NSW GOVERNMENT

BASIN PLAN IMPLEMENTATION

Risk assessment for the Namoi Surface Water Resource Plan Area (SW14)

Schedule D

NSW Department of Climate Change, Energy, the Environment and Water | dcceew.nsw.gov.au

Published by NSW Department of Climate Change, Energy, the Environment and Water - Water

Risk Assessment for the Namoi Surface Water Resource Plan Area (SW14)

Document reference: INT20/37679

More information

Department of Climate Change, Energy, the Environment and Water - Water

dcceew.nsw.gov.au

Acknowledgments

The maps in this report contain data sourced from:

Murray-Darling Basin Authority

© Commonwealth of Australia (Murray–Darling Basin Authority) 2012. (Licensed under the Creative Commons Attribution 4.0 International License)

NSW Department of Climate Change, Energy, the Environment and Water - Water

© Spatial Services - NSW Department of Finance, Services and Innovation [2016], Panorama Avenue, Bathurst 2795 http://spatialservices.finance.nsw.gov.au

NSW Department of Climate Change, Energy, the Environment and Water Atlas of NSW Wildlife data

© State of New South Wales through Department of Environment and Heritage (2016) 59-61 Goulburn Street Sydney 2000 http://www.bionet.nsw.gov.au

NSW DPI Fisheries Fish Community Status and Threatened Species data

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

NSW DPI Fisheries Fish Barrier database

© State of New South Wales through Department of Industry (2016) 161 Kite Street Orange 2800 pers. comms. Matthew Gordos

© State of New South Wales through Department of Climate Change, Energy, the Environment and Water 2024. Information contained in this publication is based on knowledge and understanding at the time of writing, January 2018, and is subject to change. For more information, please visit the following websites:
For ECCS documents: https://www.energy.nsw.gov.au/copyright
For Water and Environment https://www.environment.nsw.gov.au/about-us/copyright-and-disclaimer
For General NSW Government https://www.nsw.gov.au/nsw-government/copyright

Executive Summary

The *Basin Plan 2012* (Basin Plan) requires NSW to prepare Water Resource Plans (WRP). The *Risk Assessment for the Namoi Surface Water Resource Plan Area (SW14)* 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 Namoi Surface WRP.

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

10.41 Risk identification and assessment methodology
- (1) Regard to current and future risks
- (2) (a) Risks to meeting environmental watering requirements
  (b) Risks arising from matters referred to in subsection 10.20(1) (productive base of groundwater)
  (c) Risks arising from potential interception activities
  (d) Risks arising from elevated levels of salinity or other types of water quality degradation
- (3) (a) Risks identified in Section 4.02
- (4) List the identified risks
- (5) Assess each risks
- (6) Categories of level of risk
- (7) Description of the data and methods
- (8) Description of uncertainty

10.42 Description of risks

10.43 Strategies for addressing risks
- (1) Water resource plan risk mitigation strategies
- (2) Strategies take account of Chapter 10 requirements
- (3) (a) WRP have regard to strategies listed in section 4.03(3)

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

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

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

Medium and high risk results that were identified in this risk assessment were reviewed to determine whether they are adequately addressed by existing strategies, or whether modifications or new strategies may be required. Risk treatment options were developed following a systematic approach outlined in Figure 1 (Risk Treatment Pathway). Defining tolerable risk results (i.e. those high or medium results NSW considers are acceptable or adequately managed by existing water resource management strategies) were also part of this approach. Explanations for risk results that the WRP cannot address in a manner commensurate with the level of risk are provided in the Consolidated Risk Table (Table 1).

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

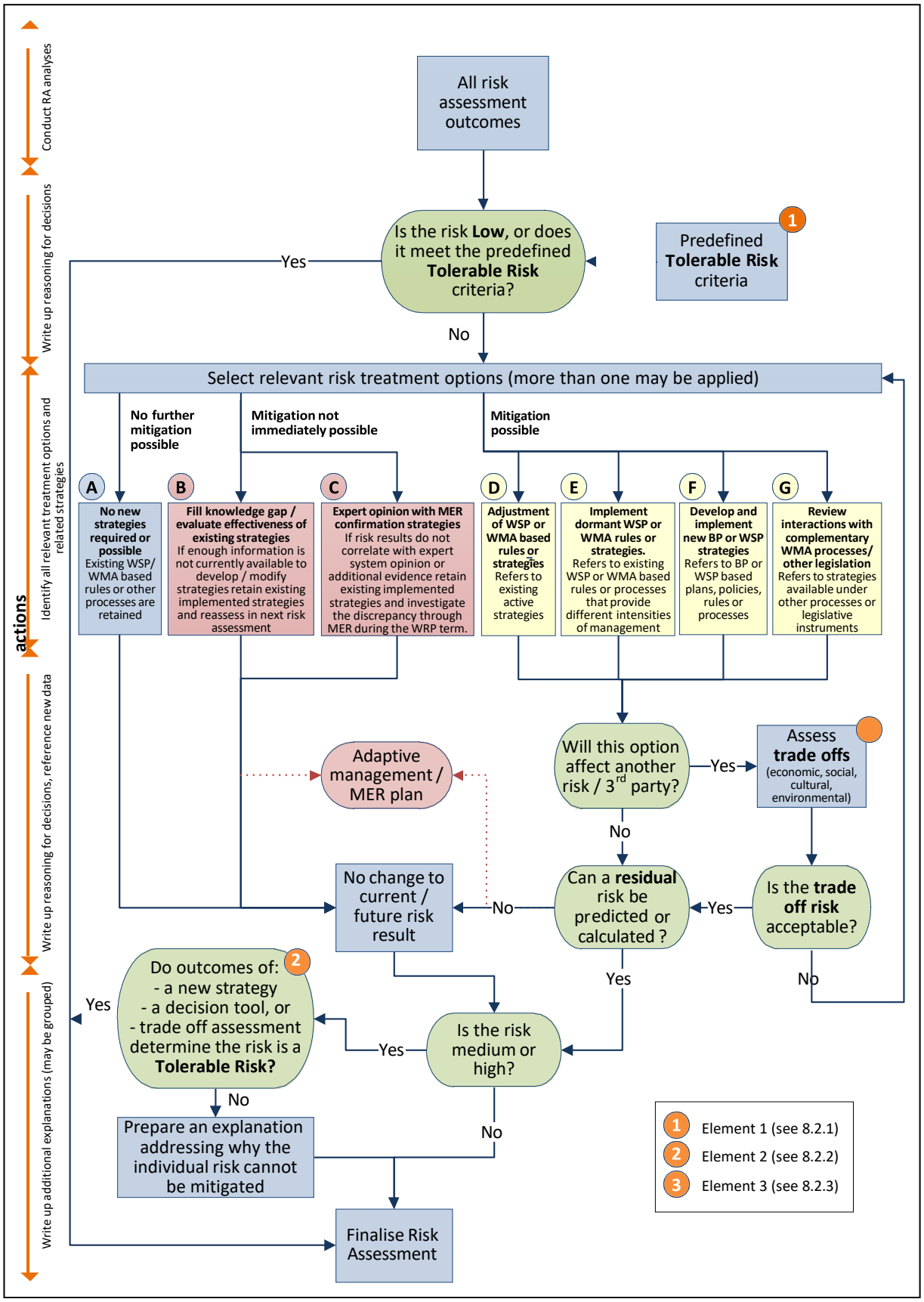


Figure 1 Risk treatment pathway

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**						

Risk assessment

Location information and flow or extraction characteristic

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

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

Information on the calculation basis of the Risk outcome

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

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

VH Very High (consequence scores only)

H High

M Medium

L Low

VL Very Low (consequence scores only)

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

Risk rating or outcome (result) and confidence ranking

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

For further information on data confidence refer to Appendix A

H High

M Medium

L Low

Risk treatment pathway

Information on the application of the Risk treatment pathway

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

Risk treatment option refers to options A-G listed in the Risk Treatment Pathway and summarised below; more than one may apply. See Table 9-1.

A No new strategies required or possible.
B Fill knowledge gap and evaluate effectiveness of existing strategies.
C Knowledge improvement via MER plan is proposed.
D Adjustment of WSPs or WMA based rules.
E Implementation dormant WSP or WMA rules.
F Develop and implement new BP or WSP strategies.
G Review interactions with complementary WMA processes/other legislation.

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

New critical mechanisms are water sharing plan or WMA 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 3.2 RISKS TO ENVIRONMENTAL ASSETS AND FUNCTIONS WITHIN THE NAMOI SURFACE WRPA DUE TO CONNECTIVITY WITH THE BARWON DARLING WATERCOURSE WRPA									
Water Source Type	**Consequence**	**Likelihood**	**Risk Rating**	**Data confidence (Consequence / Likelihood)**	**Risk treatment option**	**Strategies**	**New Critical Mechanisms**	**Tolerable risk level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and Evaluation**
Regulated	M	L	L	H/H	N/A	None required. Risk is low		N/A	N/A	No MER planned
Unregulated	M	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	No MER planned
Current Critical Mechanisms Environmental flow rules described in WRP Section 4.2										

SECTION 3.2 RISKS OF INSUFFICIENT SURFACE WATER IMPACTING ON PRIORITY GROUNDWATER ASSETS AND FUNCTIONS									
Water Source Type	**Consequence**	**Likelihood**	**Risk Rating**	**Data confidence (Consequence / Likelihood)**	**Risk treatment option**	**Strategies**	**New Critical Mechanisms**	**Tolerable risk level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and Evaluation**
Regulated	M	L	L	H/H	N/A	None required. Risk is low		N/A	N/A	No MER planned
Unregulated	M	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	No MER planned
Current Critical Mechanisms Environmental flow rules described in WRP Section 4.2										

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

River reach within WRP Area	Flow or Extraction Characteristic	Current Critical Mechanisms	Consequence	Likelihood	Risk Rating	Data confidence (Consequence / Likelihood)	Predefined Tolerable Risk Level	Risk treatment option	Strategies	New Critical Mechanisms	Residual Risk Rating	Explanation of tolerable risk application OR Explanation of why risk cannot be addressed	Monitoring & Evaluation
Peel at downstream Chaffey Dam	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) E6a - Access to uncontrolled natural flow events limited to a maximum of 50 % of forecast uncontrolled flows above either 5 ML/day or 50 ML/d dependent on General Security (GS) AWDs is <0.35 ML or >0.35 ML per unit share component. E9 – Uncontrolled flows arising from Peel ECA releases into designated sections of the Peel River protected up to 50 ML/d at Piallamore and either 40 or 50 ML/d at Carroll Gap dependent on GS AWDs. E11 - Coordinate release of environmental water provision /held environmental water with natural flow events. E 17 - Improve dam infrastructure and its management so that water releases are more closely matched to Namoi and Peel River ambient temperatures.	VH	L-	M	H/H	M	Predefined Tolerable	1 Limit consumptive water extractions in the WRP area to the predefined share of available water. 2 Protect a portion of high flow events in the Namoi WRP area. 3 Provide discretionary environmental watering events in the regulated river and downstream unregulated river sections of the WRP area. 4 Manage environmental water to meet flow targets specified in the Namoi LTWP. 8 Protect tributary flows within the WRP area as they move from the unregulated water source into the regulated river water source. 9 Protect the regulated river sections of the WRP area from rapid increases and decreases in flow following releases from Chaffey Dam.	None required – risks are tolerable. However, the following mechanisms may still be applied: N1 Sustainable Diversion Limits. N3 - Strategic use of environmental water (EWA/ECA) and relevant held environmental water licences as guided by the LTWP In this river reach the mechanism may be used to improve base/low flows, freshes and infrequent flows.	N/A	Risk inherent to regulated river reaches. Zero flow periods cannot be scheduled due to dam operational constraints and requirements to deliver water orders and BLR (stock and domestic) replenishment flows. This impact is most pronounced in reaches closest to Chaffey Dam. Zero flow periods will exhibit more natural patterns towards the downstream end of the water source.	No MER planned
	Base-flow or Low Flows		VH	L0	M	H/H	M	Predefined Tolerable			N/A	Risk inherent to regulated river reaches. Base flows cannot be scheduled due to dam operational constraints and requirements to deliver water orders and BLR (stock and domestic) replenishment flows. This impact is most pronounced in reaches closest to Chaffey Dam. Base flow periods will exhibit more natural patterns towards the downstream end of the water source.	No MER planned
	Fresh Flows		VH	L-	M	H/H	M	Predefined Tolerable			N/A	Water ordering patterns have altered the duration and timing of freshes leading to unnaturally long events in summer and less events in winter. This impact is most pronounced in the Peel River immediately downstream of Chaffey Dam where there are no significant tributary inflows.	MER planned for WSP objectives
	High and Infrequent Flows - Bank Full 1.5 years ARI		VH	L0	M	H/H	M	Predefined Tolerable			N/A	There are tributaries (e.g., Dungowan Creek) in the lower river reaches below Chaffey Dam that may supplement PEW or HEW releases to order to achieve bank full flows. The ability to mitigate the likelihood is low, hence the risk is tolerable	MER planned for WSP objectives
	High and Infrequent Flows - Over Bank 2.5 years ARI		VH	L0	M	H/H	M	Predefined Tolerable			N/A	There are tributaries (e.g., Dungowan Creek) in the lower river reaches below Chaffey Dam that may supplement PEW or HEW releases to order to achieve bank full flows, however over bank flows may not be achievable due to third party impacts. The ability to mitigate the likelihood is low, hence the risk is tolerable	MER planned for WSP objectives
	High and Infrequent Flows - Over Bank 5.0 years ARI		VH	L0	M	H/H	M	Predefined Tolerable			N/A	There are tributaries (e.g., Dungowan Creek) in the lower river reaches below Chaffey Dam that may supplement PEW or HEW releases to order to achieve bank full flows, however over bank flows may not be achievable due to third party impacts. The ability to mitigate the likelihood is low, hence the risk is tolerable	MER planned for WSP objectives
Peel at Piallamore	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) E6a - Access to uncontrolled natural flow events limited to a maximum of 50 % of forecast uncontrolled flows above either 5 ML/day or 50 ML/d dependent on General Security (GS) AWDs is <0.35 ML or >0.35ML per unit share component. E9 – Uncontrolled flows arising from Peel ECA releases into designated sections of the Peel River protected up to 50 ML/d at Piallamore and either	VH	H-	H	H/H	H	Predefined Tolerable	1 Limit consumptive water extractions in the WRP area to the predefined share of available water. 2 Protect a portion of high flow events in the Namoi WRP area. 3 Provide discretionary environmental watering events in the regulated river and downstream unregulated river sections of the WRP area. 4 Manage environmental water to meet flow targets specified in the Namoi LTWP. 8 Protect tributary flows within the WRP area as they move from the unregulated water source into the regulated river water source. 9 Protect the regulated river	None required – risks are tolerable. However, the following mechanisms may still be applied: N1 Sustainable Diversion Limits. N3 - Strategic use of environmental water (EWA/ECA) and relevant held environmental water licences as guided by the LTWP In this river reach the mechanism may be used to improve base/low flows, freshes and infrequent flows.	N/A	Risk inherent to regulated river reaches. Zero flow periods cannot be scheduled due to dam operational constraints and requirements to deliver water orders and BLR (stock and domestic) replenishment flows. This impact is most pronounced in reaches closest to Chaffey Dam. Zero flow periods will exhibit more natural patterns towards the downstream end of the water source.	No MER planned
	Base-flow or Low Flows		VH	H+	H	H/H	H	Predefined Tolerable			N/A	Risk inherent to regulated river reaches. Base flows cannot be scheduled due to dam operational constraints and requirements to deliver water orders and BLR (stock and domestic) replenishment flows. This impact is most pronounced in reaches closest to Chaffey Dam. Base flow periods will exhibit more natural patterns towards the downstream end of the water source.	No MER planned
	Fresh Flows		VH	M-	H	H/H	H	Predefined Tolerable			N/A	Water ordering patterns have altered the duration and timing of freshes leading to unnaturally long events in summer and less events in winter. This impact is most pronounced in the Peel River where there are no significant tributary inflows.	MER planned for WSP objectives
	High and Infrequent Flows - Bank Full 1.5 years ARI		VH	M-	H	H/H	H	Predefined Tolerable			N/A	There are tributaries (e.g., Cockburn River) in the mid river reaches that may supplement PEW or HEW releases to order to achieve bank full flows. The ability to mitigate the likelihood is low, hence the risk is tolerable	MER planned for WSP objectives

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

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
	High and Infrequent Flows - Over Bank 2.5 years ARI	40 or 50 ML/d at Carroll Gap dependent on GS AWDs.. E11 - Coordinate release of environmental water provision /held environmental water with natural flow events	VH	L-	M	H/H	M	Predefined Tolerable	sections of the WRP area from rapid increases and decreases in flow following releases from Chaffey Dam.		N/A	There are tributaries (e.g., Cockburn River) in the mid river reaches that may supplement PEW or HEW releases to order to achieve bank full flows, however over bank flows may not be achievable due to third party impacts. The ability to mitigate the likelihood is low, hence the risk is tolerable	MER planned for WSP objectives
	High and Infrequent Flows - Over Bank 5.0 years ARI		VH	L-	M	H/H	M	Predefined Tolerable			N/A	There are tributaries (e.g., Cockburn River) in the mid river reaches that may supplement PEW or HEW releases to order to achieve bank full flows, however over bank flows may not be achievable due to third party impacts. The ability to mitigate the likelihood is low, hence the risk is tolerable	MER planned for WSP objectives
Peel at Carroll Gap	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) E6a - Access to uncontrolled natural flow events limited to a maximum of 50 % of forecast uncontrolled flows above either 5 ML/day or 50 ML/d dependent on General Security (GS) AWDs is <0.35 ML or >0.35ML per unit share component. E9 – Uncontrolled flows arising from Peel ECA releases into designated sections of the Peel River protected up to 50 ML/d at Piallamore and either 40 or 50 ML/d at Carroll Gap dependent on GS AWDs.. E11 - Coordinate release of environmental water provision / held environmental water with natural flow events.	M	H+	H	H/H	H	Predefined Tolerable	1 Limit consumptive water extractions in the WRP area to the predefined share of available water. 3 Provide discretionary environmental watering events in the regulated river and downstream unregulated river sections of the WRP area. 4 Manage environmental water to meet flow targets specified in the Namoi LTWP. 8 Protect tributary flows within the WRP area as they move from the unregulated water source into the regulated river water source. 9 Protect the regulated river sections of the WRP area from rapid increases and decreases in flow following releases from Chaffey Dam.	None required – risks are tolerable. However, the following mechanisms may still be applied: N1 Sustainable Diversion Limits.	N/A	Risk inherent to regulated river reaches. Zero flow periods cannot be scheduled due to dam operational constraints and requirements to deliver water orders and BLR (stock and domestic) replenishment flows. This impact is most pronounced in reaches closest to Chaffey Dam. Zero flow periods will exhibit more natural patterns towards the downstream end of the water source.	No MER planned
	Base-flow or Low Flows		M	L-	L	H/H	N/A	N/A	None required - risk is low		N/A		
	Fresh Flows		M	L-	L	H/H	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Bank Full 1.5 years ARI		M	L-	L	H/H	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Over Bank 2.5 years ARI		M	L-	L	H/H	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Over Bank 5.0 years ARI		M	L-	L	H/H	N/A	N/A	None required - risk is low		N/A		

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

River reach within WRP Area	Flow or Extraction Characteristic	Current Critical Mechanisms	Consequence	Likelihood	Risk Rating	Data confidence (Consequence / Likelihood)	Predefined Tolerable Risk Level	Risk treatment option	Strategies	New Critical Mechanisms	Residual Risk Rating	Explanation of tolerable risk application OR Explanation of why risk cannot be addressed	Monitoring & Evaluation
Manilla at Brabi (Merriwee)	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 (e.g., general security extraction of uncontrolled flows in Clause 37(8) of the WSP) E11 - Coordinate release of environmental water provision / held environmental water with natural flow events.	M	H+	H	H/H	H	Predefined Tolerable	1 Limit consumptive water extractions in the WRP area to the predefined share of available water. 2 Protect a portion of high flow events in the Namoi WRP area. 3 Provide discretionary environmental watering events in the regulated river and downstream unregulated river sections of the WRP area. 4 Manage environmental water to meet flow targets specified in the Namoi LTWP. 8 Protect tributary flows within the WRP area as they move from the unregulated water source into the regulated river water source. 9 Protect the regulated river sections of the WRP area from rapid increases and decreases in flow following releases from Split Rock Dam.	None required – risks are tolerable. However, the following mechanisms may still be applied: N1 Sustainable Diversion Limits. N3 - Strategic use of environmental water (EWA/ECA) and relevant held environmental water licences as guided by the LTWP In this river reach the mechanism may be used to improve base/low flows, freshes and infrequent flows.	N/A	Risk inherent to regulated river reaches. Zero flow periods cannot be scheduled due to dam operational constraints and requirements to deliver water orders and BLR (stock and domestic) replenishment flows. This impact is most pronounced in reaches closest to Split Rock Dam. Zero flow periods will exhibit more natural patterns towards the downstream end of the water source.	No MER planned
	Base-flow or Low Flows		M	H-	H	H/H	H	Predefined Tolerable			N/A	Risk inherent to regulated river reaches. Base flows cannot be scheduled due to dam operational constraints and requirements to deliver water orders and BLR (stock and domestic) replenishment flows. This impact is most pronounced in reaches closest to Split Rock Dam. Base flow periods will exhibit more natural patterns towards the downstream end of the water source.	No MER planned
	Fresh Flows		M	M-	M	H/H	M	Predefined Tolerable			N/A	Water ordering patterns have altered the duration and timing of freshes leading to unnaturally long events in summer and less events in winter. This impact is most pronounced in the Manilla River where there are no significant tributary inflows.	MER planned for WSP objectives
	High and Infrequent Flows - Bank Full 1.5 years ARI		M	M-	M	H/H	M	Predefined Tolerable			N/A	There are tributaries (e.g., Borah Creek) in the mid river reaches below Split rock Dam that may supplement HEW releases to order to achieve bank full flows. The ability to mitigate the likelihood is low, hence the risk is tolerable	MER planned for WSP objectives
	High and Infrequent Flows - Over Bank 2.5 years ARI		M	M-	M	H/H	M	Predefined Tolerable			N/A	There are tributaries (e.g., Borah Creek) in the mid river reaches below Split Rock Dam that may supplement HEW releases to order to achieve bank full flows, however over bank flows may not be achievable due to third party impacts. The ability to mitigate the likelihood is low, hence the risk is tolerable	MER planned for WSP objectives
	High and Infrequent Flows - Over Bank 5.0 years ARI		M	M-	M	H/H	M	Predefined Tolerable			N/A	There are tributaries (e.g., Borah Creek) in the mid river reaches below Split Rock Dam that may supplement HEW releases to order to achieve bank full flows, however over bank flows may not be achievable due to third party impacts. The ability to mitigate the likelihood is low, hence the risk is tolerable	MER planned for WSP objectives
Namoi at Manilla Railway Bridge	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 (e.g., general security extraction of uncontrolled flows in Clause 37(8) of the WSP) E11 - Coordinate release of environmental water provision / held environmental water with natural flow events.	M	H-	H	H/H	H	Predefined Tolerable	1 Limit consumptive water extractions in the WRP area to the predefined share of available water. 2 Protect a portion of high flow events in the Namoi WRP area. 3 Provide discretionary environmental watering events in the regulated river and downstream unregulated river sections of the WRP area. 4 Manage environmental water to meet flow targets specified in the Namoi LTWP. 8 Protect tributary flows within the WRP area as they move from the unregulated water source into the regulated river water source. 9 Protect the regulated river sections of the WRP area from rapid increases and decreases in flow following releases from Split Rock Dam.	None required – risks are tolerable. However, the following mechanisms may still be applied: N1 Sustainable Diversion Limits. N3 - Strategic use of environmental water (EWA/ECA) and relevant held environmental water licences as guided by the LTWP In this river reach the mechanism may be used to improve base/low flows, freshes and infrequent flows.	N/A	Risk inherent to regulated river reaches. Zero flow periods cannot be scheduled due to dam operational constraints and requirements to deliver water orders and BLR (stock and domestic) replenishment flows. This impact is most pronounced in reaches closest to Split Rock Dam. Base flow periods will exhibit more natural patterns towards the downstream end of the water source.	No MER planned

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

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
	Base-flow or Low Flows		M	L-	L	H/H	N/A	N/A	None required – risk is low		N/A		
	Fresh Flows		M	M+	M	H/H	M	Predefined Tolerable	1 Limit consumptive water extractions in the WRP area to the predefined share of available water. 2 Protect a portion of high flow events in the Namoi WRP area. 3 Provide discretionary environmental watering events in the regulated river and downstream unregulated river sections of the WRP area. 4 Manage environmental water to meet flow targets specified in the Namoi LTWP. 8 Protect tributary flows within the WRP area as they move from the unregulated water source into the regulated river water source. 9 Protect the regulated river sections of the WRP area from rapid increases and decreases in flow following releases from Split Rock Dam.	None required – risks are tolerable. However, the following mechanisms may still be applied: N1 Sustainable Diversion Limits. N3 - Strategic use of environmental water (EWA/ECA) and relevant held environmental water licences as guided by the LTWP In this river reach the mechanism may be used to improve base/low flows, freshes and infrequent flows.	N/A	Water ordering patterns have altered the duration and timing of freshes leading to unnaturally long events in summer and less events in winter. This impact is most pronounced in the Upper Namoi River where there are no significant tributary inflows (e.g., seasonal flow variability).	MER planned for WSP objectives
	High and Infrequent Flows - Bank Full 1.5 years ARI		M	L-	L	H/H	N/A	N/A	None required – risk is low		N/A		
	High and Infrequent Flows - Over Bank 2.5 years ARI		M	L-	L	H/H	N/A	N/A	None required – risk is low		N/A		
	High and Infrequent Flows - Over Bank 5.0 years ARI		M	L-	L	H/H	N/A	N/A	None required – risk is low		N/A		
Namoi downstream Keepit Dam	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) E11 - Coordinate release of environmental water provision/ held environmental water with natural flow events. E6b - Supplementary access: In the lower Namoi access to a	M	H-	H	H/H	H	Predefined Tolerable	1 Limit consumptive water extractions in the WRP area to the predefined share of available water. 2 Protect a portion of high flow events in the Namoi WRP area. 3 Provide discretionary environmental watering events in the regulated river and downstream unregulated river sections of the WRP area. 4 Manage environmental water	None required – risks are tolerable. However, the following mechanisms may still be applied: N1 Sustainable Diversion Limits. N3 - Strategic use of environmental water (EWA/ECA) and relevant held environmental water	N/A	Risk inherent to regulated river reaches. Zero flow periods cannot be scheduled due to dam operational constraints and requirements to deliver water orders and BLR (stock and domestic) replenishment flows. This impact is most pronounced in reaches closest to Keepit Dam. Zero flow periods will exhibit more natural patterns towards the downstream end of the water source.	No MER planned
	Base-flow or Low Flows		M	H-	H	H/H	H	Predefined Tolerable			N/A	Risk inherent to regulated river reaches. Base flows cannot be scheduled due to dam operational constraints and requirements to deliver water orders and BLR (stock and domestic) replenishment flows. This impact is most pronounced in reaches closest to Keepit Dam. Base flow periods will exhibit more natural patterns towards the downstream end of the water source.	No MER planned

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

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
	Fresh Flows	supplementary event is currently on a trial basis: prior to 1 July 2019, should not exceed 50% of a supplementary event (all year); and after 30 June 2019: 10% access of the supplementary event between 1 July and 31 October and 50% between 1 November and 30 June. E8 – Rates of change to storage release protocol. E17 - Improve dam infrastructure and its management so that water releases are more closely matched to Namoi and Peel River ambient temperatures.	M	H+	H	H/H	H	Predefined Tolerable	to meet flow targets specified in the Namoi LTWP. 8 Protect tributary flows within the WRP area as they move from the unregulated water source into the regulated river water source. 9 Protect the regulated river sections of the WRP area from rapid increases and decreases in flow following releases from Keepit Dam.	licences as guided by the LTWP In this river reach the mechanism may be used to improve base/low flows, freshes and infrequent flows.	N/A	Water ordering patterns have altered the duration and timing of freshes leading to unnaturally long events in summer and less events in winter. This impact is most pronounced in the Namoi River where there are no significant tributary inflows, and in the Gunidgera / Pian Creek system.	MER planned for WSP objectives
	High and Infrequent Flows - Bank Full 1.5 years ARI		M	H-	H	H/H	H	Predefined Tolerable			N/A	The regulated Peel River is a major tributary in the river reach below Keepit Dam that may supplement PEW or HEW releases in order to achieve bank full or over bank flows.	MER planned for WSP objectives
	High and Infrequent Flows - Over Bank 2.5 years ARI		M	M-	M	H/H	M	Predefined Tolerable			N/A	The regulated Peel River is a major tributary in the river reach below Keepit Dam that may supplement PEW or HEW releases in order to achieve bank full or over bank flows.	MER planned for WSP objectives
	High and Infrequent Flows - Over Bank 5.0 years ARI		M	M-	M	H/H	M	Predefined Tolerable			N/A	The regulated Peel River is a major tributary in the river reach below Keepit Dam that may supplement PEW or HEW releases in order to achieve bank full or over bank flows.	MER planned for WSP objectives
Namoi at Boggabri	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) E11 - Coordinate release of environmental water provision/ held environmental water with natural flow events. E6b - Supplementary access: In the lower Namoi access to a supplementary event is currently on a trial basis: prior to 1 July 2019, should not exceed 50% of a supplementary event (all year); and after 30 June 2019: 10% access of the supplementary event between 1 July and 31 October and 50% between 1 November and 30 June. E8 – Rates of change to storage release protocol. E17 - Improve dam infrastructure and its management so that water releases are more closely matched to Namoi and Peel River ambient temperatures. .	VH	H-	H	H/H	H	Predefined Tolerable	1 Limit consumptive water extractions in the WRP area to the predefined share of available water. 2 Protect a portion of high flow events in the Namoi WRP area. 3 Provide discretionary environmental watering events in the regulated river and downstream unregulated river sections of the WRP area. 4 Manage environmental water to meet flow targets specified in the Namoi LTWP. 7 Protect important lagoons and wetlands within the WRP area. 8 Protect tributary flows within the WRP area as they move from the unregulated water source into the regulated river water source. 9 Protect the regulated river sections of the WRP area from rapid increases and decreases in flow following releases from Keepit Dam. 10 Recognise the contribution of Keepit Dam release strategies towards the maintenance of water quality within the regulated sections of the WRP area.	None required – risks are tolerable. However, the following mechanisms may still be applied: N1 Sustainable Diversion Limits. N3 - Strategic use of environmental water (EWA/ECA) and relevant held environmental water licences as guided by the LTWP In this river reach the mechanism may be used to improve base/low flows, freshes and infrequent flows.	N/A	Risk inherent to regulated river reaches. Zero flow periods cannot be scheduled due to dam operational constraints and requirements to deliver water orders and BLR (stock and domestic) replenishment flows. This impact is most pronounced in reaches closest to Keepit Dam. Zero flow periods will exhibit more natural patterns towards the downstream end of the water source.	No MER planned
	Base-flow or Low Flows		VH	L+	M	H/H	M	Predefined Tolerable			N/A	Risk inherent to regulated river reaches. Base flows cannot be scheduled due to dam operational constraints and requirements to deliver water orders and BLR (stock and domestic) replenishment flows. This impact is most pronounced in reaches closest to Keepit Dam. Base flow periods will exhibit more natural patterns towards the downstream end of the water source. Additionally this risk result is driven by a very high consequence and a low likelihood. The risk is tolerable because of the low likelihood.	No MER planned
	Fresh Flows		VH	H+	H	H/H	H	Predefined Tolerable			N/A	Water ordering patterns have altered the duration and timing of freshes leading to unnaturally long events in summer and less events in winter. This impact is most pronounced in the Namoi River where there are no significant tributary inflows, and in the Gunidgera / Pian Creek system .	MER planned for WSP objectives
	High and Infrequent Flows - Bank Full 1.5 years ARI		VH	L-	M	H/H	M	Predefined Tolerable			N/A	The regulated Peel River is a major tributary in the river reach below Keepit Dam that may supplement PEW or HEW releases in order to achieve bank full or over bank flows. Additionally this risk result is driven by a very high consequence and a low likelihood rating. The risk is tolerable because of the low likelihood.	MER planned for WSP objectives
	High and Infrequent Flows - Over Bank 2.5 years ARI		VH	L-	M	H/H	M	Predefined Tolerable			N/A	The regulated Peel River is a major tributary in the river reach below Keepit Dam that may supplement PEW or HEW releases in order to achieve bank full or over bank flows Additionally this risk result is driven by a very high consequence and a low likelihood rating. The risk is tolerable because of the low likelihood.	MER planned for WSP objectives
	High and Infrequent Flows - Over Bank 5.0 years ARI		VH	L-	M	H/H	M	Predefined Tolerable			N/A	The regulated Peel River is a major tributary in the river reach below Keepit Dam that may supplement PEW or HEW releases in order to achieve bank full or over bank flows. Additionally this risk result is driven by a very high consequence and a low likelihood rating. The risk is tolerable because of the low likelihood.	MER planned for WSP objectives

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

River reach within WRP Area	Flow or Extraction Characteristic	Current Critical Mechanisms	Consequence	Likelihood	Risk Rating	Data confidence (Consequence / Likelihood)	Predefined Tolerable Risk Level	Risk treatment option	Strategies	New Critical Mechanisms	Residual Risk Rating	Explanation of tolerable risk application OR Explanation of why risk cannot be addressed	Monitoring & Evaluation
Namoi at Mollee	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) E11 - Coordinate release of environmental water provision/ held environmental water with natural flow events. E6b - Supplementary access: In the lower Namoi access to a supplementary event is currently on a trial basis: prior to 1 July 2019, should not exceed 50% of a supplementary event (all year); and after 30 June 2019: 10% access of the supplementary event between 1 July and 31 October and 50% between 1 November and 30 June. E8 - Strategic use of environmental water provisions (EWP) as described in the WSP (e.g., Namoi end-of-system minimum daily flows in June, July and August at Walgett when the combined capacity of Keepit and Split Rock dams ≥120 GL).	VH	H-	H	H/H	H	Predefined Tolerable	1 Limit consumptive water extractions in the WRP area to the predefined share of available water. 2 Protect a portion of high flow events in the Namoi WRP area. 3 Provide discretionary environmental watering events in the regulated river and downstream unregulated river sections of the WRP area. 4 Manage environmental water to meet flow targets specified in the Namoi LTWP. 5 Protect low flow habitats from accelerated rates of drying. 7 Protect important lagoons and wetlands within the WRP area. 8 Protect tributary flows within the WRP area as they move from the unregulated water source into the regulated river water source. 10 Recognise the contribution of Keepit Dam release strategies towards the maintenance of water quality within the regulated sections of the WRP area.	None required – risks are tolerable. However, the following mechanisms may still be applied: N1 Sustainable Diversion Limits. N3 - Strategic use of environmental water (EWA/ECA) and relevant held environmental water licences as guided by the LTWP In this river reach the mechanism may be used to improve base/low flows, freshes and infrequent flows.	N/A	Risk inherent to regulated river reaches. Zero flow periods cannot be scheduled due to dam operational constraints and requirements to deliver water orders and BLR (stock and domestic) replenishment flows. This impact is most pronounced in reaches closest to Keepit Dam. Zero flow periods will exhibit more natural patterns towards the downstream end of the water source.	No MER planned
	Base-flow or Low Flows		VH	M+	H	H/H	H	Predefined Tolerable			N/A	Risk inherent to regulated river reaches. Base flows cannot be scheduled due to dam operational constraints and requirements to deliver water orders and BLR (stock and domestic) replenishment flows. This impact is most pronounced in reaches closest to Keepit Dam. Base flow periods will exhibit more natural patterns towards the downstream end of the water source.	No MER planned
	Fresh Flows		VH	H+	H	H/H	H	Predefined Tolerable			N/A	Water ordering patterns have altered the duration and timing of freshes leading to unnaturally long events in summer and less events in winter. This impact is most pronounced in the Lower Namoi River where there are no significant tributary inflows, and in the Gunidgera / Pian Creek system.	MER planned for WSP objectives
	High and Infrequent Flows - Bank Full 1.5 years ARI		VH	M-	H	H/H	H	Predefined Tolerable			N/A	There is a limited capacity to influence high flow events in WSP without significant 3rd party impacts from reducing access. It is suggested that the water purchased by the Commonwealth and the LTWP would be used to improve environmental outcomes and address risk for these high flows.	MER planned for WSP objectives
	High and Infrequent Flows - Over Bank 2.5 years ARI		VH	L-	M	H/H	M	Predefined Tolerable			N/A	There is a limited capacity to influence high flow events in WSP without significant 3rd party impacts from reducing access. It is suggested that the water purchased by the Commonwealth and the LTWP would be used to improve environmental outcomes and address risk for these high flows. Additionally this risk result is driven by a very high consequence and a low likelihood rating. The risk is tolerable because of the low likelihood.	MER planned for WSP objectives
	High and Infrequent Flows - Over Bank 5.0 years ARI		VH	L-	M	H/H	M	Predefined Tolerable			N/A	There is a limited capacity to influence high flow events in WSP without significant 3rd party impacts from reducing access. It is suggested that the water purchased by the Commonwealth and the LTWP would be used to improve environmental outcomes and address risk for these high flows. Additionally this risk result is driven by a very high consequence and a low likelihood rating. The risk is tolerable because of the low likelihood.	MER planned for WSP objectives
Namoi at Bugilbone (Riverview)	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) E11 - Coordinate release of environmental water provision/ held environmental water with natural flow events. E6b - Supplementary access: In the lower Namoi access to a supplementary event is currently on a trial basis: prior to 1 July 2019, should not exceed 50% of a supplementary event (all year); and after 30 June 2019: 10% access of the supplementary event between 1 July and 31	VH	H+	H	H/H	H	Predefined Tolerable	1 Limit consumptive water extractions in the WRP area to the predefined share of available water. 2 Protect a portion of high flow events in the Namoi WRP area. 3 Provide discretionary environmental watering events in the regulated river and downstream unregulated river sections of the WRP area. 4 Manage environmental water to meet flow targets specified in the Namoi LTWP. 5 Protect low flow habitats from accelerated rates of drying. 7 Protect important lagoons and wetlands within the WRP area. 8 Protect tributary flows within the WRP area as they move	None required – risks are tolerable. However, the following mechanisms may still be applied: N1 Sustainable Diversion Limits. N3 - Strategic use of environmental water (EWA/ECA) and relevant held environmental water licences as guided by the LTWP In this river reach the mechanism may be used to improve base/low flows, freshes and infrequent flows.	N/A	Risk inherent to regulated river reaches. Zero flow periods cannot be scheduled due to dam operational constraints and requirements to deliver water orders and BLR (stock and domestic) replenishment flows. The Lower Namoi Supplementary Flow (E6b) rule protects unregulated tributary inflows and end-of-system flow (E8) rule protects a portion of regulated flows (winter months) that have the ability to improve zero and base flow periods	No MER planned
	Base-flow or Low Flows		VH	H-	H	H/H	H	Predefined Tolerable			N/A	Risk inherent to regulated river reaches. Base flows cannot be scheduled due to dam operational constraints and requirements to deliver water orders and BLR (stock and domestic) replenishment flows. The Lower Namoi Supplementary Flow (E6b) rule protects unregulated tributary inflows and end-of-system flow (E8) rule protects a portion of regulated flows (winter months) that have the ability to improve zero and base flow periods	No MER planned
	Fresh Flows		VH	L-	M	H/H	M	Predefined Tolerable			N/A	Water ordering patterns have altered the duration and timing of freshes leading to unnaturally long events in summer and less events in winter. This impact is most pronounced in the Lower Namoi River where there are no significant tributary inflows, and in the Gunidgera / Pian Creek system Additionally this risk result is driven by a very high consequence and a low likelihood rating. The risk is tolerable because of the low likelihood.	MER planned for WSP objectives

SECTION 4.3 RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT & CAPACITY TO MEET EWRS [E(W)] - REGULATED SYSTEM													
River reach within WRP Area	**Flow or Extraction Characteristic**	**Current Critical Mechanisms**	**Consequence**	**Likelihood**	**Risk Rating**	**Data confidence (Consequence / Likelihood)**	**Predefined Tolerable Risk Level**	**Risk treatment option**	**Strategies**	**New Critical Mechanisms**	**Residual Risk Rating**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring & Evaluation**
	High and Infrequent Flows - Bank Full 1.5 years ARI	October and 50% between 1 November and 30 June. E8 - Strategic use of environmental water provisions (EWP) as described in the WSP (e.g., Namoi end-of-system minimum daily flows in June, July and August at Walgett when the combined capacity of Keepit and Split Rock dams ≥120 GL). E7 – protect large flow events in the Namoi WRP area to meet flow targets in the downstream Barwon-Darling Watercourse (SW12).	VH	L-	M	H/H	M	Predefined Tolerable	from the unregulated water source into the regulated river water source. 10 Recognise the contribution of Keepit Dam release strategies towards the maintenance of water quality within the regulated sections of the WRP area.		N/A	There is a limited capacity to influence high flow events in WSP without significant 3rd party impacts from reducing access. It is suggested that the water purchased by the Commonwealth and the LTWP would be used to improve environmental outcomes and address risk for these high flows. Additionally this risk result is driven by a very high consequence and a low likelihood rating. The risk is tolerable because of the low likelihood.	MER planned for WSP objectives
	High and Infrequent Flows - Over Bank 2.5 years ARI		VH	L-	M	H/H	M	Predefined Tolerable			N/A	There is a limited capacity to influence high flow events in WSP without significant 3rd party impacts from reducing access. It is suggested that the water purchased by the Commonwealth and the LTWP would be used to improve environmental outcomes and address risk for these high flows. Additionally this risk result is driven by a very high consequence and a low likelihood rating. The risk is tolerable because of the low likelihood.	MER planned for WSP objectives
	High and Infrequent Flows - Over Bank 5.0 years ARI		VH	L-	M	H/H	M	Predefined Tolerable			N/A	There is a limited capacity to influence high flow events in WSP without significant 3rd party impacts from reducing access. It is suggested that the water purchased by the Commonwealth and the LTWP would be used to improve environmental outcomes and address risk for these high flows. Additionally this risk result is driven by a very high consequence and a low likelihood rating. The risk is tolerable because of the low likelihood.	MER planned for WSP objectives
Namoi at Goangra	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) E11 - Coordinate release of environmental water provision/ held environmental water with natural flow events. E6b - Supplementary access: In the lower Namoi access to a supplementary event is currently on a trial basis: prior to 1 July 2019, should not exceed 50% of a supplementary event (all year); and after 30 June 2019: 10% access of the supplementary event between 1 July and 31 October and 50% between 1 November and 30 June. E8 - Strategic use of environmental water provisions (EWP) as described in the WSP (e.g., Namoi end-of-system minimum daily flows in June, July and August at Walgett when the combined capacity of Keepit and Split Rock dams ≥120 GL). E7 – protect large flow events in the Namoi WRP area to	H	H-	H	H/H	H	Predefined Tolerable	1 Limit consumptive water extractions in the WRP area to the predefined share of available water. 2 Protect a portion of high flow events in the Namoi WRP area. 3 Provide discretionary environmental watering events in the regulated river and downstream unregulated river sections of the WRP area. 4 Manage environmental water to meet flow targets specified in the Namoi LTWP. 5 Protect low flow habitats from accelerated rates of drying. 7 Protect important lagoons and wetlands within the WRP area. 8 Protect tributary flows within the WRP area as they move from the unregulated water source into the regulated river water source. 10 Recognise the contribution of Keepit Dam release strategies towards the maintenance of water quality within the regulated sections of the WRP area.	None required – risks are tolerable. However, the following mechanisms may still be applied: N1 Sustainable Diversion Limits. N3 - Strategic use of environmental water (EWA/ECA) and relevant held environmental water licences as guided by the LTWP In this river reach the mechanism may be used to improve base/low flows, freshes and infrequent flows.	N/A	Risk inherent to regulated river reaches. Zero flow periods cannot be scheduled due to dam operational constraints and requirements to deliver water orders and BLR (stock and domestic) replenishment flows. The Lower Namoi Supplementary Flow (E6b) rule protects unregulated tributary inflows and end-of-system flow (E8) rule protects a portion of regulated flows (winter months) that have the ability to improve zero and base flow periods.	No MER planned
	Base-flow or Low Flows		H	H-	H	H/H	H	Predefined Tolerable			N/A	Risk inherent to regulated river reaches. Zero flow periods cannot be scheduled due to dam operational constraints and requirements to deliver water orders and BLR (stock and domestic) replenishment flows. The Lower Namoi Supplementary Flow (E6b) rule protects unregulated tributary inflows and end-of-system flow (E8) rule protects a portion of regulated flows (winter months) that have the ability to improve zero and base flow periods.	No MER planned
	Fresh Flows		H	M-	M	H/H	M	Predefined Tolerable			N/A	There is a limited capacity to influence high flow events in WSP without significant 3rd party impacts from reducing access. It is suggested that the water purchased by the Commonwealth and the LTWP would be used to improve environmental outcomes and address risk for these high flows.	MER planned for WSP objectives
	High and Infrequent Flows - Bank Full 1.5 years ARI		H	L-	L	H/H	N/A	N/A	None required – risk are low		N/A		

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

River reach within WRP Area	Flow or Extraction Characteristic	Current Critical Mechanisms	Consequence	Likelihood	Risk Rating	Data confidence (Consequence / Likelihood)	Predefined Tolerable Risk Level	Risk treatment option	Strategies	New Critical Mechanisms	Residual Risk Rating	Explanation of tolerable risk application OR Explanation of why risk cannot be addressed	Monitoring & Evaluation
	High and Infrequent Flows - Over Bank 2.5 years ARI	meet flow targets in the downstream Barwon-Darling Watercourse (SW12).	H	L-	L	H/H	N/A	N/A	None required – risk are low		N/A		
	High and Infrequent Flows - Over Bank 5.0 years ARI		H	L-	L	H/H	N/A	N/A	None required – risk are low		N/A		
Pian Creek at Rossmore	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) E11 - Coordinate release of environmental water provision/ held environmental water with natural flow events. E6b - Supplementary access: In the lower Namoi access to a supplementary event is currently on a trial basis: prior to 1 July 2019, should not exceed 50% of a supplementary event (all year); and after 30 June 2019: 10% access of the supplementary event between 1 July and 31 October and 50% between 1 November and 30 June. E7 – protect large flow events in the Namoi WRP area to meet flow targets in the downstream Barwon-Darling Watercourse (SW12).	H	H+	H	H/H	H	Predefined Tolerable	1 Limit consumptive water extractions in the WRP area to the predefined share of available water. 2 Protect a portion of high flow events in the Namoi WRP area. 3 Provide discretionary environmental watering events in the regulated river and downstream unregulated river sections of the WRP area. 4 Manage environmental water to meet flow targets specified in the Namoi LTWP. 5 Protect low flow habitats from accelerated rates of drying. 10 Recognise the contribution of Keepit Dam release strategies towards the maintenance of water quality within the regulated sections of the WRP area.	None required – risks are tolerable. However, the following mechanisms may still be applied: N1 Sustainable Diversion Limits. N3 - Strategic use of environmental water (EWA/ECA) and relevant held environmental water licences as guided by the LTWP In this river reach the mechanism may be used to improve base/low flows, freshes and infrequent flows.	N/A	Risk inherent to regulated river reaches. The Gunidgera / Pian system is a regulated distributary channel of the Lower Namoi River with diversions from Gunidgera Weir; zero flow periods cannot be scheduled. This system generally receives flows in line with specific irrigation orders thus resulting in a high risk outcome.	No MER planned
	Base-flow or Low Flows		H	H+	H	H/H	H	Predefined Tolerable			N/A	Risk inherent to regulated river reaches. The Gunidgera / Pian system is a regulated distributary channel of the Lower Namoi River with diversions from Gunidgera Weir; base flow periods cannot be scheduled. This system generally receives flows in line with specific irrigation orders thus resulting in a high risk outcome.	No MER planned
	Fresh Flows		H	H+	H	H/H	H	Predefined Tolerable			N/A	Water ordering patterns have altered the duration and timing of freshes leading to unnaturally long events in summer and less events in winter. This impact is most pronounced in the Lower Namoi River where there are no significant tributary inflows, and in the Gunidgera / Pian Creek system	MER planned for WSP objectives
	High and Infrequent Flows - Bank Full 1.5 years ARI		H	H+	H	H/H	H	Predefined Tolerable			N/A	There is a limited capacity to influence high flow events in WSP without significant 3rd party impacts from reducing access.	MER planned for WSP objectives
	High and Infrequent Flows - Over Bank 2.5 years ARI		H	H+	H	H/H	H	Predefined Tolerable			N/A	There is a limited capacity to influence high flow events in WSP without significant 3rd party impacts from reducing access.	MER planned for WSP objectives
	High and Infrequent Flows - Over Bank 5.0 years ARI		H	H+	H	H/H	H	Predefined Tolerable			N/A	There is a limited capacity to influence high flow events in WSP without significant 3rd party impacts from reducing access.	MER planned for WSP objectives
Gunidgera Creek at downstream Pian Cutting	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) E11 - Coordinate release of environmental water provision/ held environmental water with natural flow events. E6b - Supplementary access: In the lower Namoi access to a supplementary event is currently on a trial basis: prior to 1 July 2019, should not exceed 50% of a	M	H+	H	H/H	H	Predefined Tolerable	1 Limit consumptive water extractions in the WRP area to the predefined share of available water. 2 Protect a portion of high flow events in the Namoi WRP area. 3 Provide discretionary environmental watering events in the regulated river and downstream unregulated river sections of the WRP area. 4 Manage environmental water to meet flow targets specified in the Namoi LTWP. 5 Protect low flow habitats from accelerated rates of drying.	None required – risks are tolerable. However, the following mechanisms may still be applied: N1 Sustainable Diversion Limits. N3 - Strategic use of environmental water (EWA/ECA) and relevant held environmental water licences as guided by the LTWP In this river reach the mechanism may be	N/A	Risk inherent to regulated river reaches. Zero flow periods cannot be scheduled due to dam operational constraints and requirements to deliver water orders and BLR (stock and domestic) replenishment flows. This impact is most pronounced in reaches closest to Keepit Dam. Zero flow periods will exhibit more natural patterns towards the downstream end of the water source.	No MER planned
	Base-flow or Low Flows		M	M+	M	H/H	M	Predefined Tolerable			N/A	Risk inherent to regulated river reaches. Base flows cannot be scheduled due to dam operational constraints and requirements to deliver water orders and BLR (stock and domestic) replenishment flows. This impact is most pronounced in reaches closest to Keepit Dam. Zero flow periods will exhibit more natural patterns towards the downstream end of the water source.	No MER planned
	Fresh Flows		M	M-	M	H/H	M	Predefined Tolerable			N/A	Water ordering patterns have altered the duration and timing of freshes leading to unnaturally long events in summer and less events in winter. This impact is most pronounced in the Lower Namoi River where there are no significant tributary inflows, and in the Gunidgera / Pian Creek system	MER planned for WSP objectives

SECTION 4.3 RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT & CAPACITY TO MEET EWRS [E(W)] - REGULATED SYSTEM													
River reach within WRP Area	**Flow or Extraction Characteristic**	**Current Critical Mechanisms**	**Consequence**	**Likelihood**	**Risk Rating**	**Data confidence (Consequence / Likelihood)**	**Predefined Tolerable Risk Level**	**Risk treatment option**	**Strategies**	**New Critical Mechanisms**	**Residual Risk Rating**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring & Evaluation**
	High and Infrequent Flows - Bank Full 1.5 years ARI	supplementary event (all year); and after 30 June 2019: 10% access of the supplementary event between 1 July and 31 October and 50% between 1 November and 30 June. E7 – protect large flow events in the Namoi WRP area to meet flow targets in the downstream Barwon-Darling Watercourse (SW12).	M	H-	H	H/H	H	Predefined Tolerable	10 Recognise the contribution of Keepit Dam release strategies towards the maintenance of water quality within the regulated sections of the WRP area.	used to improve base/low flows, freshes and infrequent flows.	N/A	There is a limited capacity to influence high flow events in WSP without significant 3rd party impacts from reducing access.	MER planned for WSP objectives
	High and Infrequent Flows - Over Bank 2.5 years ARI		M	M-	M	H/H	M	Predefined Tolerable			N/A	There is a limited capacity to influence high flow events in WSP without significant 3rd party impacts from reducing access.	MER planned for WSP objectives
	High and Infrequent Flows - Over Bank 5.0 years ARI		M	M-	M	H/H	M	Predefined Tolerable			N/A	There is a limited capacity to influence high flow events in WSP without significant 3rd party impacts from reducing access.	MER planned for WSP objectives

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

Water source within WRP Area	Flow or Extraction Characteristic	Current Critical Mechanisms	Consequence	Likelihood	Risk Rating	Data confidence (Consequence / Likelihood)	Predefined Tolerable Risk Level	Risk treatment option	Strategies	New Critical Mechanisms	Tolerable Risk Level	Explanation of tolerable risk application OR Explanation of why risk cannot be addressed	Monitoring and Evaluation
Upper Baradine Creek	Zero Flow Periods		L	L^0	L	H/M	N/A	N/A	None required - risk is low		N/A		
	Base-flow or Low Flows	E4 - Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use.	L	H-	M	H/M	N/A	C	1 Limit consumptive water extractions in the WRP area to the predefined share of available water. 5 Protect low flow habitats from accelerated rates of drying. 6 Protect pools in streams, wetlands, lagoons and floodplains within the WRP area during dry periods. 17 Improve knowledge used to assess risk in unregulated sections of the WRP area.	N1 – Sustainable Diversion Limits. N5 – Projects resulting from application of risk treatment option C Fill knowledge gap / evaluate effectiveness of existing strategies	M	Decision tool indicates risk is tolerable as there is low potential for extraction to impact ecological values Tolerable – recommended monitoring at WAL activation (likelihood is low as assets / values are above WAL locations)	MER planned for WSP objectives MER for N5
	Fresh Flows		L	L-	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Bank Full 1.5 years ARI		L	L^0	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Over Bank 2.5 years ARI		L	L^0	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Over Bank 5.0 years ARI		L	L^0	L	H/M	N/A	N/A	None required - risk is low		N/A		
Lower Baradine Creek (Effluent)	Zero Flow Periods	E4 - Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use.	L	M*	L	H/L	N/A	N/A	*Likelihood is based on expert opinion. As this is an effluent stream zero, base and fresh flows could not be modelled based on regulated river metrics.	None required - risk is low	N/A		
	Base-flow or Low Flows		L	M*	L	H/L	N/A	N/A			N/A		
	Fresh Flows		L	M*	L	H/L	N/A	N/A			N/A		
	High and Infrequent Flows - Bank Full 1.5 years ARI	E4 - Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use.	L	L-	L	H/M	N/A	N/A	None required – risk is low		N/A		
	High and Infrequent Flows - Over Bank 2.5 years ARI		L	L-	L	H/M	N/A	N/A	None required – risk is low		N/A		
	High and Infrequent Flows - Over Bank 5.0 years ARI		L	L-	L	H/M	N/A	N/A	None required – risk is low		N/A		

SECTION 4.3 RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT & CAPACITY TO MEET EWRS [E(W)] - UNREGULATED WATER SOURCES													
Water source within WRP Area	**Flow or Extraction Characteristic**	**Current Critical Mechanisms**	**Consequence**	**Likelihood**	**Risk Rating**	**Data confidence (Consequence / Likelihood)**	**Predefined Tolerable Risk Level**	**Risk treatment option**	**Strategies**	**New Critical Mechanisms**	**Tolerable Risk Level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and Evaluation**
Bluevale (all creeks)	Zero Flow Periods		L	L^0	L	H/M	N/A	N/A	None required – risk is low		N/A		
	Base-flow or Low Flows	E4 - Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use. E13 - Cease / commence to pump rules for in-stream and off-river pools. CtP when water level in Gulligal lagoon is less than 80% full capacity	L	H-	M	H/M	N/A	C	1 Limit consumptive water extractions in the WRP area to the predefined share of available water. 5 Protect low flow habitats from accelerated rates of drying. 6 Protect pools in streams, wetlands, lagoons and floodplains within the WRP area during dry periods. 7 Protect important lagoons and wetlands within the WRP area. 17 Improve knowledge used to assess risk in unregulated sections of the WRP area.	N1 – Sustainable Diversion Limits. N5 – Projects resulting from application of risk treatment option C Fill knowledge gap / evaluate effectiveness of existing strategies	M	Decision tool indicates risk is tolerable as there is low potential for extraction to impact ecological values Tolerable – recommended monitoring at WAL activation (likelihood is low as assets / values are above WAL locations)	MER planned for WSP objectives MER for N5
	Fresh Flows		L	L-	L	H/M	N/A	N/A	None required – risk is low		N/A		
	High and Infrequent Flows - Bank Full 1.5 years ARI		L	L^0	L	H/M	N/A	N/A	None required – risk is low		N/A		
	High and Infrequent Flows - Over Bank 2.5 years ARI		L	L^0	L	H/M	N/A	N/A	None required – risk is low		N/A		
	High and Infrequent Flows - Over Bank 5.0 years ARI		L	L^0	L	H/M	N/A	N/A	None required – risk is low		N/A		
Bohena Creek	Zero Flow Periods	E4 - Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use. E13 - Cease / commence to pump rules for in-stream and off-river pools. E15 - Restrict construction of in-river dams on 3rd order or higher streams.	VH	L-	M	H/M	N/A	C	1 Limit consumptive water extractions in the WRP area to the predefined share of available water. 5 Protect low flow habitats from accelerated rates of drying. 6 Protect pools in streams, wetlands, lagoons and floodplains within the WRP area during dry periods. 17 Improve knowledge used to assess risk in unregulated sections of the WRP area.	N1 – Sustainable Diversion Limits. N5 – Projects resulting from application of risk treatment option C Fill knowledge gap / evaluate effectiveness of existing strategies	M	Tolerable – recommended monitoring at WAL activation (likelihood is low but water source contains very high value assets and/or values)	MER planned for WSP objectives MER for N5
	Base-flow or Low Flows		VH	L-	M	H/M	N/A	C			M		MER planned for WSP objectives MER for N5
	Fresh Flows		VH	L^0	M	H/M	N/A	C			M		MER planned for WSP objectives MER for N5
	High and Infrequent Flows - Bank Full 1.5 years ARI	E15 - Restrict construction of in-river dams on 3rd order or higher streams.	VH	L^0	M	H/M	N/A	C			M		MER planned for WSP objectives MER for N5
	High and Infrequent Flows - Over Bank 2.5 years ARI		VH	L^0	M	H/M	N/A	C			M		MER planned for WSP objectives MER for N5
	High and Infrequent Flows - Over Bank 5.0 years ARI		VH	L^0	M	H/M	N/A	C			M	Tolerable – recommended monitoring at WAL activation (likelihood is low but water source contains very high value assets	MER planned for WSP objectives MER for N5

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

Water source within WRP Area	Flow or Extraction Characteristic	Current Critical Mechanisms	Consequence	Likelihood	Risk Rating	Data confidence (Consequence / Likelihood)	Predefined Tolerable Risk Level	Risk treatment option	Strategies	New Critical Mechanisms	Tolerable Risk Level	Explanation of tolerable risk application OR Explanation of why risk cannot be addressed	Monitoring and Evaluation
												and/or values)	
Brigalow Creek	Zero Flow Periods	E4 - Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use. E12 - Cease / commence to pump rules for streams. Brigalow Creek Management Zone (MZ): CtP 4 ML/d at Tharlane gauge (419083) E13 - Cease / commence to pump rules for in-stream and off-river pools.	L	L^0	L	H/M	N/A	N/A	None required - risk is low		N/A		
	Base-flow or Low Flows		L	L^0	L	H/M	N/A	N/A	None required - risk is low		N/A		
	Fresh Flows		L	L^-	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Bank Full 1.5 years ARI		I	L^0	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Over Bank 2.5 years ARI		L	L^0	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Over Bank 5.0 years ARI		L	L^0	L	H/M	N/A	N/A	None required - risk is low		N/A		
Bundock Creek	Zero Flow Periods	E4 - Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use. E12 - Cease / commence to pump rules for streams. CtP when water level in Wee Waa lagoon is less than 80% full capacity. E13 - Cease / commence to pump rules for in-stream and off-river pools. E15 - Restrict construction of in-river dams on 3rd order or higher streams.	L	H+	M	H/M	N/A	C	1 Limit consumptive water extractions in the WRP area to the predefined share of available water. 5 Protect low flow habitats from accelerated rates of drying. 6 Protect pools in streams, wetlands, lagoons and floodplains within the WRP area during dry periods. 17 Improve knowledge used to assess risk in unregulated sections of the WRP area.	N1 – Sustainable Diversion Limits. N5 – Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies	M	Tolerable – recommended monitoring at WAL activation (likelihood is low as assets / values are above WAL locations)	MER planned for WSP objectives MER for N5
	Base-flow or Low Flows		L	H-	M	H/M	N/A	C			M	Tolerable – recommended monitoring at WAL activation (likelihood is low as assets / values are above WAL locations)	MER planned for WSP objectives MER for N5
	Fresh Flows		L	M-	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Bank Full 1.5 years ARI		L	L0	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Over Bank 2.5 years ARI		L	L0	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Over Bank 5.0 years ARI		L	L0	L	H/M	N/A	N/A	None required - risk is low		N/A		

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

Water source within WRP Area	Flow or Extraction Characteristic	Current Critical Mechanisms	Consequence	Likelihood	Risk Rating	Data confidence (Consequence / Likelihood)	Predefined Tolerable Risk Level	Risk treatment option	Strategies	New Critical Mechanisms	Tolerable Risk Level	Explanation of tolerable risk application OR Explanation of why risk cannot be addressed	Monitoring and Evaluation
Chaffey with CtP	Zero Flow Periods	E4 - Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use. E12 - Cease / commence to pump rules for streams. Chaffey tributaries management zone (MZ): CtP when no visible flow at pump site. Peel River MZ: CtP of 2 ML/d at Taroona gauge (419081) E13 - Cease / commence to pump rules for in-stream and off-river pools. E15 - Restrict construction of in-river dams on 3rd order or higher streams.	M	M+	M	H/M	N/A	C B	1 Limit consumptive water extractions in the WRP area to the predefined share of available water. 5 Protect low flow habitats from accelerated rates of drying. 6 Protect pools in streams, wetlands, lagoons and floodplains within the WRP area during dry periods. 17 Improve knowledge used to assess risk in unregulated sections of the WRP area. 18 Improve knowledge of effectiveness of existing strategies	N1 – Sustainable Diversion Limits. N5 – Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies N6 - Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies	Not tolerable	Decision tool indicates risk is not tolerable as there is medium likelihood for extraction to impact ecological values and a river gauge is available. Frequent likelihood monitoring is recommended These risk results cannot be addressed during WRP development as NSW planning principles minimise change for WSPs within their initial ten year period to provide certainty for water users	MER planned for WSP objectives MER for N5 and N6
	Base-flow or Low Flows		M	M-	M	H/M	N/A	C B			Not Tolerable		
	Fresh Flows		M	L-	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Bank Full 1.5 years ARI		M	L0	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Over Bank 2.5 years ARI		M	L0	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Over Bank 5.0 years ARI		M	L0	L	H/M	N/A	N/A	None required - risk is low		N/A		
Cockburn River	Zero Flow Periods	E4 - Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use. E12 - Cease / commence to pump rules for streams. Cockburn River management zone CtP when flows ≤0.25 M height at Kootongal gauge (419099), or no visible flow at Evergreen rock bar 700-m upstream of Peel River confluence. E13 - Cease / commence to pump rules for in-stream and off-river pools. E15 - Restrict construction of in-river dams on 3rd order or higher streams.	M	H^{+}	H	H/M	N/A	C B	1 Limit consumptive water extractions in the WRP area to the predefined share of available water. 5 Protect low flow habitats from accelerated rates of drying. 6 Protect pools in streams, wetlands, lagoons and floodplains within the WRP area during dry periods. 17 Improve knowledge used to assess risk in unregulated sections of the WRP area. 18 Improve knowledge of effectiveness of existing strategies	N1 – Sustainable Diversion Limits. N5 – Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies N6 - Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies	Not tolerable	Decision tool indicates risk is not tolerable as there is high likelihood for extraction to impact ecological values and a river gauge is available. Frequent likelihood monitoring is recommended These risk results cannot be addressed during WRP development as NSW planning principles minimise change for WSPs within their initial ten year period to provide certainty for water users	MER planned for WSP objectives MER for N5 and N6
	Base-flow or Low Flows		M	H-	H	H/M	N/A	C B			Not tolerable		

SECTION 4.3 RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT & CAPACITY TO MEET EWRS [E(W)] - UNREGULATED WATER SOURCES												
Water source within WRP Area	**Flow or Extraction Characteristic**	**Current Critical Mechanisms**	**Consequence**	**Likelihood**	**Risk Rating**	**Data confidence (Consequence / Likelihood)**	**Predefined Tolerable Risk Level**	**Risk treatment option**	**Strategies**	**New Critical Mechanisms**	**Tolerable Risk Level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and Evaluation**
Coghill Creek	Fresh Flows		M	L-	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Bank Full 1.5 years ARI		M	L0	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Over Bank 2.5 years ARI		M	L0	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Over Bank 5.0 years ARI		M	L0	L	H/M	N/A	N/A	None required - risk is low		N/A		
	Zero Flow Periods		L	M+	L	H/M	N/A	N/A	None required - risk is low		N/A		
	Base-flow or Low Flows	E4 - Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use. E17 - Restrict construction of in-river dams on 3rd order or higher streams.	L	H-	M	H/M	N/A	C	1 Limit consumptive water extractions in the WRP area to the predefined share of available water. 5 Protect low flow habitats from accelerated rates of drying. 6 Protect pools in streams, wetlands, lagoons and floodplains within the WRP area during dry periods. 17 Improve knowledge used to assess risk in unregulated sections of the WRP area.	N1 – Sustainable Diversion Limits. N5 – Projects resulting from application of risk treatment option C Fill knowledge gap / evaluate effectiveness of existing strategies	M	The risk is tolerable because of the low consequence. Tolerable – recommended monitoring at WAL activation (likelihood is low as assets / values are above WAL locations)	MER planned for WSP objectives
	Fresh Flows		L	L-	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Bank Full 1.5 years ARI		L	L0	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Over Bank 2.5 years ARI		L	L0	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Over Bank 5.0 years ARI		L	L0	L	H/M	N/A	N/A	None required - risk is low		N/A		
Mid Coxs Creek	Zero Flow Periods	E4 - Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use. E12 - Cease / commence to pump rules for streams.	L	L+	L	H/M	N/A	N/A	None required - risk is low		N/A		
	Base-flow or Low Flows		L	L-	L	H/M	N/A	N/A	None required - risk is low		N/A		

SECTION 4.3 RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT & CAPACITY TO MEET EWRS [E(W)] - UNREGULATED WATER SOURCES													
Water source within WRP Area	**Flow or Extraction Characteristic**	**Current Critical Mechanisms**	**Consequence**	**Likelihood**	**Risk Rating**	**Data confidence (Consequence / Likelihood)**	**Predefined Tolerable Risk Level**	**Risk treatment option**	**Strategies**	**New Critical Mechanisms**	**Tolerable Risk Level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and Evaluation**
	Fresh Flows	Mid Coxs Creek Management Zone • CtP of 17.5 ML/d at Tambar Springs (419033) and 15 ML/day at Tourable gauge (419102). Pumping is not permitted from natural pools when the water level in the pool is lower than its full capacity. E13 - Cease / commence to pump rules for in-stream and off-river pools. E15 - Restrict construction of in-river dams on 3rd order or higher streams.	L	L-	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Bank Full 1.5 years ARI		L	L-	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Over Bank 2.5 years ARI		L	L0	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Over Bank 5.0 years ARI		L	L0	L	H/M	N/A	N/A	None required - risk is low		N/A		
	Zero Flow Periods		L	L0	L	H/M	N/A	N/AC	None required - risk is low		N/A	Decision tool indicates risk is tolerable as there is low potential for extraction to impact ecological values	
	Base-flow or Low Flows		L	L-	L	H/M	N/A	N/AC	None required - risk is low		N/A		
Lower Coxs Creek	Fresh Flows	E4 - Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use. E12 - Cease / commence to pump rules for streams. Lower Coxs Creek MZ CtP of 15 ML/day at Tourable Gauge (419102) and 11 ML/d at Boggabri gauge (419032) E13 - Cease / commence to pump rules for in-stream and off-river pools. E15 - Restrict construction of in-river dams on 3rd order or higher streams.	L	H-	M	H/M	N/A	C B	1 Limit consumptive water extractions in the WRP area to the predefined share of available water. 5 Protect low flow habitats from accelerated rates of drying. 6 Protect pools in streams, wetlands, lagoons and floodplains within the WRP area during dry periods. 17 Improve knowledge used to assess risk in unregulated sections of the WRP area.	N1 – Sustainable Diversion Limits. N5 – Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies N6 - Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies	Not tolerable	Decision tool indicates risk is not tolerable as there is high potential for extraction to impact ecological values and a river gauge is available. Frequent likelihood monitoring is recommended. These risk results cannot be addressed during WRP development as NSW planning principles minimise change for WSPs within their initial ten year period to provide certainty for water users.	MER planned for WSP objectives MER for N5 and N6
	High and Infrequent Flows - Bank Full 1.5 years ARI		L	L-	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Over Bank 2.5 years ARI		L	L-	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Over Bank 5.0 years ARI		L	L-	L	H/M	N/A	N/A	None required - risk is low		N/A		
Etoo Creek	Zero Flow Periods	E4 - Trade limits or prohibitions between surface water plan areas, water sources, and	H	L0	L	H/M	N/A	N/A	None required - risk is low		N/A		

SECTION 4.3 RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT & CAPACITY TO MEET EWRS [E(W)] - UNREGULATED WATER SOURCES												
Water source within WRP Area	**Flow or Extraction Characteristic**	**Current Critical Mechanisms**	**Consequence**	**Likelihood**	**Risk Rating**	**Data confidence (Consequence / Likelihood)**	**Predefined Tolerable Risk Level**	**Risk treatment option**	**Strategies**	**New Critical Mechanisms**	**Tolerable Risk Level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and Evaluation**
	Base-flow or Low Flows	management zones to manage growth in use. E13 - Cease / commence to pump rules for in-stream and off-river pools.	H	L^0	L	H/M	N/A	N/A	None required – risk is low		N/A		
	Fresh Flows		H	L^0	L	H/M	N/A	N/A	None required – risk is low		N/A		
	High and Infrequent Flows - Bank Full 1.5 years ARI		H	L^0	L	H/M	N/A	N/A	None required – risk is low		N/A		
	High and Infrequent Flows - Over Bank 2.5 years ARI		H	L^0	L	H/M	N/A	N/A	None required – risk is low		N/A		
	High and Infrequent Flows - Over Bank 5.0 years ARI		H	L^0	L	H/M	N/A	N/A	None required – risk is low		N/A		
Talluba Creek	Zero Flow Periods	E4 - Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use. E13 - Cease / commence to pump rules for in-stream and off-river pools. E17 - Restrict construction of in-river dams on 3rd order or higher streams.	H	L^0	L	H/M	N/A	N/A	None required – risk is low		N/A		
	Base-flow or Low Flows		H	L^-	L	H/M	N/A	N/A	None required - risk is low		N/A		
	Fresh Flows		H	L^-	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Bank Full 1.5 years ARI		H	L0	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Over Bank 2.5 years ARI		H	L0	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Over Bank 5.0 years ARI		H	L0	L	H/M	N/A	N/A	None required - risk is low		N/A		
Eulah Creek	Zero Flow Periods	E4 - Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use. E13 - Cease / commence to pump rules for in-stream and off-river pools.	L	L^0	L	H/M	N/A	N/A	None required - risk is low		N/A		
	Base-flow or Low Flows		L	M^-	L	H/M	N/A	N/A	None required - risk is low		N/A		
	Fresh Flows	E4 - Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use. E13 - Cease / commence to pump rules for in-stream and	L	L^-	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Bank Full 1.5 years ARI		L	L^-	L	H/M	N/A	N/A	None required - risk is low		N/A		

SECTION 4.3 RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT & CAPACITY TO MEET EWRS [E(W)] - UNREGULATED WATER SOURCES												
Water source within WRP Area	**Flow or Extraction Characteristic**	**Current Critical Mechanisms**	**Consequence**	**Likelihood**	**Risk Rating**	**Data confidence (Consequence / Likelihood)**	**Predefined Tolerable Risk Level**	**Risk treatment option**	**Strategies**	**New Critical Mechanisms**	**Tolerable Risk Level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and Evaluation**
	High and Infrequent Flows - Over Bank 2.5 years ARI	off-river pools.	L	L^{-}	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Over Bank 5.0 years ARI		L	L^{0}	L	H/M	N/A	N/A	None required - risk is low		N/A		
Goonoo Goonoo Creek	Zero Flow Periods	E4 - Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use. E12 - Cease / commence to pump rules for streams. Downstream Boiling Down creek MZ: CtP no visible flow at Timbumburri gauge and upstream Cala lane Bridge Upstream Boiling down Creek and tributaries MZ: CtP no visible flow in vicinity of pump site. E13 - Cease / commence to pump rules for in-stream and off-river pools. E15 - Restrict construction of in-river dams on 3rd order or higher streams	L	H^{+}	M	H/M	N/A	B C	1 Limit consumptive water extractions in the WRP area to the predefined share of available water. 5 Protect low flow habitats from accelerated rates of drying. 6 Protect pools in streams, wetlands, lagoons and floodplains within the WRP area during dry periods. 17 Improve knowledge used to assess risk in unregulated sections of the WRP area.	N1 – Sustainable Diversion Limits. N5 – Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies N6 - Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies	Not Tolerable	Decision tool indicates risk is not tolerable as there is high potential for extraction (Likelihood) to impact ecological values. These risk results cannot be addressed during WRP development as NSW planning principles minimise change for WSPs within their initial ten year period to provide certainty for water users.	MER planned for WSP objectives MER for N5 and N6
	Base-flow or Low Flows		L	H^{-}	M	H/M	N/A	B C			Not Tolerable		
	Fresh Flows	E4 - Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use.	L	L^{-}	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Bank Full 1.5 years ARI		L	L^{-}	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Over Bank 2.5 years ARI		L	L^{0}	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Over Bank 5.0 years ARI		L	L^{0}	L	H/M	N/A	N/A	None required - risk is low		N/A		
Keepit	Zero Flow Periods	E4 - Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use. E13 - Cease / commence to pump rules for in-stream and off-river pools.	L	H^{+}	M	H/M	N/A	C D	1 Limit consumptive water extractions in the WRP area to the predefined share of available water. 5 Protect low flow habitats from accelerated rates of drying. 6 Protect pools in streams, wetlands, lagoons and floodplains within the WRP area during dry periods. 17 Improve knowledge used to	N1 – Sustainable Diversion Limits. N5 – Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies N4 – Limit growth in BLR when a land holding is subdivided and there is high hydrological stress on the river or aquifer	M	The risk is tolerable because of the low consequence. Tolerable – recommended monitoring at WAL activation (impact likely to occur with growth in use)	MER planned for WSP objectives MER for N4 and N5
	Base-flow or Low Flows		L	H^{-}	M	H/M	N/A	C D			M		

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

Water source within WRP Area	Flow or Extraction Characteristic	Current Critical Mechanisms	Consequence	Likelihood	Risk Rating	Data confidence (Consequence / Likelihood)	Predefined Tolerable Risk Level	Risk treatment option	Strategies	New Critical Mechanisms	Tolerable Risk Level	Explanation of tolerable risk application OR Explanation of why risk cannot be addressed	Monitoring and Evaluation
									assess risk in unregulated sections of the WRP area.				
	Fresh Flows	E4 - Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use.	L	L-	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Bank Full 1.5 years ARI		L	L0	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Over Bank 2.5 years ARI		L	L0	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Over Bank 5.0 years ARI		L	L0	L	H/M	N/A	N/A	None required - risk is low		N/A		
Lake Goran	Zero Flow Periods	E4 - Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use. E12 - Cease / commence to pump rules for streams. Lake Goran MZ: CtP water level at height of 294.7 m AHD at Hokey Pokey gauge (419066) E13 - Cease / commence to pump rules for in-stream and off-river pools.	VL	M*	L*	H/L	N/A	N/A	*Likelihood is based on expert opinion. Flow thresholds could not be modelled as the water source is not connected to a river system. This and a Very low Consequence score results in a 'Low' risk rating.	None required - risk is low	N/A		
	Base-flow or Low Flows		VL	M*	L*	H/L	N/A	N/A			N/A		
	Fresh Flows		VL	M*	L*	H/L	N/A	N/A			N/A		
	High and Infrequent Flows - Bank Full 1.5 years ARI		VL	M*	L*	H/L	N/A	N/A			N/A		
	High and Infrequent Flows - Over Bank 2.5 years ARI		VL	M*	L*	H/L	N/A	N/A			N/A		
	High and Infrequent Flows - Over Bank 5.0 years ARI		VL	M*	L	H/L	N/A	N/A			N/A		
Lower Namoi	Zero Flow Periods	E4 - Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use. E13 - Cease / commence to pump rules for in-stream and off-river pools.	H	M*	M	H/L	N/A	C D	* Data is unavailable to model likelihood. Likelihood rating is based on expert opinion and data confidence has been rated as low.	N1 – Sustainable Diversion Limits. N5 - Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies N6 - Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness	M	This risk is considered tolerable as this section of river is reliant upon flows emanating from a regulated river and there is minimal opportunity for additional flows from unregulated tribuatarys	
	Base-flow or Low Flows		H	M*	M	H/L	N/A	C D			M		

SECTION 4.3 RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT & CAPACITY TO MEET EWRS [E(W)] - UNREGULATED WATER SOURCES													
Water source within WRP Area	**Flow or Extraction Characteristic**	**Current Critical Mechanisms**	**Consequence**	**Likelihood**	**Risk Rating**	**Data confidence (Consequence / Likelihood)**	**Predefined Tolerable Risk Level**	**Risk treatment option**	**Strategies**	**New Critical Mechanisms**	**Tolerable Risk Level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and Evaluation**
										of existing strategies			
	Fresh Flows		H	M*	M	L/M	N/A	C D			M		
	High and Infrequent Flows - Bank Full 1.5 years ARI		H	L-	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Over Bank 2.5 years ARI		H	L-	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Over Bank 5.0 years ARI		H	L-	L	H/M	N/A	N/A	None required - risk is low		N/A		
Lower Peel River Tributaries	Zero Flow Periods	E4 - Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use. E12 - Cease / commence to pump rules for streams. Moore creek and lower Peel tributaries MZ CtP based on no visible flows. Users must not commence-to-pump during the first 24-hr of visible flow at Moore Creek at Slippery Rock. E13 - Cease / commence to pump rules for in-stream and off-river pools. E15 - Restrict construction of in-river dams on 3rd order or higher streams	M	H+	H	H/M	N/A	B C	1 Limit consumptive water extractions in the WRP area to the predefined share of available water. 5 Protect low flow habitats from accelerated rates of drying. 6 Protect pools in streams, wetlands, lagoons and floodplains within the WRP area during dry periods. 17 Improve knowledge used to assess risk in unregulated sections of the WRP area.	N1 – Sustainable Diversion Limits. N5 - Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies N6 - Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies	Not Tolerable	Decision tool indicates risk is not tolerable as there is high potential for extraction (Likelihood) to impact ecological values. There is no active gauge. These risk results cannot be addressed during WRP development as NSW planning principles minimise change for WSPs within their initial ten year period to provide certainty for water users.	MER planned for WSP objectives MER for N5 and N6
	Base-flow or Low Flows		M	H-	H	H/M	N/A	BC			Not Tolerable		
	Fresh Flows	E4 - Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use.	M	L-	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Bank Full 1.5 years ARI		M	L0	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Over Bank 2.5 years ARI		M	L0	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Over Bank 5.0 years ARI		M	L0	L	H/M	N/A	N/A	None required - risk is low		N/A		

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

Water source within WRP Area	Flow or Extraction Characteristic	Current Critical Mechanisms	Consequence	Likelihood	Risk Rating	Data confidence (Consequence / Likelihood)	Predefined Tolerable Risk Level	Risk treatment option	Strategies	New Critical Mechanisms	Tolerable Risk Level	Explanation of tolerable risk application OR Explanation of why risk cannot be addressed	Monitoring and Evaluation
Maules Creek	Zero Flow Periods	E4 - Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use. E12 - Cease / commence to pump rules for streams. CtP 1 ML/d at Maules Creek Avoca East gauge (419051) E13 - Cease / commence to pump rules for in-stream and off-river pools. E15 - Restrict construction of in-river dams on 3rd order or higher streams	H	H+	H	H/M	N/A	B C	1 Limit consumptive water extractions in the WRP area to the predefined share of available water. 5 Protect low flow habitats from accelerated rates of drying. 6 Protect pools in streams, wetlands, lagoons and floodplains within the WRP area during dry periods. 7 Protect important lagoons and wetlands within the WRP area. 17 Improve knowledge used to assess risk in unregulated sections of the WRP area. 18 Improve knowledge of effectiveness of existing strategies.	N1 – Sustainable Diversion Limits. N5 - Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies N6 - Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies	Not tolerable	Decision tool indicates risk is not tolerable as there is high potential for extraction to impact ecological values and a river gauge is available. Frequent likelihood monitoring is recommended. These risk results cannot be addressed during WRP development as NSW planning principles minimise change for WSPs within their initial ten year period to provide certainty for water users.	MER planned for WSP objectives MER for N5 and N6
	Base-flow or Low Flows		H	H-	H	H/M	N/A	B C			Not tolerable		MER planned for WSP objectives MER for N5 and N6
	Fresh Flows	E4 - Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use.	H	L^0	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Bank Full 1.5 years ARI		H	L^0	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Over Bank 2.5 years ARI		H	L^0	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Over Bank 5.0 years ARI		H	L^0	L	H/M	N/A	N/A	None required - risk is low		N/A		
Mid Macdonald River	Zero Flow Periods	E4 - Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use. E12 - Cease / commence to pump rules for streams. Upstream Woolbrook MZ: CtP 10 ML/d at Macdonald River at Woolbrook gauge (419010). Downstream Woolbrook MZ: 10 ML/d at Retreat gauge (419028) E13 - Cease / commence to pump rules for in-stream and off-river pools. E15 - Restrict construction of in-river dams on 3rd order or higher streams.	M	M+	M	H/M	N/A	C	1 Limit consumptive water extractions in the WRP area to the predefined share of available water. 5 Protect low flow habitats from accelerated rates of drying. 6 Protect pools in streams, wetlands, lagoons and floodplains within the WRP area during dry periods.	N1 – Sustainable Diversion Limits. N5 - Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies	Not tolerable	Decision tool indicates risk is not tolerable as there is medium / high potential for extraction to impact ecological values and a river gauge is available. Frequent likelihood monitoring is recommended. These risk results cannot be addressed during WRP development as NSW planning principles minimise change for WSPs within their initial ten year period to provide certainty for water users.	MER planned for WSP objectives
	Base-flow or Low Flows		M	H-	H	H/M	N/A	C			Not tolerable		
	Fresh Flows	E4 - Trade limits or prohibitions between surface water plan areas, water sources, and	M	L-	L	H/M	N/A	N/A	None required - risk is low		N/A		

SECTION 4.3 RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT & CAPACITY TO MEET EWRS [E(W)] - UNREGULATED WATER SOURCES												
Water source within WRP Area	**Flow or Extraction Characteristic**	**Current Critical Mechanisms**	**Consequence**	**Likelihood**	**Risk Rating**	**Data confidence (Consequence / Likelihood)**	**Predefined Tolerable Risk Level**	**Risk treatment option**	**Strategies**	**New Critical Mechanisms**	**Tolerable Risk Level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and Evaluation**
		management zones to manage growth in use.											
	High and Infrequent Flows - Bank Full 1.5 years ARI		M	L0	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Over Bank 2.5 years ARI		M	L0	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Over Bank 5.0 years ARI		M	L0	L	H/M	N/A	N/A	None required - risk is low		N/A		
Mooki River	Zero Flow Periods	E4 - Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use. E12 - Cease / commence to pump rules for streams. CtP 50 ML/d with a commence-to-pump of 100 ML/d at Mooki River at Breeza gauge (419027) E13 - Cease / commence to pump rules for in-stream and off-river pools. E15 - Restrict construction of in-river dams on 3rd order or higher streams.	L	L+	L	H/M	N/A	N/A	None required - risk is low		N/A		
	Base-flow or Low Flows		L	M-	L	H/M	N/A	N/A	None required - risk is low		N/A		
	Fresh Flows		L	H-	M	H/M	N/A	C	1 Limit consumptive water extractions in the WRP area to the predefined share of available water. 5 Protect low flow habitats from accelerated rates of drying. 6 Protect pools in streams, wetlands, lagoons and floodplains within the WRP area during dry periods.	N1 – Sustainable Diversion Limits. N5 - Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies	Not tolerable	Decision tool indicates risk is not tolerable as there is a high potential for extraction to impact ecological values and a river gauge is available. Frequent likelihood monitoring is recommended. These risk results cannot be addressed during WRP development as NSW planning principles minimise change for WSPs within their initial ten year period to provide certainty for water users.	
	High and Infrequent Flows - Bank Full 1.5 years ARI		L	L-	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Over Bank 2.5 years ARI		L	L-	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Over Bank 5.0 years ARI		L	L-	L	H/M	N/A	N/A	None required - risk is low		N/A		
Phillips Creek no CtP	Zero Flow Periods	E4 - Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use. E12 - Cease / commence to	L	H+	M	H/M	N/A	C	1 Limit consumptive water extractions in the WRP area to the predefined share of available water. 5 Protect low flow habitats from accelerated rates of drying.	N1 – Sustainable Diversion Limits. N5 – Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies	M	Decision tool indicates risk is tolerable as there is low consequence for extraction to impact ecological values Tolerable – recommended	MER planned for WSP objectives MER for N5

SECTION 4.3 RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT & CAPACITY TO MEET EWRS [E(W)] - UNREGULATED WATER SOURCES												
Water source within WRP Area	**Flow or Extraction Characteristic**	**Current Critical Mechanisms**	**Consequence**	**Likelihood**	**Risk Rating**	**Data confidence (Consequence / Likelihood)**	**Predefined Tolerable Risk Level**	**Risk treatment option**	**Strategies**	**New Critical Mechanisms**	**Tolerable Risk Level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and Evaluation**
	Base-flow or Low Flows	pump rules for streams. CtP when no visible flow at pump site E13 - Cease / commence to pump rules for in-stream and off-river pools.	L	H-	M	H/M	N/A	C	6 Protect pools in streams, wetlands, lagoons and floodplains within the WRP area during dry periods. 17 Improve knowledge used to assess risk in unregulated sections of the WRP area.		M	monitoring at WAL activation (impact likely to occur with growth in use)	
	Fresh Flows	E4 - Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use.	L	L-	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Bank Full 1.5 years ARI		L	L^0	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Over Bank 2.5 years ARI		L	L^0	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Over Bank 5.0 years ARI		L	L^0	L	H/M	N/A	N/A	None required - risk is low		N/A		
Warrah creek no CtP	Zero Flow Periods	E4 - Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use. E12 - Cease / commence to pump rules for streams. CtP when no visible flow at pump site E13 - Cease / commence to pump rules for in-stream and off-river pools.	L	H+	M	H/M	N/A	C	1 Limit consumptive water extractions in the WRP area to the predefined share of available water. 5 Protect low flow habitats from accelerated rates of drying. 6 Protect pools in streams, wetlands, lagoons and floodplains within the WRP area during dry periods. 7 Protect important lagoons and wetlands within the WRP area.	N1 – Sustainable Diversion Limits. N5 – Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies	M	Decision tool indicates risk is tolerable as there is low consequence for extraction to impact ecological values Tolerable – recommended monitoring at WAL activation (impact likely to occur with growth in use)	MER planned for WSP objectives MER for N5
	Base-flow or Low Flows		L	H-	M	H/M	N/A	C			M		
	Fresh Flows	E4 - Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use.	L	L^0	L	H/M	N/A	N/A			N/A		
	High and Infrequent Flows - Bank Full 1.5 years ARI		L	L^0	L	H/M	N/A	N/A			N/A		
	High and Infrequent Flows - Over Bank 2.5 years ARI		L	L^0	L	H/M	N/A	N/A		None required - risk is low	N/A		
	High and Infrequent Flows - Over Bank 5.0 years ARI		L	L^0	L	H/M	N/A	N/A			N/A		

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

Water source within WRP Area	Flow or Extraction Characteristic	Current Critical Mechanisms	Consequence	Likelihood	Risk Rating	Data confidence (Consequence / Likelihood)	Predefined Tolerable Risk Level	Risk treatment option	Strategies	New Critical Mechanisms	Tolerable Risk Level	Explanation of tolerable risk application OR Explanation of why risk cannot be addressed	Monitoring and Evaluation
Pian Creek	Zero Flow Periods	E4 - Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use. E12 - Cease / commence to pump rules for streams. Lower Pian MZ: CtP 43 ML/d at Dempseys Bridge gauge (419089) and 5 ML/d Pian Creek at Waminda (419049) E13 - Cease / commence to pump rules for in-stream and off-river pools. E6b – Supplementary access: In the lower Namoi access to a supplementary event is currently on a trial basis: prior to 1 July 2019, should not exceed 50% of a supplementary event (all year); and after 30 June 2019: 10% access of the supplementary event between 1 July and 31 October and 50% between 1 November and 30 June.	H	H+	H	H/N/A	N/A	B C	1 Limit consumptive water extractions in the WRP area to the predefined share of available water. 2. Protect a portion of high flow events in the Namoi WRP area 5 Protect low flow habitats from accelerated rates of drying. 3 Provide discretionary environmental watering events in the regulated river and downstream unregulated river sections of the WRP area. 6 Protect pools in streams, wetlands, lagoons and floodplains within the WRP area during dry periods. 7 Protect important lagoons and wetlands within the WRP area. 17 Improve knowledge used to assess risk in unregulated sections of the WRP area. 18 Improve knowledge of effectiveness of existing strategies	N1 – Sustainable Diversion Limits. N5 - Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies N6 - Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies N2 - Strategic use of uncontrolled / supplementary flow events to manage environmental outcomes within the lower portions of the Namoi WRP as guided by the LTWP	Not tolerable	Decision tool indicates risk is not tolerable as there is a high potential for extraction to impact ecological values and a river gauge is available. Frequent likelihood monitoring is recommended. These risk results cannot be addressed during WRP development as NSW planning principles minimise change for WSPs within their initial ten year period to provide certainty for water users. Major constraint in mitigating risk is that the upstream reaches of Pian Creek are regulated and highly modified (via delivery from Gunidgera Weir). The unregulated section only receives 'effluent flows' when orders are placed or large uncontrolled flow events occur.	MER planned for WSP objectives MER for N5 and N6
	Base-flow or Low Flows		H	H+	H	H/N/A	N/A	B C			Not tolerable		
	Fresh Flows		H	H+	H	H/N/A	N/A	B C			Not tolerable		
	High and Infrequent Flows - Bank Full 1.5 years ARI		H	H+	H	H/N/A	N/A	B C			Not tolerable		
	High and Infrequent Flows - Over Bank 2.5 years ARI		H	M+	M	H/N/A	N/A	B C			Not tolerable		
	High and Infrequent Flows - Over Bank 5.0 years ARI		H	L+	L	H/N/A	N/A	N/A		None required - risk is low	N/A		
Quirindi with CtP	Zero Flow Periods		L	L+	L	H/M	N/A	N/A		None required - risk is low	N/A	.	
	Base-flow or Low Flows	E4 - Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use. E12 - Cease / commence to pump rules for streams. 2 ML/d Quirindi Creek at Greenacres (419098) E13 - Cease / commence to pump rules for in-stream and off-river pools. E15 - Restrict construction of in-river dams on 3rd order or higher streams.	L	H+	M	H/M	N/A	B C	1 Limit consumptive water extractions in the WRP area to the predefined share of available water. 5 Protect low flow habitats from accelerated rates of drying. 6 Protect pools in streams, wetlands, lagoons and floodplains within the WRP area during dry periods. 17 Improve knowledge used to assess risk in unregulated sections of the WRP area. 18 Improve knowledge of effectiveness of existing strategies.	N1 – Sustainable Diversion Limits. N5 - Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies N6 - Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies	Not tolerable	Decision tool indicates risk is not tolerable as there is a high potential for extraction to impact ecological values and a river gauge is available. Frequent likelihood monitoring is recommended. This risk result cannot be addressed as NSW planning principles minimise change for WSPs within their ten year terms to provide certainty for water users.	MER planned for WSP objectives MER for N5 and N6

SECTION 4.3 RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT & CAPACITY TO MEET EWRS [E(W)] - UNREGULATED WATER SOURCES												
Water source within WRP Area	**Flow or Extraction Characteristic**	**Current Critical Mechanisms**	**Consequence**	**Likelihood**	**Risk Rating**	**Data confidence (Consequence / Likelihood)**	**Predefined Tolerable Risk Level**	**Risk treatment option**	**Strategies**	**New Critical Mechanisms**	**Tolerable Risk Level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and Evaluation**
	Fresh Flows		L	L-	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Bank Full 1.5 years ARI		L	L-	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Over Bank 2.5 years ARI		L	L-	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Over Bank 5.0 years ARI		L	L-	L	H/M	N/A	N/A	None required - risk is low		N/A		
Rangira Creek	Zero Flow Periods	E4 - Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use. E12 - Cease / commence to pump rules for streams. E13 - Cease / commence to pump rules for in-stream and off-river pools.	L	L0	L	H/M	N/A	N/A	None required - risk is low		N/A		
	Base-flow or Low Flows		L	M-	L	H/M	N/A	N/A	None required - risk is low		N/A		
	Fresh Flows	E4 - Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use.	L	M-	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Bank Full 1.5 years ARI		L	M-	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Over Bank 2.5 years ARI		L	L-	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Over Bank 5.0 years ARI		L	L-	L	H/M	N/A	N/A	None required - risk is low		N/A		
Split Rock	Zero Flow Periods	E4 - Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use. E12 - Cease / commence to pump rules for streams. E13 - Cease / commence to pump rules for in-stream and off5river pools. E17 - Restrict construction of in-river dams on 3rd order or higher streams.	L	L0	L	H/M	N/A	N/A	None required - risk is low		N/A		
	Base-flow or Low Flows		L	L0	L	H/M	N/A	N/A	None required - risk is low		N/A		

SECTION 4.3 RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT & CAPACITY TO MEET EWRS [E(W)] - UNREGULATED WATER SOURCES												
Water source within WRP Area	**Flow or Extraction Characteristic**	**Current Critical Mechanisms**	**Consequence**	**Likelihood**	**Risk Rating**	**Data confidence (Consequence / Likelihood)**	**Predefined Tolerable Risk Level**	**Risk treatment option**	**Strategies**	**New Critical Mechanisms**	**Tolerable Risk Level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and Evaluation**
	Fresh Flows	E4 - Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use.	L	L0	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Bank Full 1.5 years ARI		L	L0	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Over Bank 2.5 years ARI		L	L0	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Over Bank 5.0 years ARI		L	L0	L	H/M	N/A	N/A	None required - risk is low		N/A		
Spring Creek	Zero Flow Periods	E4 - Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use. E12 - Cease / commence to pump rules for streams. E13 - Cease / commence to pump rules for in-stream and off-river pools.	H	L0	L	H/M	N/A	N/A	None required - risk is low		N/A		
	Base-flow or Low Flows		H	L-	L	H/M	N/A	N/A	None required - risk is low		N/A		
	Fresh Flows	E4 - Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use.	H	L-	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Bank Full 1.5 years ARI		H	L0	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Over Bank 2.5 years ARI		H	L0	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Over Bank 5.0 years ARI		H	L0	L	H/M	N/A	N/A	None required - risk is low		N/A		
Bobbiwaa Creek	Zero Flow Periods	E4 - Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use. E12 - Cease / commence to pump rules for streams. E13 - Cease / commence to pump rules for in-stream and off-river pools. E15 - Restrict construction of in-river dams on 3rd order or higher streams.	H	L0	L	H/M	N/A	N/A	None required - risk is low		N/A		
	Base-flow or Low Flows		H	L-	L	H/M	N/A	N/A	None required - risk is low		N/A		

SECTION 4.3 RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT & CAPACITY TO MEET EWRS [E(W)] - UNREGULATED WATER SOURCES												
Water source within WRP Area	**Flow or Extraction Characteristic**	**Current Critical Mechanisms**	**Consequence**	**Likelihood**	**Risk Rating**	**Data confidence (Consequence / Likelihood)**	**Predefined Tolerable Risk Level**	**Risk treatment option**	**Strategies**	**New Critical Mechanisms**	**Tolerable Risk Level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and Evaluation**
	Fresh Flows	E4 - Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use.	H	L-	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Bank Full 1.5 years ARI		H	L0	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Over Bank 2.5 years ARI		H	L0	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Over Bank 5.0 years ARI		H	L0	L	H/M	N/A	N/A	None required - risk is low		N/A		
Upper Macdonald River	Zero Flow Periods	E4 - Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use. E12 - Cease / commence to pump rules for streams. E13 - Cease / commence to pump rules for in-stream and off-river pools.	M	L0	L	H/M	N/A	C	None required - risk is low		N/A		
	Base-flow or Low Flows		M	L-	L	H/M	N/A	C	None required - risk is low		N/A		
	Fresh Flows	E4 - Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use.	M	L0	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Bank Full 1.5 years ARI		M	L0	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Over Bank 2.5 years ARI		M	L0	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Over Bank 5.0 years ARI		M	L0	L	H/M	N/A	N/A	None required - risk is low		N/A		
Upper Manilla	Zero Flow Periods	E4 - Trade limits or prohibitions between surface water plan areas, water sources, and	M	L0	L	H/M	N/A	N/A	None required - risk is low		N/A	.	

SECTION 4.3 RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT & CAPACITY TO MEET EWRS [E(W)] - UNREGULATED WATER SOURCES													
Water source within WRP Area	**Flow or Extraction Characteristic**	**Current Critical Mechanisms**	**Consequence**	**Likelihood**	**Risk Rating**	**Data confidence (Consequence / Likelihood)**	**Predefined Tolerable Risk Level**	**Risk treatment option**	**Strategies**	**New Critical Mechanisms**	**Tolerable Risk Level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and Evaluation**
	Base-flow or Low Flows	management zones to manage growth in use. E12 - Cease / commence to pump rules for streams. Manilla MZ CtP 3 ML/d at Black Springs gauge (419053); Ironbark Creek MZ CtP 3 ML/d at Woodsreef gauge (419047) E13 - Cease / commence to pump rules for in-stream and off-river pools. E15 - Restrict construction of in-river dams on 3rd order or higher streams.	M	M-	M	H/M	N/A	B C	1 Limit consumptive water extractions in the WRP area to the predefined share of available water. 5 Protect low flow habitats from accelerated rates of drying. 6 Protect pools in streams, wetlands, lagoons and floodplains within the WRP area during dry periods. 17 Improve knowledge used to assess risk in unregulated sections of the WRP area. 18 Improve knowledge of effectiveness of existing strategies.	N1 – Sustainable Diversion Limits. N5 - Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies N6 - Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies	Not tolerable	Decision tool indicates risk is not tolerable as there is a high potential for extraction to impact ecological values and a river gauge is available. Frequent likelihood monitoring is recommended. This risk result cannot be addressed as NSW planning principles minimise change for WSPs within their ten year terms to provide certainty for water users.	MER planned for WSP objectives MER for N5 and N6
	Fresh Flows	E4 - Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use.	M	L-	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Bank Full 1.5 years ARI		M	L0	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Over Bank 2.5 years ARI		M	L0	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Over Bank 5.0 years ARI		M	L0	L	H/M	N/A	N/A	None required - risk is low		N/A		
Upper Namoi	Zero Flow Periods	E4 - Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use. E12 - Cease / commence to pump rules for streams. Macdonald and Namoi Rivers MZ CtP no visible flow at Manilla Weir (419022) Halls Creek MZ CtP 1 ML/d at Ukolan gauge (419029) E13 - Cease / commence to pump rules for in-stream and off-river pools. E15 - Restrict construction of in-river dams on 3rd order or higher streams	H	H+	H	H/M	N/A	B C	1 Limit consumptive water extractions in the WRP area to the predefined share of available water. 5 Protect low flow habitats from accelerated rates of drying. 6 Protect pools in streams, wetlands, lagoons and floodplains within the WRP area during dry periods. 17 Improve knowledge used to assess risk in unregulated sections of the WRP area. 18 Improve knowledge of effectiveness of existing strategies	N1 – Sustainable Diversion Limits. N5 – Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies. N6 - Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies	Not tolerable	Decision tool indicates risk is not tolerable as there is a high potential for extraction to impact ecological values and a current river gauge is only available in the Halls Creek MZ. Frequent likelihood monitoring is recommended. This risk result cannot be addressed as NSW planning principles minimise change for WSPs within their ten year terms to provide certainty for water users.	MER planned for WSP objectives MER for N5 and N6
	Base-flow or Low Flows		H	H-	H	H/M	N/A	B C			Not tolerable		
	Fresh Flows		H	L-	L	H/M	N/A	N/A	None required - risk is low		N/A		

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

Water source within WRP Area	Flow or Extraction Characteristic	Current Critical Mechanisms	Consequence	Likelihood	Risk Rating	Data confidence (Consequence / Likelihood)	Predefined Tolerable Risk Level	Risk treatment option	Strategies	New Critical Mechanisms	Tolerable Risk Level	Explanation of tolerable risk application OR Explanation of why risk cannot be addressed	Monitoring and Evaluation
	High and Infrequent Flows - Bank Full 1.5 years ARI		H	L^0	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Over Bank 2.5 years ARI		H	L^0	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Over Bank 5.0 years ARI		H	L^0	L	H/M	N/A	N/A	None required - risk is low		N/A		
Upper Namoi – Halls Creek	Zero Flow Periods	E4 - Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use. E12 - Cease / commence to pump rules for streams. Halls Creek MZ 1 ML/d at Ukolan gauge (419029) E13 - Cease / commence to pump rules for in-stream and off-river pools. E15 - Restrict construction of in-river dams on 3rd order or higher streams.	M	L+	L	H/M	N/A	N/A	None required - risk is low		N/A	.	
	Base-flow or Low Flows		L	H+	M	H/M	N/A	B C	1 Limit consumptive water extractions in the WRP area to the predefined share of available water. 5 Protect low flow habitats from accelerated rates of drying. 6 Protect pools in streams, wetlands, lagoons and floodplains within the WRP area during dry periods. 17 Improve knowledge used to assess risk in unregulated sections of the WRP area. 18 Improve knowledge of effectiveness of existing strategies.	N1 – Sustainable Diversion Limits. N5 - Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies N6 - Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies	Not tolerable	Decision tool indicates risk is not tolerable as there is a high potential for extraction to impact ecological values and a river gauge is available. Frequent likelihood monitoring is recommended. This risk result cannot be addressed as NSW planning principles minimise change for WSPs within their ten year terms to provide certainty for water users.	MER planned for WSP objectives MER for N5 and N6
	Fresh Flows	E4 - Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use.	L	L-	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Bank Full 1.5 years ARI		L	L0	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Over Bank 2.5 years ARI		L	L0	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Over Bank 5.0 years ARI		L	L0	L	H/M	N/A	N/A	None required - risk is low		N/A		
Upper Peel River Tributaries	Zero Flow Periods	E4 - Trade limits or prohibitions between surface water plan areas, water sources, and	M	H+	H	H/M	N/A	B C	1 Limit consumptive water extractions in the WRP area to the predefined share of available	N1 – Sustainable Diversion Limits. N5 – Projects resulting from application	Not tolerable	Decision tool indicates risk is not tolerable as there is a high potential for extraction to impact ecological	MER planned for WSP objectives MER for N5 and N6

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

Water source within WRP Area	Flow or Extraction Characteristic	Current Critical Mechanisms	Consequence	Likelihood	Risk Rating	Data confidence (Consequence / Likelihood)	Predefined Tolerable Risk Level	Risk treatment option	Strategies	New Critical Mechanisms	Tolerable Risk Level	Explanation of tolerable risk application OR Explanation of why risk cannot be addressed	Monitoring and Evaluation
	Base-flow or Low Flows	management zones to manage growth in use. E12 - Cease / commence to pump rules for streams. Dungowan creek MZ a CtP no visible flow at Thortons Road bridge; other MZs no visible flow at pump sites. E13 - Cease / commence to pump rules for in-stream and off-river pools. E15 - Restrict construction of in-river dams on 3rd order or higher streams.	M	H-	H	H/M	N/A	B C	water. 5 Protect low flow habitats from accelerated rates of drying. 6 Protect pools in streams, wetlands, lagoons and floodplains within the WRP area during dry periods. 17 Improve knowledge used to assess risk in unregulated sections of the WRP area. 18 Improve knowledge of effectiveness of existing strategies	of risk treatment option C Expert opinion with MER confirmation strategies. N6 - Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies	Not tolerable	values, there is no active gauge. This risk result cannot be addressed as NSW planning principles minimise change for WSPs within their ten year terms to provide certainty for water users.	MER planned for WSP objectives MER for N and N65
	Fresh Flows	E4 - Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use.	M	M-	M	H/M	N/A	N/A			Not Tolerable		
	High and Infrequent Flows - Bank Full 1.5 years ARI		M	L0	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Over Bank 2.5 years ARI		M	L0	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Over Bank 5.0 years ARI		M	L0	L	H/M	N/A	N/A	None required - risk is low		N/A		
Werris Creek	Zero Flow Periods		M	L+	L	H/M	N/A	N/A	None required - risk is low		N/A	. .	
	Base-flow or Low Flows	E4 - Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use. E12 - Cease / commence to pump rules for streams. E13 - Cease / commence to pump rules for in-stream and off-river pools.	M	H-	H	H/M	N/A	B	1 Limit consumptive water extractions in the WRP area to the predefined share of available water. 5 Protect low flow habitats from accelerated rates of drying. 6 Protect pools in streams, wetlands, lagoons and floodplains within the WRP area during dry periods..	N1 – Sustainable Diversion Limits. N6 - Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies	H	The risk is tolerable because of the low consequence. Tolerable – recommended monitoring at WAL activation (impact likely to occur with growth in use)	
	Fresh Flows		M	L-	L	H/M	N/A	B			M		
	High and Infrequent Flows - Bank Full 1.5 years ARI		M	L0	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Over Bank 2.5 years ARI		M	L0	L	H/M	N/A	N/A	None required - risk is low		N/A		
	High and Infrequent Flows - Over Bank 5.0 years ARI		M	L0	L	H/M	N/A	N/A	None required - risk is low		N/A		

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

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

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

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

Water source within WRP Area	Flow or Extraction Characteristic	Consequence	Likelihood	Risk Rating	Data confidence (Consequence / Likelihood)	Risk treatment option	New Strategy	New Critical Mechanisms	Tolerable Risk Level	Explanation of Tolerable Risk Application OR Explanation (required if risk is above tolerable level)	Monitoring and Evaluation
Upper Baradine Creek and Lower Baradine (effluent)	BLR (D&S) extraction	L	H	M	H/M	A	15 Protect the environment from changes in flow attributable to growth in BLR extractive use..	N1 Sustainable diversion limits E21 Restrict BLR access through the establishment of mandatory guidelines E27 Minister may direct landholder accessing BLR to not waste or improperly use water	M	See below	MER planned for WSP objectives
Bluevale	BLR (D&S) extraction	L	H	M	H/M	A	15 Protect the environment from changes in flow attributable to growth in BLR extractive use..	N1 Sustainable diversion limits E21 Restrict BLR access through the establishment of mandatory guidelines E27 Minister may direct landholder accessing BLR to not waste or improperly use water	M	See below.	MER planned for WSP objectives
Bohena Creek	BLR (D&S) extraction	VH	H	H	H/M	A	15 Protect the environment from changes in flow attributable to growth in BLR extractive use.	N1 Sustainable diversion limits E21 Restrict BLR access through the establishment of mandatory guidelines E27 Minister may direct landholder accessing BLR to not waste or improperly use water	H	See below.	MER planned for WSP objectives
Brigalow Creek	BLR (D&S) extraction	L	H	M	N/A	A	15 Protect the environment from changes in flow attributable to growth in BLR extractive use.	N1 Sustainable diversion limits E21 Restrict BLR access through the establishment of mandatory guidelines E27 Minister may direct landholder accessing BLR to not waste or improperly use water	M	See below.	MER planned for WSP objectives
Bundock Creek	BLR (D&S) extraction	L	H	M	H/M	A	15 Protect the environment from changes in flow attributable to growth in BLR extractive use.	N1 Sustainable diversion limits E21 Restrict BLR access through the establishment of mandatory guidelines E27 Minister may direct landholder accessing BLR to not waste or improperly use water	M	See below.	MER planned for WSP objectives
Chaffey	BLR (D&S) extraction	M	M*	M*	H/L	A	15 Protect the environment from changes in flow attributable to growth in BLR extractive use.		M	N/A	
Cockburn River	BLR (D&S) extraction	M	L	L	H/M	A	None required. Risk is low.		N/A	N/A	
Coghill	BLR (D&S) extraction	L	H	M	H/M	A	15 Protect the environment from changes in flow attributable to growth in BLR extractive use.	N1 Sustainable diversion limits E21 Restrict BLR access through the establishment of mandatory guidelines	M	See below.	MER planned for WSP objectives

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**	**New Strategy**	**New Critical Mechanisms**	**Tolerable Risk Level**	**Explanation of Tolerable Risk Application OR Explanation (required if risk is above tolerable level)**	**Monitoring and Evaluation**
								E27 Minister may direct landholder accessing BLR to not waste or improperly use water			
Coxs Creek (Mid & Lower)	BLR (D&S) extraction	L	H	M	H/M	A	15 Protect the environment from changes in flow attributable to growth in BLR extractive use.	N1 Sustainable diversion limits E21 Restrict BLR access through the establishment of mandatory guidelines E27 Minister may direct landholder accessing BLR to not waste or improperly use water	M	See below.	MER planned for WSP objectives
Etoo Creek and Talluba Creek	BLR (D&S) extraction	H	H	H	H/M	A	15 Protect the environment from changes in flow attributable to growth in BLR extractive use.	N1 Sustainable diversion limits E21 Restrict BLR access through the establishment of mandatory guidelines E27 Minister may direct landholder accessing BLR to not waste or improperly use water	H	See below.	MER planned for WSP objectives
Eulah Creek	BLR (D&S) extraction	L	L	L	H/M	N/A	None required. Risk is low.		N/A	N/A	
Goonoo Goonoo Creek	BLR (D&S) extraction	L	L	L	H/M	N/A	None required. Risk is low.		N/A	N/A	
Keepit	BLR (D&S) extraction	L	H	M	H/M	A	15 Protect the environment from changes in flow attributable to growth in BLR extractive use.	N1 Sustainable diversion limits E21 Restrict BLR access through the establishment of mandatory guidelines E27 Minister may direct landholder accessing BLR to not waste or improperly use water	M	See below.	MER planned for WSP objectives
Lake Goran	BLR (D&S) extraction	VL	H	L	H/M	N/A	None required. Risk is low.		N/A	N/A	
Lower Namoi	BLR (D&S) extraction	H	M*	M*	N/A	N/A	15 Protect the environment from changes in flow attributable to growth in BLR extractive use.		M	N/A	
Lower Peel River Tributaries	BLR (D&S) extraction	M	L	L	H/M	N/A	None required. Risk is low.		N/A	N/A	
Maules Creek	BLR (D&S) extraction	H	L	L	H/N/A	N/A	None required. Risk is low.		N/A	N/A.	
Mid Macdonald River	BLR (D&S) extraction	M	L	L	H/M	N/A	None required. Risk is low.		N/A	N/A	
Mooki River	BLR (D&S) extraction	L	H	M	N/A	A	15 Protect the environment from changes in flow attributable to growth in BLR extractive use.	N1 Sustainable diversion limits E21 Restrict BLR access through the establishment of mandatory guidelines E27 Minister may direct landholder accessing BLR to not waste or improperly use water	M	See below.	MER planned for WSP objectives
Phillips Creek	BLR (D&S) extraction	L	H	M	N/A	A	15 Protect the environment from changes in flow attributable to growth in BLR extractive use.	N1 Sustainable diversion limits E21 Restrict BLR access through the establishment of mandatory guidelines E27 Minister may direct landholder accessing BLR to not waste or improperly use water	M	See below.	MER planned for WSP objectives
Pian Creek	BLR (D&S) extraction	H	M*	M*	H/M	N/A	15 Protect the environment from changes in flow attributable to growth in BLR extractive use.		M	N/A	
Quirindi Creek	BLR (D&S) extraction	L	L	L	H/M	N/A	None required. Risk is low.		N/A	N/A	

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

Water source within WRP Area	Flow or Extraction Characteristic	Consequence	Likelihood	Risk Rating	Data confidence (Consequence / Likelihood)	Risk treatment option	New Strategy	New Critical Mechanisms	Tolerable Risk Level	Explanation of Tolerable Risk Application OR Explanation (required if risk is above tolerable level)	Monitoring and Evaluation
Rangira Creek	BLR (D&S) extraction	L	L	L	H/M	N/A	None required. Risk is low.		N/A	N/A	
Split Rock	BLR (D&S) extraction	L	H	M	H/M	A	15 Protect the environment from changes in flow attributable to growth in BLR extractive use.	N1 Sustainable diversion limits E21 Restrict BLR access through the establishment of mandatory guidelines E27 Minister may direct landholder accessing BLR to not waste or improperly use water	M	See below.	MER planned for WSP objectives
Spring and Bobbiwaa Creeks	BLR (D&S) extraction	H	H	H	H/M	A	15 Protect the environment from changes in flow attributable to growth in BLR extractive use.	N1 Sustainable diversion limits E21 Restrict BLR access through the establishment of mandatory guidelines E27 Minister may direct landholder accessing BLR to not waste or improperly use water	H	See below.	MER planned for WSP objectives
Upper Macdonald River	BLR (D&S) extraction	M	L	L	H/M	A	None required. Risk is low.		N/A	N/A	
Upper Manilla	BLR (D&S) extraction	M	L	L	H/M	A	None required. Risk is low.		N/A	N/A.	
Upper Namoi (includes Halls Creek)	BLR (D&S) extraction	H	L	L	H/M	A	None required. Risk is low.		N/A	N/A	
Upper Peel River Tributaries	BLR (D&S) extraction	M	L	L	H/M	A	None required. Risk is low.		N/A	N/A	
Warrah Creek	BLR (D&S) extraction	L	H	M	H/M	A	15 Protect the environment from changes in flow attributable to growth in BLR extractive use.	N1 Sustainable diversion limits E21 Restrict BLR access through the establishment of mandatory guidelines E27 Minister may direct landholder accessing BLR to not waste or improperly use water	M	See below.	MER planned for WSP objectives
Werris Creek	BLR (D&S) extraction	M	H	H	H/M	A	15 Protect the environment from changes in flow attributable to growth in BLR extractive use.	N1 Sustainable diversion limits E21 Restrict BLR access through the establishment of mandatory guidelines E27 Minister may direct landholder accessing BLR to not waste or improperly use water	H	See below.	MER planned for WSP objectives

Current Critical Mechanisms:
E1 Reserve all water above the long-term average annual extraction limit (LTAAEL) for the environment as PEW (defined and managed by the listed WSPs).
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.
***Where No Data available**
Modelled data unavailable for likelihood. Rating was based upon the expert opinion of the ecohydrologist and data confidence is considered low.

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**	**New Strategies**	**New Critical Mechanisms**	**Tolerable risk level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and Evaluation**
Risk to water available for the environment from farm dam interception E(I-FD)	Regulated	Namoi Billabongs and Wetlands		Minor	Possible	M	L/M	N/A	11 Protect stream flow from reduced runoff attributable to farm dam interception	N1 Sustainable diversion limits	M	The risk is tolerable because of the minor consequence.	No MER planned
Risk to water available for the environment from farm dam interception E(I-FD)	Regulated	Regulated river water source	High flows	M-VH	VL	L	H/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for the environment from farm dam interception E(I-FD)	Unregulated	Lake Goran		Negligible	Possible	L	L/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for the environment from farm dam interception E(I-FD)	Unregulated	Maules Creek at Avoca East (419051)	Variation Annual Index CV	M	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	
		Maules Creek at Avoca East	Low Flow Index Q90	M	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	
		Maules Creek at Avoca East	High Flow Index Q10	M	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for the environment from farm dam interception E(I-FD)	Unregulated	Coxs Creek at Boggabri (419032)	Variation Annual Index CV	L	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	
		Coxs Creek at Boggabri	Low Flow Index Q90	L	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	
		Coxs Creek at Boggabri	High Flow Index Q10	L	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for the environment from farm dam interception E(I-FD)	Unregulated	Baradine creek at Kienbri No.2 (419025)	Variation Annual Index CV	M	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	
		Baradine creek at Kienbri No.2	Low Flow Index Q90	M	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	
		Baradine creek at Kienbri No.2	High Flow Index Q10	M	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for the environment from farm dam interception E(I-FD)	Regulated	Peel River at Carroll Gap (419006)	Variation Annual Index CV	M	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	
		Peel River at Carroll Gap	Low Flow Index Q90	M	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	
		Peel River at Carroll Gap	High Flow Index Q10	M	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for the environment from farm dam interception E(I-FD)	Unregulated	Mooki River at Breeza (419027)	Variation Annual Index CV	L	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	
		Mooki River at Breeza	Low Flow Index Q90	L	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**	**New Strategies**	**New Critical Mechanisms**	**Tolerable risk level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and Evaluation**
		Mooki River at Breeza	High Flow Index Q10	L	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for the environment from farm dam interception E(I-FD)	Unregulated	Coxs Creek at Tambar Springs (419033)	Variation Annual Index CV	L	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	
		Coxs Creek at Tambar Springs	Low Flow Index Q90	L	M	L	H/M	N/A	None required. Risk is low		N/A	N/A	
		Coxs Creek at Tambar Springs	High Flow Index Q10	L	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for the environment from farm dam interception E(I-FD)	Unregulated	Mooki River at Caroona (419034)	Variation Annual Index CV	L	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	
		Mooki River at Caroona	Low Flow Index Q90	L	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	
		Mooki River at Caroona	High Flow Index Q10	L	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for the environment from farm dam interception E(I-FD)	Unregulated	Goonoo Goonoo Creek at Timbumburi (419035)	Variation Annual Index CV	M	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	
		Goonoo Goonoo Creek at Timbumburi	Low Flow Index Q90	M	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	
		Goonoo Goonoo Creek at Timbumburi	High Flow Index Q10	M	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for the environment from farm dam interception E(I-FD)	Unregulated	Warrah Creek at Old Warrah (419076)	Variation Annual Index CV	L	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	
		Warrah Creek at Old Warrah	Low Flow Index Q90	L	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	
		Warrah Creek at Old Warrah	High Flow Index Q10	L	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for the environment from farm dam interception E(I-FD)	Unregulated	Macdonald River at Woolbrook (419010)	Variation Annual Index CV	L	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	
		Macdonald River at Woolbrook	Low Flow Index Q90	L	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	
		Macdonald River at Woolbrook	High Flow Index Q10	L	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for the environment from farm dam interception E(I-FD)	Unregulated	Swamp Oak Creek at Limbri (419054)	Variation Annual Index CV	L	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	
		Swamp Oak Creek at Limbri	Low Flow Index Q90	L	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**	**New Strategies**	**New Critical Mechanisms**	**Tolerable risk level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and Evaluation**
		Swamp Oak Creek at Limbri	High Flow Index Q10	L	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for the environment from farm dam interception E(I-FD)	Unregulated	Cockburn River at Mulla Crossing (419016)	Variation Annual Index CV	M	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	
		Cockburn River at Mulla Crossing	Low Flow Index Q90	M	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	
		Cockburn River at Mulla Crossing	High Flow Index Q10	M	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for the environment from farm dam interception E(I-FD)	Unregulated	Halls Creek at Ukolan (419029)	Variation Annual Index CV	L	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	
		Halls Creek at Ukolan	Low Flow Index Q90	L	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	
		Halls Creek at Ukolan	High Flow Index Q10	L	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for the environment from farm dam interception E(I-FD)	Unregulated	Ironbark Creek at Woodsreef (419112)	Variation Annual Index CV	M	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	
		Ironbark Creek at Woodsreef	Low Flow Index Q90	M	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	
		Ironbark Creek at Woodsreef	High Flow Index Q10	M	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for the environment from farm dam interception E(I-FD)	Unregulated	Manilla River at Black Springs (419053)	Variation Annual Index CV	L	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	
		Manilla River at Black Springs	Low Flow Index Q90	L	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	
		Manilla River at Black Springs	High Flow Index Q10	L	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for the environment from farm dam interception E(I-FD)	Unregulated	Namoi River at North Cuerindi (419005)	Variation Annual Index CV	H	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	
		Namoi River at North Cuerindi	Low Flow Index Q90	H	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	
		Namoi River at North Cuerindi	High Flow Index Q10	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	New Strategies	New Critical Mechanisms	Tolerable risk level	Explanation of tolerable risk application OR Explanation of why risk cannot be addressed	Monitoring and Evaluation

Current Critical Mechanisms - E(I-FD)
E18 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: 12 Protect stream flow from reduced runoff attributable to farm dam interception. The remaining water sources have low Risks. 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)	Regulated	M-VH	Nil	Nil	H/M	N/A	None required. Risk is nil		N/A	N/A	
	Unregulated	L_VH	Nil	Nil	H/M	N/A	None required. Risk is nil		N/A	N/A	

Current Critical Mechanisms - E(I-PF)
E19 Plantation forestry interception is considered low risk therefore no mechanisms have been implemented under the WM Act.

E20 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

SECTION 4.5.3 RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT FROM INTERCEPTION ACTIVITIES [E(I-M)]									
Risk	**Water Source Type**	**Risk Rating**	**Data confidence (Consequence / Likelihood)**	**Risk treatment option**	**Strategies**	**New Critical Mechanisms**	**Tolerable risk level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and Evaluation**
Reduced water quantity available for the environment caused by mining E(I-M)	Regulated	Nil	M/M	N/A	None required. Risk is nil		N/A	N/A	
	Unregulated	Nil	M/M	N/A	None required. Risk is nil		N/A	N/A	
Poor water quality for the environment caused by mining E(I-M)	Regulated	L	M/M	N/A	None required. Risk is low		N/A	N/A	
	Unregulated	L	M/M	N/A	None required. Risk is low		N/A	N/A	
Damage to structural integrity caused by mining E(I-M)	Regulated	L	M/M	N/A	None required. Risk is low		N/A	N/A	
	Unregulated	L	M/M	N/A	None required. Risk is low		N/A	N/A	
Current Critical Mechanisms - E(I-M) Impacts of mining and coal seam gas activities are assessed under the *Environmental Planning and Assessment Act 1979*. Water access licences must be obtained under the *NSW Water Management Act 2000*. Licences must be obtained via the market. As such, mining activities cannot increase water use and reduce water available for the environment. *Protection of the Environment Operations Act 1997* and the *Protection of the Environment Operations Act 1997* (POEO Act) the Environment Protection Authority (EPA) uses environment protection licences to regulate the activities to avoid and minimise harm caused by water pollution.									

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

SECTION 4.5.4 RISKS TO WATER AVAILABLE FOR THE ENVIRONMENT FROM INTERCEPTION ACTIVITIES [E(I-FH)]											
Risk	**Water Source Type**	**Consequence**	**Likelihood**	**Risk Rating**	**Data confidence (Consequence / Likelihood)**	**Risk treatment option**	**Strategies**	**New Critical Mechanisms**	**Tolerable risk level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and Evaluation**
Risk to water available for the environment from floodplain harvesting E(I-FH)	Regulated	VH	H	H	H/M	A B	19 Protect the environment and other users from changes in flow attributable to growth in Floodplain harvesting	N6 - Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies E23 - Implementation of the Floodplain harvesting policy and Healthy Floodplains project	H	Risk is tolerable. Floodplain Harvesting Policy and Healthy Floodplains Projects mitigate risk. See section 5.7.4 of the water resource plan for current management actions and mechanisms.	MER for N6
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 (Consquence / Likelihood)**	**Risk treatment option**	**New 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 the environment due to climate change E(CC)	Namoi River billabongs and wetlands	Wet climate change scenario	E1 Reserve all water above the long-term average annual extraction limit (LTAAEL) for the environment as PEW (defined and managed by the listed WSPs). E2 Available Water Determinations (AWD) adjust extractive use according to water availability.	Negligible	Possible	L	L/M	F	None required. Risk is low.		N/A	N/A	
		Median climate change scenario		Minor	Possible	M	L/M	F	14 Protect the environment and water users from changes in flow attributable to climate change	N1 Sustainable Diversion Limits	M	An individual licence holder's annual access to water is governed by their entitlement and climatic availability. The volume of water available to meet all competing environmental and extractive needs varies on a yearly and daily basis, depending on the weather, river flows and aquifer characteristics.	MER planned for WSP objectives
		Dry climate change scenario		Moderate	Unlikely	M	L/M	F			M		
Risk to water available for the environment due to climate change E(CC)	Lake Goran	Wet climate change scenario	E2 Available Water Determinations (AWD) adjust extractive use according to water availability. E4 Trade limits or prohibitions between surface water sources and management zones to manage growth in use	Negligible	Possible	L		F	None required. Risk is low		N/A	N/A	
		Median climate change scenario		Moderate	Possible	M		F	14 Protect the environment and water users from changes in flow attributable to climate change	N1 Sustainable Diversion Limits	M	An individual licence holder's annual access to water is governed by their entitlement and climatic availability. The volume of water available to meet all competing environmental and extractive needs varies on a yearly and daily basis, depending on the weather, river flows and aquifer characteristics.	MER planned for WSP objectives
		Dry climate change scenario		Moderate	Unlikely	M		F			M		
	Regulated											N/A	
Risk to water available for the environment due to climate change E(CC)	Peel at downstream Chaffey Dam	Dry climate change scenario	E1 - Reserve all water above the long-term average annual extraction limit (LTAAEL) for the environment as PEW (defined and managed by the listed WSPs). E2 - Available Water Determinations (AWD) adjust extractive use according to water availability.	VH	M	H	H/M	B C F	14 Protect the environment and water users from changes in flow attributable to climate change.	N1 Sustainable Diversion Limits N5 - Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies N6 - Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies	H	An individual licence holder's annual access to water is governed by their entitlement and climatic availability. The volume of water available to meet all competing environmental and extractive needs varies on a yearly and daily basis, depending on the weather, river flows and aquifer characteristics.	MER planned for WSP objectives MER for N5 and N6
	Peel at Piallamore	Dry climate change scenario		VH	M	H	H/M				H		
	Peel at Carroll Gap	Dry climate change scenario		M	M	M	H/M				M		
	Manilla at Brabi (Merriwee)	Dry climate change scenario		M	M	M	H/M				M		

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 (Consquence / Likelihood)	Risk treatment option	New 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 the environment due to climate change E(CC)	Namoi at Manilla railway bridge	Dry climate change scenario	E1 - Reserve all water above the long-term average annual extraction limit (LTAAEL) for the environment as PEW (defined and managed by the listed WSPs). E2 - Available Water Determinations (AWD) adjust extractive use according to water availability.	M	M	M	H/M	B C F	14 Protect the environment and water users from changes in flow attributable to climate change.	N1 Sustainable Diversion Limits N5 - Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies N6 - Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies	M	An individual licence holder's annual access to water is governed by their entitlement and climatic availability. The volume of water available to meet all competing environmental and extractive needs varies on a yearly and daily basis, depending on the weather, river flows and aquifer characteristics.	MER planned for WSP objectives MER for N5 and N6
	Namoi at downstream Keepit	Dry climate change scenario		M	M	M	H/M				M		
	Namoi at Boggabri	Dry climate change scenario		VH	M	H	H/M				H		
	Namoi at Mollee	Dry climate change scenario		VH	M	H	H/M				H		
	Namoi at Bugilbone	Dry climate change scenario		VH	M	H	H/M				H		
	Namoi at Goangra	Dry climate change scenario		H	M	M	H/M				M		
	Pian Creek at Rossmore	Dry climate change scenario		H	M	M	H/M				M		
	Gunidgera Creek at downstream Pian cutting	Dry climate change scenario		M	M	M	H/M				M		
	Unregulated												
Risk to water available for the environment due to climate change E(CC)	Upper Baradine Creek & Lower Baradine Creek (effluent)	Dry climate change scenario	E1 - Reserve all water above the long-term average annual extraction limit (LTAAEL) for the environment as PEW (defined and managed by the listed WSPs). E2 - Available Water Determinations (AWD) adjust extractive use according to water availability.	L	M	L	H/M	B C F	None required. Risk is Low		N/A	N/A	MER planned for WSP objectives MER for N5 and N6
	Bluevale	Dry climate change scenario		L	M	L	H/M						
	Bohena Creek	Dry climate change scenario		VH	M	H	H/M	B C F	14 Protect the environment and water users from changes in flow attributable to climate change.	N1 Sustainable Diversion Limits N5 - Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies	H	An individual licence holder's annual access to water is governed by their entitlement and climatic availability. The volume of water available to meet all competing environmental and extractive needs varies on a yearly and daily basis, depending on the weather, river flows and	

										N6 - Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies		aquifer characteristics.	

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 (Consquence / Likelihood)	Risk treatment option	New 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 the environment due to climate change E(CC)	Brigalow Creek	Dry climate change scenario	E1 - Reserve all water above the long-term average annual extraction limit (LTAAEL) for the environment as PEW (defined and managed by the listed WSPs). E2 - Available Water Determinations (AWD) adjust extractive use according to water availability.	L	M	L	H/M	B C F	None required. Risk is Low		N/A	N/A	MER planned for WSP objectives MER for N5 and N6
	Bundock Creek	Dry climate change scenario		L	M	L	H/M						
	Chaffey	Dry climate change scenario		M	M	M	H/M	B C F	14 Protect the environment and water users from changes in flow attributable to climate change.	N1 Sustainable Diversion Limits N5 - Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies N6 - Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies	M	An individual licence holder's annual access to water is governed by their entitlement and climatic availability. The volume of water available to meet all competing environmental and extractive needs varies on a yearly and daily basis, depending on the weather, river flows and aquifer characteristics.	
	Cockburn River	Dry climate change scenario		M	M	M	H/M				M		
	Coghill	Dry climate change scenario		L	M	L	H/M	B C F	None required. Risk is Low		N/A	N/A	
	Mid Coxs Creek	Dry climate change scenario		L	M	L	H/M						
	Lower Coxs Creek	Dry climate change scenario		L	M	L	H/M						
	Etoo Creek	Dry climate change scenario		H	M	M	H/M	B C F	14 Protect the environment and water users from changes in flow attributable to	N1 Sustainable Diversion Limits N5 - Projects resulting	M	An individual licence holder's annual access to water is governed by their entitlement and climatic availability.	

	Talluba Creek	Dry climate change scenario	E1 - Reserve all water above the long-term average annual extraction limit (LTAAEL) for the environment as PEW (defined and managed by the listed WSPs). E2 - Available Water Determinations (AWD) adjust extractive use according to water availability.	H	M	M	H/M	B C F	climate change.	from application of risk treatment option C Expert opinion with MER confirmation strategies N6 - Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies	M	The volume of water available to meet all competing environmental and extractive needs varies on a yearly and daily basis, depending on the weather, river flows and aquifer characteristics.	MER planned for WSP objectives MER for N5 and N6
	Eulah creek	Dry climate change scenario		L	M	L	H/M	B C F	None required. Risk is Low		N/A	N/A	
	Goonoo Goonoo Creek	Dry climate change scenario		L	M	L	H/M						

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 (Consquence / Likelihood)	Risk treatment option	New 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 the environment due to climate change E(CC)	Keepit	Dry climate change scenario	E1 - Reserve all water above the long-term average annual extraction limit (LTAAEL) for the environment as PEW (defined and managed by the listed WSPs). E2 - Available Water Determinations (AWD) adjust extractive use according to water availability.	L	M	L	H/M	B C F	None required. Risk is Low		N/A	N/A	MER planned for WSP objectives MER for N5 and N6
	Lake Goran	Dry climate change scenario		VL	M	L	H/M						
	Lower Namoi	Dry climate change scenario		H	M	M	H/M	B C F	14 Protect the environment and water users from changes in flow attributable to climate change.	N1 Sustainable Diversion Limits N5 - Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies N6 - Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies	M	An individual licence holder's annual access to water is governed by their entitlement and climatic availability. The volume of water available to meet all competing environmental and extractive needs varies on a yearly and daily basis, depending on the weather, river flows and aquifer characteristics.	
	Lower Peel River tributaries	Dry climate change scenario		M	M	M	H/M				M		
	Maules Creek	Dry climate change scenario		H	M	M	H/M				M		
	Mid Macdonald River	Dry climate change scenario		M	M	M	H/M				M		
	Mooki River	Dry climate change scenario		L	M	L	H/M	B C F	None required. Risk is Low		N/A	N/A	
	Phillips Creek	Dry climate change scenario		L	M	L	H/M						
	Warrah Creek	Dry climate change scenario	E1 - Reserve all water above the long-term average annual extraction limit (LTAAEL) for the environment as PEW (defined and managed by the listed WSPs). E2 - Available Water Determinations (AWD) adjust extractive use according to water availability.	L	M	L	H/M				N/A		
	Pian Creek	Dry climate change scenario		H	M	M	H/M	B C F	14 Protect the environment and water users from changes in flow attributable to climate change.	N1 Sustainable Diversion Limits N5 - Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies N6 - Reviews resulting from application of risk treatment option B Fill knowledge gap /	M	An individual licence holder's annual access to water is governed by their entitlement and climatic availability. The volume of water available to meet all competing environmental and extractive needs varies on a yearly and daily basis, depending on the weather, river flows and aquifer characteristics.	MER planned for WSP objectives MER for N5 and N6

										evaluate effectiveness of existing strategies			
	Quirindi Creek	Dry climate change scenario		L	M	L	H/M	B C F	None required. Risk is Low		N/A	N/A	

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 (Consqunence / Likelihood)	Risk treatment option	New 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 the environment due to climate change E(CC)	Rangira Creek	Dry climate change scenario	E1 - Reserve all water above the long-term average annual extraction limit (LTAAEL) for the environment as PEW (defined and managed by the listed WSPs). E2 - Available Water Determinations (AWD) adjust extractive use according to water availability.	L	M	L	H/M	B C F	None required. Risk is Low		N/A	N/A	MER planned for WSP objectives MER for N5 and N6
	Split Rock	Dry climate change scenario		L	M	L	H/M						
	Spring Creek	Dry climate change scenario		H	M	M	H/M		14 Protect the environment and water users from changes in flow attributable to climate change.	N1 Sustainable Diversion Limits N5 - Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies N6 - Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies	M	An individual licence holder's annual access to water is governed by their entitlement and climatic availability. The volume of water available to meet all competing environmental and extractive needs varies on a yearly and daily basis, depending on the weather, river flows and aquifer characteristics.	
	Bobbiwaa Creek	Dry climate change scenario		H	M	M	H/M				M		
	Upper Macdonald River	Dry climate change scenario		M	M	M	H/M				M		
Risk to water available for the environment due to climate change E(CC)	Upper Manilla	Dry climate change scenario		M	M	M	H/M				M		
	Upper Namoi & Upper Namoi (Halls Creek)	Dry climate change scenario		H	M	M	H/M				M		
	Upper Peel tributaries	Dry climate change scenario		M	M	M	H/M				M		
	Werris Creek	Dry climate change scenario		M	M	M	H/M				M		

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 (Consquence / Likelihood)	Risk treatment option	New 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 the environment due to climate change E(CC)	Namoi River billabongs and wetlands	Wet climate change scenario	E1 Reserve all water above the long-term average annual extraction limit (LTAAEL) for the environment as PEW (defined and managed by the listed WSPs). E2 Available Water Determinations (AWD) adjust extractive use according to water availability.	Negligible	Possible	L	L/M	F	None required. Risk is low.		N/A	N/A	
		Median climate change scenario		Minor	Possible	M	L/M	F	14 Protect the environment and water users from changes in flow attributable to climate change	N1 Sustainable Diversion Limits	M	An individual licence holder's annual access to water is governed by their entitlement and climatic availability. The volume of water available to meet all competing environmental and extractive needs varies on a yearly and daily basis, depending on the weather, river flows and aquifer characteristics.	MER planned for WSP objectives
		Dry climate change scenario		Moderate	Unlikely	M	L/M	F			M		
Risk to water available for the environment due to climate change E(CC)	Lake Goran	Wet climate change scenario	E2 Available Water Determinations (AWD) adjust extractive use according to water availability. E4 Trade limits or prohibitions between surface water sources and management zones to manage growth in use	Negligible	Possible	L		F	None required. Risk is low		N/A	N/A	
		Median climate change scenario		Moderate	Possible	M		F	14 Protect the environment and water users from changes in flow attributable to climate change	N1 Sustainable Diversion Limits	M	An individual licence holder's annual access to water is governed by their entitlement and climatic availability. The volume of water available to meet all competing environmental and extractive needs varies on a yearly and daily basis, depending on the weather, river flows and aquifer characteristics.	MER planned for WSP objectives
		Dry climate change scenario		Moderate	Unlikely	M		F			M		
Regulated													
Risk to water available for the environment due to climate change E(CC)	Peel at downstream Chaffey Dam	Dry climate change scenario	E1 - Reserve all water above the long-term average annual extraction limit (LTAAEL) for the environment as PEW (defined and managed by the listed WSPs). E2 - Available Water Determinations (AWD) adjust extractive use according to water availability.	VH	M	H	H/M	B C F	14 Protect the environment and water users from changes in flow attributable to climate change.	N1 Sustainable Diversion Limits N5 - Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies N6 - Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies	H	An individual licence holder's annual access to water is governed by their entitlement and climatic availability. The volume of water available to meet all competing environmental and extractive needs varies on a yearly and daily basis, depending on the weather, river flows and aquifer characteristics.	MER planned for WSP objectives MER for N5 and N6
	Peel at Piallamore	Dry climate change scenario		VH	M	H	H/M				H		
	Peel at Carroll Gap	Dry climate change scenario		M	M	M	H/M				M		
	Manilla at Brabi (Merriwee)	Dry climate change scenario		M	M	M	H/M				M		
Risk to water available for the environment due to climate change E(CC)	Namoi at Manilla railway bridge	Dry climate change scenario	E1 - Reserve all water above the long-term average annual extraction limit (LTAAEL) for the environment as PEW (defined and managed by	M	M	M	H/M	B C F	14 Protect the environment and water users from changes in flow attributable to climate change.	N1 Sustainable Diversion Limits N5 - Projects resulting from application of risk treatment option C	M	An individual licence holder's annual access to water is governed by their entitlement and climatic availability. The volume of water available to	MER planned for WSP objectives MER for N5 and N6
	Namoi at downstream Keepit	Dry climate change scenario		M	M	M	H/M	B C F			M		

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 (Consquence / Likelihood)	Risk treatment option	New Strategy	New Critical Mechanisms	Tolerable Risk Level	Explanation of tolerable risk application OR Explanation of why risk cannot be addressed	Monitoring and Evaluation
	Namoi at Boggabri	Dry climate change scenario	the listed WSPs). E2 - Available Water Determinations (AWD) adjust extractive use according to water availability.	VH	M	H	H/M			Expert opinion with MER confirmation strategies N6 - Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies	H	meet all competing environmental and extractive needs varies on a yearly and daily basis, depending on the weather, river flows and aquifer characteristics.	
	Namoi at Mollee	Dry climate change scenario		VH	M	H	H/M				H		
	Namoi at Bugilbone	Dry climate change scenario		VH	M	H	H/M				H		
	Namoi at Goangra	Dry climate change scenario		H	M	M	H/M				M		
	Pian Creek at Rossmore	Dry climate change scenario		H	M	M	H/M				M		
	Gunidgera Creek at downstream Pian cutting	Dry climate change scenario		M	M	M	H/M				M		
Unregulated													
Risk to water available for the environment due to climate change E(CC)	Upper Baradine Creek	Dry climate change scenario	E1 - Reserve all water above the long-term average annual extraction limit (LTAAEL) for the environment as PEW (defined and managed by the listed WSPs). E2 - Available Water Determinations (AWD) adjust extractive use according to water availability.	L	M	L	H/M	B C F	None required. Risk is Low		N/A	N/A	MER planned for WSP objectives MER for N5 and N6
	Bluevale	Dry climate change scenario		L	M	L	H/M						
	Bohena Creek	Dry climate change scenario		VH	M	H	H/M	B C F	14 Protect the environment and water users from changes in flow attributable to climate change.	N1 Sustainable Diversion Limits N5 - Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies N6 - Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies	H	An individual licence holder's annual access to water is governed by their entitlement and climatic availability. The volume of water available to meet all competing environmental and extractive needs varies on a yearly and daily basis, depending on the weather, river flows and aquifer characteristics.	
Risk to water available for the environment due to climate change E(CC)	Brigalow Creek	Dry climate change scenario	E1 - Reserve all water above the long-term average annual extraction limit (LTAAEL) for the environment as PEW (defined and managed by the listed WSPs). E2 - Available Water	L	M	L	H/M	B C F	None required. Risk is Low		N/A	N/A	MER planned for WSP objectives MER for N5 and N6
	Bundock Creek	Dry climate change scenario		L	M	L	H/M						
	Chaffey	Dry climate change scenario		M	M	M	H/M	B C F	14 Protect the environment and water users from changes in	N1 Sustainable Diversion Limits	M	An individual licence holder's annual access to water is governed by their entitlement and	

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 (Consquence / Likelihood)	Risk treatment option	New 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 the environment due to climate change E(CC)	Cockburn River	Dry climate change scenario	Determinations (AWD) adjust extractive use according to water availability.	M	M	M	H/M		flow attributable to climate change.	N5 - Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies N6 - Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies	M	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.	
	Coghill	Dry climate change scenario		L	M	L	H/M	B C F	None required. Risk is Low		N/A	N/A	
	Mid Coxs Creek	Dry climate change scenario		L	M	L	H/M						
	Lower Coxs Creek	Dry climate change scenario		L	M	L	H/M						
	Etoo Creek	Dry climate change scenario		H	M	M	H/M	B C F	14 Protect the environment and water users from changes in flow attributable to climate change.	N1 Sustainable Diversion Limits N5 - Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies N6 - Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies	M	An individual licence holder's annual access to water is governed by their entitlement and climatic availability. The volume of water available to meet all competing environmental and extractive needs varies on a yearly and daily basis, depending on the weather, river flows and aquifer characteristics.	MER planned for WSP objectives MER for N5 and N6
	Talluba Creek	Dry climate change scenario	E1 - Reserve all water above the long-term average annual extraction limit (LTAAEL) for the environment as PEW (defined and managed by the listed WSPs). E2 - Available Water Determinations (AWD) adjust extractive use according to water availability.	H	M	M	H/M	B C F			M		
	Eulah creek	Dry climate change scenario		L	M	L	H/M	B C F	None required. Risk is Low		N/A	N/A	
	Goonoo Goonoo Creek	Dry climate change scenario		L	M	L	H/M						
	Keepit	Dry climate change scenario	E1 - Reserve all water above the long-term average annual extraction limit (LTAAEL) for the environment as PEW (defined and managed by the listed WSPs). E2 - Available Water	L	M	L	H/M	B C F	None required. Risk is Low		N/A	N/A	MER planned for WSP objectives MER for N5 and N6
	Lake Goran	Dry climate change scenario		VL	M	L	H/M						
	Lower Namoi	Dry climate change scenario		H	M	M	H/M	B C F	14 Protect the environment and water users from changes in	N1 Sustainable Diversion Limits	M	An individual licence holder's annual access to water is governed by their entitlement and	

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 (Consquence / Likelihood)	Risk treatment option	New 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 the environment due to climate change E(CC)	Lower Peel River tributaries	Dry climate change scenario	Determinations (AWD) adjust extractive use according to water availability.	M	M	M	H/M		flow attributable to climate change.	N5 - Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies N6 - Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies	M	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.	
	Maules Creek	Dry climate change scenario		H	M	M	H/M				M		
	Mid Macdonald River	Dry climate change scenario		M	M	M	H/M				M		
	Mooki River	Dry climate change scenario		L	M	L	H/M	B C F	None required. Risk is Low		N/A	N/A	
	Phillips Creek	Dry climate change scenario		L	M	L	H/M						
	Warrah Creek	Dry climate change scenario	E1 - Reserve all water above the long-term average annual extraction limit (LTAAEL) for the environment as PEW (defined and managed by the listed WSPs). E2 - Available Water Determinations (AWD) adjust extractive use according to water availability.	L	M	L	H/M				N/A		
	Pian Creek	Dry climate change scenario		H	M	M	H/M	B C F	14 Protect the environment and water users from changes in flow attributable to climate change.	N1 Sustainable Diversion Limits N5 - Projects resulting from application of risk treatment option C Expert opinion with MER confirmation strategies N6 - Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies	M	An individual licence holder's annual access to water is governed by their entitlement and climatic availability. The volume of water available to meet all competing environmental and extractive needs varies on a yearly and daily basis, depending on the weather, river flows and aquifer characteristics.	MER planned for WSP objectives MER for N5 and N6
	Quirindi Creek	Dry climate change scenario		L	M	L	H/M	B C F	None required. Risk is Low		N/A	N/A	
	Rangira Creek	Dry climate change scenario	E1 - Reserve all water above the long-term average annual extraction limit (LTAAEL) for the environment as PEW (defined and managed by the listed WSPs). E2 - Available Water Determinations (AWD) adjust extractive use according to water availability.	L	M	L	H/M	B C F	None required. Risk is Low		N/A	N/A	MER planned for WSP objectives MER for N5 and N6
	Split Rock	Dry climate change scenario		L	M	L	H/M						
	Spring Creek	Dry climate change scenario		H	M	M	H/M	B C F	14 Protect the environment and water users from changes in flow attributable to climate change.	N1 Sustainable Diversion Limits N5 - Projects resulting from application of risk treatment option C	M	An individual licence holder's annual access to water is governed by their entitlement and climatic availability. The volume of water available to	
	Bobbiwaa Creek	Dry climate change scenario		H	M	M	H/M				M		

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**	**New Strategy**	**New Critical Mechanisms**	**Tolerable Risk Level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and Evaluation**
	Upper Macdonald River	Dry climate change scenario		M	M	M	H/M			Expert opinion with MER confirmation strategies N6 - Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies	M	meet all competing environmental and extractive needs varies on a yearly and daily basis, depending on the weather, river flows and aquifer characteristics.	
Risk to water available for the environment due to climate change E(CC)	Upper Manilla	Dry climate change scenario		M	M	M	H/M				M		
	Upper Namoi	Dry climate change scenario		H	M	M	H/M				M		
	Upper Peel tributaries	Dry climate change scenario		M	M	M	H/M				M		
	Werris Creek	Dry climate change scenario		M	M	M	H/M				M		

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

SECTION 6.3, 6.4, 6.5, 6.6 RISKS TO THE HEALTH OF WATER DEPENDENT ECOSYSTEMS FROM POOR WATER QUALITY [E(WQ), [E(WQ-CWP)], [E(WQ-WWP)], [E(WQ-S)], [E(WQ-PT)]														
Risk Code	**Water Source Type**	**Location, Reach, or Extraction Type within WRP Area**	**Water Quality Characteristic**	**Current Critical Mechanisms**	**Consequence**	**Likelihood**	**Risk Rating**	**Data confidence (Consequence / Likelihood)**	**Risk treatment option**	**New 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 Namoi Surface WRPA. Additional actions and mechanisms relevant to the WRP are listed below.				**WQ** 1, 2, 3, 4, 5, 6, 7
E(WQ)	Unregulated	419027 Mooki River at Breeza	Turbidity	E4 Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use. E12 Cease / commence to pump rules for streams. E13 Cease / commence to pump rules for in-stream and off-river pools. E16 Authorised in-river dam construction, operation, and passing flow requirements as specified on the dam approval. E15 Restrict construction of in-river dams on 3rd order or higher streams.	M	M	M	M/H	F	Refer to WQM Plan		Refer to WQM Plan.		
			Total Phosphorus	E4 Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use. E12 Cease / commence to pump rules for streams. E13 Cease / commence to pump rules for in-stream and off-river pools. E16 Authorised in-river dam construction, operation, and passing flow requirements as specified on the dam approval. E15 Restrict construction of in-river dams on 3rd order or higher streams. .	M	H	H	M/H	F	Refer to WQM Plan 5. Protect low flow habitats from accelerated rates of drying 8. Protect tributary flows within the WRP area as they move from the unregulated water source into the regulated water source. 11. Implement the WQM Plan for the WRP area.	N4 Limit growth in BLR when a land holding is subdivided and there is high hydrological stress on the river or aquifer.	Refer to WQM Plan.		MER planned for WSP objectives and WQ 1, 2, 4, 5
			Total Nitrogen	E4 Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use. E12 Cease / commence to pump rules for streams. E13 Cease / commence to pump rules for in-stream and off-river pools. E16 Authorised in-river dam construction, operation, and passing flow requirements as specified on the dam approval. E15 Restrict construction of in-river dams on 3rd order or higher streams.	M	L	L	M/H	F	Refer to WQM Plan		Refer to WQM Plan.		
			pH	E4 Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use. E12 Cease / commence to pump rules for streams. E13 Cease / commence to pump rules for in-stream and off-river pools. E16 Authorised in-river dam construction, operation, and passing flow requirements as specified on the dam approval. E15 Restrict construction of in-river dams on 3rd order or higher streams..	M	M	M	M/H	F	Refer to WQM Plan		Refer to WQM Plan.		

SECTION 6.3, 6.4, 6.5, 6.6 RISKS TO THE HEALTH OF WATER DEPENDENT ECOSYSTEMS FROM POOR WATER QUALITY [E(WQ), [E(WQ-CWP)], [E(WQ-WWP)], [E(WQ-S)], [E(WQ-PT)]														
Risk Code	**Water Source Type**	**Location, Reach, or Extraction Type within WRP Area**	**Water Quality Characteristic**	**Current Critical Mechanisms**	**Consequence**	**Likelihood**	**Risk Rating**	**Data confidence (Consequence / Likelihood)**	**Risk treatment option**	**New 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 Namoi Surface WRPA. Additional actions and mechanisms relevant to the WRP are listed below.				**WQ** 1, 2, 3, 4, 5, 6, 7
E(WQ)	Unregulated	419027 Mooki River at Breeza	Dissolved Oxygen	E4 Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use. E12 Cease / commence to pump rules for streams. E13 Cease / commence to pump rules for in-stream and off-river pools. E16 Authorised in-river dam construction, operation, and passing flow requirements as specified on the dam approval. E15 Restrict construction of in-river dams on 3rd order or higher streams.	M	L	L	M/H	F	Refer to WQM Plan		Refer to WQM Plan.		
E(WQ)	Unregulated	419010 Macdonald River at Woolbrook	Turbidity	E4 Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use. E12 Cease / commence to pump rules for streams. E13 Cease / commence to pump rules for in-stream and off-river pools. E16 Authorised in-river dam construction, operation, and passing flow requirements as specified on the dam approval. E15 Restrict construction of in-river dams on 3rd order or higher streams.	M	L	L	M/H	F	Refer to WQM Plan		Refer to WQM Plan.		
			Total Phosphorus	E4 Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use. E12 Cease / commence to pump rules for streams. E13 Cease / commence to pump rules for in-stream and off-river pools. E16 Authorised in-river dam construction, operation, and passing flow requirements as specified on the dam approval. E15 Restrict construction of in-river dams on 3rd order or higher streams.	M	H	H	M/H	F	Refer to WQM Plan 5. Protect low flow habitats from accelerated rates of drying 11. Implement the WQM Plan for the WRP area.	N4 Limit growth in BLR when a land holding is subdivided and there is high hydrological stress on the river or aquifer.	Refer to WQM Plan.		MER planned for WSP objectives and WQ 1, 2, 4, 5
			Total Nitrogen	E4 Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use. E12 Cease / commence to pump rules for streams. E13 Cease / commence to pump rules for in-stream and off-river pools. E16 Authorised in-river dam construction, operation, and passing flow requirements as specified on the dam approval. E15 Restrict construction of in-river dams on 3rd order or higher streams.	M	H	H	M/H	F	Refer to WQM Plan 5. Protect low flow habitats from accelerated rates of drying 11. Implement the WQM Plan for the WRP area.	N4 Limit growth in BLR when a land holding is subdivided and there is high hydrological stress on the river or aquifer.	Refer to WQM Plan.		

SECTION 6.3, 6.4, 6.5, 6.6 RISKS TO THE HEALTH OF WATER DEPENDENT ECOSYSTEMS FROM POOR WATER QUALITY [E(WQ), [E(WQ-CWP)], [E(WQ-WWP)], [E(WQ-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**	**New 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 Namoi Surface WRPA. Additional actions and mechanisms relevant to the WRP are listed below.				**WQ** 1, 2, 3, 4, 5, 6, 7
E(WQ)	Unregulated	419010 Macdonald River at Woolbrook	pH	E4 Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use. E12 Cease / commence to pump rules for streams. E13 Cease / commence to pump rules for in-stream and off-river pools. E16 Authorised in-river dam construction, operation, and passing flow requirements as specified on the dam approval. E15 Restrict construction of in-river dams on 3rd order or higher streams.	M	M	M	M/H	F	Refer to WQM Plan		Refer to WQM Plan.		
			Dissolved Oxygen	E4 Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use. E12 Cease / commence to pump rules for streams. E13 Cease / commence to pump rules for in-stream and off-river pools. E16 Authorised in-river dam construction, operation, and passing flow requirements as specified on the dam approval. E15 Restrict construction of in-river dams on 3rd order or higher streams.	M	H	H	M/H	F	Refer to WQM Plan 5. Protect low flow habitats from accelerated rates of drying 11. Implement the WQM Plan for the WRP area.	N4 Limit growth in BLR when a land holding is subdivided and there is high hydrological stress on the river or aquifer.	Refer to WQM Plan.		MER planned for WSP objectives and WQ 1, 2, 4, 5
E(WQ)	Unregulated	419016 Cockburn River at Mulla Crossing	Turbidity	E4 Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use. E12 Cease / commence to pump rules for streams. E13 Cease / commence to pump rules for in-stream and off-river pools. E16 Authorised in-river dam construction, operation, and passing flow requirements as specified on the dam approval. E15 Restrict construction of in-river dams on 3rd order or higher streams.	M	L	L	M/H	F	Refer to WQM Plan		Refer to WQM Plan.		
			Total Phosphorus	E4 Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use. E12 Cease / commence to pump rules for streams. E13 Cease / commence to pump rules for in-stream and off-river pools. E16 Authorised in-river dam construction, operation, and passing flow requirements as specified on the dam approval. E15 Restrict construction of in-river dams on 3rd order or higher streams.	M	L	L	M/H	F	Refer to WQM Plan		Refer to WQM Plan.		

SECTION 6.3, 6.4, 6.5, 6.6 RISKS TO THE HEALTH OF WATER DEPENDENT ECOSYSTEMS FROM POOR WATER QUALITY [E(WQ), [E(WQ-CWP)], [E(WQ-WWP)], [E(WQ-S)], [E(WQ-PT)]														
Risk Code	**Water Source Type**	**Location, Reach, or Extraction Type within WRP Area**	**Water Quality Characteristic**	**Current Critical Mechanisms**	**Consequence**	**Likelihood**	**Risk Rating**	**Data confidence (Consequence / Likelihood)**	**Risk treatment option**	**New 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 Namoi Surface WRPA. Additional actions and mechanisms relevant to the WRP are listed below.				**WQ** 1, 2, 3, 4, 5, 6, 7
E(WQ)	Unregulated	419016 Cockburn River at Mulla Crossing	Total Nitrogen	E4 Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use. E12 Cease / commence to pump rules for streams. E13 Cease / commence to pump rules for in-stream and off-river pools. E16 Authorised in-river dam construction, operation, and passing flow requirements as specified on the dam approval. E15 Restrict construction of in-river dams on 3rd order or higher streams.	M	L	L	M/H	F	Refer to WQM Plan		Refer to WQM Plan.		
			pH	E4 Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use. E12 Cease / commence to pump rules for streams. E13 Cease / commence to pump rules for in-stream and off-river pools. E16 Authorised in-river dam construction, operation, and passing flow requirements as specified on the dam approval. E15 Restrict construction of in-river dams on 3rd order or higher streams.	M	L	L	M/H	F	Refer to WQM Plan		Refer to WQM Plan.		
			Dissolved Oxygen	E12 Cease / commence to pump rules for streams. E13 Cease / commence to pump rules for in-stream and off-river pools. E16 Authorised in-river dam construction, operation, and passing flow requirements as specified on the dam approval. E15 Restrict construction of in-river dams on 3rd order or higher streams.	M	M	M	M/H	F	Refer to WQM Plan		Refer to WQM Plan.		
E(WQ)	Unregulated	419032 Coxs Creek at Boggabri	Turbidity	E4 Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use. E12 Cease / commence to pump rules for streams. E13 Cease / commence to pump rules for in-stream and off-river pools. E16 Authorised in-river dam construction, operation, and passing flow requirements as specified on the dam approval. E15 Restrict construction of in-river dams on 3rd order or higher streams.	L	H	M		F	Refer to WQM Plan 5. Protect low flow habitats from accelerated rates of drying 8. Protect tributary flows within the WRP area as they move from the unregulated water source into the regulated water source. 11. Implement the WQM Plan for the WRP area.	N4 Limit growth in BLR when a land holding is subdivided and there is high hydrological stress on the river or aquifer.	Refer to WQM Plan.		
			Total Phosphorus	E4 Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use. E12 Cease / commence to pump rules for streams. E13 Cease / commence to pump rules for in-stream and off-river pools. E16 Authorised in-river dam construction, operation, and passing flow requirements as specified on the dam approval. E15 Restrict construction of in-river dams on 3rd order or higher streams.	L	H	M		F	Refer to WQM Plan		Refer to WQM Plan.		

SECTION 6.3, 6.4, 6.5, 6.6 RISKS TO THE HEALTH OF WATER DEPENDENT ECOSYSTEMS FROM POOR WATER QUALITY [E(WQ), [E(WQ-CWP)], [E(WQ-WWP)], [E(WQ-S)], [E(WQ-PT)]														
Risk Code	**Water Source Type**	**Location, Reach, or Extraction Type within WRP Area**	**Water Quality Characteristic**	**Current Critical Mechanisms**	**Consequence**	**Likelihood**	**Risk Rating**	**Data confidence (Consequence / Likelihood)**	**Risk treatment option**	**New 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 Namoi Surface WRPA. Additional actions and mechanisms relevant to the WRP are listed below.				**WQ** 1, 2, 3, 4, 5, 6, 7
E(WQ)	Unregulated	419032 Coxs Creek at Boggabri	Total Nitrogen	E4 Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use. E12 Cease / commence to pump rules for streams. E13 Cease / commence to pump rules for in-stream and off-river pools. E16 Authorised in-river dam construction, operation, and passing flow requirements as specified on the dam approval. E15 Restrict construction of in-river dams on 3rd order or higher streams.	L	H	M		F	Refer to WQM Plan		Refer to WQM Plan.		MER planned for WSP objectives and WQ 1, 2, 4, 5
			pH	E4 Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use. E12 Cease / commence to pump rules for streams. E13 Cease / commence to pump rules for in-stream and off-river pools. E16 Authorised in-river dam construction, operation, and passing flow requirements as specified on the dam approval. E15 Restrict construction of in-river dams on 3rd order or higher streams.	L	L	L		F	Refer to WQM Plan		Refer to WQM Plan.		
			Dissolved Oxygen	E4 Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use. E12 Cease / commence to pump rules for streams. E13 Cease / commence to pump rules for in-stream and off-river pools. E16 Authorised in-river dam construction, operation, and passing flow requirements as specified on the dam approval. E15 Restrict construction of in-river dams on 3rd order or higher streams.	L	L	L		F	Refer to WQM Plan		Refer to WQM Plan.		
E(WQ)	Regulated	419024 Peel River at Paradise Weir	Turbidity	E1 Reserve all water above the long-term average annual extraction limit (LTAAEL) for the environment as PEW (defined and managed by the listed WSPs). E2 Available Water Determinations (AWD) adjust extractive use according to water availability. E6a Access to uncontrolled natural flow events in the regulated Peel River limited to a maximum of 50% forecast uncontrolled flow volume above either 5ML/d or 50ML/d dependent on general security AWDs is <0.35 ML or >0.35ML per unit share component. E7 - Protect large flow events in the Namoir WRP area to meet flow targets in the downstream Barwon-Darling Watercourse (SW12) E9 Uncontrolled flows arising from the release of the Peel ECA into designated sections of the Peel River protected up to 50 ML/day at Piallamore and either or 40 or 50ML/d at Caroll Gap dependent on the general security AWDs. E17 Improve dam infrastructure and its management so that water releases are more closely matched to Namoi and Peel River ambient temperatures.	VH	L	M	M/H	F	Refer to WQM Plan 2 Protect a portion of high flow events in the Namoi WRP area. 3 Provide discretionary environmental watering events in the regulated river and downstream unregulated river sections of the WRP area. 4. Manage environmental water to meet flow targets specified in the Namoi LTWP 5. Protect low flow habitats from accelerated rates of drying 8. Protect tributary flows within the WRP area as they move from the unregulated water source into the	N2 Strategic use of uncontrolled / supplementary flow events to manage environmental outcomes within the lower portions of the Namoi WRP as guided by the LTWP N3 Strategic use of environmental water (EWA/ECA) and relevant held environmental water licences as guided by the LTWP.	Refer to WQM Plan.		

SECTION 6.3, 6.4, 6.5, 6.6 RISKS TO THE HEALTH OF WATER DEPENDENT ECOSYSTEMS FROM POOR WATER QUALITY [E(WQ), [E(WQ-CWP)], [E(WQ-WWP)], [E(WQ-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**	**New 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 Namoi Surface WRPA. Additional actions and mechanisms relevant to the WRP are listed below.				**WQ** 1, 2, 3, 4, 5, 6, 7
										regulated water source. 11. Implement the WQM Plan for the WRP area.				
E(WQ)	Regulated	419024 Peel River at Paradise Weir	Total Phosphorus	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. E6a Access to uncontrolled natural flow events in the regulated Peel River limited to a maximum of 50% forecast uncontrolled flow volume above either 5ML/d or 50ML/d dependent on general security AWDs is <0.35 ML or >0.35ML per unit share component. E7 - Protect large flow events in the Namoir WRP area to meet flow targets in the downstream Barwon-Darling Watercourse (SW12) E9 Uncontrolled flows arising from the release of the Peel ECA into designated sections of the Peel River protected up to 50 ML/day at Piallamore and either or 40 or 50ML/d at Caroll Gap dependent on the general security AWDs. E17 Improve dam infrastructure and its management so that water releases are more closely matched to Namoi and Peel River ambient temperatures.	VH	L	M	M/H	F	Refer to WQM Plan		Refer to WQM Plan.		MER planned for WSP objectives and WQ 1, 2, 4, 5
			Total Nitrogen	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. E6a Access to uncontrolled natural flow events in the regulated Peel River limited to a maximum of 50% forecast uncontrolled flow volume above either 5ML/d or 50ML/d dependent on general security AWDs is <0.35 ML or >0.35ML per unit share component. E7 - Protect large flow events in the Namoir WRP area to meet flow targets in the downstream Barwon-Darling Watercourse (SW12) E9 Uncontrolled flows arising from the release of the Peel ECA into designated sections of the Peel River protected up to 50 ML/day at Piallamore and either or 40 or 50ML/d at Caroll Gap dependent on the general security AWDs. E17 Improve dam infrastructure and its management so that water releases are more closely matched to Namoi and Peel River ambient temperatures.	VH	L	M	M/H	F	Refer to WQM Plan		Refer to WQM Plan.		
			pH	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. E6a Access to uncontrolled natural flow events in the regulated Peel River limited to a maximum of 50% forecast uncontrolled flow volume	VH	L	M	M/H	F	Refer to WQM Plan		Refer to WQM Plan.		

SECTION 6.3, 6.4, 6.5, 6.6 RISKS TO THE HEALTH OF WATER DEPENDENT ECOSYSTEMS FROM POOR WATER QUALITY [E(WQ), [E(WQ-CWP)], [E(WQ-WWP)], [E(WQ-S)], [E(WQ-PT)]														
Risk Code	**Water Source Type**	**Location, Reach, or Extraction Type within WRP Area**	**Water Quality Characteristic**	**Current Critical Mechanisms**	**Consequence**	**Likelihood**	**Risk Rating**	**Data confidence (Consequence / Likelihood)**	**Risk treatment option**	**New 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 Namoi Surface WRPA. Additional actions and mechanisms relevant to the WRP are listed below.				**WQ** 1, 2, 3, 4, 5, 6, 7
				above either 5ML/d or 50ML/d dependent on general security AWDs is <0.35 ML or >0.35ML per unit share component. E7 - Protect large flow events in the Namoir WRP area to meet flow targets in the downstream Barwon-Darling Watercourse (SW12) E9 Uncontrolled flows arising from the release of the Peel ECA into designated sections of the Peel River protected up to 50 ML/day at Piallamore and either or 40 or 50ML/d at Caroll Gap dependent on the general security AWDs. E17 Improve dam infrastructure and its management so that water releases are more closely matched to Namoi and Peel River ambient temperatures.											
	Regulated	419024 Peel River at Paradise Weir	Dissolved Oxygen	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. E6a Access to uncontrolled natural flow events in the regulated Peel River limited to a maximum of 50% forecast uncontrolled flow volume above either 5ML/d or 50ML/d dependent on general security AWDs is <0.35 ML or >0.35ML per unit share component. E7 - Protect large flow events in the Namoir WRP area to meet flow targets in the downstream Barwon-Darling Watercourse (SW12) E9 Uncontrolled flows arising from the release of the Peel ECA into designated sections of the Peel River protected up to 50 ML/day at Piallamore and either or 40 or 50ML/d at Caroll Gap dependent on the general security AWDs. E17 Improve dam infrastructure and its management so that water releases are more closely matched to Namoi and Peel River ambient temperatures.	VH	M	H	M/H	F	Refer to WQM Plan 2 Protect a portion of high flow events in the Namoi WRP area. 3 Provide discretionary environmental watering events in the regulated river and downstream unregulated river sections of the WRP area. 4. Manage environmental water to meet flow targets specified in the Namoi LTWP 5. Protect low flow habitats from accelerated rates of drying 8. Protect tributary flows within the WRP area as they move from the unregulated water source into the regulated water source. 11. Implement the WQM Plan for the WRP area.	N2 Strategic use of uncontrolled / supplementary flow events to manage environmental outcomes within the lower portions of the Namoi WRP as guided by the LTWP N3 Strategic use of environmental water (EWA/ECA) and relevant held environmental water licences as guided by the LTWP.	Refer to WQM Plan.		MER planned for WSP objectives and WQ 1, 2, 4, 5
E(WQ)	Regulated	419006 Peel River at Carrol Gap	Turbidity	E1 Reserve all water above the long-term average annual extraction limit (LTAAEL) for the environment as PEW (defined and managed by the listed WSPs). E2 Available Water Determinations (AWD) adjust extractive use according to water availability. E6a Access to uncontrolled natural flow events in the regulated Peel River limited to a maximum of 50% forecast uncontrolled flow volume above either 5ML/d or 50ML/d dependent on general security AWDs is <0.35 ML or >0.35ML per unit share component. E7 - Protect large flow events in the Namoir WRP area to meet flow targets in the downstream Barwon-Darling Watercourse (SW12)	M	M	M	M/H	F	Refer to WQM Plan 2 Protect a portion of high flow events in the Namoi WRP area. 3 Provide discretionary environmental watering events in the regulated river and downstream unregulated river sections of the WRP	N2 Strategic use of uncontrolled / supplementary flow events to manage environmental outcomes within the lower portions of the Namoi WRP as guided by the LTWP	Refer to WQM Plan.		MER planned for WSP objectives and WQ 1, 2, 4, 5

SECTION 6.3, 6.4, 6.5, 6.6 RISKS TO THE HEALTH OF WATER DEPENDENT ECOSYSTEMS FROM POOR WATER QUALITY [E(WQ), [E(WQ-CWP)], [E(WQ-WWP)], [E(WQ-S)], [E(WQ-PT)]														
Risk Code	**Water Source Type**	**Location, Reach, or Extraction Type within WRP Area**	**Water Quality Characteristic**	**Current Critical Mechanisms**	**Consequence**	**Likelihood**	**Risk Rating**	**Data confidence (Consequence / Likelihood)**	**Risk treatment option**	**New 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 Namoi Surface WRPA. Additional actions and mechanisms relevant to the WRP are listed below.				**WQ** 1, 2, 3, 4, 5, 6, 7
				E9 Uncontrolled flows arising from the release of the Peel ECA into designated sections of the Peel River protected up to 50 ML/day at Piallamore and either or 40 or 50ML/d at Caroll Gap dependent on the general security AWDs. E17 Improve dam infrastructure and its management so that water releases are more closely matched to Namoi and Peel River ambient temperatures.						area. 4. Manage environmental water to meet flow targets specified in the Namoi LTWP 5. Protect low flow habitats from accelerated rates of drying 8. Protect tributary flows within the WRP area as they move from the unregulated water source into the regulated water source. 11. Implement the WQM Plan for the WRP area.	N3 Strategic use of environmental water (EWA/ECA) and relevant held environmental water licences as guided by the LTWP.			
E(WQ)	Regulated	419006 Peel River at Carrol Gap	Total Phosphorus	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. E6a Access to uncontrolled natural flow events in the regulated Peel River limited to a maximum of 50% forecast uncontrolled flow volume above either 5ML/d or 50ML/d dependent on general security AWDs is <0.35 ML or >0.35ML per unit share component. E7 - Protect large flow events in the Namoir WRP area to meet flow targets in the downstream Barwon-Darling Watercourse (SW12) E9 Uncontrolled flows arising from the release of the Peel ECA into designated sections of the Peel River protected up to 50 ML/day at Piallamore and either or 40 or 50ML/d at Caroll Gap dependent on the general security AWDs. E17 Improve dam infrastructure and its management so that water releases are more closely matched to Namoi and Peel River ambient temperatures.	M	L	L	M/H	F	Refer to WQM Plan		Refer to WQM Plan.		
			Total Nitrogen	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. E6a Access to uncontrolled natural flow events in the regulated Peel River limited to a maximum of 50% forecast uncontrolled flow volume above either 5ML/d or 50ML/d dependent on general security AWDs is <0.35 ML or >0.35ML per unit share component. E7 - Protect large flow events in the Namoir WRP area to meet flow targets in the downstream Barwon-Darling Watercourse (SW12) E9 Uncontrolled flows arising from the release of the Peel ECA into designated sections of the Peel River protected up to 50 ML/day at Piallamore and either or 40 or 50ML/d at Caroll Gap dependent on the general security AWDs.	M	M	M	M/H	F	Refer to WQM Plan 2 Protect a portion of high flow events in the Namoi WRP area. 3 Provide discretionary environmental watering events in the regulated river and downstream unregulated river sections of the WRP area. 4. Manage environmental water to meet flow targets	N2 Strategic use of uncontrolled / supplementary flow events to manage environmental outcomes within the lower portions of the Namoi WRP as guided by the LTWP N3 Strategic use of environmental water (EWA/ECA) and	Refer to WQM Plan.		MER planned for WSP objectives and WQ 1, 2, 4, 5

SECTION 6.3, 6.4, 6.5, 6.6 RISKS TO THE HEALTH OF WATER DEPENDENT ECOSYSTEMS FROM POOR WATER QUALITY [E(WQ), [E(WQ-CWP)], [E(WQ-WWP)], [E(WQ-S)], [E(WQ-PT)]														
Risk Code	**Water Source Type**	**Location, Reach, or Extraction Type within WRP Area**	**Water Quality Characteristic**	**Current Critical Mechanisms**	**Consequence**	**Likelihood**	**Risk Rating**	**Data confidence (Consequence / Likelihood)**	**Risk treatment option**	**New 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 Namoi Surface WRPA. Additional actions and mechanisms relevant to the WRP are listed below.				**WQ** 1, 2, 3, 4, 5, 6, 7
				E17 Improve dam infrastructure and its management so that water releases are more closely matched to Namoi and Peel River ambient temperatures.						specified in the Namoi LTWP 5. Protect low flow habitats from accelerated rates of drying 8. Protect tributary flows within the WRP area as they move from the unregulated water source into the regulated water source. 11. Implement the WQM Plan for the WRP area.	relevant held environmental water licences as guided by the LTWP.			
			pH	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. E6a Access to uncontrolled natural flow events in the regulated Peel River limited to a maximum of 50% forecast uncontrolled flow volume above either 5ML/d or 50ML/d dependent on general security AWDs is <0.35 ML or >0.35ML per unit share component. E7 - Protect large flow events in the Namoir WRP area to meet flow targets in the downstream Barwon-Darling Watercourse (SW12) E9 Uncontrolled flows arising from the release of the Peel ECA into designated sections of the Peel River protected up to 50 ML/day at Piallamore and either or 40 or 50ML/d at Caroll Gap dependent on the general security AWDs. E17 Improve dam infrastructure and its management so that water releases are more closely matched to Namoi and Peel River ambient temperatures.	M	L	L	M/H	F	Refer to WQM Plan		Refer to WQM Plan.		
E(WQ)	Regulated	419006 Peel River at Carrol Gap	Dissolved Oxygen	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. E6a Access to uncontrolled natural flow events in the regulated Peel River limited to a maximum of 50% forecast uncontrolled flow volume above either 5ML/d or 50ML/d dependent on general security AWDs is <0.35 ML or >0.35ML per unit share component. E7 - Protect large flow events in the Namoir WRP area to meet flow targets in the downstream Barwon-Darling Watercourse (SW12) E9 Uncontrolled flows arising from the release of the Peel ECA into designated sections of the Peel River protected up to 50 ML/day at Piallamore and either or 40 or 50ML/d at Caroll Gap dependent on the general security AWDs. E17 Improve dam infrastructure and its management so that water releases are more closely matched to Namoi and Peel River ambient temperatures.	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

SECTION 6.3, 6.4, 6.5, 6.6 RISKS TO THE HEALTH OF WATER DEPENDENT ECOSYSTEMS FROM POOR WATER QUALITY [E(WQ), [E(WQ-CWP)], [E(WQ-WWP)], [E(WQ-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**	**New 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 Namoi Surface WRPA. Additional actions and mechanisms relevant to the WRP are listed below.				**WQ** 1, 2, 3, 4, 5, 6, 7
E(WQ)	Regulated	419022 Namoi River at Manilla Railway Bridge	Turbidity	E1 Reserve all water above the long-term average annual extraction limit (LTAAEL) for the environment as PEW (defined and managed by the listed WSPs). E2 Available Water Determinations (AWD) adjust extractive use according to water availability. E17 Improve dam infrastructure and its management so that water releases are more closely matched to Namoi and Peel River ambient temperatures.	M	L	L	M/H	F	Refer to WQM Plan .		Refer to WQM Plan.		
			Total Phosphorus	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. E17 Improve dam infrastructure and its management so that water releases are more closely matched to Namoi and Peel River ambient temperatures.	M	L	L	M/H	F	Refer to WQM Plan		Refer to WQM Plan.		
E(WQ)	Regulated	419022 Namoi River at Manilla Railway Bridge	Total Nitrogen	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. E17 Improve dam infrastructure and its management so that water releases are more closely matched to Namoi and Peel River ambient temperatures.	M	L	L	M/H	F			Refer to WQM Plan.		MER planned for WSP objectives and WQ 1, 2, 4, 5
E(WQ)	Regulated	419022 Namoi River at Manilla Railway Bridge	pH	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. E17 Improve dam infrastructure and its management so that water releases are more closely matched to Namoi and Peel River ambient temperatures.	M	M	M	M/H	F	Refer to WQM Plan		Refer to WQM Plan.		
			Dissolved Oxygen	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. E17 Improve dam infrastructure and its management so that water releases are more closely matched to Namoi and Peel River ambient temperatures..	M	L	L	M/H	F			Refer to WQM Plan.		

SECTION 6.3, 6.4, 6.5, 6.6 RISKS TO THE HEALTH OF WATER DEPENDENT ECOSYSTEMS FROM POOR WATER QUALITY [E(WQ), [E(WQ-CWP)], [E(WQ-WWP)], [E(WQ-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**	**New 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 Namoi Surface WRPA. Additional actions and mechanisms relevant to the WRP are listed below.				**WQ** 1, 2, 3, 4, 5, 6, 7
E(WQ)	Regulated	419001 Namoi River at Gunnedah	Turbidity	E1 Reserve all water above the long-term average annual extraction limit (LTAAEL) for the environment as PEW (defined and managed by the listed WSPs). E4 Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use. E6b Supplementary access: In the lower Namoi access to a supplementary event is currently on a trial basis: prior to 1 July 2019, should not exceed 50% of a supplementary event; and after 30 June 2019: 10% of the supplementary event between 1 July and 31 October and 50% between 1 November and 30 June. E7 Protect large flow events in the Namoi WRP area to meet flow targets in the downstream Barwon-Darling Watercourse (SW12). E8 Strategic use of environmental water provisions (EWP) as described in the WSP (e.g., Namoi end-of-system minimum daily flows in June, July and August at Walgett when the combined capacity of Keepit and Split Rock dams ≥120 GL).E10 Rates of change to storage release protocol. E11 Coordinate release of environmental water allowance (EWA) and/or Held Environmental Water with natural flow events. E17 Improve dam infrastructure and its management so that water releases are more closely matched to Namoi and Peel River ambient temperatures.	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)	Regulated	419001 Namoi River at Gunnedah	Total Phosphorus	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). E4 Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use. E6b Supplementary access: In the lower Namoi access to a supplementary event is currently on a trial basis: prior to 1 July 2019, should not exceed 50% of a supplementary event; and after 30 June 2019: 10% of the supplementary event between 1 July and 31 October and 50% between 1 November and 30 June. E7 Protect large flow events in the Namoi WRP area to meet flow targets in the downstream Barwon-Darling Watercourse (SW12). E8 Strategic use of environmental water provisions (EWP) as described in the WSP (e.g., Namoi end-of-system minimum daily flows in June, July and August at Walgett when the combined capacity of Keepit and Split Rock dams ≥120 GL).E10 Rates of change to storage release protocol. E11 Coordinate release of environmental water allowance (EWA) and/or Held Environmental Water with natural flow events. E17 Improve dam infrastructure and its management so that water releases are more closely matched to Namoi and Peel River ambient temperatures.	M	M	M	M/H	F	Refer to WQM Plan 2 Protect a portion of high flow events in the lower Namoi WRP area. 3 Provide discretionary environmental watering events in the regulated river and downstream unregulated river sections of the WRP area. 4. Manage environmental water to meet flow targets in the Namoi LTWP. 5. Protect low flow habitats from accelerated rates of drying. 8. Protect tributary flows within the WRP area as they move from the unregulated water source into the regulated water source.	. N2 Strategic use of uncontrolled / supplementary flow events to manage environmental outcomes within the lower portions of the Namoi WRP as guided by the LTWP N3 Strategic use of environmental water (EWA/ECA) and relevant held environmental water licences as guided by the LTWP.	Refer to WQM Plan.		

SECTION 6.3, 6.4, 6.5, 6.6 RISKS TO THE HEALTH OF WATER DEPENDENT ECOSYSTEMS FROM POOR WATER QUALITY [E(WQ), [E(WQ-CWP)], [E(WQ-WWP)], [E(WQ-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**	**New 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 Namoi Surface WRPA. Additional actions and mechanisms relevant to the WRP are listed below.				**WQ** 1, 2, 3, 4, 5, 6, 7
			Total Nitrogen	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). E4 Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use. E6b Supplementary access: In the lower Namoi access to a supplementary event is currently on a trial basis: prior to 1 July 2019, should not exceed 50% of a supplementary event; and after 30 June 2019: 10% of the supplementary event between 1 July and 31 October and 50% between 1 November and 30 June. E7 Protect large flow events in the Namoi WRP area to meet flow targets in the downstream Barwon-Darling Watercourse (SW12). E8 Strategic use of environmental water provisions (EWP) as described in the WSP (e.g., Namoi end-of-system minimum daily flows in June, July and August at Walgett when the combined capacity of Keepit and Split Rock dams ≥120 GL).E10 Rates of change to storage release protocol. E11 Coordinate release of environmental water allowance (EWA) and/or Held Environmental Water with natural flow events. E17 Improve dam infrastructure and its management so that water releases are more closely matched to Namoi and Peel River ambient temperatures.	M	M	M	M/H	F	Refer to WQM Plan 2 Protect a portion of high flow events in the lower Namoi WRP area. 3 Provide discretionary environmental watering events in the regulated river and downstream unregulated river sections of the WRP area. 4. Manage environmental water to meet flow targets in the Namoi LTWP. 5. Protect low flow habitats from accelerated rates of drying. 8. Protect tributary flows within the WRP area as they move from the unregulated water source into the regulated water source.	N2 Strategic use of uncontrolled / supplementary flow events to manage environmental outcomes within the lower portions of the Namoi WRP as guided by the LTWP N3 Strategic use of environmental water EWA/ECA) and relevant held environmental water licences as guided by the LTWP.	Refer to WQM Plan.		MER planned for WSP objectives and WQ 1, 2, 4, 5
E(WQ)	Regulated	419001 Namoi River at Gunnedah	pH	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). E4 Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use. E6b Supplementary access: In the lower Namoi access to a supplementary event is currently on a trial basis: prior to 1 July 2019, should not exceed 50% of a supplementary event; and after 30 June 2019: 10% of the supplementary event between 1 July and 31 October and 50% between 1 November and 30 June. E7 Protect large flow events in the Namoi WRP area to meet flow targets in the downstream Barwon-Darling Watercourse (SW12). E8 Strategic use of environmental water provisions (EWP) as described in the WSP (e.g., Namoi end-of-system minimum daily flows in June, July and August at Walgett when the combined capacity of Keepit and Split Rock dams ≥120 GL).E10 Rates of change to storage release protocol. E11 Coordinate release of environmental water allowance (EWA) and/or Held Environmental Water with natural flow events. E17 Improve dam infrastructure and its management so that water releases are more closely matched to Namoi and Peel River ambient temperatures..	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

SECTION 6.3, 6.4, 6.5, 6.6 RISKS TO THE HEALTH OF WATER DEPENDENT ECOSYSTEMS FROM POOR WATER QUALITY [E(WQ), [E(WQ-CWP)], [E(WQ-WWP)], [E(WQ-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**	**New 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 Namoi Surface WRPA. Additional actions and mechanisms relevant to the WRP are listed below.				**WQ** 1, 2, 3, 4, 5, 6, 7
			Dissolved Oxygen	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). E4 Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use. E6b Supplementary access: In the lower Namoi access to a supplementary event is currently on a trial basis: prior to 1 July 2019, should not exceed 50% of a supplementary event; and after 30 June 2019: 10% of the supplementary event between 1 July and 31 October and 50% between 1 November and 30 June. E7 Protect large flow events in the Namoi WRP area to meet flow targets in the downstream Barwon-Darling Watercourse (SW12). E8 Strategic use of environmental water provisions (EWP) as described in the WSP (e.g., Namoi end-of-system minimum daily flows in June, July and August at Walgett when the combined capacity of Keepit and Split Rock dams ≥120 GL).E10 Rates of change to storage release protocol. E11 Coordinate release of environmental water allowance (EWA) and/or Held Environmental Water with natural flow events. E17 Improve dam infrastructure and its management so that water releases are more closely matched to Namoi and Peel River ambient temperatures.	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)	Regulated	419003 Narrabri Creek at Narrabri	Turbidity	. E1 Reserve all water above the long-term average annual extraction limit (LTAAEL) for the environment as PEW (defined and managed by the listed WSPs). E4 Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use. E6b Supplementary access: In the lower Namoi access to a supplementary event is currently on a trial basis: prior to 1 July 2019, should not exceed 50% of a supplementary event; and after 30 June 2019: 10% of the supplementary event between 1 July and 31 October and 50% between 1 November and 30 June. E7 Protect large flow events in the Namoi WRP area to meet flow targets in the downstream Barwon-Darling Watercourse (SW12). E8 Strategic use of environmental water provisions (EWP) as described in the WSP (e.g., Namoi end-of-system minimum daily flows in June, July and August at Walgett when the combined capacity of Keepit and Split Rock dams ≥120 GL).E10 Rates of change to storage release protocol. E11 Coordinate release of environmental water allowance (EWA) and/or Held Environmental Water with natural flow events. E17 Improve dam infrastructure and its management so that water releases are more closely matched to Namoi and Peel River ambient temperatures.	VH	M	H	M/H	F	Refer to WQM Plan 2 Protect a portion of high flow events in the lower Namoi WRP area. 3 Provide discretionary environmental watering events in the regulated river and downstream unregulated river sections of the WRP area. 4. Manage environmental water to meet flow targets in the Namoi LTWP. 5. Protect low flow habitats from accelerated rates of drying. 8. Protect tributary flows within the WRP area as they move from the unregulated water source into the regulated water source.	N2 Strategic use of uncontrolled / supplementary flow events to manage environmental outcomes within the lower portions of the Namoi WRP. N3 Strategic use of environmental water (EWA/ECA) and relevant held environmental water licences as guided by the LTWP.	Refer to WQM Plan.		MER planned for WSP objectives and WQ 1, 2, 4, 5
			Total Phosphorus	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). E4 Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use.	VH	H	H	M/H	F	Refer to WQM Plan 2 Protect a portion of high flow events in the lower Namoi WRP area.	N2 Strategic use of uncontrolled / supplementary flow events to manage	Refer to WQM Plan.		MER planned for WSP objectives and

SECTION 6.3, 6.4, 6.5, 6.6 RISKS TO THE HEALTH OF WATER DEPENDENT ECOSYSTEMS FROM POOR WATER QUALITY [E(WQ), [E(WQ-CWP)], [E(WQ-WWP)], [E(WQ-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**	**New 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 Namoi Surface WRPA. Additional actions and mechanisms relevant to the WRP are listed below.				**WQ** 1, 2, 3, 4, 5, 6, 7
				E6b Supplementary access: In the lower Namoi access to a supplementary event is currently on a trial basis: prior to 1 July 2019, should not exceed 50% of a supplementary event; and after 30 June 2019: 10% of the supplementary event between 1 July and 31 October and 50% between 1 November and 30 June. E7 Protect large flow events in the Namoi WRP area to meet flow targets in the downstream Barwon-Darling Watercourse (SW12). E8 Strategic use of environmental water provisions (EWP) as described in the WSP (e.g., Namoi end-of-system minimum daily flows in June, July and August at Walgett when the combined capacity of Keepit and Split Rock dams ≥120 GL).E10 Rates of change to storage release protocol. E11 Coordinate release of environmental water allowance (EWA) and/or Held Environmental Water with natural flow events. E17 Improve dam infrastructure and its management so that water releases are more closely matched to Namoi and Peel River ambient temperatures.					3 Provide discretionary environmental watering events in the regulated river and downstream unregulated river sections of the WRP area. 4. Manage environmental water to meet flow targets in the Namoi LTWP. 5. Protect low flow habitats from accelerated rates of drying. 8. Protect tributary flows within the WRP area as they move from the unregulated water source into the regulated water source.	environmental outcomes within the lower portions of the Namoi WRP as guided by the LTWP N3 Strategic use of environmental water (EWA/ECA) and relevant held environmental water licences as guided by the LTWP.			WQ 1, 2, 4, 5
			Total Nitrogen	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). E4 Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use. E6b Supplementary access: In the lower Namoi access to a supplementary event is currently on a trial basis: prior to 1 July 2019, should not exceed 50% of a supplementary event; and after 30 June 2019: 10% of the supplementary event between 1 July and 31 October and 50% between 1 November and 30 June. E7 Protect large flow events in the Namoi WRP area to meet flow targets in the downstream Barwon-Darling Watercourse (SW12). E8 Strategic use of environmental water provisions (EWP) as described in the WSP (e.g., Namoi end-of-system minimum daily flows in June, July and August at Walgett when the combined capacity of Keepit and Split Rock dams ≥120 GL).E10 Rates of change to storage release protocol. E11 Coordinate release of environmental water allowance (EWA) and/or Held Environmental Water with natural flow events. E17 Improve dam infrastructure and its management so that water releases are more closely matched to Namoi and Peel River ambient temperatures.	VH	L	M	M/H	F	Refer to WQM Plan		Refer to WQM Plan.		
E(WQ)	Regulated	419003 Narrabri Creek at Narrabri	pH	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). E4 Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use. E6b Supplementary access: In the lower Namoi access to a supplementary event is currently on a trial basis: prior to 1 July 2019, should not exceed 50% of a supplementary event; and after 30 June	VH	L	M	M/H	F	Refer to WQM Plan 2 Protect a portion of high flow events in the lower Namoi WRP area. 3 Provide discretionary environmental watering events in the	N2 Strategic use of uncontrolled / supplementary flow events to manage environmental outcomes within the lower portions of the	Refer to WQM Plan.		WQ 1, 2, 4, 5

SECTION 6.3, 6.4, 6.5, 6.6 RISKS TO THE HEALTH OF WATER DEPENDENT ECOSYSTEMS FROM POOR WATER QUALITY [E(WQ), [E(WQ-CWP)], [E(WQ-WWP)], [E(WQ-S)], [E(WQ-PT)]														
Risk Code	**Water Source Type**	**Location, Reach, or Extraction Type within WRP Area**	**Water Quality Characteristic**	**Current Critical Mechanisms**	**Consequence**	**Likelihood**	**Risk Rating**	**Data confidence (Consequence / Likelihood)**	**Risk treatment option**	**New 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 Namoi Surface WRPA. Additional actions and mechanisms relevant to the WRP are listed below.				**WQ** 1, 2, 3, 4, 5, 6, 7
				2019: 10% of the supplementary event between 1 July and 31 October and 50% between 1 November and 30 June. E7 Protect large flow events in the Namoi WRP area to meet flow targets in the downstream Barwon-Darling Watercourse (SW12). E8 Strategic use of environmental water provisions (EWP) as described in the WSP (e.g., Namoi end-of-system minimum daily flows in June, July and August at Walgett when the combined capacity of Keepit and Split Rock dams ≥120 GL).E10 Rates of change to storage release protocol. E11 Coordinate release of environmental water allowance (EWA) and/or Held Environmental Water with natural flow events. E17 Improve dam infrastructure and its management so that water releases are more closely matched to Namoi and Peel River ambient temperatures.					regulated river and downstream unregulated river sections of the WRP area. 4. Manage environmental water to meet flow targets in the Namoi LTWP. 5. Protect low flow habitats from accelerated rates of drying. 8. Protect tributary flows within the WRP area as they move from the unregulated water source into the regulated water source.	Namoi WRP as guided by the LTWP N3 Strategic use of environmental water (EWA/ECA) and relevant held environmental water licences as guided by the LTWP.			
E(WQ)	Regulated	419003 Narrabri Creek at Narrabri	Dissolved Oxygen	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). E4 Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use. E6b Supplementary access: In the lower Namoi access to a supplementary event is currently on a trial basis: prior to 1 July 2019, should not exceed 50% of a supplementary event; and after 30 June 2019: 10% of the supplementary event between 1 July and 31 October and 50% between 1 November and 30 June. E7 Protect large flow events in the Namoi WRP area to meet flow targets in the downstream Barwon-Darling Watercourse (SW12). E8 Strategic use of environmental water provisions (EWP) as described in the WSP (e.g., Namoi end-of-system minimum daily flows in June, July and August at Walgett when the combined capacity of Keepit and Split Rock dams ≥120 GL).E10 Rates of change to storage release protocol. E11 Coordinate release of environmental water allowance (EWA) and/or Held Environmental Water with natural flow events. E17 Improve dam infrastructure and its management so that water releases are more closely matched to Namoi and Peel River ambient temperatures.	VH	L	M	M/H	F	Refer to WQM Plan 2 Protect a portion of high flow events in the lower Namoi WRP area. 3 Provide discretionary environmental watering events in the regulated river and downstream unregulated river sections of the WRP area. 4. Manage environmental water to meet flow targets in the Namoi LTWP. 5. Protect low flow habitats from accelerated rates of drying. 8. Protect tributary flows within the WRP area as they move from the unregulated water source into the regulated water source.	N2 Strategic use of uncontrolled / supplementary flow events to manage environmental outcomes within the lower portions of the Namoi WRP as guided by the LTWP N3 Strategic use of environmental water (EWA/ECA) and relevant held environmental water licences as guided by the LTWP.	Refer to WQM Plan.		MER planned for WSP objectives and WQ 1, 2, 4, 5

SECTION 6.3, 6.4, 6.5, 6.6 RISKS TO THE HEALTH OF WATER DEPENDENT ECOSYSTEMS FROM POOR WATER QUALITY [E(WQ), [E(WQ-CWP)], [E(WQ-WWP)], [E(WQ-S)], [E(WQ-PT)]														
Risk Code	**Water Source Type**	**Location, Reach, or Extraction Type within WRP Area**	**Water Quality Characteristic**	**Current Critical Mechanisms**	**Consequence**	**Likelihood**	**Risk Rating**	**Data confidence (Consequence / Likelihood)**	**Risk treatment option**	**New 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 Namoi Surface WRPA. Additional actions and mechanisms relevant to the WRP are listed below.				**WQ** 1, 2, 3, 4, 5, 6, 7
E(WQ)	Regulated	419021 Namoi River at Bugilbone	Turbidity	E1 Reserve all water above the long-term average annual extraction limit (LTAAEL) for the environment as PEW (defined and managed by the listed WSPs). E4 Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use. E6b Supplementary access: In the lower Namoi access to a supplementary event is currently on a trial basis: prior to 1 July 2019, should not exceed 50% of a supplementary event; and after 30 June 2019: 10% of the supplementary event between 1 July and 31 October and 50% between 1 November and 30 June. E7 Protect large flow events in the Namoi WRP area to meet flow targets in the downstream Barwon-Darling Watercourse (SW12). E8 Strategic use of environmental water provisions (EWP) as described in the WSP (e.g., Namoi end-of-system minimum daily flows in June, July and August at Walgett when the combined capacity of Keepit and Split Rock dams ≥120 GL).E10 Rates of change to storage release protocol. E11 Coordinate release of environmental water allowance (EWA) and/or Held Environmental Water with natural flow events. E17 Improve dam infrastructure and its management so that water releases are more closely matched to Namoi and Peel River ambient temperatures.	H	L	L	M/H	F	Refer to WQM Plan 2 Protect a portion of high flow events in the lower Namoi WRP area. 3 Provide discretionary environmental watering events in the regulated river and downstream unregulated river sections of the WRP area. 4. Manage environmental water to meet flow targets in the Namoi LTWP. 5. Protect low flow habitats from accelerated rates of drying. 8. Protect tributary flows within the WRP area as they move from the unregulated water source into the regulated water source.	N2 Strategic use of uncontrolled / supplementary flow events to manage environmental outcomes within the lower portions of the Namoi WRP as guided by the LTWP N3 Strategic use of environmental water (EWA/ECA) and relevant held environmental water licences as guided by the LTWP.	Refer to WQM Plan.		MER planned for WSP objectives and WQ 1, 2, 4, 5
			Total Phosphorus	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). E4 Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use. E6b Supplementary access: In the lower Namoi access to a supplementary event is currently on a trial basis: prior to 1 July 2019, should not exceed 50% of a supplementary event; and after 30 June 2019: 10% of the supplementary event between 1 July and 31 October and 50% between 1 November and 30 June. E7 Protect large flow events in the Namoi WRP area to meet flow targets in the downstream Barwon-Darling Watercourse (SW12). E8 Strategic use of environmental water provisions (EWP) as described in the WSP (e.g., Namoi end-of-system minimum daily flows in June, July and August at Walgett when the combined capacity of Keepit and Split Rock dams ≥120 GL). E10 Rates of change to storage release protocol. E11 Coordinate release of environmental water allowance (EWA) and/or Held Environmental Water with natural flow events. E17 Improve dam infrastructure and its management so that water releases are more closely matched to Namoi and Peel River ambient temperatures.	H	L	L	M/H	F	Refer to WQM Plan		Refer to WQM Plan.		

SECTION 6.3, 6.4, 6.5, 6.6 RISKS TO THE HEALTH OF WATER DEPENDENT ECOSYSTEMS FROM POOR WATER QUALITY [E(WQ), [E(WQ-CWP)], [E(WQ-WWP)], [E(WQ-S)], [E(WQ-PT)]														
Risk Code	**Water Source Type**	**Location, Reach, or Extraction Type within WRP Area**	**Water Quality Characteristic**	**Current Critical Mechanisms**	**Consequence**	**Likelihood**	**Risk Rating**	**Data confidence (Consequence / Likelihood)**	**Risk treatment option**	**New 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 Namoi Surface WRPA. Additional actions and mechanisms relevant to the WRP are listed below.				**WQ** 1, 2, 3, 4, 5, 6, 7
E(WQ)	Regulated	419021 Namoi River at Bugilbone	Total Nitrogen	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). E4 Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use. E6b Supplementary access: In the lower Namoi access to a supplementary event is currently on a trial basis: prior to 1 July 2019, should not exceed 50% of a supplementary event; and after 30 June 2019: 10% of the supplementary event between 1 July and 31 October and 50% between 1 November and 30 June. E7 Protect large flow events in the Namoi WRP area to meet flow targets in the downstream Barwon-Darling Watercourse (SW12). E8 Strategic use of environmental water provisions (EWP) as described in the WSP (e.g., Namoi end-of-system minimum daily flows in June, July and August at Walgett when the combined capacity of Keepit and Split Rock dams ≥120 GL). E10 Rates of change to storage release protocol. E17 Improve dam infrastructure and its management so that water releases are more closely matched to Namoi and Peel River ambient temperatures.	H	L	L	M/H	F	Refer to WQM Plan		Refer to WQM Plan.		MER planned for WSP objectives and WQ 1, 2, 4, 5
E(WQ)	Regulated	419021 Namoi River at Bugilbone	pH	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). E4 Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use. E6b Supplementary access: In the lower Namoi access to a supplementary event is currently on a trial basis: prior to 1 July 2019, should not exceed 50% of a supplementary event; and after 30 June 2019: 10% of the supplementary event between 1 July and 31 October and 50% between 1 November and 30 June. E7 Protect large flow events in the Namoi WRP area to meet flow targets in the downstream Barwon-Darling Watercourse (SW12). E8 Strategic use of environmental water provisions (EWP) as described in the WSP (e.g., Namoi end-of-system minimum daily flows in June, July and August at Walgett when the combined capacity of Keepit and Split Rock dams ≥120 GL). E10 Rates of change to storage release protocol. E11 Coordinate release of environmental water allowance (EWA) and/or Held Environmental Water with natural flow events. E17 Improve dam infrastructure and its management so that water releases are more closely matched to Namoi and Peel River ambient temperatures.	H	L	L	M/H	F	Refer to WQM Plan 2 Protect a portion of high flow events in the lower Namoi WRP area. 3 Provide discretionary environmental watering events in the regulated river and downstream unregulated river sections of the WRP area. 4. Manage environmental water to meet flow targets in the Namoi LTWP. 5. Protect low flow habitats from accelerated rates of drying. 8. Protect tributary flows within the WRP area as they move from the unregulated water source into the regulated water source.	N2 Strategic use of uncontrolled / supplementary flow events to manage environmental outcomes within the lower portions of the Namoi WRP as guided by the LTWP N3 Strategic use of environmental water (EWA/ECA) and relevant held environmental water licences as guided by the LTWP.	Refer to WQM Plan.		

SECTION 6.3, 6.4, 6.5, 6.6 RISKS TO THE HEALTH OF WATER DEPENDENT ECOSYSTEMS FROM POOR WATER QUALITY [E(WQ), [E(WQ-CWP)], [E(WQ-WWP)], [E(WQ-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**	**New 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 Namoi Surface WRPA. Additional actions and mechanisms relevant to the WRP are listed below.				**WQ** 1, 2, 3, 4, 5, 6, 7
			Dissolved Oxygen	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) E4 Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use. E6b Supplementary access: In the lower Namoi access to a supplementary event is currently on a trial basis: prior to 1 July 2019, should not exceed 50% of a supplementary event; and after 30 June 2019: 10% of the supplementary event between 1 July and 31 October and 50% between 1 November and 30 June. E7 Protect large flow events in the Namoi WRP area to meet flow targets in the downstream Barwon-Darling Watercourse (SW12). E8 Strategic use of environmental water provisions (EWP) as described in the WSP (e.g., Namoi end-of-system minimum daily flows in June, July and August at Walgett when the combined capacity of Keepit and Split Rock dams ≥120 GL). E10 Rates of change to storage release protocol. E11 Coordinate release of environmental water allowance (EWA) and/or Held Environmental Water with natural flow events. E17 Improve dam infrastructure and its management so that water releases are more closely matched to Namoi and Peel River ambient temperatures.	H	L	L	M/H	F	Refer to WQM Plan		Refer to WQM Plan.		MER planned for WSP objectives and WQ 1, 2, 4, 5
E(WQ)	Regulated	419026 Namoi River at Goangra	Turbidity	E1 Reserve all water above the long-term average annual extraction limit (LTAAEL) for the environment as PEW (defined and managed by the listed WSPs) E4 Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use. . E6b Supplementary access: In the lower Namoi access to a supplementary event is currently on a trial basis: prior to 1 July 2019, should not exceed 50% of a supplementary event; and after 30 June 2019: 10% of the supplementary event between 1 July and 31 October and 50% between 1 November and 30 June. E7 Protect large flow events in the Namoi WRP area to meet flow targets in the downstream Barwon-Darling Watercourse (SW12). E8 Strategic use of environmental water provisions (EWP) as described in the WSP (e.g., Namoi end-of-system minimum daily flows in June, July and August at Walgett when the combined capacity of Keepit and Split Rock dams ≥120 GL). E10 Rates of change to storage release protocol. E11 Coordinate release of environmental water allowance (EWA) and/or Held Environmental Water with natural flow events. E17 Improve dam infrastructure and its management so that water releases are more closely matched to Namoi and Peel River ambient temperatures.	H	L	L	M/H	F	Refer to WQM Plan 2 Protect a portion of high flow events in the lower Namoi WRP area. 3 Provide discretionary environmental watering events in the regulated river and downstream unregulated river sections of the WRP area. 4. Manage environmental water to meet flow targets in the Namoi LTWP. 5. Protect low flow habitats from accelerated rates of drying. 8. Protect tributary flows within the WRP area as they move from the unregulated water source into the regulated water source.	. N2 Strategic use of uncontrolled / supplementary flow events to manage environmental outcomes within the lower portions of the Namoi WRP as guided by the LTWP N3 Strategic use of environmental water (EWA/ECA) and relevant held environmental water licences as guided by the LTWP.	Refer to WQM Plan.		

SECTION 6.3, 6.4, 6.5, 6.6 RISKS TO THE HEALTH OF WATER DEPENDENT ECOSYSTEMS FROM POOR WATER QUALITY [E(WQ), [E(WQ-CWP)], [E(WQ-WWP)], [E(WQ-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**	**New 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 Namoi Surface WRPA. Additional actions and mechanisms relevant to the WRP are listed below.				**WQ** 1, 2, 3, 4, 5, 6, 7
	Regulated	419026 Namoi River at Goangra	Total Phosphorus	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) E4 Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use. E6b Supplementary access: In the lower Namoi access to a supplementary event is currently on a trial basis: prior to 1 July 2019, should not exceed 50% of a supplementary event; and after 30 June 2019: 10% of the supplementary event between 1 July and 31 October and 50% between 1 November and 30 June. E7 Protect large flow events in the Namoi WRP area to meet flow targets in the downstream Barwon-Darling Watercourse (SW12). E8 Strategic use of environmental water provisions (EWP) as described in the WSP (e.g., Namoi end-of-system minimum daily flows in June, July and August at Walgett when the combined capacity of Keepit and Split Rock dams ≥120 GL). E10 Rates of change to storage release protocol. E17 Improve dam infrastructure and its management so that water releases are more closely matched to Namoi and Peel River ambient temperatures.	H	L	L	M/H	F	Refer to WQM Plan		Refer to WQM Plan.		MER planned for WSP objectives and WQ 1, 2, 4, 5
			Total Nitrogen	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) E4 Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use. E6b Supplementary access: In the lower Namoi access to a supplementary event is currently on a trial basis: prior to 1 July 2019, should not exceed 50% of a supplementary event; and after 30 June 2019: 10% of the supplementary event between 1 July and 31 October and 50% between 1 November and 30 June. E7 Protect large flow events in the Namoi WRP area to meet flow targets in the downstream Barwon-Darling Watercourse (SW12). E8 Strategic use of environmental water provisions (EWP) as described in the WSP (e.g., Namoi end-of-system minimum daily flows in June, July and August at Walgett when the combined capacity of Keepit and Split Rock dams ≥120 GL). E10 Rates of change to storage release protocol. E17 Improve dam infrastructure and its management so that water releases are more closely matched to Namoi and Peel River ambient temperatures.	H	L	L	M/H	F	Refer to WQM Plan		Refer to WQM Plan.		
	Regulated	419026 Namoi River at Goangra	pH	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) E4 Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use. E6b Supplementary access: In the lower Namoi access to a supplementary event is currently on a trial basis: prior to 1 July 2019, should not exceed 50% of a supplementary event; and after 30 June 2019: 10% of the supplementary event between 1 July and 31 October and 50% between 1 November and 30 June. E7 Protect large flow events in the Namoi WRP area to meet flow targets in the downstream Barwon-Darling Watercourse (SW12). E8 Strategic use of environmental water provisions (EWP) as described	H	L	L	M/H	F	Refer to WQM Plan		Refer to WQM Plan.		

SECTION 6.3, 6.4, 6.5, 6.6 RISKS TO THE HEALTH OF WATER DEPENDENT ECOSYSTEMS FROM POOR WATER QUALITY [E(WQ), [E(WQ-CWP)], [E(WQ-WWP)], [E(WQ-S)], [E(WQ-PT)]														
Risk Code	**Water Source Type**	**Location, Reach, or Extraction Type within WRP Area**	**Water Quality Characteristic**	**Current Critical Mechanisms**	**Consequence**	**Likelihood**	**Risk Rating**	**Data confidence (Consequence / Likelihood)**	**Risk treatment option**	**New 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 Namoi Surface WRPA. Additional actions and mechanisms relevant to the WRP are listed below.				**WQ** 1, 2, 3, 4, 5, 6, 7
				in the WSP (e.g., Namoi end-of-system minimum daily flows in June, July and August at Walgett when the combined capacity of Keepit and Split Rock dams ≥120 GL). E10 Rates of change to storage release protocol. E17 Improve dam infrastructure and its management so that water releases are more closely matched to Namoi and Peel River ambient temperatures.										
			Dissolved Oxygen	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) E4 Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use. E6b Supplementary access: In the lower Namoi access to a supplementary event is currently on a trial basis: prior to 1 July 2019, should not exceed 50% of a supplementary event; and after 30 June 2019: 10% of the supplementary event between 1 July and 31 October and 50% between 1 November and 30 June. E7 Protect large flow events in the Namoi WRP area to meet flow targets in the downstream Barwon-Darling Watercourse (SW12). E8 Strategic use of environmental water provisions (EWP) as described in the WSP (e.g., Namoi end-of-system minimum daily flows in June, July and August at Walgett when the combined capacity of Keepit and Split Rock dams ≥120 GL). E10 Rates of change to storage release protocol. E11 Coordinate release of environmental water allowance (EWA) and/or Held Environmental Water with natural flow events. E17 Improve dam infrastructure and its management so that water releases are more closely matched to Namoi and Peel River ambient temperatures.	H	L	L	M/H	F	Refer to WQM Plan 2 Protect a portion of high flow events in the lower Namoi WRP area. 3 Provide discretionary environmental watering events in the regulated river and downstream unregulated river sections of the WRP area. 4. Manage environmental water to meet flow targets in the Namoi LTWP. 5. Protect low flow habitats from accelerated rates of drying. 8. Protect tributary flows within the WRP area as they move from the unregulated water source into the regulated water source.	N2 Strategic use of uncontrolled / supplementary flow events to manage environmental outcomes within the lower portions of the Namoi WRP as guided by the LTWP N3 Strategic use of environmental water (EWA/ECA) and relevant held environmental water licences as guided by the LTWP.	Refer to WQM Plan.		MER planned for WSP objectives and WQ 1, 2, 4, 5
E(WQ-CWP)	Regulated	Keepit Dam (Namoi River 100km downstream of dam)	Cold Water Pollution	E6b Supplementary access: In the lower Namoi access to a supplementary event is currently on a trial basis: prior to 1 July 2019, should not exceed 50% of a supplementary event; and after 30 June 2019: 10% of the supplementary event between 1 July and 31 October and 50% between 1 November and 30 June. E8 Strategic use of environmental water provisions (EWP) as described in the WSP. E17 Improve dam infrastructure and its management so that water releases are more closely matched to Namoi and Peel River ambient temperatures.	M	H	H	M/M	F G	Refer to WQM Plan 2 Protect a portion of high flow events in the Namoi WRP area. 3 Provide discretionary environmental watering events in the regulated river and downstream unregulated river sections of the WRP area.	N2 Strategic use of uncontrolled / supplementary flow events to manage environmental outcomes within the lower portions of the Namoi WRP. N3 Strategic use of environmental water (EWA/ECA) and relevant held environmental water licences as described in the Namoi LTWP.	Refer to WQM Plan.		MER planned for WSP objectives and WQ 1, 2, 4, 5

SECTION 6.3, 6.4, 6.5, 6.6 RISKS TO THE HEALTH OF WATER DEPENDENT ECOSYSTEMS FROM POOR WATER QUALITY [E(WQ), [E(WQ-CWP)], [E(WQ-WWP)], [E(WQ-S)], [E(WQ-PT)]														
Risk Code	**Water Source Type**	**Location, Reach, or Extraction Type within WRP Area**	**Water Quality Characteristic**	**Current Critical Mechanisms**	**Consequence**	**Likelihood**	**Risk Rating**	**Data confidence (Consequence / Likelihood)**	**Risk treatment option**	**New 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 Namoi Surface WRPA. Additional actions and mechanisms relevant to the WRP are listed below.				**WQ** 1, 2, 3, 4, 5, 6, 7
		Split Rock Dam at Brabi (Manilla River immediately downstream of dam)	Cold Water Pollution	E17 Improve dam infrastructure and its management so that water releases are more closely matched to Namoi and Peel River ambient temperatures.	M	L	L	M/M	F G	Refer to WQM Plan		Refer to WQM Plan.		
		Chaffey Dam (Peel River immediately downstream of dam)	Cold Water Pollution	E17 Improve dam infrastructure and its management so that water releases are more closely matched to Namoi and Peel River ambient temperatures. E6a Access to uncontrolled natural flow events in the regulated Peel River limited to a maximum of 50% forecast uncontrolled flow volume above either 5ML/d or 50ML/d dependent on general security AWDs is <0.35 ML or >0.35ML per unit share component. E9 Uncontrolled flows arising from the release of the Peel ECA into designated sections of the Peel River protected up to 50 ML/day at Piallamore and either or 40 or 50ML/d at Caroll Gap dependent on the general security AWDs.	VH	L	M	M/M	F G	Refer to WQM Plan 2 Protect a portion of high flow events in the Namoi WRP area. 3 Provide discretionary environmental watering events in the regulated river and downstream unregulated river sections of the WRP area.	N2 Strategic use of uncontrolled / supplementary flow events to manage environmental outcomes within the lower portions of the the Namoi WRP. N3 Strategic use of environmental water (EWA/ECA) and relevant held environmental water licences as described in the Namoi LTWP.	Refer to WQM Plan.		MER planned for WSP objectives and WQ 1, 2, 4, 5
E(WQ-WWP)	Regulated	Keepit Dam (Namoi River downstream of dam)	Warm Water Pollution	E17 Improve dam infrastructure and its management so that water releases are more closely matched to Namoi and Peel River ambient temperatures. E6b Supplementary access: In the lower Namoi access to a supplementary event is currently on a trial basis: prior to 1 July 2019, should not exceed 50% of a supplementary event; and after 30 June 2019: 10% of the supplementary event between 1 July and 31 October and 50% between 1 November and 30 June.	M	L	L	M/M	F	Refer to WQM Plan 2 Protect a portion of high flow events in the Namoi WRP area. 3 Provide discretionary environmental watering events in the regulated river and downstream unregulated river sections of the WRP area.	N2 Strategic use of uncontrolled / supplementary flow events to manage environmental outcomes within the lower portions of the the Namoi WRP. N3 Strategic use of environmental water (EWA/ECA) and relevant held environmental water licences as described in the Namoi LTWP.	Refer to WQM Plan.		
		Split Rock Dam at Brabi (Manilla River immediately downstream of dam)	Warm Water Pollution	E17 Improve dam infrastructure and its management so that water releases are more closely matched to Namoi and Peel River ambient temperatures.	M	L	L	M/M	F	Refer to WQM Plan		Refer to WQM Plan.		
		Chaffey Dam (Peel River immediately downstream of dam)	Warm Water Pollution	E17 Improve dam infrastructure and its management so that water releases are more closely matched to Namoi and Peel River ambient temperatures. E6a Access to uncontrolled natural flow events in the regulated Peel River limited to a maximum of 50% forecast uncontrolled flow volume above either 5ML/d or 50ML/d dependent on general security AWDs is <0.35 ML or >0.35ML per unit share component.	VH	L	M	M/M	F	Refer to WQM Plan 2 Protect a portion of high flow events in the Namoi WRP area. 3 Provide discretionary environmental watering events in the	N2 Strategic use of uncontrolled / supplementary flow events to manage environmental outcomes within the lower portions of the the Namoi WRP. N3 Strategic use of	Refer to WQM Plan.		MER planned for WSP objectives and WQ 1, 2, 4, 5

SECTION 6.3, 6.4, 6.5, 6.6 RISKS TO THE HEALTH OF WATER DEPENDENT ECOSYSTEMS FROM POOR WATER QUALITY [E(WQ), [E(WQ-CWP)], [E(WQ-WWP)], [E(WQ-S)], [E(WQ-PT)]														
Risk Code	**Water Source Type**	**Location, Reach, or Extraction Type within WRP Area**	**Water Quality Characteristic**	**Current Critical Mechanisms**	**Consequence**	**Likelihood**	**Risk Rating**	**Data confidence (Consequence / Likelihood)**	**Risk treatment option**	**New 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 Namoi Surface WRPA. Additional actions and mechanisms relevant to the WRP are listed below.				**WQ** 1, 2, 3, 4, 5, 6, 7
				E9 Uncontrolled flows arising from the release of the Peel ECA into designated sections of the Peel River protected up to 50 ML/day at Piallamore and either or 40 or 50ML/d at Caroll Gap dependent on the general security AWDs.						regulated river and downstream unregulated river sections of the WRP area.	environmental water (EWA/ECA) and relevant held environmental water licences as described in the Namoi LTWP.			
E(WQ-S)	Regulated	419026 Namoi River at Goangra	Salinity	E6b Supplementary access: In the lower Namoi access to a supplementary event is currently on a trial basis: prior to 1 July 2019, should not exceed 50% of a supplementary event; and after 30 June 2019: 10% of the supplementary event between 1 July and 31 October and 50% between 1 November and 30 June. E8 Strategic use of environmental water provisions (EWP) as described in the WSP (e.g., Namoi end-of-system minimum daily flows in June, July and August at Walgett when the combined capacity of Keepit and Split Rock dams ≥120 GL). E10 Rates of change to storage release protocol. E17 Improve dam infrastructure and its management so that water releases are more closely matched to Namoi and Peel River ambient temperatures.	H	L	L	M/H	F	Refer to WQM Plan 2 Protect a portion of high flow events in the lower Namoi WRP area. 3 Provide discretionary environmental watering events in the regulated river and downstream unregulated river sections of the WRP area. 8. Protect tributary flows within the WRP area as they move from the unregulated water source into the regulated water source.	N2 Strategic use of uncontrolled / supplementary flow events to manage environmental outcomes within the lower portions of the Namoi WRP. N3 Strategic use of environmental water (EWA/ECA) and relevant held environmental water licences as described in the Namoi LTWP.	Refer to WQM Plan.		MER planned for WSP objectives and WQ 1, 2, 4, 5
E(WQ-PT)	Regulated & Unregulated		Pathogens and toxicants	Protection of the Environment Operations Act 1997 Local Government Act 1993 Local Government (General) Regulation 2005	VH	L	M	H/M	A	No new strategies required	NA	Refer to WQM Plan.	Risk is tolerable. Other legislative processes mitigate risk	NA

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

Risk Code	Risk	Water Source Type	Location, Reach, or Extraction Type within WRP Area	Water Quality Characteristic	Current Critical Mechanisms	Consequence	Likelihood	Risk Rating	Data confidence (Consequence / Likelihood)	Risk treatment option	Strategies	New Critical Mechanisms	Tolerable Risk Level	Explanation of tolerable risk application OR Explanation of why risk cannot be addressed	Monitoring and Evaluation
											The primary strategy for addressing risks associated with water quality is the implementation of the Water Quality Management Plan for Namoi Surface 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 Risks to recreational water quality	Reservoir	Chaffey Reservoir	Recreational Water Quality (BGA)	Refer to WQM Plan	L	H	M	H/M	F	Refer to WQM Plan		Refer to WQM Plan.		
		Regulated	Peel River downstream of Chaffey Dam			L	L	L	H/M	F	Refer to WQM Plan		Refer to WQM Plan.		
O(WQ-BGA)	Risks to recreational water quality	Reservoir	Split Rock Reservoir	Recreational Water Quality (BGA)	Refer to WQM Plan	L	L	L	H/M	F	Refer to WQM Plan		Refer to WQM Plan.		
		Regulated	Manilla River downstream of Split Rock Dam			L	L	L		F	Refer to WQM Plan		Refer to WQM Plan.		
O(WQ-BGA)	Risks to recreational water quality	Reservoir	Keepit Reservoir	Recreational Water Quality (BGA)	Refer to WQM Plan	L	L	L		F	Refer to WQM Plan		Refer to WQM Plan.		
		Regulated	Namoi River downstream of Keepit Dam		Refer to WQM Plan	L	L	L		F	Refer to WQM Plan		Refer to WQM Plan.		
O(WQ-BGA)	Risks to recreational water quality	Unregulated	Yarrie lake	Recreational Water Quality (BGA)	Refer to WQM Plan	L	L	L		F	Refer to WQM Plan		Refer to WQM Plan.		
O(WQ-BGA)	Risks to recreational water quality	Regulated	Namoi River Walgett	Recreational Water Quality (BGA)	Refer to WQM Plan	L	L	L		F	Refer to WQM Plan		Refer to WQM Plan.		

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

Risk	Water Source Type	Location, Reach, or Extraction Type within WRP Area	Consequence	Likelihood	Risk Rating	Data confidence (Consequence / Likelihood)	Risk treatment option	Strategies	New Critical Mechanisms	Tolerable risk level	Explanation of tolerable risk application OR Explanation of why risk cannot be addressed	Monitoring and Evaluation
Risk to water available for other uses due to farm dam interception (regulated rivers) O(I-FD)	Regulated	Namoi High Security	Negligible	Possible	L	M/H	N/A	None required. Risk is low.		N/A	N/A	
Risk to water available for other uses due to farm dam interception (regulated rivers) O(I-FD)	Regulated	Namoi General Security Water	Minor	Possible	L	M/H	N/A	None required. Risk is low.		N/A	N/A	
Risk to water available for other uses due to farm dam interception (regulated rivers) O(I-FD)	Regulated	Namoi Supplementary Water	Minor	Possible	L	M/H	N/A	None required. Risk is low.		N/A	N/A	
Risk to water available for other uses due to farm dam interception (regulated rivers) O(I-FD)	Regulated	Peel High Security Water	Negligible	Possible	L	M/H	N/A	None required. Risk is low.		N/A	N/A	
Risk to water available for other uses due to farm dam interception (regulated rivers) O(I-FD)	Regulated	Peel General Security Water	Negligible	Possible	L	M/H	N/A	None required. Risk is low.		N/A	N/A	
Risk to water available for other uses due to farm dam interception (regulated rivers) O(I-FD)	Regulated	Peel Supplementary Water	Minor	Possible	L	M/H	N/A	None required. Risk is low.		N/A	N/A	

Current Critical Mechanisms - O(I-FD)
E18 Require farm dams with a capacity above the maximum harvestable right dam capacity (MHRDC) to be licensed and comply with extraction limits as described in Strategy 1 (E1 Reserve all water above the long-term average annual extraction limit (LTAAEL) for the environment as PEW (defined and managed by the listed WSPs) & E2 Available Water Determinations (AWD) adjust extractive use according to water availability)

N/A no data available or not applicable

SECTION 8.2.1 RISKS TO WATER AVAILABLE FOR OTHER USES FROM INTERCEPTION ACTIVITIES [O(I-FD)] – UNREGULATED WATER SOURCES												
Risk	**Water Source Type**	**Location, Reach, or Extraction Type within WRP Area**	**Flow or Extraction Characteristic**	**Consequence**	**Likelihood**	**Risk Rating**	**Data confidence (Consequence / Likelihood)**	**Risk treatment option**	**Strategies**	**New Critical Mechanisms**	**Tolerable risk level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and Evaluation**
Risk to water available for the environment from farm dam interception O(I-FD)	Unregulated	Maules Creek at Avoca East	Variation Annual Index CV	M	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	
			Low Flow Index Q90	M	L	L		N/A	None required. Risk is low		N/A		
			High Flow Index Q10	M	L	L		N/A	None required. Risk is low		N/A		
Risk to water available for the environment from farm dam interception O(I-FD)	Unregulated	Coxs Creek at Boggabri	Variation Annual Index CV	L	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	
			Low Flow Index Q90	L	L	L		N/A	None required. Risk is low		N/A		
			High Flow Index Q10	L	L	L		N/A	None required. Risk is low		N/A		
Risk to water available for the environment from farm dam interception O(I-FD)	Unregulated	Baradine Creek at Kienbri No.2	Variation Annual Index CV	M	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	
			Low Flow Index Q90	M	L	L		N/A	None required. Risk is low		N/A		
			High Flow Index Q10	M	L	L		N/A	None required. Risk is low		N/A		
Risk to water available for the environment from farm dam interception O(I-FD)	Unregulated	Peel River at Carroll Gap	Variation Annual Index CV	M	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	
			Low Flow Index Q90	M	L	L		N/A	None required. Risk is low		N/A		
			High Flow Index Q10	M	L	L		N/A	None required. Risk is low		N/A		
Risk to water available for the environment from farm dam interception O(I-FD)	Unregulated	Mooki River at Breeeza	Variation Annual Index CV	L	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	
			Low Flow Index Q90	L	L	L		N/A	None required. Risk is low		N/A		
			High Flow Index Q10	L	L	L		N/A	None required. Risk is low		N/A		
Risk to water available for the environment from farm dam interception O(I-FD)	Unregulated	Coxs Creek at Tambar Springs	Variation Annual Index CV	L	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	
			Low Flow Index Q90	L	M	L		N/A	None required. Risk is low		N/A		

SECTION 8.2.1 RISKS TO WATER AVAILABLE FOR OTHER USES FROM INTERCEPTION ACTIVITIES [O(I-FD)] – UNREGULATED WATER SOURCES												
Risk	**Water Source Type**	**Location, Reach, or Extraction Type within WRP Area**	**Flow or Extraction Characteristic**	**Consequence**	**Likelihood**	**Risk Rating**	**Data confidence (Consequence / Likelihood)**	**Risk treatment option**	**Strategies**	**New Critical Mechanisms**	**Tolerable risk level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and Evaluation**
Risk to water available for the environment from farm dam interception O(I-FD)	Unregulated	Coxs Creek at Tambar Springs	High Flow Index Q10	L	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	
Risk to water available for the environment from farm dam interception O(I-FD)	Unregulated	Mooki River at Caroona	Variation Annual Index CV	L	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	
			Low Flow Index Q90	L	L	L		N/A	None required. Risk is low		N/A		
			High Flow Index Q10	L	L	L		N/A	None required. Risk is low		N/A		
Risk to water available for the environment from farm dam interception O(I-FD)	Unregulated	Goonoo Goonoo Creek at Timbumburi	Variation Annual Index CV	M	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	
			Low Flow Index Q90	M	L	L		N/A	None required. Risk is low		N/A		
			High Flow Index Q10	M	L	L		N/A	None required. Risk is low		N/A		
Risk to water available for the environment from farm dam interception O(I-FD)	Unregulated	Warrah Creek at Old Warrah	Variation Annual Index CV	L	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	
			Low Flow Index Q90	L	L	L		N/A	None required. Risk is low		N/A		
			High Flow Index Q10	L	L	L		N/A	None required. Risk is low		N/A		
Risk to water available for the environment from farm dam interception O(I-FD)	Unregulated	Macdonald River at Woolbrook	Variation Annual Index CV	L	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	
			Low Flow Index Q90	L	L	L		N/A	None required. Risk is low		N/A		
			High Flow Index Q10	L	L	L		N/A	None required. Risk is low		N/A		
Risk to water available for the environment from farm dam interception O(I-FD)	Unregulated	Swamp Oak creek at Limbri	Variation Annual Index CV	L	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	
			Low Flow Index Q90	L	L	L		N/A	None required. Risk is low		N/A		
			High Flow Index Q10	L	L	L		N/A	None required. Risk is low		N/A		
Risk to water available for the environment	Unregulated	Cockburn River at Mulla	Variation Annual	M	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	

SECTION 8.2.1 RISKS TO WATER AVAILABLE FOR OTHER USES FROM INTERCEPTION ACTIVITIES [O(I-FD)] – UNREGULATED WATER SOURCES												
Risk	**Water Source Type**	**Location, Reach, or Extraction Type within WRP Area**	**Flow or Extraction Characteristic**	**Consequence**	**Likelihood**	**Risk Rating**	**Data confidence (Consequence / Likelihood)**	**Risk treatment option**	**Strategies**	**New Critical Mechanisms**	**Tolerable risk level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and Evaluation**
from farm dam interception O(I-FD)		Crossing	Index CV										
			Low Flow Index Q90	M	L	L		N/A	None required. Risk is low		N/A		
			High Flow Index Q10	M	L	L		N/A	None required. Risk is low		N/A		
Risk to water available for the environment from farm dam interception O(I-FD)	Unregulated	Halls Creek at Ukolan	Variation Annual Index CV	L	L	L		N/A	None required. Risk is low		N/A		
			Low Flow Index Q90	L	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	
			High Flow Index Q10	L	L	L		N/A	None required. Risk is low		N/A		
Risk to water available for the environment from farm dam interception O(I-FD)	Unregulated	Ironbark Creek at Woodsreef	Variation Annual Index CV	M	L	L		N/A	None required. Risk is low		N/A		
			Low Flow Index Q90	M	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	
			High Flow Index Q10	M	L	L		N/A	None required. Risk is low		N/A		
Risk to water available for the environment from farm dam interception O(I-FD)	Unregulated	Manilla River at Black Springs	Variation Annual Index CV	L	L	L		N/A	None required. Risk is low		N/A		
			Low Flow Index Q90	L	L	L	H/M	N/A	None required. Risk is low		N/A	N/A	
			High Flow Index Q10	L	L	L		N/A	None required. Risk is low		N/A		
Risk to water available for the environment from farm dam interception O(I-FD)	Unregulated	Namoi River at North Cuerindi	Variation Annual Index CV	H	L	M		A	16 Protect other water users from changes in flow attributable to growth in BLR extractive use.	N1 Sustainable diversion limits	Medium	The taking of water from farm dams is regulated by the Harvestable Rights Policy. Any take above that allowed under the policy must be licensed.	MER planned for WSP objectives
			Low Flow Index Q90	H	L	M	H/M	A			Medium		
			High Flow Index Q10	H	L	M		A			Medium		
CV = variation index annual; HF Q_{10} = high flow index; LF Q_{90} = low flow index													

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

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

Current Critical Mechanisms - E(I-PF)
E19 Plantation forestry interception is considered low risk therefore no mechanisms have been implemented under the WM Act.
E20 Ongoing risk monitoring to determine impact of future expansion of forest plantations at local and regional scales

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

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

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

SECTION 8.2.4 RISKS TO WATER AVAILABLE FOR OTHER USES FROM INTERCEPTION ACTIVITIES [O(I-FH)]											
Risk	**Water Source Type**	**Consequence**	**Likelihood**	**Risk Rating**	**Data confidence (Consequence / Likelihood)**	**Risk treatment option**	**Strategies**	**New Critical Mechanisms**	**Tolerable risk level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and Evaluation**
Risk to water available for other uses from farm dam interception O(I-FH)	Regulated	H	H	H	H/M	A B	Floodplain Harvesting Policy Healthy Floodplains	N6 - Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies	H	Floodplain Harvesting Policy and Healthy Floodplains Projects mitigate risk	MER for N6
Risk to water available for other uses from farm dam interception O(I-FH)	Unegulated	L	H	M	H/M	A B	Floodplain Harvesting Policy Healthy Floodplains	N6 - Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies	M	Floodplain Harvesting Policy and Healthy Floodplains Projects mitigate risk	MER for N6
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**	**New 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)	Namoi High Security Water	Wet climate change scenario	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		
	Namoi General Security Water			Negligible	Possible	L	M/M	N/A	None required. Risk is low.		N/A		
	Namoi Supplementary Water			Negligible	Possible	L	M/M	N/A	None required. Risk is low.		N/A		
	Peel High Security Water			Negligible	Possible	L	M/M	N/A	None required. Risk is low.		N/A		
	Peel General Security			Negligible	Possible	L	M/M	N/A	None required. Risk is low.		N/A		
	Peel Supplementary Water			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)	Namoi High Security water	Median climate change scenario		Minor	Possible	L	M/M	N/A	None required. Risk is low.		N/A		
	Namoi General Security Water			Minor	Possible	L	M/M	N/A	None required. Risk is low.		N/A		
	Namoi Supplementary Water			Minor	Possible	L	M/M	N/A	None required. Risk is low.		N/A		
	Peel High Security Water			Minor	Possible	L	M/M	N/A	None required. Risk is low.		N/A		
	Peel General Security Water			Minor	Possible	L	M/M	N/A	None required. Risk is low.		N/A		

	Peel Supplementary Water			Minor	Possible	L	M/M	N/A	None required. Risk is low		N/A		
Risk to water available for other uses due to climate change O(CC)	Namoi High Security Water	Dry climate change scenario		Minori	Likely	M	M/M	F	14 Protect the environment and water users from changes in flow attributable to climate change.	N1 Sustainable Diversion Limits	M	An individual licence holder's annual access to water is governed by their entitlement and climatic availability. The volume of water available to meet all competing environmental and extractive needs varies on a yearly and daily basis, depending on the weather, river flows and aquifer characteristics	
	Namoi General Security Water			Major	Likely	H	M/M	F			H		
	Namoi Supplementary Water			Moderate	Likely	H	M/M	F			H		
	Peel High Security Water			Minor	Likely	M	M/M	F	14 Protect the environment and water users from changes in flow attributable to climate change.	N1 Sustainable Diversion Limits	M	An individual licence holder's annual access to water is governed by their entitlement and climatic availability. The volume of water available to meet all competing environmental and extractive needs varies on a yearly and daily basis, depending on the weather, river flows and aquifer characteristics.	
	Peel General Security Water			Major	Likely	H	M/M	F			H		
	Peel Supplementary Water			Moderate	Likely	H	M/M	F			H		

SECTION 8.3 RISKS TO WATER AVAILABLE FOR OTHER USES DUE TO CLIMATE CHANGE [O(CC)] – UNREGULATED WATER SOURCES

Risk	Location, Reach, or Extraction Type within WRP Area	Climate Change Scenario (MDBSY)	Current Critical Mechanisms	Consequence	Likelihood	Risk Rating	Data confidence (Consequence / Likelihood)	Risk treatment option	Strategy	New Critical Mechanisms	Tolerable Risk Level	Explanation of tolerable risk application OR Explanation of why risk cannot be addressed	Monitoring and Evaluation
Risk to water available for other uses due to climate change O(CC)	Baradine Creek	Dry climate change scenario	E1 - Reserve all water above the long-term average annual extraction limit (LTAAEL) for the environment as PEW (defined and managed by the listed WSPs). E2 - Available Water Determinations (AWD) adjust extractive use according to water availability.	M	M	M	H/M	F	14 Protect the environment and water users from changes in flow attributable to climate change.	N1 Sustainable Diversion Limits	M	An individual licence holder's annual access to water is governed by their entitlement and climatic availability. The volume of water available to meet all competing environmental and extractive needs varies on a yearly and daily basis, depending on the weather, river flows and aquifer characteristics.	
	Bluevale	Dry climate change scenario		M	M	M	H/M	F			M		
	Bohena Creek	Dry climate change scenario		L	M	L	H/M	N/A	None required. Risk is low.		N/A	N/A	
	Brigalow Creek	Dry climate change scenario		M	M	M	H/M	F	14 Protect the environment and water users from changes in flow attributable to climate change.	N1 Sustainable Diversion Limits	M	An individual licence holder's annual access to water is governed by their entitlement and climatic availability. The volume of water available to meet all competing environmental and extractive needs varies on a yearly and daily basis, depending on the weather, river flows and aquifer characteristics.	
	Bundock Creek	Dry climate change scenario		M	M	M	H/M	F			M		
	Chaffey	Dry climate change scenario		L	M	L	H/M	N/A	None required. Risk is low.		N/A	N/A	
	Cockburn River	Dry climate change scenario		M	M	M	H/M	F	14 Protect the environment and water users from changes in flow attributable to climate change.	N1 Sustainable Diversion Limits	M	An individual licence holder's annual access to water is governed by their entitlement and climatic availability. The volume of water available to meet all competing environmental and extractive needs varies on a yearly and daily basis, depending on the weather, river flows and aquifer characteristics.	
	Coghill Creek	Dry climate change scenario		L	M	L	H/M	N/A	None required. Risk is low.		N/A	N/A	
	Coxs Creek	Dry climate change scenario		H	M	M	H/M	F	14 Protect the environment and water users from changes in flow attributable to climate change.	N1 Sustainable Diversion Limits	M	An individual licence holder's annual access to water is governed by their entitlement and climatic availability. The volume of water available to meet all competing environmental and extractive needs varies on a yearly and daily basis, depending on the weather, river flows and aquifer characteristics.	

SECTION 8.3 RISKS TO WATER AVAILABLE FOR OTHER USES DUE TO CLIMATE CHANGE [O(CC)] – UNREGULATED WATER SOURCES

Risk	Location, Reach, or Extraction Type within WRP Area	Climate Change Scenario (MDBSY)	Current Critical Mechanisms	Consequence	Likelihood	Risk Rating	Data confidence (Consequence / Likelihood)	Risk treatment option	Strategy	New Critical Mechanisms	Tolerable Risk Level	Explanation of tolerable risk application OR Explanation of why risk cannot be addressed	Monitoring and Evaluation
Risk to water available for other uses due to climate change O(CC)	Etoo & Talluba Creeks	Dry climate change scenario	E1 - Reserve all water above the long-term average annual extraction limit (LTAAEL) for the environment as PEW (defined and managed by the listed WSPs). E2 - Available Water Determinations (AWD) adjust extractive use according to water availability.	L	M	L	H/M	N/A	None required. Risk is low.		N/A	N/A	
	Eulah Creek	Dry climate change scenario		L	M	L	H/M	N/A					
	Goonoo Goonoo Creek	Dry climate change scenario		L	M	L	H/M	N/A					
	Keepit	Dry climate change scenario		L	M	L	H/M	N/A					
	Lake Goran	Dry climate change scenario		M	M	M	H/M	F	14 Protect the environment and water users from changes in flow attributable to climate change.	N1 Sustainable Diversion Limits	M	An individual licence holder's annual access to water is governed by their entitlement and climatic availability. The volume of water available to meet all competing environmental and extractive needs varies on a yearly and daily basis, depending on the weather, river flows and aquifer characteristics.	
	Lower Namoi	Dry climate change scenario		M	M	M	H/M	F			M		
	Lower Peel River tributaries	Dry climate change scenario		M	M	M	H/M	F			M		
	Maules Creek	Dry climate change scenario		L	M	L	H/M	N/A	None required. Risk is low.		N/A	N/A	
	Mid Macdonald River	Dry climate change scenario		M	M	M	H/M	F	14 Protect the environment and water users from changes in flow attributable to climate change.	N1 Sustainable Diversion Limits	M	An individual licence holder's annual access to water is governed by their entitlement and climatic availability. The volume of water available to meet all competing environmental and extractive needs varies on a yearly and daily basis, depending on the weather, river flows and aquifer characteristics.	
	Mooki River	Dry climate change scenario		H	M	M	H/M	F			M		

SECTION 8.3 RISKS TO WATER AVAILABLE FOR OTHER USES DUE TO CLIMATE CHANGE [O(CC)] – UNREGULATED WATER SOURCES

Risk	Location, Reach, or Extraction Type within WRP Area	Climate Change Scenario (MDBSY)	Current Critical Mechanisms	Consequence	Likelihood	Risk Rating	Data confidence (Consequence / Likelihood)	Risk treatment option	Strategy	New Critical Mechanisms	Tolerable Risk Level	Explanation of tolerable risk application OR Explanation of why risk cannot be addressed	Monitoring and Evaluation
Risk to water available for other uses due to climate change O(CC)	Phillips Creek	Dry climate change scenario	E1 - Reserve all water above the long-term average annual extraction limit (LTAAEL) for the environment as PEW (defined and managed by the listed WSPs). E2 - Available Water Determinations (AWD) adjust extractive use according to water availability.	H	M	M	H/M	F	14 Protect the environment and water users from changes in flow attributable to climate change.	N1 Sustainable Diversion Limits	M	An individual licence holder's annual access to water is governed by their entitlement and climatic availability. The volume of water available to meet all competing environmental and extractive needs varies on a yearly and daily basis, depending on the weather, river flows and aquifer characteristics.	
	Pian Creek	Dry climate change scenario		H	M	M	H/M	F			M		
	Quirindi Creek	Dry climate change scenario		H	M	M	H/M	F			M		
	Rangira Creek	Dry climate change scenario		L	M	L	H/M	N/A	None required. Risk is low.		N/A	N/A	
	Split Rock	Dry climate change scenario		L	M	L	H/M	N/A					
	Spring & Bobbiwaa creeks	Dry climate change scenario		H	M	M	H/M	F	14 Protect the environment and water users from changes in flow attributable to climate change.	N1 Sustainable Diversion Limits	M	An individual licence holder's annual access to water is governed by their entitlement and climatic availability. The volume of water available to meet all competing environmental and extractive needs varies on a yearly and daily basis, depending on the weather, river flows and aquifer characteristics.	
	Upper Macdonald River	Dry climate change scenario		L	M	L	H/M	N/A	None required. Risk is low.		N/A	N/A	
	Upper Manilla River	Dry climate change scenario		L	M	L	H/M	N/A					
	Upper Namoi	Dry climate change scenario		M	M	M	H/M	F	14 Protect the environment and water users from changes in flow attributable to climate change.	N1 Sustainable Diversion Limits	M	An individual licence holder's annual access to water is governed by their entitlement and climatic availability. The volume of water available to meet all competing environmental and extractive needs varies on a yearly and daily basis, depending on the weather, river flows and aquifer characteristics.	
	Upper Peel River tributaries	Dry climate change scenario		M	M	M	H/M	F			M		

SECTION 8.3 RISKS TO WATER AVAILABLE FOR OTHER USES DUE TO CLIMATE CHANGE [O(CC)] – UNREGULATED WATER SOURCES

Risk	Location, Reach, or Extraction Type within WRP Area	Climate Change Scenario (MDBSY)	Current Critical Mechanisms	Consequence	Likelihood	Risk Rating	Data confidence (Consequence / Likelihood)	Risk treatment option	Strategy	New Critical Mechanisms	Tolerable Risk Level	Explanation of tolerable risk application OR Explanation of why risk cannot be addressed	Monitoring and Evaluation
Risk to water available for other uses due to climate change O(CC)	Warrah creek	Dry climate change scenario	E1 - Reserve all water above the long-term average annual extraction limit (LTAAEL) for the environment as PEW (defined and managed by the listed WSPs). E2 Available Water Determinations (AWD) adjust extractive use according to water availability.	H	M	M	H/M	F	14 Protect the environment and water users from changes in flow attributable to climate change.	N1 Sustainable Diversion Limits	M	An individual licence holder's annual access to water is governed by their entitlement and climatic availability. The volume of water available to meet all competing environmental and extractive needs varies on a yearly and daily basis, depending on the weather, river flows and aquifer characteristics.	
	Werris Creek	Dry climate change scenario		M	M	M	H/M	F			M		

SECTION 8.4 RISKS TO WATER AVAILABLE FOR OTHER USES DUE TO GROWTH IN BLR [O(BLR)] - – REGULATED WATER SOURCE

Water Source Type	Flow or Extraction Characteristic	Current Critical Mechanisms	Consequence	Likelihood	Risk Rating	Data confidence (Consequence / Likelihood)	Risk treatment option	Strategy	New Critical Mechanisms	Tolerable Risk Level	Explanation of tolerable risk application OR Explanation of why risk cannot be addressed	Monitoring and Evaluation
Regulated river	BLR (D&S) extraction	E21 - Restrict BLR access through the establishment of mandatory guidelines. E25 - Minister may limit growth in BLR when a land holding is subdivided and there is high hydrological stress on the river or aquifer E24 - Minister may temporarily restrict groundwater access where it is in the public interest to do so.	H	Nil	Nil							

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	New Strategy	New Critical Mechanisms	Tolerable Risk Level	Explanation of tolerable risk application OR Explanation of why risk cannot be addressed	Monitoring and Evaluation
Unregulated	Baradine Creek	E21 Restrict BLR access through the establishment of mandatory guidelines under the WMA s. 52(2) and S. 336B E22 Temporarily restrict access under the WMA s. 324 when there are water shortages.	H	L	L	M/M	N/A	None required. Risk is low		N/A		
Unregulated	Bluevale		L	L	L	M/M	N/A	None required. Risk is low		N/A	.	
Unregulated	Bohena Creek		L	L	L	M/M	N/A	None required. Risk is low.		N/A		
Unregulated	Brigalow Creek		L	L	L	M/M	N/A	None required. Risk is low.		N/A		
Unregulated	Bundock Creek		L	L	L	M/M	N/A	None required. Risk is low.		N/A		
Unregulated	Chaffey		L	L	L	M/M	N/A	None required. Risk is low.		N/A		
Unregulated	Cockburn River		L	L	L	M/M	N/A	None required. Risk is low		N/A		
Unregulated	Coghill Creek		L	L	L	M/M	N/A	None required. Risk is low.		N/A		
Unregulated	Coxs Creek		H	L	L	M/M	N/A	None required. Risk is low.		N/A		
Unregulated	Ettoo Creek and Talluba Creek		L	L	L	M/M	N/A	None required. Risk is low		N/A		
Unregulated	Eulah Creek		L	L	L	M/M	N/A	None required. Risk is low.		N/A		
Unregulated	Goonoo Goonoo Creek		L	L	L	M/M	N/A	None required. Risk is low.		N/A		
Unregulated	Keepit		L	L	L	M/M	N/A	None required. Risk is low.		N/A		
Unregulated	Lake Goran		H	L	L	M/M	N/A	None required. Risk is low.		N/A		
Unregulated	Lower Namoi		L	L	L	M/M	N/A	None required. Risk is low.		N/A		
Unregulated	Lower Peel River tributaries		L	L	L	M/M	N/A	None required. Risk is low.		N/A		

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

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	New Strategy	New Critical Mechanisms	Tolerable Risk Level	Explanation of tolerable risk application OR Explanation of why risk cannot be addressed	Monitoring and Evaluation
Unregulated	Maules Creek	E21 Restrict BLR access through the establishment of mandatory guidelines under the WMA s. 52(2) and S. 336B E22 Temporarily restrict access under the WMA s. 324 when there are water shortages.	L	L	L	M/M	N/A	None required. Risk is low.		N/A		
Unregulated	Mid Macdonald River		L	L	L	M/M	N/A	None required. Risk is low.		N/A		
Unregulated	Mooki River		H	L	L	M/M	N/A	None required. Risk is low.		N/A		
Unregulated	Phillips Creek		L	L	L	M/M	N/A	None required. Risk is low.		N/A		
Unregulated	Pian Creek		H	L	L	M/M	N/A	None required. Risk is low		N/A		
Unregulated	Quirindi Creek		L	L	L	M/M	N/A	None required. Risk is low.		N/A		
Unregulated	Rangira Creek		L	L	L	M/M	N/A	None required. Risk is low.		N/A		
Unregulated	Split Rock		L	H	M	M/M	D	15 Protect the environment from changes in flow attributable to growth in BLR extractive use. 16 Protect other water users from changes in flow attributable to growth in BLR extractive use.	N4 Limit growth in BLR when a land holding is subdivided and there is high hydrological stress on the river or aquifer	M	Risk to other users from growth in domestic and stock rights in these circumstances is tolerable because there are mechanisms available to manage demand if required.	
Unregulated	Spring and Bobbiwaa Creeks		L	L	L	M/M	N/A	None required. Risk is low.		N/A		
Unregulated	Upper Macdonald River		M	H	H	M/M	D	15 Protect the environment from changes in flow attributable to growth in BLR extractive use. 16 Protect other water users from changes in flow attributable to growth in BLR extractive use.	N4 Limit growth in BLR when a land holding is subdivided and there is high hydrological stress on the river or aquifer	H	Risk to other users from growth in domestic and stock rights in these circumstances is tolerable because there are mechanisms available to manage demand if required.	
Unregulated	Upper Manilla River		L	L	L	M/M	N/A	None required. Risk is low.		N/A		
Unregulated	Upper Namoi		H	L	L	M/M	N/A	None required. Risk is low.		N/A		
Unregulated	Upper Peel River tributaries		M	L	L	M/M	N/A	None required. Risk is low.		N/A		
Unregulated	Warrah Creek		L	M	L	M/M	N/A	None required. Risk is low.		N/A		
Unregulated	Werris Creek		L	L	L	M/M	N/A	None required. Risk is low.		N/A		

SECTION 8.4 RISKS TO WATER AVAILABLE FOR OTHER USES DUE TO GROWTH IN BLR [O(BLR)]												
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**	**New Strategy**	**New Critical Mechanisms**	**Tolerable Risk Level**	**Explanation of tolerable risk application OR Explanation of why risk cannot be addressed**	**Monitoring and Evaluation**
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 Restrict BLR access through the establishment of mandatory guidelines under the WMA s. 52(2) and S. 336B. E25 Temporarily restrict access under the WMA s. 324 when there are water shortages. N/A no data available or not applicable												

Consolidated Risk Maps

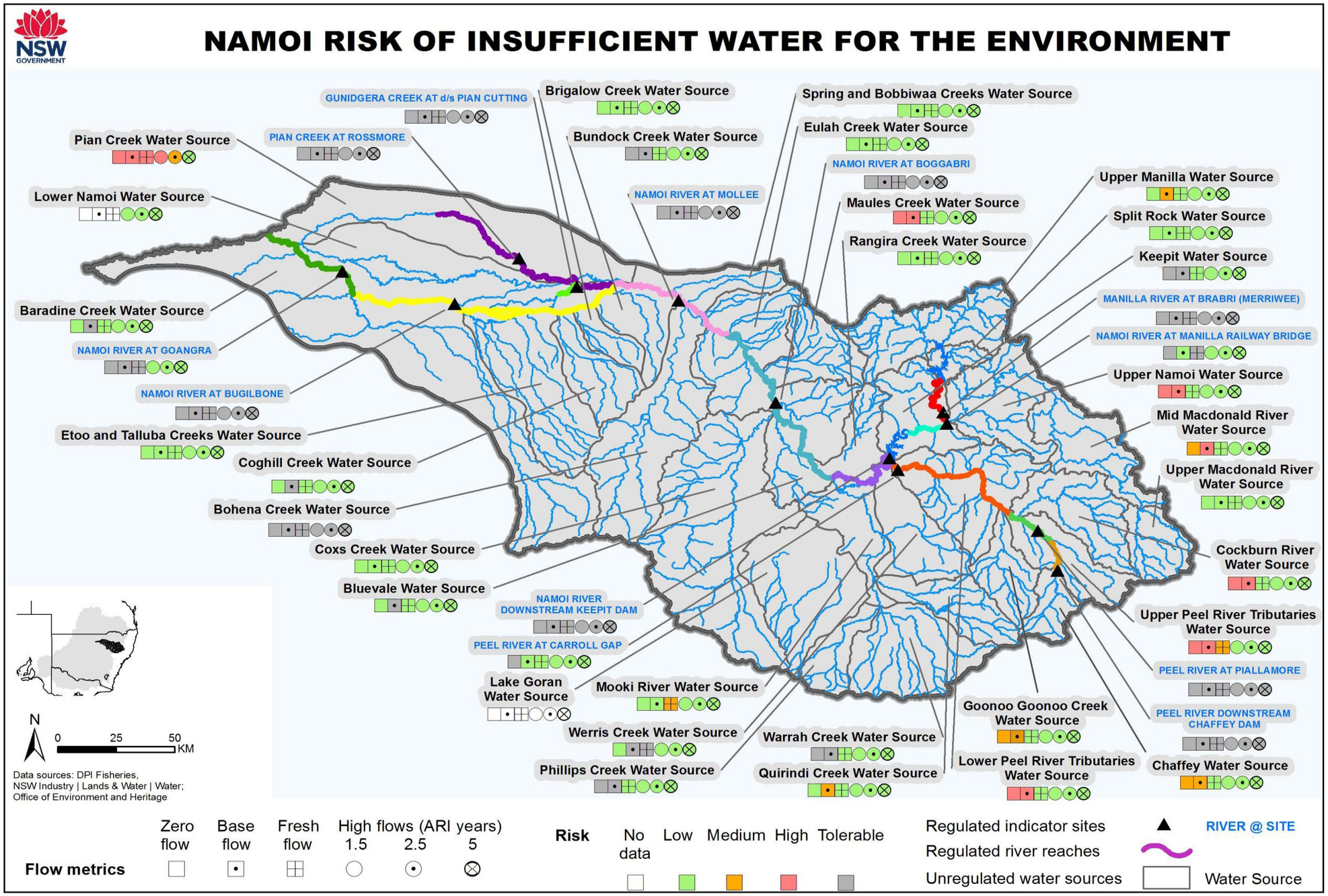


Figure 2 Consolidated risk map – Insufficient water for the environment

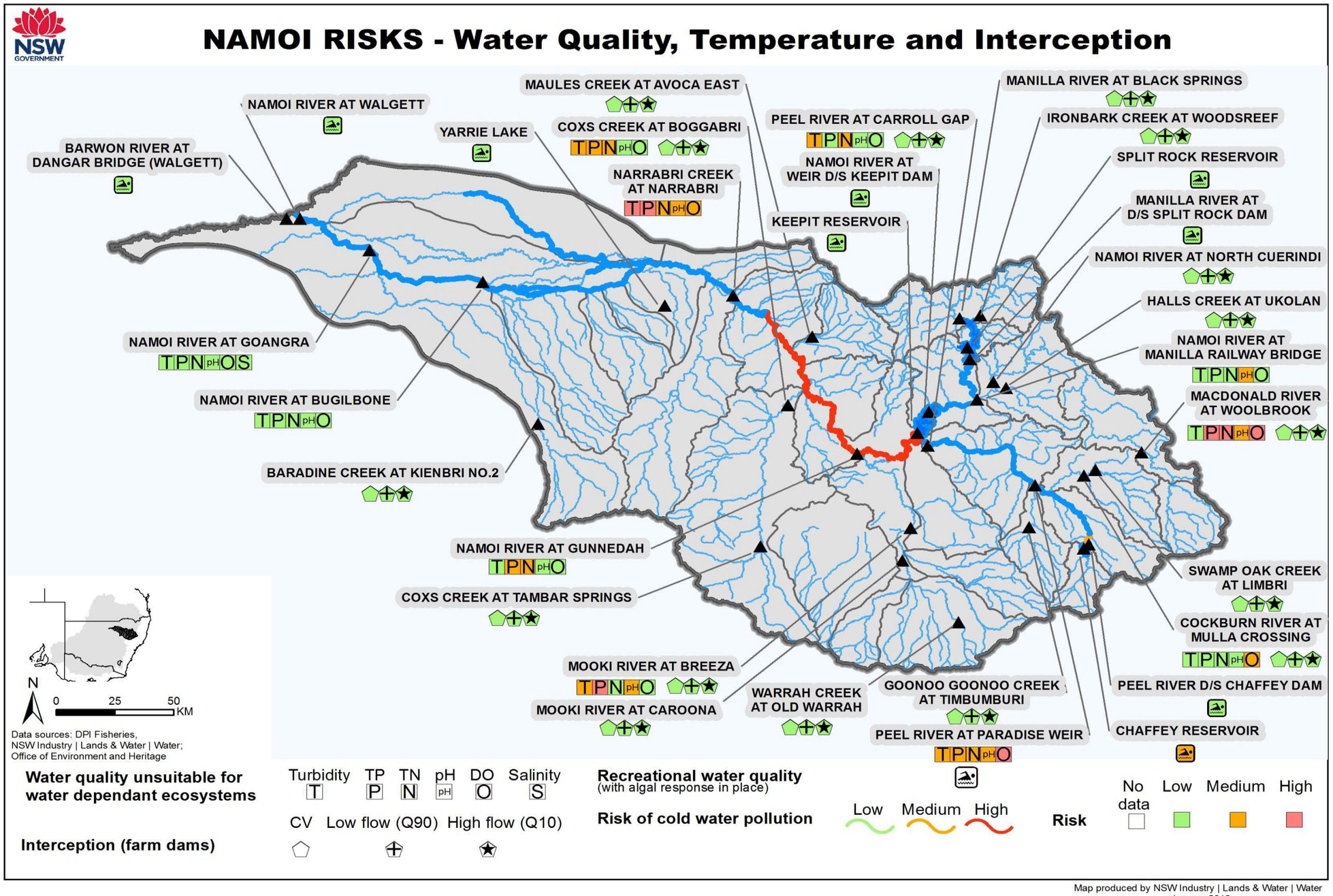


Figure 3 Consolidated risk map – Water quality, temperature and interception

Contents

Executive Summary i
Consolidated Risk Tables i
Consolidated Risk Maps xc
Contents i
List of Figures v
List of Tables vii
Abbreviations i
1. Introduction 1
1.1. Background 1
1.2. Document map 1
2. NSW Basin Plan risk assessment framework overview 6
2.1. Introduction 6
2.2. The risk assessment framework 6
2.3. Risk assessment scope 8
2.4. Limitations and uncertainties 9
3. Overview of the Namoi surface water resource plan area (SW14) 10
3.1. Identification of the Namoi water resource plan area 10
3.2. Characterisation of the Namoi surface water resource plan area 10
3.3. Connectivity 13
3.3.1. Connectivity between unregulated and regulated water sources within the Namoi Surface WRPA 13
3.3.2. Connectivity with other WRP areas 14
4. Risk of insufficient water available for the environment 19
4.1. Background 19
4.2. Assigning a consequence rating 20
4.2.1. HEVAE 22
4.2.2. Consequence decision tree 24
4.2.3. Consequence Score 24
4.3. Risks to water available for the environment and capacity to meet environmental water requirements [E(W)] 29
4.3.1. Determining the likelihood rating 29
4.3.2. Existing water management actions & mechanisms 38
4.3.3. Risk outcomes 40
4.4. Risks to water available for the environment from extraction under basic landholder rights [E(BLR)] 45
4.4.1. Determining the likelihood rating 46
4.4.2. Existing water management actions & mechanisms 47

4.4.3. Risk outcomes 48
4.5. Risk to water available for the environment from interception activities [E(I-FD), E(I-PF), E(I-M), E(I-FH)] 50
4.5.1. Farm dams (runoff dams) [E(I-FD)] 50
4.5.2. Commercial plantations [E(I-PF)] 60
4.5.3. Mining [E(I-M)] 62
4.5.4. Floodplain harvesting [E(I-FH)] 64
4.6. Risk to water available for the environment due to climate change [E(CC)] 65
4.6.1. Assigning a consequence rating 65
4.6.2. Determine the likelihood rating 66
4.6.3. Existing water management actions & mechanisms 68
4.6.4. Risk outcomes 68
5. Risk to environmental assets and functions from pest plants and animals 72
6. Risks to health of water-dependent ecosystems from poor water quality [E(WQ)] 73
6.1. Background 73
6.2. Existing water management actions & mechanisms 73
6.3. Risks due to water temperature outside natural ranges 74
6.3.1. Assigning a consequence rating 75
6.3.2. Determine the likelihood rating 75
6.3.3. Risk outcomes 77
6.4. Risks due to turbidity, TP, TN, pH & DO 78
6.4.1. Assigning a consequence rating 79
6.4.2. Determine the likelihood rating 81
6.4.3. Risk outcomes 82
6.5. Risks due to elevated levels of instream salinity [E(WQ-S)] 86
6.5.1. Assigning a consequence rating 86
6.5.2. Determine the likelihood rating 86
6.5.3. Risk outcomes 87
6.6. Risks due to pathogens and toxicants [E(WQ-PT)] 87
6.6.1. Assigning a consequence rating 88
6.6.2. Determining the likelihood rating 88
7. Risk to other water uses due to unsuitable water quality [O(WQ) 90
7.1. Background 90
7.2. Existing water management actions & mechanisms 90
7.3. Risks to irrigation water from elevated instream salinity [O(WQ-S)] 90
7.4. Risks to water used for recreational purposes [O(WQ-BGA)] 90
7.4.1. Existing water management actions & mechanisms 91
7.4.2. Assigning a consequence rating 92

7.4.3. Determining the likelihood rating 93
7.4.4. Risk outcomes 94
7.5. Risks to water used for human consumption 95
7.6. Other values 95
8. Risks to water available for other uses 96
8.1. Background 96
8.2. Risks to other water users from interception activities [O(I-FD),O(I-PF), O(I-M),O(I-FH)] 96
8.2.1. Farm dams (runoff dams) [O(I-FD)] 96
8.2.2. Commercial plantations [O(I-PF)] 102
8.2.3. Mining (including CSG) 103
8.2.4. Floodplain harvesting [O(I-FH)] 104
8.3. Risk to other water users due to climate change [O(CC)] 105
8.3.1. Assigning a consequence rating 106
8.3.2. Determine the likelihood rating 109
8.3.3. Existing water management actions & mechanisms 110
8.3.4. Risk outcomes 110
8.4. Risk to other water users due to growth in BLR [O(BLR)] 113
8.4.1. Assigning a consequence rating 113
8.4.2. Determine the likelihood rating 115
8.4.3. Existing water management actions & mechanisms 116
8.4.4. Risk outcomes 117
8.5. Other values 119
9. Risk treatment overview 120
9.1. Existing water resource management strategies, actions and mechanisms 126
9.2. Tolerable risk results 126
9.2.1. Predefined tolerable risk criteria 126
9.2.2. Risks assessed as tolerable following application of a risk treatment option 128
9.2.3. Trade-off assessments 128
9.3. New or modified water resource management strategies, actions and mechanisms. 128
9.4. Knowledge strategies 130
9.5. Summary of strategies to address risk 131
Definitions 146
References 149
Appendix A Data summary tables 155
Appendix B HEVAE alignment with Schedules 8 & 9 of the Basin Plan 166
Appendix C HEVAE consequence scoring 168
Appendix D Threatened fish species & distribution 172

Appendix E Flow variation indices in unregulated water sources 174
Appendix F Unregulated rivers tolerable risk decision tool 177
Appendix G Strategy development – constraints & decision trees 181
Appendix H Risk assessment definitions 194

List of Figures

Figure 1 Risk treatment pathway ii
Figure 2 Consolidated risk map – Insufficient water for the environment xc
Figure 3 Consolidated risk map – Water quality, temperature and interception xci
Figure 1-1 Components of the WRP 2
Figure 2-1 The NSW Basin Plan risk assessment framework 6
Figure 2-2 Example of an impact pathway for identifying risks to the environment associated with river regulation and licensed extraction 7
Figure 3-1 The Namoi Surface WRPA (SW14) 11
Figure 3-2 Sub areas of the Namoi Surface WRPA (SW14) (upland, midland and lowland) 12
Figure 3-3 Regulated river entitlement in the Namoi Surface WRPA (SW14) 12
Figure 3-4 Unregulated water sources and entitlement in the Namoi Surface WRPA (SW14) 13
Figure 3-5 Impact pathway showing risk to groundwater ecological assets and functions from reduced recharge 16
Figure 4-1 Risk pathways for risks of insufficient water for the environment and capacity to meet environmental watering requirements 20
Figure 4-2 MDBA hydrologic indicator sites and representative regulated reaches for the Namoi Surface WRPA 21
Figure 4-3 Location of unregulated flow gauges and the MDBA hydrologic indicator site used for generating flow sequences in unregulated rivers in the Namoi Surface WRPA 22
Figure 4-4 The four HEVAE criteria and associated attributes used in assessing HEVAE in NSW 23
Figure 4-5 HEVAE scoring of instream values in the Namoi Surface WRPA 28
Figure 4-6 Impact pathway showing impact of river regulation and licensed extraction on water available for the environment 29
Figure 4-7 Impact pathway showing risk of growth in BLR reducing water available for the environment 45
Figure 4-8 Impact pathway showing impact of interception activities on ecological functions and assets 51
Figure 4-9 Impact pathway showing risk of growth in plantation forests reducing water available for the environment 61
Figure 4-10 Impact pathway showing risk of growth in floodplain harvesting reducing water available for the environment 64
Figure 4-11 Impact pathway showing how change in climate can impact on the availability of water for the environment 65
Figure 6-1 Impact pathway showing impact of cold water pollution on ecological functions and assets 75
Figure 6-2 Impact pathway showing impact of warm water pollution on ecological functions and assets 75
Figure 6-3 Impact pathway showing impact of water quality degradation (increased turbidity, TP, TN, pH & DO) on ecological functions and assets 79
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) 80
Figure 6-5 Impact pathway showing impact of elevated levels of instream salinity on ecological functions and assets in the Namoi Surface WRPA 86

Figure 6-6. Impact pathway showing how risk of poor water quality (pathogens, pesticides and other toxic contaminants) can impact on ecological assests and functions 88
Figure 7-1 Impact pathway showing risk to recreation water quality and human health from blue-green algae 91
Figure 7-2 Conceptual outline of how algal alert levels are used in NSW 92
Figure 8-1 Impact pathway showing impact of farm dams on water available for other uses 97
Figure 8-2 Impact pathway showing impact of commercial plantations on water available for other uses 102
Figure 8-3 Impact pathway showing impact of mining on water available for other uses 103
Figure 8-4 Impact pathway showing impact of floodplain harvesting on water available for other users 105
Figure 8-5 Impact pathway showing impact of change in climate on ability to meet other water user's water requirements 106
Figure 8-6 Impact pathway showing risk to licensed water users due to growth in BLR access in unregulated water sources in the Namoi Surface WRPA 113
Figure 9-1 Risk treatment pathway 123

List of Tables

Table 1-1 Basin Plan requirements and where each is addressed in this risk assessment document 3
Table 2-1 Summary of causes, threats and impacts considered in this risk assessment.....7
Table 2-2 The risk assessment matrix.....8
Table 2-3 Criteria used for rating confidence in data 9
Table 3-1 Risk to environmental assets and functions within the Namoi Surface WRPA due to connectivity with Barwon- Darling Watercourse WRPA 14
Table 3-2 Adjacent SDL resource units 15
Table 3-3 Risk of insufficient surface water impacting on groundwater priority assets and functions in regulated and unregulated water sources in the Namoi Surface WRPA.....16
Table 3-4 Connectivity management in the Namoi-Peel Alluvium 18
Table 4-1 Examples of flow sensitivity weightings used in the HEVAE process 24
Table 4-2 Consequence results for the Namoi regulated water source in the Namoi Surface WRPA 25
Table 4-3 Consequence results for the Namoi unregulated water sources in the Namoi Surface WRPA.....27
Table 4-4 Key features of flow regimes which impact on ecosystem functions and environmental assets 30
Table 4-5 Alignment of EWRs of the LTWP and flow components assessed in the Namoi Surface WRPA risk assessment 32
Table 4-6 Likelihood metrics for risk of insufficient water available for the environment and risk to EWRs in the regulated Namoi-Peel River.....35
Table 4-7 Likelihood results for the Namoi-Peel regulated river 36
Table 4-8 Likelihood metrics for risk of insufficient water available for the environment and risk to EWRs in unregulated water sources in the Namoi Surface WRPA 37
Table 4-9 Likelihood results for unregulated water sources in the Namoi Surface WRPA.....37
Table 4-10 Risk matrix to determine risk outcomes of insufficient water for the environment and capacity to meet EWRs 40
Table 4-11 Risk of insufficient water for the environment and capacity to meet EWRs in the regulated Namoi & Peel Rivers [E(W)] 42
Table 4-12 Risk of insufficient water for the environment and capacity to meet EWRs in the unregulated water sources of the Namoi Surface WRPA [E(W)].....43
Table 4-13 Likelihood metrics for risk of growth in BLR in unregulated water sources 46
Table 4-14 Likelihood results for unregulated water sources in the Namoi Surface WRPA.....47
Table 4-15 Risk matrix to determine risk outcomes of increased BLR extraction impacting on water available for the environment 48
Table 4-16 Risk of increased BLR extraction impacting on water available for the environment in the regulated water source of the Namoi Surface WRPA [E(BLR)] 48
Table 4-17 Risk of increased BLR extrcation impacting on water available for the environment in the unregulated water sources of the Namoi Surface WRPA [E(BLR)].....49
Table 4-18 Environmental flow indicators developed in the MDBSY Project for the Duncan's Junction gauge 419094 (CSIRO 2007).....52
Table 4-19 Consequence results for environmental assets (Namoi River billabongs and wetlands, and Lake Goran) in the Namoi regulated water source in the Namoi Surface WRPA 52

Table 4-20 Consequence results for the unregulated water sources in the Namoi Surface WRPA 53
Table 4-21 MDBSY Project Scenarios 54
Table 4-22 Likelihood metrics selected for modelled scenarios in the Namoi Regulated River Water Source in the Namoi Surface WRPA (SKM 2008) 54
Table 4-23 Likelihood results for modelled scenarios in the Namoi River billabongs, wetlands and Lake Goran 55
Table 4-24 Likelihood metrics for Regulated river water sources 55
Table 4-25 Likelihood results for Namoi regulated river 56
Table 4-26 Likelihood metrics for risk to water available for the environment in unregulated water sources due to interception 56
Table 4-27 Likelihood results for risk to water for the environment in unregulated water sources in the Namoi Surface WRPA due to interception activities 57
Table 4-28 Matrix used to determine risk outcomes of insufficient water available for the Namoi River billabongs, wetlands and lake Goran from potential interception activities in Namoi Regulated River Water Source, adapted from CSIRO (2008) 58
Table 4-29 Risks of insufficient water available for the environment in the Namoi River billabongs and wetlands and Lake Goran as a result of growth in interception by farm dams [E(I-FD)] 58
Table 4-30 Matrix used to determine risk outcomes of insufficient water available for the environment from potential interception activities in Namoi Regulated River Water Source 58
Table 4-31 Risks of insufficient water available for the environment in the regulated Namoi River as a result of growth in interception by farm dams [E(I-FD)] 59
Table 4-32 Matrix used to determine risk outcomes of insufficient water available for the environment from potential interception activities in unregulated water sources in the Namoi Surface WRPA 59
Table 4-33 Risks of insufficient water available for the environment in unregulated water sources in the Namoi Surface WRPA as a result of growth in interception by farm dams [E(I-FD)] 60
Table 4-34 Risk matrix to determine risk outcomes of increased commercial plantations impacting on water available for the environment 62
Table 4-35 Risks of insufficient water available for the environment in regulated and unregulated water sources in the Namoi Surface WRPA as a result of plantation forests [E(I-PF)] 62
Table 4-36 Risks of insufficient water available for the environment in regulated and unregulated water sources in the Namoi Surface WRPA as a result of mining activities [E(I-M)] 63
Table 4-37 Risks of insufficient water available for the environment in regulated and unregulated water sources in the Namoi Surface WRPA as a result of floodplain harvesting activities [E(I-FH)] 65
Table 4-38 Consequence results for environmental assets receiving flows from the Namoi regulated river in the Namoi Surface WRPA 66
Table 4-39 Data used to assess risk likelihood to the Namoi River billabongs and wetlands from change in climate (CSIRO 2007) 67
Table 4-40 Likelihood results for environmental assets receiving flows from the Namoi regulated river in the Namoi Surface WRPA 67
Table 4-41 Impacts of climate change scenarios on mean annual runoff and rainfall 67
Table 4-42 Likelihood metrics for climate change impacts on surface water 68
Table 4-43 Matrix used to determine risk of insufficient water available for the environment from potential change in climate 69
Table 4-44 Risks of insufficient water available for the Namoi environmental assets as a result of change in climate [E(CC)] 69

Table 4-45 Risk matrix to determine risk outcomes of insufficient water for the environment from potential change in climate in regulated and unregulated rivers 69

Table 4-46 Risks of insufficient water available for the environment in regulated river sections in the Namoi Surface WRPA as a result of climate change [E(CC)] 70

Table 4-47 Risks of insufficient water available for the environment in unregulated river sections in the Namoi Surface WRPA as a result of climate change [E(CC)] 70

Table 5-1 Risk to environmental assets and functions within the Namoi Surface WRPA due to pest plants and animals 72

Table 6-1 Likelihood metrics for risk to the health of water-dependent ecosystems from CWP 76

Table 6-2 Likelihood metrics for risk to the health of water-dependent ecosystems from WWP 77

Table 6-3 Risk matrix to determine risk outcomes of water temperature outsidenatural ranges impacting the health of water-dependent ecosystems 77

Table 6-4 Risks of water temperature below natural range impacting the health of water-dependent ecosystems [E(WQ-CWP)] 78

Table 6-5 Consequence results for reaches of the Namoi regulated river in the Namoi Surface WRPA 79

Table 6-6 Consequence ratings in unregulated reaches in the Namoi Surface WRPA 80

Table 6-7 Basin Plan (Schedule 11) water quality targets for 'other water-dependent ecosystems' 81

Table 6-8 Likelihood metrics for risk of water quality impacting water-dependent ecosystems in the Namoi Surface WRPA 81

Table 6-9 Likelihood results in regulated river reaches exceeding Basin Plan water quality targets 81

Table 6-10 Likelihood results in unregulated river reaches exceeding Basin Plan water quality targets 82

Table 6-11 Risk matrix to determine risk outcomes of exceeding water quality targets on water-dependent ecosystems 82

Table 6-12 Risks of exceeding water quality targets impacting the health of water-dependent ecosystems in the regulated reaches of the Namoi Surface WRPA [E(WQ)] 84

Table 6-13 Risks of exceeding water quality targets impacting the health of water-dependent ecosystems in the unregulated water sources of the Namoi Surface WRPA [E(WQ)] 85

Table 6-14 Likelihood metrics for risk to health of water-dependent ecosystems from poor water quality in the regulated river in the Namoi Surface WRPA 87

Table 6-15 Risk matrix to determine risk outcomes of elevated levels of instream salinity on water-dependent ecosystems 87

Table 6-16 Risks of elevated levels of instream salinity impacting the health of water-dependent ecosystems in the regulated system of the Namoi Surface WRPA [E(WQ-S)] 87

Table 6-17 Likelihood metrics and categories for risk to health of water-dependent ecosystems from poor water quality (pathogens and toxicants) in the Namoi Surface WRPA 89

Table 6-18 Risk matrix to determine risk outcomes of impact of pathogens and toxicants on water-dependent ecosystems 89

Table 7-1 Consequence metrics for risk to water used for recreational uses due to blue-green algae in the Namoi Surface WRPA 93

Table 7-2 Consequence results for risk to recreational water users in the Namoi Surface WRPA 93

Table 7-3 Likelihood metrics for risks from blue-green algae in the Namoi Surface WRPA 93

Table 7-4 Likelihood results for risk due to blue-green algae 94

Table 7-5 Risk matrix to determine risk outcomes of blue-green algae to recreational water uses 94

Table 7-6 Risks from blue-green algae to recreational water uses in the Namoi Surface WRPA [O(WQ-BGA)] 94

Table 8-1 Consequence thresholds for different types of water access licences in regulated rivers....98

Table 8-2 Data used to assess consequences to different types of water access licences in the regulated Namoi River and Peel River due to interception by farm dams....98

Table 8-3 Consequence results for different types of water access licences in the Namoi regulated river due to interception by farm dams....98

Table 8-4 Likelihood results for different types of water access licences in the regulated Namoi and Peel Rivers. Likelihood metric estimates the likelihood of insufficient water access. 99

Table 8-5 Matrix used to determine risk from potential interception activities to other water users....100

Table 8-6 Risks of insufficient water available for different categories of water access licences in the Namoi and Peel regulated rivers as a result of growth in interception by farm dams [O(I-FD)]....100

Table 8-7 Matrix used to determine risk from potential interception activities to other water users in Namoi and Peel unregulated water sources....101

Table 8-8 Risks of insufficient water available for other users in unregulated water sources in the Namoi Surface WRPA as a result of growth in interception by farm dams [O(I-FD)] 102

Table 8-9 Risks of insufficient water available for other water users in regulated and unregulated water sources in the Namoi Surface WRPA as a result of plantation forests [O(I-PF)] 103

Table 8-10 Risks of insufficient water available for other water users in regulated and unregulated water sources in the Namoi Surface WRPA as a result of mining [O(I-M)]....104

Table 8-11 Likelihood metrics for floodplain harvesting 104

Table 8-12 Risk matrix to determine risk outcomes of increased floodplain harvesting to other water users . 105

Table 8-13 Risks of insufficient water available for other water users in regulated and unregulated water sources in the Namoi Surface WRPA as a result of floodplain harvesting [O(I-FH)]....105

Table 8-14 Consequence results for different types of water access licences in the Namoi and Peel regulated rivers....107

Table 8-15 Data used to assess consequences to different types of water access licences in the Namoi and Peel regulated rivers due to climate change 108

Table 8-16 Likelihood results for different types of water access licences in the Namoi and Peel regulated rivers under different climate change scenarios....109

Table 8-17 Matrix used to determine risk from potential change in climate 110

Table 8-18 Risks to different types of water access licences in the Namoi and Peel regulated rivers under different climate change scenarios [O(CC)] 111

Table 8-19 Risks of insufficient water available for other water users in unregulated river sections in the Namoi Surface WRPA as a result of climate change [O(CC)]....112

Table 8-20 Consequence metrics for increased extraction by BLR in unregulated water sources in the Namoi Surface WRPA 114

Table 8-21 Consequence ratings for increased extraction by BLR in unregulated water sources in the Namoi Surface WRPA 114

Table 8-22 Likelihood metrics for increased extraction by BLR in unregulated water sources in the Namoi Surface WRPA 115

Table 8-23 Likelihood ratings for increased extraction by BLR in unregulated water sources in the Namoi Surface WRPA 115

Table 8-24 Risk of increased BLR extraction impacting on water available for other water users in the regulated water source of the Namoi Surface WRPA [O(BLR)] 117

Table 8-25 Risk matrix to determine risk outcomes of increased BLR extraction to other water users in unregulated water sources 117

Table 8-26 Risks of increased BLR extraction to other water users in unregulated water sources in the Namoi Surface WRPA [O(BLR)] 118

Table 8-27 BLR and entitlement volumes for medium and high risk water sources in the Namoi Surface WRPA 119

Table 9-1 Risk treatment options explained 124

Table 9-2 Further information regarding existing WMA 2000 based strategies, actions and mechanisms 126

Table 9-3 Tolerable risk result rationale 127

Table 9-4 Principles guiding development of strategies in NSW 129

Table 9-5 New or modified water management actions and mechanisms 129

Table 9-6 Knowledge strategies 130

Table 9-7 Summary of strategies to address risk 131

Table 9-8 Abbreviations used in Table 9-7 143

Abbreviations

Abbreviation	Description
ARI	Average recurrence interval
AWD	Available water determination
BLR	basic landholder rights
COAG	Council of Australian Governments
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CWP	Cold water pollution
CSG	Coal seam gas
DCCEEW	NSW Department of Climate Change, Energy, the Environment and Water
DoI-Water	Department of Industry – Water (now DCCEEW-Water)
DPI Water	Department of Primary Industries Water (now DCCEEW-Water)
DPIE	Department of Planning Industry and Environment (now DCCEEW-Water)
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 DCCEEW-Water)
NRC	Natural Resources Commission
NRM	Natural Resource Management
NWI	National Water Initiative
OEH	Office of Environment and Heritage (now DCCEEW Biodiversity, Conservation and Science Group)
PEA	Priority environmental assets
PEF	Priority environmental function
SDL	Sustainable diversion limit
WMA	*Water Management Act 2000*
WRP	Water Resource Plan
WRPA	Water Resource Plan Area
WSP	Water Sharing Plan
WQM Plan	Water Quality Management Plan
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)
E(WQ-PT)	Risks due to pathogens and toxicants

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

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 and 5) and risks to other water-dependent values and users (Sections 6 and 7) are assessed together.

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

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

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

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

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

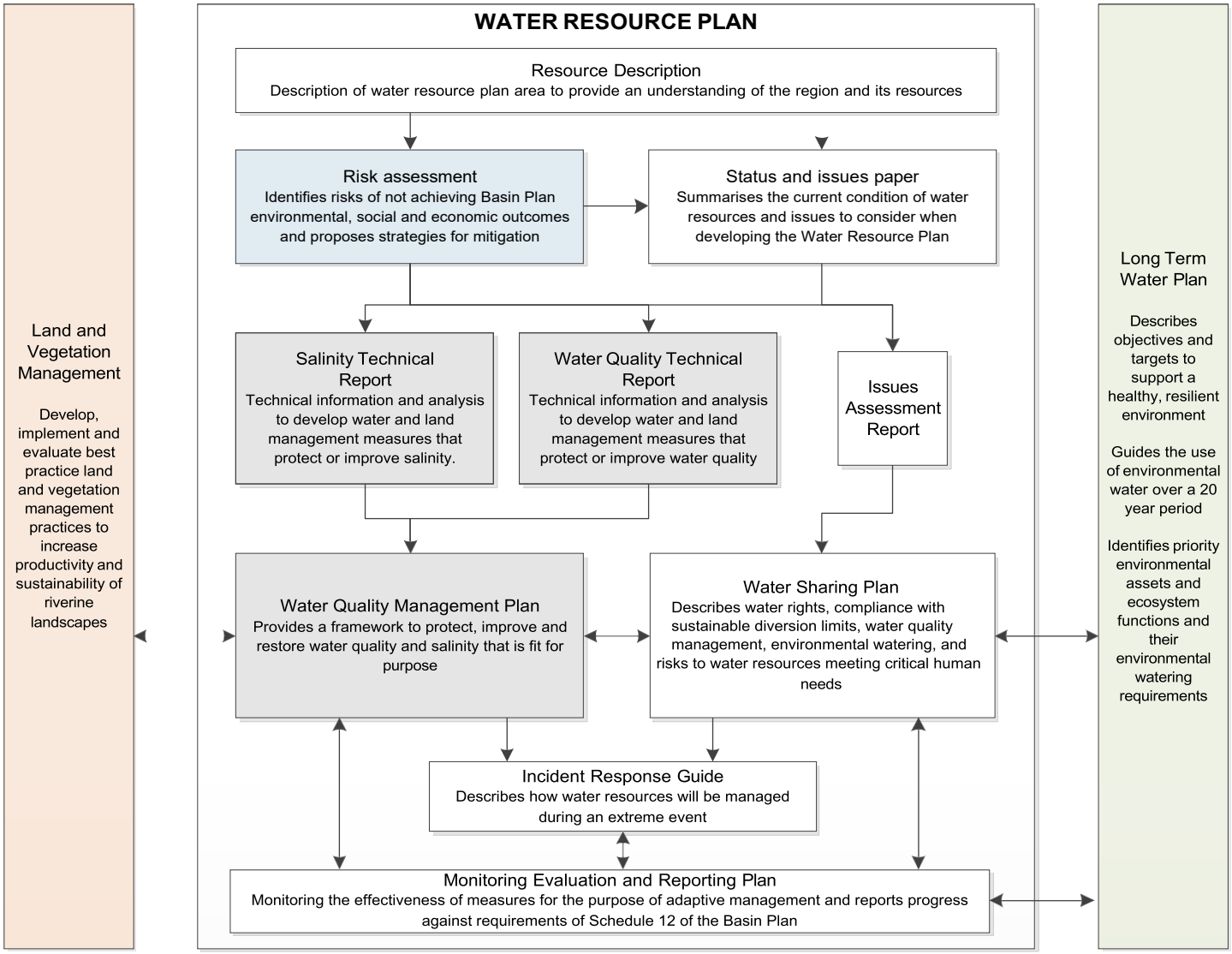


Figure 1-1 Components of the WRP

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

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

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

Basin Plan requirement		Location in Risk Assessment		Location in WRP
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

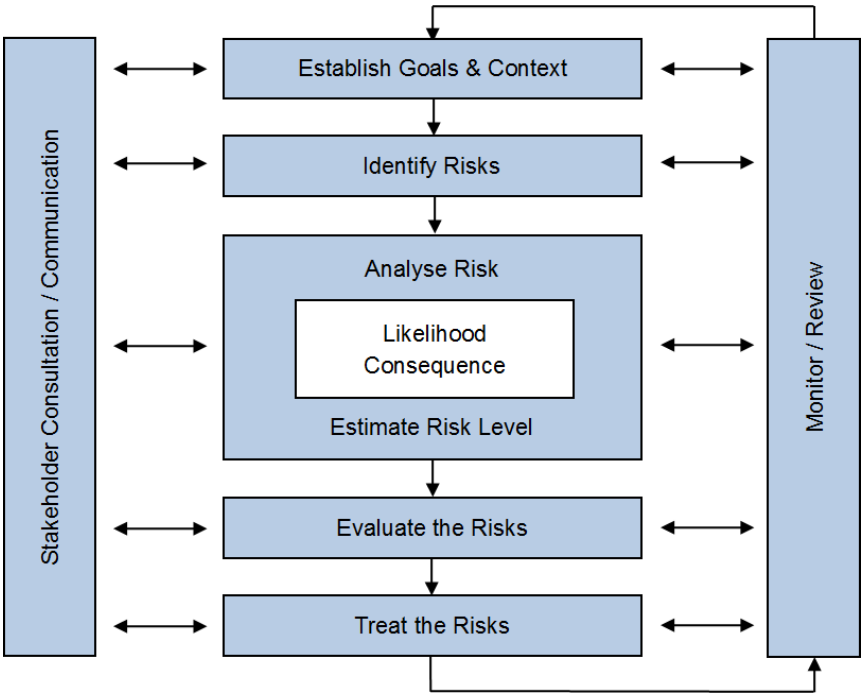
Risk-based management is not a new concept in water resource planning in NSW. Considerable work has been undertaken by State governments and under Commonwealth-level intergovernmental initiatives to design and implement risk-based water planning. The *National Water Initiative* (NWI) *Policy Guidelines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

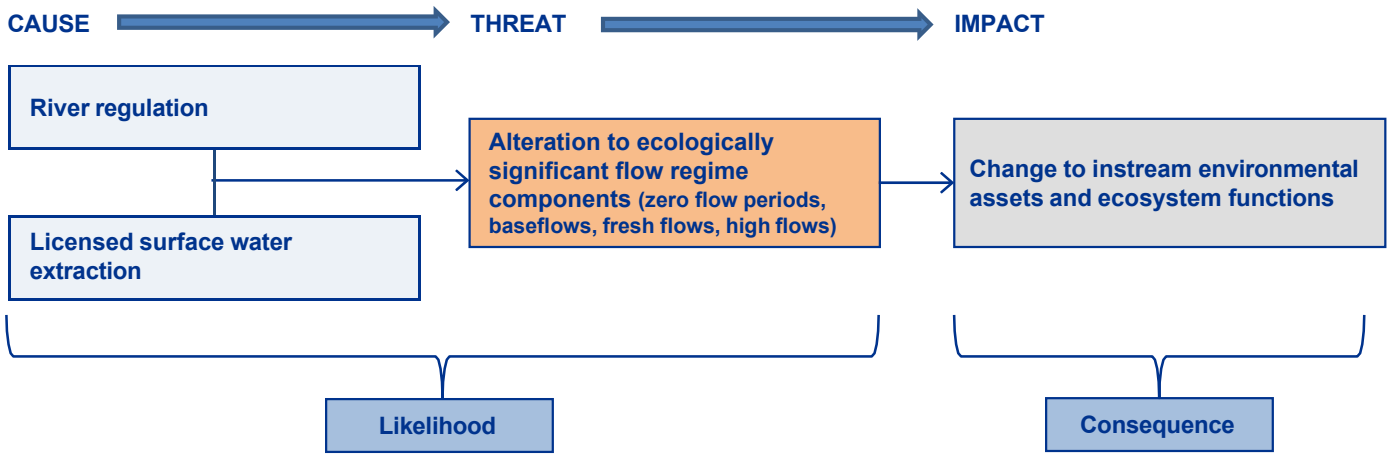


Figure 2-2 Example of an impact pathway for identifying risks to the environment associated with river regulation and licensed extraction

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 *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 Namoi 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 Namoi surface water resource plan area (SW14)

3.1. Identification of the Namoi water resource plan area

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

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

- The SDL resource unit in the Namoi Surface WRPA is that described in section 6.02 and Schedule 2 to the Basin Plan within the Namoi Surface WRPA, (being the Namoi surface water SDL resource unit SS21) 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 Namoi Surface WRPA.

3.2. Characterisation of the Namoi surface water resource plan area

The Namoi Surface WRPA (Murray-Darling Basin reference number SW14), is bounded by the Macquarie-Castlereagh catchment to the south, the Barwon River to the west (a tributary of the Darling), the slopes of the Great Dividing Range to the east and the Gwydir River catchment to the north (**Figure** 3-1). There are approximately 68 streamflow gauging stations with continuous flow measurements in the Namoi river basin. The average annual flow in the Namoi River at Gunnedah between 1900 and 2011 was 669 GL (Welsh et al. 2014).

The Namoi River and the Peel River tributary both begin in the Great Dividing Range in the north-east near Bendemeer, and east of Tamworth respectively. The Namoi flows more than 350 km across north western NSW to its junction with the Barwon River near Walgett (Green et al. 2011). The Namoi River is a typical alluvial Australian inland river, originating in a comparatively wet upland area, and for the majority of its length, flows through a semi-arid landscape that provides little additional discharge (Thoms and Sheldon 2000).

Nearly two thirds of the catchment is flat, with land slopes of less than 3 degrees, with the riverine plains commencing at Narrabri (elevation approximately 150 metres above sea level). Here the carrying capacity of the river channel becomes smaller and the decreasing gradient can result in flooding that can spread out for many kilometres. The headwaters rise at elevations of up to 1,400 m and are characterised by rapidly flowing streams with sandy and pebbly beds and granite bedrock which flow through a mix of steep forested ranges and cleared grazing lands. The undulating landscape of the middle catchment has been extensively cleared but pockets of remnant vegetation remain. The upper Namoi river basin hosts open box woodlands on the slopes and temperate to subalpine forests in the ranges, whereas the Liverpool Plains supports some endangered native grasslands. River oaks and willows dominate riverine vegetation and river red gums grow along some streams (Welsh et al. 2014). There are a number of lagoons and anabranches within the extensive floodplain environment of the western part of the catchment (downstream of Narrabri) with up to half of these areas subject to inundation by 1 in 2 year floods (MDBA 2015).

Average rainfall in the Namoi Surface WRPA varies from a maximum of 1,300mm per year over the ranges in the eastern part of the catchment to just 400mm in the far west, near Walgett. On average approximately 40% more rain falls in the summer months, normally consisting of short duration heavy falls, than in the winter months (lowest falls occurring from April – September). Rainfall is highly variable between years and seasons, resulting in drought and low river flows, or at the other extreme, flooding. Evaporation varies from less than 1000 mm per annum in the east to more than 1750 mm per annum in the west of the catchment (DLWC 2000; Green et al. 2011).

The Namoi Surface WRPA is comprised of regulated and unregulated rivers. Under the NSW Water Management Act 2000, a regulated river is a gazetted river where downstream flows are regulated by a major State-owned storage or dam to supply water. The Namoi and Peel Regulated River Water Sources comprises water between the banks of all rivers, from the walls of Chaffey (Peel River), Split Rock (Manilla River) and Keepit Dam water storages downstream to the junction of the Namoi River and its effluent rivers with the Barwon River. Figure 3-3 shows the spatial distribution of water access licence entitlements in the Namoi Regulated River Water Source. For the purpose of this risk assessment in the Namoi Surface WRPA, the Namoi and Peel regulated rivers were divided into reaches based upon hydrologic modelling at specific hydrologic indicator sites (Figure 4-2).

The remaining rivers in the Namoi Surface WRPA not gazetted as regulated rivers fall under the category of unregulated rivers. The unregulated rivers were embargoed in 1982 (DPI 2013) and their ecological water requirements progressively protected with the introduction of water sharing plans (WSPs). For the unregulated water sources, the Namoi Surface WRPA can be divided into three main areas based upon upland (downstream to Split Rock and Chaffey dams), midland (Chaffey Dam to confluence with the Namoi and Split Rock Dam to downstream of Narrabri) and lowland (downstream of Narrabri to the Barwon River) characteristics (Figure 3-2). There are 31 water sources in the Namoi unregulated river water source. Figure 3-4 shows the unregulated water sources in the Namoi Surface WRPA and the spatial distribution of licence entitlements.

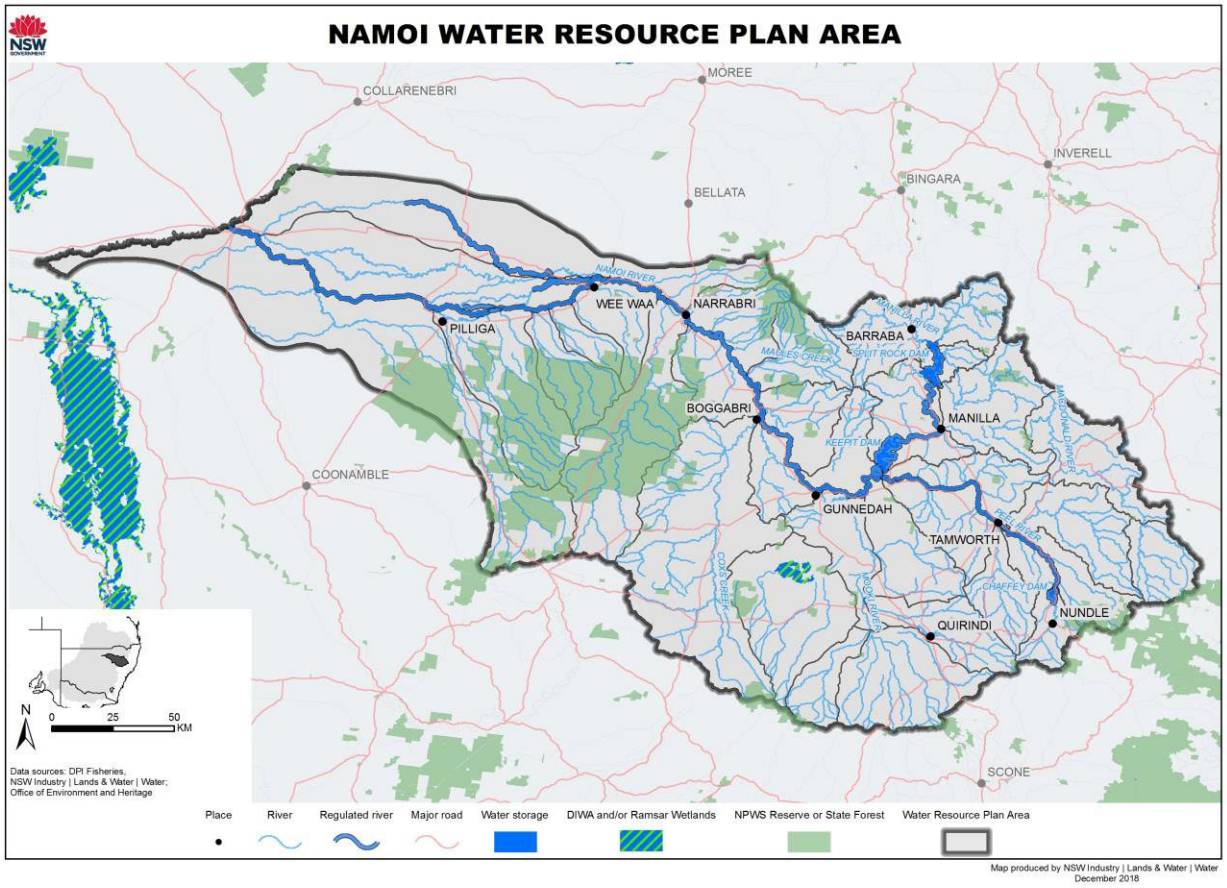


Figure 3-1 The Namoi Surface WRPA (SW14)

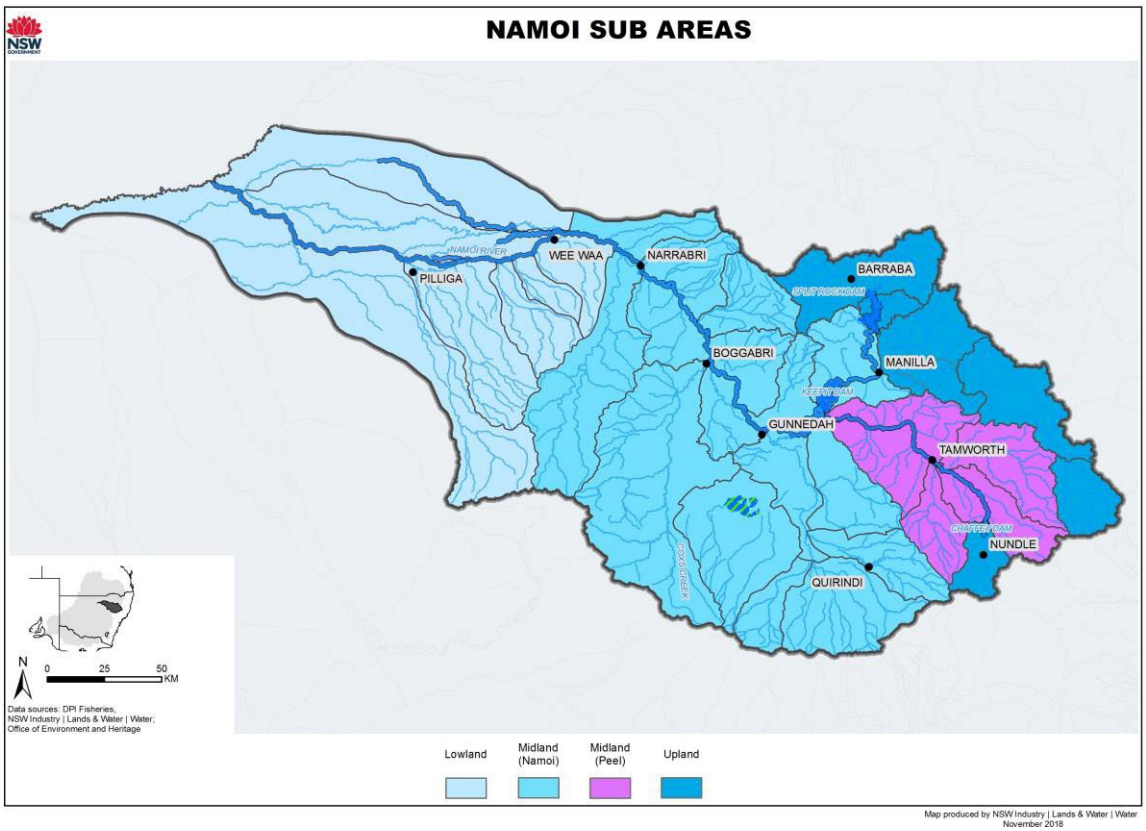


Figure 3-2 Sub areas of the Namoi Surface WRPA (SW14) (upland, midland and lowland)

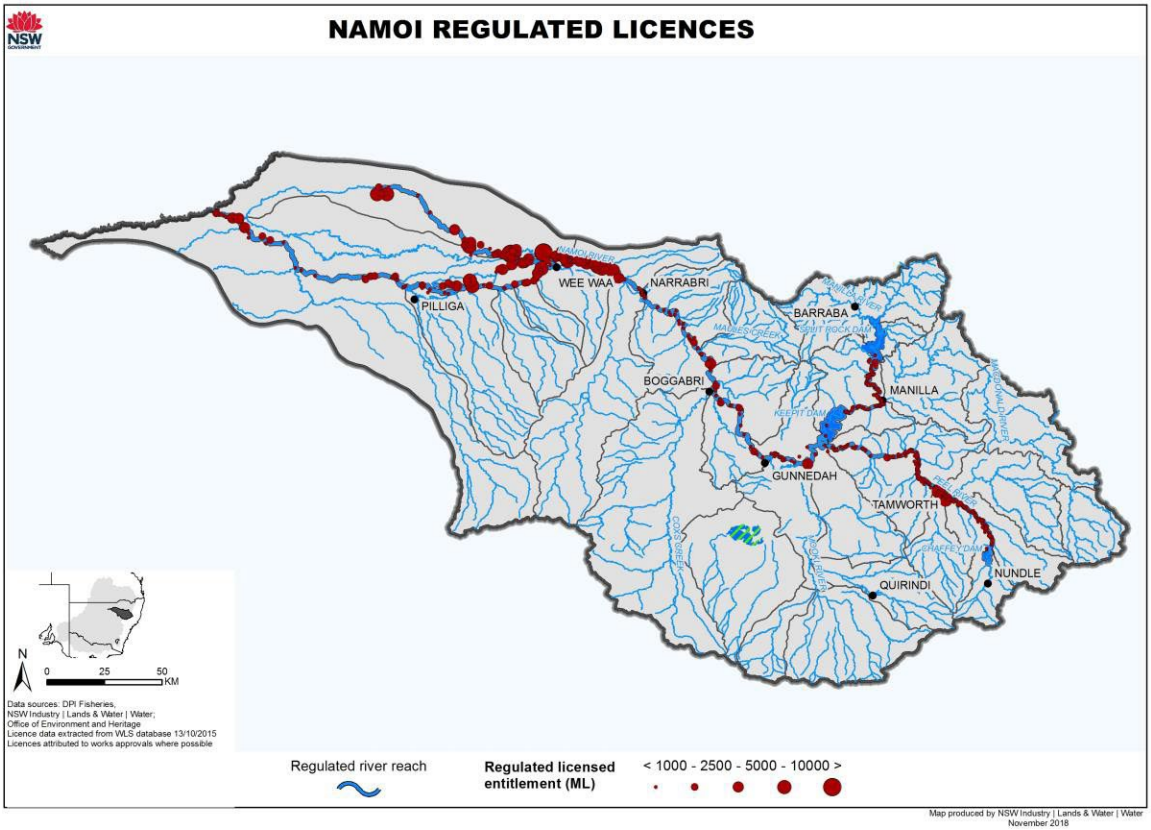


Figure 3-3 Regulated river entitlement in the Namoi Surface WRPA (SW14)

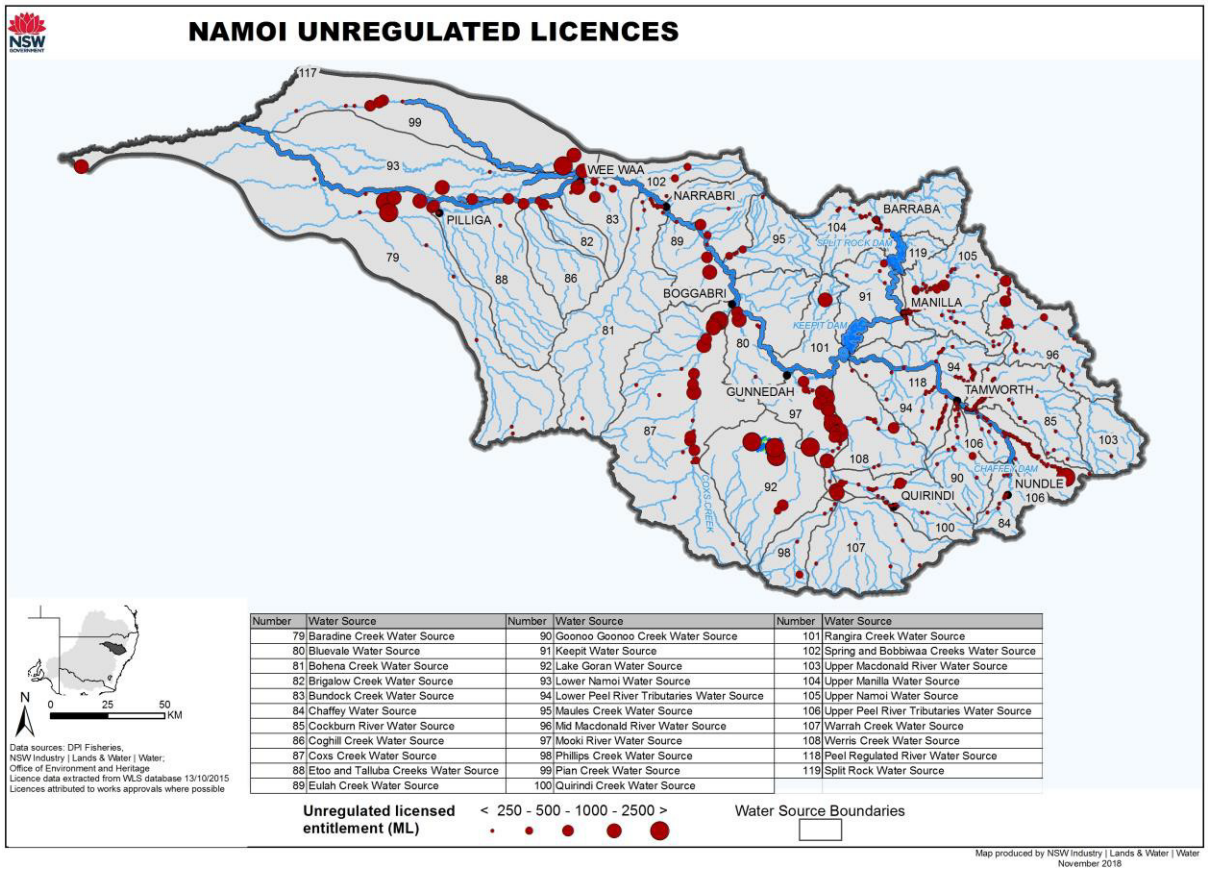


Figure 3-4 Unregulated water sources and entitlement in the Namoi Surface WRPA (SW14)

3.3. Connectivity

The Namoi Surface WRPA contains a single SDL resource unit, Namoi SS21. Within this resource unit, the three WSPs within the Namoi Surface WRPA recognise and manage the hydrological connection between regulated and unregulated surface water sources. Water management actions and mechanisms that are included in the *Water Sharing Plan for the Peel Valley Regulated River Water Source 2022,* the *Water Sharing Plan for the Namoi and Peel Unregulated Water Sources 2012,* and the *Water Sharing Plan for the Upper Namoi and Lower Namoi Regulated River Water Sources 2016* to manage hydrological connections within the WRP area are discussed below.

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

3.3.1. Connectivity between unregulated and regulated water sources within the Namoi Surface WRPA

The connectivity between the Namoi and Peel unregulated and regulated water sources is managed by a suite of rules within the three WSPs. Unregulated water sources are both upstream and downstream of the Peel and Upper and Lower Namoi Regulated River Water Sources and rules are applied to manage both connectivity situations.

In order to protect a portion of very low flows for the benefit of the environment, the *Water Sharing Plans for both the Peel and Namoi Unregulated Water Sources* provides cease to pump rules at the lowest downstream point for some water sources. Cease to pump rules specify a flow requirement to benefit important environmental attributes in that water source and provides for connectivity between water sources, including into the regulated river. Cease to pump rules ensure that very low flows are protected by requiring water users to stop taking water when flow declines below a set level.

The *Water Sharing Plan for the Namoi and Peel Unregulated Water Sources 2012* also has commence to pump rules that are used to protect water for the environment released from Keepit Dam. The commence to pump rules protect a portion of water delivered from the regulated Namoi River once it reaches the unregulated section of Pian Creek, downstream of Dundee weir.. This is achieved by only allowing users on the specified unregulated water source to recommence taking water once flow has increased above a specified level.

The *Water Sharing Plan for the Upper and Lower Namoi Regulated River Water Sources 2016* establishes provisions for environmental water. These provisions include rules that protect a minimum daily flow (equivalent to 75% of the natural 95th percentile daily flow) for the months of June, July and August be maintained in the Namoi River at Walgett with the objective of achieving a range of environmental purposes, including pool refugia protection. There are also restrictions on extractions under supplementary water access licences where supplementary water is protected for the environment.

In the *Water Sharing Plan for the Peel Valley Regulated River Water Source 2022* an environmental contingency allowance (ECA) also specifies a volume of water to be set aside in Chaffey Dam to deliver water for environmental purposes, including connectivity between the regulated river to the unregulated water sources in the upper to mid sections of the Peel valley.

Lastly, the Plans reserves water above the Plan limit which provides water for environmental benefits, including connectivity between the regulated rivers and unregulated rivers in the Namoi and Peel valleys.

3.3.2. Connectivity with other WRP areas

Surface water to surface water

For the purposes of section 10.05 of the Basin Plan, the Namoi Surface WRPA (SW14) is considered to have significant hydrological connection to surface water resource units within the downstream Barwon-Darling Watercourse WRPA (SW12) (Barwon Darling Watercourse SDL resource unit SS19). The Namoi Surface WRPA does not have a significant hydrological connection to the Macquarie-Castlereagh Surface WRPA (SW11) and Gwydir Surface WRPA (SW15). Adjacent resource units are summarised in Table 3-2.

Any potential risks to the Barwon-Darling Watercourse WRPA (SW12) from water management related activities in the Namoi Surface Water Resource Plan area are considered in the Barwon-Darling Watercourse WRPA (SW12) Risk Assessment.

The following is a qualitative assessment based on NSW Department of Climate Change, Energy, the Environment and Water (the department) ecohydrology specialist expert opinion. There are potential risks to environmental assets and functions in the Namoi Surface WRP from the Barwon-Darling Watercourse WRPA (SW12). 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 Namoi Surface WRP area was 'low' given the impacts of existing invasive species, and the consequence score was 'medium'. Using the risk matrix Table 4-10, the overall risk rating was '**low**' (Table 3-1)

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

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

Connectivity between the upstream water resource units of the Namoi Surface WRPA and the Barwon-Darling Watercourse WRPA is managed via a number of planned environmental water rules (PEW). The *Water*

Sharing Plan for the Upper Namoi and Lower Namoi Regulated River Water Sources 2016 contains clauses that allow extraction by supplementary water access licence holders of locally generated uncontrolled flows in the Lower Namoi River and Gunidgera/Pian system to be delayed until the downstream flow requirements are met.

Contributions towards flow targets are also provided by the NSW Border Rivers Surface WRP SW16 and Gwydir Surface WRP SW15. These targets recognise the significant connectivity between the water resources and aim to manage access when extractions have the highest likelihood of impacting the connectivity relationship. The flow targets have been set to provide opportunity for the passage of fish across the major weirs in the Barwon-Darling River, to protect flows needed to suppress blue-green algae blooms, and to meet basic landholder rights requirements along the Barwon-Darling River.

This strategy manages potential risks to the downstream connected surface water resources, including risks to the environment and other uses, and is not considered further in this risk assessment.

Table 3-2 Adjacent SDL resource units

SDLRU	Adjacent SDLRU	Adjacent WRP / non Basin WSP
Namoi SS21	Barwon-Darling Watercourse SS19	Barwon-Darling Watercourse SW12
	Gunnedah-Oxley Basin MDB GS17	NSW Murray-Darling Basin Porous Rock WRP GW6
	Liverpool Ranges Basalt GS22	NSW Murray-Darling Basin Fractured Rock WRP GW11
	Lower Namoi Alluvium GS29	Namoi Alluvium WRP GW14
	Manilla Alluvium GS30	Namoi Alluvium WRP GW14
	Upper Namoi Alluvium GS47	Namoi Alluvium WRP GW14
	NSW GAB Surat Shallow GS34	NSW Great Artesian Basin Shallow GW13
	Peel Valley Alluvium GS40	New England fractured Rock and Northern Basalts (GW17)
	Upper Namoi Tributary Alluvium GS48	Namoi Alluvium WRP GW14
	New England Fold Belt MDB GS37	NSW Murray-Darling Basin Fractured Rock WRP GW11
	NSW Non-Basin resources (GAB)	*Water Sharing Plan for the NSW Great Artesian Basin Groundwater Sources 2008*

Surface water to groundwater

Adjacent resource units are summarised in Table 3-2. In NSW, connectivity between surface and groundwaters is primarily managed through rules for specific areas in groundwater WSPs and by managing surface and groundwater extraction to LTAAELs and SDLs. Any potential groundwater risks from surface water extraction are managed by PEW rules in the surface water WSPs that also protect the surface water resources.

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



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

The protection of the environmental water provisions under section 4.2 of the WRP ensures that the PEW in the WRP area is protected. Therefore the volume of water available as groundwater recharge throughout the Namoi 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 4-10, the likelihood and consequence metrics result in a '**low**' risk rating for both regulated and unregulated water sources (Table 3-3).

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

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

For the purposes of section 10.05 of the Basin Plan, the Namoi Surface WRPA (SW14) is considered to have significant hydrological connection to ground water resource units within the Namoi Alluvium WRPA (GW14) (resource units Upper Namoi Alluvium (GS47), Lower Namoi Alluvium (GS29), Manilla Alluvium (GS30), Upper Namoi Tributaries Alluvium (GS48) and Peel Valley Alluvium (GS40)).

Any potential risks to surface water (including risks to the environment and risks to other users) as a result of ground water extraction are considered in the Risk Assessment for the Namoi Alluvial WRPA (NSW DoI, 2019).

Linking the groundwater AWD to the surface water AWD acknowledges the potential impact of groundwater pumping on surface water during periods of reduced surface water availability, therefore the linked AWDs protect against increasing losses from the regulated Namoi and Peel rivers to groundwater during times of reduced allocations for the regulated rivers. This strategy adequately manages any potential risks to surface water resources in the Namoi Surface WRPA (including the environment and other water users).

The regulated Peel, Namoi and Manilla rivers and several unregulated rivers (e.g. Cockburn and Macdonald rivers) are considered to be connected to the shallow aquifers in the Peel Valley Alluvium, Manilla Alluvium and the Upper Namoi Tributary Alluvium within the resource area boundary. Where joint ground and surface water connectivity management is in place, a WSP rule summary is provided in Table 3-4.

The Peel and Manilla Alluviums, where they are associated with regulated rivers, are linked to surface water rules. The high level of hydraulic connection is recognised in the *Water Sharing Plan for the Namoi Alluvial Groundwater Sources 2020* by linking annual available water determinations (AWDs) for aquifer access

licences in the alluvial groundwater sources to AWDs for surface water access licences in the regulated river. Linking extraction of groundwater to surface water availability according to the level of connectivity, limits to acceptable levels, groundwater extraction impacts on surface water users and the environment.

The reaches of the unregulated Namoi River and Halls Creek within the Manilla Alluvium and the Cockburn River and Goonoo Goonoo Creek reaches of the Peel Valley Alluvium are highly connected perennial streams and this high level of hydraulic connection is recognised and managed in the *Water Sharing Plan for the Namoi Alluvial Groundwater Sources 2020* by linking groundwater access to surface water access via time lags.

The Attunga, Moore, Dungowan and Duncans Creek reaches within the Peel Valley Alluvium, and the streams connected to the Upper Namoi Tributary Alluvium are not perennial. Consequently these groundwater resources are managed independently of the surface water access rules although the water sharing plan extraction limit was set at historic levels of extraction to limit further impact induced from groundwater pumping on these surface water systems.

The Upper Namoi Alluvium and Lower Namoi Alluvium have varying degrees of hydraulic connection to surface waters. For some localities within the Upper Namoi Alluvium that are composed of shallow narrow alluvial systems, the level of hydraulic connection can be high, however at the scale of the SDL resource unit this connection is not considered significant, and these systems are managed independently of the surface water sources.

In accordance with principles in the WMA, the *Water Sharing Plan for the Namoi Alluvial Groundwater Sources 2020* sets rules to minimise the cumulative impacts resulting from groundwater extraction. To do this, the plan specifies rules which prohibit new or amended works from extracting water within certain distances of; a river, other water users, contaminated sites, groundwater-dependent ecosystems (GDE) and groundwater-dependent culturally significant sites. This is to prevent unacceptable or damaging levels of drawdown of water occurring in the local vicinity of these users and sites. Cumulative impacts are also managed by setting the long term average annual extraction limit at past history of extraction; that is, no growth is allowed above the current level of pumping.

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.

Risks to surface waters (including risks to the environment and surface water users) as a result of groundwater extraction in connected water resource units are addressed in sections 4.6 and 6.3 (with additional information in section 4.3) of the Risk Assessment for the Namoi Alluvial WRPA (NSW DoI, 2019). Compaction and subsidence of the aquifer system occurred in the Lower Namoi valley, due to large scale groundwater extraction in the 1970's and early 1980's, resulting in subsidence of 70 mm to 120 mm over an area of up to 360 km^2 measured between 1981 and 1990 (Ross and Jeffery, 1991). Post this study resource management policies and legislation have been introduced to address extraction issues including the introduction of water sharing plans and a structural adjustment program to address extraction demand. There is no known compaction and subsidence in the Upper Namoi valley or other groundwater sources / SDL resource units in the Namoi Alluvium.

Table 3-4 Connectivity management in the Namoi-Peel Alluvium

SDL resource unit	Connectivity management type	Groundwater source / management zone	Associated WSP management unit within the Namoi WRP area (SW14)
Peel Valley Alluvium (GS40)	Regulated river AWD link	Peel Valley Alluvium Water Source • Peel Regulated River Alluvium Management Zone	Peel Regulated River Water Source *Water Sharing Plan for the Peel Regulated Water Source 2022*
	Unregulated river (perennial streams) Access rules with time lag linked to stream gauge	Peel Valley Alluvium Water Source • Cockburn River Alluvium Management Zone • Goonoo Goonoo Creek Alluvium Management Zone	Cockburn River Water Source • Cockburn River at Kootingal gauge (419099) Goonoo Goonoo Creek Water Source • Goonoo Goonoo Creek at Timbumburi gauge (419035) *Water Sharing Plan for the Namoi and Peel Unregulated Water Sources 2012*
Manilla Alluvium (GS30)	Regulated river AWD link	Manilla Alluvial Groundwater Source • Namoi and Manilla Regulated Rivers Alluvial Management Zone	Upper Namoi Regulated River Water Source *Water Sharing Plan for the Upper and Lower Namoi Regulated Water Sources 2016*
	Unregulated river (perennial streams) Access rules with time lag linked to flow classes controlled via reference point	Manilla Alluvial Groundwater Source • Namoi Unregulated River Alluvial Management Zone • Halls Creek Alluvial Management Zone	Upper Namoi Water Source • Macdonald and Namoi Rivers Management Zone (reference point: Manilla Weir on the Namoi River) • Halls Creek Management Zone (reference point: Halls Creek at Ukolan gauge (419029)) *Water Sharing Plan for the Namoi and Peel Unregulated Water Sources 2012*

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

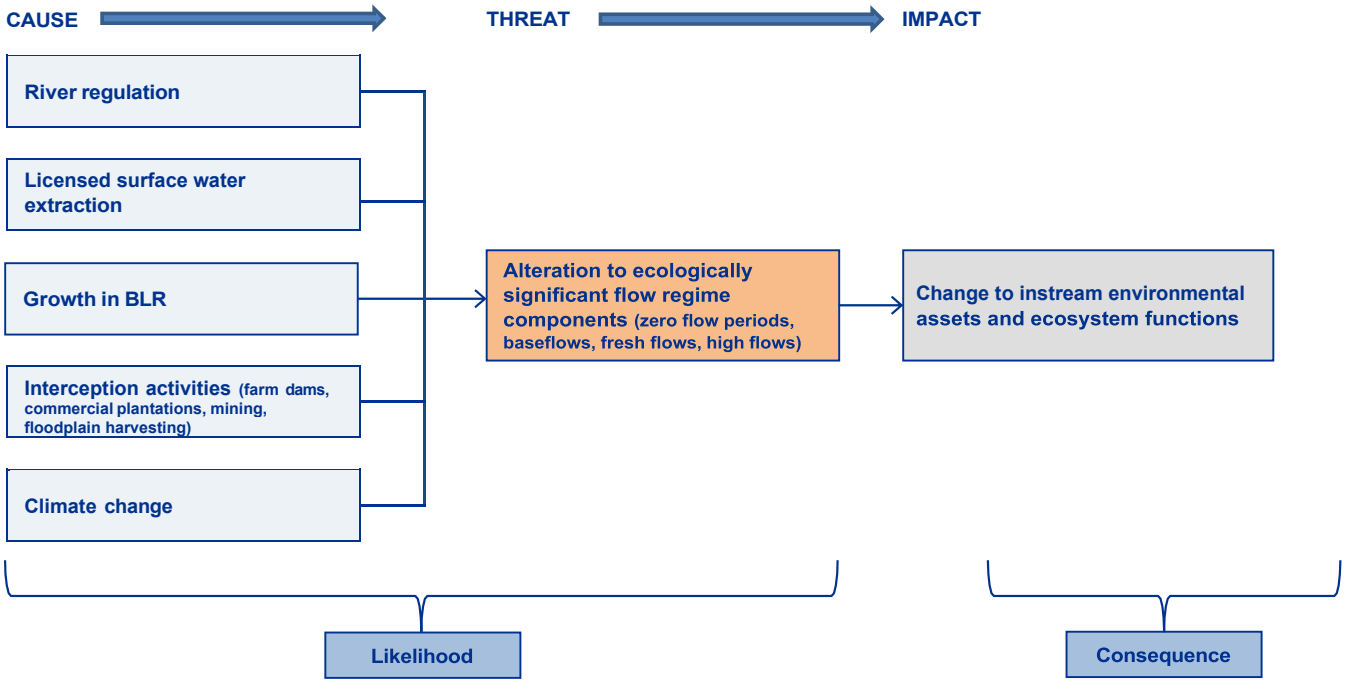


Figure 4-1 Risk pathways for risks of insufficient water for the environment and capacity to meet environmental watering requirements

4.2. Assigning a consequence rating

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 (AETG) 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.

A consequence score is assigned at a reach scale for regulated rivers. The regulated river was broken into reaches that were represented by MDBA hydrologic indicator sites used for modelling or where required, additional DPI Water hydrologic sites were used (Figure 4-2). These sites correspond to selected streamflow gauging stations. The reaches represented by the hydrologic indicator sites were selected by identifying where significant tributaries, effluents or regulators both upstream and downstream of the site change the hydrology significantly. For example, in Figure 4-2, the reach assigned to the indicator site 419007 Namoi River downstream of Keepit Dam extends upstream to the wall of Keepit Dam and downstream to include the confluence with the Peel River, a significant tributary of the Namoi regulated river.

A consequence score is assigned at a water source scale for unregulated rivers. Single reach Integrated Quantity and Quality Models (IQQM) were applied at a water source scale for unregulated rivers. Where appropriate, unregulated flow gauges were also used for single reach models in adjacent water sources if a suitable gauge was not available. The exceptions are the unregulated effluent rivers associated with high flows in the regulated river or unregulated reaches directly downstream of regulated rivers, as was the case for the Lower Baradine and Pian Creek unregulated river water sources (Figure 4-3).

To ensure the HEVAE outcomes developed by the Department of Industry Water (DoI-Water) (Healey et al. 2012; Healey et al. 2018) could be useful spatially and report consistently across a WRPA and water sources, available data was attached to the River Styles® spatial layer. The River Styles® mapping has been

undertaken across all catchments in NSW to third or fourth order streams and greater. It is the primary spatial layer to which the HEVAE data are applied, enabling instream value to be represented on a spatial scale.

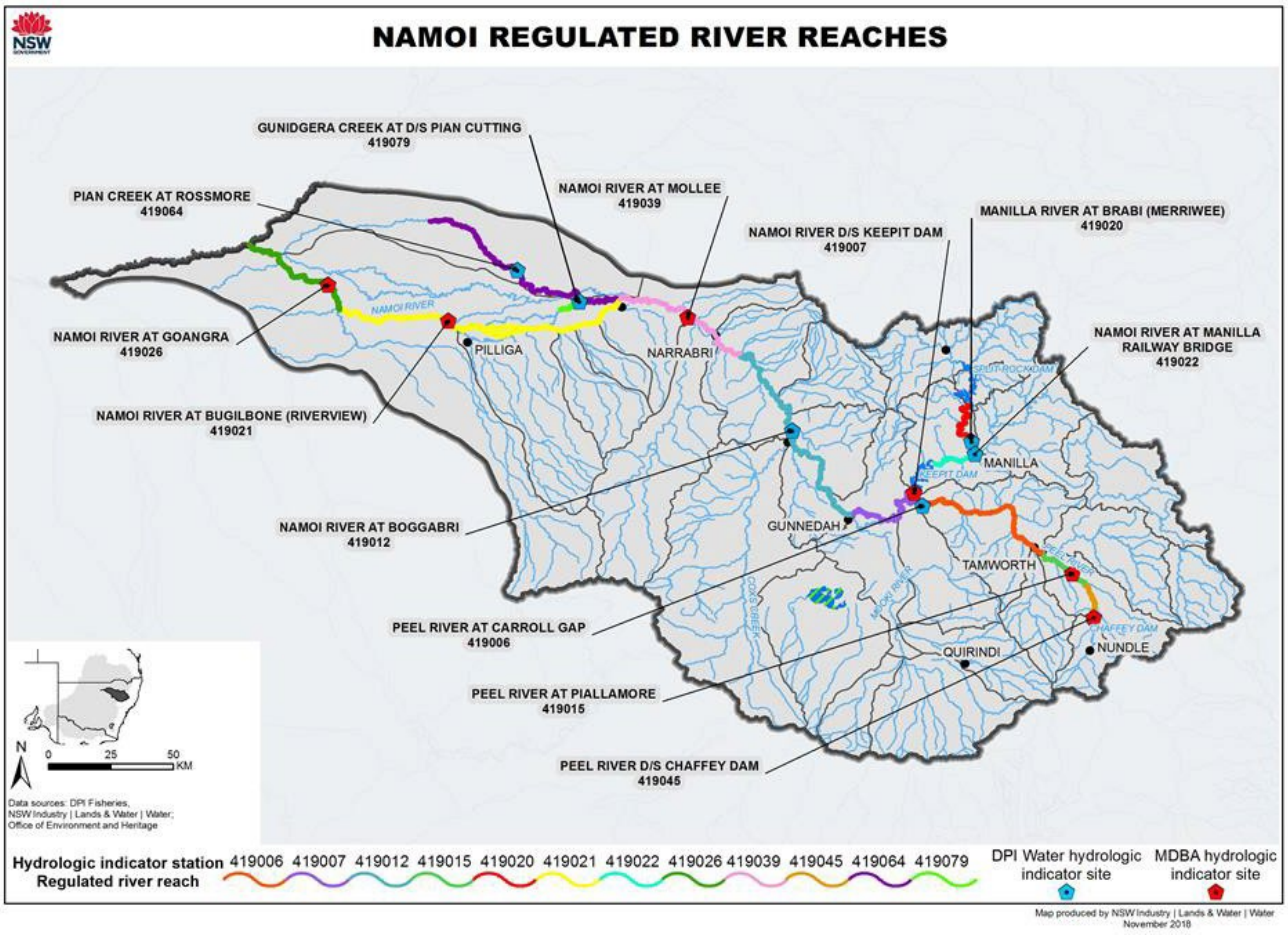


Figure 4-2 MDBA hydrologic indicator sites and representative regulated reaches for the Namoi Surface WRPA

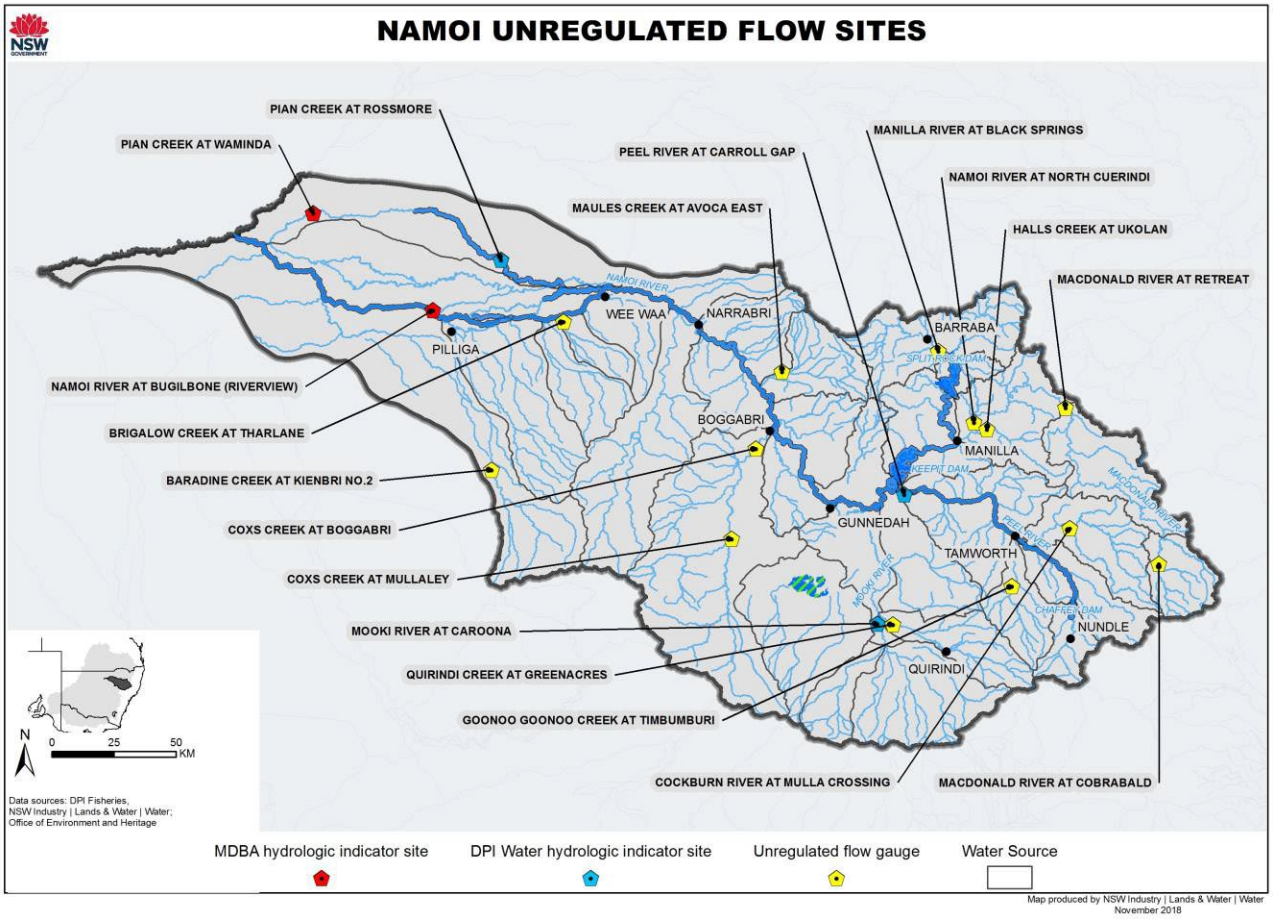


Figure 4-3 Location of unregulated flow gauges and the MDBA hydrologic indicator site used for generating flow sequences in unregulated rivers in the Namoi Surface WRPA

4.2.1. HEVAE

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

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

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

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

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

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

During the development of macro WSPs in NSW, specific weightings were linked to the flow sensitivity (Table 4-1) of in-stream flow dependent threatened species, populations and communities (NSW Office of Water 2010; DIPNR 2005). The weightings for each species were agreed upon through discussions with participating NSW agencies, with consideration to the importance of flow alteration as a key threatening process. These same flow sensitivity weightings were applied in the HEVAE scoring. Evidence was collated to support the weightings associated with attributes. For example, if a threatened species population or endangered ecological community had alteration to natural flow listed as a key threat, it receives a flow sensitivity weighting of 4.

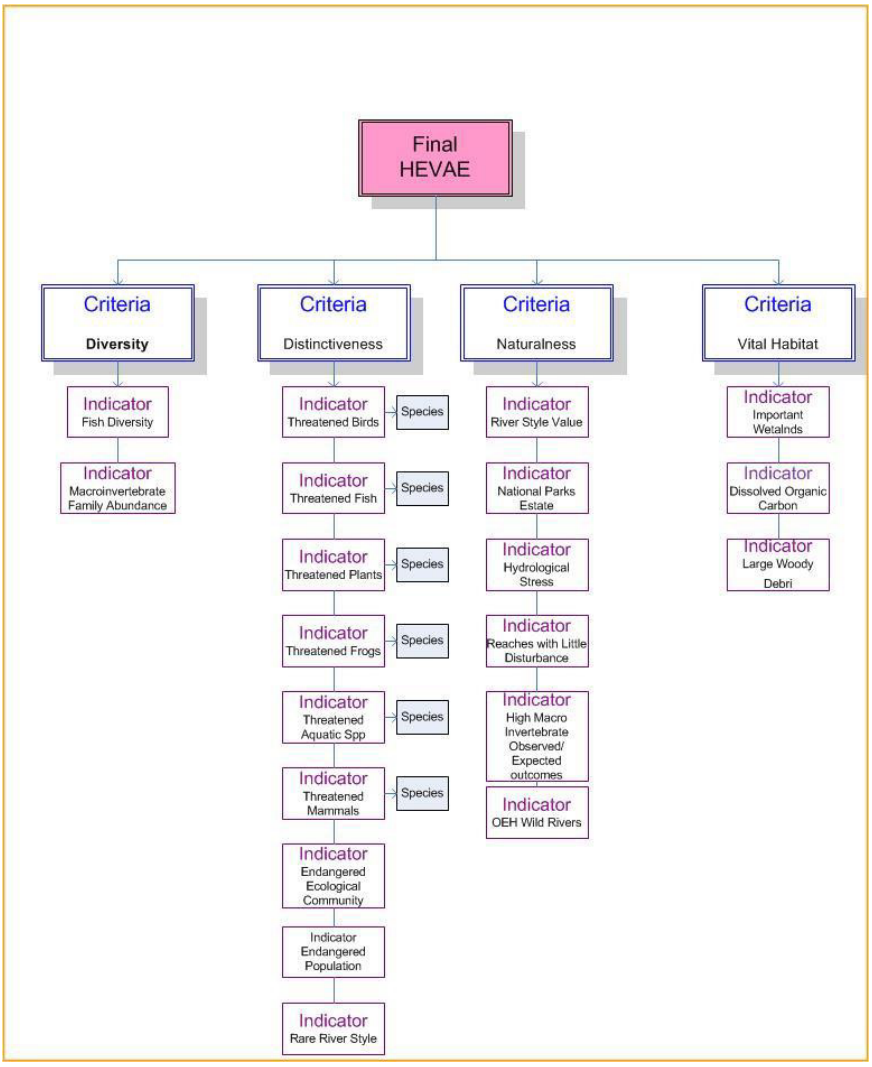


Figure 4-4 The four HEVAE criteria and associated attributes used in assessing HEVAE in NSW

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

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

4.2.2. Consequence decision tree

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

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

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

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

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

4.2.3. Consequence Score

Regulated river water source

Key aquatic ecological assets in the Namoi Surface WRPA include:

- River reaches with high fish diversity

- Threatened or endangered fish species including silver perch, Murray cod and unspecked hardyhead
- Threatened species such as Davie's tree frog, Booroolong frog, and threatened endangered populations including eel-tailed catfish and tusked frog
- Endangered ecological communities (EECs) including carbeen woodlands, river red gum woodlands, coolibah-black box woodlands, bimble box woodlands, river cooba and lignum and the Lowland Darling River Aquatic EEC
- Lower Namoi anabranch and floodplain wetlands
- In-stream pools and low flow channel refuges that support local and migratory species and riparian and in-channel vegetation (e.g., *Myriophyllum implicatum*).

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

Table 4-2 Consequence results for the Namoi regulated water source in the Namoi Surface WRPA

Regulated river reach	Consequence Rating (HEVAE consequence score)
Peel at downstream Chaffey Dam	Very high
Peel at Piallamore	Very high
Peel at Carroll Gap	Medium
Manilla at Brabi (Merriwee)	Medium
Namoi at Manilla Railway Bridge	Medium
Namoi at downstream Keepit Dam	Medium
Namoi at Boggabri	Very High
Namoi at Mollee	Very High
Namoi at Bugilbone	Very High
Namoi at Goangra	High
Pian Creek at Rossmore	High
Gunidgera Creek at downstream Pian Cutting	Medium
Reference: Healey et al. 2018.	

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

Unregulated water sources

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

- Bohena Creek water source has very high values, supporting Eel-tailed Catfish, Murray Cod and the Lowland Darling River Endangered Ecological Communities (LDREEC). Both 'diversity' and 'vital habitat' HEVAE criteria gave very high values. This also results in very high consequence for base flow alteration due to extraction demands.

- Lower Namoi water source has very high values due to the presence of Murray Cod and LDREEC. Extraction pressures particularly during base flows results in a very high consequence. The HEVAE criteria 'vital habitat' was very high, while 'naturalness' and 'distinctiveness' criteria were both high (Figure 4.5).
- In the lowland sub area, both Pian Creek and Etoo – Talluba Creeks water sources recorded high values and consequence scores. Both water sources support Murray Cod and the LDREEC. Pian Creek also contains the endangered ecological community: Carbeen Open Forest. Pian Creek water source had very high 'vital habitat' and high 'distinctiveness'(Figure 4.5)
- In the midland sub area the Spring and Bobbiwaa Creeks water source recorded high values and consequence scores, and contains the LDREEC. The 'vital habitat' criteria was very high, 'naturalness' was medium
- In the upland sub area above Keepit Dam, the Upper Namoi water source also recorded high values and high consequence scores. This water source supports both the Eel-tailed Catfish and Murray Cod. The Office of Environment and Heritage website (http://www.environment.nsw.gov.au/search.htm?q=Namoi%3A+Distribution+and+vegetation+associations), contains 'known' records for two tree frog species: the endangered Booroolong Frog (*Litoria booroolongensis*) and the vulnerable Davies' Tree frog (*Litoria daviesae*). Whilst the Tusked Frog (*Adelotus brevis*) is predicted to be in the bioregion and is classed as an endangered population.

Table 4-3 Consequence results for the Namoi unregulated water sources in the Namoi Surface WRPA

Unregulated water source	Consequence Rating (HEVAE consequence score)
Upper Baradine Creek	Low
Lower Baradine Creek (effluent)	Low
Bluevale (all creeks)	Low
Bohena Creek	Very High
Brigalow Creek	Low
Bundock Creek	Low
Chaffey with CtP*	Medium
Cockburn River	Medium
Coghill Creek	Low
Mid Coxs Creek	Low
Lower Coxs Creek	Low
Etoo Creek	High
Talluba Creek	High
Eulah Creek	Low
Goonoo Goonoo Creek	Low
Keepit	Low
Lake Goran	Very Low
Lower Namoi	High
Lower Peel River Tributaries	Medium
Maules Creek	High
Mid Macdonald River	Medium
Mooki River*	Low
Phillips Creek no CtP	Low
Warrah Creek no CtP	Low
Pian Creek	High
Quirindi with CtP*	Low
Rangira Creek	Low
Split Rock	Low
Spring Creek	High
Bobbiwaa Creek	High
Upper Macdonald River	Medium
Upper Manilla	Medium
Upper Namoi	High
Upper Namoi – Halls Creek	Low
Upper Peel Tributaries	Medium
Werris Creek	Medium
* – a water source where a CtP (cease to pump) was included in the scenario	
Reference: Healey et al. 2018.	

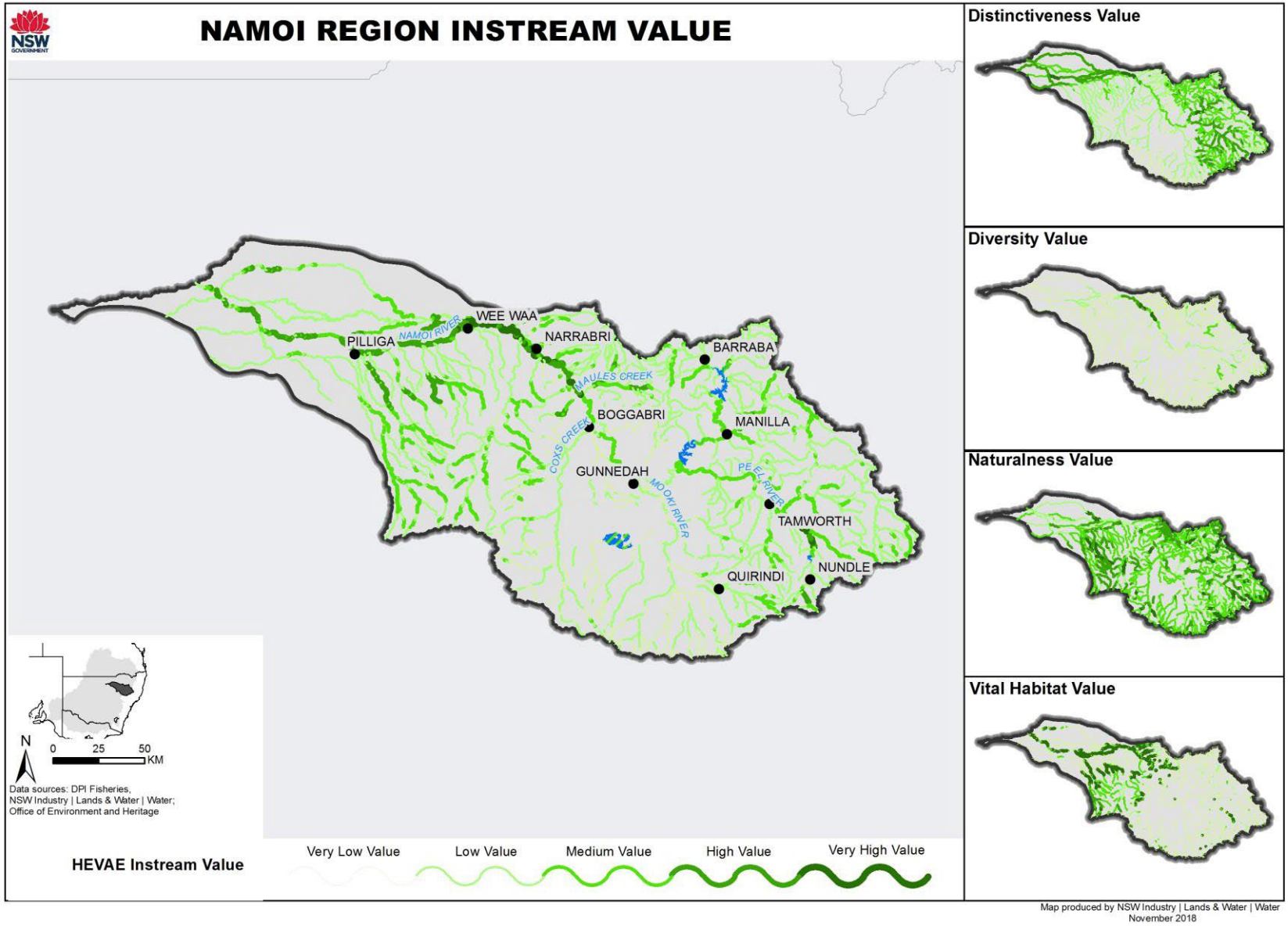


Figure 4-5 HEVAE scoring of instream values in the Namoi Surface WRPA

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

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

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

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

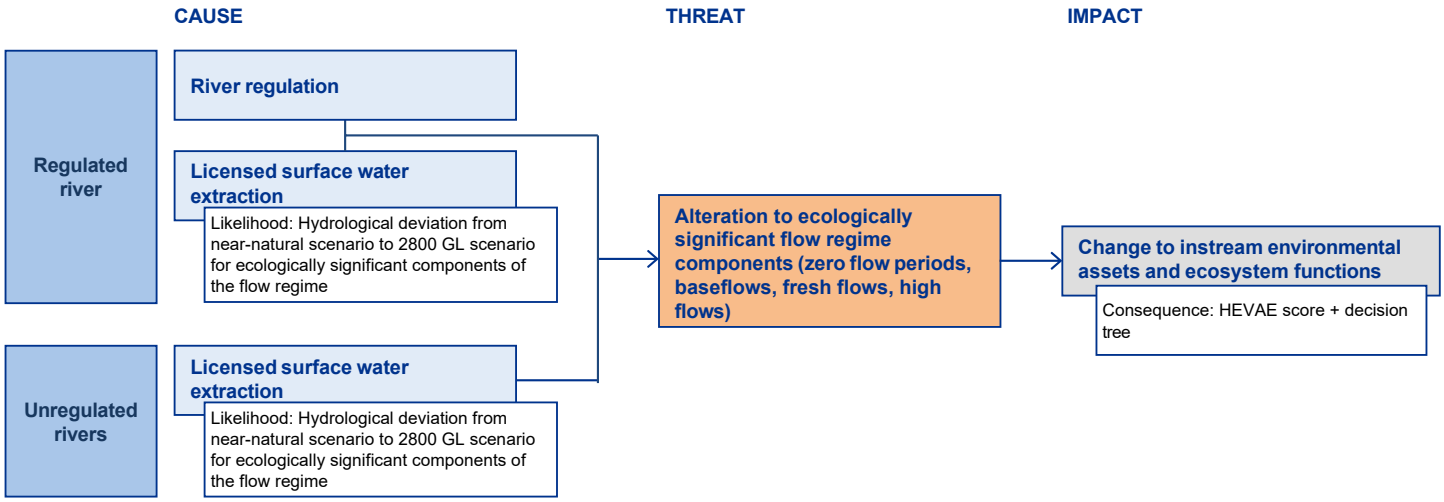


Figure 4-6 Impact pathway showing impact of river regulation and licensed extraction on water available for the environment

4.3.1. Determining the likelihood rating

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

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

Table 4-4 Key features of flow regimes 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. 2006	

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 4-4. These metrics indicate change to the following flow components:

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

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

Under the Basin Plan, environmental watering requirements (EWRs) are 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 Namoi Surface WRPA in the LTWP developed by DPIE (2019; Table 6) 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 Namoi Surface WRPA; therefore the ideal timing of EWRs was not an explicit consideration in the likelihood calculations discussed below. However, the likelihood assessment does identify the change in frequency, magnitude or duration of certain flow components, regardless of the seasonality. Therefore any changes to hydrology during the ideal LTWP timing periods have been identified.

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

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

Long Term Water Plan (DPIE)[1]						Namoi Surface WRPA risk assessment (DPIE-Water)	
			Ideal EWR				
Flow component[1]	EWR reference	Maximum inter-flow period (note LTWP flow components do not provide definitions of percentiles or frequencies)	Timing	Duration	Frequency	Flow component assessed (section 4.3)	How this risk assessment considers the EWR
Cease-to-flow	CF1	N/A	In line with historical low flow season (April to June)	In line with natural, unless key refuges endangered, or as described in planning unit specific EWR tables	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	In line with natural	Annual	Base flow (BF)	Metrics used to calculate likelihood of base flow components included identifying low flows during 'wet' and 'dry' seasons. The dry season calculation is equivalent to very low flows (approximately 90-95 %ile)
"Base flow"[2]	BF1	No greater than natural	Any time	In line with natural	No less than modelled natural	Base flow (BF)	Metrics used to calculate likelihood of base flow components included identifying low flows during 'wet' and 'dry' seasons. Likelihoods were generally calculated on flows between the 80-95 %ile, depending on which percentile most accurately described low flows in the water source.
"Base flow"[2]	BF2	2 years	September to March	In line with natural	5–10 years in 10 (75% LTA)	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.

Long Term Water Plan (DPIE)[1]						Namoi Surface WRPA risk assessment (DPIE-Water)	
Flow component[1]	EWR reference	Maximum inter-flow period (note LTWP flow components do not provide definitions of percentiles or frequencies)	Ideal EWR			Flow component assessed (section 4.3)	How this risk assessment considers the EWR
			Timing	Duration	Frequency		
Small fresh	SF1	1 year	October to April (but can occur anytime)	10 days minimum	Annual	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	September to April	14 days minimum	5–10 years in 10 (75% LTA)	ARI 1.5 (BKF1.5)	Metrics used to calculate likelihood of ARI 1.5 flow component identifies changes to SF2.
Large fresh	LF1	2 years	July to September (but can occur anytime)	5 days minimum	5–10 years in 10 (75% LTA)	ARI 1.5 (BKF1.5)	Metrics used to calculate likelihood of ARI 1.5 flow component identifies changes to LF1.
Large Fresh	LF2	4 years	October to April	5 days minimum	3–5 in 10 (40 % LTA)	ARI 2.5 (BKF2.5)	Metrics used to calculate likelihood of ARI 2.5 flow component identifies changes to LF2.
Large Fresh	LF3	4 years	July - September (but can occur any time)	5 days minimum	Triggered when LF1 at Barwon @ Collarenebri is detected within 18 months of LF2 at Darling @ Wilcannia	ARI 2.5 (BKF2.5)	Metrics used to calculate likelihood of ARI 2.5 flow component identifies changes to LF3.
Anabranch connection	AC1	2 years	July - May (but can occur any time)	45 days (7 consecutive days); 3-8 months (habitat inundated)	7-10 years in 10 (85% LTA)	ARI 1.5 (BKF1.5)	Metrics used to calculate likelihood of ARI 1.5 flow component identifies changes to LF1.
Bankfull	BKF1	4 years	October to April	10 days minimum	5 years in 10 (85% LTA)	ARI 1.5 (BKF 1.5)	Metrics used to calculate likelihood of ARI 1.5 flow component identifies changes to OB1.

Long Term Water Plan (DPIE)[1]						Namoi Surface WRPA risk assessment (DPIE-Water)	
Flow component[1]	EWR reference	Maximum inter-flow period (note LTWP flow components do not provide definitions of percentiles or frequencies)	Ideal EWR			Flow component assessed (section 4.3)	How this risk assessment considers the EWR
			Timing	Duration	Frequency		
Bankfull	BKF2	5 years	September to February (but can occur anytime)	5 days minimum	3–5 years in 10 (40% LTA)	ARI 2.5 (OB2.5)	Metrics used to calculate likelihood of ARI 2.5 flow component identifies changes to OB2.
Over bank	OB1	4 years	October to April	10 days minimum,	3–5 in a 10 year period (1:2–4) (Ideally the year following OB2 to support woodland regeneration)	ARI 2.5 (OB2.5)	Metrics used to calculate likelihood of ARI 2.5 flow component identifies changes to OB3.
Over bank	OB2	5 years	September to February (but can occur anytime)	5 days minimum,	2–3 in a 10 year period (1:4–5)	ARI 5 (OB5)	Metrics used to calculate likelihood of ARI 5 flow component identifies changes to OB4.
Over bank	OB3	7 years	Any time	2–6 months	2-3 years in 10 (25% LTA)	ARI 5 (OB5)	Metrics used to calculate likelihood of ARI 5 flow component identifies changes to OB5.
Over bank	OB4	10 years	Any time	0-1 month (habitat inundated)	1 year in 10 (10% LTA)	ARI 5 (OB5)	Metrics used to calculate likelihood of ARI 5 flow component identifies changes to OB5.

[1] Table 6, DPIE 2019. Note that LTWP flow components do not provide definitions of percentiles or frequencies

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

Regulated river water source

The MDBA modelled a 2800 gigalitre (GL) reduction target across the Basin (MDBA 2012). Flow sequences were generated by the MDBA using DoI-Water IQQM models. This modelling scenario modelled a 2800 GL/year reduction in consumptive water use across the Basin; this included 450 GL/yr recovery from the northern Basin. While an eventual Basin Plan recovery target was 2750 GL, the 2800 GL scenario is considered relevant as the change in the Condamine-Balonne valley had little impact on the environmental flow indicators downstream (MDBA 2012).

The results published by the MDBA (2012) are the percentage change of the 2800 GL target scenario from a near-natural condition scenario; the latter is a modelled scenario approximating river flows without any dams, weirs or extraction (MDBA 2012).

Likelihood category definitions were defined based on the extent of deviation from the near-natural condition (Table 4-6). Flow deviation can be positive (e.g. 125%), which means more water is available for that particular flow component under the 2800 GL scenario than the near-natural condition; conversely a negative deviation (e.g. 75%) means less water for that particular flow component.

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

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

Six of the seven MDBA hydrologic indicator sites were used along with six DoI-Water hydrologic indicator sites to calculate likelihood results in the assessment of risk for the Namoi-Peel regulated river (Table 4-7). The additional DoI-Water sites were included as they provided a more detailed reach representation of hydrological change particularly with regard flow inputs from major unregulated tributaries (e.g. Mooki River).

Table 4-7 Likelihood results for the Namoi-Peel regulated river

Regulated river reach	Likelihood rating					
	Zero Flow Periods	Base-flow or Low Flows	Fresh Flows	High and Infrequent Flows		
				OB 1.5 ARI	OB 2.5 ARI	OB 5.0 ARI
Peel at downstream Chaffey Dam	L^-	L^0	L^-	L^0	L^0	L^0
Peel at Piallamore	H^-	H^+	M^-	M^-	L^-	L^-
Peel at Carroll Gape	H^+	L^-	L^-	L^-	L^-	L^-
Manilla at Brabi (Merriwee)	H^+	H^-	M^-	M^-	M^-	M^-
Namoi at Manilla Railway Bridge	H^-	L^-	M^+	L^-	L^-	L^-
Namoi at downstream Keepit Dam	H^-	H^-	H^+	H^-	M^-	M^-
Namoi at Boggabrii	H^-	L^+	H^+	L^-	L^-	L^-
Namoi at Mollee	H^-	M^+	H^+	M^-	L^-	L^-
Namoi at Bugilbone (Riverview)	H^+	H^-	L^-	L^-	L^-	L^-
Namoi at Goangra	H^-	H^-	M^-	L^-	L^-	L^-
Pian Creek at Rossmore	H^+	H^+	H^+	H^+	H^+	H^+
Gunidgera Creek at downstream Pian Crossing	H^+	M^+	M^-	H^-	M^-	M^-

Key: L = low; M = medium; H = high; N/A = no hydrological data available
+ increase from near-natural condition; – decrease from near natural condition; 0 no change from near-natural condition
Reference: MDBA 2012

Unregulated water sources

For the majority of unregulated water sources, single reach IQQM models were used to derive flow sequences. Extraction at full development of unregulated entitlement was assumed to simulate flow sequences to compare against the near-natural condition scenario (as defined above). Where appropriate, unregulated flow gauges were also used for single reach models in adjacent water sources if a suitable gauge was not available.

MDBA modelling was generally not used in the unregulated rivers as it is not representative of the hydrology at the water source scale; however, in some locations the hydrologic alteration metrics for the regulated river could be used. An example is the unregulated effluent rivers associated with high flows in the regulated river or unregulated reaches directly downstream of regulated rivers. Therefore, MDBA modelling was used for the Lower Baradine and Pian Creek unregulated river water sources (see Figure 4-3).

Similar to regulated systems, likelihood category definitions are defined based on the extent of deviation from the near-natural condition (Table 4-8).

Table 4-8 Likelihood metrics for risk of insufficient water available for the environment and risk to EWRs in unregulated water sources in the Namoi Surface 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 Namoi water source are Table 4-9.

Table 4-9 Likelihood results for unregulated water sources in the Namoi Surface 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
Upper Baradine Creek	L^{0}	H^{-}	L^{-}	L^{0}	L^{0}	L^{0}
Lower Baradine Creek (effluent)	M*	M*	M*	L^{-}	L^{-}	L^{-}
Bluevale (all creeks)	L^{0}	H^{-}	L^{-}	L^{0}	L^{0}	L^{0}
Bohena Creek	L^{-}	L^{-}	L^{0}	L^{0}	L^{0}	L^{0}
Brigalow Creek	L^{0}	L^{0}	L^{-}	L^{0}	L^{0}	L^{0}
Bundock Creek	H^{+}	H^{-}	M^{-}	L^{0}	L^{0}	L^{0}
Chaffey **	M^{+}	M^{-}	L^{-}	L^{0}	L^{0}	L^{0}
Cockburn River	H^{+}	H^{-}	L^{-}	L^{0}	L^{0}	L^{0}
Coghill Creek	M^{+}	H^{-}	L^{-}	L^{0}	L^{0}	L^{0}
Mid Coxs Creek	L^{+}	L^{-}	L^{-}	L^{-}	L^{0}	L^{0}
Lower Coxs Creek	L^{0}	L^{-}	H^{-}	L^{-}	L^{-}	L^{-}
Etoo Creek	L^{0}	L^{0}	L^{0}	L^{0}	L^{0}	L^{0}
Talluba Creek	L^{0}	L^{-}	L^{-}	L^{0}	L^{0}	L^{0}
Eulah Creek	L^{0}	M^{-}	L^{-}	L^{-}	L^{-}	L^{0}
Goonoo Goonoo Creek	H^{+}	H^{-}	L^{-}	L^{-}	L^{0}	L^{0}
Keepit	H^{+}	H^{-}	L^{-}	L^{0}	L^{0}	L^{0}
Lake Goran	M*	M*	M*	M*	M*	M*
Lower Namoi	M*	M*	M^{*}	L^{-}	L^{-}	L^{-}
Lower Peel Tributaries	H^{+}	H^{-}	L^{-}	L^{0}	L^{0}	L^{0}
Maules Creek	H^{+}	H^{-}	L^{-}	L^{0}	L^{0}	L^{0}
Mid Macdonald River	M^{+}	H^{-}	L^{-}	L^{0}	L^{0}	L^{0}
Mooki River	L^{+}	M^{-}	H^{-}	L^{-}	L^{-}	L^{-}
Phillips Creek	H^{+}	H^{-}	L^{-}	L^{0}	L^{0}	L^{0}
Warrah Creek	H^{+}	H^{-}	L^{0}	L^{0}	L^{0}	L^{0}
Pian Creek	H^{+}	H^{+}	H^{+}	H^{+}	M^{+}	L^{+}
Quirindi **	L^{+}	H^{+}	L^{-}	L^{-}	L^{-}	L^{-}
Rangira Creek	L^{0}	M^{-}	M^{-}	M^{-}	L^{-}	L^{-}
Split Rock	L^{0}	L^{0}	L^{0}	L^{0}	L^{0}	L^{0}

Unregulated water source	Likelihood rating					
	Zero Flow Periods	Base-flow or Low Flows	Fresh Flows	High and Infrequent Flows		
				OB 1.5 ARI	OB 2.5 ARI	OB 5.0 ARI
Spring Creek	L^0	L^-	L^-	L^0	L^0	L^0
Bobbiwaa Creek	L^0	L^-	L^-	L^0	L^0	L^0
Upper Macdonald River	L^0	L^-	L^0	L^0	L^0	L^0
Upper Manilla	L^0	M^-	L^-	L^0	L^0	L^0
Upper Namoi	H^+	H^-	L^-	L^0	L^0	L^0
Upper Namoi – Halls Creek	L^0	H^+	L^-	L^0	L^0	L^0
Upper Peel Tributaries	H^+	H^-	M^-	L^0	L^0	L^0
Werris Creek	L^+	H^-	L^-	L^0	L^0	L^0
Key: L = low; M = medium; H = high; $^+$ increase from near-natural condition; $^-$ decrease from near-natural condition; ^{0} no change from near-natural condition ** A Cease to Pump (CtP) was included in the modelling scenario. *Likelihood rating could not be modelled as there was no data available. Rating is based upon expert opinion of ecohydrologist						
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 Namoi and Peel valleys. These mechanisms are provided for under the NSW *Water Management Act 2000* and through specific rules within the regulated and unregulated water sharing plans.

The *Water Sharing Plan for the Upper Namoi and Lower Namoi Regulated River Water Sources 2016* has the following actions and mechanisms to provide water for the environment:

- Reserve all water above the long term average annual extraction limit (LTAAEL) for planned environmental water.
- Minimum end-of-system flows of 21ML/d in June, 24ML/d in July and 17ML/d in August (equivalent to 75% of the natural 95th percentile) are targeted at Walgett when Split Rock and Keepit dams hold more than 120 gigalitres.
- The volume of water that may be made available for extraction under supplementary water access licences during a supplementary flow event under a trial basis prior to 1 July 2019, should not exceed 50% of the supplementary event volume, and after 30 June 2019, should not exceed 10% of the flow event volume for events occurring between 1 July and 31 October, and 50% of the supplementary event volume for events between 1 November and 30 June. Outcomes of the trial will inform longer term supplementary water sharing rules that is consistent with the requirements of the Murray-Darling Basin Plan.
- The limits to supplementary water access licences in the lower Namoi also provide environmental benefits by protecting water level rises, maintaining inundation and flow variability.
- Supplementary access is only permitted under the following conditions: from unregulated flows; when flows are in excess of those required to provide specific replenishment flows; when flows are in excess of those needed to meet the requirements of the Barwon-Darling Flow Targets specified in Schedule 1 of the *Water Sharing Plan for Upper Namoi and Lower Namoi Regulated River Water Sources (2016)* ; and when flows are in excess of the thresholds specified in the WSP.

- Reserve water in Split Rock and Keepit dams for replenishment flows (total volume of 14,000 ML) in any water year to be provided to Pian Creek downstream of Dundee Weir if required.
- Allow for connectivity between the Namoi valley and 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.
- To provide for specified replenishment flows that refill pools or waterholes in effluent systems downstream of a water source and provide water for stock and domestic purposes.
- The Minister can specify rules relating to the rates of change to releases from water storages to minimise environmental and geomorphological impacts.
- Adjust available water determinations to ensure compliance with the long term average annual extraction limit.
- The plan also provides for licensed water to be committed for adaptive environmental water purposes.

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

- Reserve all water above the long term average annual extraction limit for planned environmental water.
- Cease to pump rules, commence to pump rules and flow rates/levels provide protection during dry times. Aquifer access licences that extract groundwater that is highly connected to the unregulated surface water may also have a cease to pump rule applied.
- Rules for granting and amending water supply works approvals are established for groundwater sources to provide protection for environmental assets. This provides protection for base flows and key assets such as groundwater-dependent ecosystems (GDEs). These rules stipulate buffer distances from which new bores can be placed from specific features such as GDEs, neighbouring bores and contaminated sites, as well as rules for existing bores.
- Restrictions on trade to protect areas of high ecological value.
- Restrictions on in-river and off-river pools when the volume of that water is less than the full capacity of the pool. Restrictions apply to Gulligal and Wee Waa lagoons when the water is less than 80% full capacity.

The 2800 GL scenario modelling (MDBA 2012) included a water recovery volume in the Namoi of 11.5 GL/yr (average long term use). This volume represents the volume of water already recovered in the Namoi.

The *Water Sharing Plan for the Peel Regulated River Water Source 2022* has the following actions and mechanisms to provide water for the environment:

- Reserve all water above the long term average annual extraction limit for planned environmental water.
- The Regulated Peel 5000 ML Environmental Contingency Allowance (ECA) designed to return natural flow variability to the upper reaches of the Peel River. Any potential extraction of an ECA once it is downstream of the designated watering reach will also be dependent on the AWD (if the AWD account is 100% in Chaffey, no extraction is permitted).
- Cease-to-pump rule from uncontrolled stimulus flow or ECA in the regulated Peel when flow <50ML/d at Piallamore gauge.
- Protect a minimum daily release of 3ML/d, minus any extraction, except when a release is greater than 3ML/d, is required for basic landholder rights and access licence extractions or the ECA.
- Planned environmental water of at least 50% of water above the threshold for access to uncontrolled flows originating from tributary inflows into the Peel regulated water source to mimic the natural shape of the hydrograph.

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

4.3.3. Risk outcomes

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

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

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

Regulated river water source

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

The flow regime of the Namoi and Peel rivers has been substantially altered by the construction of Split Rock, Keepit and Chaffey dams and the various weirs and regulators that regulate water along distributary channels such as the Gunidgera-Pian system and lower Baradine Creek.

The combination of very high and high values of consequence, along with significant flow alterations (likelihood), were a contributing factor in influencing the high and medium risk categories throughout the regulated river. In particular, the regulated Peel River at Piallamore had very high consequence coupled with high likelihood metrics for the zero and base flow components. The regulated section of Pian Creek had a high consequence coupled with high likelihood metrics for each of the flow components.

The influence of inflows from unregulated tributaries has in some cases resulted in a low risk rating for a range of higher flow components (e.g., Peel River @ Carroll Gap and Namoi @ Goangra). Regulation has also contributed to an increase in the average period between large flows (5 year ARI), and a reduction in the average volume of large flows. In some sections of the lower Namoi the frequency of freshes has increased, however the duration of an event has been greatly reduced, thus reducing the capacity of a fresh event to provide connectivity with in-channel features such as benches and bars.

Unregulated water sources

Combining the risk consequence and likelihood ratings (Table 4-3 and Table 4-9) for the Namoi unregulated water sources resulted in the overall risk levels to ecological assets and functions as shown in Table 4-12. Overall, risks to unregulated water sources were largely restricted to the zero flow and base flow components. Of the 31 water sources within the Namoi, eight demonstrated a medium risk to an increase in zero flow periods, while 6 water sources had a high risk. There were thirteen water sources (includes Halls Creek management zone in the Upper Namoi) with a medium risk to the reduction in base flows and 8 water sources returning a high risk.

Few water sources had medium and high risks associated with freshes and larger ARI flow components; these were located in the Bohena and Pian Creek water sources, whilst the Upper peel tributaries, Mooki River and lower Coxs Creek and Werris Creek water sources had a medium risk associated only with the freshes flow component.

Table 4-11 Risk of insufficient water for the environment and capacity to meet EWRs in the regulated Namoi & Peel Rivers [E(W)]

Regulated river reach	Consequence	Likelihood						Overall risk rating - E(W)					
		Zero Flow Periods	Base-flow or Low Flows	Fresh Flows	High and Infrequent Flows			Zero Flow Periods	Base-flow or Low Flows	Fresh Flows	High and Infrequent Flows		
					OB 1.5 ARI	OB 2.5 ARI	OB 5.0 ARI				OB 1.5 ARI	OB 2.5 ARI	OB 5.0 ARI
Peel at downstream Chaffey Dam	VH	L⁻	L⁰	L⁻	L⁰	L⁰	L⁰	M	M	M	M	M	M
Peel at Piallamore	VH	H⁻	H⁺	M⁻	M⁻	L⁻	L⁻	H	H	H	H	M	M
Peel at Carroll Gap	M	H⁺	L⁻	L⁻	L⁻	L⁻	L⁻	H	L	L	L	L	L
Manilla River at Brabi (Merriwee)	M	H⁺	H⁻	M⁻	M⁻	M⁻	M⁻	H	H	M	M	M	M
Namoi at Manilla Railway Bridge	M	H⁻	L⁻	M⁺	L⁻	L⁻	L⁻	H	L	M	L	L	L
Namoi at downstream Keepit Dam	M	H⁻	H⁻	H⁺	H⁻	M⁻	M⁻	H	H	H	H	M	M
Namoi at Boggabrii	VH	H⁻	L⁺	H⁺	L⁻	L⁻	L⁻	H	M	H	M	M	M
Namoi at Mollee	VH	H⁻	M⁺	H⁺	M⁻	L⁻	L⁻	H	H	H	H	M	M
Namoi at Bugilbone	VH	H⁺	H⁻	L⁻	L⁻	L⁻	L⁻	H	H	M	M	M	M
Namoi at Goangra	H	H⁻	H⁻	M⁻	L⁻	L⁻	L⁻	H	H	M	L	L	L
Pian Creek at Rossmore	H	H⁺	H⁺	H⁺	H⁺	H⁺	H⁺	H	H	H	H	H	H
Gunidgera Creek at downstream Pian Cutting	M	H⁺	M⁺	M⁻	H⁻	M⁻	M⁻	H	M	M	H	M	M

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

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

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

Unregulated water source	Consequence	Likelihood						Overall risk rating - E(W)					
		Zero Flow Periods	Base-flow or Low Flows	Fresh Flows	High and Infrequent Flows			Zero Flow Periods	Base-flow or Low Flows	Fresh Flows	High and Infrequent Flows		
					OB 1.5 ARI	OB 2.5 ARI	OB 5.0 ARI				OB 1.5 ARI	OB 2.5 ARI	OB 5.0 ARI
Upper Baradine Creek	L	L⁰	H⁻	L⁻	L⁰	L⁰	L⁰	L	M	L	L	L	L
Lower Baradine creek (effluent)	L	M*	M*	M*	L⁻	L⁻	L⁻	L*	L*	L*	L	L	L
Bluevale (all creeks)	L	L⁰	H⁻	L⁻	L⁰	L⁰	L⁰	L	M	L	L	L	L
Bohena Creek	VH	L⁻	L⁻	L⁰	L⁰	L⁰	L⁰	M	M	M	M	M	M
Brigalow Creek	L	L⁰	L⁰	L⁻	L⁰	L⁰	L⁰	L	L	L	L	L	L
Bundock Creek	L	H⁺	H⁻	M⁻	L⁰	L⁰	L⁰	M	M	L	L	L	L
Chaffey**	M	M⁺	M⁻	L⁻	L⁰	L⁰	L⁰	M	M	L	L	L	L
Cockburn River	M	H⁺	H⁻	L⁻	L⁰	L⁰	L⁰	H	H	L	L	L	L
Coghill Creek	L	M⁺	H⁻	L⁻	L⁰	L⁰	L⁰	L	M	L	L	L	L
Mid Coxs Creek	L	L⁺	L⁻	L⁻	L⁻	L⁰	L⁰	L	L	L	L	L	L
Lower Coxs Creek	L	L⁰	L⁻	H⁻	L⁻	L⁻	L⁻	L	L	M	L	L	L
Etoo Creek	H	L⁰	L⁰	L⁰	L⁰	L⁰	L⁰	L	L	L	L	L	L
Talluba Creek	H	L⁰	L⁻	L⁻	L⁰	L⁰	L⁰	L	L	L	L	L	L
Eulah Creek	L	L⁰	M⁻	L⁻	L⁻	L⁻	L⁰	L	L	L	L	L	L
Goonoo Goonoo Creek	L	H⁺	H⁻	L⁻	L⁻	L⁰	L⁰	M	M	L	L	L	L
Keepit	L	H⁺	H⁻	L⁻	L⁰	L⁰	L⁰	M	M	L	L	L	L
Lake Goran*	VL	M*	M*	M*	M*	M*	M*	L*	L*	L*	L*	L*	L*
Lower Namoi*	H	M*	M*	M*	L⁻	L⁻	L⁻	M*	M*	M*	L	L	L
Lower Peel Tributaries	M	H⁺	H⁻	L⁻	L⁰	L⁰	L⁰	H	H	L	L	L	L
Maules Creek	H	H⁺	H⁻	L⁻	L⁰	L⁰	L⁰	H	H	L	L	L	L
Mid Macdonald River	M	M⁺	H⁻	L⁻	L⁰	L⁰	L⁰	M	H	L	L	L	L

Unregulated water source	Consequence	Likelihood						Overall risk rating - E(W)					
		Zero Flow Periods	Base-flow or Low Flows	Fresh Flows	High and Infrequent Flows			Zero Flow Periods	Base-flow or Low Flows	Fresh Flows	High and Infrequent Flows		
					OB 1.5 ARI	OB 2.5 ARI	OB 5.0 ARI				OB 1.5 ARI	OB 2.5 ARI	OB 5.0 ARI
Mooki River	L	L^{+}	M^{-}	H^{-}	L^{-}	L^{-}	L^{-}	L	L	M	L	L	L
Phillips Creek no CtP	L	H^{+}	H^{-}	L^{-}	L^{0}	L^{0}	L^{0}	M	M	L	L	L	L
Warrah Creek no CtP	L	H^{+}	H^{-}	L^{0}	L^{0}	L^{0}	L^{0}	M	M	L	L	L	L
Pian Creek	H	H^{+}	H^{+}	H^{+}	H^{+}	M^{+}	L^{+}	H	H	H	H	M	L
Quirindi Creek**	L	L^{+}	H^{-}	L^{-}	L^{-}	L^{-}	L^{-}	L	M	L	L	L	L
Rangira Creek	L	L^{0}	M^{-}	M^{-}	M^{-}	L^{-}	L^{-}	L	L	L	L	L	L
Split Rock	L	L^{0}	L^{0}	L^{0}	L^{0}	L^{0}	L^{0}	L	L	L	L	L	L
Spring Creek	H	L^{0}	L^{-}	L^{-}	L^{0}	L^{0}	L^{0}	L	L	L	L	L	L
Bobbiwaa Creek	H	L^{0}	L^{-}	L^{-}	L^{0}	L^{0}	L^{0}	L	L	L	L	L	L
Upper Macdonald River	M	L^{0}	L^{-}	L^{0}	L^{0}	L^{0}	L^{0}	L	L	L	L	L	L
Upper Manilla	M	L^{0}	M^{-}	L^{-}	L^{0}	L^{0}	L^{0}	L	M	L	L	L	L
Upper Namoi	H	H^{+}	H^{-}	L^{-}	L^{0}	L^{0}	L^{0}	H	H	L	L	L	L
Upper Namoi – Halls Creek	L	L^{0}	H^{+}	L^{-}	L^{0}	L^{0}	L^{0}	L	M	L	L	L	L
Upper Peel Tributaries	M	H^{+}	H^{-}	M^{-}	L^{0}	L^{0}	L^{0}	H	H	M	L	L	L
Werris Creek	M	L^{+}	H^{-}	L^{-}	L^{0}	L^{0}	L^{0}	L	H	M	L	L	L

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

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

* Risk outcome based upon expert opinion of ecohydrologist due to lack of data

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

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

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

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

  There are currently no native title rights to water in NSW; however, these rights may be activated during the term of a WSP.

- Domestic and stock rights: owners or occupiers of land which has river, estuary or lake frontage can take water without a licence for domestic (household) purposes or to water stock.

- harvestable rights (dams): harvestable right water allows landholders in most rural areas to collect a proportion of BLR runoff on their property and store it in one or more farm dams up to a certain size.

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

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

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

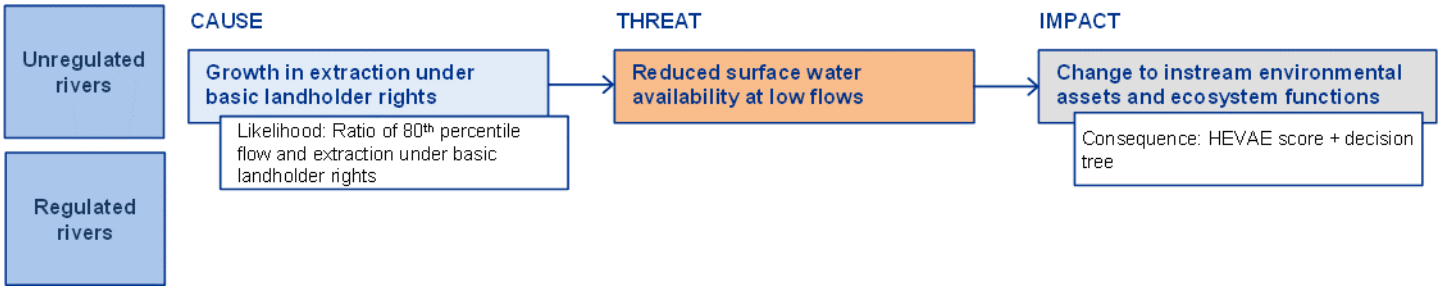


Figure 4-7 Impact pathway showing risk of growth in BLR reducing water available for the environment

4.4.1. Determining the likelihood rating

Regulated river water source

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

Unregulated river water source

The nature of BLR extraction cannot impact upon medium to high flows, and therefore has a 'nil' risk on these components of the flow regime. The assessment of risks of BLR extraction impacting on the environment are relevant to base flows, very-low flows and cease-to-flows (EWRs: BF1, VF1, CF1; Table 4-5). The likelihood of growth in BLR causing a reduction in water available for the environment 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 was high and the daily BLR take was low, then the likelihood is low. Alternatively, where the 80th percentile flow is low when compared to the daily extraction of BLR, the likelihood was high. If the 80th percentile flow was 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 used for the macro-planning process. The 80th percentile was selected as it is generally considered to represent the low flow portion.

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

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

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

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

Table 4-14 Likelihood results for unregulated water sources in the Namoi Surface WRPA

Unregulated water source	Likelihood rating
Baradine Creek	High
Bluevale	High
Bohena Creek	High
Brigalow Creek	High
Bundock Creek	High
Chaffey	Medium*
Cockburn River	Low
Coghill Creek	High
Coxs Creek	High
Etoo and Talluba creeks	High
Eulah Creek	Low
Gonnoo Goonoo Creek	Low
Keepit	High
Lake Goran	High
Lower Namoi River	Medium*
Lower Peel River tributaries	Low
Maules Creek	Low
Mid Macdonald River	Low
Mooki River	High
Phillips Creek	High
Pian Creek	Medium*
Quirindi Creek	Low
Rangira Creek	Low
Split Rock	High
Spring and Bobbiwaa creeks	High
Upper Macdonald River	Low
Upper Manilla River	Low
Upper Namoi River (includes Halls Creek)	Low
Upper Peel River tributaries	Low
Warrah Creek	High
Werris Creek	High
* = Risk could not be calculated because hydrological data was unavailable or unsuitable for this analysis. Rating is based upon expert opinion of ecohydrologist	

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 Namoi Surface WRPA is provided in Table 4-15.

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

		Likelihood (low flow against BLR extraction)		
		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, Table 4-3 and Table 4-14) for the Namoi regulated and unregulated water sources resulted in the overall risk levels to ecological assets and functions as shown in Table 4-16 and Table 4-17 respectively. Overall, 4 unregulated water sources had a high risk and 11 water sources had a medium risk. Eleven water sources had a low risk due to extraction by BLR.

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

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

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

Risk factor/source	Consequence	Likelihood	Overall risk rating - E(BLR)
Baradine Creek	Low	High	Medium
Bluevale	Low	High	Medium
Bohena Creek	Very High	High	High
Brigalow Creek	Low	High	Medium
Bundock Creek	Low	High	Medium
Chaffey*	Medium	Medium*	Medium*
Cockburn River	Medium	Low	Low
Coghill Creek	Low	High	Medium
Coxs Creek#	Low	High	Medium
Etoo and Talluba creeks	High	High	High
Eulah Creek	Low	Low	Low
Gonnoo Goonoo Creek	Low	Low	Low
Keepit	Low	High	Medium
Lake Goran	Very Low	High	Low
Lower Namoi*	High	Medium*	Medium*
Lower Peel River tributaries	Medium	Low	Low
Maules Creek	High	Low	Low
Mid Macdonald River	Medium	Low	Low
Mooki River	Low	High	Medium
Phillips Creek	Low	High	Medium
Pian Creek*	High	Medium*	Medium*
Quirindi Creek	Low	Low	Low
Rangira Creek	Low	Low	Low
Split Rock	Low	High	Medium
Spring and Bobbiwaa creeks#	High	High	High
Upper Macdonald River	Medium	Low	Low
Upper Manilla	Medium	Low	Low
Upper Namoi (includes Halls Creek)	High	Low	Low
Upper Peel River tributaries	Medium	Low	Low
Warrah Creek	Low	High	Medium
Werris Creek	Medium	High	High

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

* Risk could not be calculated because hydrological data was unavailable or unsuitable for this analysis. Rating is based upon expert opinion of ecohydrologist.

Coxs Creek water source made up mid and lower management zones. Spring and Bobbiwaa Creeks combined as sit in one water source

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 excluded precipitation and focused solely on changes to runoff and recharge. This is further expanded by NWC to imply that interception activities, for the purpose of water management, are human-induced activities that intercept significant volumes of water and therefore decrease the amount of water reaching surface water and groundwater bodies.

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

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

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

For the purpose of risk due to interception in this risk assessment, NSW utilised results published in the CSIRO Murray Darling Basin Sustainable Yields (MDBSY) project (CSIRO 2007; CSIRO 2008) 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 rightthat permits landholders to capture rainwater runoff on their property, within limits, without requiring a licence. The harvestable right is intended to satisfy essential farm needs such as stock and household water, but can be used for any purpose, including commercial irrigation.

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

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

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

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

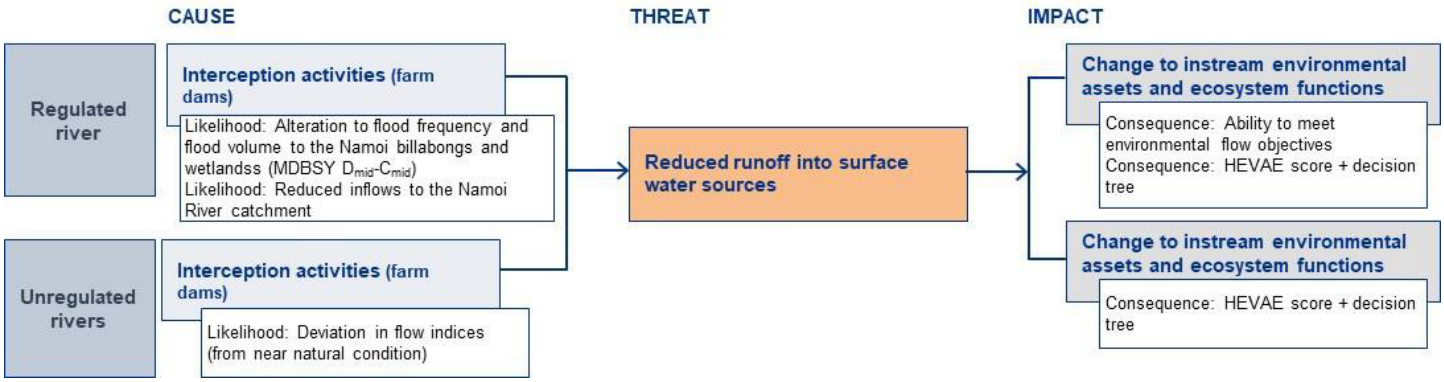


Figure 4-8 Impact pathway showing impact of interception activities on ecological functions and assets

4.5.1.1. Assigning a consequence score

Regulated river water source

Geoscience Australia mapped farm dams in the MDB in 2006 (Geosciences Australia 2007 in CSIRO 2007). Satellite imagery analysis was used to detect which of the farm dams mapped using the 2004/5 imagery also existed in 1994. This mapping was used to determine growth trends over a ten year period.

The CSIRO MDBSY project (CSIRO 2007; CSIRO 2008) considered the impacts of climate change, increases in farm dams and plantation forests and changes in groundwater use on water resources across the MDB. In the MDBSY project, farm dams refer only to dams with their own water supply catchment and do not include those dams that store diverted (and licensed) water, as these are already included within existing river system models. A 2030 farm dam development scenario was developed by considering current distribution and storage volume, and policy controls and trends in farm dam expansion. The NSW maximum harvestable right volume was also considered.

Environmental asset – Namoi River billabongs, wetlands and Lake Goran

In assigning a consequence level to farm dams, the approach undertaken by the NSW Office of Water (NoW 2010) for the *Assessment of risk to NSW Murray-Darling Basin shared water resources* was applied in this current risk assessment. The approach used in NSW Office of Water (2010) adopted indicators that were based on information readily available in the MDBSY reports (CSIRO 2007; CSIRO 2008).

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

The criteria used were:

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

The MDBSY project (CSIRO 2007) assessed a single environmental asset for the Namoi Surface WRPA; the Namoi River and connected billabongs and wetlands between Gunnedah and Walgett. A flow threshold of 4 GL/d at Duncan's Junction gauge 419094 was calculated to achieve environmental flow connectivity with the river and the associated billabongs and wetlands. Connectivity provides carbon exchange between benches, billabongs and wetlands and the main river channel, which is essential for maintaining a healthy aquatic community. Additionally, the minimum flow rule of the water sharing plan, the percentage of the pre-development scenario 95th percentile which passes Walgett, was assessed (Table 4-18).

The MDBSY project also included Lake Goran as an environmental asset in the Namoi Surface WRPA, but flow thresholds could not be modelled as it is not connected to a river (NSW Office of Water 2010). Where possible, critical thresholds were estimated by experienced experts.

Table 4-18 Environmental flow indicators developed in the MDBSY Project for the Duncan's Junction gauge 419094 (CSIRO 2007)

Namoi River indicators	Description
River-floodplain connecting flows	
Average period between events	Average period (months) between events 4 GL/day at Duncan's Junction gauge
Maximum period between events	Maximum period (months) between events 4 GL/day at Duncan's Junction gauge
Average flooding volume per event	Average volume (GL) per event above 4 GL/day at Duncan's Junction gauge
Average flooding volume per year	Average volume (GL) per year above 4 GL/day at Duncan's Junction gauge
Minimum flows	
Minimum flow rule indicator	Percentage of the pre-development 95th percentile daily flow passing Walgett

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

The consequence of meeting all objectives was then classified based on level of objectives being met for the Namoi River billabongs and wetlands, and Lake Goran environmental assets (NSW Office of Water 2010). The consequence score for this asset was assessed as minor and negligible respectively (Table 4-19).

Table 4-19 Consequence results for environmental assets (Namoi River billabongs and wetlands, and Lake Goran) in the Namoi regulated water source in the Namoi Surface WRPA

Environmental asset	Consequence
Namoi River billabongs and wetlands	Minor
Lake Goran	Negligible
Reference: NSW Office of Water 2010	

Regulated rivers

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

Unregulated water sources

The MDBSY project did not consider environmental assets in the Namoi unregulated water sources.

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

Table 4-20 Consequence results for the unregulated water sources in the Namoi Surface WRPA

Gauging Station	Consequence Rating (HEVAE consequence score)
Maules Creek at Avoca East 419051	Medium
Coxs Creek at Boggabri 419032	Low
Baradine Creek at Kienbri No.2 419025	Medium
Peel River at Carroll Gap 419006	Medium
Mooki River at Breeza 419027	Low
Coxs Creek at Tambar Springs 419033	Low
Mooki River at Caroona 419034	Low
Goonoo Goonoo Creek at Timbumburi 419035	Medium
Warrah Creek at Old Warrah 419076	Low
Macdonald River at Woolbrook 419010	Low
Swamp Oak Creek at Limbri 419054	Low
Cockburn River at Mulla Crossing 419016	Medium
Halls Creek at Ukolan 419029	Low
Ironbark Creek at Woodsreef 419112	Medium
Manilla River at Black Springs 419053	Low
Namoi River at North Cuerindi 419005	High
Reference: Healey et al. 2018.	

4.5.1.2. Determine the likelihood rating

Regulated river water source

Environmental asset – Namoi River billabongs, wetlands and Lake Goran

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

Table 4-21 MDBSY Project Scenarios

MDBSY Scenario		Description
P	Modelling period standardised to 1/7/1895-30/6/2006 and all water regulation and usage removed	Estimate of natural flow regime
A	Historical climate and current development	When compared to A0 risk from current groundwater usage determined
A0	Historical climate and 2004/5 water sharing arrangements and development levels	Baseline for comparison with projected climate change and development scenarios
B	Same as A0 with future climate based on recent decade's climate	
C_{dry}	2nd driest of 45 estimates of future climate, and 2004/5 levels of development	When compared to A0 climate change risk determined
C_{mid}	Median of 45 estimates of future climate, and 2004/5 levels of development	When compared to A0 climate change risk determined
C_{wet}	2nd wettest of 45 estimates of future climate, and 2004/5 levels of development	When compared to A0 climate change risk determined
D_{dry}	C_{dry} with projected 2030 levels of groundwater usage, and increases in farm dams and plantation forestry	When compared to C_{dry} development risk (farm dams and plantations) determined When compared to A0 cumulative risk (climate change + development) determined
D_{mid}	C_{mid} with projected 2030 levels of groundwater usage, and increases in farm dams and plantation forestry	When compared to C_{mid} development risk (farm dams and plantations) determined When compared to A0 cumulative risk (climate change + development) determined
D_{wet}	C_{wet} with projected 2030 levels of groundwater usage, and increases in farm dams and plantation forestry	When compared to C_{mid} development risk (farm dams and plantations) determined When compared to A0 cumulative risk (climate change + development) determined

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

The SKM report defined likelihood as the chance of a specified event occurring under different climate scenarios, with events being the specific flow indicators identified for a WRPA. Specified flow indicators for the Namoi Surface WRPA, based on flow thresholds at the Duncan's Junction gauge, are described in Table 4-17. Likelihoods are therefore the chance that a given flow indicator would be reported under a given climate scenario. For example, if there was a 1% chance that annual average volumes of 4 GL/day at Duncan's Junction would be recorded in a given climate scenario, the likelihood would be classed as "rare" (Table 4-22). Likelihoods for Lake Goran were estimated based on historical patterns of connecting flows, rainfall and drying, by experienced experts.

Table 4-22 Likelihood metrics selected for modelled scenarios in the Namoi Regulated River Water Source in the Namoi Surface WRPA (SKM 2008)

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

As stated, the likelihood rating is based on the differences between the MDBSY D_{mid} – C_{mid} scenario and relates to high flows (EWRs: e.g., LF2, AC1, OB1; Table 4-5). The likelihood rating for the Namoi River billabongs and wetlands, and Lake Goran, from interception by farm dams was assessed as possible (Table 4-23).

Table 4-23 Likelihood results for modelled scenarios in the Namoi River billabongs, wetlands and Lake Goran

Environmental asset	Likelihood
Namoi River billabongs and wetlands	Possible
Lake Goran	Possible
Reference: NoW 2010	

Regulated rivers

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

Estimates of inflow reductions to the entire Namoi River catchment due to farm dams were used as likelihood ratings for the Namoi regulated water source (NoW 2010). These estimates were calculated at the valley scale and were used as the likelihood metric for each regulated water source (Table 4-24). The effect of farm dams on runoff is greatest on low flows and high flows (SKM 2010). Low flows cannot be affected by farm dam interception because of regulation and management of BLR (Section 4.4.1). Similarly, medium flows (i.e. bankful flows) are not impacted by farm dams (SKM 2010). Therefore, the likelihood and associated risks of low and medium flows is 'low'. The following likelihood ratings are based on inflow reduction and impacts on high flows (EWRs: LF2, AC1, BKF, OB, Table 4-5).

Table 4-24 Likelihood metrics for Regulated river water sources

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

In 2008 the volume of in-stream farm dams in the Namoi valley was estimated at 145 GL (NoW 2010). The MDBSY Project estimated growth rate of 0.6% for the entire Basin was applied to the 2008 Namoi valley estimated volume, yielding a predicted increase of 19 GL. This equates to a reduction of inflows of 12 GL or 1.4% to streams as a result of farm dam interception, depending on the climatic scenario adopted (NoW 2010). Furthermore, river regulation and Planned Environmental Water rules within the Namoi Regulated WSP substantially reduce any effect of farm dams on river flows.

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

Table 4-25 Likelihood results for Namoi regulated river

Regulated river reach	Likelihood
All regulated water sources	Very Low

Unregulated water sources

The MDBSY Project did not assess unregulated rivers; therefore the SKM (2011) assessment of the hydrological impacts of farm dams in the MDB was used to describe likelihood. This study assessed the impact of existing farm dams at a detailed regional scale and fitted into the hydrology theme of the Sustainable Rivers Audit 2 (SRA2) (Davies et al. 2012). The assessment undertook a sensitivity analysis on the results of the SRA hydrology metrics to identify those most sensitive to farm dams. Sixteen flow stress indices were calculated across 162 study catchments using catchments and flow gauges that met a set of criteria, including a record of at least 15 years of gauged streamflow data. In this work, the reference regime assumed 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 CF1, VF1, BF: Table 4-5);
- The annual variation index (CV) (the ratio of coefficient of variation of flow in reference and current regime) was moderately affected by farm dams, possibly because flow variability was increased as low flows are made lower by farm dams (EWRs CF1, VF1, BF: Table 4-5);
- The high flow (HF) index was moderately affected, possibly because farm dams can delay the onset of high flows at the start of winter in highly developed catchments (EWRs LF1-3, AC1, BKF1-2: Table 4-5).

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

Likelihood category definitions were defined by the extent of deviation from the near-natural condition (Table 4-26). Likelihood results are provided in Table 4-27 for sixteen flow gauges used in the hydrological assessment (SKM 2010) that are within the Namoi Surface WRPA..

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

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

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

Gauging Station	Likelihood		
	CV	LF Q_{90}	HF Q_{10}
Maules Creek at Avoca East 419051	Low	Low	Low
Coxs Creek at Boggabri 419032	Low	Low	Low
Baradine Creek at Kienbri No.2 419025	Low	Low	Low
Peel River at Carroll Gap 419006	Low	Low	Low
Mooki River at Breeza 419027	Low	Low	Low
Coxs Creek at Tambar Springs 419033	Low	Medium	Low
Mooki River at Caroona 419034	Low	Low	Low
Goonoo Goonoo Creek at Timbumburi 419035	Low	Low	Low
Warrah Creek at Old Warrah 419076	Low	Low	Low
Macdonald River at Woolbrook 419010	Low	Low	Low
Swamp Oak Creek at Limbri 419054	Low	Low	Low
Cockburn River at Mulla Crossing 419016	Low	Low	Low
Halls Creek at Ukolan 419029	Low	Low	Low
Ironbark Creek at Woodsreef 419112	Low	Low	Low
Manilla River at Black Springs 419053	Low	Low	Low
Namoi River at North Cuerindi 419005	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 allows a Maximum harvestable right Dam Capacity on each property and is the total dam capacity allowed for your property and takes into account rainfall and variations in rainfall pattern. Also see Section 4.4.2.

4.5.1.4. Risk outcomes

Regulated river water source

Environmental asset – Namoi River billabongs, wetlands and Lake Goran

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

Table 4-28 Matrix used to determine risk outcomes of insufficient water available for the Namoi River billabongs, wetlands and lake Goran from potential interception activities in Namoi Regulated River Water Source, adapted from CSIRO (2008)

		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 rating (Table 4-19 and Table 4-23) resulted in a medium risk level to ecological assets and functions at the Namoi River billabongs and wetlands and a low risk level to Lake Goran (Table 4-29).

Table 4-29 Risks of insufficient water available for the environment in the Namoi River billabongs and wetlands and Lake Goran as a result of growth in interception by farm dams [E(I-FD)]

Environmental asset	Consequence	Likelihood	Risk level - E(I-FD)
Namoi River billabongs and wetlands	Minor	Possible	Medium
Lake Goran	Negligible	Possible	Low
Reference: NoW 2010			

Regulated rivers

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

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

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

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

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

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

Unregulated water sources

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

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

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

Combining the risk consequence and likelihood ratings (Table 4-20 and Table 4-27) results in a low risk level to ecological assets and functions in unregulated water sources in the Namoi Surface WRPA (Table 4-33) from interception due to farm dams.

Table 4-33 Risks of insufficient water available for the environment in unregulated water sources in the Namoi Surface 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}
Maules Creek at Avoca East 419051	Medium	Low	Low	Low	Low	Low	Low
Coxs Creek at Boggabri 419032	Low	Low	Low	Low	Low	Low	Low
Baradine Creek at Kienbri No.2 419025	Medium	Low	Low	Low	Low	Low	Low
Peel River at Carroll Gap 419006	Medium	Low	Low	Low	Low	Low	Low
Mooki River at Breeza 419027	Low	Low	Low	Low	Low	Low	Low
Coxs Creek at Tambar Springs 419033	Low	Low	Medium	Low	Low	Low	Low
Mooki River at Caroona 419034	Low	Low	Low	Low	Low	Low	Low
Goonoo Goonoo Creek at Timbumburi 419035	Medium	Low	Low	Low	Low	Low	Low
Warrah Creek at Old Warrah 419076	Low	Low	Low	Low	Low	Low	Low
Macdonald River at Woolbrook 419010	Low	Low	Low	Low	Low	Low	Low
Swamp Oak Creek at Limbri 419054	Low	Low	Low	Low	Low	Low	Low
Cockburn River at Mulla Crossing 419016	Medium	Low	Low	Low	Low	Low	Low
Halls Creek at Ukolan 419029	Low	Low	Low	Low	Low	Low	Low
Ironbark Creek at Woodsreef 419112	Medium	Low	Low	Low	Low	Low	Low
Manilla River at Black Springs 419053	Low	Low	Low	Low	Low	Low	Low
Namoi River at North Cuerindi 419005	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 increase evapotranspiration and therefore reduce water yield (SMEC 2010).

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

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

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

- Softwood forest plantations – stands of softwood trees for commercial production using various species of pines (including Radiata pine). Rotation lengths are typically 25-35 years; and

- Hardwood forestry plantations – stands of hardwood trees for commercial production typically on a short rotation (i.e. 10-15 years). The species used varies across the MDB.

As part of the MDBSY Project (CSIRO 2007), a 2030 scenario for commercial forestry plantations for the MDB was developed using regional projections from the Bureau of Rural Sciences which takes into account trends, policies and industry feedbacks. The increase in commercial forestry plantations is distributed to areas adjacent to existing plantations (which are not natural forest land use) to project likely growth.

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

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

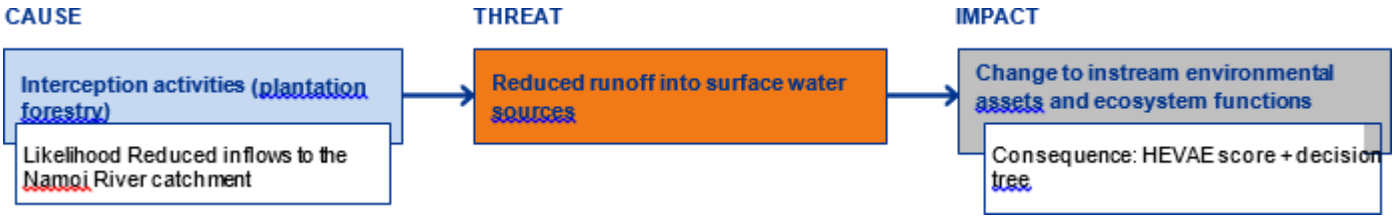


Figure 4-9 Impact pathway showing risk of growth in plantation forests reducing water available for the environment

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

4.5.2.1. Assigning a consequence score

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

4.5.2.2. Determining the likelihood rating

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

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

4.5.2.3. Existing water management actions & mechanisms

The NSW regulatory approach including compliance to plantation forests is described in DWE (2009). Compliance with the Plantations and Reafforestation Act (PRA) is considered to be high as it provides a basis for legal harvesting. The PRA and regulations exclude the consideration of water impacts from the assessment process. However scope for amending the PRA will be considered as part of NSW response to its interception obligations under the NWI and COAG Water Reform agenda.

4.5.2.4. Risk outcomes

The risk matrix used to determine the risk of commercial plantations impacting the availability of water to the environment in the regulated and unregulated water sources in the Namoi Surface WRPA is provided in Table 4-34.

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

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

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

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

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

4.5.3. Mining [E(I-M)]

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

Mining activities in the catchment currently comprise less than one percent of the total catchment area (Welsh et al, 2014), although the region contains substantial coal and coal seam gas-bearing geological sequences. Current coal and CSG development and exploration are primarily in the central and eastern parts of the subregion (Commonwealth of Australia, 2018). The Commonwealth Government Bioregional Assessment for the Namoi subregion identified six baseline coal mines in the region, including one underground mine (Northey et al. 2014). As of January 2018, no further coal mines have been approved, however there have been ten additional coal resource developments (e.g. three expansions to open-cut mines, three new open-cut mines). Of the ten developments, eight were incorporated into the hydrological modelling with the six baseline mines (Commonwealth of Australia, 2018a). Six coal seam gas (CSG) exploration and pilot testing developments had commenced in the Namoi catchment, however only the Narrabri Gas Project development is currently under consideration and is included in the modelling. Regional scale modelling undertaken by the Commonwealth Government estimated that changes in the streamflow of the Namoi River would be minimal (<1% reduction). Modelling of unregulated streams using three hydrological variables (zero-flow, high-flow and annual flow characteristics) within the unregulated water sources of Bluevale and Maules Creek did show increases in the number of zero-flow days (e.g. Back, Merrygowen, Driggle Draggle and Bollol creeks), it is predicted that any effects will be localised as these catchments are small (<100 km^2). However, it is suggested that "changes in streamflow may lead to potential impacts on water-dependent floodplain or lowland riverine landscapes" (Commonwealth of Australia, 2018b). Reductions in mean annual flows for the above-mentioned unregulated creeks is very likely to be 5% (or greater), however zero-flows decreases in annual flow are smaller than inter-annual variability under baseline conditions (Commonwealth of Australia, 2018a). Impacts on water quality could not be assessed and remains a knowledge gap; however regulatory requirements are in place in NSW

that aim to minimise potential salinity impacts due to coal resource development (Commonwealth of Australia, 2018b).

Modelling risk of hydrological change to ecosystems (using aquatic macroinvertebrates as an impact variable) within the lowland riverine landscape (Namoi River and major tributaries) predicted that the greatest decline in the average number of macroinvertebrate families due to additional coal resource development would occur in Maules Creek and Bollol Creek. With the greatest concentration of risk of ecological and hydrological change located along the Namoi River and its tributaries (Maules, Back and Bollol creeks) (Commonwealth of Australia, 2018b).

4.5.3.1. Existing water management actions & mechanisms

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

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

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

4.5.3.2. Risk outcomes

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

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

The Bioregional assessment for the Namoi subregion identified areas of mining and growth in mining as outlined in Section 4.5.3. Modelling by the Commonwealth Government estimated that changes in the streamflow of the Namoi River would be minimal, and any potential localised impacts to unregulated water sources being less than the inter-annual variability under baseline conditions (Section 4.5.3). Therefore, the risk of mining causing impacts to structural integrity is considered '**low**'.

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

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

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

4.5.4. Floodplain harvesting [E(I-FH)]

The unconstrained harvesting of water from floodplains reduces the amount of water reaching or returning to rivers. This decreases the amount of water available to meet downstream river health and wetland and floodplain needs. Floodplain harvesting can affect the connectivity between the local floodplain wetlands and the river through the loss of flow volume and the redirection of flood flows. The impact pathway for floodplain harvesting is shown in Figure 4-10

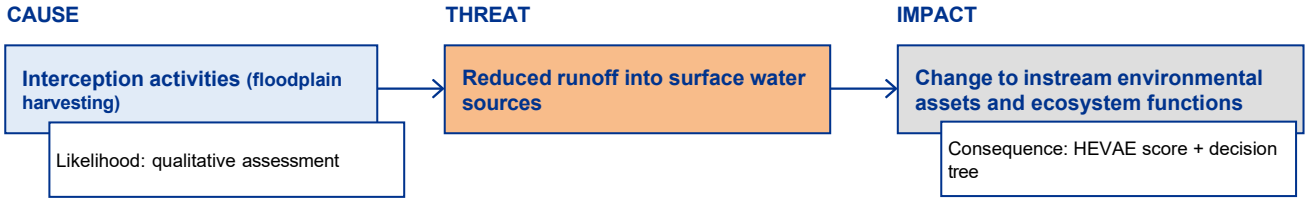


Figure 4-10 Impact pathway showing risk of growth in floodplain harvesting reducing water available for the environment

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 regulated and unregulated water sources were determined using the HEVAE instream values listed in Table 4-2 and Table 4-3. However, because the total volume floodplain harvesting (likelihood) was assessed at the WRP area scale (see below), and the consequence scores for the water sources ranged from 'low' to 'very high', a 'very high' consequence was used in determining the risk outcomes. In addition, there are significant Namoi River billabongs and wetlands 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 determined by a qualitative assessment based on expert opinion of department hydrology specialists. The likelihood metric was assessed as 'high'.

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 (Table 4-37).

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

Table 4-37 Risks of insufficient water available for the environment in regulated and unregulated water sources in the Namoi Surface WRPA as a result of floodplain harvesting activities [E(I-FH)]

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

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 Namoi Surface WRPA.

The likelihood is described as the change in frequency of flow indicators at the Duncan's Junction gauge 419094 on the Namoi River, while the consequence is assessed as the loss of annual water diversions for environmental entitlements.

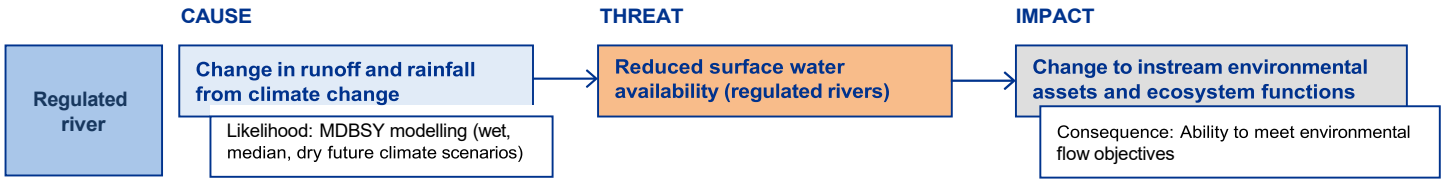


Figure 4-11 Impact pathway showing how change in climate can impact on the availability of water for the environment

4.6.1. Assigning a consequence rating

Regulated river water source

Environmental asset – Namoi River billabongs, wetlands and Lake Goran

The MDBSY Project (CSIRO 2007; CSIRO 2008) considered the impacts of climate change on water resources across the Murray-Darling Basin. A range of likely climate conditions at the year 2030 was assessed by analysing three global warming scenarios in 15 global climate models (GCM) to provide a spectrum of 45 climate variants. The method also took into account overall changes in total runoff for a dry, median and wet climate change scenarios (scenario type C), these were compared to scenario A0 (Table 4-21) (NoW 2010).

As noted in Section 4.5.1.1, the environmental assets assessed in the MDBSY Project were the Namoi River and associated billabongs and wetlands between Gunnedah and Walgett, and Lake Goran. The consequence scores for these assets are provided below (Table 4-38). Consequence levels were defined by the magnitude of change and were set by experienced consultants at levels considered to be 'reasonable'.

Table 4-38 Consequence results for environmental assets receiving flows from the Namoi regulated river in the Namoi Surface WRPA

Environmental asset	Consequence		
	Dry climate change scenario	Median climate change scenario	Wet climate change scenario
Namoi River billabongs and wetlands	Moderate	Minor	Negligible
Lake Goran	Moderate	Moderate	Negligible
Reference: NoW 2010			

Regulated rivers

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

Unregulated water sources

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

4.6.2. Determine the likelihood rating

Regulated river water source

Environmental asset – Namoi River billabongs, wetlands and Lake Goran

As discussed earlier in Section 4.5.1.2 customised hydrological indicators were developed in the MDBSY Project for the Namoi River and associated billabongs and wetlands between Gunnedah and Walgett (CSIRO 2007). Comparing MDBSY Project C scenarios to the 2004/05 (A0 scenario) determines likelihood of climate change impacting water available for the environment under the three different climate projections (wet, dry, median) (Table 4-39). Likelihood rankings are provided in Table 4-40 . 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 4-37), which defined likelihood differently to how it has been defined in the majority of this risk assessment (Section 2.2). This likelihood assessment applies to high flows (EWRs: LF2-3, AC1, OB1-4; Table 4-5).

Note that hydrological indicators were not modelled for the Lake Goran environmental asset because it is not connected to a river. Appropriate indicators were developed in consultation with experienced experts (CSIRO 2007).

Table 4-39 Data used to assess risk likelihood to the Namoi River billabongs and wetlands from change in climate (CSIRO 2007)

Environmental flow indicator	A0	C_{dry} (% change from A0)	C_{mid} (% change from A0)	C_{wet} (% change from A0)
Average period between flows exceeding 4 GL/day at Duncan's Junction gauge	3.8 yrs	36%	6%	-21%
Maximum period (years) between exceeding 4 GL/day at Duncan's Junction gauge	37.2 yrs	5%	0	-31%
Average annual volume above 4 GL/day at Duncan's Junction gauge	140 GL	-25%	-3%	31%
Average event volume above 4 GL/day at Duncan's Junction gauge	395 GL	-46%	-8%	63%
Reference: CSIRO 2007				
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 4-40 Likelihood results for environmental assets receiving flows from the Namoi regulated river in the Namoi Surface WRPA

Environmental asset	Likelihood		
	Dry climate change scenario	Median climate change scenario	Wet climate change scenario
Namoi River billabongs and wetlands	Unlikely	Possible	Possible
Lake Goran	Unlikely	Possible	Possible
Reference: NoW 2010			

Regulated rivers

In the Namoi River valley, there was no direct assessment of climate change impacts on surface water flows in the regulated river other than for the Namoi billabongs and wetlands (NoW 2010). Therefore, the three climate change scenarios (dry, median, wet) were used to define likelihood ratings (Table 4-41 and Table 4-42). The C_{Dry} scenario was used to define the likelihood rating and a 'medium' likelihood category was assigned to all water sources. There is no detailed information on the effects of climate change on different parts of the flow regime. Therefore, the 'medium' likelihood and associated risks equally assess all components of the flow regime (all EWRs; Table 4-5).

Table 4-41 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	-31
C_{mid}	-2	-6
C_{wet}	+13	+39

According to the MDBSY Project (CSIRO 2007), wet scenario climate change is predicted to increase mean annual runoff by 39%, but there is a predicted 31% and 6 % reduction in inflows for the dry and median climate change scenarios respectively.

Table 4-42 Likelihood metrics for climate change impacts on surface water

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

Unregulated water sources

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

4.6.3. Existing water management actions & mechanisms

The WSPs for NSW MDB catchments were developed in consultation with community stakeholders and are applicable for 10 year periods. The WSPs are designed to share the available water on both a daily and long term basis for the full range of known (historical) climate variability. There is provision in the WM Act 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 WM Act provision has been invoked in NSW MDB valleys where actual climatic conditions have occurred outside the range of prior climate variability.

4.6.4. Risk outcomes

Regulated river water source

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

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

Environmental asset – Namoi River billabongs, wetlands and Lake Goran

As discussed in Section 4.5.1.2, the risk matrix used to determine the risk rating of flow alteration from change in climate impacting the availability of water for the environment in the Namoi River billabongs, wetlands and lake Goran 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 4-28.

The risk matrix used to determine the risk rating of flow alteration from change in climate impacting the availability of water for the Namoi environmental assets is provided in Table 4-43.

Table 4-43 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 4-38 and Table 4-40) results in the overall risk levels to the ecological assets and functions at the Namoi River billabongs and wetlands and Lake Goran is shown in Table 4-44. The risk assessment determined a low risk to both these assets from the wet scenario. Under a medium and dry climate change scenario, the Namoi River billabongs and Lake Goran are at medium risk of a reduction in inflows.

Table 4-44 Risks of insufficient water available for the Namoi environmental assets as a result of change in climate [E(CC)]

Environmental asset	Climate scenario	Consequence	Likelihood	Risk level - E(CC)
Namoi River billabongs and wetlands	Wet climate change scenario	Negligible	Possible	Low
Namoi River billabongs and wetlands	Median climate change scenario	Minor	Possible	Medium
Namoi River billabongs and wetlands	Dry climate change scenario	Moderate	Unlikely	Medium
Lake Goran	Wet climate change scenario	Negligible	Possible	Low
Lake Goran	Median climate change scenario	Moderate	Possible	Medium
Lake Goran	Dry climate change scenario	Moderate	Unlikely	Medium

Regulated rivers

The risk matrix used to determine the risk rating of flow alteration from change in climate impacting the availability of water for the environment is provided in Table 4-45.

Table 4-45 Risk matrix to determine risk outcomes of insufficient water for the environment from potential change in climate in regulated and unregulated rivers

		Likelihood (of reduction in runoff)		
		Low	Medium	High
Consequence (HEVAE 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 4-2) and 'medium' likelihood ratings resulted in 'High' and 'Medium" risk levels to all regulated river reaches (Table 4-46).

Table 4-46 Risks of insufficient water available for the environment in regulated river sections in the Namoi Surface WRPA as a result of climate change [E(CC)]

Regulated river reach	Consequence	Likelihood	Overall risk rating - E(CC)
Peel at downstream Chaffey Dam	VH	M	H
Peel at Piallamore	VH	M	H
Peel at Carroll Gap	M	M	M
Manilla at Brabi (Merriwee)	M	M	M
Namoi at Manilla railway bridge	M	M	M
Namoi at downstream Keepit Dam	M	M	M
Namoi at Boggabri	VH	M	H
Namoi at Mollee	VH	M	H
Namoi at Bugilbone	VH	M	H
Namoi at Goangra	H	M	M
Pian Creek at Rossmore	H	M	M
Gunidgera Creek at downstream Pian Cutting	M	M	M

Unregulated water sources

The risk matrix used to determine the risk rating of flow alteration from change in climate impacting the availability of water for the environment is provided in Table 4-45.

Combining the unregulated risk consequence (Table 4-3) and 'medium' likelihood ratings resulted in the majority of water sources having either a '**Low'** or **'Medium'** risk rating, with Bohena Creek having a '**High**' risk (Table 4-47).

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

Unregulated water source	Consequence	Likelihood	Overall risk rating – E(CC)
Upper Baradine Creek & Lower Baradine Creek (effluent)	L	M	L
Bluevale (all creeks)	L	M	L
Bohena Creek	VH	M	H
Brigalow Creek	L	M	L
Bundock Creek	L	M	L
Chaffey	M	M	M
Cockburn River	M	M	M

Unregulated water source	Consequence	Likelihood	Overall risk rating – E(CC)
Coghill Creek	L	M	L
Mid Coxs Creek	L	M	L
Lower Coxs Creek	L	M	L
Etoo Creek	H	M	M
Talluba Creek	H	M	M
Eulah Creek	L	M	L
Goonoo Goonoo Creek	L	M	L
Keepit	L	M	L
Lake Goran	VL	M	L
Lower Namoi	H	M	M
Lower Peel River Tributaries	M	M	M
Maules Creek	H	M	M
Mid Macdonald River	M	M	M
Mooki River	L	M	L
Phillips Creek	L	M	L
Warrah Creek	L	M	L
Pian Creek	H	M	M
Quirindi Creek	L	M	L
Rangira Creek	L	M	L
Split Rock	L	M	L
Spring Creek	H	M	M
Bobbiwaa Creek	H	M	M
Upper Macdonald River	M	M	M
Upper Manilla	M	M	M
Upper Namoi (includes Halls Creek)	H	M	M
Upper Peel tributaries	M	M	M
Werris Creek	M	M	M

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

The main strategies to mitigate the likelihood of impact from freshwater pest species risk fall outside the scope of the water resource plan, the water quality management plan and this risk assessment. In NSW, the *Biosecurity Act 2015* and the *Biodiversity Conservation Act 2016* provide a number of controls to manage aquatic pests. In addition, the environmental flows rules of the Upper and Lower Namoi Regulated WSP, the Peel Regulated WSP and the Namoi and Peel Unregulated WSP described in section 4.2 of the Namoi Surface Water Resource Plan will also assist in mitigating the impacts of pest species.The following is a qualitative assessment based on department ecohydrology specialist expert opinion. There are potential risks to environmental assets and functions in the Namoi 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 Namoi Surface WRP area was ‘medium’, and the consequence of the impact from pest species was ‘medium’. Using the risk matrix Table 4-10, the overall risk rating was ‘**medium**’ (Table 5-1).

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

	Consequence	Likelihood	Overall risk rating
Namoi 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 Namoi Surface 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 Namoi catchment are mostly caused by a combination of alteration to natural flow regimes and land use change (DPI Water 2018). 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

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

There are a suite of rules within the WSPs that assist in protecting and maintaining water quality within the valley. Under the current water sharing plan there are restrictions on drawdowns on in-river and off-river pools when the volume of water is less than full capacity of the pool. Cease to pump rules and commence to pump rules also reduce the pressure on pools by extraction of water. During these low flow periods and as pools

contract, water quality can deteriorate, algal blooms occur, dissolved oxygen levels decline. Restricting the extraction pressure on these systems helps protect water quality.

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

- Reserve all water above the long term average annual extraction limit for planned environmental water. This helps maintain base flows which are important to slow the decline in water quality by preventing pools from stratifying and stagnating.
- Protect minimum end-of-system daily winter flows in the Namoi River at Walgett, except when water stored in Keepit and Split Rock dams is less than 120,000 Ml. The protection of base flows is important for maintaining habitat refugia and water quality.
- Protect supplementary water events from extraction by users. This protects important rises in the water level and natural flow variability, preserves a significant portion of natural tributary flows for river health and maintains wetland and floodplain inundation.
- Reserve ECA water in Chaffey Dam to the limit of 5,000 ML to strategically use for environmental purposes including water quality outcomes.
- Allow for connectivity between the Namoi valley and the Barwon-Darling River to suppress algal blooms in the Barwon-Darling River watercourse.
- Provide for specified replenishment flows that refill pools or waterholes in effluent systems downstream of a water source and provide water for stock and domestic purposes.
- The plans also provide for licensed water to be committed for adaptive environmental water purposes.

Further details can be found in the WQM Plan, Salinity Technical Report and the Surface Water Quality Technical Report.

6.3. Risks due to water temperature outside natural ranges

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

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

This risk assessment focuses on both cold water pollution (CWP) (see Preece, 2004 *Cold water pollution below dams in NSW*), and warm water pollution (WWP). Keepit Dam is the only large storage located in the Namoi Surface WRPA; the risk from CWP and WWP is relevant to the regulated river only.

Water temperature influences many biological and ecosystem processes. The release of cold water from Keepit Dam in the regulated Namoi River can impact on ecosystem function and ecological condition by causing temperature depression in the mid-Namoi regulated river. Releases from Chaffey and Split Rock Dams during summer can result in localised cold water impacts in the Peel and Manilla Rivers downstream of the dams. Warmer temperatures can increase growth rates and metabolism of in-stream plants, animals and algae. Temperature influences spawning, breeding and migration patterns of many aquatic animals.

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



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



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

6.3.1. Assigning a consequence rating

Temperature has a wide range of influences on biological processes. The release of cold water can interrupt important biological cues such as fish spawning and other fauna, and can reduce the growth rate of fish, and increase mortality (Lugg & Copeland 2014). CWP also has the potential to impact on the recovery potential of fish in the Namoi catchment (DPI Water 2017).

Thermal pollution from Keepit Dam results in water temperatures below natural during the summer months and above natural during the winter months. Releases from Keepit Dam are typically drawn from the hypolimnion via fixed-level intakes. Based on extrapolation from other storages, NSW Fisheries (Lugg 1999) estimated that severe cold water pollution (defined as more than 5°C peak depression) persists for 300 km downstream of the dam. This estimate was refined to 100 km by Preece and Jones (2002).

Due to the low release volumes and multi-level offtakes, the impacts from Chaffey and Split Rock Dams are localised in nature.

The impact of CWP and WWP on water-dependent ecosystems is only applicable to the regulated Peel, Manilla and Namoi Rivers.

The same consequence scores as determined in Section 4.2.3 (regulated only) are used to assess risks due to water temperatures falling outside natural ranges due to releases from major storages. As HEVAE scoring for the majority of the length of the Namoi regulated river to Gunnedah is medium, it has been assessed as one reach only. Similarly the regulated Peel River has been assessed as very high and Manilla River as medium. These consequence scores were used to assess risks due to water temperatures falling outside natural ranges due to releases from major storages.

6.3.2. Determine 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 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		

Regulated discharge from Keepit Dam is made via two fixed level pipes, with the intake centreline of both approximately 24 m below full storage level. The largest discharges take place between September and January with a median January discharge of approximately 2000 ML/day. Keepit Dam has a relatively shallow mean depth (<10 m), and a large surface area. Despite releasing water from the bottom of the storage, the shallow water depth means that mixing of the surface and bottom waters is likely to occur. In a typical irrigation season, most of the cold hypolimnion can be removed through releases, effectively destratifying the water column earlier in the year (Boys et al. 2009). In addition, during high volume releases, water is drawn into the outlet from a range of depths rather than purely from the bottom of the storage. In this case, warmer water from closer to the surface would be drawn into the outlet, helping to raise the temperature of the water being released. An analysis of Keepit Dam's impact suggests the natural temperature regime of the Namoi River recovers within 100 km, by Gunnedah (Preece and Jones 2002).

Cold water pollution impacts below Chaffey and Split Rock Dams are relatively small and localised to the area immediately downstream of the dams, due to the typically small discharges (approximately 120 and 75 ML/day respectively) and shallow withdrawal depth via the multi-level intakes.

Chaffey Dam has a long history of blue-green algal blooms. As Tamworth's town water supply is taken from the Peel River approximately 46 km downstream of Chaffey Dam, the trash racks are often lowered to mitigate against the release of algal rich water into the Peel River, resulting in the release of unseasonally cold water. The cold water impacts appear to be largely limited to immediately downstream of Chaffey Dam, with the water returning to a more natural temperature before Tamworth. Future assessments will identify if the completion of upgrade works to increase the storage capacity of Chaffey Dam influences cold water pollution impacts downstream.

There is some thermal depression evident immediately downstream of Split Rock Dam during summer. However, due to the low volumes of water being released, this does not persist down the Manilla River to the junction with the Namoi River at Manilla, restricting the impacts to immediately downstream of the dam. Similar to Chaffey Dam, the trash racks can be lowered to avoid releasing algal rich water downstream, resulting in the release of cold water. During bulk water transfers from Split Rock to Keepit, the release of larger volumes (up to 4000 ML/day) mean the cold water impacts can extend 35 km down to Manilla and possibly to the upper reaches of the impoundment of Keepit Dam.

Based on the above criteria, Keepit Dam has a high likelihood for causing CWP, while Chaffey Dam has a low likelihood and Split Rock Dam has a low likelihood.

The likelihood for warm water pollution was determined by assessing the maximum difference between mean monthly water temperatures downstream of Split Rock and Keepit dams during winter (July) to the 80th percentile mean monthly temperature of reference sites (Table 6-2). There was insufficient data to assess WWP from Chaffey Dam (Peel River), data from Spilt Rock Dam (gauge 419043) was used as a surrogate. The monthly 80th percentiles were calculated using the combined hourly water temperature data from three upstream unregulated sites (*Water quality technical report for the Namoi Surface water resource plan area (SW14)*). The monthly median temperature downstream of Keepit Dam was also calculated using the hourly

water temperature data. The gauging station downstream of Keepit Dam is located 1 km below the outlet of the dam (419007 Namoi River downstream of Keepit Dam).

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

Likelihood metric	Metric category	Metric category definition
Potential severity of downstream WWP	Low	< 2 °C maximum difference of mean monthly temperatures in winter (July) between Namoi and Peel rivers below Keepit and Chaffey dDams and reference sites respectively
	Medium	2 °C – 4 °C maximum difference of mean monthly temperatures in winter (July) between Namoi and Peel rivers below Keepit and Chaffey dams and reference sites respectively
	High	≥ 6 °C maximum difference of mean monthly temperatures in winter (July) between Namoi and Peel rivers below Keepit and Chaffey dams and reference sites respectively

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

6.3.3. Risk outcomes

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

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

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

Combining the consequence and likelihood ratings (Table 4-2 and Table 6-3) for the Namoi regulated river CWP is a high risk level to ecological assets and functions downstream of Keepit Dam to Gunnedah, as shown in Table 6-4. The Peel regulated river has a medium risk from CWP immediately downstream of Chaffey Dam and the Manilla River has a low risk from CWP immediately downstream of Split Rock Dam. WWP presents a medium risk level to the Namoi River and Peel River downstream of Keepit and Chaffey dams respectively (Table 6-4). The Manilla River has a low risk from WWP immediately downstream of Split Rock Dam. The WWP risk level only applies to the Namoi and Peel rivers immediately below the respective dams, as the low likelihood rating would diminish even further downstream.

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

Regulated river reach	Consequence rating	Likelihood rating	Risk rating - E(WQ-CWP) / E(WQ-WWP)
(WQ-CWP) Peel River immediately downstream of Chaffey Dam	Very high	Low	Medium
E(WQ-CWP) Manilla River immediately downstream of Split Rock Dam	Medium	Low	Low
E(WQ-CWP) Namoi River 100 km downstream of Keepit Dam	Medium	High	High
E(WQ-WWP) Peel River immediately downstream of Chaffey Dam	Very high	Low	Medium
E(WQ-WWP) Manilla River immediately downstream of Split Rock Dam	Medium	Low	Low
E(WQ-WWP) Namoi River immediately downstream of Keepit Dam	Medium	Low	Low

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

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

Nutrient concentrations are influenced by land use, rainfall and discharge, as well as the combination of naturally occurring high concentrations of nitrogen and phosphorus in soils and erosion. Soil erosion can be exacerbated by clearing, degradation of stream banks and other land use issues. Turbidity and suspended sediment are also influenced by high flows, particularly in those reaches where bank and riparian condition is poor (DPI Water 2017).

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.

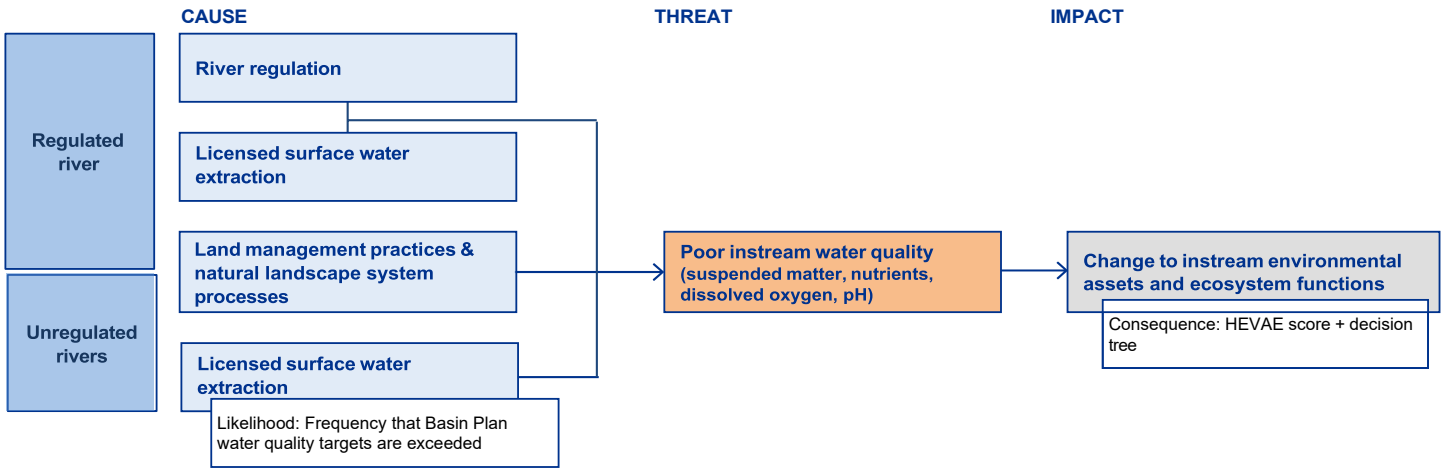


Figure 6-3 Impact pathway showing impact of water quality degradation (increased turbidity, TP, TN, pH & DO) on ecological functions and assets

6.4.1. Assigning a consequence rating

There are 11 DoI-Water water quality monitoring sites in the Namoi Surface WRPA across the unregulated and regulated systems. For each monitoring station, a reach was defined as 25 km upstream and downstream (Figure 6-4) as a conservative estimate of the spatial representativeness of water quality data and movement of instream biota within the river channel.

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

Regulated river water source

Table 6-5 Consequence results for reaches of the Namoi regulated river in the Namoi Surface WRPA

River reach	Consequence Rating
419024 Peel River at Paradise Weir	Very high
419006 Peel River at Carrol Gap	Medium
419022 Namoi River at Manilla Railway Bridge	Medium
419001 Namoi River at Gunnedah	Medium
419003 Narrabri Creek at Narrabri	Very high
419021 Namoi River at Bugilbone	High
419026 Namoi River at Goangra	High

Unregulated water sources

Table 6-6 Consequence ratings in unregulated reaches in the Namoi Surface WRPA

River reach	Consequence Rating
419010 Macdonald River at Woolbrook	Medium
419016 Cockburn River at Mulla Crossing	Medium
419027 Mooki River at Breeza	Medium
419032 Coxs Creek at Boggabri	Low

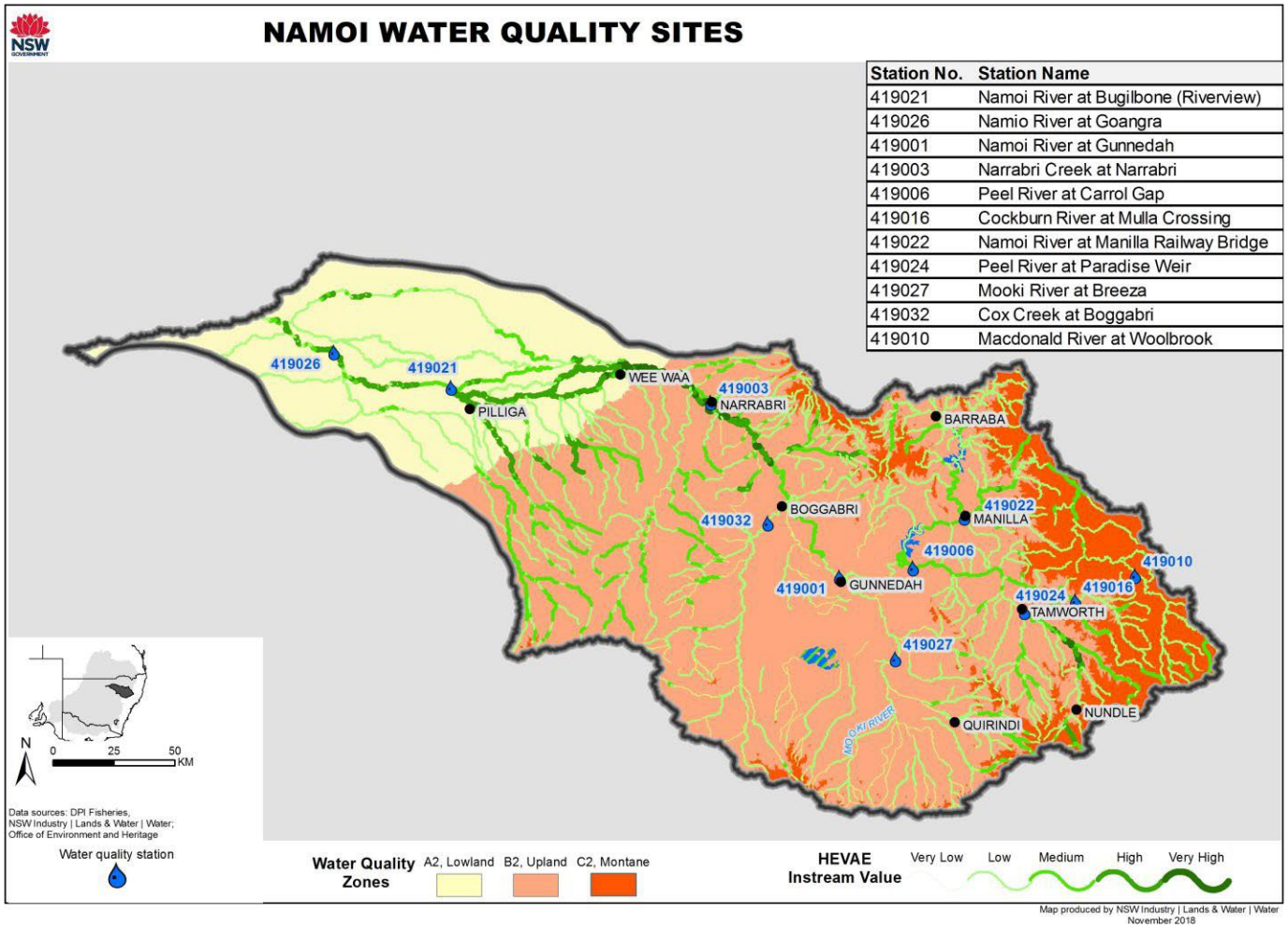


Figure 6-4 Water quality monitoring sites used to determine water quality target application zones for water-dependent ecosystems (Schedule 11 of the Basin Plan)

6.4.2. Determine the likelihood rating

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

Schedule 11 water quality target values used for this risk assessment were for 'other water-dependent ecosystems' in the Montane, Upland and Lowland zones (C2, B2 and A2 zones respectively) (Figure 6-4 and Table 6-7).

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

Ecosystem type	Target application zone	Turbidity (NTU) (annual median)	Total Phosphorus (µg/L) (annual median)	Total Nitrogen (µg/L) (annual median)	Dissolved oxygen (mg/L; or saturation (%)) (annual median within the range)	pH (annual median within the range)
Streams, rivers, lakes & wetlands	C2 (includes Namoi WRPA Montane zone)	25	20	250	90-110%	6.5-7.5
	B2 (includes Namoi WRPA Upland zone)	30	80	750	60-110%	7.5-8.5
	A2 (includes Namoi WRPA Lowland zone)	200	200	1000	>5.0 mg/L or 65-110%	7.0-8.3

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

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

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

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

Regulated river water source

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

Regulated river reach	Turbidity	Total phosphorus	Total nitrogen	pH	DO
419024 Peel River at Paradise Weir	Low	Low	Low	Low	Medium
419006 Peel River at Carrol Gap	Medium	Low	Medium	Low	Low
419022 Namoi River at Manilla Railway Bridge	Low	Low	Low	Medium	Low

419001 Namoi River at Gunnedah	Low	Medium	Medium	Low	Low
419003 Narrabri Creek at Narrabri	Medium	High	Low	Low	Low
419021 Namoi River at Bugilbone	Low	Low	Low	Low	Low
419026 Namoi River at Goangra	Low	Low	Low	Low	Low

Unregulated water sources

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

Unregulated river reach	Turbidity	Total phosphorus	Total nitrogen	pH	DO
419010 Macdonald River at Woolbrook	Low	High	High	Medium	High
419016 Cockburn River at Mulla Crossing	Low	Low	Low	Low	Medium
419027 Mooki River at Breeza	Medium	High	Low	Medium	Low
419032 Coxs Creek at Boggabri	High	High	High	Low	Low

6.4.3. Risk outcomes

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

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

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

Combining the risk consequence (Table 6-5 and Table 6-6) and likelihood ratings (Table 6-9 and 6-10) for the Namoi Surface WRPA resulted in the overall risk levels to ecological assets and functions as shown in Table 6-12 and Table 6-13 for regulated and unregulated water sources respectively.

Within the regulated reaches turbidity and total phosphorus levels in Narrabri Creek at Narrabri pose a high risk to the health of water dependent ecosystems due to the very high consequence score. Similarly, the dissolved oxygen levels posed a high risk for the Peel River at Paradise Weir. Low concentrations of dissolved oxygen and elevated levels of nutrients are the highest risks to water-dependent ecosystems. There are also high risks from total phosphorus, total nitrogen and dissolved oxygen levels to water-dependent ecosystems in the unregulated Macdonald River water source. The water quality for this monitoring site is driven by the basalt

derived soils along the Great Dividing Range, providing a source of phosphorus, nitrogen, and an alkaline pH. The Mooki River also recorded a high risk for total phosphorus.

Regulated river water source

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

Regulated river reach	Consequence	Turbidity		Total phosphorus		Total nitrogen		pH		DO	
		Likelihood	Overall risk rating	Likelihood	Overall risk rating	Likelihood	Overall risk rating	Likelihood	Overall risk rating	Likelihood	Overall risk rating
419024 Peel River at Paradise Weir	Very high	Low	Medium	Low	Medium	Low	Medium	Low	Medium	Medium	High
419006 Peel River at Carrol Gap	Medium	Medium	Medium	Low	Low	Medium	Medium	Low	Low	Low	Low
419022 Namoi River at Manilla Railway Bridge	Medium	Low	Low	Low	Low	Low	Low	Medium	Medium	Low	Low
419001 Namoi River at Gunnedah	Medium	Low	Low	Medium	Medium	Medium	Medium	Low	Low	Low	Low
419003 Narrabri Creek at Narrabri	Very high	Medium	High	High	High	Low	Medium	Low	Medium	Low	Medium
419021 Namoi River at Bugilbone	High	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
419026 Namoi River at Goangra	High	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low

Unregulated water sources

Table 6-13 Risks of exceeding water quality targets impacting the health of water-dependent ecosystems in the unregulated water sources of the Namoi Surface 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
419010 Macdonald River at Woolbrook	Medium	Low	Low	High	High	High	High	Medium	Medium	High	High
419016 Cockburn River at Mulla Crossing	Medium	Low	Low	Low	Low	Low	Low	Low	Low	Medium	Medium
419027 Mooki River at Breeza	Medium	Medium	Medium	High	High	Low	Low	Medium	Medium	Low	Low
419032 Coxs Creek at Boggabri	Low	High	Medium	High	Medium	High	Medium	Low	Low	Low	Low

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

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

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

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

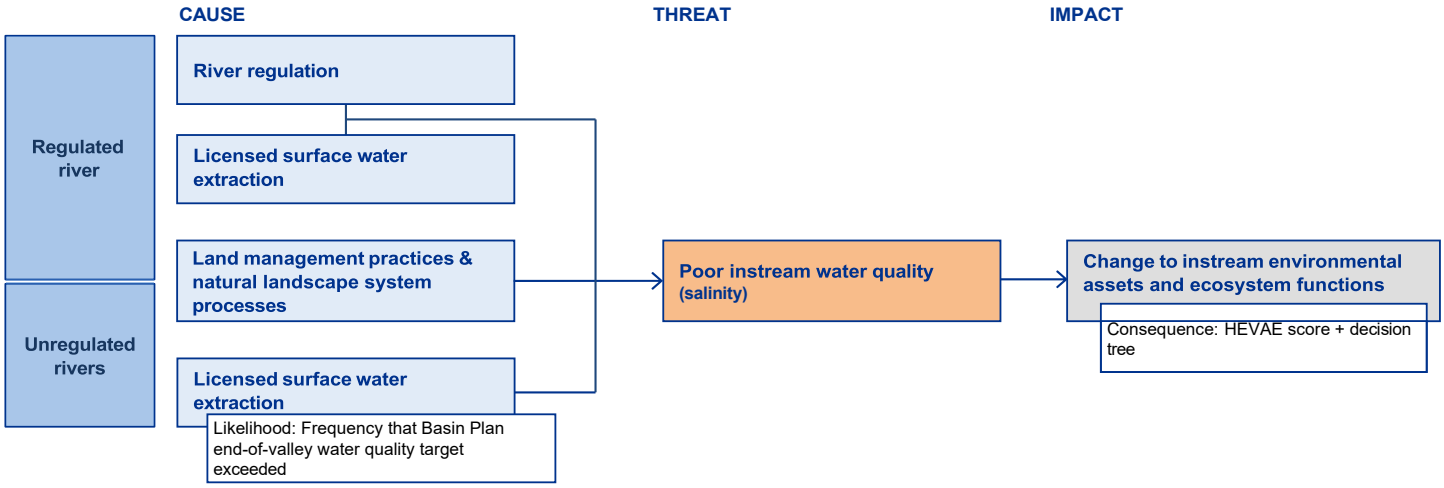


Figure 6-5 Impact pathway showing impact of elevated levels of instream salinity on ecological functions and assets in the Namoi Surface WRPA

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 Namoi is nominated for Gauging Station 419026 (Namoi River at Goangra) (Schedule B, Appendix 1 of the Commonwealth Water Act 2007). This station has a high consequence rating (Table 6-5).

6.5.2. Determine 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 monthly sampling for the period 2010/11 - 2014/15.

The end-of-valley salinity targets for the Namoi Surface WRPA nominated in the Basin Plan is the 80th percentile should not exceed 715 µS/cm.

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

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

Likelihood metric	Metric category	Metric category definition
Number of years the annual 80th percentile salinity exceeds the end-of-valley target of 715 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 Namoi River at Goangra (Station 419026) exceeded the salinity target no more than once between 2010/11 and 2014/15. Therefore this risk has a low likelihood rating.

6.5.3. Risk outcomes

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

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

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

Combining the high risk consequence (Table 6-5) and high likelihood rating (Section 6.5.2) results in a low overall risk rating (Table 6-16). The annual 80th percentile result did not exceed the salinity target between 2010/11 and 2014/15.

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

Regulated river reach	Consequence rating	Likelihood rating	Risk rating - E(WQ-S)
419026 Namoi River at Goangra	High	Low	Low

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.

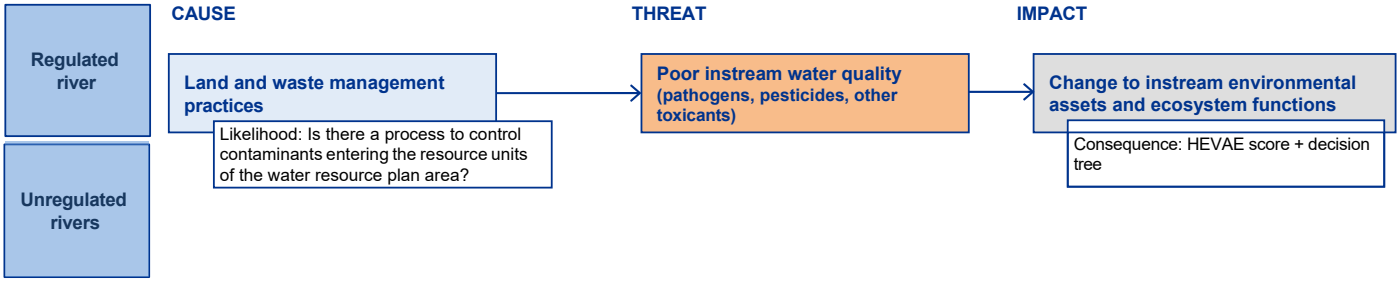


Figure 6-6. Impact pathway showing how risk of poor water quality (pathogens, pesticides and other toxic contaminants) can impact on ecological assets and functions

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

6.6.2. Determining the likelihood rating

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

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

various agricultural processing activities. Licensing conditions also include a monitoring and reporting component for compliance.

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

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

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

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

6.6.3. Risk outcomes

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

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

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

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

7.1. Background

There are a number of risks that may reduce the quality of water used for a number of consumptive and other economic uses in the Namoi Surface WRPA. Land use within the Namoi catchment 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 above, under the WMA a key principle 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. Refer to Chapter 6 above, and the WQM Plan, Salinity Technical Report and the Surface Water Quality Technical Report.

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

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

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

Irrigation water with elevated levels of salinity can lead to potential crop damage. The Basin Plan sets water quality targets for irrigation water for salinity (Part 4 of Chapter 9). The target 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 Namoi Surface 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 (Part 4 of Chapter 9). 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.

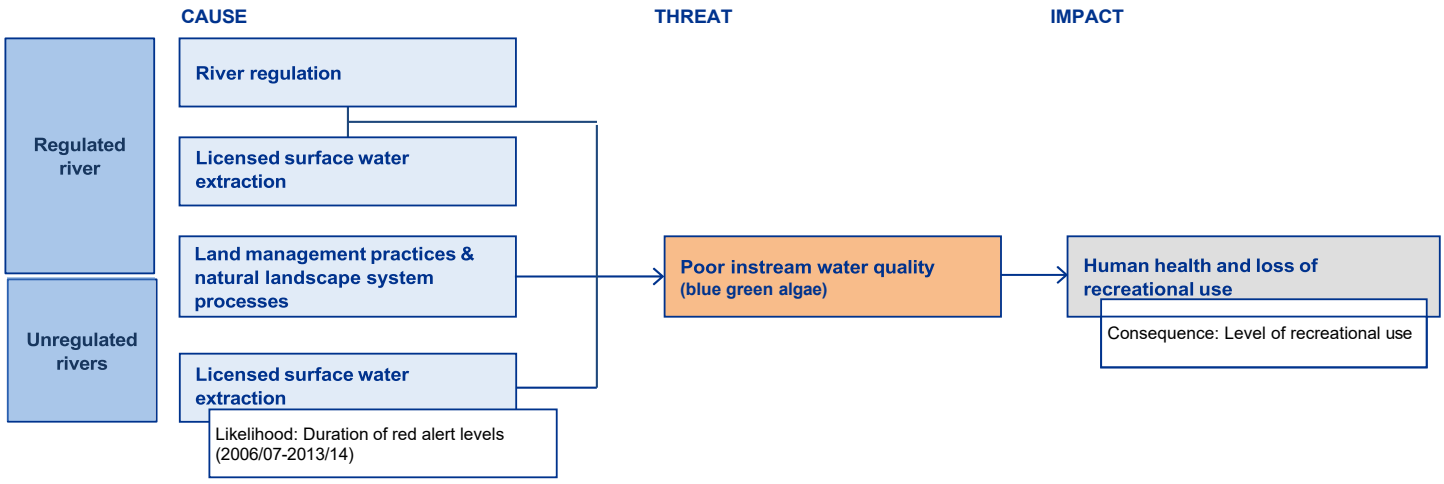


Figure 7-1 Impact pathway showing risk to recreation water quality and human health from blue-green algae

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.

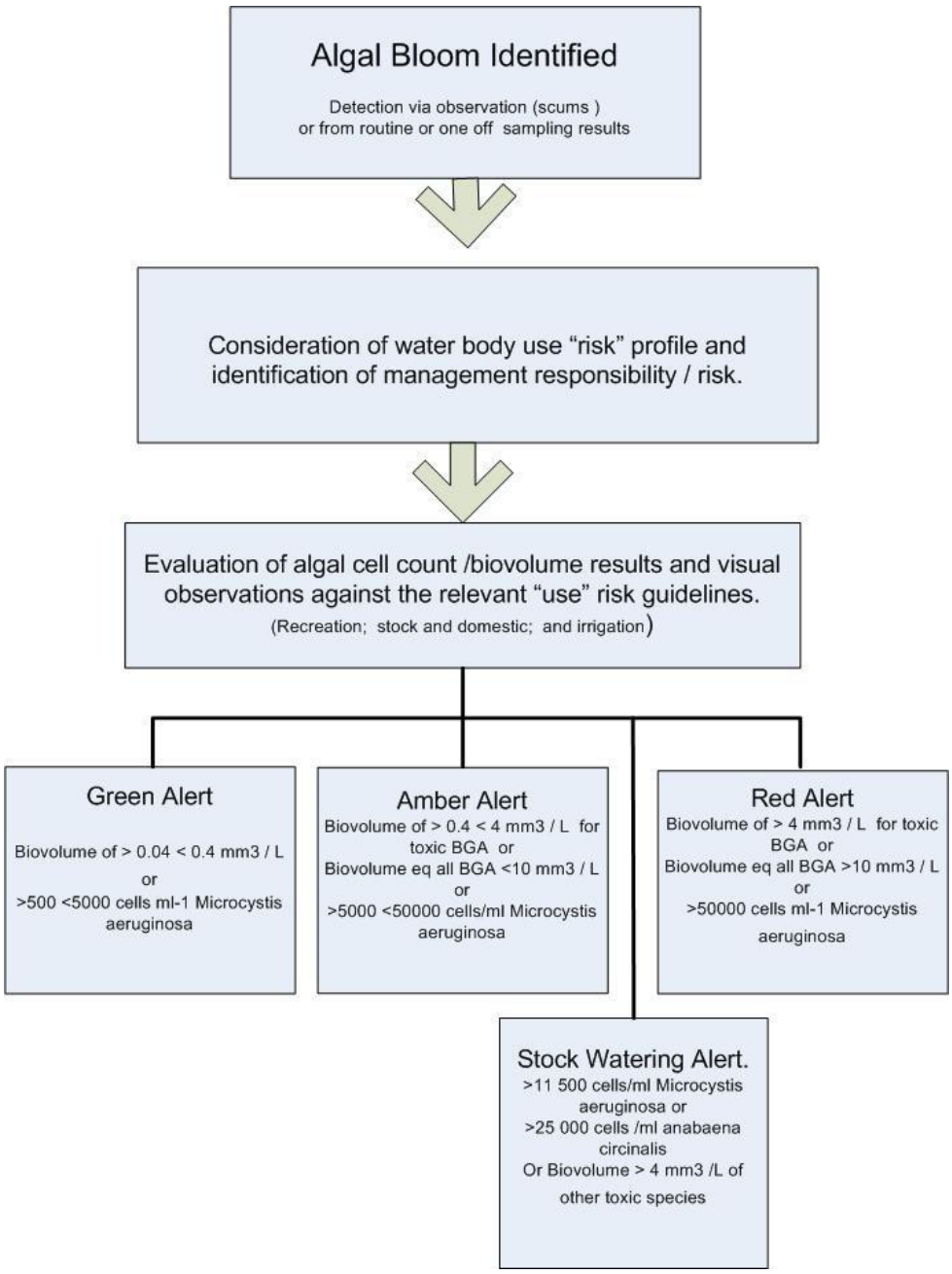


Figure 7-2 Conceptual outline of how algal alert levels are used in NSW

7.4.2. Assigning a consequence rating

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

Consequence categories are defined by usage levels (Table 7-1). 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 Namoi Surface 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 Namoi Surface WRPA

River reach	Consequence
Chaffey Reservoir	Low
Peel River downstream of Chaffey Dam	Low
Split Rock Reservoir	Low
Manilla River downstream Split Rock Dam	Low
Keepit Reservoir	Low
Namoi River downstream of Keepit Dam	Low
Yarrie Lake	Low
Namoi River at Walgett	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 Namoi Surface 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
Chaffey Reservoir	High
Peel River downstream of Chaffey Dam	Low
Split Rock Reservoir	Low
Manilla River downstream Split Rock Dam	Low
Keepit Reservoir	Low
Namoi River downstream of Keepit Dam	Low
Yarrie Lake	Low
Namoi River at Walgett	Low

7.4.4. Risk outcomes

The risk matrix used to determine the risk to recreational water users from blue-green algae in the Namoi Surface 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
	Very High	Medium	High	High

Combining the risk consequence and likelihood ratings (Table 7-2 and Table 7-4) results in the overall risk as medium for Chaffey Reservoir and low for other locations (Table 7-6).

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

Regulated river reach	Consequence rating	Likelihood rating	Risk rating – O(WQ-BGA)
Chaffey Reservoir	Low	High	Medium
Peel River downstream of Chaffey Dam	Low	Low	Low
Split Rock Reservoir	Low	Low	Low
Manilla River downstream Split Rock Dam	Low	Low	Low
Keepit Reservoir	Low	Low	Low
Namoi River downstream of Keepit Dam	Low	Low	Low
Yarrie Lake	Low	Low	Low
Namoi River at Walgett	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 Namoi Surface WRPA:

- Tamworth Shire Council;
- Liverpool Plains Shire Council;
- Gunnedah Shire Council;
- Narrabri Shire Council; and
- Walgett Shire Council.

7.6. Other values

Regard has been had to risks to the suitability of water for public benefit values (i.e. Indigenous, social, cultural) as required under 10.41(3)(a) in relation to 4.02(2)(b) through the assessment of risks to other water uses due to unsuitable water quality. These risks are linked to a number of public benefit values. The benefits and values associated with improved water quality and ecosystem health provide both directly and indirectly for various social, cultural and other public benefit values. Consideration within the development of the WRP is limited on the basis that current methodologies to assess broader benefits are still under development. Future risk assessments will include an assessment of these risks as further data becomes available. As there is a related requirement in 10.53(f), refer to sections 1.3.1 and 1.7 of the WRP for further information relevant to risks to Indigenous values and uses of surface waters.

8. Risks to water available for other uses

8.1. Background

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

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

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

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

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

For the purpose of risk due to interception, NSW utilised results published in the CSIRO Murray Darling Basin Sustainable Yields (MDBSY) project (CSIRO 2007; CSIRO 2008) and model outputs that contributed to the MDBSY project. Comparative results were also produced by NSW. Details on the methodology used for determining likelihood ratings and consequence scores for risk due to interception are detailed in the section below.

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

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

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

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

In 2008 the volume of in-stream farm dams in the Namoi Surface WRPA was estimated at 145 GL (NoW 2010). The MDBSY Project estimated growth rate of 0.6% for the entire Basin was applied to the 2008 Namoi valley estimated volume, yielding a predicted increase of 19 GL. This equates to a reduction of approximately 1.4% to stream inflows as a result of farm dam interception, depending on the climatic scenario adopted (NoW 2010).

The impact pathway (Figure 8-1) 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.

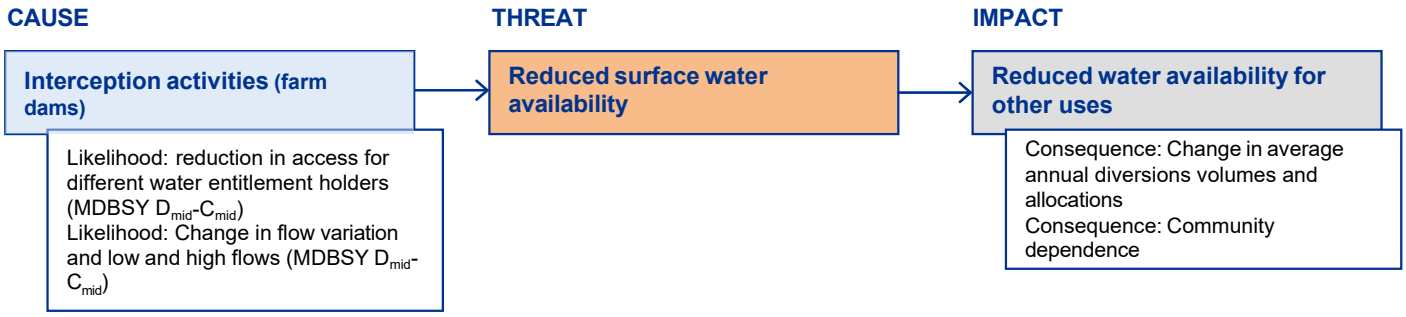


Figure 8-1 Impact pathway showing impact of farm dams on water available for other uses

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).

Regulated river water source

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 2007; CSIRO 2008).

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

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

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

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

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

Consequence Levels	Percent Change Relative to Base Case				
	High Security	General Security			Supplementary Access
	Average annual diversions	Average annual diversions	% years with 100% allocation	% years with 0% allocation	Average annual diversions
Negligible	x < 1	x < 1	x < 1	x < 1	x < 1
Minor	1 ≤ x < 10	1 ≤ x < 10	1 ≤ x < 10	1 ≤ x < 5	1 ≤ x < 10
Moderate	10 ≤ x < 20	10 ≤ x < 20	10 ≤ x < 20	5 ≤ x < 10	10 ≤ x < 20
Major	20 ≤ x < 30	20 ≤ x	20 ≤ x	10 ≤ x	20 ≤ x
Severe	30 ≤ x	N/A*	N/A	N/A	N/A
Reference: NoW 2010 N/A = This consequence level was not used for this indicators					

Table 8-2 Data used to assess consequences to different types of water access licences in the regulated Namoi River and Peel River due to interception by farm dams

Regulated system	Water access licence type	Consequence		
		% change in average annual diversions	% change years with 100% allocation	% change in years with 0% allocation
Namoi	High security	0	N/A	N/A
Namoi	General security	-1.3	-1.2	0
Namoi	Supplementary access	-1.3	N/A	N/A
Peel	High security	0	N/A	N/A
Peel	General security	-0.3	0	0
Peel	Supplementary access	-1.3	N/A	N/A
	Reference: CSIRO 2007 N/A = This metric was not used for this type of water access licence			

Table 8-3 Consequence results for different types of water access licences in the Namoi regulated river due to interception by farm dams

Regulated system	Water access licence type	Consequence		
		% change in average annual diversions	% change years with 100% allocation	% change in years with 0% allocation
Namoi	High security	Negligible	N/A	N/A
Namoi	General security	Minor	Minor	Negligible
Namoi	Supplementary access	Minor	N/A	N/A
Peel	High security	Negligible	N/A	N/A
Peel	General security	Negligible	Negligible	Negligible
Peel	Supplementary access	Minor	N/A	N/A
Reference: CSIRO 2007 N/A = This metric was not used for this type of water access licence [1] An overall consequence level of minor will be applied to general security to calculate risk (i.e. the most conservative)				

8.2.1.2. Determine the likelihood rating

Regulated river water source

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

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

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

The SKM report defined likelihood as the chance of a specified event occurring under different climate scenarios, with events being the specific flow indicators identified for a WRPA. Specified flow indicators for the Namoi Surface WRPA, based on flow thresholds at the Duncan's Junction gauge, are described in Table 4-18 Likelihoods are therefore the chance that a given flow indicator would be reported under a given climate scenario. For example, if there was a 1% chance that annual average volumes of 4 GL/month at Duncan's Junction would be recorded in given climate scenario, the likelihood would be classed as "rare" (Table 4-22).

These thresholds describe the overall chance that the scenario will have on the assessed impact.

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

Table 8-4 Likelihood results for different types of water access licences in the regulated Namoi and Peel Rivers. Likelihood metric estimates the likelihood of insufficient water access.

Water access entitlement holder	Likelihood
High Security	Possible
General Security	Possible
Supplementary Water	Possible
Reference: NoW 2010	

Unregulated water sources

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

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

8.2.1.3. Existing water management actions & mechanisms

The current harvestable rights provisions allow for farm dams to capture some rainfall runoff under BLR, as previously discussed in section 4.5.1. 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 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.

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

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

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

8.2.1.4. Risk outcomes

Regulated river water source

The risk matrix used to determine the risk rating of flow alteration from an increase in farm dams intercepting runoff and impacting the water available to different categories of water access licences in the Namoi Surface 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 projected hydrologic change				
		Rare	Unlikely	Possible	Likely	Almost Certain
Consequence (%change)	Negligible	Low	Low	Low	Medium	Medium
	Minor	Low	Low	Low	Medium	High
	Moderate	Low	Low	Medium	High	High
	Major	Low	Medium	Medium	High	High
	Severe	Medium	Medium	High	High	High

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

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

Regulated system	Water access licence type	Consequence (% change in annual average diversion	Likelihood	Risk level – O(I-FD)
Namoi	High security	Negligible	Possible	Low
Namoi	General security[1]	Minor	Possible	Low
Namoi	Supplementary access	Minor	Possible	Low
Peel	High security	Negligible	Possible	Low
Peel	General security[1]	Negligible	Possible	Low
Peel	Supplementary access	Minor	Possible	Low

	Reference: CSIRO 2007 N/A = This metric was not used for this type of water access licence [1] An overall consequence level of minor was applied to general security to calculate risk

Unregulated water sources

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

Table 8-7 Matrix used to determine risk from potential interception activities to other water users in Namoi and Peel unregulated water sources

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

Combining the consequence and likelihood ratings resulted in '**Low**' overall risk levels to other water users in all but one unregulated water source with the the unregulated Namoi River at Cuerindi receiving a likelihood rating of '**Medium**' due to a 'high' HEVAE consequence score (Table 8-8).

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

Gauging Station	Consequence*	Likelihood			Risk level - O(I-FD)		
		CV	LF Q_{90}	HF Q_{10}	CV	LF Q_{90}	HF Q_{10}
Maules Creek at Avoca East	M	L	L	L	L	L	L
Coxs Creek at Boggabri	L	L	L	L	L	L	L
Baradine Creek at Kienbri No.2	M	L	L	L	L	L	L
Peel River at Carroll Gap	M	L	L	L	L	L	L
Mooki River at Breeeza	L	L	L	L	L	L	L
Coxs Creek at Tambar Springs	L	L	M	L	L	L	L
Mooki River at Caroona	L	L	L	L	L	L	L
Goonoo Goonoo Creek at Timbumburi	M	L	L	L	L	L	L
Warrah Creek at Old Warrah	L	L	L	L	L	L	L
Macdonald River at Woolbrook	L	L	L	L	L	L	L
Swamp Oak creek at Limbri	L	L	L	L	L	L	L
Cockburn River at Mulla Crossing	M	L	L	L	L	L	L
Halls Creek at Ukolan	L	L	L	L	L	L	L
Ironbark Creek at Woodsreef	M	L	L	L	L	L	L
Manilla River at Black Springs	L	L	L	L	L	L	L
Namoi river at North Cuerindi	H	L	L	L	M	M	M

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

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

As previously mentioned in section 4.5.2, afforestation is defined as the large-scale planting of trees for timber production, carbon offsetting, land conservation or other environmental purposes. The Bureau of Rural Sciences projected negligible growth in commercial forestry plantations in the Namoi region. As such, no growth in plantation forestry was included in the modelling completed for the MDBSY Project in the Namoi (CSIRO 2007).

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

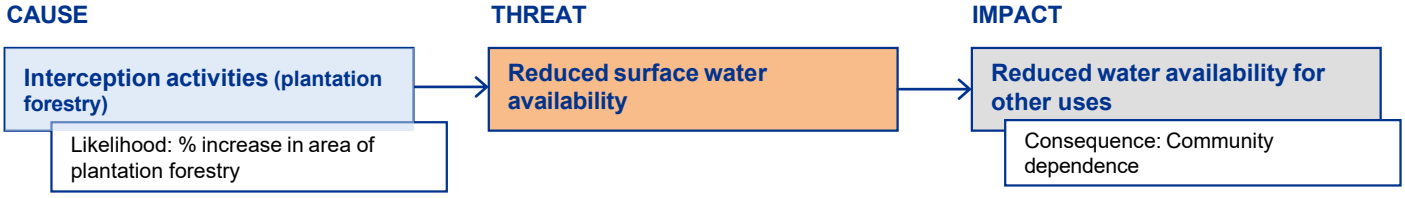


Figure 8-2 Impact pathway showing impact of commercial plantations on water available for other uses

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

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

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

8.2.2.1. Risk outcomes

Combining the consequence and likelihood ratings resulted in '**Nil**' overall risk levels to other water users in the Namoi river catchment (Table 8-9).

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

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

8.2.3. Mining (including CSG)

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

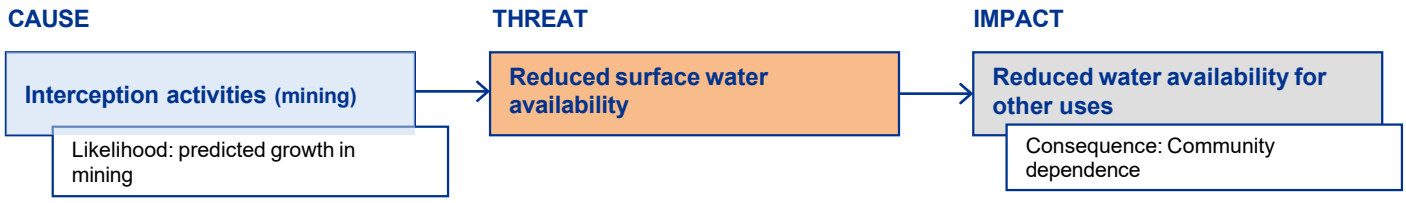


Figure 8-3 Impact pathway showing impact of mining on water available for other uses

8.2.3.1. Existing water management actions and mechanisms

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

8.2.3.2. Risk outcomes

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

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

The Bioregional assessment for the Namoi subregion identified areas of mining and growth in mining as outlined in Section 4.5.3. Based on modelling undertaken by the Commonwealth Government, the risk of mining causing impacts to structural integrity is '**low**'.

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

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

8.2.4. Floodplain harvesting [O(I-FH)]

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

Floodplain harvesting activities in the Namoi catchment are described in section 4.5.4. See section 5.7.4 of the water resource plan for current management actions and mechanisms.

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 8-11.

Table 8-11 Likelihood metrics for floodplain harvesting

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

An estimation to determine the growth in FPH in the Namoi WRP area has not been determined. Therefore, growth in FPH was determined by a qualitative assessment based on expert opinion of department hydrology specialists. The growth in FPH in the Namoi River WRP area was estimated to be significant. Therefore, a ‘high’ likelihood rating was assigned.

8.2.4.2. Assigning a consequence score

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

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

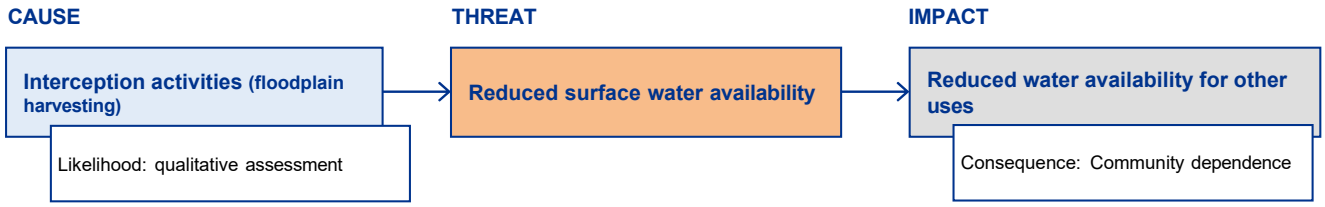


Figure 8-4 Impact pathway showing impact of floodplain harvesting on water available for other users

8.2.4.3. Risk outcomes

The risk matrix used to determine the risk rating of flow alteration from an increase in floodplain harvesting intercepting runoff and impacting the water available to other users is provided in Table 8-12.

Table 8-12 Risk matrix to determine risk outcomes of increased floodplain harvesting to other water users

		Likelihood (% growth in FPH)		
		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 '**High**' overall risk level to other water users in the regulated water source and '**Medium**' in the unregulated water sources (Table 8-15).

Table 8-13 Risks of insufficient water available for other water users in regulated and unregulated water sources in the Namoi Surface WRPA as a result of floodplain harvesting [O(I-FH)]

	Consequence	Likelihood	Overall risk rating - O(I-M)
Regulated river water source	High	High	High
Unregulated river water sources	Low	High	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 2007; CSIRO 2008) and model outputs that contributed to the MDBSY project. Comparative results were also produced by NSW. Details on the methodology used for determining likelihood ratings and consequence scores are detailed in the section below. The impact pathway is shown in Figure 8-5

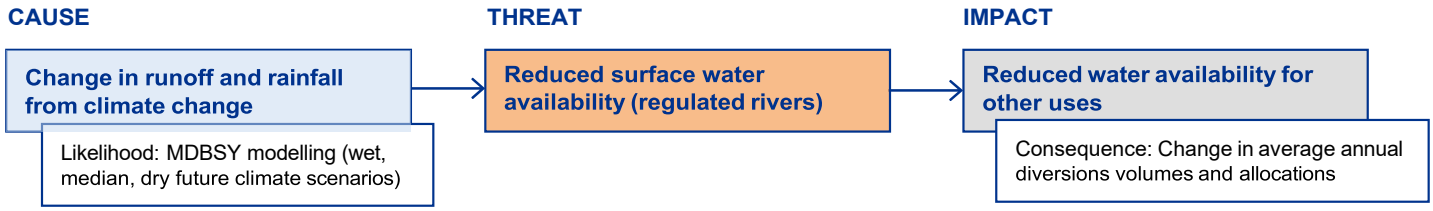


Figure 8-5 Impact pathway showing impact of change in climate on ability to meet other water user's water requirements.

8.3.1. Assigning a consequence rating

8.3.1.1. Regulated river water source

Using the approach taken in NSW Office of Water (2010) in assisgning a consequence score, indicators were adopted that were based on information readily available in the Murray Darling Basin Sustainable Yields (MDBSY) reports (CSIRO 2007; CSIRO 2008).

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

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

The MDBSY reports covered a range of possible 2030 climate scenarios (CSIRO 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 8-14

Data used to assess consequence is presented in Table 8-15; results are provided in Table 8-14.

Table 8-14 Consequence results for different types of water access licences in the Namoi and Peel regulated rivers

Regulated system	Water access licence type	Consequence
Namoi	**Wet climate change scenario**	
	High Security	Negligible
	General Security	Negligible
	Supplementary Water	Negligible
	Median climate change scenario	
	High Security	Minor
	General Security	Minor
	Supplementary Water	Minor
	Dry climate change scenario	
	High Security	Minor
	General Security	Major
	Supplementary Water	Moderate
Peel	**Wet climate change scenario**	
	High Security	Negligible
	General Security	Negligible
	Supplementary Water	Negligible
	Median climate change scenario	
	High Security	Minor
	General Security	Minor
	Supplementary Water	Minor
	Dry climate change scenario	
	High Security	Minor
	General Security	Major
	Supplementary Water	Moderate
Reference: NoW 2010		

Table 8-15 Data used to assess consequences to different types of water access licences in the Namoi and Peel regulated rivers due to climate change

Regulated system	Water access licence type	Consequence		
		% change in average annual diversions	% change years with 100% allocation	% change in years with 0% allocation
Namoi	**Wet climate change scenario**			
	High security	0	N/A	N/A
	General security	10	28	0
	Supplementary access	12	N/A	N/A
	Median climate change scenario			
	High security	-1	N/A	N/A
	General security	-3	-2	0
	Supplementary access	-1	N/A	N/A
	Dry climate change scenario			
	High Security	-1	N/A	N/A
	General Security	-19	-11	0
	Supplementary Water	-11	N/A	N/A
Peel	**Wet climate change scenario**			
	High security	0	N/A	N/A
	General security	0	14.4	0
	Supplementary access	12	N/A	N/A
	Median climate change scenario			
	High security	-1	N/A	N/A
	General security	6	-2.7	0.9
	Supplementary access	-1	N/A	N/A
	Dry climate change scenario			
	High Security	-1	N/A	N/A
	General Security	0	-20.7	7.2
	Supplementary Water	-11	N/A	N/A
Reference: CSIRO 2007 N/A = This metric was not used for this type of water access licence				

8.3.1.2. Unregulated river water source

The consequence scores in unregulated water sources were based on community dependence on water use (NOW 2011).

8.3.2. Determine the likelihood rating

8.3.2.1. Regulated river water source

Comparing MDBSY Project C scenarios to the 2004/05 (A0 scenario) determined likelihood of climate change impacting water available for other users under the three different climate projections (wet, median and dry) (Table 4-38). Likelihood rankings are provided in Table 8-16.

Table 8-16 Likelihood results for different types of water access licences in the Namoi and Peel regulated rivers under different climate change scenarios

Regulated system	Water access licence type	Likelihood
Namoi	**Wet climate change scenario**	
	High Security	Possible
	General Security	Possible
	Supplementary Water	Possible
	Median climate change scenario	
	High Security	Possible
	General Security	Possible
	Supplementary Water	Possible
	Dry climate change scenario	
	High Security	Likely
	General Security	Likely
	Supplementary Water	Likely
Peel	**Wet climate change scenario**	
	High Security	Possible
	General Security	Possible
	Supplementary Water	Possible
	Median climate change scenario	
	High Security	Possible
	General Security	Possible
	Supplementary Water	Possible
	Dry climate change scenario	
	High Security	Likely
	General Security	Likely
	Supplementary Water	Likely
Reference: NoW 2010		

8.3.2.2. Unregulated river water sources

The three climate change scenarios outlined in Table 4-41 were used to define likelihood ratings in unregulated water sources. To determine the highest potential risk to the environment from surface water reductions due to climate change, the C_{Dry} scenario was used to define the likelihood rating and a 'medium' likelihood category was assigned to all water sources. The 'medium' likelihood applies to all components of the flow regime.

8.3.3. Existing water management actions & mechanisms

Existing actions and mechanisms correspond to those identified in Section 4.6.30.

8.3.4. Risk outcomes

8.3.4.1. Regulated river water source

The risk matrix used to determine the risk rating of flow alteration from change in climate impacting the availability of water for other uses in the Namoi and Peel regulated rivers is provided in Table 8-17.

Table 8-17 Matrix used to determine risk from potential change in climate

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

Combining the risk consequence and likelihood ratings (Table 8-14 and Table 8-16) resulted in the overall risk levels to other users from climate change are shown in Table 8-18. The risk assessment determined a low risk under the wet and medium scenario. Under a dry climate change scenario, general security and supplementary water users were at '**High**' risk and high security users were at a '**Medium**' risk of a reduction in inflows.

Table 8-18 Risks to different types of water access licences in the Namoi and Peel regulated rivers under different climate change scenarios [O(CC)]

Namoi	Consequence	Likelihood	Risk level – O(CC)
Wet climate change scenario			
High Security	Negligible	Possible	Low
General Security	Negligible	Possible	Low
Supplementary Water	Negligible	Possible	Low
Median climate change scenario			
High Security	Minor	Possible	Low
General Security	Minor	Possible	Low
Supplementary Water	Minor	Possible	Low
Dry climate change scenario			
High Security	Negligible	Likely	Medium
General Security	Major	Likely	High
Supplementary Water	Moderate	Likely	High
Peel	**Consequence**	**Likelihood**	**Risk level – O(CC)**
Wet climate change scenario			
High Security	Negligible	Possible	Low
General Security	Negligible	Possible	Low
Supplementary Water	Negligible	Possible	Low
Median climate change scenario			
High Security	Minor	Possible	Low
General Security	Minor	Possible	Low
Supplementary Water	Minor	Possible	Low
Dry climate change scenario			
High Security	Negligible	Likely	Medium
General Security	Major	Likely	High
Supplementary Water	Moderate	Likely	High
Reference: NoW 2010			

8.3.4.2. Unregulated river water source

The risk matrix used to determine the risk rating of flow alteration from change in climate impacting the availability of water for other users is provided in Table 4-44.

Combining the unregulated risk consequence and 'medium' likelihood ratings resulted in the majority of water sources having either a '**Low**' or '**Medium**' risk rating (Table 8-19).

Table 8-19 Risks of insufficient water available for other water users in unregulated river sections in the Namoi Surface WRPA as a result of climate change [O(CC)]

Unregulated water source	Consequence (community dependence)	Likelihood	Overall risk rating – O(CC)
Baradine Creek	M	M	M
Bluevale	M	M	M
Bohena Creek	L	M	L
Brigalow Creek	M	M	M
Bundock Creek	M	M	M
Chaffey	L	M	L
Cockburn River	M	M	M
Coghill Creek	L	M	L
Coxs Creek	H	M	M
Etto Creek & Talluba Creek	L	M	L
Eulah Creek	L	M	L
Goonoo Goonoo Creek	L	M	L
Keepit	L	M	L
Lake Goran	M	M	M
Lower Namoi	M	M	M
Lower Peel River tributaries	M	M	M
Maules Creek	L	M	L
Mid Macdonald River	M	M	M
Mooki River	H	M	M
Phillips Creek	H	M	M
Pian Creek	H	M	M
Quirindi Creek	H	M	M
Rangira Creek	L	M	L
Split Rock	L	M	L
Spring and Bobbiwaa Creeks	H	M	M
Upper Macdonald River	L	M	L
Upper Manilla River	L	M	L
Upper Namoi	M	M	M
Upper Peel River tributaries	M	M	M
Warrah Creek	H	M	M
Werris Creek	M	M	M

8.4. Risk to other water users due to growth in BLR [O(BLR)]

As described earlier in Section 4.4, all landholders in NSW have rights to access water for some basic purposes. The principles of the WMA 2000 require that water sharing must protect BLR.

Access to BLR is not controlled by access rules that restrict licensed water users in unregulated water sources (for example, low flow access cease to pump rules); BLR is afforded a higher priority of access.

Any future growth in BLR therefore represents a potential future risk to other (licensed) water users at very low flows. Any increase in the volume taken by BLR access will necessitate a decrease in the volume share of access by licensed water users.

This risk is not applicable in regulated systems where the system is managed in such a way to maintain supply of BLR water requirements. This is further discussed in Section 8.4.2.1.

The impact pathway is shown in Figure 8-6 and demonstrates the risk to water availability for licensed water uses driven by growth in BLR in unregulated water sources. The consequence is described by the volume of licensed entitlement in the unregulated water source. Likelihood is described by the ratio of BLR to licensed entitlement. The greater the ratio of BLR to entitlement, the greater the likelihood that there will be less water available to other licensed water users; this consequence will be greater in areas of high entitlement.



Figure 8-6 Impact pathway showing risk to licensed water users due to growth in BLR access in unregulated water sources in the Namoi Surface WRPA

8.4.1. Assigning a consequence rating

8.4.1.1. Regulated river water source

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

8.4.1.2. Unregulated river water sources

In unregulated river water sources consequence was described by the current volume of entitlement in each water source. It was 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 were triggered more frequently due to increased BLR access.

Consequence categories are defined in Table 8-20. Consequence ratings are shown in Table 8-21.

It was assumed that all entitlement was fully active and utilised. That is, the volume extracted was the volume of entitlement for each water source.

Table 8-20 Consequence metrics for increased extraction by BLR in unregulated water sources in the Namoi Surface WRPA

Consequence metric	Metric category	Metric category definition
Volume of entitlement	Low	Volume of entitlement < 5,000 ML
	Medium	Volume of entitlement 5,000 – 10,000 ML
	High	Volume of entitlement > 10,000 ML
Reference: NSW Water Register (DoI-Water)		

Table 8-21 Consequence ratings for increased extraction by BLR in unregulated water sources in the Namoi Surface WRPA

Water source	Consequence rating
Baradine Creek	High
Bluevale	Low
Bohena Creek	Low
Brigalow Creek	Low
Bundock Creek	Low
Chaffey	Low
Cockburn River	Low
Coghill Creek	Low
Coxs Creek	High
Etto Creek & Talluba Creek	Low
Eulah Creek	Low
Goonoo Goonoo Creek	Low
Keepit	Low
Lake Goran	High
Lower Namoi River	Low
Lower Peel River tributaries	Low
Maules Creek	Low
Mid Macdonald River	Low
Mooki River	High
Phillips Creek	Low
Pian Creek	High
Quirindi Creek	Low
Rangira Creek	Low
Split Rock	Low
Spring and Bobbiwaa Creeks	Low

Water source	Consequence rating
Upper Macdonald River	Medium
Upper Manilla River	Low
Upper Namoi River	High
Upper Peel River tributaries	Medium
Warrah Creek	Low
Werris Creek	Low
N/A = no data available	

8.4.2. Determine the likelihood rating

8.4.2.1. Regulated river water source

In regulated systems, BLR is managed in such a way to maintain supply of BLR water requirements. Sufficient reserves of water are set aside and held in storage to ensure supply of domestic and stock rights and native title rights.

Therefore there is no pathway for impact on water for other users from BLR extraction in regulated river sections, and a 'nil' likelihood has been assigned to all regulated rivers.

8.4.2.2. Unregulated river water sources

Likelihood is described by the ratio of the volume of BLR to all licensed water entitlement in each water source (i.e. irrigation, town water supply, etc.). Entitlement is the current volume of licensed entitlement in each water source. It was assumed that all entitlement is fully active in the unregulated water sources.

Likelihood categories are defined in Table 8-22. Consequence ratings are shown in Table 8-23.

Table 8-22 Likelihood metrics for increased extraction by BLR in unregulated water sources in the Namoi Surface 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 (DoI-Water)		

Table 8-23 Likelihood ratings for increased extraction by BLR in unregulated water sources in the Namoi Surface WRPA

Water source	Likelihood rating
Baradine Creek	Low
Bluevale	Low
Bohena Creek	Low
Brigalow Creek	Low
Bundock Creek	Low
Chaffey	Low

Water source	Likelihood rating
Cockburn River	Low
Coghill Creek	Low
Coxs Creek	Low
Etto Creek & Talluba Creek	Low
Eulah Creek	Low
Goonoo Goonoo Creek	Low
Keepit	Low
Lake Goran	Low
Lower Namoi River	Low
Lower Peel River tributaries	Low
Maules Creek	Low
Mid Macdonald River	Low
Mooki River	Low
Phillips Creek	Low
Pian Creek	Low
Quirindi Creek	Low
Rangira Creek	Low
Split Rock	High
Spring and Bobbiwaa Creeks	Low
Upper Macdonald River	High
Upper Manilla River	Low
Upper Namoi River	Low
Upper Peel River tributaries	Low
Warrah Creek	Medium
Werris Creek	Low
N/A = No data available	

8.4.3. Existing water management actions & mechanisms

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

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

intended that such limitations will be applied only to rivers and aquifers that could be subject to high hydrologic stress or high instream risk

8.4.4. Risk outcomes

Regulated river water source

Table 8-24 Risk of increased BLR extraction impacting on water available for other water users in the regulated water source of the Namoi Surface WRPA [O(BLR)]

	Consequence	Likelihood	Overall risk rating - O(BLR)
Regulated river water sources	High	Nil	Nil

Unregulated water source

The risk matrix used to determine the risk to water availability for other uses due to growth in BLR extraction is provided in Table 8-25.

Note that the standard matrix has been altered so that when the likelihood is low (i.e. the ratio of BLR to entitlement <0.5), the risk outcome is always considered low regardless of the level of consequence. This change was made to avoid falsely assigning medium risk outcomes when BLR ratios are very low but entitlement is high. High BLR ratios (e.g. >0.5) usually reflect higher levels of urban/peri-urban development within a water source and therefore a higher likelihood of future BLR growth.

Table 8-25 Risk matrix to determine risk outcomes of increased BLR extraction to other water users in unregulated water sources

		Likelihood (ratio of BLR to entitlement)		
		Low	Medium	High
Consequence (licensed volume of entitlement)	Low	Low	Low	Medium
	Medium	Low	Medium	High
	High	Low	High	High

Combining the risk consequence and likelihood ratings resulted in a low risk for all unregulated water sources in the Namoi Surface WRPA (Table 8-26) except for the Split Rock and Upper Macdonald River water sources. The risk level in these water sources was medium and high respectively; Table 8-27 shows data on BLR volumes and entitlement volumes for these two water sources.

The Upper Macdonald water source has a high BLR estimate compared to entitlement, the Split Rock water source has no entitlement.

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

Table 8-26 Risks of increased BLR extraction to other water users in unregulated water sources in the Namoi Surface WRPA [O(BLR)]

Water source	Consequence rating	Likelihood rating	Risk level – O(BLR)
Baradine Creek	High	Low	Low
Bluevale	Low	Low	Low
Bohena Creek	Low	Low	Low
Brigalow Creek	Low	Low	Low
Bundock Creek	Low	Low	Low
Chaffey	Low	Low	Low
Cockburn River	Low	Low	Low
Coghill Creek	Low	Low	Low
Coxs Creek	High	Low	Low
Etto Creek & Talluba Creek	Low	Low	Low
Eulah Creek	Low	Low	Low
Goonoo Goonoo Creek	Low	Low	Low
Keepit	Low	Low	Low
Lake Goran	High	Low	Low
Lower Namoi	Low	Low	Low
Lower Peel River tributaries	Low	Low	Low
Maules Creek	Low	Low	Low
Mid Macdonald River	Low	Low	Low
Mooki River	High	Low	Low
Phillips Creek	Low	Low	Low
Pian Creek	High	Low	Low
Quirindi Creek	Low	Low	Low
Rangira Creek	Low	Low	Low
Split Rock	Low	High	Medium
Spring and Bobbiwaa Creeks	Low	Low	Low
Upper Macdonald River	Medium	High	High
Upper Manilla River	Low	Low	Low
Upper Namoi	High	Low	Low
Upper Peel River tributaries	Medium	Low	Low
Warrah Creek	Low	Medium	Low
Werris Creek	Low	Low	Low

Table 8-27 BLR and entitlement volumes for medium and high risk water sources in the Namoi Surface WRPA

Water source	BLR rights[1] (ML/yr)	Total entitlement[2] (ML/yr)	Number of WALs
Split Rock	12	0	0
Upper Macdonald River	101	30	1

References:
1 Water Sharing Plan for the Namoi and Peel Unregulated Water Sources 2012
2 DoI-Water Register for the 2017/18 Water Year

8.5. Other values

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

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

9. Risk treatment overview

Section 10.43(1) of the Basin Plan requires WRPs to describe water resource management strategies to address medium or high levels of risk or explain why the risk cannot be addressed by the WRP in a manner commensurate with the level of risk. As strategies are not required for risk results that are low, they have not been further considered in the risk treatment overview.

Medium and high risk results were reviewed to determine whether they are adequately addressed by existing strategies, or whether modifications or new strategies may be required. Risk treatment options were developed following a systematic approach outlined in Figure 9-1 and further explained in Section 10.43(1) of the Basin Plan requires WRPs to describe water resource management strategies to address medium or high levels of risk or explain why the risk cannot be addressed by the WRP in a manner commensurate with the level of risk. As strategies are not required for risk results that are low, they have not been further considered in the risk treatment overview.

Medium and high risk results were reviewed to determine whether they are adequately addressed by existing strategies, or whether modifications or new strategies may be required. Risk treatment options were developed following a systematic approach outlined in Figure 9-1 and further explained in Table 9-1.

Defining tolerable risk results (those high or medium results NSW considers are acceptable or adequately managed by existing water resource management strategies) were also part of this approach.

Explanations for risk results that the WRP cannot address in a manner commensurate with the level of risk are provided in the consolidated risk table (Table 1) at the start of this document.

As this risk assessment examines risks to water quality, it is relevant to note that s10.31 of the Basin Plan also requires the WQM Plan to include measures to address water quality risks. Where the WQM Plan identifies measures that are contained within the WRP or WSPs, these strategies are also shown in this chapter. Note this material is included to show linkages between the two documents and the WQM Plan should be referred to in the first instance.

The risk treatment options reflect the complex nature of risk based water resource management and allow for a range of strategies to be identified and applied irrespective of their legislative base or approach.

Option A is used when other risk options have been assessed and no further strategies are available, or by default when a risk is defined as tolerable.

Options B and C guide the development of strategies that aim to improve knowledge about the risk or the resource. They allow for instances where there has not been adequate information available to fully assess a risk or to develop or modify an existing mitigation strategy. Although associated strategies cannot directly mitigate risk, they aim to provide sufficient information to enable mitigation strategies to be reassessed or developed under options D to G. Options B and C may be linked to adaptive management strategies that are responsive to information improvements during the term of the WRP or related plan. Additional information on strategies related to these options can be found in the Namoi 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 below.

For detailed information on the application of the options and strategies applied to individual risk results see the consolidated risk table (Table 1 of the Executive Summary). Note risk results that are low or have been

assigned a tolerable status based on predefined criteria are assumed to have adequate strategies in place and have not been further reviewed in this risk assessment.

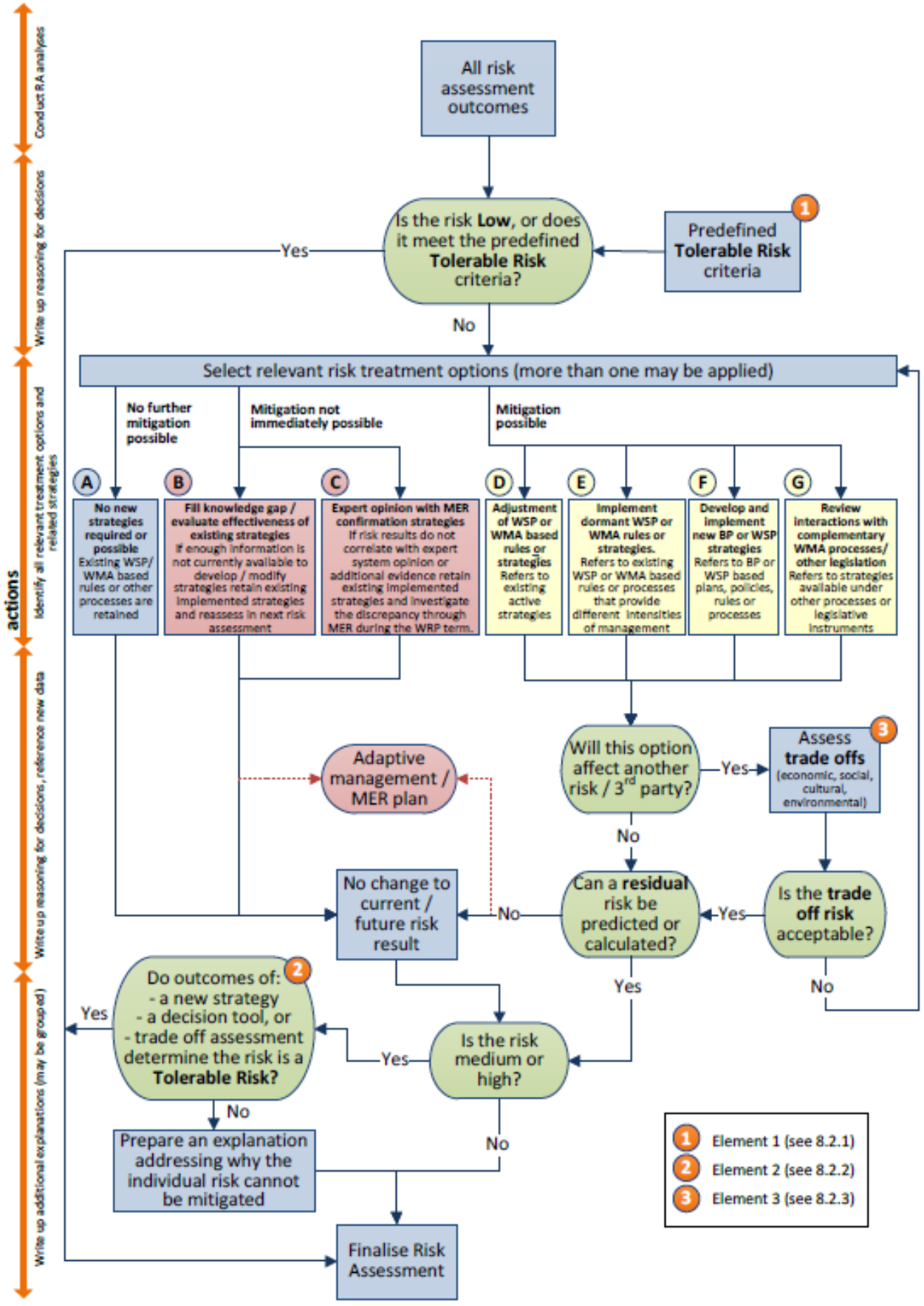


Figure 9-1 Risk treatment pathway

Table 9-1 Risk treatment options explained

Element	Description
A No new strategies required or possible	No further mitigation is possible and no new strategies are proposed. This may be relevant where the risk is adequately managed via existing strategies or where a risk cannot be fully mitigated and trade-offs limit other options. *Note:* existing strategies are retained and the risk result does not change.
B Fill knowledge gap / evaluate effectiveness of existing strategies	Mitigation is not immediately possible and knowledge improvement is proposed. Where there is not enough information available regarding the resource and/or the effectiveness of existing or alternative strategies this option can be used. The MER plan will address the knowledge gaps to enable the existing strategies to be reviewed in the future. *Note:* existing strategies are retained and the risk result does not change
C Expert opinion with MER confirmation strategies	Mitigation is not immediately possible and knowledge improvement via the MER plan is proposed. This option may be used where there is a discrepancy between risk assessment results and expert opinion or alternative evidence. Differences may be due to conservative estimations of consequence or likelihood in risk assessment calculations, knowledge from complementary WRP activities such as LTWP development (including identification of asset watering requirements), type of data available for risk calculation, or other factors that affect results such as data confidence. Note: existing strategies are retained and the risk result does not change. Alternative information sources may enable decisions around the tolerability of a risk result to be made.
D Adjustment of WSP or WMA 2000 based rules or strategies	Mitigation is possible through adjustment of an existing active (i.e. implemented) water sharing strategy. These strategies are generally those currently implemented via WSPs, the WMA 2000 or related policies. Note: existing strategies that are not modified by this risk treatment option are retained. Other risk results may change as a result of strategy modification. As use of this option may affect risks or a third party, care should be taken to assess the proposed changes through secondary lenses as indicated by the flow chart.
E Implement dormant WSP or WMA 2000 strategies	Mitigation is possible through the implementation of an existing dormant (i.e. non-implemented but available for use via WSP or WMA 2000) water sharing strategy. These strategies often describe alternative levels of management intensity than the implemented active strategy. Examples include IDELs/TDELs or local area management in groundwater systems where they are not already in place. Note: unaffected existing strategies are retained, risk results may change. As use of this option may affect risks or a third party, care should be taken to assess the proposed changes through secondary lenses as indicated by the flow chart.
F (i) Develop and implement new water sharing strategies	Mitigation is possible through the development and implementation of new WSP or WMA 2000 based sharing strategies such as rules, policies or other processes. Note: unaffected existing strategies are retained, risk results may change. As use of this option may affect risks or a third party, care should be taken to assess the proposed changes through secondary lenses as indicated by the flow chart.
F (ii) Develop / implement new strategies (WRP/WQSMP/IRG/LTWP/ BP)	Mitigation is possible through the development and implementation of new strategies that are not covered by F(i) and are related to the introduction of the Basin Plan and appear in associated instruments. Note: unaffected existing strategies are retained, risk results may change. As use of this option may affect risks or a third party, care should be taken to assess the proposed changes through secondary lenses as indicated by the flow chart.
G (i) Review interaction with complementary WMA 2000 processes	The WMA 2000 covers a broad range of activities of which water sharing is one. This option focuses on reviewing linkages to WMA 2000 based strategies that are complementary to water sharing such as floodplain harvesting and floodplain management. Note: unaffected existing strategies are retained, risk results may change. As use of this option may affect risks or a third party, care should be taken to assess the proposed changes through secondary lenses as indicated by the flow chart.
G (ii) Review interaction with strategies available under other legislation	Other legislative instruments that contain strategies that may mitigate risk to water sources (e.g. the Environmental Planning and Assessment Act 1979, Contaminated Land Management Act 1997, Dam Safety Act 2015). Multi agency strategies such as the NSW Cold Water Pollution Strategy and others covering land management should also be included. This strategy type aims to review interaction with and improve linkages to complementary non WMA 2000 or Basin Plan processes and controls. Examples include: major storage infrastructure upgrades can mitigate risk to the environment from cold water pollution; improvement in land use management practices can reduce the risk to the environment by reducing suspended solid loads. Note: unaffected existing strategies are retained, risk results may change. As use of this option may affect risks or a third party, care should be taken to assess the proposed changes through secondary lenses as indicated by the flow chart.

9.1. Existing water resource management strategies, actions and mechanisms

This risk assessment has assessed risks with existing WSP or WMA 2000 based rules in place. It builds on the knowledge and experience of earlier risk based approaches to water planning and management in NSW (NoW, 2011). A range of strategies under the WMA 2000 and associated WSPs address risk for the WRP area, these are consistent with strategies applied elsewhere in the NSW portion of the Basin and other areas of the State. These strategies have been identified for each risk as water management actions and mechanisms in previous sections of this report. They are also shown later in this chapter in the strategy summary table (Table 9-7) and the consolidated risk table. Further information on existing strategies and the way in which they address risk can also be found in the following documents (Table 9-2), and other material available from the DoI-Water website. These references are provided for background information purposes and may be replaced with updated references as water resource plans are finalised and implemented.

Table 9-2 Further information regarding existing WMA 2000 based strategies, actions and mechanisms

Document
Evaluation of NSW Water sharing plans for the major regulated rivers in the Murray-Darling Basin (DPI 2017) (in final draft)
Water Sharing Plan for the Namoi Unregulated and Alluvial Water Sources Background Document, DPI Water 2013
Water Sharing Plan Peel Valley regulated, unregulated, alluvial and fractured rock water sources Background Document, NSW Office of Water 2010
A guide to the Water Sharing Plan for the Upper and Lower Namoi Regulated River Water Sources, NSW Department of Infrastructure, Planning and Natural Resources 2004.
Macro water sharing plans – the approach for unregulated rivers. A report to assist community consultation, Office of Water 2011
Water sharing plans - Inland NSW unregulated and alluvial water sources – Overview NSW, Office of Water 2011

9.2. Tolerable risk results

A medium or high risk result does not necessarily imply that existing water management strategies require change or are inadequate. In many circumstances these risks will already have an appropriate level of management in place under the WMA 2000 that is commensurate with the risk result (i.e. via the relevant water sharing or other water management plans, water management policies etc.). In these situations NSW has made an informed decision to accept the risk result as an acceptable or tolerable risk in line with the *Basin Plan Water Resource Plan Requirements Position Statement 9B Strategies for addressing risks.* 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 required or possible.

There are a variety of reasons why medium or high risk results may be tolerable including acceptance of fundamental changes river regulation has made to some NSW rivers and the balancing of environmental, social, cultural and economic demands on water resources. Table 9-3 lists the criteria that have been used to predefine risk results as tolerable. If a risk does not appear, no predefined criteria have been identified. The consolidated risk table identifies for each river reach the tolerable status and relevant rationale for each risk result. As noted earlier, strategies relating to risks to water quality are not discussed in this chapter; refer to the WQM Plan for this material.

Table 9-3 Tolerable risk result rationale

Risk	Component	Tolerable rationale
E(W) Risk to water available for the environment due to river regulation and licensed extraction (regulated rivers)	Zero flows	Zero flow periods cannot be scheduled due to dam operational constraints and requirements to deliver water orders and BLR (stock and domestic) replenishment flows. This impact is most pronounced in reaches closest to Keepit, Split Rock and Chaffey dams. Zero flow periods will exhibit more natural patterns towards the downstream end of the water source.
	Base flows	Base flows cannot be scheduled due to dam operational constraints and requirements to deliver water orders and BLR (stock and domestic) replenishment flows. This impact is most pronounced in reaches closest to Keepit, Split Rock and Chaffey dams. Base flows will exhibit more natural patterns towards the downstream end of the water source.
	Fresh flows	Water ordering patterns have altered the duration and timing of freshes leading to unnaturally long events in summer and less events in winter. This impact is most pronounced in the Lower Namoi River where there are no significant tributary inflows, and in the Gunidgera / Pian Creek system.
	Bank full flows ARI 1.5	Water ordering patterns have altered the duration and timing of bank full events, leading to more events in summer and less events in winter. This impact is similar for the Peel River downstream of Chaffey dam and the Namoi River downstream of Keepit Dam, where there are no significant tributary inflows.
		There are no tributaries in the river reach immediately below Chaffey and Keepit Dams to supplement PEW or HEW releases to order to achieve bank full or over bank flows.
		In the Peel River 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. In the Namoi River this high risk is driven by a high likelihood and a medium ecological consequence. The ability to mitigate the likelihood is low, hence the risk is tolerable.
	Over bank flows ARI 2.5	River regulation, water ordering patterns, and third party inundation risks prevent an increase in the frequency of 2.5 ARI flows
		In the Peel River 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. In the Namoi River this medium risk is driven by a medium likelihood and a medium ecological consequence. The ability to mitigate the likelihood is low, hence the risk is tolerable.
		There are no tributaries in the river reach immediately below Chaffey and Keepit Dams to supplement PEW or HEW releases to order to achieve bank full or over bank flows. The ability to mitigate the likelihood is low, hence the risk is tolerable
	Over bank flows ARI 5	River regulation, water ordering patterns, and third party inundation risks prevent an increase in the frequency of 5 ARI flows
		In the Peel River 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. In the Namoi River this medium risk is driven by a medium likelihood and a medium ecological consequence. The ability to mitigate the likelihood is low, hence the risk is tolerable
		There are no tributaries in the river reach immediately below Chaffey and Keepit Dams to supplement PEW or HEW releases to order to achieve bank full or over bank flows. The ability to mitigate the likelihood is low, hence the risk is tolerable

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

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

In this assessment risk treatment option C *Expert opinion with MER confirmation* has been applied to the following risks.

9.2.2.1. Risk to the environment and capacity to meet environmental water requirements from insufficient water (unregulated rivers)

The level of risk to the environment from water extraction in unregulated rivers has been difficult to assess. As there is little water extraction information collected, volumes and patterns of current use cannot be used to determine the likelihood of extraction impacts. The best available information is the entitlement information shown on water access licences and in WSPs. While this can be used to assess the risk to the environment for full extraction development, the information reflects potential risk rather than the current risk in those water sources where extraction has not reached full development levels.

In many circumstances these water sources may already have an appropriate level of management in place under the WMA 2000 that is commensurate with the risk from current levels of water extraction. As the level of risk for many unregulated water sources is unclear, risk treatment option C has been applied and a strategy developed to improve the knowledge used to assess risk from extraction in unregulated sections of the WRP area (see strategy 17 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 17.

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 uncontrolled / supplementary flow events to manage environmental outcomes within the lower portions of the Namoi Surface WRPA	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 (e.g., Gunidgera / Pian system) 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 (EWA/ECA) and relevant held environmental water licences as guided by the 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.
N4 Limit growth in BLR (domestic and stock rights) when a land holding is subdivided and there is high hydrological stress on the river	Risks: Risks to water available for the environment from extraction by basic landholder rights (unregulated) and Risk to water available for other uses from growth in BLR (unregulated rivers) Risk driver addressed: Likelihood of growth in extraction for basic landholder rights (domestic and stock rights) Locations: unregulated water sources with high hydrological stress at low flow Benefits: Maintain access for other consumptive users in peri urban and other areas of

	population growth. Refer to earlier sections of this report for discussion of BLR 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 on can be found in the MER Plan.

Table 9-6 Knowledge strategies

Strategy	Mechanism and description
17 Improve knowledge used to assess risk in unregulated sections of the WRPA	N5 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*
18 Improve knowledge of effectiveness of existing strategies	N6 Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies This risk assessment recommends review of current extraction management strategies in those unregulated water sources where medium or high risks have not been assessed as tolerable and no new strategies have been identified. Refer to the MER plan for further information. In this WRP area those water sources are: **Chaffey, Cockburn River, Lower Coxs, Keepit, Lower Peel, Maules Creek, Mid Macdonald, Mooki River, Pian Creek, Quirindi, Upper Manilla, Upper Namoi, Upper Peel tributaries and Werris Creek.** *Note: where N6 applies, N5 also applies*

9.5. Summary of strategies to address risk

A summary of strategies is presented in Table 9-7 to complement the consolidated risk table. Hydrology components used in this risk assessment and the EWR references from Table 6 of the Namoi Long-term Water Plan Technical Report (DPIE 2019) are provided where relevant in the 'relevant risks column'. This meets the requirements of 10.41(2)(a) and 10.17(1). The listed strategies align with those used in the WRP, WSP, WQM Plan and LTWP objectives. Here, strategies are described with associated actions and mechanisms for each risk and the relevant WRP and water quality objectives. The applicable risk treatment option is included as well as links to relevant sections of the Basin Plan in order to streamline strategy assessment. For more information refer to the document map. Table 9-8 contains a list of abbreviations used in Table 9-7.

Table 9-7 Summary of strategies to address risk

Strategies	Water management actions and mechanisms / supporting activities	RTO*	Associated management plan or instrument	Relevant risks & EWR ref	Relevant BP clauses	Relevant objectives
1 Limit consumptive water extractions in the WRP area to the predefined share of available water. This strategy reserves a share of water for the environment in order to protect: * native fish communities * flow dependent vegetation communities * low flow macroinvertebrate communities * carbon and nutrient flow pathways * flow dependent frog communities * significant in-stream refuge pools, lagoons, wetlands and upland wetlands * connectivity with the Barwon-Darling Watercourse WRP area.	E1 Reserve all water above the long-term average annual extraction limit (LTAAEL) for the environment as PEW (defined and managed by the listed WSPs). E2 Available Water Determinations (AWD) adjust extractive use according to water availability. N1 Sustainable Diversion Limits	**D** **A** **F**	*Water Sharing Plan for the Upper Namoi and Lower Namoi Regulated River Water Sources 2016* *Water Sharing Plan for the Peel Regulated River Water Source 2022* *Water Sharing Plan for the Namoi and Peel Unregulated Water Sources 2012* Namoi Water Resource Plan	**E(W)** Z, BF, F, BKF1.5, OB2.5, OB5 **EWR ref.** LTWP CF1, LTWP VF1, LTWP BF1, LTWP BF2, LTWP SF1, LTWP SF2, LTWP LF1, LTWP LF2, LTWP AC1, LTWP OB1, LTWP OB2, LTWP OB3, LTWP OB4, LTWP OB5	**4.03(3) (a)(iii) (a)(iv) (c) (f)** **Ch. 10 Part 3, Part 8 Part 10**	**WSP** - Part-2 Environmental objectives **WQ** 1, **WQ** 3, **WQ** 4, **WQ** 9
	E 26 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 Upper Namoi and Lower Namoi Regulated River Water Sources 2016* *Water Sharing Plan for the Peel Regulated River Water Source 2022* *Water Sharing Plan for the Namoi and Peel Unregulated Water Sources 2012*			

Strategies	Water management actions and mechanisms / supporting activities	RTO*	Associated management plan or instrument	Relevant risks & EWR ref	Relevant BP clauses	Relevant objectives
	E16 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 management zones to manage growth in use. E5 Prohibit trade between surface water and groundwater sources.	A	*Water Sharing Plan for the Peel Regulated River Water Source 2022* *Water Sharing Plan for the Namoi and Peel Unregulated Water Sources 2012* *Water Sharing Plan for the Namoi Groundwater Sources 2020*			
2 Protect a portion of high flow events in the Namoi WRP area. This strategy reserves a share of high flows for the environment and aims to: * wet benches, banks, wetlands and floodplains, and recharge shallow groundwater lenses to facilitate vegetation growth and recruitment and provide fish and frog habitat, * facilitate the mobilisation of carbon and nutrients from river benches and floodplains, and facilitate deposition into lowland streams and floodplains, * Facilitate fish recruitment and movement, * allow flows to pass through to the Barwon-Darling Watercourse WRP (SW12) area. This strategy provides connectivity between WRP areas and facilitates fish movement and recruitment.	E6a Access to uncontrolled natural flow events in regulated Peel River limited to a maximum of 50 % of forecast uncontrolled flow volume above either 5ML/d or 50ML/d dependent on general security AWDs is < 0.35 ML or > 0.35 ML per unit share component. E6b Supplementary access: In the lower Namoi access to a supplementary event is currently on a trial basis: prior to 1 July 2019, should not exceed 50% of a supplementary event (all year); and after 30 June 2019: 10% access of the supplementary event between 1 July and 31 October and 50% between 1 November and 30 June..	A	*Water Sharing Plan for the Upper Namoi and Lower Namoi Regulated River Water Sources 2016* *Water Sharing Plan for the Peel Regulated River Water Source 2022*	**E(W)** F, BKF1.5, OB2.5, OB5 **E(WQ)** turbidity,TP, TN, dissolved oxygen **EWR ref.** LTWP BF2, LTWP SF1, LTWP SF2, LTWP LF1, LTWP LF2, LTWP AC1, 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 **WQ** 3, **WQ** 4, **WQ** 9
	N2 Strategic use of the uncontrolled / supplementary flow events to manage environmental outcomes within the lower portions of the Namoi WRP as guided by the LTWP (e.g., Gunidgera / Pian system).	F	*Water Sharing Plan for the Upper Namoi and Lower Namoi Regulated River Water Sources 2016* Namoi 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
	E7 Protect large flow events in the Namoi WRP area to meet flow targets in the downstream Barwon-Darling Watercourse (SW12). *Note: contributions towards flow targets are provided by the Gwydir WRP SW15, NSW Border Rivers WRP SW16 and Namoi WRP SW 14 for the purposes of BLR, environmental (fish passage across weirs) and water quality benefit (algal management).*	A	*Water Sharing Plan for the Upper Namoi and Lower Namoi Regulated River Water Sources 2016* *Water Sharing Plan for the Barwon-Darling Unregulated Water Source 2012* Barwon-Darling Watercourse WRP	LTWP OB4, LTWP OB5		
3 Provide discretionary environmental watering events in the regulated river and downstream unregulated river sections of the WRP area. This strategy offsets some effects of river regulation on the environment and aims to: * protect refuge pools during dry periods, * facilitate fish recruitment and movement, * wet benches, banks and wetlands to facilitate vegetation growth and recruitment, * mobilise carbon and nutrients from channels, river benches and low lying areas (wetlands) in the Namoi regulated water source, * reduce prolonged accumulation of organic material on floodplains, * connect the lower Namoi and/or Gunidgera/Pian systems with the Barwon River.	N2 Strategic use of uncontrolled / supplementary flow events to manage environmental outcomes within the lower portions of the Namoi WRP as guided by the LTWP (e.g., Gunidgera / Pian system). .	A	*Water Sharing Plan for the Upper Namoi and Lower Namoi Regulated River Water Sources 2016* Namoi Long Term Water Plan	**E(W)** Z, BF, F, BKF1.5, OB2.5, OB5 **E(WQ)** TP TN **EWR ref.** LTWP CF1, LTWP VF1, LTWP BF1, LTWP BF2, LTWP SF1, LTWP SF2, LTWP LF1, LTWP LF2, LTWP AC1, LTWP OB1, LTWP OB2, LTWP OB3, LTWP OB4, LTWP OB5	**4.03(3) (a)(i) (a)(ii) (a)(iv) (c)** **Ch. 10 Part 6 Part 7**	**WSP** -Part-2 Environmental objectives **WQ** 3, **WQ** 4, **WQ** 9
	E8 Strategic use of environmental water provisions (EWP) as described in the WSP (e.g., Namoi end-of-system minimum daily flows in June, July and August at Walgett when the combined capacity of Keepit and Split Rock dams ≥120 GL). N3 Strategic use of environmental water (EWA/ECA) and relevant held environmental water licences as guided by the LTWP.	A F	*Water Sharing Plan for the Upper Namoi and Lower Namoi Regulated River Water Sources 2016* *Water Sharing Plan for the Peel Regulated River Water Source 2022* Namoi Annual Environmental Water Plans Namoi 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
4 Manage environmental water to meet flow targets specified in the Namoi LTWP. This strategy aims to improve environmental water management in the WRP area.	E9 Uncontrolled flows arising from the release of the Peel ECA into designated sections of the Peel River protected up to 50 ML/day at Piallamore and either or 40 or 50ML/d at Caroll Gap dependent on the general security AWDs.	**A**	*Water Sharing Plan for the Peel Regulated River Water Source 2022*	**E(W)** Z, BF, F, BKF1.5, OB2.5, OB5 **EWR ref.** LTWP CF1, LTWP VF1, LTWP BF1, LTWP BF2, LTWP SF1, LTWP SF2, LTWP LF1, LTWP LF2, LTWP AC1, LTWP OB1, LTWP OB2, LTWP OB3, LTWP OB4, LTWP OB5	**4.03(3)** **(a)(i)** **(a)(iv)** **(c)** **Ch. 10 Part 6**	**WSP -** Part-2 Environmental objectives **WQ** 2, **WQ** 3, **WQ** 4, **WQ** 5, **WQ** 9,
	E6a Access to uncontrolled natural flow events in regulated Peel River limited to a maximum of 50 % of forecast uncontrolled flow volume above either 5ML/d or 50ML/d dependent on general security AWDs is < 0.35 ML or > 0.35 ML per unit share component. E6b Supplementary access: In the lower Namoi access to a supplementary event is currently on a trial basis: prior to 1 July 2019, should not exceed 50% of a supplementary event (all year); and after 30 June 2019: 10% access of the supplementary event between 1 July and 31 October and 50% between 1 November and 30 June.	**A**	*Water Sharing Plan for the Upper Namoi and Lower Namoi Regulated River Water Sources 2016* *Water Sharing Plan for the Peel Regulated River Water Source 2022*			
	E11 Coordinate release of environmental water provision / held environmental water with natural flow events. E8 Strategic use environmental water allowance (EWA) as described in the WSP (e.g., Namoi end-of-system minimum daily flows in June, July and August at Walgett when the combined capacity of Keepit and Split Rock dams ≥120 GL).	**A**	*Water Sharing Plan for the Upper Namoi and Lower Namoi Regulated River Water Sources 2016* *Water Sharing Plan for the Peel Regulated River Water Source 2022* Namoi Annual Environmental Water Plans			

Strategies	Water management actions and mechanisms / supporting activities	RTO*	Associated management plan or instrument	Relevant risks & EWR ref	Relevant BP clauses	Relevant objectives
	N2 Strategic use of uncontrolled / supplementary flow events to manage environmental outcomes within the lower portions of the Namoi WRP as guided by the LTWP (e.g., Gunidgera / Pian system).	F	*Water Sharing Plan for the Upper Namoi and Lower Namoi Regulated River Water Sources 2016* Namoi Long Term Water Plan			
5 Protect low flow habitats from accelerated rates of drying. This strategy offsets impacts of water extraction in rivers of the WRP area and aims to: * maintain surface water connectivity and habitat variability, * prevent accelerated rates of deterioration in water quality, * maintain surface/groundwater connectivity where there is groundwater-dependent riparian vegetation. *Note: BLR replenishment flows may provide incidental environmental benefit in line with this strategy.*	E12 Cease / commence to pump rules for streams.	A	*Water Sharing Plan for the Peel Regulated River Water Source 2022* *Water Sharing Plan for the Namoi and Peel Unregulated Water Sources 2012*	**E(W)** Z, BF, F **EWR ref.** LTWP CF1, LTWP VF1, LTWP BF1, LTWP BF2, LTWP SF1, LTWP AC1	**4.03(3) (a)(i) (a)(ii) (a)(iv) (c) (d)** **Ch. 10 Part 4, Part 6**	**WSP** - Part-2 Environmental objectives **WQ** 1, **WQ** 2, **WQ** 3, **WQ** 4, **WQ** 5, **WQ** 6, **WQ** 9 -
	E9 Uncontrolled flows arising from the release of thePeelECA into designated sections of the Peel Riverprotected up to 50 ML/day at Piallamore and eitheror 40 or 50ML/d at Caroll Gap dependent on the general security AWDs.	A	*Water Sharing Plan for the Peel Regulated River Water Source 2022*			
	E8 Strategic use environmental water allowance (EWA) as described in the WSP (e.g., Namoi end-of-system minimum daily flows in June, July and August at Walgett when the combined capacity of Keepit and Split Rock dams ≥120 GL).	A	*Water Sharing Plan for the Upper Namoi and Lower Namoi Regulated River Water Sources 2016* Namoi Long Term Water Plan Namoi Annual Environmental Water Plans			
	N3 Strategic use of environmental water (EWA/ECA) and relevant held environmental water licences as guided by the LTWP.	F				
	Note: Complimentary groundwater actions and mechanisms are identified in the Namoi Alluvium Water Resource Plan (GW14).		Namoi Alluvium Water Resource Plan (GW14)			
6 Protect pools in streams, wetlands, lagoons and floodplains within the WRP area during dry	E13 Cease / commence to pump rules for in-stream and off-river pools.	A	*Water Sharing Plan for the Peel Regulated River Water Source 2022*	**E(W)** Z, BF, F	**4.03(3) (a)(i)**	**WSP** - Part-2 Environmental

Strategies	Water management actions and mechanisms / supporting activities	RTO*	Associated management plan or instrument	Relevant risks & EWR ref	Relevant BP clauses	Relevant objectives
periods. Thisstrategyoffsets impacts of water extraction frompools and aims to maintain natural rates of drying to protect water quality, and provide refugiahabitatforfish, frogs and other water-dependent biota.	E12 Cease / commence to pump rules for streams.	A	*Water Sharing Plan for the Namoi and Peel Unregulated Water Sources 2012*	**E(WQ)** all **EWR ref.** LTWP CF1, LTWP VF1, LTWP BF1, LTWP BF2, LTWP SF1	**(a)(ii)** **(a)(iv)** **(c)** **Ch. 10 Part 4 Part 6 Part 7**	objectives **WQ** 1, **WQ** 3, **WQ** 4, **WQ** 5, **WQ** 9
	E14 Authorised in-river dam construction, operation, and passing flow requirements as specified on the dam approval.	A				
	E15 Restrict construction of in-river dams on 3rd order or higher streams.	A				
	E4 Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage growth in use.	A				
7 Protect important lagoons and wetlands within the WRP area. This strategy aims to limit extraction induced declines in water quality and condition of: significant wetlands and lagoons in the lower portion of the WRP area	E12 Cease / commence to pump rules for streams.		*Water Sharing Plan for the Namoi and Peel Unregulated Water Sources 2012*	**E(WQ)** all **EWR ref.** LTWP CF1, LTWP VF1, LTWP BF1, LTWP BF2, LTWP SF1	**4.03(3)** **(a)(i)** **(a)(ii)** **(a)(iv)** **(c)** **Ch 10 Part 4 Part 6 Part 7**	**WSP -** Part-2 Environmental objectives **WQ** 3, **WQ** 4
	E13 Cease / commence to pump rules for in-stream and off-river pools.					
	E15 Restrict construction of in-river dams on 3rd order or higher streams					
	E4 Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage entitlement growth.					
8 Protect tributary flows within the WRP area as they move from the unregulated water source into the regulated river water source. This strategy protects connectivity within the WRP area and facilitates:	E12 Cease / commence to pump rules for streams.	A	*Water Sharing Plan for the Peel Regulated River Water Source 2022* *Water Sharing Plan for the Namoi and Peel Unregulated Water Sources 2012*	**E(W)** Z, BF **E(WQ-CWP)** **EWR ref.** LTWP CF1,	**4.03(3)** **(a)(i)** **(a)(ii)** **(a)(iv)** **(c)**	**WSP -** Part-2 Environmental objectives **WQ** 5, **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
* fish dispersal and carbon and nutrient transport, * facilitate thermal mixing in the Lower Namoi and Peel Regulated River Water Sources.	E6a.Accessto uncontrolled natural flow events in regulatedPeel River limited to a maximum of 50 % of forecast uncontrolled flow volume above either 5ML/d or 50ML/d dependent on general security AWDs is < 0.35 ML or > 0.35 ML per unit share component. E6b Supplementary access: In the lower Namoi access to a supplementary event is currently on a trial basis: prior to 1 July 2019, should not exceed 50% of a supplementary event (all year); and after 30 June 2019: 10% access of the supplementary event between 1 July and 31 October and 50% between 1 November and 30 June.	A	*Water Sharing Plan for the Upper Namoi and Lower Namoi Regulated River Water Sources 2016* *Water Sharing Plan for the Peel Regulated River Water Source 2022*	LTWP VF1, LTWP BF1	**Ch. 10 Part 6 Part 7**	
9 Protect the regulated river sections of the WRP area from rapid increases and decreases in flow following releases from Chaffey, Split Rock and Keepit Dams. This strategy protects the integrity of river banks and assists in the management of suspended sediment loads.	E10 Rates of change to storage release protocol.	A	*Water Sharing Plan for the Upper Namoi and Lower Namoi Regulated River Water Sources 2016* *Water Sharing Plan for the Peel Regulated River Water Source 2022* WaterNSW Chaffey, Split Rock and Keepit Dam Water Supply Work Approvals	**E(WQ)** Turbidity	**4.03(3) (a)(ii) (a)(iv) (c)** **Ch. 10 Part 7**	**WSP -** Part-2 Environmental objectives **WQ** 1, **WQ** 2, **WQ** 3, **WQ** 5, **WQ** 6
10 Recognise the contribution of Chaffey, Split Rock and Keepit Dam release strategies towards the maintenance of water quality within the regulated sections of the WRP area. This strategy aims to mitigate the following water	E9 Uncontrolled flows arising from the release of the Peel ECA into designated sections of the Peel River protected up to 50 ML/day at Piallamore and either or 40 or 50ML/d at Caroll Gap dependent on the general security AWDs.	A	*Water Sharing Plan for the Peel Regulated River Water Source 2022* Water Quality Management Plan for the Namoi WRP area	**E(WQ-S)** **E(WQ-CWP)** **E(WQ)**	**4.03(3) (a)(i) (a)(ii) (a)(iv) (c)**	**WSP -** Part-2 Environmental objectives **WQ** 1, **WQ** 2, **WQ** 3, **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
quality impacts of river regulation and flow regime alteration: * minimise the risk of cold or warm water thermal shock, * reduce the risk of CWP or poor WQ, * facilitate the dilution of saline tributary inflows from Mooki and Coxs creeks on the Namoi; and, Goonoo Goonoo, Tangaratta and Timbumburri creeks on the Peel. *Note: all releases made from Chaffey, Split Rock and Keepit Dams contribute to the achievement of this aspect of the strategy.*	E6a.Accessto uncontrolled natural flow events in regulatedPeel River limited to a maximum of 50 % of forecast uncontrolled flow volume above either 5ML/d or 50ML/d dependent on general security AWDs is < 0.35 ML or > 0.35 ML per unit share component. E6b Supplementary access: In the lower Namoi access to a supplementary event is currently on a trial basis: prior to 1 July 2019, should not exceed 50% of a supplementary event (all year); and after 30 June 2019: 10% access of the supplementary event between 1 July and 31 October and 50% between 1 November and 30 June.	A	*Water Sharing Plan for the Upper Namoi and Lower Namoi Regulated River Water Sources 2016* *Water Sharing Plan for the Peel Regulated River Water Source 2022* Water Quality Management Plan for the Namoi WRP area		(d) Ch. 10 Part 6 Part 7	WQ 6
	E8 Strategic use environmental water allowance (EWA) as described in the WSP (e.g., Namoi end-of-system minimum daily flows in June, July and August at Walgett when the combined capacity of Keepit and Split Rock dams ≥120 GL). N3 Strategic use of environmental water (EWA/ECA) and relevant held environmental water licences as guided by the LTWP.	A F	*Water Sharing Plan for the Upper Namoi and Lower Namoi Regulated River Water Sources 2016* Namoi Long Term Water Plan Namoi Annual Environmental Water Plans			
	E17 Improve dam infrastructure and its management so that water releases are more closely matched to Namoi River ambient temperatures.	A	NSW Cold Water Pollution Strategy WaterNSW Keepit Dam Water Supply Work Approval			

Strategies	Water management actions and mechanisms / supporting activities	RTO*	Associated management plan or instrument	Relevant risks & EWR ref	Relevant BP clauses	Relevant objectives
11 Implement the WQM Plan for the WRP area.	*Refer to the WQM Plan for detailed listing. Note: actions and mechanisms are relevant to the WRP are listed in previous strategies.*	F	Water Quality Management Plan for the Namoi 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 **WQ** 1, **WQ** 2, **WQ** 3, **WQ** 4, **WQ** 5, **WQ** 6, **WQ** 7, **WQ** 8, **WQ** 9.
12 Protect stream flow from reduced runoff attributable to farm dam interception. This strategy aims to reduce impacts on the health of rivers and on other consumptive water users.	E18 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.	A	*Water Sharing Plan for the Peel Regulated River Water Source 2022* *Water Sharing Plan for the Namoi and Peel Unregulated Water Sources 2012* Harvestable Rights Policy (commenced 1999) NSW Government Gazette 40 dated 31 March 2006	**E(I-FD)** **O(I-FD)**	**4.03(3)(a)(iv)(c)(h)(i)** **Ch. 10 Part 5**	**N/A**
13 Protect stream flow from reduced runoff attributable to plantation forestry interception. This strategy aims to reduce impacts on the health of rivers and on other consumptive water users.	E19 Plantation forestry interception is considered low risk therefore no mechanisms have been implemented under the WMA 2000.	A	Plantation Forestry Policy Plantations and Reafforestation Act 1999 (PRA) Plantations and Reafforestation (Code) Regulation 2001 Namoi 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**
	E20 Ongoing risk monitoring to determine impact of future expansion of forest plantations at local and regional scales.	B				

Strategies	Water management actions and mechanisms / supporting activities	RTO*	Associated management plan or instrument	Relevant risks & EWR ref	Relevant BP clauses	Relevant objectives
14 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 averageannualextraction limit (LTAAEL) for the environment as PEW (defined and managed by the listed WSPs). E2Available Water Determinations (AWD) adjust extractive use according to water availability. N1 Sustainable Diversion Limits.	D F	*Water Sharing Plan for the Peel Regulated River Water Source 2022* *Water Sharing Plan for the Namoi and Peel Unregulated Water Sources 2012* *Water Sharing Plan for the Upper Namoi and Lower Namoi Regulated River Water Sources 2016* Namoi Water Resource Plan *NSW Water Strategy. Implementation Plan-2022 to 2024. September 2022.*	**E(CC)** **O(CC)**	**4.03(3)** **(a)(iv)** **(c)** **(g)(iii)** **(h)(iii)** (h)(iii) **Ch. 10 Part 3**	**N/A**
15 Protect the environment from changes in flow attributable to growth in BLR extractive use. This strategy aims to reduce impacts on the health of rivers and on other consumptive water users.	E1 Reserve all water above the long-term averageannualextraction limit (LTAAEL) for the environment as PEW (defined and managed by the listed WSPs). E2Available Water Determinations (AWD) adjust extractive use according to water availability. N1 Sustainable Diversion Limits	D F	*Water Sharing Plan for the Peel Regulated River Water Source 2022* *Water Sharing Plan for the Namoi and Peel Unregulated Water Sources 2012* *Water Sharing Plan for the Upper Namoi and Lower Namoi Regulated River Water Sources 2016* Namoi Water Resource Plan	**E(BLR)**	**4.03(3)** **(a)(iv)** **(c)** **h(ii)** **Ch 10 Part 3**	**N/A**
	E25 Minister may limit growth in BLR when a land holding is subdivided and there is high hydrological stress on the river or aquifer.	D	*Water Management Act 2000* s.52(2)			
	N4 Limit growth in BLR when a land holding is subdivided and there is high hydrological stress on the river or aquifer.	D	*Note: NSW Planning processes govern land subdivision*			

Strategies	Water management actions and mechanisms / supporting activities	RTO*	Associated management plan or instrument	Relevant risks & EWR ref	Relevant BP clauses	Relevant objectives
16 Protect other water users from changes in flow attributable to growth in BLR extractive use. This strategy aims to reduce impacts on other consumptive water users. *Note: BLR are established and controlled through the WMA and are recognised in WSPs. Control mechanisms are only applied when required.*	E21 Restrict BLR access through the establishment of mandatory guidelines E22 Temporarily restrict access under the WMAs. 324 when there are water shortages.	A	*Water Management Act 2000* s.52(2), s.336B, s.324	**O(BLR)**	**4.03(3)(a)(iv)(c)(d)h(ii)** **Ch. 10 Part 3**	**N/A**
	E24 Minister may temporarily restrict access where it is in the public interest to do so.		*Water Management Act 2000 s.324(1)*			
	E25 Minister may limit growth in BLR when a land holding is subdivided and there is high hydrological stress on the river or aquifer.		*Water Management Act 2000* s.52(2)			
	E27 Minister may direct landholder accessing BLR to not waste or improperly use water		*Water Management Act 2000 s.325*			
	N4 Limit growth in BLR when a land holding is subdivided and there is high hydrological stress on the river or aquifer.	D	*Note: NSW Planning processes govern land subdivision*			
17 Improve knowledge used to assess risk in unregulated sections of the WRP area.	N5 Projects resulting from application of risk treatment option C Fill knowledge gap / evaluate effectiveness of existing strategies. *Note: It is expected there will be ongoing monitoring to determine current extraction in the unregulated water sources of the WRP area resulting in a dataset that can be used to assess and monitor the likelihood component of relevant risks.*	C	Namoi Monitoring, Evaluation and Reporting Plan	**E(W)** unregulated Z, BF, F **EWR ref.** LTWP CF1, LTWP VF1, LTWP BF1, LTWP BF2, LTWP SF1	**4.03(3)(c)** **4.03(3)(i)(i)** **4.03(3)(i)(ii)**	**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
18 Improve knowledge of effectiveness of existing strategies.	N6 Reviews resulting from application of risk treatment option B Fill knowledge gap / evaluate effectiveness of existing strategies.	**B**	Namoi Monitoring, Evaluation and Reporting Plan.	**E(W)** unregulated Z, BF, F **EWR ref.** LTWP CF1, LTWP VF1, LTWP BF1, LTWP BF2, LTWP SF1	**4.03(3)** **(b)** **(c)** **(e)** **(g)** **4.03(3)(i)(i)** **4.03(3)(i)(ii)**	**N/A**
19 Protect the environment and other users from changes in flow attributable to growth in Floodplain harvesting.	E23 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 Upper Namoi and Lower Namoi Regulated River Water Sources 2016* *Water Sharing Plan for the Peel Regulated River Water Source 2022* Namoi Water Resource Plan NSW Floodplain Harvesting Policy	E(I-FH) O(I-FH) EWR ref. LTWP AC1 LTWP OB1-4	4.03(3)(h)(i), Ch 10, Part 5	**N/A**

*RTO: risk treatment options

Table 9-8 Abbreviations used in Table 9-7

Abbreviation	Explanation
RTO	Risk treatment option refer Figure 9-1
E	Existing action / mechanism / supporting activity
N	New or modified action / mechanism / supporting activity
E(W)	Risks to water available for the environment due to river regulation and licensed extraction (regulated and unregulated)
E(BLR)	Risks to water available for the environment from extraction by basic landholder rights
E(I-FD)	Risk to water available for the environment from interception activities (farm dams)
E(I-PF)	Risk to water available for the environment from interception activities (plantation forestry)
E(I-M)	Risk to water available for the environment from interception activities (mining)
E(I-FH)	Risk to water available for the environment from interception activities (floodplain harvesting)
E(CC)	Risk to water available for the environment due to climate change (regulated)
E(WQ-CWP)	Risk to the health of water-dependent ecosystems from poor water quality (cold water pollution)
E(WQ-WWP)	Risk to the health of water-dependent ecosystems from poor water quality (warm water pollution)
E(WQ)	Risk to the health of water-dependent ecosystems from poor water quality (TP, TN, pH, Turbidity, DO)
E(WQ-S)	Risk to the health of water-dependent ecosystems from poor water quality (instream salinity)
O(WQ-BGA)	Risks to recreational water quality and human health from blue-green algae
O(I-FD)	Risk to water available for other uses from interception activities (farm dams) (regulated rivers)
O(I-PF)	Risk to water available for other uses from interception activities (plantation forestry) (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 CF1	Cease-to-flow, no greater than modelled natural maximum inter-flow period (note LTWP flow components do not provide definitions of percentiles or frequencies)
LTWP VF1	Very-low flow, no greater than modelled natural maximum inter-flow period (note LTWP flow components do not provide definitions of percentiles or frequencies)
LTWP BF1	Base flow, As required during dry periods maximum inter-flow period (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 migratory fish. This is different to the definition used in this risk assessment which defines base flow as a flow percentile or flow component.
LTWP BF2	Base flow, 2 year maximum inter-flow period (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 migratory fish. This is different to the definition used in this risk assessment which defines base flow as a flow percentile or flow component.
LTWP SF1	Small fresh, 1 year maximum inter-flow period (note LTWP flow components do not provide definitions of percentiles or frequencies)
LTWP SF2	Small fresh, 2 years maximum inter-flow period (note LTWP flow components do not provide definitions of percentiles or frequencies)
LTWP LF1	Large fresh, 2 years maximum inter-flow period (note LTWP flow components do not provide definitions of percentiles or frequencies)
LTWP LF2	Large Fresh, 4 years maximum inter-flow period (note LTWP flow components do not provide definitions of percentiles or frequencies)
LTWP LF3	Large Fresh, 4 years maximum inter-flow period (note LTWP flow components do not provide definitions of percentiles or frequencies)
LTWP AC1	Anabranch connection flow, 2 years maximum inter-flow period (note LTWP flow components do not provide definitions of percentiles or frequencies)
LTWP OB1	Over bank, 2 years maximum inter-flow period (note LTWP flow components do not provide definitions of percentiles or frequencies)
LTWP OB2	Over bank, 3–5 years maximum inter-flow period (note LTWP flow components do not provide definitions of percentiles or frequencies)
LTWP OB3	Over bank, 4 years maximum inter-flow period (note LTWP flow components do not provide definitions of percentiles or frequencies)
LTWP OB4	Over bank, 5 years maximum inter-flow period (note LTWP flow components do not provide definitions of percentiles or frequencies)
WSP 1	Regulated WSP (a) protect, maintain or enhance the recorded distribution or extent of target native fish, native vegetation and native frog populations
WSP 2	Regulated WSP (b) protect, maintain or enhance the population structure of target native fish, native frogs and native vegetation communities
WSP 3	Regulated WSP (c) protect, maintain or enhance the connectivity between water sources to support downstream processes including priority carbon and nutrient pathways and priority fish passages
WSP 4 (WQ)	Regulated WSP (d) protect, maintain or enhance water quality to support water dependent ecosystems and ecosystem functions within the water source
WSP 5	Regulated WSP (e) Support environmental watering to contribute to the maintenance or enhancement of ecological condition in streams, riparian zones, dependent wetlands and floodplains within the water source
WSP 6	Unregulated WSP (a) protect, maintain or enhance the recorded distribution or extent of target native fish, native vegetation and native frog populations
WSP 7	Unregulated WSP (b) protect, maintain or enhance the population structure of target native fish, native frogs, native vegetation and low flow macroinvertebrate communities
WSP 8	Unregulated WSP (c) protect, maintain and/or enhance the connectivity between these water sources and other water sources, including to support downstream processes including priority carbon and nutrient pathways and priority fish passages

WSP 9 (WQ)	Unregulated WSP	(d) protect, maintain and/or enhance water quality to support water dependent ecosystems and ecosystem functions within the water source
WSP 10	Unregulated WSP	(e) protect significant identified lagoons and wetlands, and upland wetlands of the New England Tablelands Bioregion endangered ecological community within these water sources
WSP 11	Unregulated WSP	(f) protect connectivity with the upstream Namoi Regulated River Water Source to support environmental watering events that contribute to the maintenance or enhancement of ecological condition within these water sources

Abbreviation	Explanation	
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 Namoi River 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 regulated Namoi, Manilla and Peel Rivers 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
WQ9	Water Quality Objective 9	Protect, maintain or enhance connectivity between water sources to support downstream processes including priority carbon and nutrient pathways (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

References

ABS (2010) Measures of Australia's Progress Land Theme: Plantation Forests: http://www.abs.gov.au/ausstats/abs@.nsf/Lookup/by%20Subject/1370.0~2010~Chapter~Plantation%20forests%20%286.2.4.3%29, Australian Bureau of Statistics, viewed 25 May 2015.

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

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, ACT.

Basin Plan (2012) Amendment to the Water Act 2007, Commonwealth.

Baumgartner LJ & Boys C (2012) Reducing the perversion of diversion: Applying world-standard fish screening practices to the Murray-Darling Basin. Ecological Management & Restoration 13, 135–143.

Baumgartner L, Reynoldson N, Cameron L & Stanger J (2007) The effects of selected irrigation practices on the fish of the Murray-Darling Basin. NSW Department of Primary Industries, Cronulla, NSW.

Bennett J, Sanders N, Moulton D, Phillips N, Lukas G, Walker K & Redfern F (2002) Guidelines for Protecting Australian Waterways. Land and Water Australia, Canberra, ACT.

Boys C, Miles, N. and Raynor T. 2009. Scoping options for the ecological assessment of cold water pollution mitigation downstream of Keepit Dam, Namoi River. Report prepared for the Murray Darling Basin Authority. NSW Department of Primary Industries. ISBN 978-1-921257-82-7.

Brierley G & Fryirs K (2005) Geomorphology and river management: application of the river styles framework. Blackwell Publications, Oxford, UK.

Brooks AP & Brierley GJ (2002) Mediated equilibrium: the influence of riparian vegetation and wood on the long-term evolution and behaviour of a near-pristine river. Earth Surface Processes & Landforms 27, 343-367.

Chessman BC, Fryirs KA & Brierley GJ (2006) Linking geomorphic character, behaviour and condition to fluvial biodiversity: implications for river management. Aquatic Conservation: Marine and Freshwater Ecosystems 16, 267-288.

Commonwealth of Australia (2018) Bioregional Assessment Program: Resource Assessment for the Namoi subregion. https://www.bioregionalassessments.gov.au/assessments/12-resource-assessment-namoi-subregion

Commonwealth of Australia (2018a) Assessing impacts of coal resource development on water resources in the Namoi subregion: Key findings. Product 5: Outcome synthesis for the Namoi subregion from the Northern Inland Catchments Bioregional Assessment https://www.bioregionalassessments.gov.au/assessments/5-outcome-synthesis-namoi-subregion

Commonwealth of Australia (2018b) Impact and risk analysis for the Namoi subregion: Product 3-4 for the Namoi subregion from the Northern Inland Catchments Bioregional Assessment.

Cook N & Schneider G (2006) River Styles® in the Hunter Catchment. Science and Information Division, New South Wales Department of Natural Resources, Sydney, NSW.

CSIRO (2007) Water availability in the Namoi. A report to the Australian Government from the CSIRO Murray-darling Basin Sustainable Yields Project. CSIRO, Australia.

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.

Davies PE, Stewardson MJ, Hillman TJ, Roberts JR & Thoms MC (2012) Sustainable Rivers Audit 2: The ecological health of rivers in the Murray Darling Basin at the end of the millennium drought (2008-2010), vol 1, Murray Darling Basin Authority, Canberra, ACT.

DIPNR (2005) Macro water planning process for unregulated streams: A manual to assist regional agency staff and regional panels to develop water sharing rules in accordance with the Minister's requirements. NSW Department of Infrastructure, Planning and Natural Resources, Sydney, NSW.

DLWC 1998a, *Aquifer Risk Assessment Report*, Department of Land and Water Conservation, Sydney.

DLWC 1998b, *Stressed Rivers Assessment Report, NSW State Summary*, Department of Land and Water Conservation, Sydney.

DLWC 2000. *Namoi: state of the rivers report 2000,* New South Wales Department of land and water Conservation: Sydney

DPI Office of Water (2013) Water Sharing Plan for the Namoi Unregulated and Alluvial Water Sources – Background document. NSW Department of Industries-Office of Water), First published July 2013

DPI Water (2017) Namoi Water Resource Plan: Surface water resource description. NSW Department of Primary Industries, Water, Sydney, NSW.

DPI Water (2017) Draft Floodplain harvesting Monitoring Policy. March 2017. Department of Primary Industries - Water. https://www.water.nsw.gov.au/__data/assets/pdf_file/0016/700801/Draft-floodplain-harvesting-monitoring-policy.pdf

DPI Water (2018) Water quality technical report for the Namoi Water Resource Plan area (SW14), Department of Industry, Lands and Water, Parramatta.

DWE (2009), Basic landholder rights for NSW: Estimations of stock & domestic rights Dept of Water & Energy, September 2009

Green D., Petrovic J., Moss P. and Burrell M. (2011) *Water resources and management overview: Namoi Catchment.* NSW Office of Water, Sydney.

Healey M, Raine A, Parsons L & Cook N (2012) River Condition Index in New South Wales: Method development and application. NSW Office of Water, Sydney, NSW.

Healey M, Raine A, Lewis A, Hossain B, Hancock F & Sayers J and Dabovic J (2018) Applying the High Ecological Value Aquatic Ecosystem (HEVAE) Framework to Water Management Needs in NSW. NSW DPI Water, Sydney, NSW.

Hughey KFD (2013) Development and Application of the River Values Assessment System for Ranking New Zealand River Values. Water Resource Management 27:7, 2013-2027.

Jansen A, Robertson A, Thompson L & Wilson A (2003) Development and application of a method for the rapid appraisal of riparian condition. River Management Technical Guideline No. 4, Land & Water Australia, Canberra, ACT.

Jones M (2009) Effects of environmental flow allocations on the lateral movements of native fish in the Barmah-Millewa Forest. Murray-Darling Basin Commission, Canberra, ACT.

Jones HA & Byrne M (2010) The impact of catastrophic channel change on freshwater mussels in the Hunter River system, Australia: a conservation assessment. Aquatic Conservation: Marine and Freshwater Ecosystems 20, 18-30.

Jones M & Stuart I (2004) Impact of Flow Regulation Structures on Fish in the Barmah-Millewa Forest: Final Report for the Barmah-Millewa Forum. Department of Sustainability & Environment, Melbourne, Vic.

Jones MJ & Stuart IG (2008) Regulated floodplains - a trap for unwary fish. Fisheries Management and Ecology 15, 71–79.

Lintermans, M. (2009). *Fishes of the Murray-Darling Basin*. Murray Darling Basin Authority, Canberra.

Local Land Services (2016) State Strategic Plan 2016 - 2026. Local Land Services NSW. Viewed 9 February 2017. http://www.lls.nsw.gov.au/__data/assets/pdf_file/0007/658492/state-strategic-plan.pdf.

Lovett S & Price P (eds) (2007) Principles of riparian lands management. Land and Water Australia, Canberra, ACT.

Lugg A (1999) Eternal winter in our rivers: Addressing the Issue of Cold Water Pollution. NSW Fisheries, Nowra, NSW.

Lugg A & Copeland C (2014) Review of cold water pollution in the Murray-Darling Basin and the impacts on fish communities, Ecological Management & Restoration vol. 15, pp. 71-79.

Macgregor C, Cook B, Farrell C & Mazzella L (2011) Assessment framework for prioritising waterways for management in Western Australia. Centre of Excellence in Natural Resource Management, University of Western Australia, Albany, WA.

Maloney KO & Weller DE (2011) Anthropogenic disturbance and streams: land use and land-use change affect stream ecosystems via multiple pathways. Freshwater Biology 56, 611-626.

Matheson A & Thoms MC (2017), The spatial pattern of large wood in a large low gradient river: the Barwon–Darling River, International Journal of River Basin Management, 16:1, 21-33, DOI: 10.1080/15715124.2017.1387123.

MDBA (2008) Mapping the growth, location, surface area and age of man-made water bodies, including farm dams, in the Murray-Darling Basin. Murray-Darling Basin Commission, Canberra, ACT.

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

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

MDBA 2015, *Spotlight on Namoi*. Murray-Darling Basin Authority, version February 2015. http://www.mdba.gov.au/sites/default/files/Spotlight-on-Namoi.pdf.

MDBA (2017) The Murray-Darling Basin Water Compliance Review. Containing reports by the Murray-Darling Basin Authority and the Independent Review Panel. November 2017. Licensed from the Murray–Darling Basin Authority under a Creative Commons Attribution 4.0 Licence. Accessed online: https://www.mdba.gov.au/sites/default/files/pubs/MDB-Compliance-Review-Final-Report.pdf

NHMRC (2008) Guidelines for managing risks in recreational water. National Health and Medical Research Council, Canberra, ACT.

NLWRA (2002) *Australian Catchment, River and Estuary Assessment 2002: volume 1*. National Land and Water Resources Audit, Canberra, ACT.

Northey J, Pinetown K and Sander R (2014) Coal and cold seam gas resource assessment for the Namoi subregion. Product 1.2 for the Namoi subregion from the Northern Inland Catchments Bioregional Assessment. Department of the Environment, Bureau of Meteorology, CSIRO and Geoscience Australia, Australia.

NRC (2010) Progress towards healthy resilient landscapes: Implementing the Standards and Targets and Catchment Action Plans – 2010 Progress report. NSW Natural Resource Commission, Sydney. Viewed 9 February 2017. http://www.nrc.nsw.gov.au/publications.

NSW Ministry of Health (2013) NSW Guidelines for Drinking Water Management Systems. Health Protection NSW, NSW Ministry of Health, North Sydney, NSW.

NSW DoI (2019) Risk assessment for the Namoi Alluvial Water Resource Plan Area (GW14). Nsw Department of Industry.

NSW Department of Primary Industries 2015a, *Fish and flows in the Namoi Constraints Management Strategy.* Report prepared for DPI Water. NSW Department of Primary Industries, Tamworth, NSW.

NSW Department of Primary Industries 2015b, *Fish and Flows in the Northern Basin: responses of fish to changes in flow in the Northern Murray–Darling Basin – Valley Scale Report*. Final report prepared for the Murray–Darling Basin Authority. NSW Department of Primary Industries, Tamworth.

NSW DPIE (2019) Namoi Long Term Water Plan. Part A – Namoi Catchment. Draft for exhibition. NSW Department of Planning, Industry and Environment.

NSW Office of Water (2010) Assessment of risk to NSW Murray-Darling Basin shared water resources – 2008. NSW Office of Water, Sydney, NSW.

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 4.

NSW Office of Water (2014) Draft Algal Risk Management Sub-Plan under the NSW Emergency Management Energy and Utility Services Supporting Plan, NSW Office of Water, Sydney, NSW.

NSW Water Management Act (2000) www.legislation.nsw.gov.au/viewtop/inforce/act+92+2000+first+0+N/

NWI (2010), *NWI Policy Guidelines for Water Planning and Management 2010.* National Water Initiative, Canberra, ACT. Accessed online: http://webarchive.nla.gov.au/gov/20160105002803/http://www.coag.gov.au/node/461

OEH (2014) Cooperative management of environmental water to improve river and wetland health in NSW. NSW and Office of Environment and Heritage, Goulburn St, Sydney.

Peterson EE, Sheldon F, Darnell R, Bunn SE & Harch BD (2011) A comparison of spatially explicit landscape representation methods and their relationship to stream condition. *Freshwater Biology* 56, 590-610.

Preece R (2004) Cold water pollution below dams in New South Wales. Department of Infrastructure, Planning and Natural Resources, Sydney, NSW.

Preece, R.M. and Jones, H.A. (2002). The effect of Keepit Dam on the temperature regime of the Namoi River, Australia. River Research and Applications **18**: 397-414.

Raine, A, Healey, M and Ryan, N (2012) *Water Sharing Plans: Priorities for implementation activity in unregulated river water sharing plans - a risk assessment approach,* NSW Office of Water, Sydney.

Robertson AI, Bunn SE, Boon PI & Walker KF (1999) Sources, sinks and transformations of organic carbon in Australian floodplain rivers. Marine & Freshwater Research 50, 813-829.

Ross J, & Jeffrey L (1991) *Groundwater subsidence and bore collapse associated with groundwater withdrawals – Namoi valley,* NSW. TS 91.007.

SKM (2008) Development and implementation of methods to consistently assess risks to shared water resources in the Murray-Darling Basin: 2008 Risk Assessment Guidelines. Sinclair-Knight Merz, Canberra, ACT.

SKM, CSIRO & The Bureau of Rural Sciences (2010) Surface and/or groundwater interception activities: initial estimates. National Water Commission, Canberra, ACT.

SKM (2010) Assessment of the hydrological impact of farm dams in the Murray-Darling Basin. Murray Darling Basin Authority, Canberra, ACT.

SMEC (2010) Afforestation risks to water resources in the Murray-Darling Basin. Murray-Darling Basin Authority, Canberra, ACT.

Standards Australia (2009) Risk management principles – Principles and guidelines. AS/NZS ISO 31000:2009, Sydney, NSW.

Thoms M.C. and Sheldon F. 2000, Lowland rivers: an Australian introduction. *Regulated Rivers: research and Management*. 16, 357-383.

Treadwell S, Koen J, Bunn S & Brooks A (2007) Wood and other aquatic habitat, in S Lovett & P Price (eds) Principles for riparian land management. Land and Water Australia, Canberra, ACT.

Van Dijk A, Evans R, Hairsine P, Khan S, Nathan R, Paydar A, Winey N, & Zhang L (2006) Risks to the Shared Water Resources of the Murray-Darling Basin. Murray-Darling Basin Commission, Canberra ACT.

Van Dijk AIJM, Kirby M, Paydar Z, Podger G, Mainuddin Md, Marvanek S and Peña Arancibia J (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.

VanLaarhoven, JM & van der Wielen, M (2009) Environmental water requirements for the Mount Lofty Ranges prescribed water resource areas. DWLBC Report 2009/29, Department of Water, Land and Biodiversity Conservation & South Australian Murray-Darling Basin NRM Board, Adelaide, SA.

Water Act 2007, www.comlaw.gov.au/series/C2007A00137.

WaterNSW (n.d.) Algae. Accessed online: https://www.waternsw.com.au/water-quality/algae.

Watson G, Nullock E, Sharpe C & Baldwin D (2009) Water quality tolerances of aquatic biota of the Murray-Darling Basin. Report to Murray-Darling Basin Authority. Murray Darling Freshwater Research Centre, Wodonga, Vic.

Welsh W, Hodgkinson J, Strand J, Northey J, Aryal S, O'Grady A, Slatter E, Herron N, Pinetown K, Carey H, Yates G, Raisbeck-Brown N and Lewis S (2014) Context statement for the Namoi subregion. Product 1.1 from the Northern Inland Catchments Bioregional Assessment. Department of the Environment, Bureau of Meteorology, CSIRO and Geoscience Australia, Australia.
https://www.bioregionalassessments.gov.au/assessments/11-context-statement-namoi-subregion

Westhorpe DP, Mitrovic SM, Ryan D & Kobayashi T (2010) Limitation of lowland riverine bacterioplankton by dissolved organic carbon and inorganic nutrients. Hydrobiologia 652, 101-117.

Appendix A Data summary tables

Table A-1 Summary of data used for the Namoi Water Resource Plan Area risk assessment

#	Metric	Data Description	Report Reference	Relevant risk #		Data source/s	Reference	Time period	Data confidence	Reasoning
	Basin Plan requirements	The MDBA provides a number of Position Statements (PS) that provide guidance material	not listed (generic background information logic to the RA)			1. Relevant Position Statements (PS) for the development of a Risk Assessment include but are not limited to: PS 1B, 4A, 5A, 6A, 7B, 9A, 9B, 12A	https://www.mdba.gov.au/publications/policies-guidelines/water-resource-plans-what-they-are-how-they-are-developed	Not Applicable (N/A)	N/A	Position statements are designed to assist in the development of water resource plans by the Basin states.
	Hydrological modelling - regulated river	Flow Metrics (hydrological alteration): 2800 GL reduction scenario (MDBA 2012) against near-natural condition scenario	4.3.1 (Regulated river water source)	E(W)	Likelihood	1. MDBA 2012. Hydrologic modeling 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: DoI-Water IQQM (Integrated Quantity Quality Model) used for both MDBA & DoI-Water sites. 4. MDBA modelling report appendix - 2800 GL scenario - 847	**Regulated River Hydrologic Sites**: Peel River downstream Chaffey Dam - Peel at downstream Chaffey - Peel at Piallamore - Peel at Carroll Gap Manilla and Namoi River downstream of Split Rock Dam - Manilla River at Brabi - Namoi River at Manilla Railway Bridge Namoi River downstream of Keepit Dam - Namoi at downstream Keepit - Namoi at Boggabri - Namoi at Mollee - Namoi at Bugilbone - Namoi at Goangra - Pian Creek at Rossmorei - Gunidgera Creek at downstream Pian Cutting	July 1895 to June 2009	High	Peer reviewed MDBA (MDBA 2012) & Alluvium (2010) reports. The models provide a tool to apply new management of water resources across a longer period to see how the new arrangements would work under different water availability conditions. For the Basin Plan, the proposed new arrangements have been applied to the historical climate period of July 1895 to June 2009, which covers periods of drought as well as floods. A detailed description for the development of environmental watering requirements for key ecosystem functions and the basis for adopting the flow metrics can be found in 'Attachment C Technical Paper-3' (pp.90-134) in Alluvium (2010).
2	Hydrological modelling - unregulated water sources	Flow Metrics (hydrological alteration): 2800 GL reduction scenario (MDBA 2012) against near-natural condition scenario	4.3.1 (Unregulated water sources)	E(W)	Likelihood	1. Unregulated water sources: single reach DoI-Water IQQM.	**Unregulated River hydrologic Sites:** Upper Baradine Creek; Lower Baradine; Bluevale; Bohena; Brigalow; Bundock; Chaffey; Cockburn River; Coghill Creek; Mid Coxs; Lower Coxs; Etoo Creek; Talluba; Eulah; Goonoo Goonoo; Keepit; Lake Goran; Lower Namoi; Lower Peel tribs; Maules Creek; Mid Macdonald River; Mooki River; Phillip Creek; Pian; Quirindi; Rangira; Split Rock; Spring; Bobbiwaa; Upper Macdonald River; Upper Manilla; Upper Namoi; Upper Peel tribs; Warrah Creek; Werris	July 1895 to June 2009	Moderate	The assessment assumes all entitlement is active, whereas this is unlikely to be the case. The method assumes the worst case scenario and therefore likelihood may be overemphasised.
3	basic landholder rights - unregulated water sources	Based on dividing the 80th percentile flow (for all days) for each water source by the estimated BLR.	4.4.1	E(BLR)	Likelihood	1. Unregulated water sources: single reach DoI-Water IQQM. 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 hydrologic Sites:** Baradine Creek; Bluevale; Bohena; Brigalow; Bundock; Chaffey; Cockburn River; Coghill Creek; Coxs; Etoo & Talluba Creeks; Eulah; Goonoo Goonoo; Keepit; Lake Goran; Lower Namoi; Lower Peel tribs; Maules Creek; Mid Macdonald River; Mooki River; Phillip Creek; Pian; Quirindi; Rangira; Split Rock; Spring & Bobbiwaa; Upper Macdonald River; Upper Manilla; Upper Namoi; Upper Peel tribs; Warrah Creek; Werris.		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)

#	Metric	Data Description	Report Reference	Relevant risk #		Data source/s	Reference	Time period	Data confidence	Reasoning
4	Pest plants and animals	Qualitative assessment	5			Expert opinion	none	Not applicable (N/A)	Low	Qualitative assessment based on department ecohydrology specialist expert opinion
5	Risk from climate change – estimated for regulated and unregulated water sources	Extrapolation of CSIRO MDBSY Project modelling of Duncan's Junction gauge	4.6.4	E(CC)	likelihood	1. CSIRO (2007) Water availability in the Namoi. 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.	Duncan's Junction gauge		Low	Extrapolation of outcomes from a single modelled location, applied to all reaches and water sources in WRP area
6	Interception due to floodplain harvesting	Preliminary modelled estimate of total floodplain harvesting volume	4.5.4	E(I-FH)	likelihood	DPI-Water modelling			Low	Preliminary modelling, indicative only. Modelled estimate is for the WRP Area, no finer scale available

<table>
<tr><th>#</th><th>Metric</th><th>Data Description</th><th>Report Reference</th><th colspan="2">Relevant risk #</th><th>Data source/s</th><th>Reference</th><th>Time period</th><th>Data confidence</th><th>Reasoning</th><th></th></tr>
<tr><td>7</td><td>High ecological value aquatic ecosystems</td><td>HEVAE (high ecological value aquatic ecosystem) - Identifying environmental assets and ecosystems functions</td><td>4.2
4.2.3
4.3.3
4.5.1.1
4.5.2.1
4.5.4.1

6.3.1 (Regulated river water source)
6.4.1
6.5.1
See also Appendix B: HEVAE alignment with Basin Plan Schedules 8 & 9 Appendix C: HEVAE consequence scoring & decision tree</td><td>E(W)
E(BLR)
E(I-FD)
E(I-PF)
E(I-FH)
E(CC)
E(WQ-CWP)
E(WQ-WWP)
E(WQ)
E(WQ-S)</td><td>Consequence</td><td>1. HEVAE data based on the following sources:

Table 1: Data sources used in each of the criteria
<table><tr><th>Criteria</th><th>Data Sources</th></tr><tr><td>Base layer in all criteria</td><td>• River Styles® (DPI Water)
• Geofabric data layer (BOM)
• IBRA Subregions layer (OEH)</td></tr><tr><td>Diversity</td><td>• Fish diversity data (DPI Fisheries)
• AUSRIVAS macroinvertebrate data (OEH)</td></tr><tr><td>Distinctiveness</td><td>• Threatened species, populations and communities (recorded, known and predicted data) (OEH and DPI Fisheries)
• Rare River Styles® (DPI Water)</td></tr><tr><td>Vital Habitat</td><td>• Riparian Woody Extent raster dataset (DECC 2008)
• River Styles® recovery potential (DPI Water)</td></tr><tr><td>Naturalness</td><td>• Hydrologic stress and catchment disturbance (from River Condition Index) (DPI Water);
• Natural Parks estate (OEH)
• RAMSAR/DIWA/SEPP14 (Coastal) (OEH)
• Observed/Expected (O/E) macroinvertebrate data (OEH)</td></tr></table>Table A1 within Healey et al. (2017) also provides examples of primary evidence for each attribute within a HEVAE Criteria that is influenced / associated with hydrological flow.</td><td>1. Healey et al. 2017. Draft Applying the High Ecological Value Aquatic Ecosystem (HEVAE) Framework to Water Management Needs in NSW. DPI Water. June 2017.
2. Aquatic Ecosystems Task Group. 2012. Aquatic Ecosystems Toolkit Module 3: Guidelines for identifying high ecological value aquatic ecosystems (HEVAE). Australian Government Department of Sustainability, Environment, Water, Population and Communities, Canberra.</td><td>Time periods vary for each source: Examples for the following criteria:
'Diversity' fish species abundance data covered a 10-yr period: 2002 - 2011.
'Naturalness' macroinvertebrate data from 1994 - 2013.
For more information see Healey et al. 2017.</td><td>High</td><td>A. External Peer review by three independent organisations and also from NSW DPI-Fisheries.
B. The Threatened Species Table below provides an example list of threatened species of the Namoi Catchment. This information is used in helping determine consequence outcomes in the HEVAE process.</td><td>How Consequence Scores are derived:
Unregulated rivers, the scale of assessment was the Water Source. Each was analysed separately using the HEVAE layer, a licensing layer and the reg river layer (where reg river is excluded from water source);
Regulated river reaches are assessed separately, using the same process and decision tree, but based on individual reaches centred on Hydrologic Indicator sites.
Decision Tree:
The decision tree pushes the user through a series of questions about the ecological value of the Water Source, whether there is extraction in the Water Source, and whether the HEVAE result includes a high 'distinctiveness' metric (i.e. threatened species, populations, communities or rare river styles)</td></tr>
</table>

#	Metric	Data Description	Report Reference	Relevant risk #		Data source/s	Reference	Time period	Data confidence	Reasoning
	Water Quality	Documented procedures are stored in the Corporate Data Quality System (Scientific and Technical Operating Procedures; STOP). All laboratory analysis undertaken at a NATA accredited laboratory. All data was audited and validated in accordance with documented procedures. Quality codes were assigned and the data archived in the Corporate Database (KiWQM).	6. Risks to health of water-dependent ecosystems from poor water quality	E(WQ) E(WQ-CWP) E(WQ-WWP) E(WQ-S)		1. Schedule 11 of Basin Plan lists water quality targets for water-dependent ecosystems and Ramsar wetlands.	Basin Plan 2012, Compilation No.2 (24 November 2016) registered 23 January 2017. W*aterAct2007*, Commonwealth.	2010/11 - 2014/15 (5-year period)	High	The Basin States are required to report against these targets to the MDBA every five years. For this reason, five years of water quality data was used in the Risk assessment, to be consisted with the MDBA reporting requirement. All data are generated according to documented procedures for collecting samples, providing quality control samples and the preservation and transport of samples as recommended in Australia Standard AS/NZS 5667.1:1998 Water Quality Sampling. All procedures are based on, and comply with, recognised departmental and external standards to ensure that the project delivers data of the highest possible standard. HEVAE instream values used to determine impact of water quality on instream biota only at the reach scale (25-km upstream and downstream) and are therefore an approximation for the whole water source.
8	Cold water pollution	Real-time gauge based monitoring	6.3.2	E(WQ-CWP)	Likelihood	1. WaterNSW water quality monitoring stations. 2. Preece, R 2004, Cold water pollution below dams in New South Wales, Department of Infrastructure, Planning and Natural Resources, Sydney. 3. Preece, R.M. and Jones, H.A. 2002. The effect of Keepit Dam on the temperature regime of the Namoi River, Australia. River Research and Applications **18**: 397-414.	Keepit Dam (Namoi River 100km downstream of dam); Chaffey Dam (Peel River immediately downstream of dam); Split Rock Dam (Manilla River immediately downstream of dam)	From March 2012 to January 2016.	High	Based on Real-time data.
9	Warm water pollution	Real-time gauge based monitoring	6.3.2	E(WQ-WWP)	Likelihood	1. WaterNSW water quality monitoring stations	Keepit Dam (Namoi River immediately downstream of dam); Chaffey Dam (Peel River immediately downstream of dam); Split Rock Dam (Manilla River immediately downstream of dam)	From July 2010 to January 2016	High	Based on Real-time data.
10	Water quality - pH, turbidity, total phosphorus & nitrogen, dissolved oxygen	Routine real-time site based sampling	6.4.2	E(WQ)	Likelihood	1. WaterNSW water quality monitoring stations	419024 Peel River at Paradise Weir 419006 Peel River at Carroll Gap 419022 Namoi River at Manilla Railway Bridge 419001 Namoi River at Gunnedah 419003 Narrabri Creek at Narrabri 419021 Namoi River at Bugilbone 419026 Namoi River at Goangra 419010 Macdonald River at Woolbrook 419016 Cockburn River at Mulla Crossing 419027 Mooki River at Breeza 419032 Coxs Creek at Boggabri	2010/11 - 2014/15 (5-year period)	High	Based on Real-time data.

#	Metric	Data Description	Report Reference	Relevant risk #		Data source/s	Reference	Time period	Data confidence	Reasoning
11	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: Namoi River at Goangra (419026)	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)						
12	Recorded mean daily electrical conductivity 2005/06 – 2014/15	Continuous real-time gauge based monitoring	7.3.1	O(WQ-S)	Consequenc	*Not assessed as there are no irrigation infrastructure operators in the Namoi Surface WRPA*				
13	Annual 95th percentile of daily mean electrical conductivity recorded between 2004/05 to 2014/15	Frequency that the 95th percentile of mean daily electrical conductivity exceeds the irrigation salinity target for 10-yr (Northern Basin target = 957µS/cm)	7.3.2	O(WQ-S)	Likelihood	*Not assessed as there are no irrigation infrastructure operators in the Namoi Surface WRPA*				
14	Degree of recreation usage	Level of recreational usage for eight monitoring sites	7.4.2	O(WQ-BGA)	Consequence	1. WaterNSW water quality monitoring stations	Chaffey Reservoir Peel River downstream of Chaffey Dam Split Rock Reservoir Manilla River downstream Split Rock Dam Keepit Reservoir Namoi River downstream of Keepit Dam Yarrie Lake Namoi River at Walgett		Moderate	
15	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	Chaffey Reservoir Peel River downstream of Chaffey Dam Split Rock Reservoir Manilla River downstream Split Rock Dam Keepit Reservoir Namoi River downstream of Keepit Dam Yarrie Lake Namoi River at Walgett	Based on 2006 - 2014	High	Based on Real-time data. The water quality targets for water used for recreational purposes are that the values for cyanobacteria cell counts or bio-volume meet the guideline values set out in Chapter 6 of the Guidelines for Managing Risks in Recreational Water. National Health and Medical Research Council 2008, Guidelines for managing risks in recreational water. (National Health and Medical Research Council, Canberra).
16	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.
17	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.

#	Metric	Data Description	Report Reference	Relevant risk #		Data source/s	Reference	Time period	Data confidence	Reasoning
	Interception Activities	Risk due to interception activities - farm dams, commercial plantations, mining, floodplain harvesting	4.5 8.2	E(I-FD) E(I_PF) O(I-FD) O(I-PF)		1. CSIRO 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. 2. Van Dijk AIJM, et al. (2008) Uncertainty in river modelling across the Murray Darling Basin. A report to the Australian Government from the CSIRO Murray-Darling Basin Sustainable Yields Project, CSIRO Australia. 93pp.			Moderate / High	CSIRO project undergone extensive peer review. Furthermore, NSW obtained the model output data from the MDBYS project (2008) and extracted 112 year time series on a daily time-step as well as the reliability data to improve the quality of analysis (NOW 2010).
18	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. NOW 2010, *Assessment of risk to NSW Murray-Darling Basin shared water resources – 2008*, NSW Office of Water, Sydney. 2. Sustainable Rivers Audit 2 (SRA) in: MDBA 2011, Assessment of the hydrological impact of farm dams in the Murray-Darling Basin. Murray Darling Basin Authority, Canberra. https://www.mdba.gov.au/sites/default/files/archived/annualreports/2011-12/chapter_02_6.html 3. CSIRO 2008, Water availability in the Murray-Darling Basin; A report to the Australian Government from the CSIRO Murray-Darling Basin Sustainable Yields Project. CSIRO, Australia.	Namoi High Security Namoi General Security Namoi Supplementary Water Peel High Security Peel General Security Peel Supplementary (uncontrolled) Water	Based on 2004/2005 satellite imagery (MDBYS Project) compared to 1994 to determine growth trends over 10-yr. Also based on period of prediction (from 2020 - 2030) and current period (from 2003 - 2008) (Van Dijk, 2008).	Moderate / High	Peer reviewed. 1. The estimated uncertainty associated with farm dam growth and plantation expansion is estimated in the order of 1 percent of total inflows across the MDB, increasing up to about 3 percent in sensitive regions, and more in certain catchments within regions. These are small numbers when compared to climate and other uncertainties (Van Dijk, 2008). 2. The uncertainty associated with the impact of farm dams is greater than that associated with forestry, particularly when considering the large uncertainty in farm dam expansion rate estimates. The estimate rate is about an order of magnitude smaller than rates in the recent past and therefore this must still be considered a significant uncertainty. If farm dam construction rates were to be closer to historical rates their impact would be very significant in several regions, and therefore this may still be considered a significant risk (Van Dijk, 2008). 1. Control measure: harvestable rights provisions which are one of the basic landholder rights under the WMA (NOW 2010). 2. Farm dams, forestry plantations and floodplain harvesting are all instances of non-metered take. Therefore, the hydrometric network and hydrological modelling are the way in which estimates are derived (MDBA 2017. The Murray-Darling Basin Water Compliance Review. Licensed from the MDBA under a Creative Commons Attribution 4.0 Licence).
19	Ability to meet environmental flow objectives		4.5.1.1	E(I-FD)	Consequence		Namoi River billabongs and wetlands Lake Goran		Moderate / High	
20	Change in average annual diversions and allocations for licence holders		8.2.1.1	O(I-FD)	Consequence		Namoi High Security Namoi General Security Namoi Supplementary Water Peel High Security Peel General Security Peel Supplementary (uncontrolled) Water		Moderate / High	

#	Metric	Data Description	Report Reference	Relevant risk #		Data source/s	Reference	Time period	Data confidence	Reasoning
21	Growth in farm dams	Deviation in flow indices from the reference (near natural) regime (SKM 2010)	4.5.1.2	E(I-FD)	Likelihood	1. Sustainable Rivers Audit 2 (SRA) in: MDBA 2011, Assessment of the hydrological impact of farm dams in the Murray-Darling Basin. 2. Murray Darling Basin Authority, Canberra. https://www.mdba.gov.au/sites/default/files/archived/annualreports/2011-12/chapter_02_6.html 2. NOW 2010, Assessment of risk to NSW Murray-Darling Basin shared water resources – 2008, NSW Office of Water, Sydney. 3. CSIRO 2008, Water availability in the Murray-Darling Basin; A report to the Australian Government from the CSIRO Murray-Darling Basin Sustainable Yields Project. CSIRO, Australia. 4. NOW 2010, Assessment of risk to NSW Murray-Darling Basin shared water resources – 2008, NSW Office of Water, Sydney. 5. SKM (2011) Assessment of the hydrological impact of farm dams in the Murray-Darling Basin. Murray Darling Basin Authority, Canberra, ACT	Maules Creek at Avoca East; Coxs Creek at Boggabri Baradine Creek at Kienbri No.2; Peel River at Carroll Gap; Mooki River at Caroona; Goonoo Goonoo Creek at Timbumburi; Warrah Creek at Old Warrah; Macdonald River at Woolbrook; Swamp Oak Creek at Limbri; Cockburn River at Mulla Crossing; Halls Creek at Ukolan Ironbark Creek at Woodsreef; Manilla River at Black Springs; Namoi River at North Cuerindi	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).
22	HEVAE (see 4 above)	See 4 above	4.5.1.1	E(I-FD)	Consequence	See 4 above	Maules Creek at Avoca East; Coxs Creek at Boggabri Baradine Creek at Kienbri No.2; Peel River at Carroll Gap; Mooki River at Caroona; Goonoo Goonoo Creek at Timbumburi; Warrah Creek at Old Warrah; Macdonald River at Woolbrook; Swamp Oak Creek at Limbri; Cockburn River at Mulla Crossing; Halls Creek at Ukolan Ironbark Creek at Woodsreef; Manilla River at Black Springs; Namoi River at North Cuerindi	See42 above	See 4 above	See 4 above.
23	Growth in plantation forestry	Farm dam and plantation impacts on streamflow estimated using the SIMHYD rainfall-runoff model; this data was adapted to fit into river system models of state agencies (Van Dijk et al. 2008). A 2030 farm dam development scenario was developed by considering current distribution and policy controls and trends in farm dam expansion.	4.5.2 8.2.2	E(I-PF) O(I-PF)	Likelihood	1. SMEC 2010, Afforestation risks to water resources in the Murray-Darling Basin, Murray-Darling Basin Authority, Canberra; 2. CSIRO 2008, Water availability in the Murray-Darling Basin; A report to the Australian Government from the CSIRO Murray-Darling Basin Sustainable Yields Project. CSIRO, Australia. 3. NOW 2010, Assessment of risk to NSW Murray-Darling Basin shared water resources – 2008, NSW Office of Water, Sydney. 4. SKM (2011) Assessment of the hydrological impact of farm dams in the Murray-Darling Basin. Murray Darling Basin Authority, Canberra, ACT	Namoi River billabongs and wetlands Lake Goran Namoi High Security Namoi General Security Namoi Supplementary Water Peel High Security Peel General Security Peel Supplementary (uncontrolled) Water	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).
24	Ability to meet environmental flow objectives		4.5.2	E(I-PF)	Consequence	1. NOW 2010, Assessment of risk to NSW Murray-Darling Basin shared water resources – 2008, NSW Office of Water, Sydney. 2. Sustainable Rivers Audit 2 (SRA) in: MDBA 2011, Assessment of the hydrological impact of farm dams in the Murray-Darling Basin. Murray	Namoi River billabongs and wetlands Lake Goran			

#	Metric	Data Description	Report Reference	Relevant risk #		Data source/s	Reference	Time period	Data confidence	Reasoning
25	Change in average annual diversions and allocations for licence holders		8.2.2	O(I-PF)	Consequence	Darling Basin Authority, Canberra. https://www.mdba.gov.au/sites/default/files/archived/annualreports/2011-12/chapter_02_6.html 3. CSIRO 2008, Water availability in the Murray-Darling Basin; A report to the Australian Government from the CSIRO Murray-Darling Basin Sustainable Yields Project. CSIRO, Australia.	Namoi High Security Namoi General Security Namoi Supplementary Water Peel High Security Peel General Security Peel Supplementary (uncontrolled) Water			
26	Mining area and growth	Mining area type and grwoth	4.5.3 8.2.3			Commonwealth of Australia (2018) Bioregional Assessment Program: Resource Assessment for the Namoi subregion. Commonwealth of Australia (2018a) Assessing impacts of coal resource development on water resources in the Namoi subregion: Key findings. Product 5: Outcome synthesis for the Namoi subregion from the Northern Inland Catchments Bioregional Assessment Commonwealth of Australia (2018b) Impact and risk analysis for the Namoi subregion: Product 3-4 for the Namoi subregion from the Northern Inland Catchments Bioregional Assessment. Northey J, Pinetown K and Sander R (2014) Coal and cold seam gas resource assessment for the Namoi subregion. Product 1.2 for the Namoi subregion from the Northern Inland Catchments Bioregional Assessment. Department of the Environment, Bureau of Meteorology, CSIRO and Geoscience Australia, Australia.		2014 - current	Moderate / High	
27	Floodplain harvesting volumes		4.5.4 (environment) 8.2.4 (Other uses)			1. DPI-Water 2017. Draft Floodplain harvesting Monitoring Policy. March 2017. Department of Primary Industries - Water. https://www.water.nsw.gov.au/__data/assets/pdf_file/0016/700801/Draft-floodplain-harvesting-monitoring-policy.pdf		N/A	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
28	Future climate scenarios	The MDBSY project assessed scenarios: i.e., historical climate change & current development; recent climate change & current development; future climate change and current & future development, respectively. All scenarios are defined at daily time series of climate 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. NOW 2010, Assessment of risk to NSW Murray-Darling Basin shared water resources – 2008, NSW Office of Water, Sydney. 2. CSIRO 2008, Water availability in the Murray-Darling Basin; A report to the Australian Government from the CSIRO Murray-Darling Basin Sustainable Yields Project. CSIRO, Australia. 3. Van Dijk, et al. (2008) Uncertainty in river modelling across the Murray-Darling Basin. A report to the Australian Government from the CSIRO Murray-Darling Basin Sustainable Yields Project, CSIRO Australia. 93pp.	Namoi River billabongs and wetlands Lake Goran Namoi High Security Namoi General Security Namoi Supplementary Water Peel High Security Peel General Security Peel Supplementary (uncontrolled) Water	The average rainfall during the calibration period (Namoi: 1985-1990) was compared to the long-term average rainfall, the number of years in the historical record (1895 to 2006) (Van Dijk 2008).	Low / Moderate	CSIRO project undergone extensive peer review. NSW obtained the model output data from the MDBYS project (2008) and extracted 112 year time series on a daily time-step as well as the reliability data to improve the quality of analysis (NOW 2010). Historical 112-year climate transformed to have the same statistics as the second-wettest, second-driest and median predictions of climate change by 15 different global climate models given three alternative emission scenarios (Cwet, Cdry and Cmid scenarios). However, there is still relatively high uncertainty associated with natural variability and also uncertainty associated with the range of climate models, with this combined uncertainty considered greater than the 'best estimate' climate change projection (Van Dijk, et al. 2008). 1. This section addresses NSW's obligations under the Basin Plan (2012): Chapter 10, Part 9: Section 10.41(1) - A water resource plan must be prepared having regard to current and future risks to the condition and continued availability of the water resource plan area. 2. Water Sharing Plans are the control mechanism which base water sharing decisions on the availability of flow and therefore they implicitly adjust for both climate variability and change. The legislation enables powers to temporarily suspend water sharing rules during extreme climatic conditions. WSPs are reviewed on a 10-yr cycle and the climatic record used as input to these planning decisions is based on all of the available data up to that point. 3. There is currently no explicit adjustment to the input data or selective sequencing from the data to use as input to the planning process to allow for potential future climate change. Water sharing plans cover all of the regulated systems in NSW, i.e. all but the Barwon-Darling in this risk assessment. In the Barwon-Darling, licence conditions on entitlements specify access rules based on the occurrence of flows above a specified level prior to allowing pumping to occur. These therefore implicitly allow for both climate variability & change (NOW 2010).
29	Ability to meet environmental flow objectives		4.6	E(CC)	Consequence		Namoi River billabongs and wetlands Lake Goran			
30	Change in average annual diversions and allocations for licence holders		8.3.2	O(CC)	Consequence		High Security General Security Supplementary Water			
	Growth in basic landholder rights									
31	Growth in basic landholder rights	Based on dividing the 80th percentile flow (for all days) for each water source by the estimated BLR.	4.4.1 8.4 (other uses)	E(BLR)	Likelihood	1. WaterNSW gauging stations	Upper Baradine Creek; Lower Baradine; Bluevale; Bohena; Brigalow; Bundock; Chaffey; Cockburn River; Coghill Creek; Mid Coxs; Lower Coxs; Etoo Creek; Talluba; Eulah; Goonoo Goonoo; Keepit; Lake Goran; Lower Namoi; Lower Peel tribs; Maules Creek; Mid Macdonald River; Mooki River; Phillip Creek; Pian; Quirindi; Rangira; Split Rock; Spring; Bobbiwaa; Upper Macdonald River; Upper Manilla; Upper Namoi; Upper Peel tribs; Warrah Creek; Werris		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
32	Growth in basic landholder rights	Ratio of BLR volume to total licensed entitlement	8.4.2	O(BLR)	Likelihood	1. WaterNSW gauging stations 2. NSW Water Register 3. Basic landholder rights for NSW: Estimations of stock & domestic rights Dept of Water & Energy, September 2009.	Upper Baradine Creek; Lower Baradine; Bluevale; Bohena; Brigalow; Bundock; Chaffey; Cockburn River; Coghill Creek; Mid Coxs; Lower Coxs; Etoo Creek; Talluba; Eulah; Goonoo Goonoo; Keepit; Lake Goran; Lower Namoi; Lower Peel tribs; Maules Creek; Mid Macdonald River; Mooki River; Phillip Creek; Pian; Quirindi; Rangira; Split Rock; Spring; Bobbiwaa; Upper Macdonald River; Upper Manilla; Upper Namoi; Upper Peel tribs; Warrah Creek; Werris		High	
33	Volume of entitlement	Volume of entitlement (2015)	8.4.1	O(BLR)	Consequence	1. NSW Water Register			High	

LIST OF THREATENED SPECIES OF THE_NAMOI CATCHMENT							
Common Name	**Scientific Name**	**Distinctiveness Parameter**	**NSW Status**	**Commonwealth listing**	**Flow sensitivity Weighting**	**Status Weights**	**Layers from DPIE**
eel-tailed catfish	*Tandanustandanus*	EP	Endangered Population	not listed	4	3	Known.
olive perchlet	*Ambassisagassizii*	EP	Endangered Populations	not listed	4	3	Known
silver perch	*Bidyanusbidyanus*	Fish	Vulnerable	Critically endangered	4	4	Known
purple spotted gudgeon	*Mogurndaadspersa*	Fish	Endangered Population	not listed	4	3	Only available in new fish modelled data
Murray cod	*MaccullochellapeeIii*	Fish	not listed	Vulnerable	4	2	Known & predicted.
Flathead Galaxis		Fish	Critically endangered	Not listed	4	4	Only available in new fish modelled data
Booroolong frog	*Litoriabooroolongensis*	Frog	Endangered	Endangered	4	3	Known
Tusked frog	*Adelotusbrevis*	Frog	Endangered population	Not listed	4	3	Known & Predicted
Davies tree frog	*Litoriadaviesae*	Frog	Vulnerable	Not listed	4	2	Predicted
Lowland Darling River aquatic ecological community		EEC	Endangered Ecological Community	Not listed	4	3	from DPI and EEC layer available on the EDB
river snail	*Notopalasublineata*	Other aquatic	Endangered	Not listed	4	3	
Marsh Club-rush sedgeland in the Darling Riverine Plains Bioregion		EEC	Critically endangered ecological community	not listed	3	4	Known
Carbeen Open forest Community in the Darling Riverine Plains and Brigalow Belt South Bioregions		EEC	Endangered Ecological Community	Not listed	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
Bell's Turtle	*Elseyabelli*	Other aquatic	Vulnerable	Vulnerable	3	2	Known
Australian painted snipe	*Rostratulaaustralis*	Bird	Endangered	Endangered	2	3	Known & Predicted
black-necked stork	*Ephippiorhynchusasiaticus*	Bird	Endangered	not listed	2	3	Known
blue-billed duck	*Oxyuraaustralis*	Bird	Vulnerable	not listed	2	2	Known
brolga	*Grusrubicunda*	Bird	Vulnerable	not listed	2	2	Known
freckled duck	*Stictonettanaevosa*	Bird	Vulnerable	not listed	2	2	Known & Predicted
magpie goose	*Anseranassemipalmata*	Bird	Vulnerable	not listed	2	2	Known
Australasian Bittern	*Botauruspoiciloptilus*	Bird	Endangered	Endangered	2	3	Known
Black-tailed Godwit	*Limosalimosa*	Bird	Vulnerable	Not listed	2	2	
Comb-crested jacana	*Irediparragalinacea*	Bird	Vulnerable	Not listed	2	2	

LIST OF THREATENED SPECIES OF THE_NAMOI CATCHMENT							
Common Name	**Scientific Name**	**Distinctiveness Parameter**	**NSW Status**	**Commonwealth listing**	**Flow sensitivity Weighting**	**Status Weights**	**Layers from DPIE**
Carbeen Open Forest Community in the Darling Riverine Plains and Brigalow Belt South Bioregions		EEC	Endangered Ecological Community	not listed	2	3	Known
greater broad-nosed bat	*Scoteanaxrueppelii*	Mammal	Vulnerable	not listed	2	2	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
Watermilfoil	*Myriophyllumimplicatum*	Plant	Critically Endangered	Not listed	4	4	Known
Sida shrub	*Sidarohlenae*	Plant	Endangered	not listed	1	3	Known
Cyperusconicus	*Cyperusconicus*	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 HEAVE 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 DPI Water, Sydney, NSW.	

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

Key ecosystem function criteria (Schedule 9)	HEVAE or risk assessment criteria/associated attributes
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.	species; and/or ii. maintenance of populations of specific species at critical life cycle stages; and/or iii) key/significant refugia for aquatic species that are dependent on the habitat, particularly at times of stress. • Vital wetlands (Ramsar and DIWA listed wetlands) • Dissolved Organic Carbon (DOC) input (surrogate measure = river reaches of 60% woody riparian vegetation cover & measure of unconfined or partially confined River Style) • Large Woody Debris (LWB) (surrogate measure = river reaches of 60% woody riparian vegetation cover & specific River Styles®) **Risk Assessment** The risk assessment process has identified key features of flow regimes which have impacts on key ecosystem functions identified by the MDBA (2010; 2012) and Alluvium (2010). Within the risk assessment method, impacts on ecosystem function are considered through assessment of altered stream flow in regulated and unregulated rivers. Flow regimes influence the hydrologic connectivity, longitudinal and lateral pathways for ecological dispersal, nutrient and organic and inorganic material delivery in river systems.
Criterion 2: The ecosystem function supports the transportation and dilution of nutrients, organic matter and sediment Assessment indicator: An ecosystem function requires environmental watering to sustain it if it provides for the transportation and dilution of nutrients, organic matter and sediment, including: (a) pathways for the dispersal and movement of organic and inorganic sediment, delivery to downstream reaches and to the ocean, and to and from the floodplain; or (b) the dilution of carbon and nutrients from the floodplain to the river systems.	
Criterion 3: The ecosystem function provides connections along a watercourse (longitudinal connections) Assessment indicator: An ecosystem function requires environmental watering to sustain it if it provides connections along a watercourse or to the ocean, including longitudinal connections: (a) for dispersal and re-colonisation of native water-dependent communities; or (b) for migration to fulfil requirements of life-history stages; or (c) for in-stream primary production.	
Criterion 4: The ecosystem function provides connections across floodplains, adjacent wetlands and billabongs (lateral connections) Assessment indicator: An ecosystem function requires environmental watering to sustain it if it provides connections across floodplains, adjacent wetlands and billabongs, including: (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

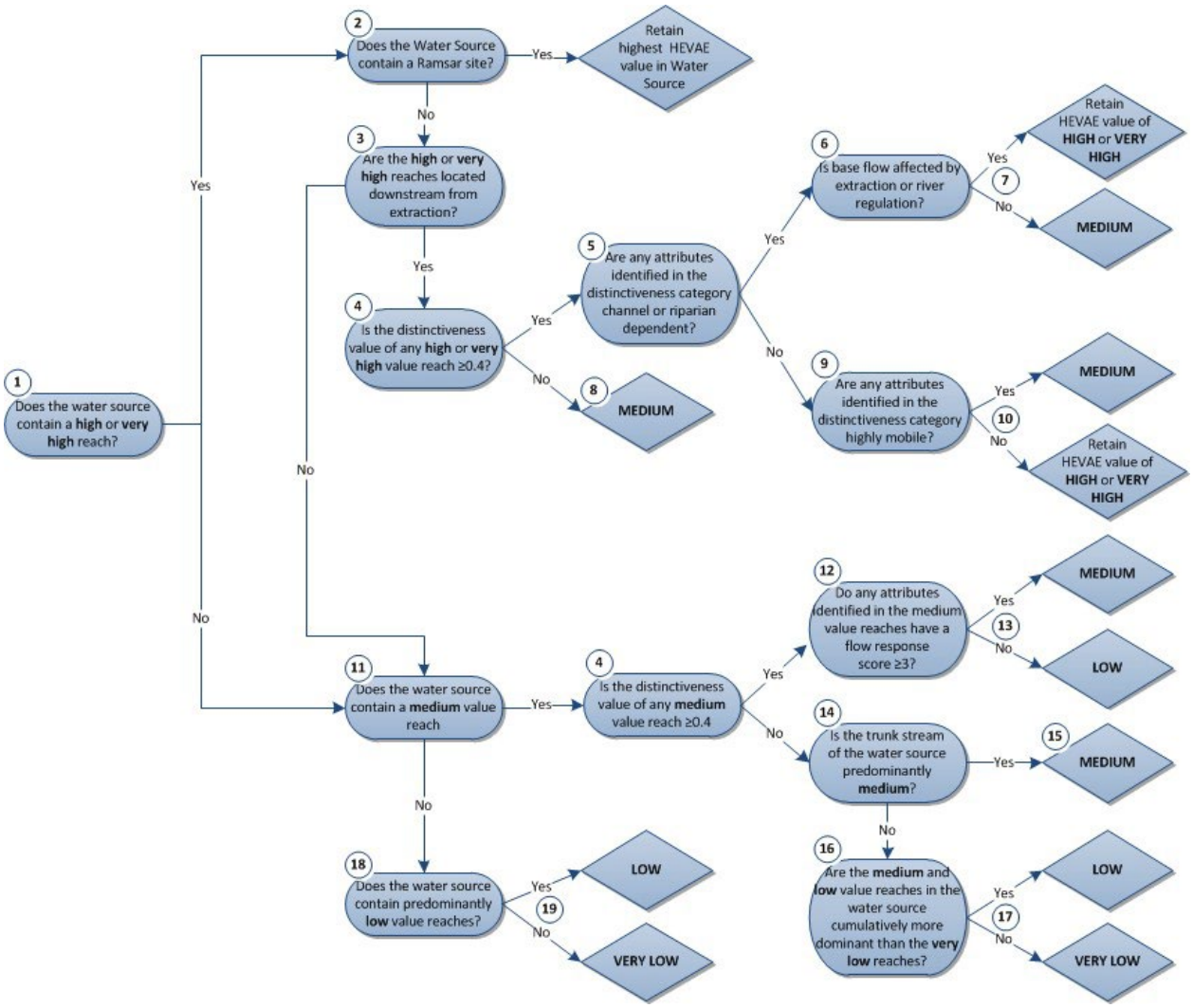

1
Does the water source contain a high or very high reach?
2
Does the Water Source contain a Ramsar site?
Yes
Retain highest HEVAE value in Water Source
No
3
Are the high or very high reaches located downstream from extraction?
Yes
4
Is the distinctiveness value of any high or very high value reach ≥0.4?
Yes
5
Are any attributes identified in the distinctiveness category channel or riparian dependent?
Yes
6
Is base flow affected by extraction or river regulation?
Yes
7
Retain HEVAE value of HIGH or VERY HIGH
No
MEDIUM
No
9
Are any attributes identified in the distinctiveness category highly mobile?
Yes
MEDIUM
10
No
Retain HEVAE value of HIGH or VERY HIGH
No
8
MEDIUM
No
11
Does the water source contain a medium value reach
Yes
4
Is the distinctiveness value of any medium value reach ≥0.4
Yes
12
Do any attributes identified in the medium value reaches have a flow response score ≥3?
Yes
MEDIUM
13
No
LOW
No
14
Is the trunk stream of the water source predominantly medium?
Yes
15
MEDIUM
No
16
Are the medium and low value reaches in the water source cumulatively more dominant than the very low reaches?
Yes
LOW
17
No
VERY LOW
No
18
Does the water source contain predominantly low value reaches?
Yes
LOW
19
No
VERY LOW

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

DECISION TREE ANNOTATION	RATIONALE
1	• Management for retention of conservation values is a higher priority in high and very high value reaches • Limiting extraction is easier to justify in high and very high value reaches, than it is in medium reaches
2	• Ramsar sites are valued for their contribution to international conservation efforts for migratory species. Australia is a signatory country and has an obligation to maintain these sites. This includes maintenance of flows.
3	• The attributes of high or very high value sites are influenced by extraction pressure. • Sites that are upstream of extraction points are assumed to be unaffected by extraction pressure, so the assessment focus shifts to whether there are medium value reaches in the water source. • If a high or very high value site is likely to be affected by extraction pressure the focus shift to whether any threatened species, populations, communities or rare River Styles® could be affected.
4	• The attributes of high or very high value sites are influenced by extraction pressure. • The most 'at risk' HEVAE criterion from extraction pressure (in the short-term) is distinctiveness. Distinctiveness includes consideration of biotic and abiotic characteristics and function of the reach (i.e. threatened species, populations, communities and rare River Styles®). • A distinctiveness score of ≥ 0.4 in the HEVAE means the reach has a medium, high or very high value as habitat for threatened species, populations, or communities, or a rare River Style®. • Habitat for threatened species, populations and communities is protected under State and Commonwealth legislation.
5	• Distinguishes between species, populations, communities and/or rare River Styles® that occur on the floodplain versus the channel and riparian zone because (it was assumed) extraction pressure is more likely to affect attributes that occur in the channel and riparian zone, rather than the floodplain. • *This is a decision that relies on expert understanding of the attribute's ecology and biology.*
6	• Given the attribute is identified as relying on channel and riparian habitat (from 5), this step assumes the least possible habitat available to the attribute occurs under low flow conditions, and asks whether the lowest flows in the system are affected by extraction.
7	• Any attributes that are channel and/or riparian dependent, and are considered vulnerable to extraction of low flows retain their original high or very high value category. • Any attributes that are channel and/or riparian dependent and are considered resilient to extraction of low flows are allocated a 'medium' consequence category.
8	• High or very high value reaches that have low distinctiveness are assumed to have attributes that are more resilient to extraction pressure (at least in the short-term), and are assigned a 'medium' consequence category.
9	• Establishes that attributes are floodplain dependent, and asks whether they are able to move (i.e. birds, bats) or not (i.e. plant). The assumption is that more mobile species/population/community can move to avoid changes in habitat owing to extraction pressure.

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

Appendix D Threatened fish species & distribution

Fish data from the MDB Sustainable Rivers Audit (Davies et al. 2012) and other sources were analysed by NSW Fisheries to assess the distribution of threatened species and to identify areas of relative high fish biodiversity within the Namoi Surface WRPA. These data have been included in the HEVAE assessment and the results presented below. They are also further detailed in the Water Source Summaries provided in Volume 2.

Results show a significant spread of threatened fish species or endangered populations within the Namoi Surface WRPA. Eel-tailed catfish and Murray cod were widespread in the regulated river sites, while silver perch was found in at least four sites. Fish biodiversity was highest in the lowland to midland reaches of the Namoi River between Wee Waa and upstream of Narrabri.

Figure D-1 Distribution of Endangered Ecological Communities in the Namoi Surface WRPA

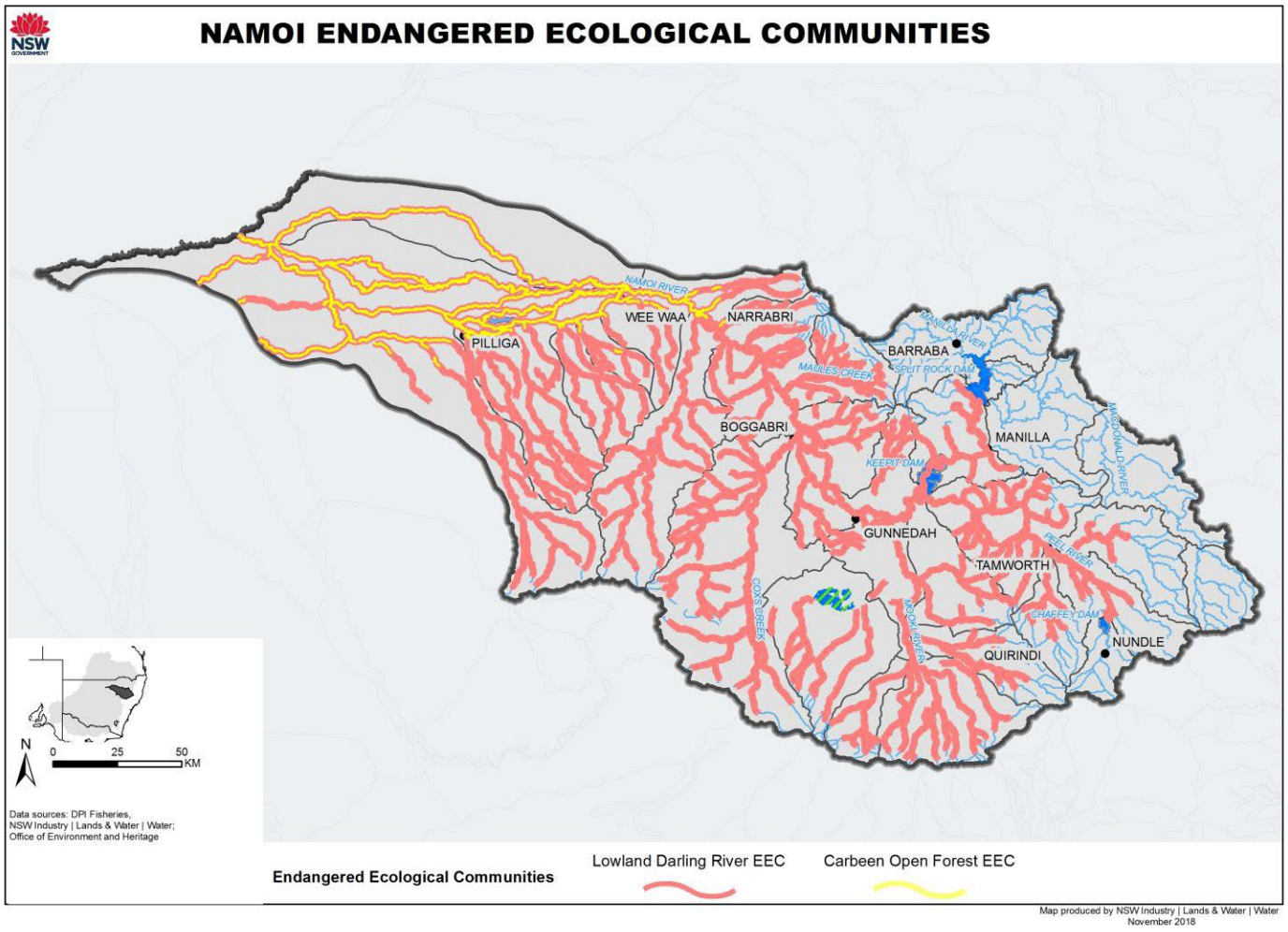


Figure D-2 Distribution of threatened fish species within the Namoi Surface WRPA

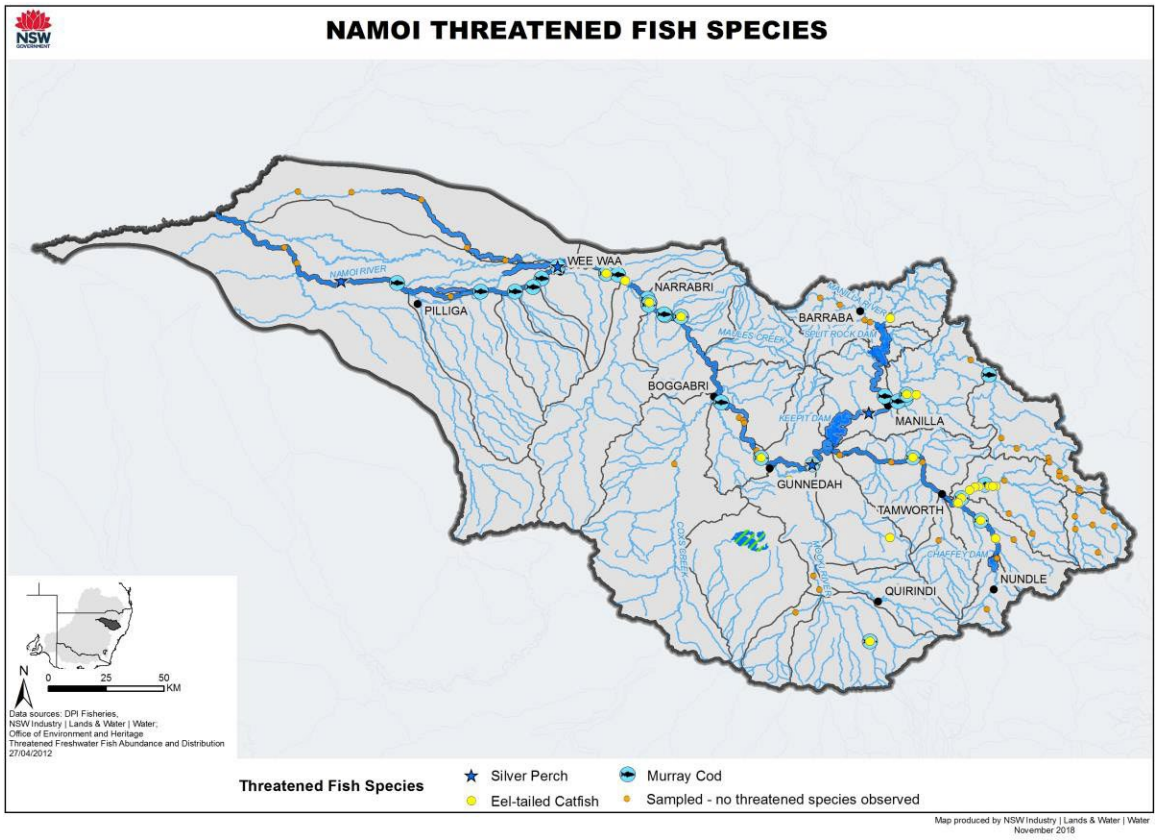
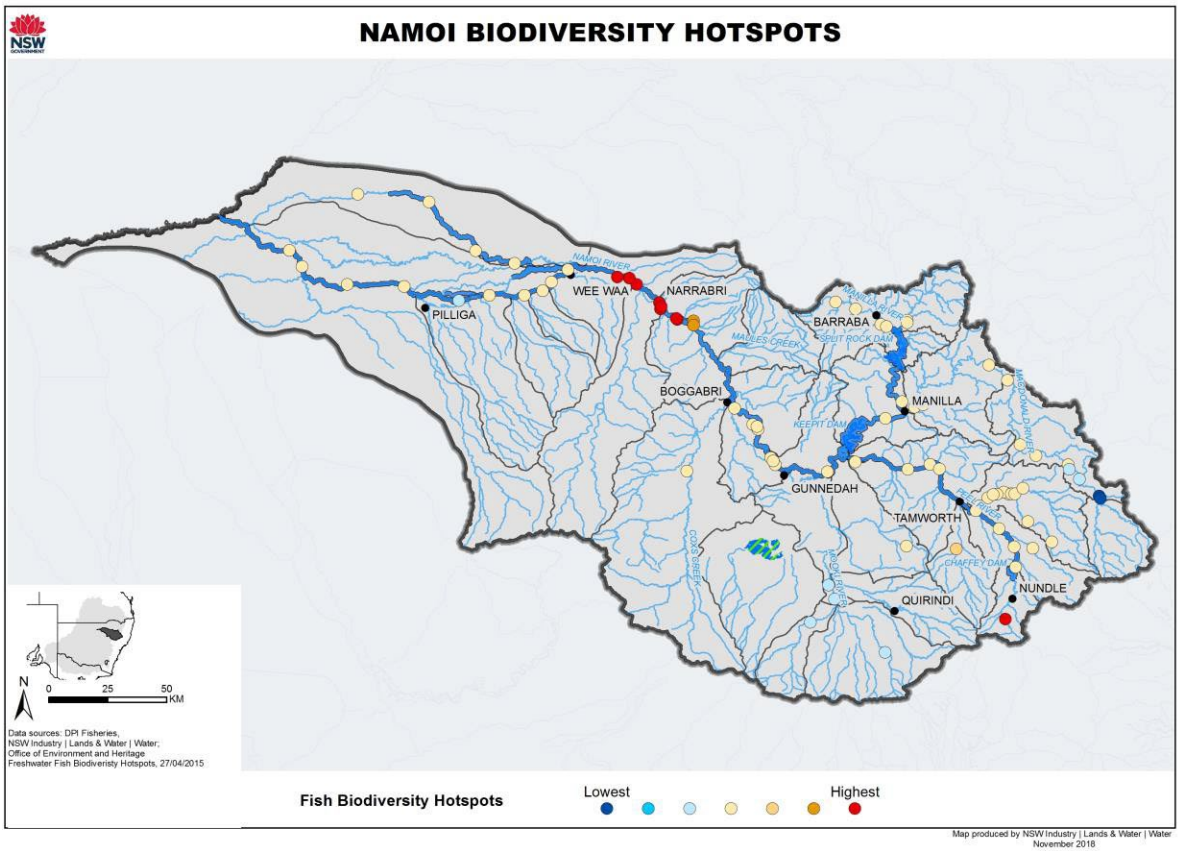


Figure D-3 Fish biodiversity hotspots in the Namoi Surface WRPA



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 Namoi Surface WRPA are shown in the figures below.

Figure E-1 Flow variation index (CV) results for farm dams in the Namoi Surface WRPA (SKM 2010)

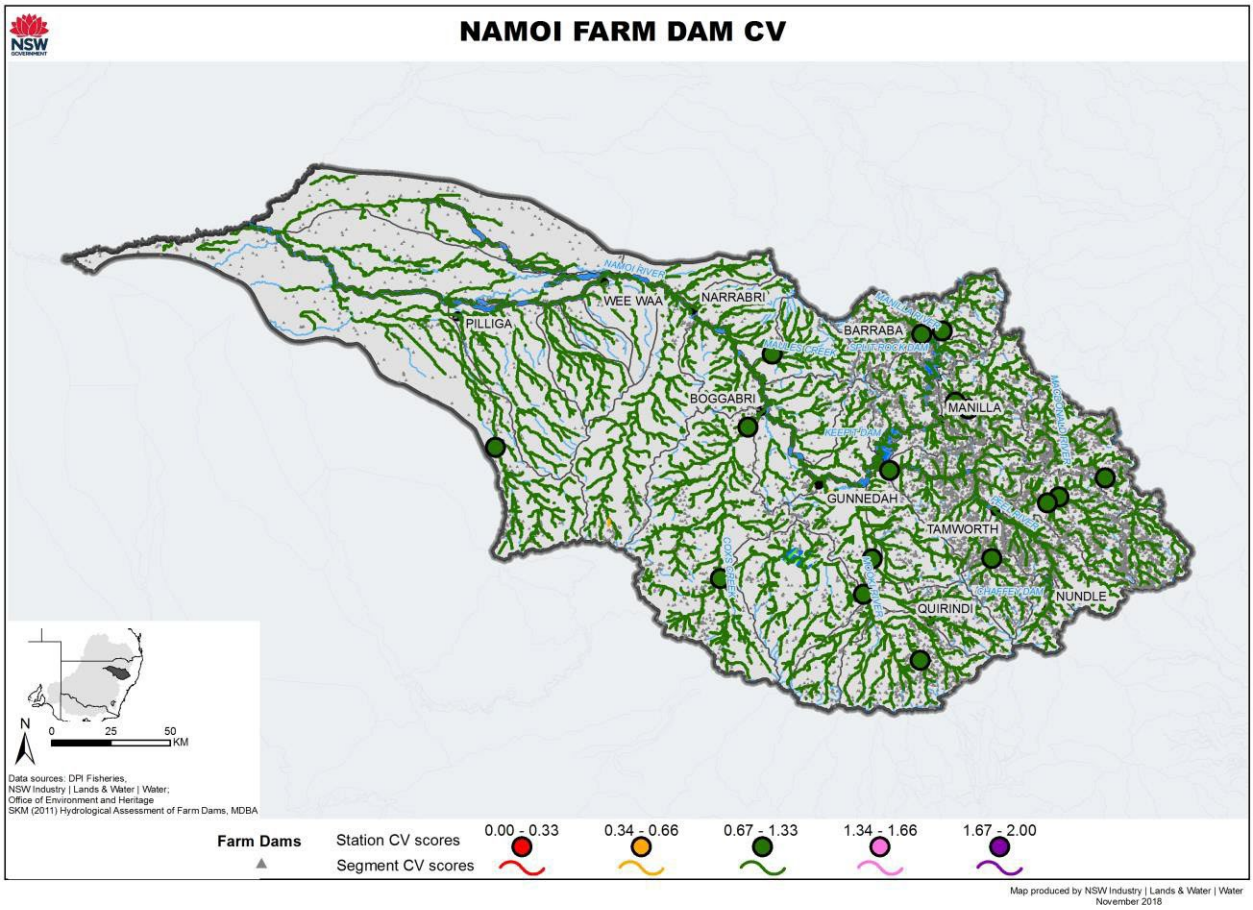


Figure E-2 Results for the Q90 low flow metric for farm dams in the Namoi Surface WRPA (SKM 2010)

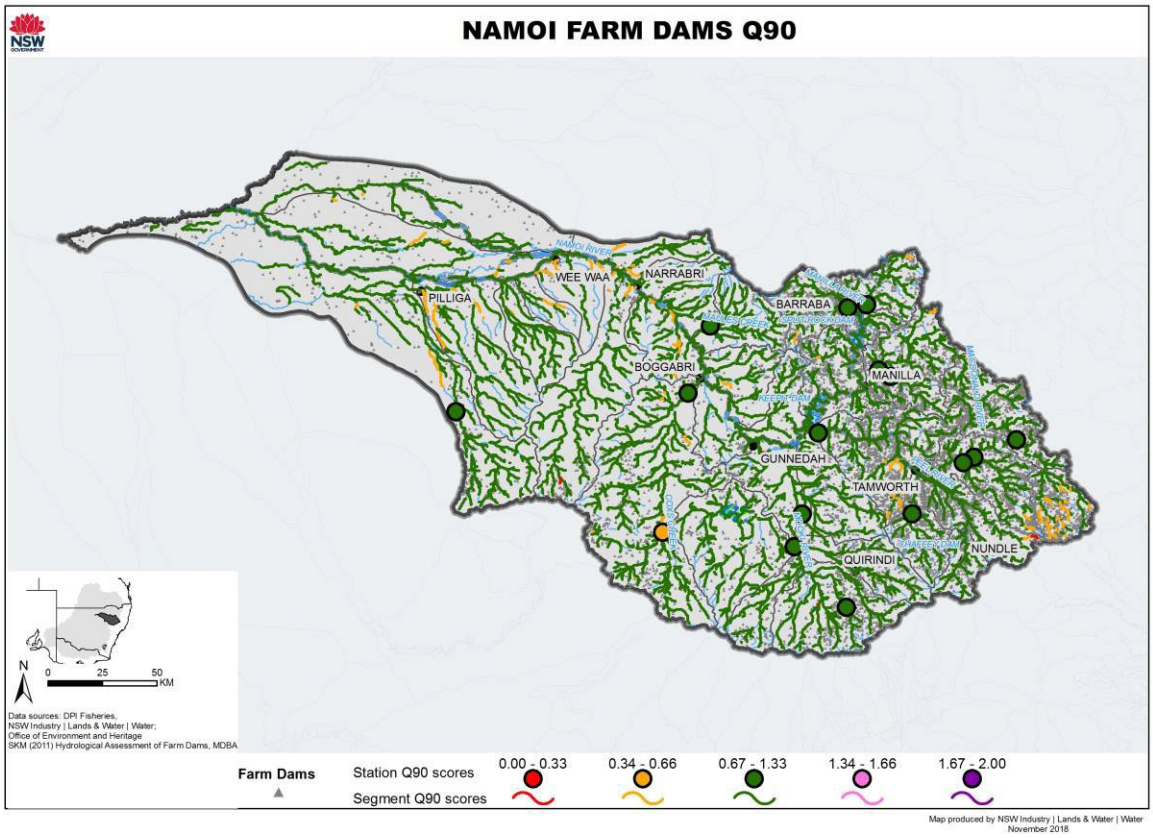


Figure E-3 Results for the Q10 high flow metric for farm dams in the Namoi Surface WRPA (SKM 2010)

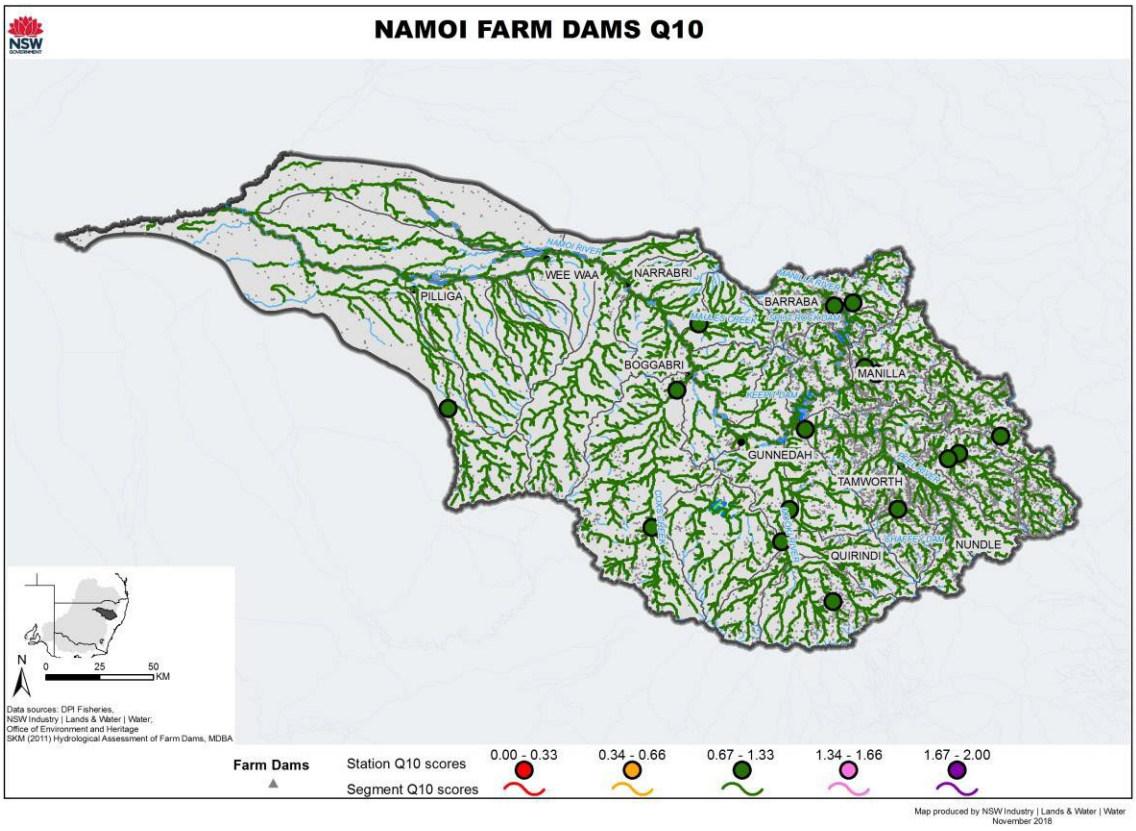
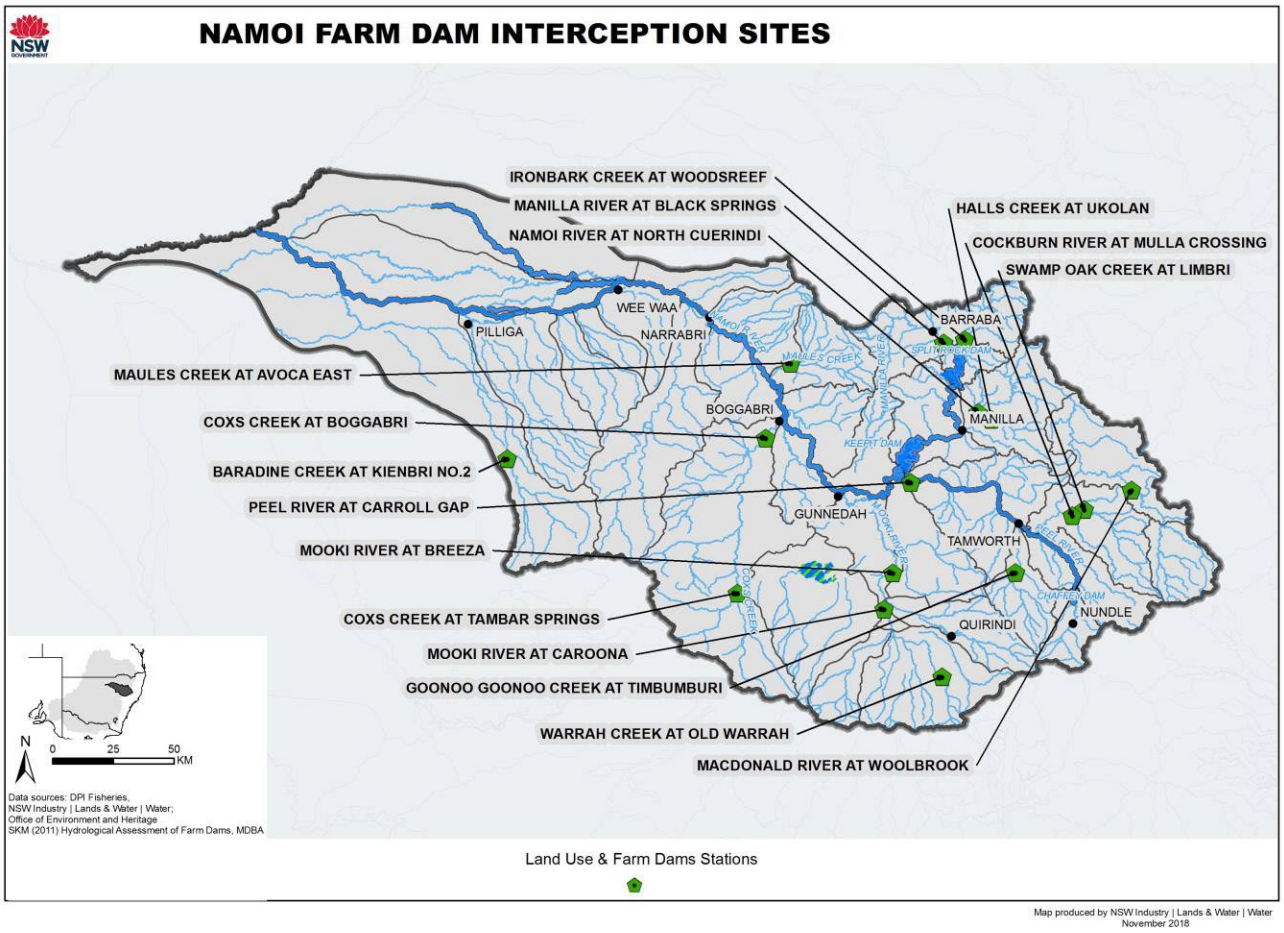


Figure E-4 Location of land use and farm dam stations in the Namoi Surface WRPA (MDBA 2011)



Appendix F Unregulated rivers tolerable risk decision tool

This appendix relates to Figure 9-1Figure 9-1 Risk treatment pathway (in particular element 2 and risk treatment option C), associated text in section 9.2.2.1, and strategy 17 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

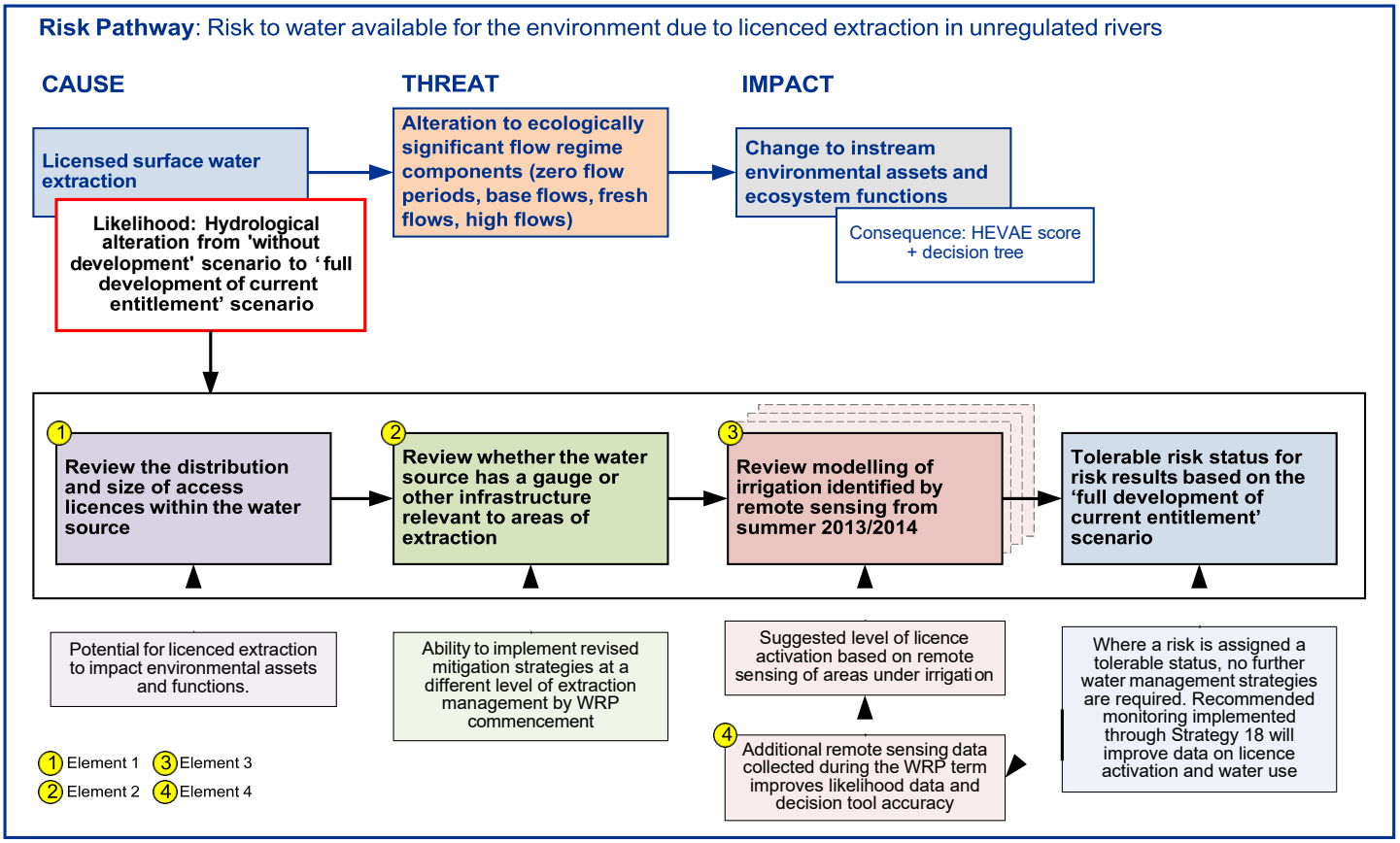
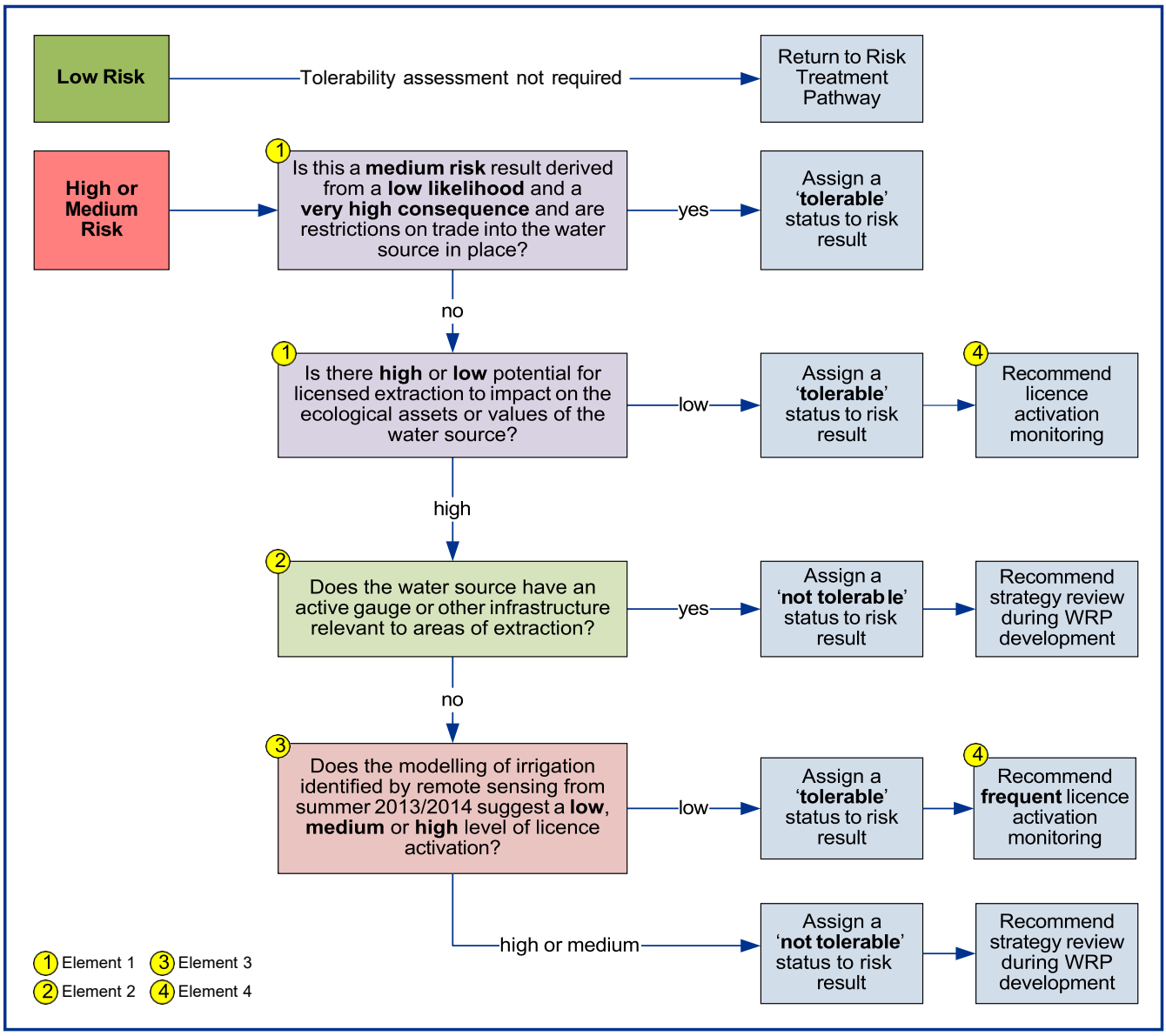


Figure F-2 Decision tree used as a guide to apply elements of the unregulated rivers tolerable risk decision tool



Review the distribution and size of access licences within the water source.

Element 1 of the decision tool reviews the potential for licensed extraction to impact on the ecological assets and values of a water source if all access licences were activated[1]. Where ecological value drivers of the consequence result occur upstream or on stream sections that are disconnected from access licence locations, there is little potential for extraction to impact environmental assets or functions. An exception to this statement may occur where an asset has high dispersal characteristics (e.g. fish such as Murray cod or silver perch).

Where there are significant access licences on the main stem of a stream in the water source, the single reach IQQMs will reflect the impact along the main stream and at the end of the water source. Where there are only a few small access licences on different tributaries, or just one tributary, the single reach IQQMs may not reflect the impacts on the ecological values in the water source (see Figure F-3 for examples). This is most

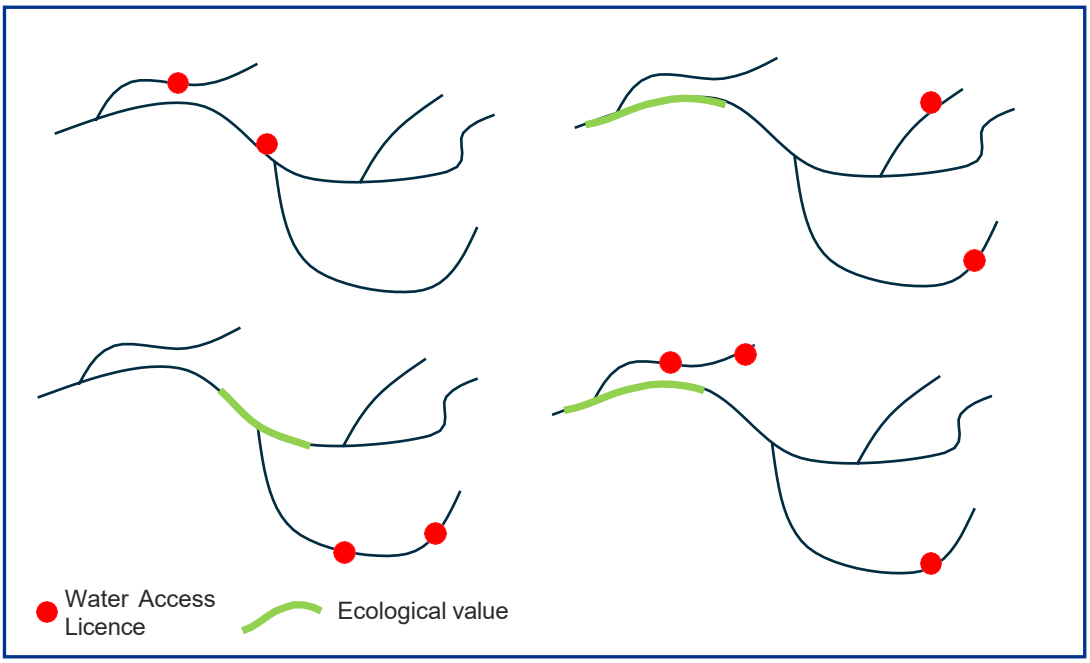
[1] An access licence must be linked to at least one pump (water supply work) for extraction to be possible.

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 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 17 and the MER Plan for further information). This is indicated in Figure F-1 by the broken line boxes underlying element 3.

Possible outcomes from this element are the suggested activation levels high, medium, and low. Where low is applied, the risk result is assigned a ‘tolerable’ status and further frequent monitoring of access licence activation via remote sensing is recommended (element 4). Where medium or high is applied the risk is assigned a ‘not tolerable’ status as the current use level is likely to be similar to the full entitlement scenario. This indicates the risk result should prompt the consideration of alternative risk mitigation strategies during WRP development.

Appendix G Strategy development – constraints & decision trees

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

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

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

Operational constraints considered in developing and implementing new strategies

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

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

Social or economic constraints to implementing a strategy

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

The objectives of the Basin Plan as a whole are:

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

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

Potential social or economic constraints were identified by:

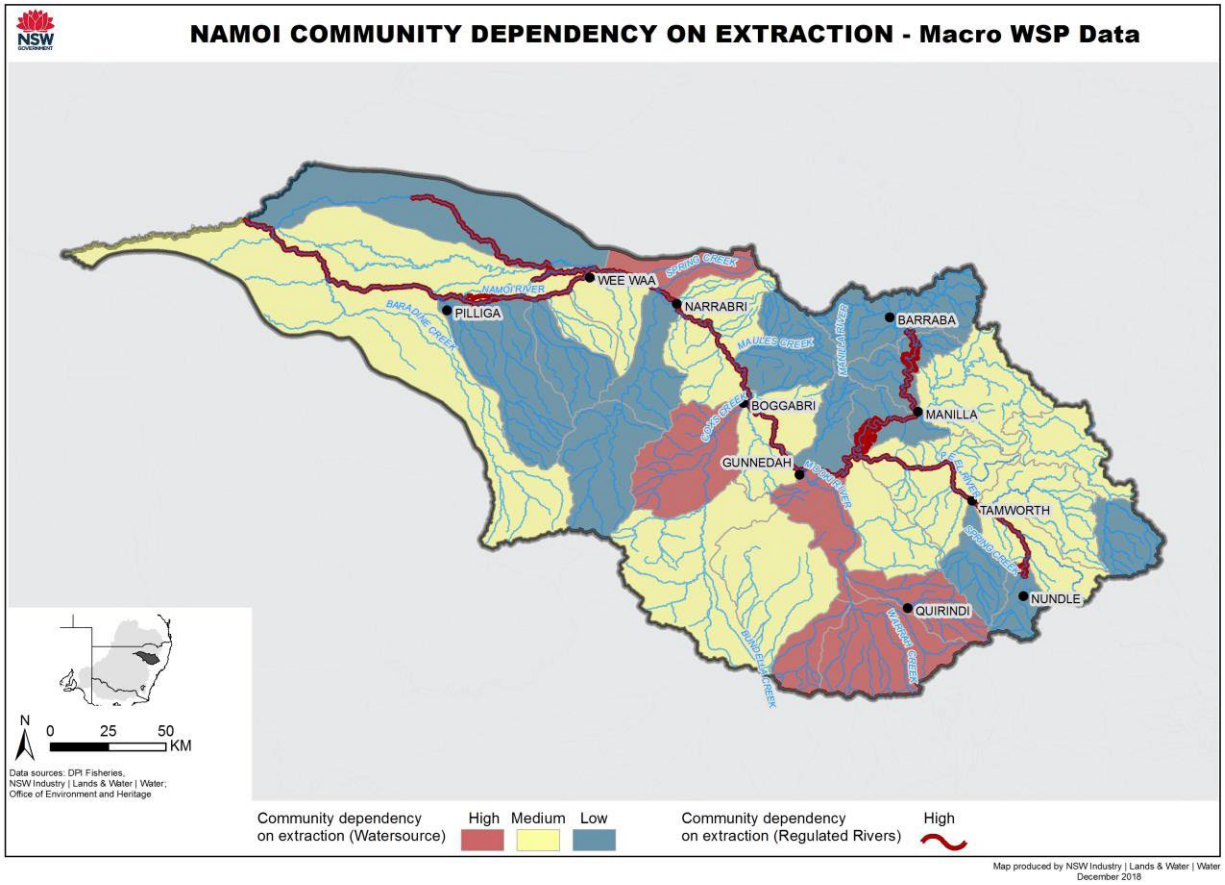
- Estimating the community dependence on water extraction in each unregulated water source
- Directly consulting with stakeholders through forums such as Stakeholder Advisory Panels (SAPs).

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

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

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

Figure G-1 Community dependency on extraction



In each unregulated water source, community dependence and risk to the environment were compared using an indicative matrix 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 DoI-Water in managing external constraints through complementary measures. Collaboration between natural resource management (NRM) groups to examine alignment of priorities has been a continued focus of NSW Government (NRC 2010). Alignment of NRM continues to be identified as a priority for LLS (Local Land Services 2016) and for the management of environmental water and water quality in NSW (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 Namoi WRP.

Cold water pollution

Cold water pollution is the release of unseasonable cold water from deeper layers of thermally stratified storages. This occurs most often during the warmer months when irrigation water is in high demand. Temperature has a wide range of influences on biological processes, where the release of cold water can interrupt important biological cues such as spawning in fish and other fauna, creating a physiological barrier to habitat connectivity, reducing the growth rate of fish and also result in mortality (Lugg & Copeland 2014).

Keepit Dam has been identified as causing relatively large and pervasive cold water pollution, as it impounds deep storages and releases large volumes of cold hypo limnetic water during spring and summer. The largest discharges occur between September and February, with a median monthly discharge of 2,000 ML/day in January (Preece, 2004). Preece and Jones (2002) report the extent of cold water pollution from Keepit Dam (as defined by a 5 °C peak depression) occurring three weeks later than the pre-dam condition. This change is deemed sufficient to disrupt thermal spawning cues for selected Australian native fish species. The magnitude of the disturbance diminishing with river distance, with key aspects of the river's annual temperature cycle restored within 100 river km downstream from the dam.

Regardless of the spatial extent that cold water pollution affects, it is important to acknowledge the influence that this impact can have. Cold water pollution is therefore a potentially significant external constraint to the success of some strategies identified in this report. This constraint can be addressed by the implementation of concurrent mitigation strategies such as a thermal curtain, or other variable offtake infrastructure on the inlet works of Keepit Dam. Such infrastructure would allow the warmer waters located near the surface of the storage to be released during the warmer months.

Barriers to fish passage

Migratory pathways across the majority of rivers in NSW have been disrupted through the construction of instream structures associated with river regulation such as dams and weirs as well as road crossings, culverts and other road infrastructure.

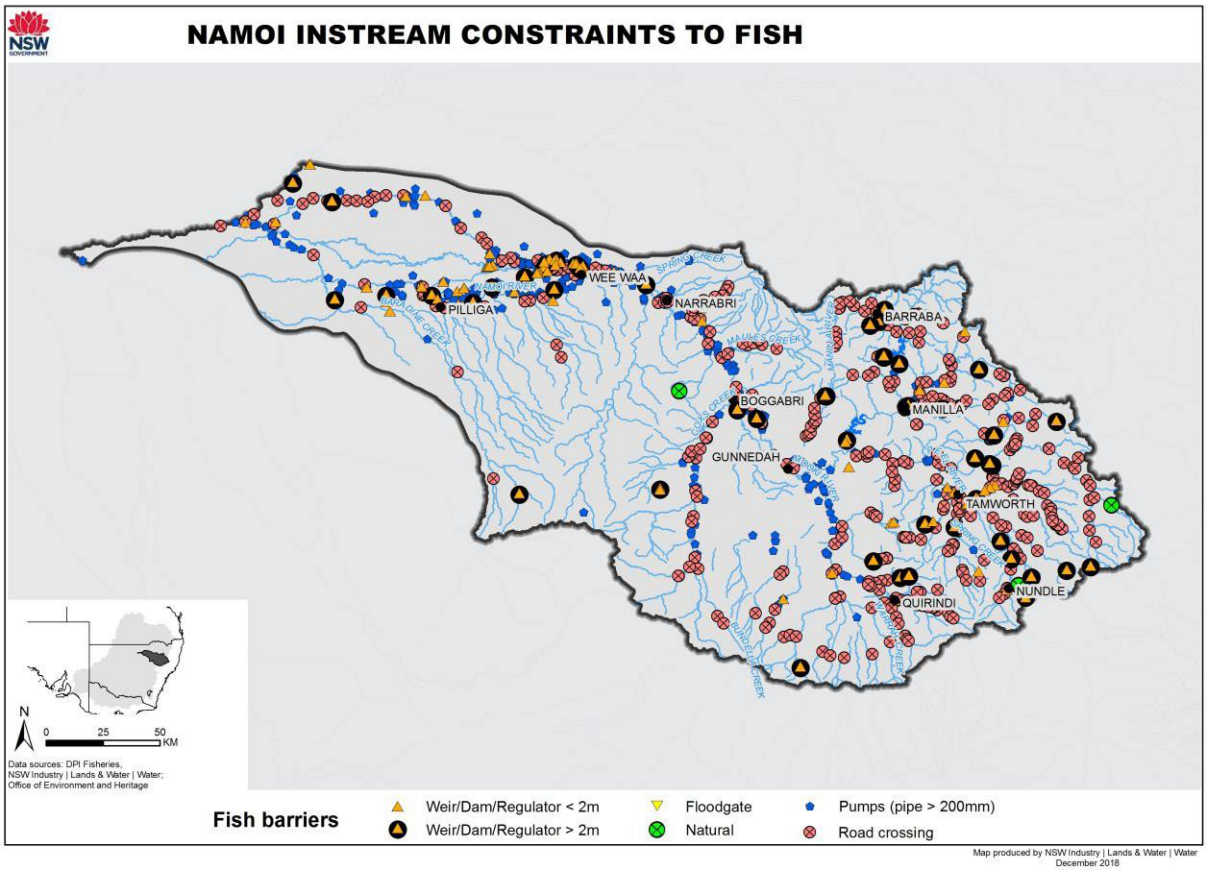
NSW Department of Primary Industries (2015a) report that barriers to fish passage can impact native fish populations by:

- Interrupting spawning and seasonal migrations;
- Restricting access to preferred habitat, food resources and breeding partners;
- Reducing genetic flow between populations;
- Increasing susceptibility to predation and disease through aggregation below barriers;
- Stranding fish on floodplains or in drying waterbodies;
- Fragmenting communities and preventing colonisation;
- Advantage introduced species such as Carp (NSW Department of Primary Industries 2015b); and
- Disrupting downstream movement of adults and impeding larval drift (Jones & Stuart 2004; NSW Department of Primary Industries 2006; Jones & Stuart 2008; Jones 2009).

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

NSW DPI Fisheries (2015b) have identified over 496 instream structures, including weirs, regulators and road crossings in the Namoi Surface WRPA, of which 57 are considered likely to pose a significant barrier to fish passage with a head loss greater than 2 m, including the major regulating structures of the system (Figure G-2). 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 WRPA impedes natural flow and connectivity, which is a fundamental ecological feature (NSW Department of Primary Industries 2015a) and likely to be a considerable constraint to the success of strategies. DPI Fisheries have identified 20 barriers which are considered to be high priority for mitigation action. These barriers are identified in the summaries presented in Volume 2 and are considered potential constraints to the success of hydrological risk mitigation strategies.

Figure G-2 Instream constraints to fish in the Namoi Surface WRPA (adapted from NSW Department of Primary Industries, 2015a)



Water diversion

NSW Department of Primary Industries (2015a) cite that the diversion of water by pumps, pipelines, irrigation canals or regulators can have a significant impact on native fish by altering habitat and affecting flow dependent life history strategies such as spawning and recruitment (Baumgartner & Boys 2012). Diversion and stranding in off-channel irrigation systems is said to be particularly problematic for the larval stage of most native fish species, especially golden perch, silver perch and Murray cod, as the timing of irrigation diversion coincides with the peak egg and larval drift during the spring and summer seasons (Baumgartner et al. 2007).

The entrainment of fish in irrigation infrastructure is an issue which may influence the ability of flow management strategies to meet their ecological objectives. In Europe and the United States, a wide variety of pump screens are currently applied which could be readily adapted for use in the MDB. In New Zealand, the screen designs routinely applied are modifications of existing designs to meet the requirements of local conditions (Baumgartner & Boys 2012). For some years, DPI Fisheries have been advocating a screening program as the best way to reduce fish losses without compromising the needs of irrigators within the MDB.

There is some suggestion that irrigation pump offtakes with a diameter greater than 200 mm influence the entrainment of freshwater fish (NSW DPI 2015a). Based on current information from the Queensland Department of Agriculture and Fisheries and NSW DPI Fisheries, a 200 mm diameter pump size threshold was selected as a potential threat to native fish (pers. comm. Andrew Norris, Qld Department of Agriculture and Fisheries). 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 during peak extraction times (NSW DPI 2015a).

In the Namoi Surface WRPA, it is reported that there are over 300 pump offtakes with a diameter greater than 200 mm, with a further 5 pump offtakes in the Peel Valley sub-catchment (Figure G-2) (pers. comm. Greg Ditter, NSW DPI-Water August 2016: derived from the NSW Water Licencing System data base). The

cumulative effect of these offtakes is expected to have a significant impact on native fish populations in the Namoi Surface WRPA during peak extraction times. In addition to this, there are over 60 diversion channels that capture overbank flows in key fish habitats (Figure G-2), significantly influencing an important flow component in the system with the potential to impact native fish populations

Riparian vegetation condition and catchment disturbance

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

Changes to riparian vegetation can reduce the geomorphic condition of rivers (Brierley & Fryirs 2005). Reduction in geomorphic condition from good to moderate can be linked to reductions in macrophyte and macroinvertebrate assemblages (Chessman et. al 2006), while freshwater mussel abundance declines in river reaches where geomorphic condition also reduces (Jones & Byrne 2010). River Styles® recovery potential is synonymous with geomorphic condition. Recovery potential represents geomorphic stability and can indicate the capacity of a stream to return to good condition or to a realistic rehabilitated condition (Brierley & Fryirs 2005). Streams rated as having conservation or rapid recovery potential are likely to be the most stable and in a good condition, whereas streams with low recovery potential may never recover to a natural condition or may continue to decline quickly without intervention (Cook & Schneider 2006).

Long-lasting and complicated changes to stream ecosystems can occur through catchment disturbance impacts attributed to land use change (Maloney & Weller 2011). Catchment disturbance is recognised as an important factor that influences river condition (NLWRA 2002), where land use changes close to streams can have a more pronounced impact on reducing stream condition (Peterson et. al. 2011).

Figure G-3 and Figure G-4 provide a general overview of riparian and geomorphic condition for the Namoi Surface WRPA. For river recovery potential (Figure G-4), river reaches identified as being “strategic” can be in good, moderate or poor geomorphic condition. These reaches are often undergoing rapid change and should be a focus for action to control degradation. Where these constraints are considered to be particularly important for a specific water source and its mitigation strategies, further details are in the water source summaries (Volume 2).

Figure G-3 Percent cover categories of native woody riparian vegetation in the Namoi Surface WRPA

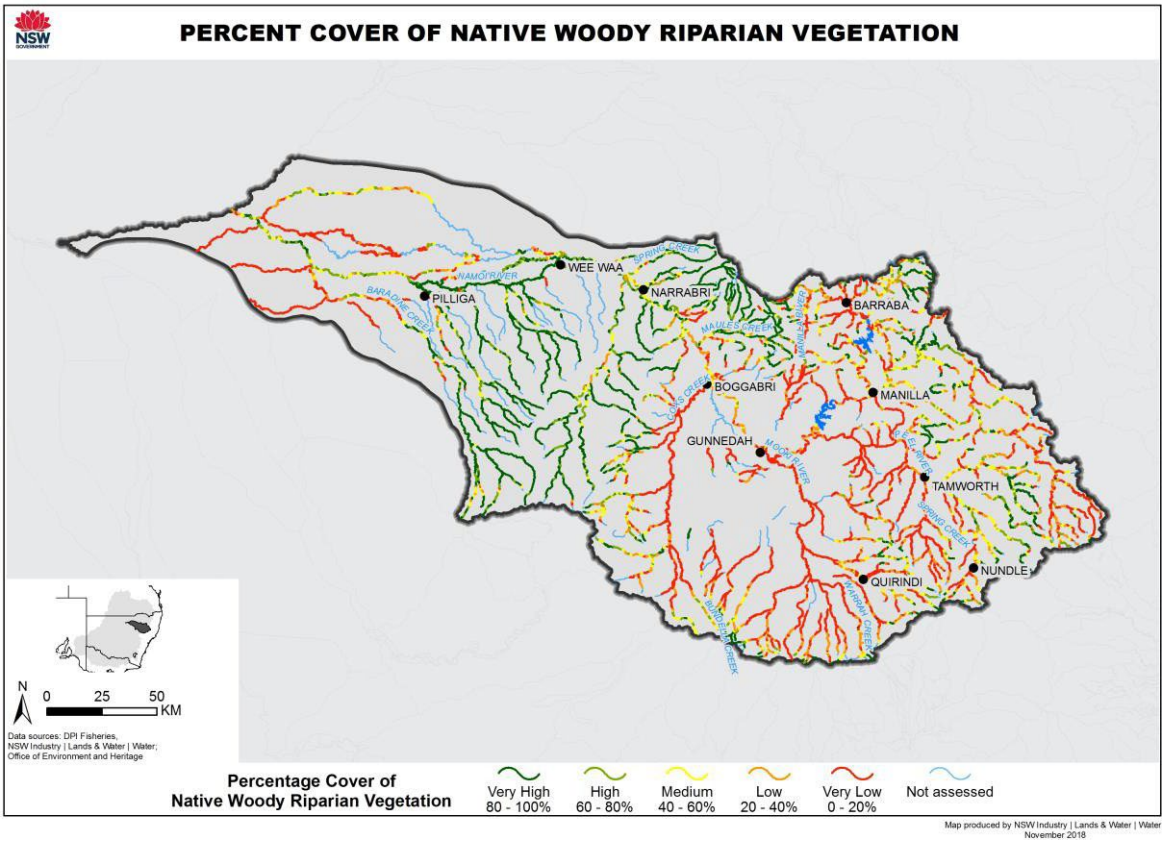
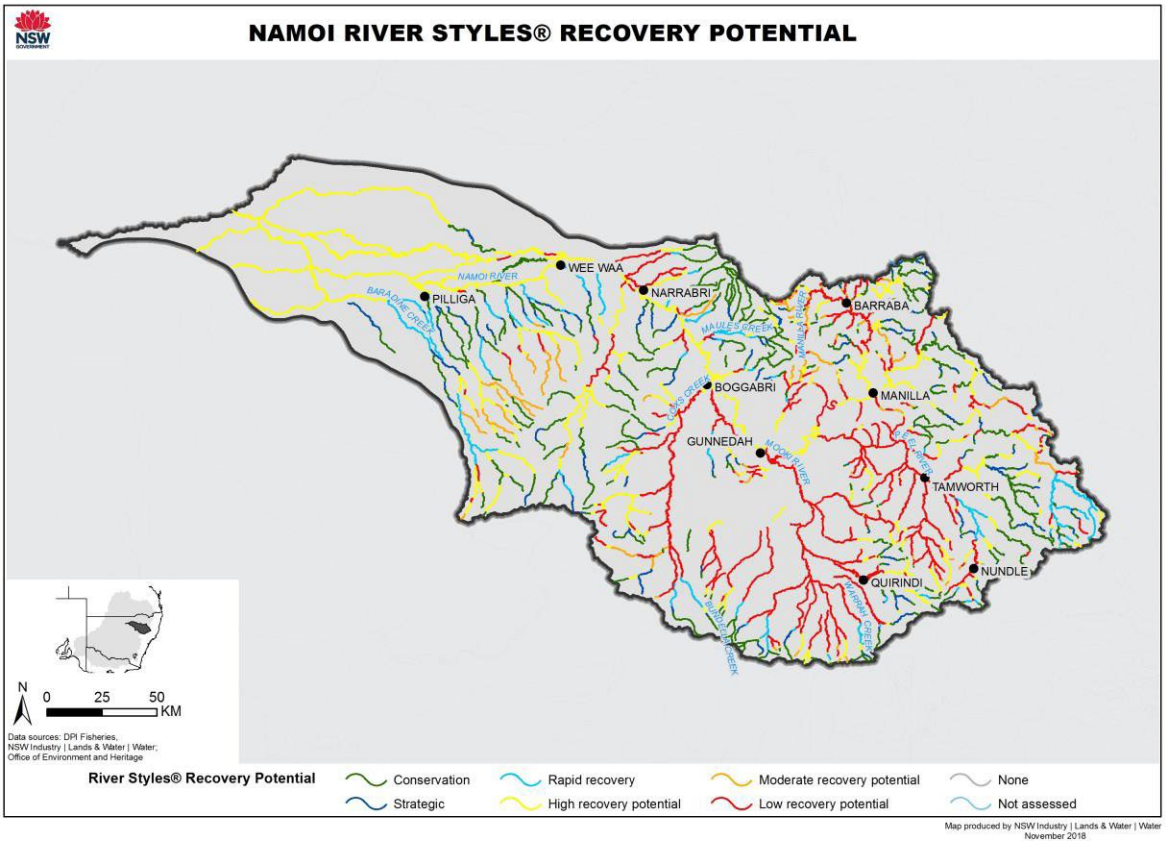


Figure G-4 Geomorphic recovery potential in streams in the Namoi Surface WRPA



Determining new or modified strategies for unregulated water sources

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

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

Each bifurcation in the decision tree was annotated, allowing for a rationale for each decision to be explained .

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

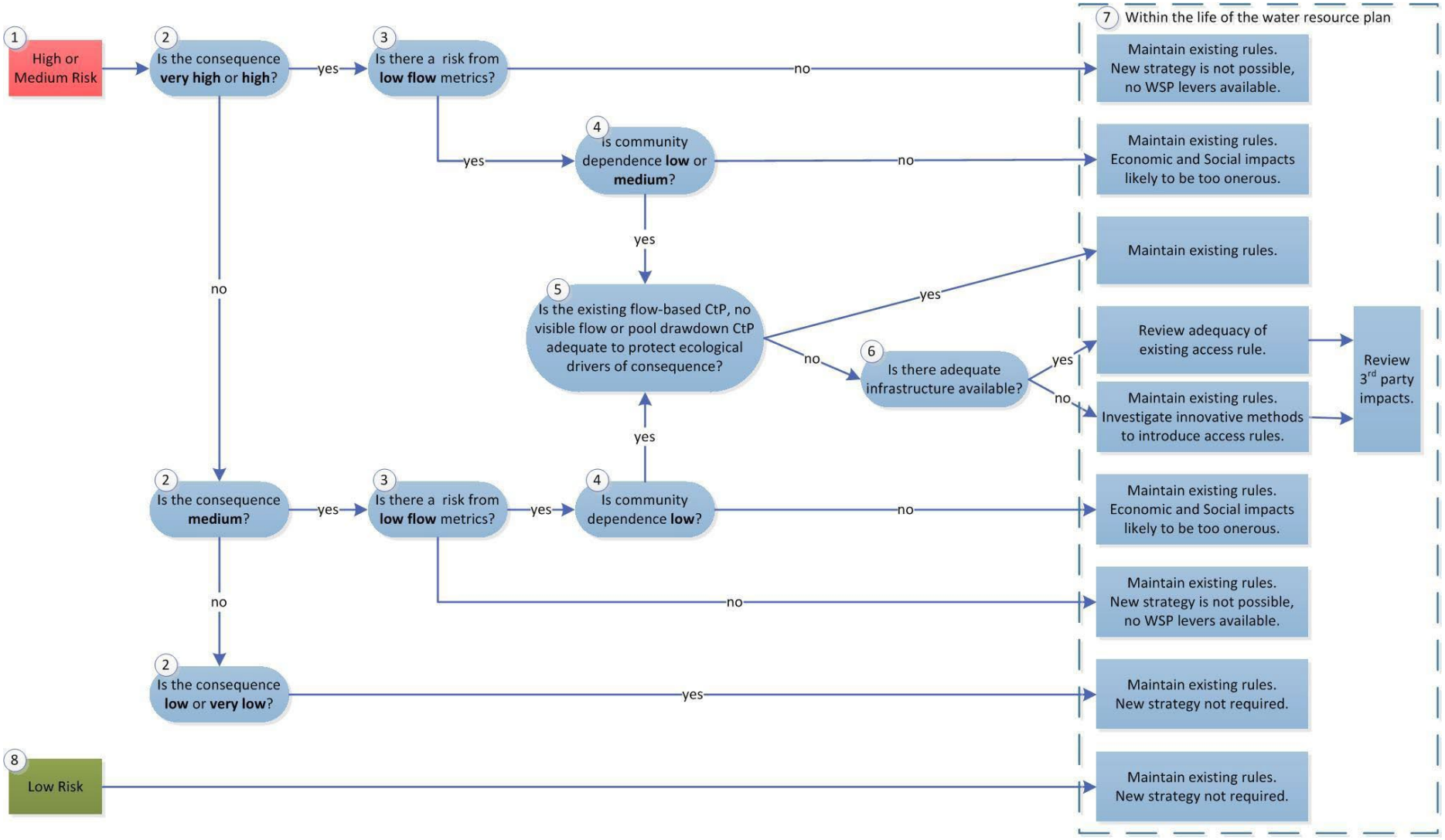


Table G-2 Rationale for each bifurcation in the decision tree used for determining strategies for unregulated water sources

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 2010), confidence would be higher. • * Where there is no Community Dependency data, by-pass this step and the decision tree moves from step 4 to step 5. The attributes of high or very high value sites are influenced by extraction pressure.

DECISION TREE ANNOTATION	RATIONALE
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.

Determining new or modified strategies for regulated water sources

As identified in previous sections, the operational, social, economic and environmental constraints to mitigating risks often provide limited scope for addressing risks in regulated rivers. The ability to mitigate a risk in a regulated water source primarily depends upon the flow class in which the risk occurs, the rules available within the WSP or WRP, and any potential impact upon third parties. The rules available in a WSP for planned environmental water generally only apply to low and medium flows. Rules are specific and can be unique to each regulated river. They can take the form of rules to manage supplementary water, or in some WSP areas, translucency rules, which allow small volumes of water to be released from storages to introduce flow variability, often subject to seasonal and flow triggers. Large volumes of held environmental water are managed by NSW DPIE through the LTWP component of the Basin Plan. The operation of held environmental water is not within the scope of either the WSP or the WRP.

Figure G-6 shows the general decision making process to address risks of insufficient water for the environment in regulated rivers. A rationale was not provided for this diagram as it is a consolidation of the concepts that are already detailed above.

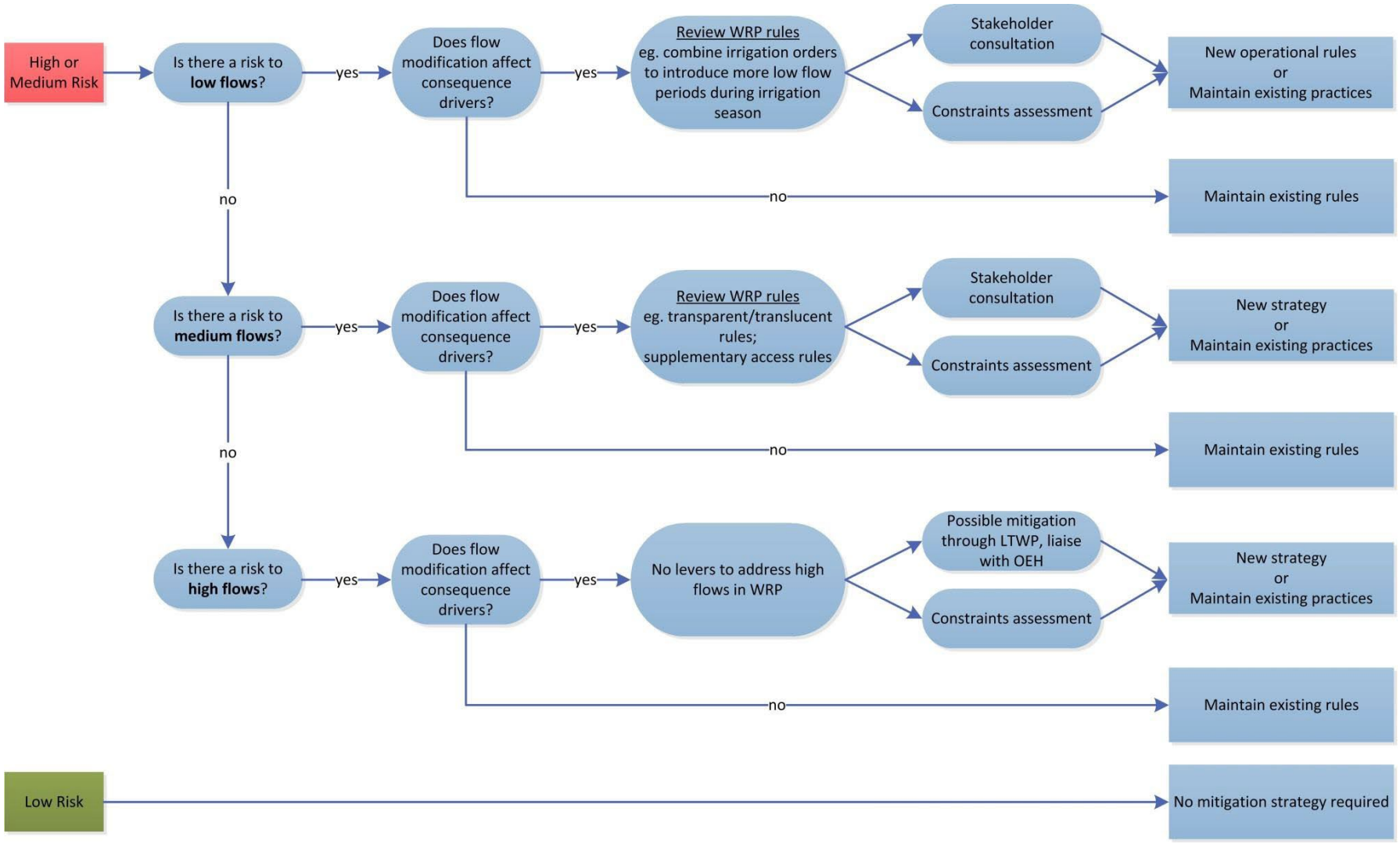
Further draft strategies for future consideration

The following draft strategies were also considered during the development of the WRP (Table G-3).

Table G-3 Draft strategies

Draft Strategy Details	Relevant River Reaches
Strategic delivery of irrigation orders to mimic natural flow events This draft strategy will investigate whether the risk associated with the reduced frequency of freshes during late spring and summer can be mitigated by delivering bulk water in patterns that mimic natural flow conditions. The ability to implement this strategy will vary between years and seasons and must be consistent with the need for efficient and timely water deliver. Discussions would need to be undertaken between DPIE and the CSC at the start of the irrigation planning season, to examine whether delivery patterns can be varied without impacting on water security and efficiency.	Regulated river reaches below Chaffey and Keepit Dams
Reduce the risk to freshes and high flow frequencies by restricting trade of supplementary flow access licences or new supplementary flow access licences This draft strategy will investigate whether the risk to freshes and high flow frequencies can be mitigated by preventing any further growth in supplementary flow access.	Regulated river reaches in the Lower Namoi.

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



Appendix H Risk assessment definitions

