 3 on the risk treatment pathway. Risk results may arrive at this element of the pathway following the application of options D to G where a new or modified strategy affects another risk result or may result in a third party impact.

9.3. New or modified water resource management strategies, actions and mechanisms

This section refers to strategies developed or modified as a result of applying options D to G on the risk treatment pathway. Although several options for new or modified strategies were developed for consideration, only those that are proceeding into the WRP have been included in this section. Appendix G contains further information on strategy development constraints, decision processes and draft strategies. The WRP describes the consultation undertaken to determine which strategies will be implemented.

A number of overarching principles guide the development of WRPs in NSW. These acknowledge the legislative framework and water resource management strategies in place in NSW prior to the introduction of the Basin Plan. These principles have been considered during the preparation of new actions and mechanisms and are summarised in Table 9-4.

Table 9-4 Principles guiding development of strategies in NSW

Instrument or source	Principles
Commonwealth Water Act 2007	There will be no net reduction in the protection of planned environmental water
	The Commonwealth is responsible for funding the gap between existing limits and the Sustainable Diversion Limits (SDL).
	WRPs will meet the requirements set out in the Basin Plan
Basin Plan	Nothing in the Basin Plan requires a change in the reliability of water allocations of a kind that would trigger Subdivision B of Division 4 of Part 2 of the Act (s. 6.14)
NSW Water Management Act 2000	WSPs are required to balance social, cultural, economic and environmental needs of the community and catchments (this is a fundamental objective of water management in NSW and is described in the objects of the Act).
Delivering WRP Plans for NSW Roadmap 2016-2019	WRPs are cost neutral for NSW licence holders
	Development of WRPs minimises change to NSW WSPs within their initial 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 environmental portion of supplementary flow events to manage environmental outcomes within the lower portions of the Barwon-Darling WRP	Risk: Risk to the environment and risk to the capacity to meet environmental water requirements from insufficient water. Risk driver addressed: Frequency of freshes and high flow events Locations: Regulated rivers and downstream unregulated water sources Benefits: Discretionary control over the environmental portion of supplementary flow events improves environmental water management by directing flow to target streams.

N3 Strategic use of environmental water allowance (EWA) (and relevant held environmental water licences) as described in the Barwon-Darling LTWP	Risk: Risk to the environment and risk to the capacity to meet environmental water requirements from insufficient water. Risk driver addressed: Reduced frequency and altered seasonality of freshes, reduced frequency of over bank flows in unregulated water sources downstream of the regulated river. Locations: Regulated rivers and downstream unregulated water sources Benefits: Improved pattern of freshes through improved environmental water management.

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
14 Improve knowledge used to assess risk in unregulated sections of the WRP area.	N6 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: N5 may also be used in conjunction with N6*
15 Improve knowledge of effectiveness of existing strategies	N7 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 new strategies have been identified. Refer to the MER plan for further information. The existing and new WSP rules associated with active management will require and extra degree of scrutiny to ensure that they have been effective in meeting the recommendations of the Mathews inquiry (Mathews 2017) and the NSW Governments support of an Interim solutions package for the better management of environmental water (NSW Department of Industry 2018a). In this WRP area all river sections where current and new water sharing rules are implements will be assessed through the Barwon-Darling MER Plan. *Note: where N7 applies, N6 also applies*

9.5. Summary of strategies to address risk

A summary of strategies is presented in Table 9-7 to complement the consolidated risk table. Hydrology components used in this risk assessment and the EWR references from Table 6 of the Barwon-Darling Long-term Water Plan Technical Report (NSW DPIE 2019d) 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, Water Quality Management Plan (WQ) 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 Barwon-Darling WRPA.	**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 Barwon-Darling Unregulated Water Sources 2012 (Proposed Amendments 2020)* Barwon-Darling Watercourse Water Resource Plan	**E(W)** Z, BF, F, BKF1.5, OB2.5, OB5 **EWR ref.** LTWP CTF1, LTWP VLF1, LTWP BF1, LTWP BF2, LTWP SF1, LTWP SF2, LTWP LF1, LTWP LF2, LTWP BK1 LTWP OB1, LTWP OB2, LTWP OB3 ,	**4.03(3)** **(a)(iii)** **(a)(iv)** **(c)** **(f)** **Ch. 10** **Part 3,** **Part 8** **Part 10**	**WSP -** Part 2 – Environmental Objectives Section 10 (1-2) WQ 1 WQ 3 WQ 9
	E 28 Require all take to be licensed except for BLR or where a policy indicates otherwise. **E3** Extraction limits for individual extractors and associated accounting provisions to manage extraction at the extraction point.	**A**	*Water Sharing Plan for the Barwon-Darling Unregulated Water Sources 2012 (Proposed Amendments 2020)*			
	E19 Compliance with individual extraction limits	**D**	Water Take Measurement and Metering Policy			
	E4 Trade limits or prohibitions between surface water plan areas, water sources, and river Sections to manage entitlement growth. **E5** Prohibit trade between surface water and groundwater sources.	**A**	*Water Sharing Plan for the Barwon-Darling Unregulated Water Sources 2012 (Proposed Amendments 2020)* *Darling Alluvium Water Resource Plan (GW7)* *Upper Darling Alluvium (GS42)SDL Resource Unit*			

Strategies	Water management actions and mechanisms / supporting activities	RTO	Associated management plan or instrument	Relevant risks & EWR ref	Relevant BP clauses	Relevant objectives
2 Protect a portion of natural flow events in the Barwon-Darling WRP area to enable longitudinal hydrologic connectivity within the WRP area and with the downstream NSW Murray and Lower Darling WRP area and inflowing tributaries This strategy reserves a share of natural 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, frog, and other instream biota 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, * facilitate connectivity between pools and riffle habitat * allow flows to pass through to the Barwon-Darling Watercourse WRP (SW12) area. This strategy provides connectivity between WRP areas and facilitates fish movement and recruitment.	**E6** Cease / commence to pump rules for streams **E7** Cease / commence to pump rules for in-stream pools **E9** Implement Total Daily Extraction Limits (TDELs) and Individual Daily Extraction Limits (IDELs) (not currently in operation) **E10** Implement flow targets within the former Interim Unregulated Flow Management Plan for the North West (North West Plan) into the New WSP **N1** Sustainable Diversion Limits **N2** Implementation of a first flush rule to manage the resumptions of flows after a cease to flow period (proposed new active management option) **N3** Protection of Held Environmental Water through water take restrictions (proposed new active management option) **N4** Investigate and implement water/flow protection measures to improve northern hydrological connectivity between Northern Basin catchments (proposed new active management option)	**A** **F**	*Water Sharing Plan for the Barwon-Darling Unregulated River Water Source 2012 (Proposed Amendments 2020)* Barwon-Darling Long Term Water Plan *Water Management Amendment Bill 2018*	**E(W)** F, BKF1.5, OB2.5, OB5 **E(WQ)** turbidity, TP, TN, dissolved oxygen **EWR ref.** LTWP BF1, LTWP BF2, LTWP SF1, LTWP SF2, LTWP LF1, LTWP LF2, LTWP BK1 LTWP OB1, LTWP OB2, LTWP OB3	**4.03(3)** **(a)(i)** **(a)(ii)** **(a)(iv)** **(c)** **(d)** **Ch. 10** **Part 6** **Part 7**	**WSP –** Part 2 – Environmental Objectives Section 10 (1-2) **WQ** 3 **WQ** 9

Strategies	Water management actions and mechanisms / supporting activities	RTO	Associated management plan or instrument	Relevant risks & EWR ref	Relevant BP clauses	Relevant objectives
3 Protect a portion of natural flows to maintain hydrological connectivity between this water source and riparian zones, wetlands and floodplains connected to this water source. This strategy reserves a share of natural flows for the environment to maintain hydrologic connectivity and 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 Barwon-Darling regulated water source, * reduce prolonged accumulation of organic material on floodplains, *facilitate catchment water quality targets to being met * allow flows to pass through to the Barwon-Darling Watercourse WRP (SW12) area. This strategy provides connectivity between WRP areas and facilitates fish movement and recruitment.	**E6** Cease / commence to pump rules for streams **E7** Cease / commence to pump rules for in-stream pools. **E9** Implement Total Daily Extraction Limits (TDELs) and Individual Daily Extraction Limits (IDELs) (not currently in operation) **E10** Incorporate former flow targets within the former Interim Unregulated Flow Management Plan for the North West (North West Plan) into the New WSP **N1** Sustainable Diversion Limits **N2** Implementation of a first flush rule to manage the resumptions of flows after a cease to flow period (proposed new active management option) **N3** Protection of Held Environmental Water through water take restrictions (proposed new active management option) **N4** Investigate and implement water/flow protection measures to improve northern hydrological connectivity between Northern Basin catchments (proposed new active management option) **N5** Strategic use of held environmental water licences as guided by the LTWP.	**A** **F**	*Water Sharing Plan for the Barwon-Darling Unregulated River Water Source 2012 (Proposed Amendments 2020)* Barwon-Darling Long Term Water Plan *Water Management Amendment Bill 2018*	**E(W)** Z, BF, F, BKF1.5, OB2.5, OB5 **E(WQ)** TP TN **EWR ref.** LTWP CTF1, LTWP VLF1, LTWP BF1, LTWP BF2, LTWP SF1, LTWP SF2, LTWP LF1, LTWP LF2, LTWP BK1 LTWP OB1, LTWP OB2, LTWP OB3 ,	**4.03(3)** **(a)(i)** **(a)(ii)** **(a)(iv)** **(c)** **Ch. 10** **Part 6** **Part 7**	**WSP** Part 2 – Environmental Objectives Section 10 (1-2) **WQ** 3 **WQ** 4 **WQ** 9

Strategies	Water management actions and mechanisms / supporting activities	RTO	Associated management plan or instrument	Relevant risks & EWR ref	Relevant BP clauses	Relevant objectives
4 Manage environmental water to meet Environmental Water Requirements specified in the Barwon-Darling LTWP. This strategy aims to improve environmental water management in the WRP area and 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 Barwon-Darling regulated water source, * reduce prolonged accumulation of organic material on floodplains, *facilitate catchment water quality targets to being met * allow flows to pass through to the Barwon-Darling Watercourse WRP (SW12) area. This strategy provides connectivity between WRP areas and facilitates fish movement and recruitment.	**E6** Cease / commence to pump rules for streams **E7** Cease / commence to pump rules for in-stream pools. **E9** Implement Total Daily Extraction Limits (TDELs) and Individual Daily Extraction Limits (IDELs) (not currently in operation) **E10** Incorporate former flow targets within the former Interim Unregulated Flow Management Plan for the North West (North West Plan) into the New WSP **N1** Sustainable Diversion Limits **N2** Implementation of a first flush rule to manage the resumptions of flows after a cease to flow period (proposed new active management option) **N4** Investigate and implement water/flow protection measures to improve northern hydrological connectivity between Northern Basin catchments (proposed new active management option) **N5** Strategic use of held environmental water licences as guided by the LTWP.	**A** **F**	*Water Sharing Plan for the Barwon-Darling Unregulated River Water Source 2012 (Proposed Amendments 2020)* Barwon-Darling Long Term Water Plan	**E(W)** Z, BF, F, BKF1.5, OB2.5, OB5 **EWR ref.** LTWP CTF1, LTWP VLF1, LTWP BF1, LTWP BF2, LTWP SF1, LTWP SF2, LTWP LF1, LTWP LF2, LTWP BK1 , LTWP OB1, LTWP OB2, LTWP OB3 ,	**4.03(3)** **(a)(i)** **(a)(iv)** **(c)** **Ch. 10 Part 6**	**WSP** Part 2 – Environmental Objectives Section 10 (1-2) **WQ** 3 **WQ** 4 **WQ** 5

Strategies	Water management actions and mechanisms / supporting activities	RTO	Associated management plan or instrument	Relevant risks & EWR ref	Relevant BP clauses	Relevant objectives
5 Contribute to critical environmental and water quality events in downstream water sources. This strategy aims to: *enable fish passage and connectivity between pools * protect flows needed to suppress blue-green algae blooms	**E9** Implement Total Daily Extraction Limits (TDELs) and Individual Daily Extraction Limits (IDELs) (not currently in operation) **E10** Incorporate former flow targets within the former Interim Unregulated Flow Management Plan for the North West (North West Plan) into the New WSP **N1** Sustainable Diversion Limits **N2** Implementation of a first flush rule to manage the resumptions of flows after a cease to flow period (proposed new active management option) **N4** Investigate and implement water/flow protection measures to improve northern hydrological connectivity between Northern Basin catchments (proposed new active management option) **N5** Strategic use of held environmental water licences as guided by the LTWP	**A** **F**	*Water Sharing Plan for the Barwon-Darling Unregulated River Water Source 2012 (Proposed Amendments 2020)* *Water quality management plan for the Barwon-Darling WRPA(SW12)* Barwon-Darling Long Term Water Plan	**E(W)** Z, BF, F, BKF1.5, OB2.5, OB5 **EWR ref.** LTWP CTF1, LTWP VLF1, LTWP BF1, LTWP BF2, LTWP SF1, LTWP SF2, LTWP LF1, LTWP LF2, LTWP BK1 LTWP OB1, LTWP OB2, LTWP OB3 ,	**4.03(3) (a)(i) (a)(iv) (c)** **Ch. 10 Part 6**	**WSP** Part 2 – Environmental Objectives Section 10 (1-2) **WQ 1** **WQ** 2 **WQ** 3 **WQ** 4 **WQ** 5 **WQ** 6
6 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.*	**E6** Cease / commence to pump rules for streams **E7** Cease / commence to pump rules for in-stream pools. **E9** Implement Total Daily Extraction Limits (TDELs) and Individual Daily Extraction Limits (IDELs) (not currently in operation)	**A**	*Water Sharing Plan for the Barwon-Darling Unregulated Water Sources 2012 (Proposed Amendments 2020)*	**E(W)** Z, BF, F **EWR ref.** LTWP CTF1, LTWP VLF1, LTWP BF1, LTWP BF2, LTWP SF1 LTWP SF2, LTWP LF1, LTWP LF2,	**4.03(3) (a)(i) (a)(ii) (a)(iv) (c) (d)** **Ch. 10 Part 4, Part 6**	- Part 2 – Environmental Objectives Section 10 (1-2) **WQ** 1 **WQ** 2, **WQ** 3 **WQ** 4 **WQ** 5 **WQ** 6 **WQ** 9
	N2 Implementation of a first flush rule to manage the resumptions of flows after a cease to flow period (proposed new active management option) **N3** Protection of Held Environmental Water through water take restrictions (proposed new active management option) **N4** Investigate and implement water/flow protection measures to improve northern hydrological connectivity between Northern Basin catchments (proposed new active management option)	**F**	*Water Sharing Plan for the Barwon-Darling Unregulated River Water Source 2012 (Proposed Amendments 2020)* Barwon-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
	N5 Strategic use of held environmental water licences as guided by the LTWP.					
	Note: Complimentary groundwater actions and mechanisms are identified in the Darling Alluvium Water Resource Plan (GW7) and a section of the Upper Darling Alluvium (GS42)SDL Resource Unit		*Darling Alluvium Water Resource Plan (GW7)* *Upper Darling Alluvium (GS42)SDL Resource Unit*			
7 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 refugia habitat for fish, frogs and other water-dependent biota.	**E6** Cease / commence to pump rules for streams **E7** Cease / commence to pump rules for in-stream pools.	**A**	*Water Sharing Plan for the Barwon-Darling Unregulated Water Sources 2012 (Proposed Amendments 2020)*	**E(W)** Z, BF, F **E(WQ)** all **EWR ref.** LTWP CTF1, LTWP VLF1, LTWP BF1, LTWP BF2, LTWP SF1	**4.03(3) (a)(i) (a)(ii) (a)(iv) (c)** **Ch. 10 Part 4 Part 6 Part 7**	- Part 2 – Environmental Objectives Section 10 (1-2) **WQ 1** **WQ** 3 **WQ** 4, **WQ 5** **WQ** 9
	E16 Authorised in-river dam construction, operation, and passing flow requirements as specified on the dam approval. **E18** Prohibit trade onto a water supply work within a natural pool, lagoon or lake that is not in a river or in a floodplain or flood-runner	**A**				
8 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 Barwon-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** - Part 2 – Environmental Objectives Section 10 (1-2) **WQ** 1 **WQ** 2 **WQ** 3 **WQ** 4 **WQ** 5 **WQ** 6 **WQ** 7 **WQ** 8 **WQ** 9

Strategies	Water management actions and mechanisms / supporting activities	RTO	Associated management plan or instrument	Relevant risks & EWR ref	Relevant BP clauses	Relevant objectives
9 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.	**E21** 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. E29 Ongoing monitoring of potential growth in number of farm dams within medium and high risk water sources	**A**	*Water Sharing Plan for the Barwon-Darling Unregulated Water Sources 2012 (Proposed Amendments 2020)* 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**
10 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.	**E22** Plantation forestry interception is currently considered low risk therefore no mechanisms have been implemented under the WMA .	**A**	Plantation Forestry Policy Plantations and Reafforestation Act 1999 (PRA) Plantations and Reafforestation (Code) Regulation 2001 Barwon-Darling Monitoring, Evaluation and Reporting Plan	**E(I-PF)** **O(I-PF)**	**4.03(3)** **(a)(iv)** **(c)** **(h)(i)** **Ch. 10 Part 5**	**N/A**
	E23 Ongoing risk monitoring to determine impact of future expansion of forest plantations at local and regional scales.	**B**				
11 Protect the environment and water users from changes in flow attributable to climate change. This strategy aims to reduce impacts on the health of rivers and on other consumptive water users. *Note: significant volumes of held environmental water may offset climate change impacts under the median scenario.*	**E1** Reserve all water above the long-term average annual extraction limit (LTAAEL) for the environment as PEW (defined and managed by the listed WSPs). **E2** Available Water Determinations (AWD) adjust extractive use according to water availability. E30 Review and update climate change models when new data is available **N1** Sustainable Diversion Limits. **N3** Protection of Held Environmental Water through water take restrictions (proposed new active management option) **N5** Strategic use of held environmental water licences as guided by the LTWP.	**D** **F**	*Water Sharing Plan for the Barwon-Darling Unregulated Water Sources 2012 (Proposed Amendments 2020)* Barwon-Darling Water Resource Plan *Draft Western Regional Water Strategy 2021* *Draft NSW State Water Strategy 2021* *Barwon-Darling Incident Response Guide (included as a schedule in the Barwon-Darling Watercourse WRP)*	**E(CC)** **O(CC)**	**4.03(3)** **(a)(iv)** **(c)** **(g)(iii)** **(h)(ii)** **(h)(iii)** **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
12 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 Barwon-Darling Unregulated Water Sources 2012 (Proposed Amendments 2020)* Barwon-Darling Watercourse Resource Plan	**E(BLR)**	**4.03(3) (a)(iv) (c) h(ii)** **Ch 10 Part 3**	**N/A**
	E26 Minister may limit growth in BLR when a land holding is subdivided and there is high hydrological stress on the river or aquifer. *Note: this mechanism is not currently applied in the Barwon-Darling WRPA*	D	*Water Management Act 2000* s.52(2)			
13 Protect licenced water users from changes in flow attributable to growth in BLR extractive use. This strategy aims to reduce impacts on 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 Barwon-Darling WRPA.*	**E24** Minister may restrict BLR access *Note: this mechanism is not currently applied in the Barwon-Darling WRPA*	A	*Water Management Act 2000* s.331 and 336B	**O(BLR)**	**4.03(3) (a)(iv) (c) (d) h(ii)** **Ch. 10 Part 3**	**N/A**
	E25 Minister may temporarily restrict access where it is in the public interest to do so. *Note: this mechanism is not currently applied in the Barwon-Darling WRPA*	A	*Water Management Act 2000* s.324 and 331			
	E26 Minister may limit growth in BLR when a land holding is subdivided and there is high hydrological stress on the river or aquifer. *Note: this mechanism is not currently applied in the Barwon-Darling WRPA*	A	*Water Management Act 2000* s.52(2)			
	E27 Minister may direct landholder accessing BLR to not waste or improperly use water *Note: this mechanism is not currently applied in the Barwon-Darling WRPA*	A	*Water Management Act 2000* s.325			
14 Improve knowledge used to assess risk in unregulated sections of the WRP area.	**N6** Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies.	C	Barwon-Darling Monitoring, Evaluation and Reporting Plan	**E(W)** unregulated Z, BF, F	**4.03(3) (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
	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.			**EWR ref.** LTWP BF1, LTWP BF2, LTWP SF1, LTWP SF2, LTWP LF1, LTWP LF2, LTWP LF3, LTWP BK1 LTWP BK2, LTWP OB1, LTWP OB2, LTWP OB3	**4.03(3)(i) (i)** **4.03(3)(i) (ii)**	
15 Improve knowledge of effectiveness of existing strategies.	**N7** Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies.	**B**	Barwon-Darling Monitoring, Evaluation and Reporting Plan.	**E(W)** unregulated Z, BF, F **EWR ref.** LTWP BF1, LTWP BF2, LTWP SF1, LTWP SF2, LTWP LF1, LTWP LF2, LTWP LF3, LTWP BK1 LTWP BK2, LTWP OB1, LTWP OB2, LTWP OB3	**4.03(3) (b) (c) (e) (g)** **4.03(3)(i) (i)** **4.03(3)(i) (ii)**	**N/A**
16 Protect the environment and other users from changes in flow attributable to growth in Floodplain harvesting	**E28** Implementation of the Floodplain harvesting policy and Healthy Floodplains project **N6** Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies.	B	*Water Sharing Plan for the Barwon-Darling Unregulated Water Sources 2012 (Proposed Amendments 2020)* Barwon-Darling Water Resource Plan NSW Floodplain Harvesting Policy	E(I-FH) O(I-FH) EWR ref LTWP OB1-5	4.03(3) (h) (i), Ch 10, Part 5	N/A

Table 9-8 Abbreviations used in Table 9-7

Abbreviation	Explanation
BP	
RTO	Risk treatment option refer Figure 9-1
E	Existing action / mechanism / supporting activity
N	New or modified action / mechanism / supporting activity
E(W)	Risks to water available for the environment due to river regulation and licensed extraction
E(BLR)	Risks to water available for the environment from extraction by basic landholder rights
E(I-FD)	Risk to water available for the environment from interception activities (farm dams)
E(I-PF)	Risk to water available for the environment from interception activities (plantation forestry)
E(I-M)	Risk to water available for the environment from interception activities (mining)
E(I-FH)	Risk to water available for the environment from interception activities (floodplain harvesting)
E(CC)	Risk to water available for the environment due to climate change (regulated)
E(WQ-CWP)	Risk to the health of water-dependent ecosystems from poor water quality (cold water pollution)
E(WQ-WWP)	Risk to the health of water-dependent ecosystems from poor water quality (warm water pollution)
E(WQ)	Risk to the health of water-dependent ecosystems from poor water quality (TP, TN, pH, Turbidity, DO)
E(WQ-S)	Risk to the health of water-dependent ecosystems from poor water quality (instream salinity)
O(WQ-BGA)	Risks to recreational water quality and human health from blue-green algae
O(I-FD)	Risk to water available for other uses from interception activities (farm dams) (regulated rivers)
O(I-PF)	Risk to water available for other uses from interception activities (plantation forestry) (regulated rivers)
O(I-M)	Risk to water available for other uses from interception activities (mining)
O(I-FH)	Risk to water available for other uses from interception activities (floodplain harvesting)
O(CC)	Risk to water available for other uses from climate change (regulated rivers)
O(BLR)	Risk to water available for other uses from growth in BLR (unregulated rivers)
E(W)	Risks to water available for the environment due to river regulation and licensed extraction (regulated and unregulated)
E(BLR)	Risks to water available for the environment from extraction by basic landholder rights (unregulated)
Z	Zero flows
BF	Base flows
F	Fresh flows
BKF1.5	Bank full flows, average recurrence interval 1.5 years
OB2.5	Over bank flows, average recurrence interval 2.5 years
OB5	Over bank flows, average recurrence interval 5 years
LTWP CTF1	Cease-to-flow. Frequency of occurring is no more than natural rates, unless key refuges endangered. Ideal flow timing in line with low flow season. (note LTWP flow components do not provide definitions of percentiles or frequencies)
LTWP VLF1	Very low flow. Frequency is no less than natural, there is no specified ideal timing, with duration no less than natural. Maximum inter-event period is no greater than natural. (note LTWP flow components do not provide definitions of percentiles or frequencies)
LTWP BF1	Base flow. Ideal occurrence is anytime with an inter-flow period no less than natural (note LTWP flow components do not provide definitions of percentiles or frequencies) This term is defined in the LTWP as the flow required to provide minimum depth and connectivity requirements to support fish dispersal and to manage water quality, prevent destratification and reduce risk of blue-green algal blooms. 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., Frequency is no less than natural, maximum duration is no less than natural. (note LTWP flow components do not provide definitions of percentiles or frequencies) This term is defined in the LTWP as the flow

Abbreviation	Explanation	
	required to provide minimum depth and connectivity requirements to support fish dispersal. This is different to the definition used in this risk assessment which defines base flow as a flow percentile or flow component.	
LTWP SF1	Small fresh, frequency is annually, the ideal timing is October to April, minimum duration is 10 days, and maximum inter-event period is one year (note LTWP flow components do not provide definitions of percentiles or frequencies)	
LTWP SF2	Small fresh, Frequency is 5-10 years in 10, the ideal timing is October to April, minimum duration is 14 days, and maximum inter-event period is two years (note LTWP flow components do not provide definitions of percentiles or frequencies)	
LTWP LF1	Large fresh, Frequency is 5-10 years in 10, the ideal timing is July to September, minimum duration is 15 days, and maximum inter-event period is two years (note LTWP flow components do not provide definitions of percentiles or frequencies)	
LTWP LF2	Large Fresh, Frequency is 3-5 years in 10, the ideal timing is October to April, minimum duration is 15 days, and maximum inter-event period is two years (note LTWP flow components do not provide definitions of percentiles or frequencies)	
LTWP BK1	Bankfull. Frequency is 5-10 years in 10, there is no specified ideal timing, minimum duration is 3 days, and maximum inter-event period is four years.	
LTWP OB1	Small Over bank. Frequency is once in every 2 to 4 years in 10, there is no specified ideal timing,, minimum duration is 3 days, and maximum inter-event period is four years. (note LTWP flow components do not provide definitions of percentiles or frequencies)	
LTWP OB2	Small Over bank. Frequency is once in every 2 to 3 years in 10, there is no specified ideal seasonal timing, minimum duration is 1 day, and maximum inter-event period is seven years (note LTWP flow components do not provide definitions of percentiles or frequencies)	
LTWP OB3	Medium Over bank. Frequency is once in every 1 to 2 years in 10, there is no specified ideal seasonal timing, minimum duration is 1 day minimum, and maximum inter-event period is ten years (note LTWP flow components do not provide definitions of percentiles or frequencies)	
WSP - Part 2 – Environmental Objectives	Location of the broad and targeted ecological objectives associated within the Barwon-Darling Watercourse Sharing Plan (WSP)	
WQ1	Water Quality Objective 1	Protect, maintain or enhance water quality to ensure it is fit for purpose
WQ2	Water Quality Objective 2	Manage water source salinity concentrations and salt mobilisation within Barwon-Darling end-of-valley targets
WQ3	Water Quality Objective 3	Maintain turbidity, total nitrogen and total phosphorus within target ranges to minimise eutrophication in the WRP Area
WQ4	Water Quality Objective 4	Maintain dissolved oxygen and pH measurements within target ranges that support water dependent ecosystems
WQ5	Water Quality Objective 5	Maintain water temperature within the Barwon-Darling within target ranges that support water dependent ecosystems
WQ6	Water Quality Objective 6	Manage the risk of harmful algal blooms in recreational use areas
WQ7	Water Quality Objective 7	Reduce the mobilisation of toxicants and pesticides
WQ8	Water Quality Objective 8	Reduce contamination from pathogens into water sources

Abbreviation	Explanation	
WQ9	Water Quality Objective 9	Protect, maintain or enhance connectivity between water sources to support downstream processes including priority carbon and nutrient pathways (Knowledge gap - under development)

Definitions

Access licence	Access licences allow the licence holder a share of the available water in the water source. An access licence is separate from the approvals to use the water or to construct and operate the works to extract the water e.g. pump, dam. Access licences do not have to be renewed.
Allocation	The volume of water assigned to water allocation accounts in a given season, defined according to rules in the relevant water plan.
Aquatic ecosystems	Ecosystems that are dependent on flows, or periodic or sustained inundation/waterlogging for their ecological integrity. Examples include wetlands, rivers, karst and other groundwater-dependent ecosystems, saltmarshes, estuaries and areas of marine water not exceeding 6 m deep at low tide.
Available water	In relation to a water management area or water source, is the water that is available in that area or water source in accordance with an available water determination that is in force in respect of that area or water source.
Available water determination (AWD)	A determination referred to in section 59 of the *Water Management Act 2000* that defines the proportion of the share component that will be available for extraction under each category of water access licence.
Bank full events	Reshapes the channel, creating habitats such as pools, bars and benches. Also called High Flows.
Base flows	Flows that are confined to the lower part of the channel and are also often called low flows. These flows are between pools and riffle areas between pools.
Basic landholder rights (BLR)	Domestic and stock rights, harvestable rights or native title rights.
Blue-green algae (cyanobacteria)	A type of microscopic, algae-like bacteria that inhabit freshwater, coastal and marine waters. Some species are known to produce toxins which are harmful to humans and livestock.
Cold water pollution	An artificial decrease in the temperature of water in a natural river.
Consequence	The loss of value for an impacted receptor
Dissolved oxygen	Concentration of oxygen dissolved in water.
Domestic consumption	In relation to land means consumption for normal household purposes in domestic premises on the land.
Ecological value	The perceived importance of an ecosystem which is underpinned by the biotic and/or abiotic components and processes that characterise that ecosystem.
Ecologically significant components of the flow regime	Comprise of cease to flow periods, base flows (low flows), freshes, bank full flows and over bank flows.
Ecosystem	A specific composition of animals and plants that interact with one another and their environment.
Ecosystem functions	The processes that occur between organisms and within and between populations and communities. They include interactions with the nonliving environment that result in existing ecosystems and bring about dynamism through changes in ecosystems over time.
Effluent	An effluent stream is one which leaves the main river and does not return.
Endangered ecological community	Ecological communities as listed in Schedule 1 of the *Threatened Species Conservation Act 1995* or Schedule 4 of the *Fisheries Management Act 1994*.
Eutrophication	The process where an accumulation of nutrients in water bodies leads to rapid growth of aquatic plants.

Farm dams	Private dams that are used to intercept catchment runoff that would otherwise contributed to streamflow or recharge of aquifers. For this risk assessment they are predominantly hillside dams. It does not include floodplain harvesting dams.
Floodplain harvesting dams	Are often entirely encircled by embankments and rely mainly on pumped diversions during episodic flushes or overland flow. Prevalent in southern Queensland and northern NSW.
Freshes	Larger flows that inundate the sides of the banks and any in-channel benches that may be present.
Groundwater-dependent ecosystems	Ecosystems that require access to groundwater to meet all or some of their water requirements so as to maintain their communities of plants and animals, ecological processes and ecosystem services.
High Flows	Reshapes the channel, creating habitats such as pools, bars and benches. Also called bank full events.
Indices	Metrics are combined as indicators and indicators are combined as indices.
Instream Value	Ecological condition value of river reaches based upon High Ecological Value Aquatic Ecosystems (HEVAE). In NSW HEVAE was calculated using the 4 criteria: distinctiveness, diversity, naturalness and vital habitat.
Interception	Occurs when flows or surface or groundwater are stopped, reduced or redirected.
Key Environmental Asset	Better studied key environmental assets identified across the Murray Darling Basin with significant and representative high-flow requirements.
Likelihood	The probability that a cause will result in a threat. It is not an indication of the size of the threat, but rather conveys the probability that the threat will be significant.
Long term average annual extraction limit	The target for total extractions (under all water access licences plus an estimate of basic landholder rights within an EMU or water source) which is used to assess whether growth in extractions has occurred.
Low flows	Flows that are confined to the lower part of the channel and are also often called base flows. These flows are between pools and riffle areas between pools. Generally defined as the 80th percentile flow.
Macro water sharing plans	Water sharing plans that apply to a number of water sources across catchments or different types of aquifers. The macro planning process is designed to develop broader scale water sharing plans covering most of the remaining water sources in NSW.
Management zones	An area within a water source used for defining the location and applicability of water sharing rules, but secondary to the water source. A management zone is more likely to be designated where local dealing restrictions are in place or where ‘cease to pump’ (CtP) rules for works approvals apply.
Metric	A numerical comparison of an observed variable and its value expected under reference condition.
Nitrogen and phosphorous	Chemical nutrients essential for growth and added to many fertilisers.
Operational constraints	Existing infrastructure systems that may preclude the delivery of certain flows.
Over bank flows	Connect the river to floodplain and wetlands allowing the exchange of nutrients and sediment to these areas.
Pools	Lentic water bodies (standing water), including anything falling within the definition of a “lake” found in the Dictionary of the *Water Management Act 2000*, except for tidal pools and estuaries.
Reference condition	Is the benchmark against which the health of the ecosystem metric is assessed. Reference condition describes the patterns and processes that would be expected to prevail without substantial human intervention. A reference condition is not a target or

	an implied objective for management but is merely representing the river ecosystem in a definitive state of good health.
Regulated river	Gazetted under the NSW *Water Management Act 2000* and is a river where downstream flows are regulated by a major state-owned storage or dam to supply irrigation water.
Replenishment flows	Flows provided along effluent systems to supply water for household, town use and stock.
Salinity	The concentration of sodium chloride or other dissolved minerals in water, usually expressed in EC units or milligrams of total dissolved solids per litre. Conversion factor is 0.64 mg/l TDS = 1000 µS/cm = 1 dS/m.
SDL resource unit	Means the water sources, or particular parts of the water resources, of a water resource plan area that is either a surface water SDL resource unit or groundwater SDL resource unit.
Seasonality	The timing of flooding and low flow events.
Stock watering	The watering of stock animals being raised on the land but does not include water in connection with the raising of stock animals on an intensive commercial basis that are housed or kept in feedlots or buildings for all (or a substantial part) of the period during which the stock animals are being raised.
Stratification	The formation of separate water layers.
Supplementary water	Formerly known as off-allocation water, this is surplus flow resulting from storm events that cannot be captured in storages or weirs. When the water is not needed to meet current demands or commitments, then it is considered surplus to requirements and a period of Supplementary Access is announced. Supplementary Water Access Licence holders can only pump water against these licences during these announced periods. Other categories of licence holders may also pump water during these periods.
Trade zones	A trading zone represents a portion of a water source which may then be specified so that trading rules can be applied, if required.
Warm water pollution	An artificial increase in the temperature of water in a natural river.
Water access entitlement	A water product issued under the *Water Management Act 2000*.
Water sources	Under the *Water Management Act 2000*, is defined as the whole or any part of: (a) one or more rivers, lakes or estuaries, or (b) one or more places where water occurs on or below the surface of the ground (including overland flow water flowing over or lying there for the time being), and includes the coastal waters of the State. Water sources are used to define where water sharing rules apply

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Appendix A Data summary tables

Table A-1 Summary of data used for the Barwon-Darling Watercourse Resource Plan Area risk assessment

#	Metric	Data Description	Report Reference	Relevant risk #		Data source/s	Reference	Time period	Data confidence	Reasoning
	Basin Plan requirements	The MDBA provides a number of Position Statements (PS) that provide guidance material	not listed (generic background information logic to the RA)			1. Relevant Position Statements (PS) for the development of a Risk Assessment include but are not limited to: PS 1B, 4A, 5A, 6A, 7B, 9A, 9B, 12A	https://www.mdba.gov.au/publications/policies-guidelines/water-resource-plans-what-they-are-how-they-are-developed	Not Applicable (N/A)	N/A	Position statements are designed to assist in the development of water resource plans by the Basin states.
1	Hydrological modelling - 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	A.. For MDBA hydrologic modelling sites: 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 and Environment IQQM (Integrated Quantity Quality Model) used for both MDBA & Department of Planning and Environment sites. 4. MDBA modelling report appendix - 2800 GL scenario - 847 B. . For Department of Primary Industries—Water hydrologic indicator sites: Unregulated water sources: single reach Department of Planning and Environment IQQM.	MDBA hydrologic modelling sites include: - 422003 Barwon River at Collarenebri main channel - 425003 Darling River at Bourke town - 425004 Darling River@Louth - 425008 Darling River at Wilcannia main channel Department of Primary Industries—Water hydrologic indicator site: 422027 Barwon River at Geera	For MDBA hydrologic modelling sites: July 1895 to June 2009 For Department of Primary Industries—Water hydrologic indicator sites: Variable period record specific to river gauge site that ranges from 1890 to 2009	Moderate	For MDBA hydrologic modelling sites, 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). For Department of Primary Industries—Water hydrologic indicator sites, the assessment is based on surveyed use of water (not full development) and impacts on the hydrograph are not potential impacts, but reasonable estimates of real impacts.
2	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: NSW Office of Water (2012). 2. Basic landholder rights for NSW: Estimations of stock & domestic rights Dept of Water & Energy, September 2009. 3. NSW Office of Water (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 water sources as per risk assessment:** 1 (Mungindi to Walgett) 2 (Walgett to Brewarrina) 3 (Brewarrina to Bourke) 4a (Bourke to Louth) 4b (Louth to Wilcannia)		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)
3	Pest plants and animals	Qualitative assessment	5			Expert opinion	none	Not applicable (N/A)	Low	Qualitative assessment based on NSW Department of Industry ecohydrology specialist expert opinion

#	Metric	Data Description	Report Reference	Relevant risk #		Data source/s	Reference	Time period	Data confidence	Reasoning	
4	Risk from climate change – estimated for regulated and unregulated water sources	Extrapolation of CSIRO MDBSY Project modelling of Bourke Weir drownout	4.6.4	E(CC)	likelihood	1. CSIRO (2007) Water availability in the Ba. A report to the Australian Government from the CSIRO Murray-darling Basin Sustainable Yields Project. CSIRO, Australia 2. CSIRO 2008, Water availability in the Murray-Darling Basin; A report to the Australian Government from the CSIRO Murray-Darling Basin Sustainable Yields Project. CSIRO, Australia.	Bourke Weir drownout		low	Extrapolation of outcomes from a single modelled location, applied to all reaches and water sources in WRP area	
5	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	
6	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 4.5.4.1 5.3.1 4.6.1 6.3.1 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 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. Department of Primary Industries—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. 3. MaxEnt predicted threatened fish distribution (NSW Department of Primary Industries 2016)	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 Department of Primary Industries—Fisheries. B. The Threatened Species Table below provides an example list of threatened species of the Barwon-Darling 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 river Sections. Each was analysed separately using the HEVAE layer, a licensing layer and the reg river layer (where reg river is excluded from water source); **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)

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)

#	Metric	Data Description	Report Reference	Relevant risk #		Data source/s	Reference	Time period	Data confidence	Reasoning
	Water Quality	Documented procedures are stored in the Corporate Data Quality System (Scientific and Technical Operating Procedures; STOP). All laboratory analysis undertaken at a NATA accredited laboratory. All data was audited and validated in accordance with documented procedures. Quality codes were assigned and the data archived in the Corporate Database (KiWQM).	6. Risks to health of water-dependent ecosystems from poor water quality	E(WQ) E(WQ-CWP) E(WQ-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.
7	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	**Unregulated River Sites** 416001 Barwon River at Mungindi 422003 Barwon River at Collarenebri 422001 Barwon River at Dangar Bridge (Walgett) 422002 Barwon River at Brewarrina 425003 Darling River at Bourke 425004 Darling River at Louth 425008 Darling River at Wilcannia	2010/11 - 2014/15 (5-year period)	High	Based on Real-time data.
8	Levels of instream salinity	Real-time gauge based monitoring	6.5.2	E(WQ-S)	Likelihood	1. WaterNSW water quality monitoring stations	End of valley target site: Darling River at Wilcannia (425008)	2010/11 - 2014/15 (5-year period)	High	Based on Real-time data.
	Water quality for other uses		7. Risk to other water uses due to unsuitable water quality	O(WQ) O(WQ-BGA) O(WQ-S)						
9	Recorded mean daily electrical conductivity 2010/11 – 2014/15	Continuous real-time gauge based monitoring	7.5.1	O(WQ-S)	Consequence	*Not assessed as there are no irrigation infrastructure operators in the Barwon-Darling WRPA*				
10	Annual 95th percentile of daily mean electrical conductivity recorded between 2010/11 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	O(WQ-S)	Likelihood	*Not assessed as there are no irrigation infrastructure operators in the Barwon-Darling WRPA*				

#	Metric	Data Description	Report Reference	Relevant risk #		Data source/s	Reference	Time period	Data confidence	Reasoning
11	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	Barwon River at Mungindi Barwon River at Collarenebri Barwon River at Dangar Bridge (Walgett) Barwon River at Brewarrina Darling River at Bourke Darling River at Rose Isle Darling River at Louth Darling River at Tilpa Darling River at Trevallyn Darling River at Wilcannia Darling River at Atley Darling River at Culpaulin	Annual frequency of red alerts during the period 2006/07 to 2013/14.	Moderate	
12	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	Barwon River at Mungindi Barwon River at Collarenebri Barwon River at Dangar Bridge (Walgett) Barwon River at Brewarrina Darling River at Bourke Darling River at Rose Isle Darling River at Louth Darling River at Tilpa Darling River at Trevallyn Darling River at Wilcannia Darling River at Atley Darling River at Culpaulin	Based on 2006/07 – 2013/14	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).
13	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.
14	Indigenous & Socio-economic		7.6 & 8.5	O				N/A	N/A	Cultural requirements addressed in a separate document. Socio-economic not assessed due to lack of data.
	Interception Activities	Risk due to interception activities - farm dams, commercial plantations, mining, floodplain harvesting	4.5 8.2	E(I-FD) E(I_PF) E(I-M) O(I-FD) O(I-PF) O(I-M)		1. CSIRO (2008a) Water availability in the Barwon-Darling. 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-Darling Basin; A report to the Australian Government from the CSIRO Murray-Darling Basin Sustainable Yields Project. CSIRO, Australia. 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. NSW Dept. Planning and Environment https://minview.geoscience.nsw.gov.au			Moderate / High	CSIRO project undergone extensive peer review. Furthermore, NSW obtained the model output data from the MDBYS project (2008) and extracted 112 year time series on a daily time-step as well as the reliability data to improve the quality of analysis (NOW 2010).

#	Metric	Data Description	Report Reference	Relevant risk #		Data source/s	Reference	Time period	Data confidence	Reasoning
15	Growth in farm dams (regulated)	Farm dam and plantation impacts on streamflow estimated using the SIMHYD rainfall-runoff model; this data was adapted to fit into river system models of state agencies (Van Dijk et al. 2008). A 2030 farm dam development scenario was developed by considering current distribution and policy controls and trends in farm dam expansion.	4.5.1.2 8.2.1.2	E(I-FD) O(I-FD)	Likelihood	1. NSW Office of Water (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 2008b, Water availability in the Murray-Darling Basin; A report to the Australian Government from the CSIRO Murray-Darling Basin Sustainable Yields Project. CSIRO, Australia.	Section 1 (Mungindi to Walgett) Section 2 (Walgett to Brewarrina) Section 3 (Brewarrina to Bourke) Section 4a (Bourke to Louth) Section 4b (Louth to Wilcannia)	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 (NSW Office of Water 2010). 2. Farm dams, forestry plantations and floodplain harvesting are all instances of non-metered take. Therefore, the hydrometric network and hydrological modelling are the way in which estimates are derived (MDBA 2017. The Murray-Darling Basin Water Compliance Review. Licensed from the MDBA under a Creative Commons Attribution 4.0 Licence).
16	Ability to meet environmental flow objectives		4.5.1.1	E(I-FD)	Consequence		Section 1 (Mungindi to Walgett) Section 2 (Walgett to Brewarrina) Section 3 (Brewarrina to Bourke) Section 4a (Bourke to Louth) Section 4b (Louth to Wilcannia)		Moderate / High	
17	Change in average annual diversions and allocations for licence holders		8.2.1.1	O(I-FD)	Consequence		A, B and C Class Licences		Moderate / High	
18	Growth in farm dams (unregulated)	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. CSIRO 2008b, Water availability in the Murray-Darling Basin; A report to the Australian Government from the CSIRO Murray-Darling Basin Sustainable Yields Project. CSIRO, Australia. 3. NSW Office of Water (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	Section 1 (Mungindi to Walgett) Section 2 (Walgett to Brewarrina) Section 3 (Brewarrina to Bourke) Section 4a (Bourke to Louth) Section 4b (Louth to Wilcannia)	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 Licence).
19	HEVAE (see 3 above)	See 3 above	4.5.1.1	E(I-FD)	Consequence	See 3 above	Section 1 (Mungindi to Walgett) Section 2 (Walgett to Brewarrina) Section 3 (Brewarrina to Bourke) Section 4a (Bourke to Louth) Section 4b (Louth to Wilcannia)	See 3 above	See 3 above	See 3 above.

#	Metric	Data Description	Report Reference	Relevant risk #		Data source/s	Reference	Time period	Data confidence	Reasoning
20	Growth in plantation forestry (regulated)	Farm dam and plantation impacts on streamflow estimated using the SIMHYD rainfall-runoff model; this data was adapted to fit into river system models of state agencies (Van Dijk et al. 2008). A 2030 farm dam development scenario was developed by considering current distribution and policy controls and trends in farm dam expansion.	4.5.2 8.2.2	E(I-PF) O(I-PF)	Likelihood	1. SMEC (2010), Afforestation risks to water resources in the Murray-Darling Basin, Murray-Darling Basin Authority, Canberra; 2. CSIRO (2008a) Water availability in the Barwon-Darling. A report to the Australian Government from the CSIRO Murray-darling Basin Sustainable Yields Project. CSIRO, Australia. 3. CSIRO (2008b), Water availability in the Murray-Darling Basin; A report to the Australian Government from the CSIRO Murray-Darling Basin Sustainable Yields Project. CSIRO, Australia. 4. NSW Office of Water (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	There are no existing or anticipated future increases in plantation forestry in the Barwon-Darling WRPA.	Based on 2004/2005 satellite imagery (MDBYS Project). Also based on period of prediction (from 2020 - 2030) and current period (from 2003 - 2008) (Van Dijk, 2008).	Moderate / High	Peer reviewed. The estimated uncertainty associated with farm dam growth and plantation expansion is estimated in the order of 1 percent of total inflows across the MDB, increasing up to about 3 percent in sensitive regions, and more in certain catchments within regions. These are small numbers when compared to climate and other uncertainties (Van Dijk, 2008). Plantations and Reafforestation Act controls the establishment and harvesting of plantations, although importantly it doesn't currently account for water use impacts. No methods have yet been developed to look at the probability of future bushfires and their hydraulic impact (NOW 2010).
21	Ability to meet environmental flow objectives		4.5.1	E(I-PF)	Consequenc	1. NSW Office of Water (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 2008b, Water availability in the Murray-Darling Basin; A report to the Australian Government from the CSIRO Murray-Darling Basin Sustainable Yields Project. CSIRO, Australia.	Section 1 (Mungindi to Walgett) Section 2 (Walgett to Brewarrina) Section 3 (Brewarrina to Bourke) Section 4a (Bourke to Louth) Section 4b (Louth to Wilcannia)			
22	Change in average annual diversions and allocations for licence holders		8.2.1	O(I-PF)	Consequence		A, B and C Class licences			
23	Mining area and growth	Mining area and growth	4.5.3 & 8.2.3			ABARES (2011) '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. Australian Mining (2015) Australian Mine Map 2015. Viewed 29 November 2018. https://www.autralianmining.com.au/mine-map/ NSW Dept. Planning and Environment https://minview.geoscience.nsw.gov.au	No current mining activities in the Barwon-Darling WRPA	N/A	Moderate/High	
24	Floodplain harvesting volumes		4.5.4 (environment) 8.2.4 (Other uses)			1. Department of Primary Industries—Water (2017b). 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	Moderate/High	To be managed under Floodplain licencing framework. Farm dams, forestry plantations and floodplain harvesting are all instances of non-metered take. Therefore, the hydrometric network and hydrological modelling are the way in which estimates are derived (MDBA 2017. The Murray-Darling Basin Water Compliance Review. Licensed from the MDBA under a Creative Commons Attribution 4.0 Licence).

#	Metric	Data Description	Report Reference	Relevant risk #		Data source/s	Reference	Time period	Data confidence	Reasoning
25	Future climate scenarios	The MDBSY project assessed scenarios: i.e., historical climate change & current development; recent climate change & current development; future climate change and current & future development, respectively. All scenarios are defined at daily time series of climate variables based on different scaling of the historical 1895 - 2006 climate sequence (Van Dijk et al. 2008).	4.6.2 8.3.2	E(CC) O(CC)	Likelihood	1. NSW Office of Water (2010), Assessment of risk to NSW Murray-Darling Basin shared water resources – 2008, NSW Office of Water, Sydney. 2. CSIRO (2008b), Water availability in the Murray-Darling Basin; A report to the Australian Government from the CSIRO Murray-Darling Basin Sustainable Yields Project. CSIRO, Australia. 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.	Wet climate change scenario Median climate change scenario Dry climate change scenario	The average rainfall during the calibration period (Barwon-Darling: 1986–1990) was compared to the long-term average rainfall, the number of years in the historical record (1895 to 2006) (Van Dijk 2008).	Low / Moderate	CSIRO project undergone extensive peer review. NSW obtained the model output data from the MDBYS project (2008) and extracted 112 year time series on a daily time-step as well as the reliability data to improve the quality of analysis (NOW 2010). Historical 112-year climate transformed to have the same statistics as the second-wettest, second-driest and median predictions of climate change by 15 different global climate models given three alternative emission scenarios (Cwet, Cdry and Cmid scenarios). However, there is still relatively high uncertainty associated with natural variability and also uncertainty associated with the range of climate models, with this combined uncertainty considered greater than the 'best estimate' climate change projection (Van Dijk, et al. 2008). 1. This section addresses NSW's obligations under the Basin Plan (2012): Chapter 10, Part 9: Section 10.41(1) - A water resource plan must be prepared having regard to current and future risks to the condition and continued availability of the water resource plan area. 2. Water Sharing Plans are the control mechanism which base water sharing decisions on the availability of flow and therefore they implicitly adjust for both climate variability and change. The legislation enables powers to temporarily suspend water sharing rules during extreme climatic conditions. WSPs are reviewed on a 10-yr cycle and the climatic record used as input to these planning decisions is based on all of the available data up to that point. 3. There is currently no explicit adjustment to the input data or selective sequencing from the data to use as input to the planning process to allow for potential future climate change. Water sharing plans cover all of the regulated systems in NSW, i.e. all but the Barwon-Darling in this risk assessment. In the Barwon-Darling, licence conditions on entitlements specify access rules based on the occurrence of flows above a specified level prior to allowing pumping to occur. These therefore implicitly allow for both climate variability & change (NOW 2010).
26	Ability to meet environmental flow objectives		4.6	E(CC)	Conseque		Bourke Weir drown-out flow			
27	Change in average annual diversions and allocations for licence holders		8.3.1	O(CC)	Consequence		Wet climate change scenario Median climate change scenario Dry climate change scenario			
	Growth in basic landholder rights									
28	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	1 (Mungindi to Walgett) 2 (Walgett to Brewarrina) 3 (Brewarrina to Bourke) 4a (Bourke to Louth) 4b (Louth to Wilcannia)		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)

#	Metric	Data Description	Report Reference	Relevant risk #		Data source/s	Reference	Time period	Data confidence	Reasoning	
29	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.	1 (Mungindi to Walgett) 2 (Walgett to Brewarrina) 3 (Brewarrina to Bourke) 4a (Bourke to Louth) 4b (Louth to Wilcannia)		High		
30	Volume of entitlement	Volume of entitlement (2015)	8.4.1	O(BLR)	Consequence	1. NSW Water Register			High		

Table A-2 List of threatened species of the Barwon-Darling catchment

LIST OF THREATENED SPECIES OF THE BARWON-DARLING CATCHMENT							
Common Name	**Scientific Name**	**Distinctiveness Parameter**	**NSW Status**	**Commonwealth listing**	**Flow sensitivity Weighting**	**Status Weights**	**Layers from OEH/Department of Primary Industries—Fisheries**
Lowland Darling River endangered ecological community	Aquatic Ecological Community in the Natural Drainage System of the Lowland Catchment of the Darling River	EEC	Endangered Ecological Community	Not Listed	4	3	Predicted
Western population Olive Perchlet	*Ambassia agassizii*	EP	Endangered Populations	not listed	4	3	Known and available in new fish modelled data
Eel-tailed catfish	*Tandanus tandanus*	EP	Endangered Population	not listed	4	3	Known and available in new fish modelled data
Silver perch	*Bidyanus bidyanus*	Fish	Vulnerable	Critically endangered	4	4	Known and available in new fish modelled data
Murray Cod	*Maccullochella peelii*	Fish	not listed	Vulnerable	4	2	Known and available in new fish modelled data
Menindee nightshade	*Solanum karsense*	Plant	Vulnerable	Vulnerable	3	2	Known & Predicted
Marsh Club-rush sedgeland endangered ecologiical community	Marsh Club-rush sedgeland in the Darling Riverine Plains Bioregion	EEC	Critically endangered ecological community	Not Listed	3	4	Known
Myriophyllum implicatum	*Myriophyllum implicatum*	Plant	Critically endangered	not listed	3	4	Predicted
Australasian Bittern	*Botaurus poiciloptilus*	Bird	Endangered	Endangered	2	3	Known & Predicted
Australian Painted snipe	*Rostratula australis*	Bird	Endangered	Endangered	2	3	Known & Predicted
Black-necked stork	*Ephippiorhynchus asiaticus*	Bird	Endangered	Not Listed	2	3	Known & Predicted
Black-tailed godwit	*Limosa limosa*	Bird	Vulnerable	Not Listed	2	2	Known & Predicted
Blue-billed Duck	*Oxyura australis*	Bird	Vulnerable	Not Listed	2	2	Known & Predicted
Freckled duck	*Stictonetta naevosa*	Bird	Vulnerable	Not Listed	2	2	Known & Predicted
Magpie Goose	*Anseranas semipalmata*	Bird	Vulnerable	Not Listed	2	2	Known & Predicted
Brolga	*Grus rubicunda*	Bird	Vulnerable	Not Listed	2	2	Known & Predicted
Curlew sandpiper	*Calidris ferruginea*	Bird	Endangered	Critically endangered	2	4	Predicted
Carbeen Open Forest Community in the Darling Riverine Plains and Brigalow Belt South Bioregions		EEC	Endangered Ecological Community	Not listed	2	3	Known
Winged Peppercress	*Lepidium monoplocoides*	Plant	Endangered	Endangered	2	3	Known & Predicted
Coolibah-Black Box Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain and Mulga Lands Bioregion		EEC	Endangered Ecological Community	Endangered	1	3	Known & Predicted
Cyperus conicus	*Cyperus conicus*	Plant	Endangered	Not Listed	1	3	Known
Shrub Sida	*Sida rohlenae*	Plant	Endangered	Not Listed	1	3	Known
Braid fern	*Platyzoma microphyllum*	Plant	Endangered	Not Listed	1	3	Predicted

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 are dependent on the habitat, particularly at times of stress. • Vital wetlands (Ramsar and DIWA listed wetlands) • Dissolved Organic Carbon (DOC) input (surrogate measure = river reaches of 60% woody riparian vegetation cover & measure of unconfined or partially confined River Style) • Large Woody Debris (LWB) (surrogate measure = river reaches of 60% woody riparian vegetation cover & specific River Styles®)

Key environmental asset criteria (Schedule 8)	HEVAE criteria/associated attributes
Criterion 4: Water-dependent ecosystems that support Commonwealth, State or Territory listed threatened species or communities Assessment indicator: A water-dependent ecosystem is an environmental asset that requires environmental watering if it: (a) Supports a listed threatened ecological community or listed threatened species; or Note: See the definitions of listed threatened ecological community and listed threatened species in section 1.07. (b) Supports water-dependent ecosystems treated as threatened or endangered (however described) under State or Territory law; or (c) Supports one or more native water-dependent species treated as threatened or endangered (however described) under State or Territory law.	Distinctiveness: The aquatic ecosystem is rare/threatened or unusual; and/or The aquatic ecosystem supports rare/threatened/ endemic species/communities/genetically unique populations; and/or The aquatic ecosystem exhibits rare or unusual geomorphological features/processes and/or environmental conditions, and is likely to support unusual assemblages of species adapted to these conditions, and/or are important in demonstrating key features of the evolution of Australia's landscape, riverscape or biota. • State and/or Commonwealth listed threatened species, endangered populations and endangered ecological communities • Rare River Styles®
Criterion 5: The water-dependent ecosystem supports, or with environmental watering is capable of supporting, significant biodiversity Assessment indicator: A water-dependent ecosystem is an environmental asset that requires environmental watering if it supports, or with environmental watering is capable of supporting, significant biological diversity. This includes a water-dependent ecosystem that: (a) Supports, or with environmental watering is capable of supporting, significant numbers of individuals of native water-dependent species; or (b) Supports, or with environmental watering is capable of supporting, significant levels of native biodiversity at the genus or family taxonomic level, or at the ecological community level.	Diversity: The aquatic ecosystem exhibits exceptional diversity of species (native/migratory), habitats, and/or geomorphological features/processes. • Macroinvertebrate Diversity (No. of AUSRIVAS Families) • Fish Diversity (Fish biodiversity hot spots assigned to specific River Styles® reach)
Reference: Healey M, Raine A, Lewis A, Hossain B, Hancock F & Sayers J (2018) Applying the High Ecological Value Aquatic Ecosystem (HEVAE) Framework to Water Management Needs in NSW, NSW Department of Primary Industries—Water, Sydney, NSW.	

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

Key ecosystem function criteria (Schedule 9)	HEVAE or risk assessment criteria/associated attributes
Criterion 1: The ecosystem function supports the creation and maintenance of vital habitats and populations Assessment indicator: An ecosystem function requires environmental watering to sustain it if it provides vital habitat, including: (a) a refugium for native water-dependent biota during dry periods and drought; or (b) pathways for the dispersal, migration and movement of native water-dependent biota; or (c) a diversity of important feeding, breeding and nursery sites for native water-dependent biota; or (d) a diversity of aquatic environments including pools, riffle and run environments; or (e) a vital habitat that is essential for preventing the decline of native water-dependent biota.	**HEVAE** The HEVAE method identifies a diverse range of instream and riparian riverine areas in very poor through to very high ecological value. Highest ecological value areas are assumed to provide a diverse range of aquatic habitats for native water-dependent flora and fauna. Vital habitat is a key criteria assessed in the HEVAE method. Vital Habitat: An aquatic ecosystem provides vital habitat for flora and fauna species if it supports: i. unusually large numbers of a particular native or migratory species; and/or ii. maintenance of populations of specific species at critical life cycle stages; and/or iii) key/significant refugia for aquatic species that are dependent on the habitat, particularly at times of stress. • Vital wetlands (Ramsar and DIWA listed wetlands) • Dissolved Organic Carbon (DOC) input (surrogate measure = river reaches of 60% woody riparian vegetation cover & measure of unconfined or partially confined River Style)
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:	

Key ecosystem function criteria (Schedule 9)	HEVAE or risk assessment criteria/associated attributes
(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.	• Large Woody Debris (LWB) (surrogate measure = river reaches of 60% woody riparian vegetation cover & specific River Styles®) **Risk Assessment** The risk assessment process has identified key features of flow regimes which have impacts on key ecosystem functions identified by the MDBA (2010; 2012) and Alluvium (2010). Within the risk assessment method, impacts on ecosystem function are considered through assessment of altered stream flow in regulated and unregulated rivers. Flow regimes influence the hydrologic connectivity, longitudinal and lateral pathways for ecological dispersal, nutrient and organic and inorganic material delivery in river systems.
Criterion 3: The ecosystem function provides connections along a watercourse (longitudinal connections) Assessment indicator: An ecosystem function requires environmental watering to sustain it if it provides connections along a watercourse or to the ocean, including longitudinal connections: (a) for dispersal and re-colonisation of native water-dependent communities; or (b) for migration to fulfil requirements of life-history stages; or (c) for in-stream primary production.	
Criterion 4: The ecosystem function provides connections across floodplains, adjacent wetlands and billabongs (lateral connections) Assessment indicator: An ecosystem function requires environmental watering to sustain it if it provides connections across floodplains, adjacent wetlands and billabongs, including: (a) lateral connections for foraging, migration and re-colonisation of native water-dependent species and communities; or (b) lateral connections for off-stream primary production.	

References

Alluvium, (2010), Key ecosystem functions and their environmental water requirements. Report by Alluvium for Murray-Darling Basin Authority, Canberra, ACT.

MDBA, (2010), Guide to the proposed Basin Plan: Technical Background, Murray Darling Basin Authority, Volume 2, Part 1, Canberra, ACT.

MDBA, (2012), Hydrologic modelling to inform the proposed Basin Plan - methods and results. Murray-Darling Basin Authority, Canberra, ACT.

Appendix C HEVAE consequence scoring

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

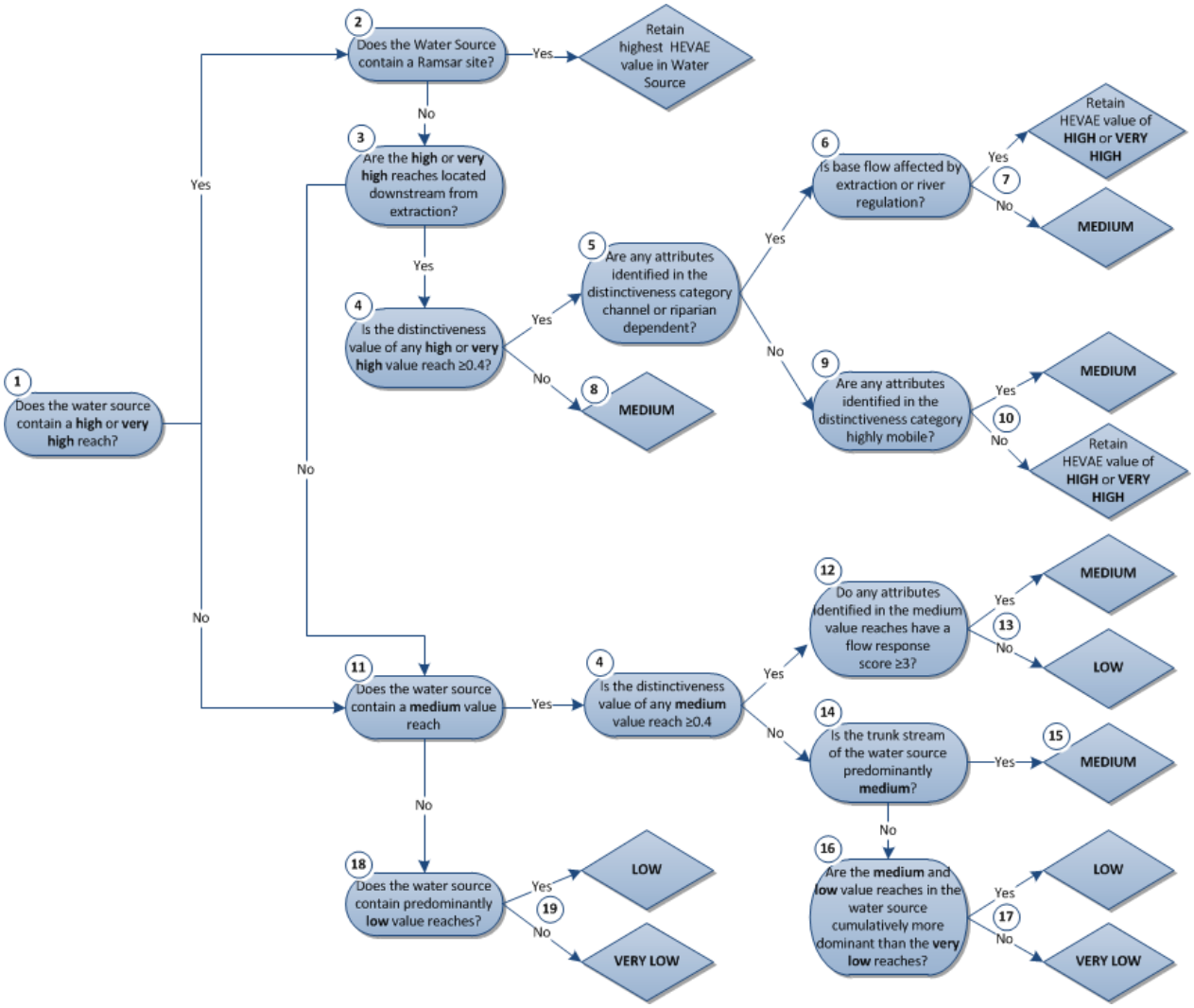


Table C-1 Rationale for each bifurcation in the decision tree used for converting HEVAE scores to 'consequence of extraction pressure on aquatic ecosystem condition' ranks

DECISION TREE ANNOTATION	RATIONALE
1	• Management for retention of conservation values is a higher priority in high and very high value reaches • Limiting extraction is easier to justify in high and very high value reaches, than it is in medium reaches
2	• Ramsar sites are valued for their contribution to international conservation efforts for migratory species. Australia is a signatory country and has an obligation to maintain these sites. This includes maintenance of flows.
3	• The attributes of high or very high value sites are influenced by extraction pressure. • Sites that are upstream of extraction points are assumed to be unaffected by extraction pressure, so the assessment focus shifts to whether there are medium value reaches in the water source. • If a high or very high value site is likely to be affected by extraction pressure the focus shift to whether any threatened species, populations, communities or rare River Styles® could be affected.
4	• The attributes of high or very high value sites are influenced by extraction pressure. • The most 'at risk' HEVAE criterion from extraction pressure (in the short-term) is distinctiveness. Distinctiveness includes consideration of biotic and abiotic characteristics and function of the reach (i.e. threatened species, populations, communities and rare River Styles®). • A distinctiveness score of ≥ 0.4 in the HEVAE means the reach has a medium, high or very high value as habitat for threatened species, populations, or communities, or a rare River Style®. • Habitat for threatened species, populations and communities is protected under State and Commonwealth legislation.
5	• Distinguishes between species, populations, communities and/or rare River Styles® that occur on the floodplain versus the channel and riparian zone because (it was assumed) extraction pressure is more likely to affect attributes that occur in the channel and riparian zone, rather than the floodplain. • *This is a decision that relies on expert understanding of the attribute's ecology and biology.*
6	• Given the attribute is identified as relying on channel and riparian habitat (from 5), this step assumes the least possible habitat available to the attribute occurs under low flow conditions, and asks whether the lowest flows in the system are affected by extraction.
7	• Any attributes that are channel and/or riparian dependent, and are considered vulnerable to extraction of low flows retain their original high or very high value category. • Any attributes that are channel and/or riparian dependent and are considered resilient to extraction of low flows are allocated a 'medium' consequence category.
8	• High or very high value reaches that have low distinctiveness are assumed to have attributes that are more resilient to extraction pressure (at least in the short-term), and are assigned a 'medium' consequence category.

DECISION TREE ANNOTATION	RATIONALE
9	• Establishes that attributes are floodplain dependent, and asks whether they are able to move (i.e. birds, bats) or not (i.e. plant). The assumption is that more mobile species/population/community can move to avoid changes in habitat owing to extraction pressure.
10	• If the species can move they are assigned a risk category of 'medium'. • If the species/population/community is sessile, it is assumed to be at greater risk of harm from extraction pressure (because it can't move to avoid the pressure), and retains its original categorisation of 'high' or 'very high'.
11	• Establishes that the water source either doesn't have 'high' or 'very high' reaches, OR there are 'high' or 'very high' reaches but they are above extraction points (and therefore assumed unaffected by extraction pressure), and asks whether there are 'medium' value reaches in the water source. • This allows the risk of extraction pressure on medium value aquatic ecosystems to be assessed independently of the 'low' and 'very low' value aquatic ecosystems.
12	• Asks whether species/populations/communities in the reach are moderately to highly sensitive to extraction, primarily because they specific flow requirements and limited ability to move if those flow requirements are not met (e.g. fish, frogs, turtles, macrophytes). • This information is in the MS Excel Distinctiveness file for each catchment, in the column labelled 'Flow Sensitivity Weighting'
13	• If a species/population/community has a flow response score ≥3 (i.e. it is sensitive to extraction), it is assigned a risk category of 'medium'. • If a species/population/community has a flow response score <3 (i.e. it is less sensitive to extraction), it is assigned a risk category of 'low'.
14	• Deals with 'medium' value reaches that don't have high Distinctiveness (i.e. ≥0.4). • Asks whether the main river in the water source has a predominantly 'medium' value. This question weights the value of the main river higher than any tributaries, because it is assumed the main river is likely more affected by extraction pressure than tributaries.
15	• If the main river in a water source has a predominantly medium HEVAE condition, the consequence ranking is also medium.
16	• Asks whether the combined length of medium and low HEVAE reaches in a main river in an assessment area is less than the length of reaches in the same main river with a very low HEVAE rank. • The rationale is if the main river is comprised of mostly low with some medium HEVAE reaches, then a conservative approach should be adopted and the low consequence rank prevails.
17	• If the reach has a mainly very low HEVAE rank, and there is little apparent reliance on the reach by freshwater-dependent flora and fauna, the consequence awarded is 'very low'.
18	• There are no very high, high or medium HEVAE ranked reaches in the assessment area – only low and very low. • It is assumed there is little reliance on habitats in these reaches by freshwater-dependent flora and fauna.
19	• The assessment area is awarded the same consequence rank as the predominant HEVAE rank for the area.

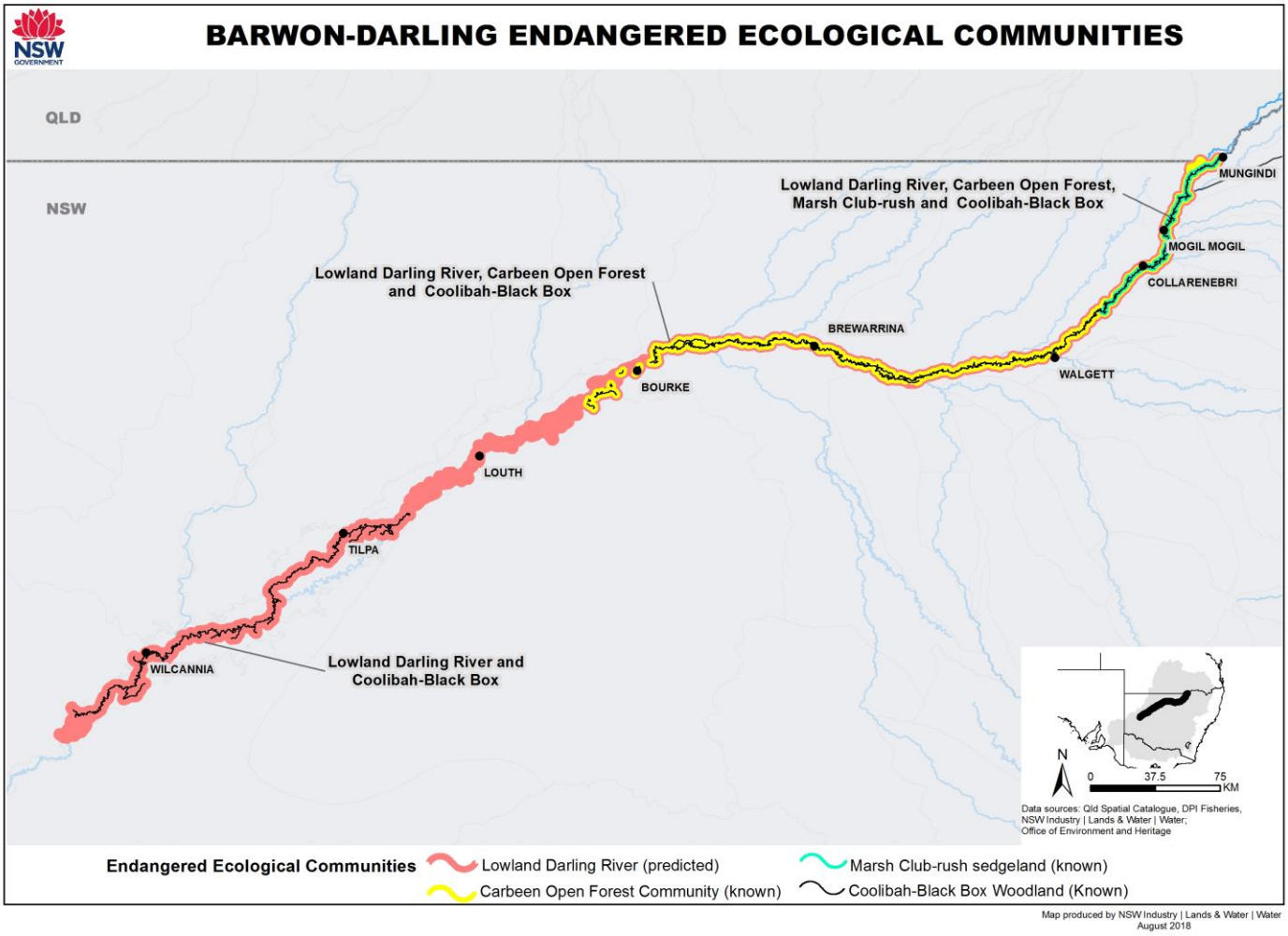
DECISION TREE ANNOTATION	RATIONALE
	• It is assumed there is little reliance on habitats in these reaches by freshwater-dependent flora and fauna.

Appendix D Endangered Ecological Communities, threatened fish species & distributions

Endangered Ecological Communities (EECs) occur along the entire length of the Barwon-Darling WRPA (Figure D-1). Lowland Darling River EEC occurs across all Sections, with Carbeen Open Forest and Coolibah-Black Box Woodland the next most dominant EECs in the area. Marsh Club-rush EEC occurs only in Section 1 (D-1).

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 Barwon-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.

Figure D-1 Distribution of Endangered Ecological Communities in the Barwon-Darling WRPA



Results show a significant spread of threatened fish species or endangered populations within the Barwon-Darling WRPA. Four threatened fish species have been recorded along the WRPA, with most records occurring above the Bourke weir in Section 3 (Figure D-2). Murray cod and Sliver perch have been most frequently recorded in the Barwon-Darling WRPA, found in each of the five Sections. Olive Perchlet was found

at only three sites in three Sections, while the Eel-tailed catfish, an endangered population within the MDB, was found at only one location in Section 4b (Figure D-2).

Fish diversity was highest in Section 3 above the Bourke weir and downstream of the confluence of the Culgoa River, with moderate fish diversity scores most frequently recorded along the Barwon-Darling WRPA (Figure D-3).

Figure D-2 Distribution of threatened fish species within the Barwon-Darling WRPA

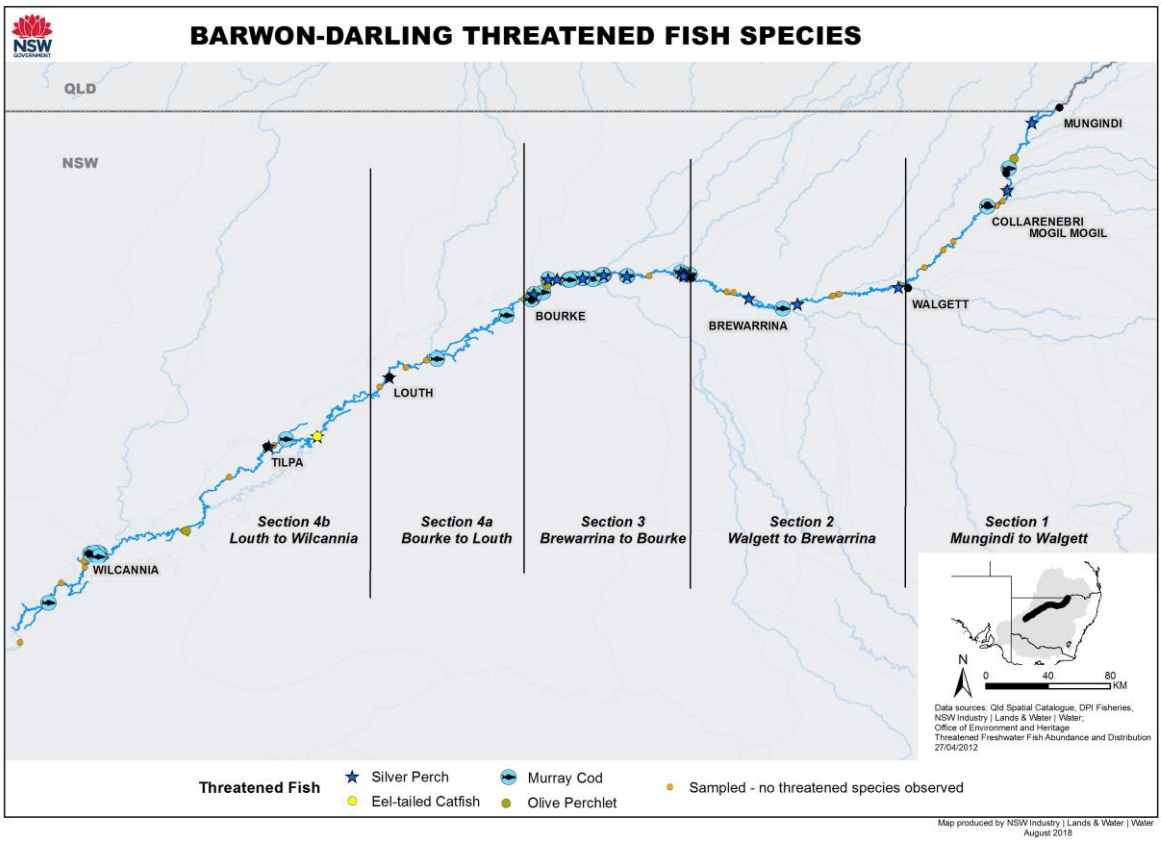
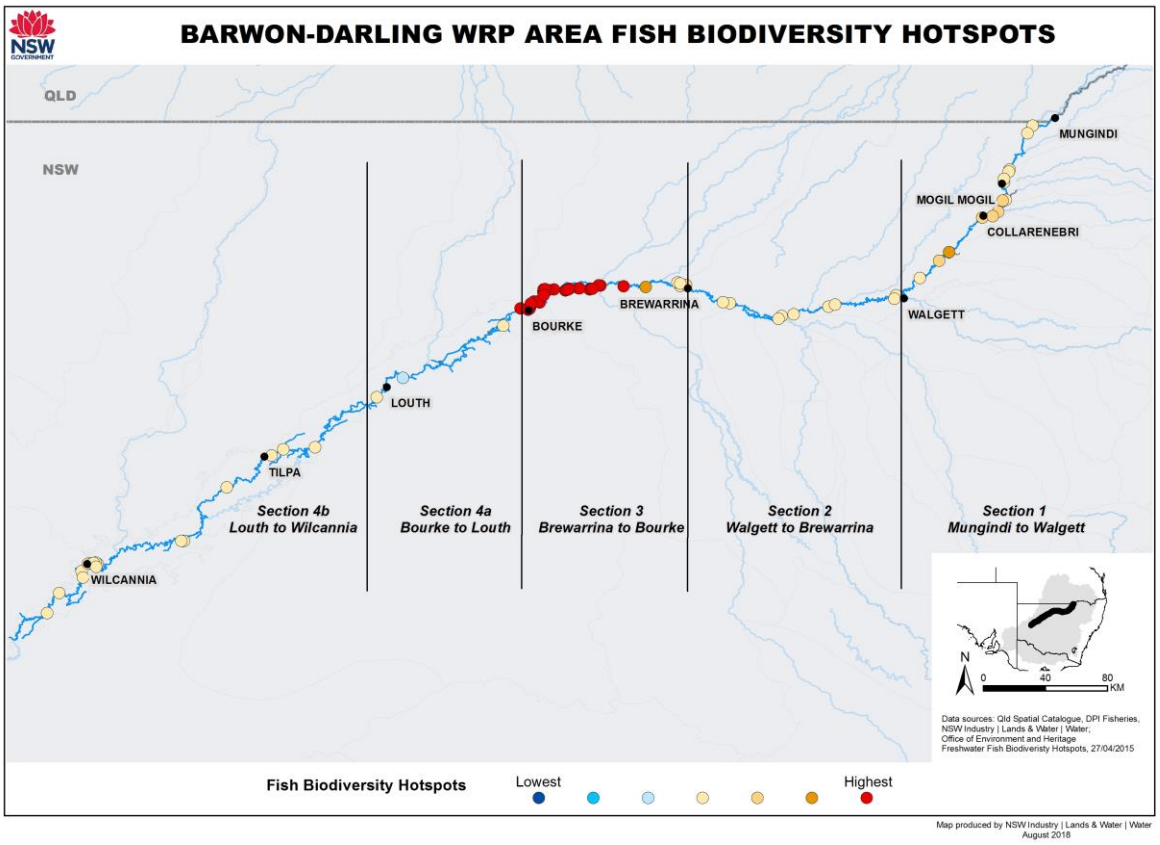


Figure D-3 Fish biodiversity hotspots in the Barwon-Darling WRPA



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 Barwon-Darling WRPA are shown in the figures below.

Figure E-1 Flow variation index (CV) results for farm dams in the Barwon-Darling WRPA (SKM 2011)

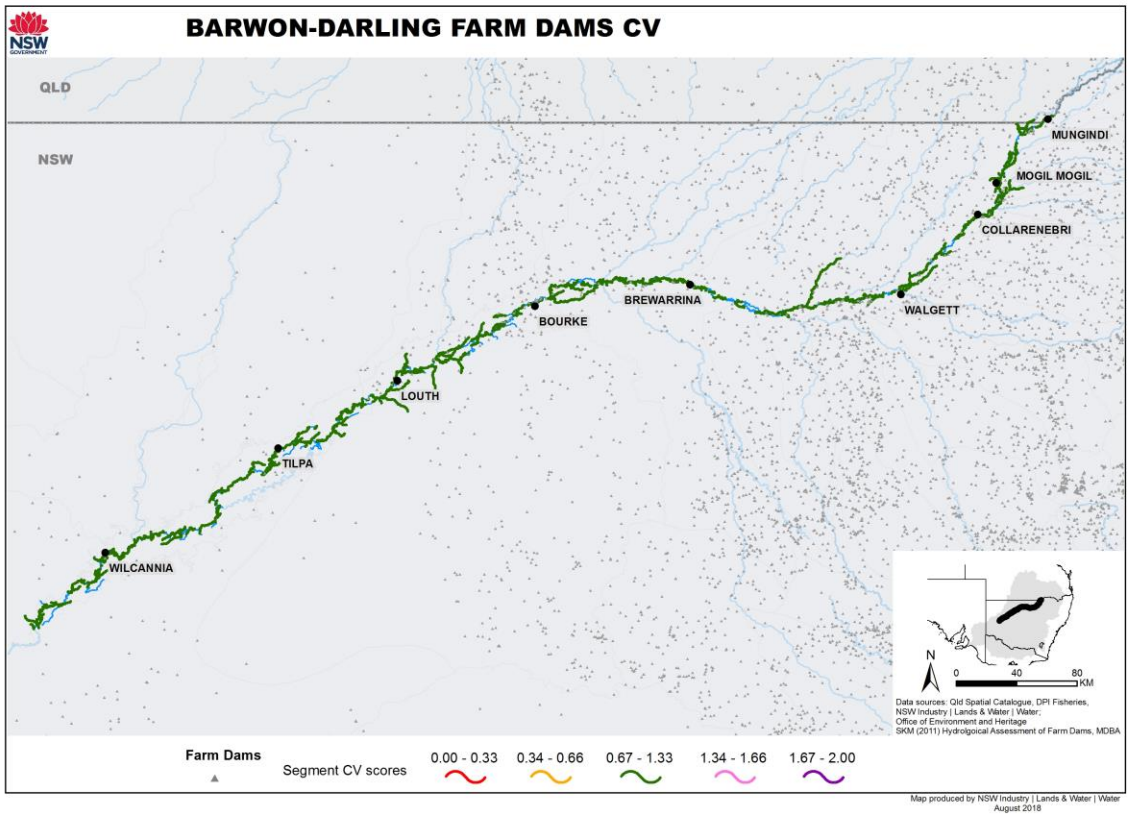


Figure E-2 Results for the Q90 low flow metric for farm dams in the Barwon-Darling WRPA (SKM 2011)

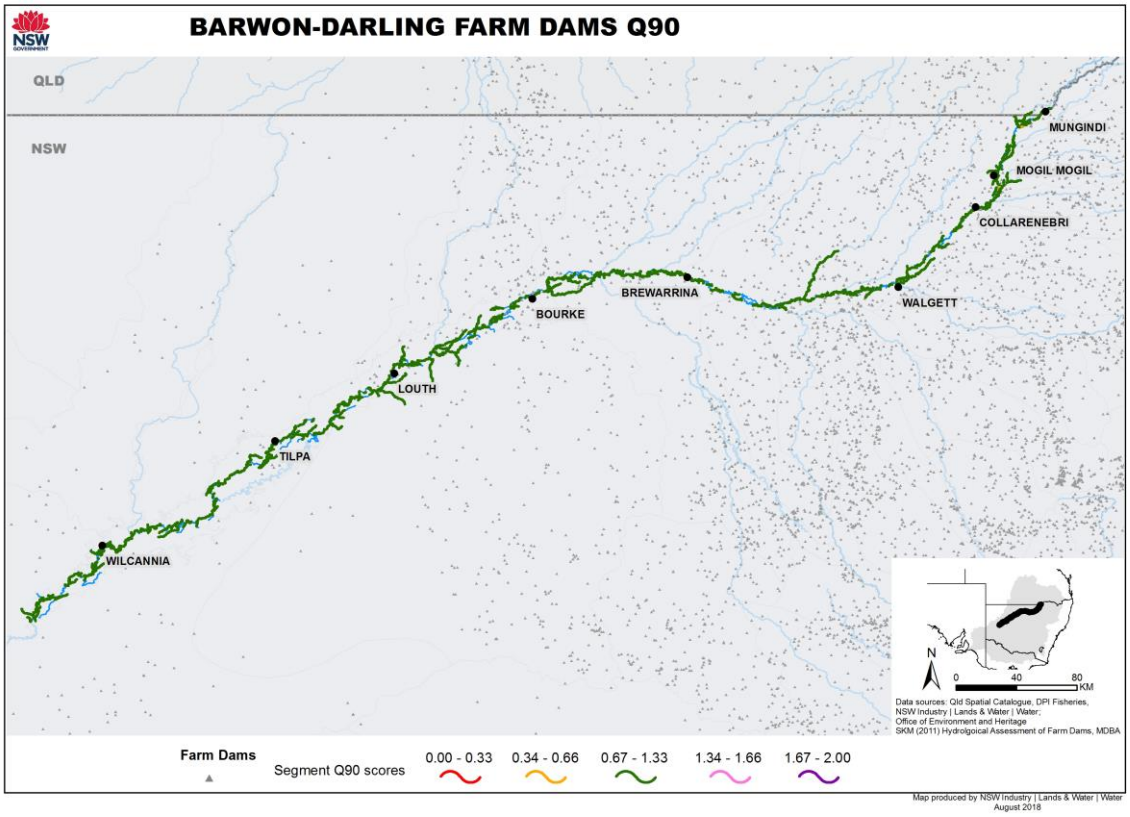


Figure E-3 Results for the Q10 high flow metric for farm dams in the Barwon-Darling WRPA (SKM 2011)

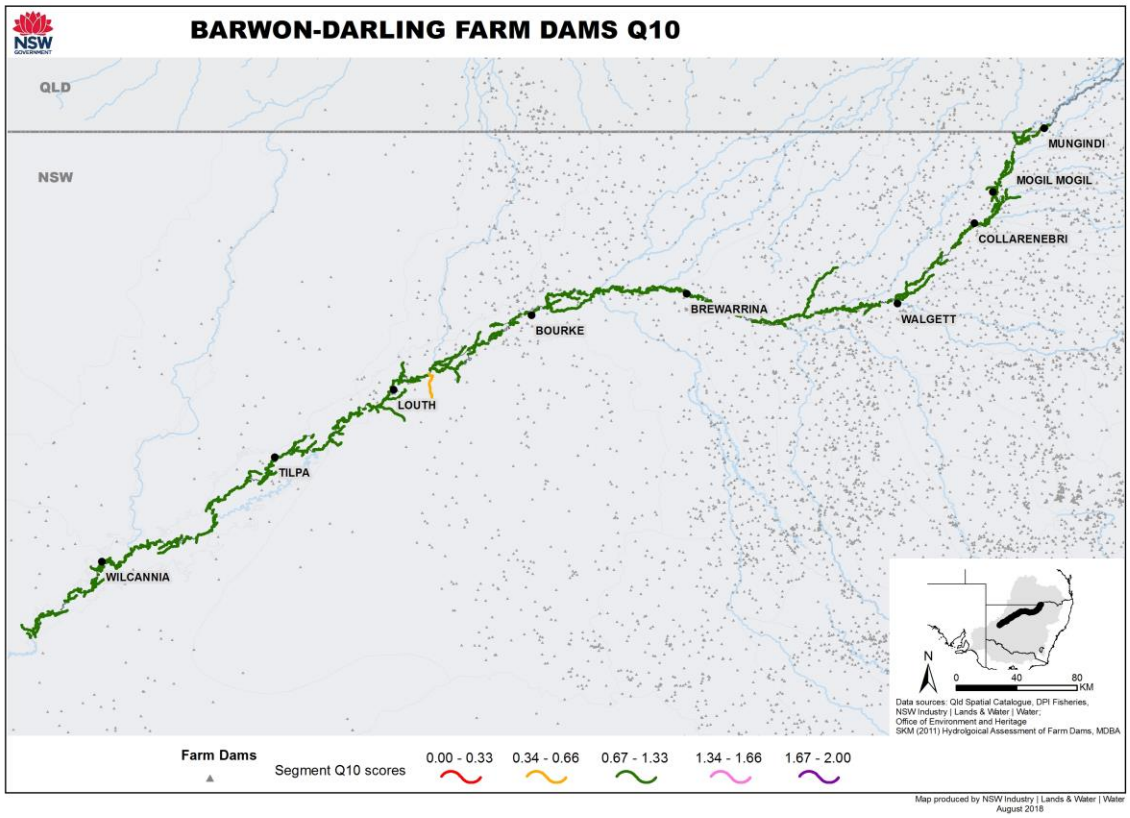
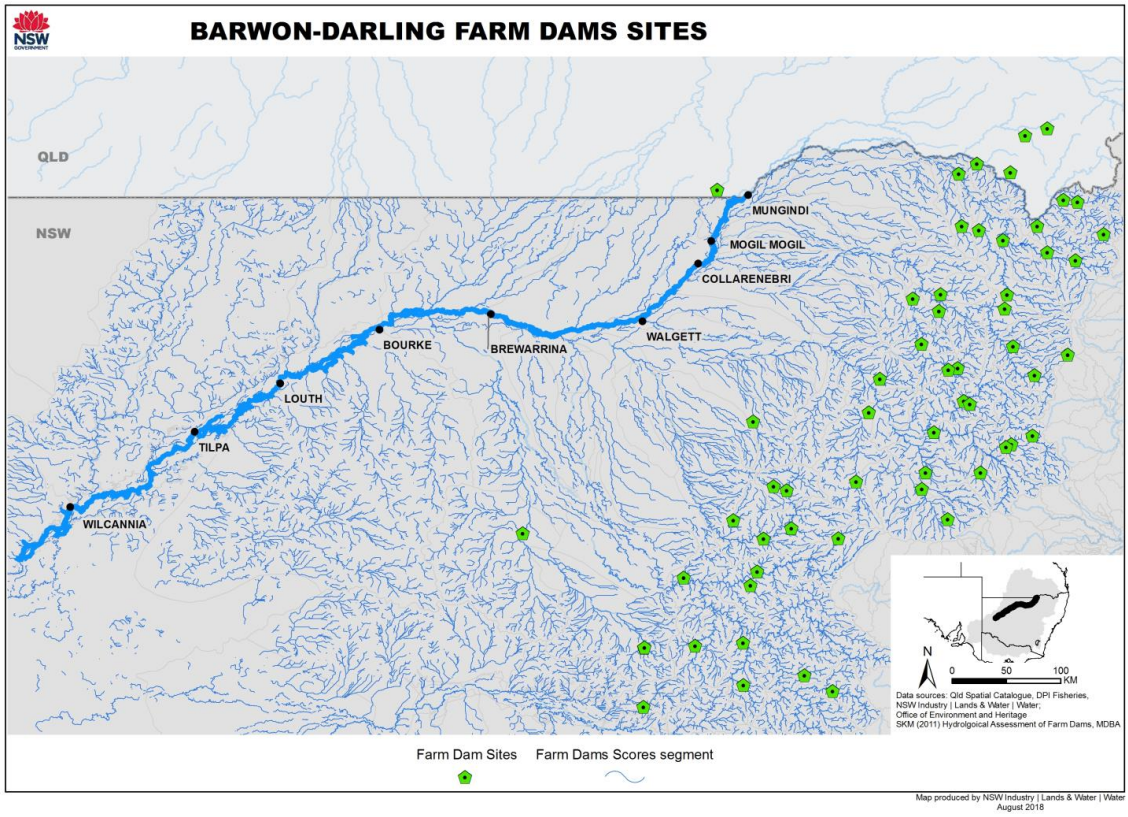


Figure E-4 Location of land use and farm dam stations in the Barwon-Darling WRPA (MDBA 2011)



Appendix F Unregulated rivers tolerable risk decision tool

This appendix relates to Figure 9-1 Risk treatment pathway (in particular element 2 and risk treatment option C associated text), and strategy 18 in Table 9-6 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

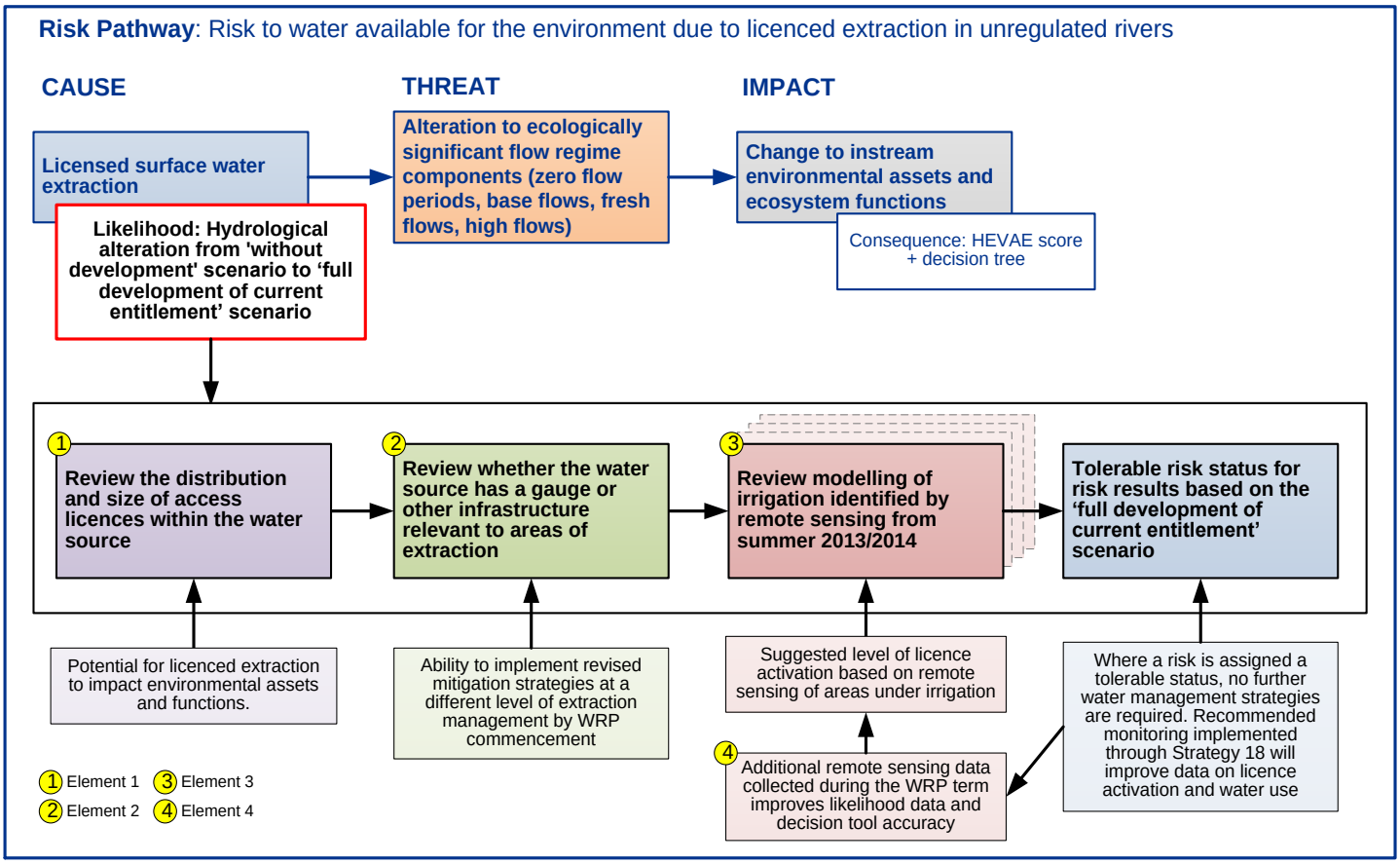
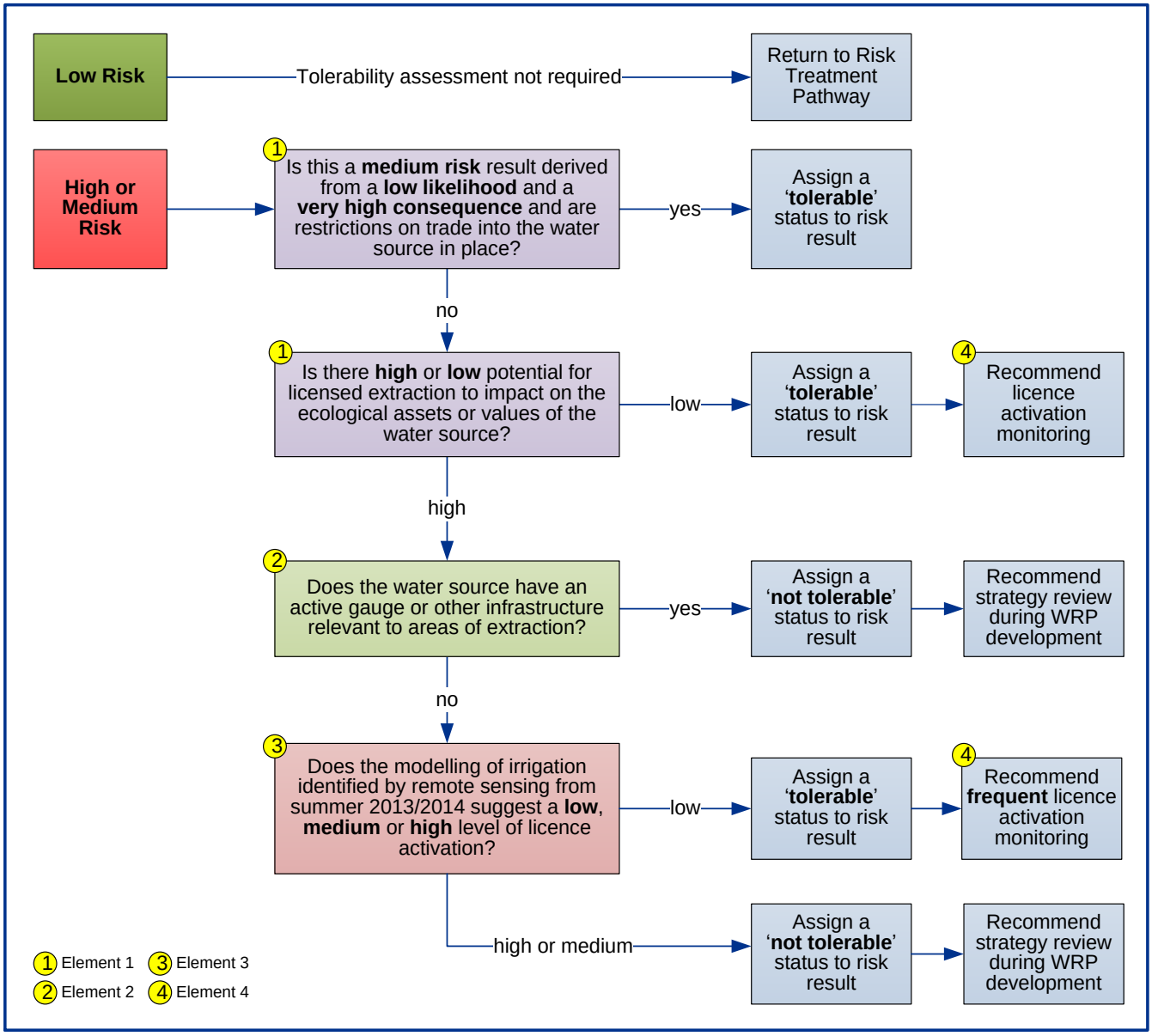


Figure F-2 Decision tree used as a guide to apply elements of the unregulated rivers tolerable risk decision tool



Review of 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).

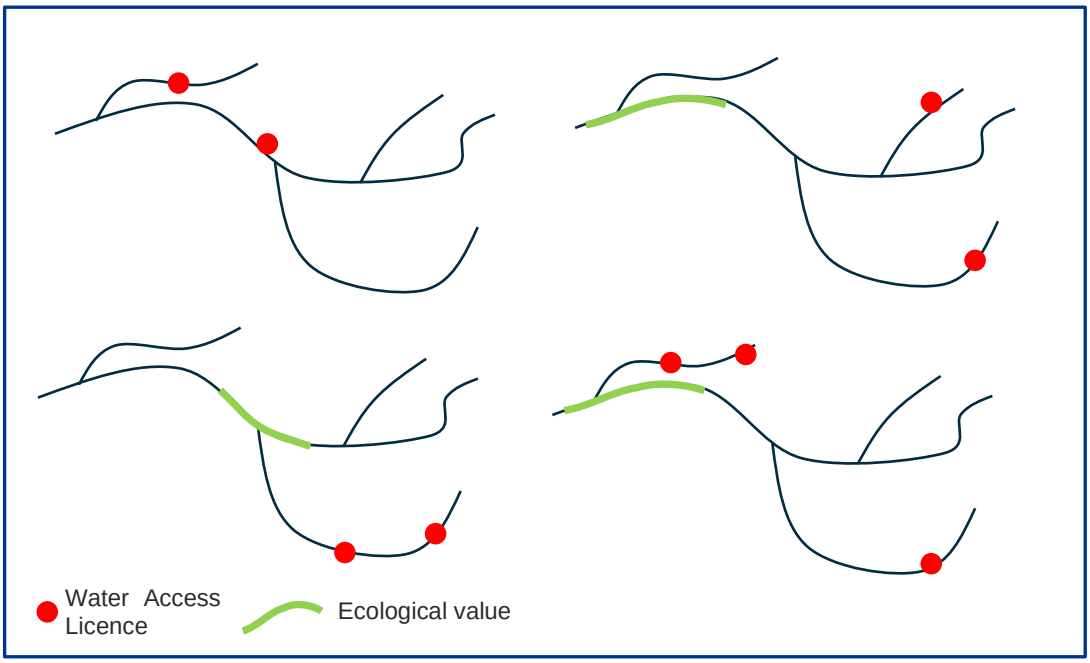
[1] An access licence must be linked to at least one pump (water supply work) for extraction to be possible.

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 (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 of 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 and decision trees

Material in this appendix has previously been presented in earlier drafts of this document. It describes considerations and decision processes supporting strategy development. A list of draft strategies that were considered for inclusion in the WRP has also been included.

The draft strategies outlined in this section have been developed with consideration to the means through which they can be implemented, which is primarily through the rules and conditions within the WRP. Risks that are associated with high flow events, however, may also be mitigated through discretionary environmental water, which is part of the operational scope of the LTWP rather than a WRP. In such instances, the mitigation strategy suggests that the risk would be most effectively managed by the LTWP. Mitigation strategies for water quality risks may be represented in one or more of the WRP, LTWP and WQM Plan. However, there may be unavoidable circumstances or constraints that prevent a strategy from being implemented, including:

- Operational constraints due to infrastructure or channel capacity, or
- Constraints due to a proposed strategy resulting in a risk to social and economic interests that is considered to outweigh the risk to the environment, or
- Environmental or other external constraints which limit a strategy from achieving its full ecological objective.

Operational constraints considered in developing and implementing new strategies

Operational constraints were identified through consultation with WaterNSW and other water management agencies that provided technical input around the operation of water regulation structures. Some examples of operational constraints may be the ability of a stream channel to convey a certain volume of water without incurring third party impacts (for example, through over bank flows), the inability of dam outlet works to be turned off, or conversely, to release a certain volume of water.

Operational constraints were considered against the anticipated resources that would be required to remedy them. Often the significance of these constraints means they are unable to be abated.

Social or economic constraints to implementing a strategy

The Basin Plan's objective is to achieve an optimal outcome for all water stakeholders in the Basin. Sections 5.02(1) (c) and 5.02(1) (d) of the Basin Plan state that:

The objectives of the Basin Plan as a whole are:

> *(c) To optimise social, economic and environmental outcomes arising from the use of Basin water resources in the Murray-Darling Basin; and*
>
> *(d) To improve water security for all uses of Basin water resources.*

NSW WSPs also have the objective of achieving optimal outcomes for social, economic and environmental objectives, but there are instances where it is not possible to achieve all of these outcomes in equal measure. Each mitigation strategy must therefore be considered in view of the potential impacts on water-dependent communities. If those impacts are considered to be significant, then the strategy may have to be constrained or modified.

Potential social or economic constraints were identified by:

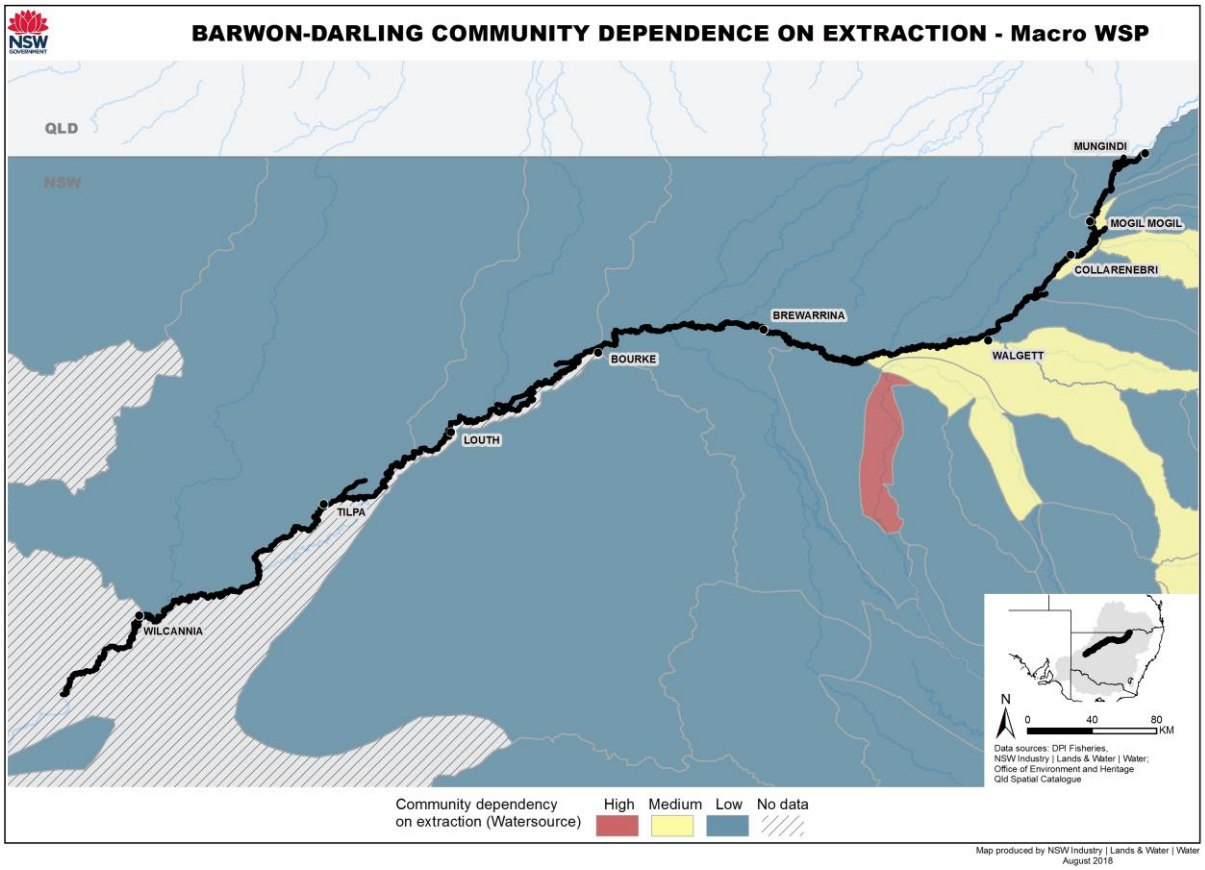
- Estimating the community dependence on water extraction in each unregulated water source
- Directly consulting with stakeholders through forums such as Stakeholder Advisory Panels (SAPs).

Estimates of community dependence on water extraction were based on previous calculations undertaken as part of the Macro Water Sharing Plan process (NOW, 2011).

Community dependence was estimated by combining information about the volumes and economic value of water extraction (value of irrigated industries, town water supply, proportion of community employment in agriculture etc.) with information about community resilience to change, based on data obtained from the Australian Bureau of Statistics Index of Advantage and Disadvantage.

Community dependence for each unregulated water source was classified as either low, medium or high (Figure G-1). The regulated river network, however, was not assessed but deemed to always have high community dependence.

Figure G-1 Community dependency on extraction



In each unregulated water source, community dependence and risk to the environment were compared using an indicative matrix 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 NSW Department of Planning and Environment in managing external constraints through complementary measures. Collaboration between natural resource management (NRM) groups to examine alignment of priorities has been a continued focus of NSW Government (NRC 2010). Alignment of NRM continues to be identified as a priority for LLS (Local Land Services 2016) and for the management of environmental water and water quality in NSW (OEH 2014). Alignment of NRM priorities for river management will assist in strengthening the outcomes of mitigation measures identified through this risk assessment.

This section identifies the major environmental and external constraints to implementing strategies in the Barwon-Darling WRP.

Cold water pollution

All significant water storages are located a considerable distance upstream and any cold water pollution is unlikely to impact the Barwon-Darling WRPA

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.

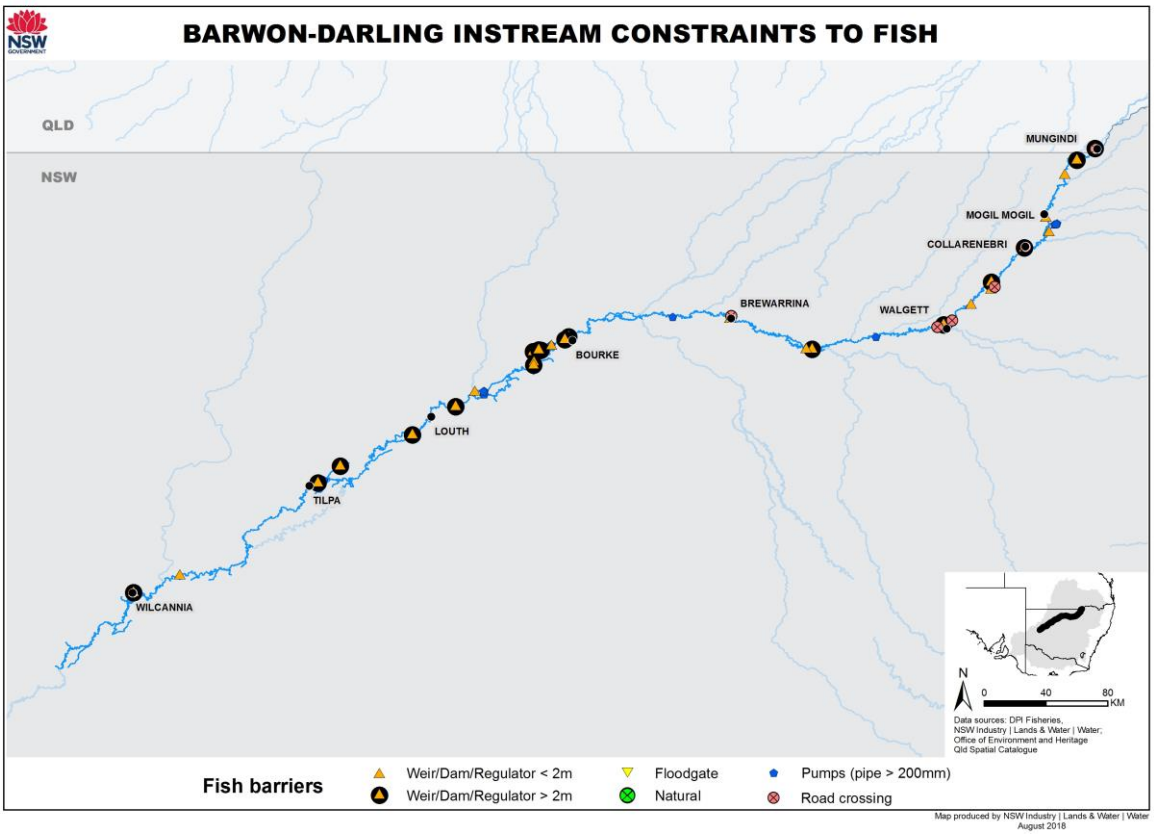
NSW Department of Primary Industries (2005; 2016) report that barriers to fish passage can impact native fish populations by:

- 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
- Disrupting downstream movement of adults and impeding larval drift (Jones & Stuart 2004; NSW Department of Primary Industries 2006; Jones & Stuart 2008; Jones 2009).

Instream structures and other mechanisms that alter natural flow regimes have been listed as a key threatening process under the *Fisheries Management Act 1994*. The NSW Office of Environment and Heritage has also listed instream barriers as a key threatening process under the *Threatened Species Conservation Act 1995*. The construction of fishways at major barriers and the management of instream structures to reduce their impact on biodiversity and habitats (for example, opening of flood gates at certain times of year) have been identified as high priority abatement actions.

NSW Department of Primary Industries—Fisheries have identified over 100 barriers to fish passage in the Barwon-Darling WRPA (NSW Department of Primary Industries 2015) including weirs, regulators and road crossings (Figure G2). These fish barriers have a varying degree of impact on native fish, with some drowning out more frequently than others to provide suitable passage. The cumulative impact of such structures across the catchment impedes natural flow and connectivity, which is a fundamental ecological feature (NSW Department of Primary Industries 2015) and likely to be a considerable constraint to the success of strategies. NSW Department of Primary Industries—Fisheries have identified a number of barriers which are considered to be high priority for mitigation action. These barriers are identified in the summaries presented in the Part 2 water source summaries and are considered potential constraints to the success of hydrological risk mitigation strategies.

Figure G-2 Major Instream constraints to fish in the Barwon-Darling WRPA (adapted from NSW Department of Primary Industries, 2015)



Water diversion

The diversion of water by pumps, pipelines, irrigation canals or regulators can have a significant impact on native fish by altering habitat and affecting flow-dependent life history strategies such as spawning and recruitment (Baumgartner & Boys 2012). Diversion and stranding in off-channel irrigation systems is said to be particularly problematic for the larval stage of most native fish species, especially golden perch, silver perch and Murray cod, as the timing of irrigation diversion coincides with the peak egg and larval drift during the spring and summer seasons (Baumgartner et al. 2007).

The entrainment of fish in irrigation infrastructure is an issue which may influence the ability of flow management strategies to meet their ecological objectives. In Europe and the United States, a wide variety of pump screens are currently applied which could be readily adapted for use in the MDB. In New Zealand, the screen designs routinely applied are modifications of existing designs to meet the requirements of local conditions (Baumgartner & Boys 2012). For some years, NSW Department of Primary Industries—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 Barwon-Darling WRPA, there are 209 water extraction pumps, with 124 at a capacity of 200 mm or more (Figure G2). There is some suggestion that irrigation pump offtakes, with a diameter greater than 200 mm, influence the entrainment of freshwater fish (NSW Department of Primary Industries 2015). Based on the current information from the QLD Department of Agriculture and Fisheries and NSW Department of Primary Industries—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 Barwon-Darling WRPA during peak extraction times.

Riparian vegetation condition and catchment disturbance

Riparian vegetation is a key attribute connecting rivers and terrestrial ecosystems. It is important for controlling river bank stability, mitigating runoff, providing sediment and nutrients from the adjacent land, providing habitat for a range of biota and influences instream processes (Lovett & Price 2007). Leaf litter derived from riparian vegetation is also a key contributor of allochthonous energy sources into rivers, driving primary production and stimulating the development of food chains (Robertson et al. 1999; Westhorpe et al. 2010). Native riparian vegetation cover greater than 60% and a riparian buffer zone width of up to 30 m are considered to be within the ranges important for influencing good riparian condition (Jansen et. al. 2003). A positive increase in the presence of large woody debris (LWD) within rivers was correlated with a positive increase in riparian tree cover, maximising when tree cover reaches 60 percent (Matheson & Thoms 2017). LWD derived from the riparian zone is associated with primary control on geomorphic stability and habitat heterogeneity in rivers (Brooks & Brierley 2002; Treadwell et al. 2007).

Changes to riparian vegetation can reduce the geomorphic condition of rivers (Brierley & Fryirs 2005). Reduction in geomorphic condition from good to moderate can be linked to reductions in macrophyte and macroinvertebrate assemblages (Chessman et. al 2006b), 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 Barwon-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 (Part2).

Figure G-3 Percent cover categories of native woody riparian vegetation in the Barwon-Darling WRPA

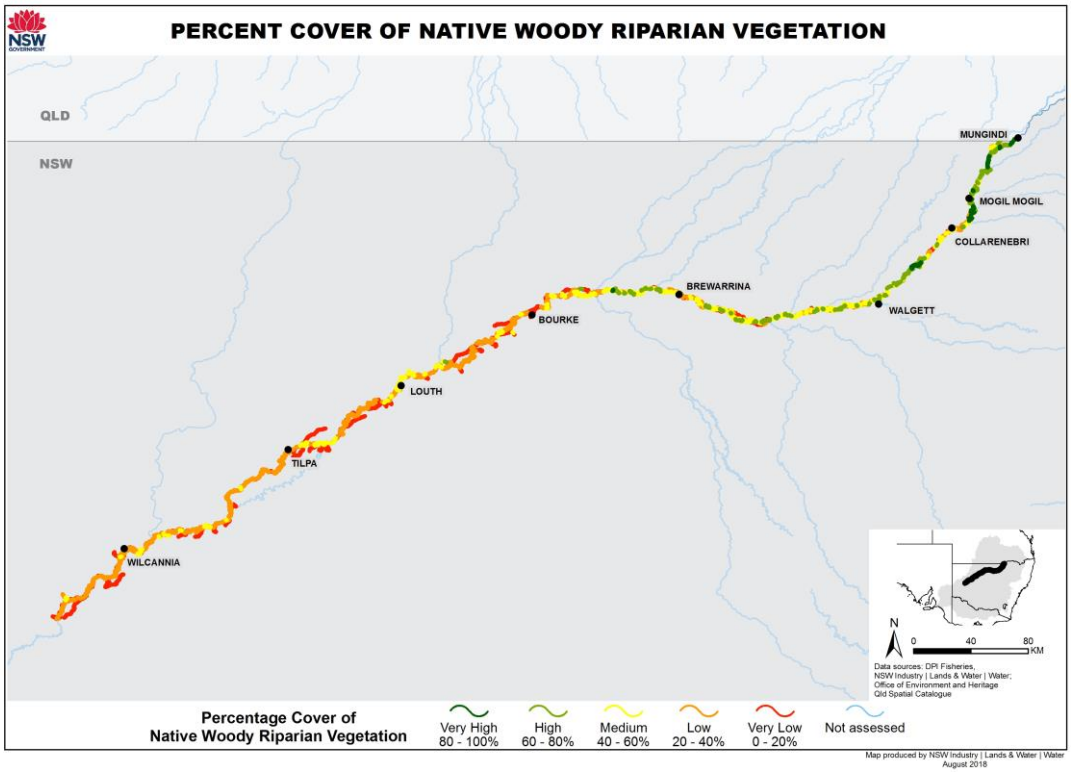
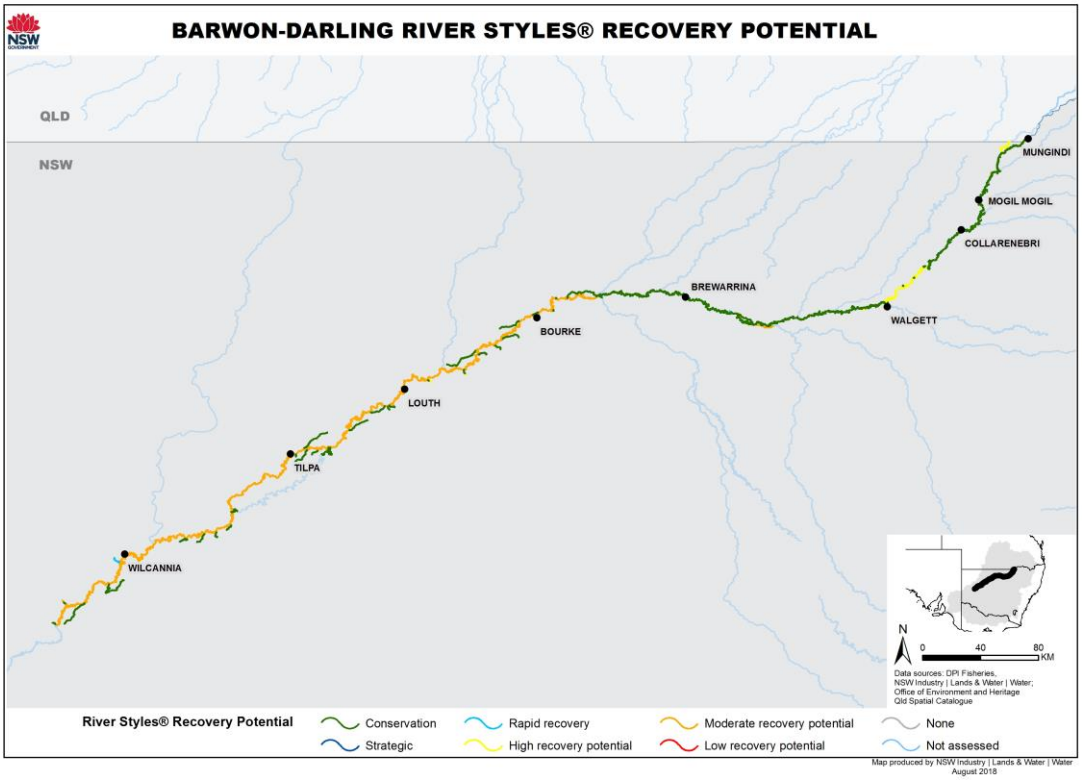


Figure G-4 Geomorphic recovery potential in streams in the Barwon-Darling WRPA



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 NSW Department of Planning and Environment, Water Resource Plan Stakeholder Advisory Panels, the MDBA and other relevant stakeholders. The outcomes of these discussions can influence the development of the final strategies within the WRP in order to reduce the impact of medium and high risks of insufficient water for key ecosystem functions and assets.

The decision tree is focused on specific rules, such as a flow-based cease to pump (CtP). This is considered an immediate strategy with the potential to mitigate medium and high risks identified in a water source. Although the trade of entitlement is another potential rule to manage medium and high risks, it is not considered an immediate mitigation measure, as there is no certainty of it occurring. Should trade of entitlement occur within a medium or high risk water source, it will likely have a longer term benefit by also assisting in mitigating the impact on instream values via reduced levels of extraction.

Each bifurcation in the decision tree was annotated, allowing for a rationale for each decision to be explained (Table G-2).

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

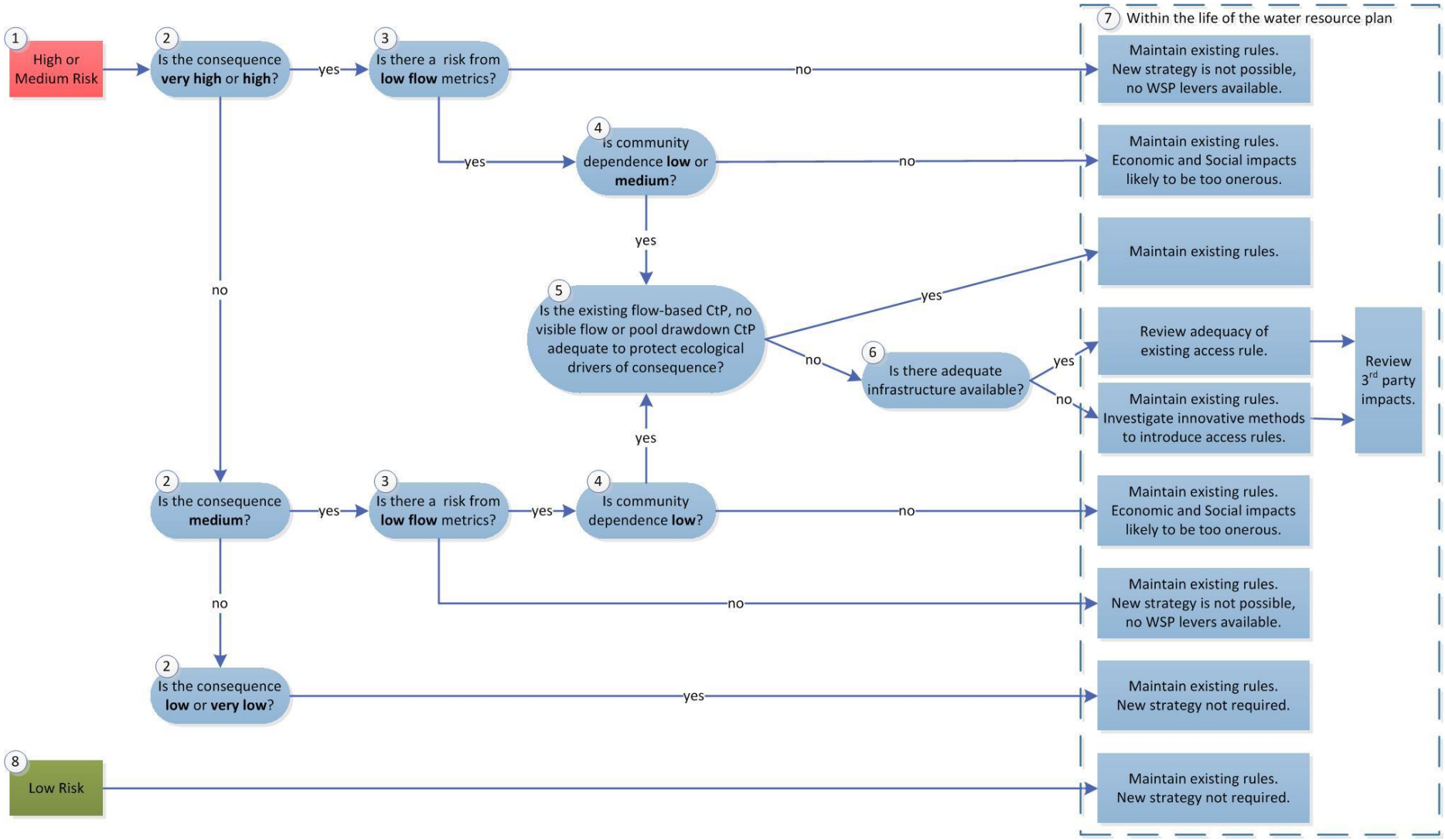


Table G-2 Rationale for each bifurcation in the decision tree used for determining strategies for unregulated water sources

DECISION TREE ANNOTATION	RATIONALE
1	• This step breaks up the strategies based on the Murray-Darling Basin Plan requirements that strategies are commensurate with the level of risk. • Where possible, draft strategies are being proposed to address water sources classified as medium or high risk. • Medium and high risks are considered the most important categories for ensuring adequate mitigation measures are determined. • Confidence in the data is high.
2	• This step is associated with medium and high risk water sources. • High and very high consequence categories are considered the most important for ensuring adequate mitigation measures are determined. • Medium consequence categories are considered important but are not prioritised over high and very high consequence. • Low and very low consequence categories do not provide sufficient evidence to justify the changing of access rules. • Confidence in the data is high.
3	• Low and high flow risks to instream values are determined through the risk assessment process, where risks to six flow metrics were assessed. • Low flows are considered to be zero flows, base flows and freshes. High flows are considered to be the bank full to over bank flows, identified in the risk assessment as an average recurrence intervals (ARI) of 1.5, 2.5 and 5 years. • In unregulated systems, there are only opportunities to consider mitigation measures in low flows within a WSP. • Mitigation measures for high flows are outside the influence of a WSP/WRP, where low flow management is the key focus. • Confidence in the data is high.
4	• Community dependence is a factor that identifies the economic value of water extracted and the social benefit of extraction within a water source. • Where community dependence is high and the consequence is high or very high, competition for water between licensed extractors and the environment is greatest. Hence the need for more certainty in a CtP level using accurate, flow-based infrastructure. Low or medium community dependence allows high and very high consequence water sources to be further investigated for potential access rule options. • Medium consequence water sources are not prioritised for access rule reviews if the community dependence is considered to be high or medium. However, if community dependence is low, there is potential to further investigate access rule options. • 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.

DECISION TREE ANNOTATION	RATIONALE
	• * 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.
8	• The Murray-Darling Basin Plan does not require mitigation strategies for water sources identified as low risk.

Appendix H Risk assessment definitions