Environmental Protection (Water and Wetland Biodiversity) Policy 2019

Burdekin, Don and Haughton River Basins

Groundwater Environmental Values and Water Quality Objectives

All groundwaters of basins 119, 120, 121

Queensland Government

Prepared by: Environmental Policy and Planning Division, Department of Environment and Science

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1 Introduction

This document is made pursuant to the provisions of the Environmental Protection (Water and Wetland Biodiversity) Policy 2019 (EPP [Water and Wetland Biodiversity]), which is subordinate legislation under the *Environmental Protection Act 1994*. The EPP (Water and Wetland Biodiversity) provides a framework for:

- identifying environmental values (EVs) for Queensland waters and wetlands
- identifying the management intent for waters
- identifying management goals for waters
- stating water quality objectives (WQOs) to protect or enhance EVs for waters (WQOs are long-term goals for receiving waters, not individual point source emission objectives.)
- including the identified EVs, management goals and WQOs for waters under Schedule 1 of the EPP (Water and Wetland Biodiversity).

This document contains EVs and WQOs for groundwaters in the Burdekin, Don and Haughton River basins, and is listed under schedule 1 of the EPP (Water and Wetland Biodiversity). For information on wetland EVs, refer to section 7 of the EPP (Water and Wetland Biodiversity). The accompanying plans (refer below for details) identify the EVs, water type and management intent for the different waters covered by this document.

1.1 Purpose

The purpose of this document is to identify locally relevant environmental values (EVs) and water quality objectives (WQOs) for groundwaters in the Burdekin, Don and Haughton River basins, pursuant to section 12 of the EPP (Water and Wetland Biodiversity) for inclusion in Schedule 1 of the EPP (Water and Wetland Biodiversity). EVs and WQOs are used to help set development conditions, influence local government planning schemes, and underpin report card grades for ecosystem health monitoring programs. Aquatic ecosystem water quality objectives have, where possible, been established using local data, and present a truer picture of the physico-chemical water quality of local waterways than national and state water quality guidelines. The adoption of local water quality monitoring data in deriving WQOs ensures the values the community holds for its waterways can be maintained and improved.

1.2 Queensland waters to which this document applies

This document applies to groundwaters draining the Burdekin, Don and Haughton River basins (basins 119, 120, 121[1]), as indicated in the accompanying plans GWQ1201–GWQ1204, and GWQ1207–GWQ1209[2]. Queensland groundwaters covered by this document include alluvial, fractured rock, Great Artesian Basin (GAB) and pre-GAB aquifer classes.

For surface waters of the Burdekin, Don and Haughton River basins (including fresh, estuarine and coastal waters), refer to separate documents under schedule 1 of the EPP (Water and Wetland Biodiversity).

[1] Australia's River Basins 1997—Product User Guide. Published by Geoscience Australia. Canberra, ACT (3rd edition, 2004).

[2] This document and the accompanying plans are available from the department's website. The boundaries in the accompanying plans GWQ1201–GWQ1204, and GWQ1207–GWQ1209 are indicative only. Schedule outlines, EVs, water types and aquatic ecosystem management intent (level of protection) depicted in the accompanying plans are available on Queensland Globe (qldglobe), and the GIS datasets can be downloaded from the Queensland Spatial Catalogue (QSpatial). For further information, email the department at epa.ev@des.qld.gov.au.

1.3 Great Barrier Reef end-of-basin load objectives

Annual end-of-basin load water quality objectives covering all Great Barrier Reef mainland basins have been established pursuant to section 11 of the EPP (Water and Wetland Biodiversity) for dissolved inorganic nitrogen and fine sediment across all mainland basins draining to the Great Barrier Reef. These are included in a separate document titled 'Great Barrier Reef River Basins End-of-Basin Load Water Quality Objectives', published by the department in September 2019, and available from the department's website.

1.4 Guidance on using this document

1.4.1 Key terms (refer to dictionary for additional terms)

ADWG means the Australian Drinking Water Guidelines, published on the National Health and Medical Research Council (NHMRC) website.

ANZG (previously ANZECC) means the Australian and New Zealand Guidelines for Fresh and Marine Water Quality, published on the Australian Government's Water Quality Australia website.

Environmental values (EVs) for water means under section 6 of the EPP (Water and Wetland Biodiversity) the EVs specified in the EVs tables of this document for the corresponding water, or for other waters the EVs stated in subsection 6(2) of the EPP (Water and Wetland Biodiversity). EVs for water are the qualities of water that make it suitable for supporting aquatic ecosystems and human water uses. These EVs need to be protected from the effects of habitat alteration, waste releases, contaminated runoff and changed flows to ensure healthy aquatic ecosystems and waterways that are safe for community use. Particular waters may have different EVs. The range of EVs that can potentially apply to groundwaters is listed below, and further details are provided in the dictionary.

List of EVs and applicable waters

Environmental value (EV)	Potentially applicable to groundwaters
Protection of aquatic ecosystems (aquatic ecosystem EV) Protection or enhancement of aquatic ecosystem values, under four possible levels of ecosystem conditions: • high ecological value (effectively unmodified) waters • slightly disturbed waters • moderately disturbed waters • highly disturbed waters. (Suitability for seagrass and wildlife habitat have also been specifically identified for some Queensland waters as a component of this EV).	✓
EVs other than aquatic ecosystem EV (called human use EVs)	
Suitability for drinking water supplies	✓
Suitability for primary contact recreation (e.g. swimming)	✓
Suitability for secondary contact recreation (e.g. boating)	✓
Suitability for visual (no contact) recreation	✓
Suitability of water for producing or taking aquatic foods (such as fish, shellfish and other plants and animals) that are safe and suitable for human consumption	✓
Protection of cultural and spiritual values, including traditional owner values of water	✓
Suitability for industrial use (including mining, minerals refining/processing)	✓
Suitability for aquaculture (e.g. red claw, barramundi)	✓
Suitability for crop irrigation	✓
Suitability for stock watering	✓
Suitability for farm supply/use	✓

Level of protection for a water (aquatic ecosystem EV) means the level of aquatic ecosystem condition specified for waters in the Aquatic Ecosystem water quality objectives tables of this document that the corresponding WQOs for that water are intended to achieve (refer to management intent definition below for further information).

Management goal means the goal/s (if any) stated in this document to support the EVs for waters identified in the EVs tables.

Management intent for a water (aquatic ecosystem EV) is defined in s.15 of the EPP (Water and Wetland Biodiversity). It is the management intent for the waters that the decision to release waste water or contaminant to waters must ensure that:

- for high ecological value (HEV) waters—the measures for the indicators for all EVs of water are maintained;
- for slightly disturbed (SD) waters—the measures for the slightly modified physical or chemical indicators are progressively improved to achieve the water quality objectives for high ecological value water;
- for moderately disturbed (MD) waters:
  - if the measures for indicators of the EVs achieve the water quality objectives for the water—the measures for the indicators are maintained at levels that achieve the water quality objectives for the water, or
  - if the measures for indicators of the EVs do not achieve the water quality objectives for the water—the measures for indicators of the EVs are improved to achieve the water quality objectives for the water;
- for highly disturbed (HD) waters—the measures for the indicators of all EVs are progressively improved to achieve the water quality objectives for the water.

QWQG means the Queensland Water Quality Guidelines, published on the Department's website.

Water quality guidelines means under section 8 of the EPP (Water and Wetland Biodiversity), numerical concentration levels or statements for indicators that protect a stated environmental value. Under the EVs setting process contained in the EPP (Water and Wetland Biodiversity), water quality guidelines are used as an input to the development of WQOs.

Water quality indicator (for an EV) means under section 8 of the EPP (Water and Wetland Biodiversity), a property that is able to be measured or decided in a quantitative way. Examples of water quality indicators include physical indicators (e.g. temperature), chemical indicators (e.g. nitrogen, phosphorus, metals), and biological indicators (e.g. macroinvertebrates, seagrass, fish).

Water quality objectives (WQOs) means under section 11 of the EPP (Water and Wetland Biodiversity), the WQOs specified in tables of this document to support the corresponding EVs for waters identified in the EVs table.

WQOs are long-term goals for water quality management. They are numerical concentration levels or narrative statements of indicators established for receiving waters to support and protect the stated EVs for those waters. Water quality objectives are not individual point source emission objectives, but the receiving water quality objectives.

WQOs are derived from scientific criteria or water quality guidelines but may be modified by consideration of economic and social impacts of protecting the EVs for the waters.

Examples of WQOs for the aquatic ecosystem EV (which should not be directly adopted for use) include:

- electrical conductivity less than 500 microsiemens per centimetre (µS/cm)
- pH between 6.5 and 8.4
- calcium less than 50 milligrams per litre (mg/L)

Water type means groupings of waters with similar characteristics, as shown in the accompanying plans. This document is focussed on groundwaters. More details on groundwater water types are provided in section 1.6. WQOs applying to different water types are outlined in this document.

1.4.2 Use of this document

Section 2 lists the identified EVs for protection for particular waters. EVs are mapped in the accompanying plans. The aquatic ecosystem EV is a default applying to all Queensland waters. Reference to tables in sections 3–4 provides the corresponding WQOs to protect the aquatic ecosystem EV, and human use EVs.

Where more than one EV applies to a given water, the adoption of the most stringent WQO for the identified EVs applies to each water quality indicator in order to protect all identified EVs.

This document also refers to a number of guidelines, codes and other reference sources on water quality. In particular, the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG) and the QWQG provide more detailed information on water types, water quality indicators, derivation of local water quality guidelines, application during flood events, monitoring, and other matters.

1.5 Information about mapped areas and boundaries

The boundaries in the accompanying plans GWQ1201–GWQ1204 and GWQ1207–GWQ1209 are indicative only. Schedule outlines, EVs, water types and aquatic ecosystem management intent (level of protection) depicted in the accompanying plans are available on Queensland Globe (qldglobe), and the GIS datasets can be downloaded from the Queensland Spatial Catalogue (QSpatial). For further information, email the department at epa.ev@des.qld.gov.au.

1.6 Water types and basis for boundaries

1.6.1 Water types

Water types are groupings of waters with similar characteristics. Groundwaters in this document have been classified into aquifer classes and chemistry zones within each aquifer class, as defined below, and summarised in Table 1. EVs and WQOs are provided for chemistry zones as shown in the accompanying tables and plans.

Aquifer class: a classification system for major aquifer types, including division of large systems such as the GAB, to avoid difficulties in mapping overlapping units. The aquifer types occurring in Queensland have been subdivided into nine major classes for mapping purposes. Seven of these classes occur in the Burdekin region. Each aquifer class is subdivided into chemistry zones, with boundaries mapped around distributions of similar water chemistry and a consistent suite of aquifers (refer Table 1)

Chemistry zone: Chemistry zone: a section of an aquifer class where the baseline water chemistry is reasonably consistent, and the bores access one or more major aquifers or other geological formations which are related in space, time and origin (refer Table 1). A chemistry zone may contain more than one aquifer, as well as other geological formations (e.g. aquitards) from the same aquifer class, but the aquifers will generally be closely related. Chemistry zones may extend across (under) surface water basin boundaries.

1.6.2 Water type boundaries

The boundaries of different groundwater aquifer classes and chemistry zones have been mapped using relevant attributes, including:

- geographic coordinates
- boundaries based on technical investigations
- water quality chemistry
- lithology
- aquifer depth

Boundaries are shown on the accompanying plans. The boundaries of water types may be confirmed or revised by site investigations.

1.7 Matters for amendment

Amendments of the following type may be made to this schedule 1 document (and accompanying plans) for the purposes of replacement under section 13(2)(b) of the EPP (Water and Wetland Biodiversity):

- changes to EVs
- changes to management goals
- changes to WQOs
- changes to management intent (level of protection) categories
- changes to waterway or water type boundaries/descriptions
- updates to information/data sources, websites and email contact details, agency/departmental names, other institutional names, references.

Table 1 Aquifer classes and chemistry zones summary (Burdekin-Don Haughton)

Aquifer class	Description, including component chemistry zones[1, 2]	Burdekin-Don-Haughton GWQ plan reference
Alluvium	Recent alluvium divided into multiple chemistry zones based on water quality and factors such as extent of alluvium, and sub-catchment characteristics. It includes deltaic sediments in the Burdekin Delta and in some other coastal areas, and acid sulphate soils may be prevalent in low lying coastal locations. Water quality is moderate to saline NaCl or $NaHCO_3$, generally hard with a tendency to scale. Groundwater in larger, deeper catchments may be altered in the vicinity of streams, due to recent recharge. Zones containing basalts or other weatherable terrains tend to be richer in Ca and Mg. Data sufficiency varies, with best for the Burdekin delta and the adjoining coastal catchments.	GWQ1201
Fractured rock	Aquifers in hard rock with water stored in fractures or permeable sandstones other than those considered part of the GAB, or the Bowen and Galilee Basins. Divided into multiple zones on the basis of rock type, location and water quality, including zones in basalt, one with substantial serpentinite, and the remaining granite and trap rock, including some from the Precambrian. Based on reasonable amounts of data, water quality in the basalts is moderately saline, with Mg then Na, with HCO_3 then Cl. It is hard, with a tendency to scale. There is little data for the other zones, but the water quality appears mainly to be of moderate to high salinity, with Na then Ca, and Cl. The Serpentinite may be high in nickel.	GWQ1202
Cainozoic deposits (including sediments overlying the GAB)	The overlying sediments consist of Tertiary sediments, particularly in the Dawson catchment and including the Biloela Formation, as well as weathered Cainozoic alluvium surrounding and underlying recent alluvium. Sand dunes occur in some coastal areas, particularly on Curtis Island. Based on few data, the water quality varies spatially but is usually moderately to highly saline NaCl, with lower salinity and higher HCO_3 near streams. It has the capacity to contribute saline seepages to nearby alluvial aquifers under stress, such as has occurred in the Callide.	GWQ1203
Mid GAB aquifers	Only the edge of this layer, which contains the main confined GAB aquifers, is present within the region, however, these aquifers do include recharge areas. The Eromanga Basin overlaps the Upper Burdekin and Suttor zones in three small, western extensions, considered as one zone, with water being extracted from the Ronlow Beds and Gilbert River Formations. The Dawson catchment in the Fitzroy overlaps the northernmost Surat Basin as two zones, with water being drawn from shallow Bungil, Mooga, Orallo, and Gubberamunda Formations, with springs being common.	GWQ1204
Lower GAB	The lower GAB aquifers also only outcrop as a small patch of the Eromanga in the north-western Suttor catchment, with a more extensive area in the upper Dawson sandstone country. The water quality is very variable, due to the complex lithology, as water is withdrawn from the Hutton and Springbok aquifers, as well as several aquitards, including the Westbourne, Injune Creek, and Walloon Coal Measures. The groundwater is probably also influenced by overlying geology, and has been divided into seven zones.	GWQ1207
Basal GAB	This division represents the lowest beds in the GAB, mainly the Evergreen aquitard and underlying Precipice Sandstone. With a minor extension of the Precipice Outcrop in the south of the Burdekin Basin, chemistry zones in this aquifer class are basically confined to the Fitzroy Basin, underlying the Lower GAB Formations in the Fitzroy. The groundwater is generally moderately saline, dominated by HCO_3 with either Na, or mixed cations in outcrop areas near basaltic remnants.	GWQ1208

Aquifer class	Description, including component chemistry zones[1, 2]	Burdekin-Don-Haughton GWQ plan reference
Earlier basins partially underlying the GAB (i.e. pre GAB)	The Permian-Triassic Bowen and Galilee Basins represent hydrological networks that pre-date the GAB and were eroded before GAB sedimentation commenced. They were laid down contemporaneously, comprise the same geological formations in their upper layers, and are united in the Springsure area. Both contain important coal deposits. The Bowen Basin underlies the Surat, and most of the Fitzroy, and extends into the Bowen Basin in the Burdekin. The Galilee, to the west, underlies the Eromanga, the southern Nogoa headwaters and the western edge of the Suttor. The main aquifer is the Clematis Sandstone, but numerous formations are accessed, some of them coal bearing, so that the water quality is very complex. Fourteen zones are identified on the basis of location and hydrological unit, with four in the Galilee, nine in the Bowen, and one at the intersection.	GWQ1209

Notes:

1. Groundwater assessment and classification originally prepared for Burdekin-Fitzroy regions (refer reference below). Some comments in table refer to groundwaters of Fitzroy Basin, however these are not part of this schedule document.

2. Water quality characteristics of springs are expected to relate to the source aquifer from which a spring emanates, for example artesian springs (subject to local catchment and other influences).

Reference:

McNeil, V.H., Thames, D., Vaca, F., Bennett, L. & McGregor, G.B. 2018. Regional groundwater chemistry zones: Fitzroy-Capricorn-Curtis Coast and Burdekin-Haughton-Don regions: Summary and results. Draft for consultation. Water Planning Ecology: Department of Environment and Science, Queensland Government

ENVIRONMENTAL VALUES AND MANAGEMENT GOALS

2 Environmental values and management goals

2.1 Environmental values

Environmental values (EVs) for water are the qualities of water that make it suitable for supporting aquatic ecosystems and human water uses (refer dictionary to this document for further details). EVs for waters covered by this document are shown in Table 2 and the accompanying plans (GWQ1201–GWQ1204, and GWQ1207–GWQ1209).

Table 2 Environmental values: Burdekin-Don-Haughton Basin groundwaters

GROUNDWATERS (Refer plans GWQ1201–GWQ1204, and GWQ1207–GWQ1209)	Environmental values[1–6]											
	Aquatic ecosystem	Irrigation	Farm supply/use	Stock water	Aquaculture	Human consumer [5]	Primary recreation [5]	Secondary recreation[5]	Visual recreation [5]	Drinking water [5]	Industrial use	Cultural and spiritual values
Water (listed alphabetically)												
ALLUVIUM (refer plan GWQ1201)												
Don and Southern Burdekin Delta	✓	✓	✓	✓						✓	✓	✓
Haughton	✓	✓	✓	✓						✓	✓	✓
Suttor	✓	✓		✓								✓
Lower Burdekin with Bowen	✓	✓	✓	✓						✓	✓	✓
Upper Burdekin	✓	✓	✓	✓						✓		✓
Burdekin Delta Coastal Area	✓	✓	✓	✓						✓	✓	✓
West Barratta	✓	✓	✓	✓						✓	✓	✓
Mid Burdekin Delta	✓	✓	✓	✓						✓	✓	✓
East Barratta	✓	✓	✓	✓						✓	✓	✓
Native Companion Creek	✓			✓								✓

GROUNDWATERS (Refer plans GWQ1201–GWQ1204, and GWQ1207–GWQ1209)	Environmental values[1–6]											
	Aquatic ecosystem	Irrigation	Farm supply/use	Stock water	Aquaculture	Human consumer [5]	Primary recreation [5]	Secondary recreation[5]	Visual recreation [5]	Drinking water [5]	Industrial use	Cultural and spiritual values
Water (listed alphabetically)												
Cape River Alluvium	✓			✓								✓
Campaspe River Alluvium	✓			✓								✓
Upper Barratta	✓	✓	✓	✓						✓	✓	✓
FRACTURED ROCK (refer plan GWQ1202)												
Drummond Basin Sediments	✓			✓								✓
Greenvale Craton	✓											✓
Eastern Basement with Basalt Remnants	✓	✓	✓	✓	✓					✓	✓	✓
Ravenswood Granites and Volcanics	✓	✓	✓	✓						✓	✓	✓
Northern Basalt	✓			✓								✓
Main Range Volcanics	✓	✓	✓	✓	✓					✓	✓	✓
Central Cratonic Basement	✓	✓	✓	✓						✓	✓	✓

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GROUNDWATERS (Refer plans GWQ1201–GWQ1204, and GWQ1207–GWQ1209)	**Environmental values**[1–6]											
	Aquatic ecosystem	**Irrigation**	**Farm supply/use**	**Stock water**	**Aquaculture**	**Human consumer** [5]	**Primary recreation** [5]	**Secondary recreation**[5]	**Visual recreation** [5]	**Drinking water** [5]	**Industrial use**	**Cultural and spiritual values**
Water (listed alphabetically)												
CAINOZOIC DEPOSITS INCLUDING DEPOSITS OVERLYING GAB (refer plan GWQ1203)												
Scattered Remnants Northern Burdekin Headwaters	✓											✓
Eastern Weathered Cainozoic Remnants	✓											✓
Central Moderately Saline Weathered Remnants	✓	✓		✓						✓	✓	✓
Saline Tertiary Sediments	✓	✓		✓						✓	✓	✓
North West Suttor Catchment	✓	✓		✓								✓
Don and Bogie Coastal Area	✓											✓

GROUNDWATERS (Refer plans GWQ1201–GWQ1204, and GWQ1207–GWQ1209)	**Environmental values**[1–6]											
	Aquatic ecosystem	**Irrigation**	**Farm supply/use**	**Stock water**	**Aquaculture**	**Human consumer** [5]	**Primary recreation** [5]	**Secondary recreation**[5]	**Visual recreation** [5]	**Drinking water** [5]	**Industrial use**	**Cultural and spiritual values**
Water (listed alphabetically)												
MID GAB (refer plan GWQ1204)												
Northeastern GAB border, Ronlow and Gilbert River	✓			✓								✓
LOWER GAB (refer plan GWQ1207)												
Northeastern Eromanga (extending into Thompson)	✓											✓
Northern Hutton Outcrop (QMDB)	✓		✓	✓						✓		✓
BASAL GAB (refer plan GWQ1208)												
Precipice Outcrop (continued in upper Dawson)	✓	✓	✓	✓						✓		✓

GROUNDWATERS (Refer plans GWQ1201–GWQ1204, and GWQ1207–GWQ1209)	Environmental values[1–6]											
	Aquatic ecosystem	Irrigation	Farm supply/use	Stock water	Aquaculture	Human consumer [5]	Primary recreation [5]	Secondary recreation[5]	Visual recreation [5]	Drinking water [5]	Industrial use	Cultural and spiritual values
Water (listed alphabetically)												
BASINS PARTIALLY UNDERLYING THE GAB (refer plan GWQ1209)												
Central Galilee Coal Measures	✓			✓						✓		✓
Southern Galilee Clematis	✓			✓						✓		✓
Western Galilee Clematis	✓	✓		✓						✓		✓
Northern Galilee Clematis	✓	✓		✓					✓	✓		✓
Eastern Bowen Coal Measures	✓	✓		✓						✓	✓	✓
Bowen Basin Basalt Area	✓	✓		✓						✓	✓	✓
Northwestern Bowen Coal Measures	✓			✓							✓	✓

Notes:

1. Refer to the accompanying groundwater plans GWQ1201–GWQ1204, and GWQ1207–GWQ1209 for locations of EVs. EVs shown relate to waters within each unit (for example 'Haughton') as shown on the plans. This information does not replace the need for more detailed testing to ascertain suitability of a specific water source (e.g. bore) for a particular use (e.g. irrigation).

2. ✓ means the EV is selected for protection. Blank indicates that the EV is not chosen for protection. Note in relation to connections with surface water (covered in separate schedule documents), the ANZG Application of the Water Quality Guidelines to groundwater states: "…*groundwater should be managed in such a way that when it comes to the surface, whether from natural seepages or from bores, it will not cause the established water quality objectives for these waters to be exceeded, nor compromise their designated community values"*

3. Refer to the dictionary for further explanation of EVs.

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4. Refer to sections 3–4 for WQOs applying to the EVs in this table.

5. (This note applies primarily to surface waters.) The selection of recreational and other human use EVs for waters does not mean that these waters are free of dangerous aquatic organisms, for example venomous organisms (e.g. marine stingers including box jellyfish, irukandji jellyfish), crocodiles, and sharks. Direct contact with dangerous aquatic organisms should be avoided. Refer to DES Crocodiles, council, Queensland Health, Beachsafe, marine stingers, and other information sources for further details on swimming safety and information on specific waters. Access restrictions may apply in certain locations (e.g. ports, defence, Traditional Owner lands), or at certain times of the year. Restrictions on certain activities (e.g. fishing, camping) may also apply in particular areas. Check with relevant authorities.

6. The selection of EVs for waters does not mean that these are currently free of toxicants (including bioaccumulative toxicants). Information about contaminated land can be accessed by searching the Environmental Management and Contaminated Land Registers. For information on per and poly-fluoroalkyl substances (PFAS), including alert areas and links to further health advice on water use in such areas, refer to PFAS in Queensland.

References:

McNeil, V.H., Thames, D., Vaca, F., Bennett, L. & McGregor, G.B. 2018. Regional groundwater chemistry zones: Fitzroy-Capricorn-Curtis Coast and Burdekin-Haughton-Don regions: Summary and results. Draft for consultation. Water Planning Ecology: Department of Environment and Science, Queensland Government

NQ Dry Tropics (2016) *Burdekin Region Water Quality Improvement Plan*, NQ Dry Tropics, Townsville

NQ Dry Tropics (2013) *Community draft environmental values for the waters of the Burdekin Dry Tropics Region*, June (Ed: R Kerr)

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2.2 Management goals to support environmental values

2.2.1 Management intent for waters

It is the management intent for Queensland waters that the decision to release waste water or contaminant to waters must ensure the following:

- for high ecological value (HEV) waters—the measures for the indicators for all EVs of waters are maintained
- for slightly disturbed (SD) waters—the measures for the slightly modified physical or chemical indicators are progressively improved to achieve the water quality objectives for high ecological value water
- for moderately disturbed (MD) waters:
  - if the measures for indicators of the EVs achieve the water quality objectives for the water—the measures for the indicators are maintained at levels that achieve the water quality objectives for the water, or
  - if the measures for indicators of the EVs do not achieve the water quality objectives for the water—the measures for indicators are improved to achieve the water quality objectives for the water
- for highly disturbed (HD) waters—the measures for the indicators of all EVs are progressively improved to achieve the water quality objectives for the water.

Note 1 — refer to accompanying plans for locations of waters and level of protection/management intent

Note 2 — see the Environmental Protection Regulation 2019, section 35

Note 3 — see the EPP (Water and Wetland Biodiversity), section 15.

Aquatic ecosystem WQOs are provided in section 3 of this document.

2.2.2 National policy guidance on groundwaters

National guidance on the management of ground water quality is provided in the following sources. Extracts of relevant advice informing derivation of water quality objectives in this document are provided in supporting table notes:

- ANZG Application of the Water Quality Guidelines to groundwater
- Guidelines for groundwater quality protection in Australia
- Great Artesian Basin Strategic Management Plan

2.2.3 Reef water quality improvement plan

The Reef 2050 Water Quality Improvement Plan 2017–2022 (Reef 2050 WQIP) is a joint commitment of the Australian and Queensland governments that seeks to improve the quality of water flowing from the catchments adjacent to the Great Barrier Reef. The plan identifies how catchment water quality outcomes under the broader Reef 2050 Long-Term Sustainability Plan will be delivered. The long-term (2050) outcome under the Reef 2050 WQIP is that 'Good water quality sustains the outstanding universal value of the Great Barrier Reef, builds resilience, improves ecosystem health and benefits communities'. The Reef 2050 WQIP includes the following commitment, identified as contributing to the delivery of Reef 2050 action 1.2: *Review and update water quality objectives and water quality guidelines at regionally relevant scales under the Environmental Protection Policy (Water) 2009* [remade to become the EPP (Water and Wetland Biodiversity) in 2019].

The Reef 2050 WQIP contains end of basin annual load reduction targets for dissolved inorganic nitrogen and fine sediment across mainland basins draining to the Great Barrier Reef. These have been reflected in the document titled 'Great Barrier Reef River Basins End-of-Basin Load Water Quality Objectives' (September 2019), pursuant to section 11 of the EPP (Water and Wetland Biodiversity), and are available from the department's website.

The Reef 2050 WQIP also contains targets for pesticides such that end of catchment concentrations of pesticides protect 99% of aquatic species. This corresponds to a high ecological value level of protection. Further information is available from the reef plan website.

2.2.4 Management goals for human use environmental values

Management goals for human use EVs are provided below. WQOs to support these goals are provided in section 4 of this document.

2.2.4.1 Irrigation water quality

The management goal for irrigation water is that the quality of water, when used in accordance with the best irrigation and crop management practices and principles of ecologically sustainable development, does not result in crop yield loss or soil degradation (noting that water quality requirements may differ by crop type).

2.2.4.2 Farm supply use

The management goal for farm supply use is that the quality of water is suitable for produce preparation and domestic uses other than drinking. (Drinking and other human uses outlined below.)

2.2.4.3 Stock water quality

The management goal for stock watering is that the quality of water provided to stock does not cause deterioration in stock health or condition (noting that water quality requirements may differ by stock type).

2.2.4.4 Aquaculture

The management goal for aquaculture is that the quality of water provided for aquaculture does not cause deterioration in stocked species health or condition (noting that water quality requirements may differ by species).

2.2.4.5 Human consumers of aquatic foods

The management goal is that the water quality is suitable for producing or taking aquatic foods that are safe and suitable for human consumption.

2.2.4.6 Recreational water quality

The management goal for recreational water quality is to achieve a low risk to human health from water quality threats posed by exposure through ingestion, inhalation or contact during recreational use of water resources.

2.2.4.7 Raw water for drinking water consumption

The management goal is to:

- minimise the risk that the quality of raw water taken for treatment for human consumption results in adverse human health effects
- maintain the palatability rating of water taken for treatment for human consumption at the level of ‘good’ as set out in the ADWG
- minimise the risk that the quality of raw water taken for treatment for human consumption results in the odour of drinking water being offensive to consumers.

2.2.4.8 Industrial use

The management goal for industrial use is that the quality of water provided to industry is, with an appropriate level of treatment, suitable for industrial use. Industries usually treat water supplies to meet their specific needs, accordingly no WQOs are specified in this document for industrial use.

2.2.4.9 Cultural and spiritual values and uses of water

The management goal is that water is suitable to support identified cultural and spiritual values of waters, including those of Aboriginal people or Torres Strait Islanders. Management goals and objectives specified for aquatic ecosystems and other human water uses (including recreation, human consumption of aquatic foods, and drinking water) will assist in supporting some aspects of cultural and spiritual values of water.

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WATER QUALITY OBJECTIVES TO PROTECT ENVIRONMENTAL VALUES

3 Water quality objectives to protect aquatic ecosystem environmental values

Water quality objectives (WQOs) are long-term goals for water quality management. They are numerical concentration levels or narrative statements of indicators established for receiving waters to support and protect the designated EVs for those waters. Water quality objectives are not individual point source emission objectives, but the receiving water quality objectives.

Where more than one EV applies to a given water, the most stringent WQO for each water quality indicator applies, which will then protect all identified EVs. Refer to the following example on selection of most stringent WQOs.

3.1 Aquatic ecosystem water quality objectives

This section provides physical, chemical and where available, biological water quality objectives (WQOs) to support and protect the aquatic ecosystem EV. (Human use EVs, including recreation, stock watering etc, are addressed in section 4).

The aquatic ecosystem EV is a default applying to all Queensland waters, and therefore the WQOs for aquatic ecosystems form the minimum WQOs for all waters. Where no human use EVs are identified, the WQOs identified for aquatic ecosystem protection remain applicable.

WQOs for specified indicators are listed in Table 3 (by aquifer type/chemistry zone).

Details on management intent are included in the tables and notes supporting tables. Links to wetland, riparian and State Planning Policy (state interest – water quality) mechanisms are provided in and after the tables. Sources used in deriving WQOs are provided in and after the tables.

3.1.1 Comparison of test data with WQOs

The following protocols are recommended when comparing groundwater quality (at a 'test' site) with the corresponding groundwater aquatic ecosystem water quality objective (WQO). The management intent for all groundwaters corresponds to an HEV level of protection, namely that there should be 'no change' to existing water quality, i.e. no change in the natural range of values (except in circumstances where water quality is modified and improvement is sought in relevant parameters). No change is deemed to have occurred if there are no detectable changes to the 20th, 50th and 80th percentiles of the natural distribution of values (or no change to the 50th percentile where there is insufficient data to derive a range of WQOs). A summary of procedures for comparing test data with WQOs is provided below and detailed methods are provided in the QWQG.

- Where the WQO is expressed as a 20th–50th–80th percentile range of values to be maintained (e.g. Total N: 65–100–125 µg/L), the 20th–50th–80th percentile distributions of the test data should meet the specified range of values. The sample number is a minimum of 24 test values over the relevant period (12 months if a continuous activity or alternatively a shorter period for activities where discharge occurs for only part of the year).
- Where, due to data limitations, the WQO is expressed as a single figure (50th percentile) value, the same comparison (i.e. with minimum 24 samples) is made.

For toxicants in water: unless otherwise stated, WQOs for toxicants are derived from the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG, 2018) default guideline values for the corresponding level of species protection. The ANZG recommends that the 95th percentile of test data is compared against the default guideline value. As the proportion of test values that is required to be less than the default guideline value is high, the ANZG indicates that a single observation greater than the default guideline value is considered an exceedance.

For comparisons of toxicants in sediments, refer to ANZG.

Further information: Refer to the QWQG, the Queensland Monitoring and Sampling Manual (2018), and ANZG for more details.

AQUATIC ECOSYSTEM WATER QUALITY OBJECTIVES

Table 3 Aquatic ecosystem water quality objectives – groundwaters (by aquifer class and chemistry zone)

AQUIFER CLASS Chemistry zone (Source: s1)		Percentile	BURDEKIN, DON, HAUGHTON RIVER BASINS – GROUNDWATERS (refer plans GWQ1201–GWQ1204, and GWQ1207–GWQ1209) [1–3] Aquatic ecosystem water quality objectives **Note:** Except where indicated, the level of protection/management intent for groundwaters is high ecological value (HEV), where groundwater quality should be maintained within the natural range of variability. WQOs for indicators are typically shown as a range of 20th, 50th and 80th percentiles, to be maintained or achieved. Refer to section 3.1.1 for details on comparing test water quality data with the WQOs. Note that the WQOs in this table are solely for groundwater aquatic ecosystems and may not be protective of surface water aquatic ecosystems. Where groundwater is expressed to surface waters, readers should refer to surface water EVs and WQOs tables contained in separate schedule documents for surface waters (including aquatic ecosystem WQOs). **Sources**: S1: Local datasets/reporting (applies to all WQOs except where indicated); S2: ANZG											
			Na (mg/L)	**Ca** (mg/L)	**Mg** (µg/L)	**HCO_3** (mg/L)	**Cl** (mg/L)	**SO_4** (mg/L)	**NO_3** (mg/L)	**EC** (µS/cm)	**Hardness** (mg/L)	**pH**	**Alkalinity** (mg/L)	**SiO_2** (mg/L)
Note: Information on lakes, wetlands, toxicants, temperature, and State Planning Policy (water quality state interest) provided at end of table.													
ALLUVIUM (refer plan GWQ1201)													
ALLUVIUM	**1 – Don and Southern Burdekin Delta** (s1) - MD	**20th**	94	33	22	225	110	19.0	0.10	770	187	7.6	190.0	27.0
		50th	300	73	68	340	570	60.0	1.70	2200	489	8.0	288.0	39.0
		80th	1742	180	195	471	2750	781.0	8.20	6400	1278	8.3	399.0	58.0
ALLUVIUM	**1 – Don and Southern Burdekin Delta near stream** (s1) - MD	**20th**	66	27	17	200	70	15.0	0.10	600	151	7.7	169.0	23.0
		50th	228	46	33	305	343	64.0	2.00	1125	273	8.0	260.0	30.0
		80th	3900	170	293	430	5737	1500.0	9.59	9106	1691	8.4	365.0	39.0
ALLUVIUM	**2 – Haughton** (s1) - MD	**20th**	55	20	12	145	56	2.0	0.20	485	104	7.3	120.0	49.0
		50th	95	40	22	203	140	5.0	0.60	974	191	7.8	169.0	63.0
		80th	509	102	66	287	754	50.0	5.87	6059	517	8.2	240.1	75.0
ALLUVIUM	**2 – Haughton near stream** (s1) - MD	**20th**	40	15	11	189	40	2.5	0.21	440	95	7.6	156.3	35.0
		50th	132	30	18	340	92	9.0	1.00	850	152	8.1	284.5	55.0
		80th	396	55	31	541	350	28.0	8.44	1990	251	8.4	473.1	79.9

BURDEKIN, DON, HAUGHTON RIVER BASINS – GROUNDWATERS
(refer plans GWQ1201–GWQ1204, and GWQ1207–GWQ1209) [1–3]
Aquatic ecosystem water quality objectives

Note: Except where indicated, the level of protection/management intent for groundwaters is high ecological value (HEV), where groundwater quality should be maintained within the natural range of variability. WQOs for indicators are typically shown as a range of 20th, 50th and 80th percentiles, to be maintained or achieved. Refer to section 3.1.1 for details on comparing test water quality data with the WQOs. Note that the WQOs in this table are solely for groundwater aquatic ecosystems and may not be protective of surface water aquatic ecosystems. Where groundwater is expressed to surface waters, readers should refer to surface water EVs and WQOs tables contained in separate schedule documents for surface waters (including aquatic ecosystem WQOs).

Sources: S1: Local datasets/reporting (applies to all WQOs except where indicated); S2: ANZG

AQUIFER CLASS	Chemistry zone (Source: s1)	Percentile	Na (mg/L)	Ca (mg/L)	Mg (µg/L)	HCO_3 (mg/L)	Cl (mg/L)	SO_4 (mg/L)	NO_3 (mg/L)	EC (µS/cm)	Hardness (mg/L)	pH	Alkalinity (mg/L)	SiO_2 (mg/L)
ALLUVIUM	3 – Suttor (s1)	20th	142	11	6	49	94	23.2	0.00	821	45	7.1	40.0	19.2
		50th	838	48	71	142	1180	99.1	0.50	6500	462	7.6	129.0	32.0
		80th	3170	443	410	399	6354	629.3	1.77	21380	2646	8.1	352.6	49.8
ALLUVIUM	4 – Lower Burdekin with Bowen (s1) - MD	20th	80	20	13	222	41	4.7	1.10	583	118	7.6	189.3	45.0
		50th	110	39	20	285	110	10.0	4.70	790	185	8.1	240.5	55.0
		80th	415	107	70	386	447	24.7	10.6	2250	562	8.5	340.8	65.0
ALLUVIUM	4 – Lower Burdekin with Bowen near stream (s1) - MD	20th	69	24	15	260	25	2.4	2.42	554	132	7.3	216.0	52.5
		50th	92	36	19	323	45	7.7	9.15	682	161	8.0	266.0	62.0
		80th	129	45	26	377	151	14.1	10.6	886	231	8.3	313.5	72.5
ALLUVIUM	5 – Upper Burdekin	All	ID for all											
ALLUVIUM	17 –Burdekin Delta Coastal Area (s1) - MD	20th	200	26	23	115	270	67.0	0.20	1240	169	7.3	97.0	26.0
		50th	1158	97	110	201	1910	330.0	1.00	4480	690	7.7	170.0	38.0
		80th	10500	1050	1800	339	22723	2920.0	7.50	42900	10362	8.1	283.0	50.0

BURDEKIN, DON, HAUGHTON RIVER BASINS – GROUNDWATERS
(refer plans GWQ1201–GWQ1204, and GWQ1207–GWQ1209) [1–3]
Aquatic ecosystem water quality objectives

Note: Except where indicated, the level of protection/management intent for groundwaters is high ecological value (HEV), where groundwater quality should be maintained within the natural range of variability. WQOs for indicators are typically shown as a range of 20th, 50th and 80th percentiles, to be maintained or achieved. Refer to section 3.1.1 for details on comparing test water quality data with the WQOs. Note that the WQOs in this table are solely for groundwater aquatic ecosystems and may not be protective of surface water aquatic ecosystems. Where groundwater is expressed to surface waters, readers should refer to surface water EVs and WQOs tables contained in separate schedule documents for surface waters (including aquatic ecosystem WQOs).

Sources: S1: Local datasets/reporting (applies to all WQOs except where indicated); S2: ANZG

AQUIFER CLASS	Chemistry zone (Source: s1)	Percentile	Na (mg/L)	Ca (mg/L)	Mg (µg/L)	HCO_3 (mg/L)	Cl (mg/L)	SO_4 (mg/L)	NO_3 (mg/L)	EC (µS/cm)	Hardness (mg/L)	pH	Alkalinity (mg/L)	SiO_2 (mg/L)
ALLUVIUM	**17 –Burdekin Delta Coastal Area near stream** (s1) - MD	**20th**	234	21	23	112	296	62.6	0.20	1150	160	7.4	95.0	27.0
		50th	1150	72	94	210	1690	260.0	1.00	4370	553	7.8	176.0	37.0
		80th	9114	857	1500	370	19500	2700.0	5.82	22200	7816	8.2	311.8	50.0
ALLUVIUM	**18 –West Barratta** (s1) - MD	**20th**	21	9	4	91	13	0.6	0.00	226	41	7.4	75.0	38.0
		50th	45	14	8	129	35	2.0	0.50	390	68	7.8	107.0	51.0
		80th	145	23	14	335	95	6.2	0.80	986	114	8.2	281.0	60.0
ALLUVIUM	**18 –West Barratta near stream** (s1) - MD	**20th**	17	7	3	82	12	0.4	0.00	196	33	7.2	68.0	36.0
		50th	26	12	6	111	19	2.0	0.50	268	56	7.7	92.0	46.5
		80th	67	17	9	134	49	6.3	0.80	576	78	8.1	112.0	55.0
ALLUVIUM	**19 – Mid Burdekin Delta** (s1) - MD	**20th**	25	14	7	100	18	5.3	0.25	275	64	7.4	85.0	28.0
		50th	58	26	15	174	46	17.5	2.40	505	133	7.8	148.0	39.0
		80th	250	72	51	349	328	90.0	10.6	1415	381	8.2	294.4	49.0
ALLUVIUM	**19 – Mid Burdekin Delta near stream** (s1) - MD	**20th**	22	17	9	116	16	4.8	0.60	267	82	7.5	99.0	29.3
		50th	41	34	19	240	36	10.0	7.60	450	171	7.9	203.0	40.0
		80th	98	66	44	405	128	20.0	10.6	970	342	8.2	343.2	55.0

BURDEKIN, DON, HAUGHTON RIVER BASINS – GROUNDWATERS
(refer plans GWQ1201–GWQ1204, and GWQ1207–GWQ1209) [1–3]
Aquatic ecosystem water quality objectives

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Sources: S1: Local datasets/reporting (applies to all WQOs except where indicated); S2: ANZG

AQUIFER CLASS	Chemistry zone (Source: s1)	Percentile	Na (mg/L)	Ca (mg/L)	Mg (µg/L)	HCO_3 (mg/L)	Cl (mg/L)	SO_4 (mg/L)	NO_3 (mg/L)	EC (µS/cm)	Hardness (mg/L)	pH	Alkalinity (mg/L)	SiO_2 (mg/L)
ALLUVIUM	**20 – East Barratta** (s1) - MD	**20th**	70	21	13	150	80	4.0	0.30	650	112	7.5	124.0	43.0
		50th	122	51	29	306	180	10.0	1.10	1100	251	8.0	256.0	54.0
		80th	246	88	55	412	456	20.0	9.0	1950	447	8.2	345.0	62.0
ALLUVIUM	**20 – East Barratta near stream** (s1) - MD	**20th**	153	37	25	242	233	ID	ID	529	204	ID	204.2	ID
		50th	268	71	55	300	540	9.0	1.00	2100	369	8.0	250.0	54.0
		80th	402	115	85	388	818	ID	ID	3702	638	ID	322.6	ID
ALLUVIUM	**21 – Native Companion Creek** (s1)	**20th**	42	20	20	126	65	11.0	1.60	642	134	6.9	103.0	57.1
		50th	210	35	34	195	330	34.5	15.00	1560	228	7.3	160.0	70.0
		80th	270	48	51	246	474	47.7	39.05	1930	329	7.6	202.0	80.0
ALLUVIUM	**22 – Cape River alluvium** (s1)	**20th**	29	18	8	117	19	ID	ID	236	79	7.5	96.0	ID
		50th	33	20	10	140	24	8.4	0.00	330	93	7.9	116.0	52.0
		80th	50	32	17	175	48	ID	ID	350	152	8.1	142.9	ID
ALLUVIUM	**23 – Campaspe River alluvium** (s1)	**20th**	41	23	13	155	37	12.5	0.30	466	124	7.1	124.7	23.0
		50th	87	40	37	317	109	39.3	2.20	962	268	7.6	256.5	34.0
		80th	379	71	71	669	423	114.8	10.60	2457	456	8.1	535.7	58.2

BURDEKIN, DON, HAUGHTON RIVER BASINS – GROUNDWATERS
(refer plans GWQ1201–GWQ1204, and GWQ1207–GWQ1209) [1–3]
Aquatic ecosystem water quality objectives

Note: Except where indicated, the level of protection/management intent for groundwaters is high ecological value (HEV), where groundwater quality should be maintained within the natural range of variability. WQOs for indicators are typically shown as a range of 20th, 50th and 80th percentiles, to be maintained or achieved. Refer to section 3.1.1 for details on comparing test water quality data with the WQOs. Note that the WQOs in this table are solely for groundwater aquatic ecosystems and may not be protective of surface water aquatic ecosystems. Where groundwater is expressed to surface waters, readers should refer to surface water EVs and WQOs tables contained in separate schedule documents for surface waters (including aquatic ecosystem WQOs).

Sources: S1: Local datasets/reporting (applies to all WQOs except where indicated); S2: ANZG

AQUIFER CLASS	Chemistry zone (Source: s1)	Percentile	Na (mg/L)	Ca (mg/L)	Mg (µg/L)	HCO_3 (mg/L)	Cl (mg/L)	SO_4 (mg/L)	NO_3 (mg/L)	EC (µS/cm)	Hardness (mg/L)	pH	Alkalinity (mg/L)	SiO_2 (mg/L)
ALLUVIUM	**23 – Campaspe River alluvium near stream** (s1)	**20th**	15	4	2	37	16	0.0	0.00	375	15	7.1	30.0	ID
		50th	87	9	4	127	70	5.9	0.00	760	38	7.6	103.5	56.0
		80th	288	36	36	273	300	32.2	0.35	2263	237	7.9	227.0	ID
ALLUVIUM	**24 – Upper Barratta** (s1) - MD	**20th**	175	34	33	375	265	16.0	0.50	1863	228	7.6	314.0	32.0
		50th	668	70	72	580	817	52.8	2.50	3930	478	8.0	486.0	50.0
		80th	1400	140	150	759	2184	150.0	6.47	8152	987	8.3	639.0	68.0
ALLUVIUM	**24 – Upper Barratta near stream** (s1) - MD	**20th**	107	32	28	315	162	9.9	1.00	920	219	7.6	264.5	25.0
		50th	315	61	63	498	423	33.0	3.20	2350	392	8.0	418.0	41.0
		80th	1050	129	103	679	1450	138.4	8.27	5799	737	8.3	579.5	53.0

BURDEKIN, DON, HAUGHTON RIVER BASINS – GROUNDWATERS
(refer plans GWQ1201–GWQ1204, and GWQ1207–GWQ1209) [1–3]
Aquatic ecosystem water quality objectives

Note: Except where indicated, the level of protection/management intent for groundwaters is high ecological value (HEV), where groundwater quality should be maintained within the natural range of variability. WQOs for indicators are typically shown as a range of 20th, 50th and 80th percentiles, to be maintained or achieved. Refer to section 3.1.1 for details on comparing test water quality data with the WQOs. Note that the WQOs in this table are solely for groundwater aquatic ecosystems and may not be protective of surface water aquatic ecosystems. Where groundwater is expressed to surface waters, readers should refer to surface water EVs and WQOs tables contained in separate schedule documents for surface waters (including aquatic ecosystem WQOs).

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AQUIFER CLASS	Chemistry zone (Source: s1)	Percentile	Na (mg/L)	Ca (mg/L)	Mg (µg/L)	HCO_3 (mg/L)	Cl (mg/L)	SO_4 (mg/L)	NO_3 (mg/L)	EC (µS/cm)	Hardness (mg/L)	pH	Alkalinity (mg/L)	SiO_2 (mg/L)
FRACTURED ROCK (refer plan GWQ1202)														
FRACTURED ROCK	1 – Drummond Basin sediments (s1)	20th	235	19	13	133	220	19.4	0.00	1700	152	7.4	109.5	21.0
		50th	650	85	45	370	860	135.0	0.55	4500	450	7.8	306.0	32.5
		80th	1527	299	171	734	2830	528.8	3.15	13514	1377	8.2	609.0	46.0
FRACTURED ROCK	2 – Greenvale Craton (s1)	20th	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID
		50th	ID	ID	ID	ID	ID	ID	ID	1582	ID	7.9	ID	ID
		80th	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID
FRACTURED ROCK	3 – Eastern Basement with Basalt Remnants (s1)	20th	157	10	4	361	102	11.6	0.00	1033	49	8.0	308.1	18.0
		50th	225	32	52	519	275	30.0	0.30	1500	331	8.3	431.5	25.0
		80th	668	109	129	719	933	130.5	3.33	2922	750	8.5	596.3	55.7

BURDEKIN, DON, HAUGHTON RIVER BASINS – GROUNDWATERS
(refer plans GWQ1201–GWQ1204, and GWQ1207–GWQ1209) [1–3]
Aquatic ecosystem water quality objectives

Note: Except where indicated, the level of protection/management intent for groundwaters is high ecological value (HEV), where groundwater quality should be maintained within the natural range of variability. WQOs for indicators are typically shown as a range of 20th, 50th and 80th percentiles, to be maintained or achieved. Refer to section 3.1.1 for details on comparing test water quality data with the WQOs. Note that the WQOs in this table are solely for groundwater aquatic ecosystems and may not be protective of surface water aquatic ecosystems. Where groundwater is expressed to surface waters, readers should refer to surface water EVs and WQOs tables contained in separate schedule documents for surface waters (including aquatic ecosystem WQOs).

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AQUIFER CLASS	Chemistry zone (Source: s1)	Percentile	Na (mg/L)	Ca (mg/L)	Mg (µg/L)	HCO_3 (mg/L)	Cl (mg/L)	SO_4 (mg/L)	NO_3 (mg/L)	EC (µS/cm)	Hardness (mg/L)	pH	Alkalinity (mg/L)	SiO_2 (mg/L)
FRACTURED ROCK	5 – Ravenswood Granites and Volcanics (s1)	20th	116	36	36	314	183	11.5	0.50	1300	265	7.7	260.0	40.0
		50th	320	73	94	528	635	32.0	2.35	2865	568	8.0	439.5	50.0
		80th	730	130	200	701	1469	86.3	6.41	5800	1143	8.2	596.0	65.0
FRACTURED ROCK	6 – Northern Basalt (s1)	20th	ID	ID	ID	ID	ID	ID	ID	804	ID	ID	ID	ID
		50th	72	51	57	522	52	ID	0.00	1050	357	7.8	431.5	ID
		80th	ID	ID	ID	ID	ID	ID	ID	1442	ID	ID	ID	ID
FRACTURED ROCK	7 – Main Range Volcanics (s1)	20th	72	15	13	302	35	4.0	0.40	688	104	7.5	247.5	25.0
		50th	122	38	44	460	80	12.0	2.55	1032	291	8.0	383.0	45.0
		80th	237	68	80	602	245	45.9	20.12	1866	489	8.3	500.0	61.0
FRACTURED ROCK	8 – Central Cratonic Basement (s1)	20th	152	32	47	360	176	24.0	0.04	1369	344	7.5	298.1	28.0
		50th	380	69	125	628	610	101.9	1.10	3335	692	7.9	530.0	42.0
		80th	1124	183	352	938	1946	294.2	7.43	7565	1708	8.1	780.0	58.0

BURDEKIN, DON, HAUGHTON RIVER BASINS – GROUNDWATERS
(refer plans GWQ1201–GWQ1204, and GWQ1207–GWQ1209) [1–3]
Aquatic ecosystem water quality objectives

Note: Except where indicated, the level of protection/management intent for groundwaters is high ecological value (HEV), where groundwater quality should be maintained within the natural range of variability. WQOs for indicators are typically shown as a range of 20th, 50th and 80th percentiles, to be maintained or achieved. Refer to section 3.1.1 for details on comparing test water quality data with the WQOs. Note that the WQOs in this table are solely for groundwater aquatic ecosystems and may not be protective of surface water aquatic ecosystems. Where groundwater is expressed to surface waters, readers should refer to surface water EVs and WQOs tables contained in separate schedule documents for surface waters (including aquatic ecosystem WQOs).

Sources: S1: Local datasets/reporting (applies to all WQOs except where indicated); S2: ANZG

AQUIFER CLASS	Chemistry zone (Source: s1)	Percentile	Na (mg/L)	Ca (mg/L)	Mg (µg/L)	HCO_3 (mg/L)	Cl (mg/L)	SO_4 (mg/L)	NO_3 (mg/L)	EC (µS/cm)	Hardness (mg/L)	pH	Alkalinity (mg/L)	SiO_2 (mg/L)
CAINOZOIC DEPOSITS, including deposits overlying the GAB (refer plan GWQ1203)														
CAINOZOIC DEPOSITS	1 – Scattered Remnants Northern Burdekin Headwaters (s1)	All	ID for all											
CAINOZOIC DEPOSITS	2 – Eastern Weathered Cainozoic Remnants (s1)	20th	33	32	15	100	51	7.3	0.00	1007	142	7.2	85.3	16.5
		50th	188	45	30	195	289	35.8	0.10	1760	203	7.7	165.0	25.0
		80th	1502	99	200	368	2817	172.8	2.55	9519	1084	8.1	448.1	48.6
CAINOZOIC DEPOSITS	4 – Central Moderately Saline Weathered Remnants (s1)	20th	96	23	17	170	75	12.0	0.83	880	135	7.1	140.0	25.5
		50th	215	37	35	256	303	32.0	7.00	1410	241	7.7	218.0	60.0
		80th	286	59	64	511	430	52.0	46.00	1953	411	8.1	425.6	78.0
CAINOZOIC DEPOSITS	6 – Saline Tertiary Sediments (s1)	20th	257	10	11	132	326	7.1	0.00	1019	81	7.1	58.4	15.0
		50th	690	54	70	290	1000	51.0	0.50	3760	458	7.8	224.5	25.5
		80th	1800	202	220	508	3596	192.3	2.47	12306	1458	8.2	406.8	56.0

BURDEKIN, DON, HAUGHTON RIVER BASINS – GROUNDWATERS
(refer plans GWQ1201–GWQ1204, and GWQ1207–GWQ1209) [1–3]
Aquatic ecosystem water quality objectives

Note: Except where indicated, the level of protection/management intent for groundwaters is high ecological value (HEV), where groundwater quality should be maintained within the natural range of variability. WQOs for indicators are typically shown as a range of 20th, 50th and 80th percentiles, to be maintained or achieved. Refer to section 3.1.1 for details on comparing test water quality data with the WQOs. Note that the WQOs in this table are solely for groundwater aquatic ecosystems and may not be protective of surface water aquatic ecosystems. Where groundwater is expressed to surface waters, readers should refer to surface water EVs and WQOs tables contained in separate schedule documents for surface waters (including aquatic ecosystem WQOs).

Sources: S1: Local datasets/reporting (applies to all WQOs except where indicated); S2: ANZG

AQUIFER CLASS	Chemistry zone (Source: s1)	Percentile	Na (mg/L)	Ca (mg/L)	Mg (µg/L)	HCO_3 (mg/L)	Cl (mg/L)	SO_4 (mg/L)	NO_3 (mg/L)	EC (µS/cm)	Hardness (mg/L)	pH	Alkalinity (mg/L)	SiO_2 (mg/L)
CAINOZOIC DEPOSITS	7 – North West Suttor Catchment (s1)	20th	56	8	5	87	50	3.0	0.00	276	36	7.1	71.1	49.5
		50th	208	24	23	211	300	29.7	0.70	940	158	7.4	173.5	79.5
		80th	605	83	70	476	885	84.7	3.08	2585	495	7.8	392.9	99.3
CAINOZOIC DEPOSITS	8 – Don and Bogie Coastal Area (s1)	20th	205	51	74	420	385	20.5	0.50	2100	475	7.8	352.0	43.0
		50th	435	95	145	559	870	50.0	2.35	3950	859	8.0	467.0	55.0
		80th	916	160	236	742	1788	175.0	5.40	7250	1300	8.3	628.0	67.0

BURDEKIN, DON, HAUGHTON RIVER BASINS – GROUNDWATERS
(refer plans GWQ1201–GWQ1204, and GWQ1207–GWQ1209) [1–3]
Aquatic ecosystem water quality objectives

Note: Except where indicated, the level of protection/management intent for groundwaters is high ecological value (HEV), where groundwater quality should be maintained within the natural range of variability. WQOs for indicators are typically shown as a range of 20th, 50th and 80th percentiles, to be maintained or achieved. Refer to section 3.1.1 for details on comparing test water quality data with the WQOs. Note that the WQOs in this table are solely for groundwater aquatic ecosystems and may not be protective of surface water aquatic ecosystems. Where groundwater is expressed to surface waters, readers should refer to surface water EVs and WQOs tables contained in separate schedule documents for surface waters (including aquatic ecosystem WQOs).

Sources: S1: Local datasets/reporting (applies to all WQOs except where indicated); S2: ANZG

AQUIFER CLASS	Chemistry zone (Source: s1)	Percentile	Na (mg/L)	Ca (mg/L)	Mg (µg/L)	HCO_3 (mg/L)	Cl (mg/L)	SO_4 (mg/L)	NO_3 (mg/L)	EC (µS/cm)	Hardness (mg/L)	pH	Alkalinity (mg/L)	SiO_2 (mg/L)
MID GAB (refer plan GWQ1204)														
MID GAB	2 – Northeastern GAB border, Ronlow and Gilbert River (s1)	All	ID for all											
LOWER GAB (refer plan GWQ1207)														
LOWER GAB	2 – Northeastern Eromanga (s1)	20th	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID
		50th	ID	ID	ID	ID	ID	ID	ID	1050	ID	ID	ID	ID
		80th	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID
LOWER GAB	9 – Northern Hutton Outcrop (s1)	20th	39	20	5	0	40	9.3	0.00	437	91	7.0	134.2	12.0
		50th	78	36	15	213	65	26.0	0.25	570	162	8.0	185.0	19.5
		80th	135	63	27	264	194	64.1	0.70	934	259	8.3	218.0	36.4

BURDEKIN, DON, HAUGHTON RIVER BASINS – GROUNDWATERS
(refer plans GWQ1201–GWQ1204, and GWQ1207–GWQ1209) [1–3]
Aquatic ecosystem water quality objectives

Note: Except where indicated, the level of protection/management intent for groundwaters is high ecological value (HEV), where groundwater quality should be maintained within the natural range of variability. WQOs for indicators are typically shown as a range of 20th, 50th and 80th percentiles, to be maintained or achieved. Refer to section 3.1.1 for details on comparing test water quality data with the WQOs. Note that the WQOs in this table are solely for groundwater aquatic ecosystems and may not be protective of surface water aquatic ecosystems. Where groundwater is expressed to surface waters, readers should refer to surface water EVs and WQOs tables contained in separate schedule documents for surface waters (including aquatic ecosystem WQOs).

Sources: S1: Local datasets/reporting (applies to all WQOs except where indicated); S2: ANZG

AQUIFER CLASS	Chemistry zone (Source: s1)	Percentile	Na (mg/L)	Ca (mg/L)	Mg (µg/L)	HCO_3 (mg/L)	Cl (mg/L)	SO_4 (mg/L)	NO_3 (mg/L)	EC (µS/cm)	Hardness (mg/L)	pH	Alkalinity (mg/L)	SiO_2 (mg/L)
BASAL GAB (refer plan GWQ1208)														
BASAL GAB	3 – Precipice Outcrop continued (s1)	20th	16	14	6	101	16	4.3	0.00	247	75	7.0	89.4	11.0
		50th	23	24	12	136	25	9.7	0.00	340	110	7.5	133.0	13.0
		80th	34	38	18	194	35	14.0	0.50	440	157	8.1	189.2	21.2
EARLIER BASINS PARTIALLY UNDERLYING GAB (refer plan GWQ1209)														
EARLIER BASINS PARTLY UNDER GAB	1 – Central Galilee Coal Measures (s1)	20th	121	8	4	83	120	5.4	0.00	780	47	7.2	76.4	13.0
		50th	293	32	22	191	370	73.0	0.00	1555	174	7.7	174.5	17.0
		80th	1032	122	105	406	1666	248.8	3.00	4600	753	8.0	333.6	25.7
EARLIER BASINS PARTLY UNDER GAB	2 – Southern Galilee Clematis (s1)	20th	104	3	1	16	30	0.0	ID	450	13	7.2	179.3	ID
		50th	124	5	2	253	50	0.0	1.00	571	17	8.0	218.0	13.0
		80th	145	10	4	301	92	8.9	ID	1252	44	8.2	250.5	ID

BURDEKIN, DON, HAUGHTON RIVER BASINS – GROUNDWATERS
(refer plans GWQ1201–GWQ1204, and GWQ1207–GWQ1209) [1–3]
Aquatic ecosystem water quality objectives

Note: Except where indicated, the level of protection/management intent for groundwaters is high ecological value (HEV), where groundwater quality should be maintained within the natural range of variability. WQOs for indicators are typically shown as a range of 20th, 50th and 80th percentiles, to be maintained or achieved. Refer to section 3.1.1 for details on comparing test water quality data with the WQOs. Note that the WQOs in this table are solely for groundwater aquatic ecosystems and may not be protective of surface water aquatic ecosystems. Where groundwater is expressed to surface waters, readers should refer to surface water EVs and WQOs tables contained in separate schedule documents for surface waters (including aquatic ecosystem WQOs).

Sources: S1: Local datasets/reporting (applies to all WQOs except where indicated); S2: ANZG

AQUIFER CLASS	Chemistry zone (Source: s1)	Percentile	Na (mg/L)	Ca (mg/L)	Mg (µg/L)	HCO_3 (mg/L)	Cl (mg/L)	SO_4 (mg/L)	NO_3 (mg/L)	EC (µS/cm)	Hardness (mg/L)	pH	Alkalinity (mg/L)	SiO_2 (mg/L)
EARLIER BASINS PARTLY UNDER GAB	3 – Western Galilee Clematis (s1)	20th	ID	ID	ID	ID	ID	ID	ID	210	ID	6.9	ID	ID
		50th	122	3	6	51	115	5.3	0.50	470	34	7.4	66.0	14.0
		80th	ID	ID	ID	ID	ID	ID	ID	3375	ID	7.8	ID	23.2
EARLIER BASINS PARTLY UNDER GAB	6 – Northern Galilee Clematis (s1)	20th	54	3	3	65	70	1.6	ID	415	25	7.5	58.5	ID
		50th	88	6	4	100	85	7.7	0.00	690	29	7.8	90.0	50.0
		80th	492	24	23	170	650	25.3	ID	790	155	8.1	190.0	ID
EARLIER BASINS PARTLY UNDER GAB	11 – Eastern Bowen Coal Measures (s1)	20th	283	38	72	277	444	69.8	0.05	2005	459	7.5	207.7	7.9
		50th	536	90	182	610	1115	172.5	1.90	4200	1000	7.8	502.5	23.0
		80th	1965	248	433	850	4500	896.1	7.47	10670	2327	8.2	705.4	50.0

BURDEKIN, DON, HAUGHTON RIVER BASINS – GROUNDWATERS
(refer plans GWQ1201–GWQ1204, and GWQ1207–GWQ1209) [1–3]
Aquatic ecosystem water quality objectives

Note: Except where indicated, the level of protection/management intent for groundwaters is high ecological value (HEV), where groundwater quality should be maintained within the natural range of variability. WQOs for indicators are typically shown as a range of 20th, 50th and 80th percentiles, to be maintained or achieved. Refer to section 3.1.1 for details on comparing test water quality data with the WQOs. Note that the WQOs in this table are solely for groundwater aquatic ecosystems and may not be protective of surface water aquatic ecosystems. Where groundwater is expressed to surface waters, readers should refer to surface water EVs and WQOs tables contained in separate schedule documents for surface waters (including aquatic ecosystem WQOs).

Sources: S1: Local datasets/reporting (applies to all WQOs except where indicated); S2: ANZG

AQUIFER CLASS	Chemistry zone (Source: s1)	Percentile	Na (mg/L)	Ca (mg/L)	Mg (µg/L)	HCO_3 (mg/L)	Cl (mg/L)	SO_4 (mg/L)	NO_3 (mg/L)	EC (µS/cm)	Hardness (mg/L)	pH	Alkalinity (mg/L)	SiO_2 (mg/L)
EARLIER BASINS PARTLY UNDER GAB	13 – Northwestern Bowen Coal Measures (s1)	**20th**	360	37	12	195	391	29.9	ID	1836	199	7.7	160.0	ID
		50th	1000	175	105	534	1810	160.0	0.10	6640	1021	8.1	444.0	ID
		80th	3115	335	553	727	6422	529.0	ID	18453	3081	8.4	601.0	ID
EARLIER BASINS PARTLY UNDER GAB	14 – Bowen Basin Basalt Area (s1)	**20th**	100	15	8	331	63	15.9	0.00	840	76	7.5	274.0	19.1
		50th	152	46	46	505	134	33.0	0.30	1565	288	8.0	419.0	33.0
		80th	516	65	87	698	611	117.3	1.40	3707	551	8.3	578.5	51.3
Springs		-	Maintain/achieve effectively unmodified water quality (20th, 50th and 80th percentiles of HEV waters), habitat, biota, flow and riparian areas. There is insufficient information available to establish aquatic ecosystem water quality objectives for these waters. Refer to QWQG for details on how to establish a minimum water quality data set for deriving local 20th, 50th and 80th percentiles.											

AQUIFER CLASS Chemistry zone (Source: s1)	Percentile	BURDEKIN, DON, HAUGHTON RIVER BASINS – GROUNDWATERS (refer plans GWQ1201–GWQ1204, and GWQ1207–GWQ1209) [1–3] Aquatic ecosystem water quality objectives **Note:** Except where indicated, the level of protection/management intent for groundwaters is high ecological value (HEV), where groundwater quality should be maintained within the natural range of variability. WQOs for indicators are typically shown as a range of 20th, 50th and 80th percentiles, to be maintained or achieved. Refer to section 3.1.1 for details on comparing test water quality data with the WQOs. Note that the WQOs in this table are solely for groundwater aquatic ecosystems and may not be protective of surface water aquatic ecosystems. Where groundwater is expressed to surface waters, readers should refer to surface water EVs and WQOs tables contained in separate schedule documents for surface waters (including aquatic ecosystem WQOs). **Sources**: S1: Local datasets/reporting (applies to all WQOs except where indicated); S2: ANZG											
		Na (mg/L)	**Ca** (mg/L)	**Mg** (µg/L)	**HCO_3** (mg/L)	**Cl** (mg/L)	**SO_4** (mg/L)	**NO_3** (mg/L)	**EC** (µS/cm)	**Hardness** (mg/L)	**pH**	**Alkalinity** (mg/L)	**SiO_2** (mg/L)
		TOXICANTS (INCLUDING METALS, BIOCIDES) Note: The adoption of toxicant default guideline values for water quality objectives should not be interpreted as upper limits to which groundwater contaminant concentrations can be increased. Rather, if existing groundwater quality is below the adopted water quality guideline values, the groundwater should be maintained within the range of natural quality variations established through baseline characterisation (DES 2021; Australian Government 2013)											
HEV groundwaters (all aquifers other than alluvium in lower Burdekin, Haughton, Barratta alluvium): **Toxicants** (s2)	**HEV**	• Toxicants (including metals, biocides) in water: refer to 99% species protection values contained in: o ANZG (2018) 'toxicant default guideline values for water quality in aquatic ecosystems', as amended o The following sources, where their guideline values post-date the specified ANZG guideline value, or where there is no ANZG value specified for a toxicant (Note: the ANZG specifies the date of guideline development for each toxicant): ▪ Biocides: King et al (2017, as amended) (vol 1 and 2) *Proposed aquatic ecosystem protection guideline values for pesticides commonly used in the Great Barrier Reef catchment area* (available from Queensland Government publications) • Toxicants in sediments: refer to ANZG 'toxicant default guideline values for sediment quality'											
Lower Burdekin, Haughton, Barratta alluvium groundwaters not identified as HEV: **Toxicants** (s2)	**SMD**	• Toxicants (including metals, biocides) in water: o Refer to 95% species protection values contained in sources below. Note: refer to 99% species protection values where indicated by ANZG (including for toxicants with bioaccumulation, toxicity effects): ▪ ANZG (2018) 'toxicant default guideline values for water quality in aquatic ecosystems', as amended ▪ The following sources, where their guideline values post-date the specified ANZG guideline value, or where there is no ANZG value specified for a toxicant (Note: the ANZG specifies the date of guideline development for each toxicant) - Biocides: King et al (2017, as amended) (vol 1 and 2) *Proposed aquatic ecosystem protection guideline values for pesticides commonly used in the Great Barrier Reef catchment area* (available from Queensland Government publications) • Toxicants in sediments: refer to ANZG 'toxicant default guideline values for sediment quality'											

AQUIFER CLASS Chemistry zone (Source: s1)	Percentile	BURDEKIN, DON, HAUGHTON RIVER BASINS – GROUNDWATERS (refer plans GWQ1201–GWQ1204, and GWQ1207–GWQ1209) [1–3] Aquatic ecosystem water quality objectives **Note:** Except where indicated, the level of protection/management intent for groundwaters is high ecological value (HEV), where groundwater quality should be maintained within the natural range of variability. WQOs for indicators are typically shown as a range of 20th, 50th and 80th percentiles, to be maintained or achieved. Refer to section 3.1.1 for details on comparing test water quality data with the WQOs. Note that the WQOs in this table are solely for groundwater aquatic ecosystems and may not be protective of surface water aquatic ecosystems. Where groundwater is expressed to surface waters, readers should refer to surface water EVs and WQOs tables contained in separate schedule documents for surface waters (including aquatic ecosystem WQOs). **Sources**: S1: Local datasets/reporting (applies to all WQOs except where indicated); S2: ANZG											
		Na (mg/L)	**Ca** (mg/L)	**Mg** (µg/L)	**HCO_3** (mg/L)	**Cl** (mg/L)	**SO_4** (mg/L)	**NO_3** (mg/L)	**EC** (µS/cm)	**Hardness** (mg/L)	**pH**	**Alkalinity** (mg/L)	**SiO_2** (mg/L)
		STATE PLANNING POLICY, RIPARIAN, WETLANDS											
State Planning Policy	**all**	Refer to section 3.2											
Riparian	**all**	Refer to separate schedule documents for Burdekin surface waters											
Wetlands	**all**	Refer to separate schedule documents for Burdekin surface waters											

Abbreviations: ANZG – Australian and New Zealand guidelines for fresh and marine water quality; QWQG – Queensland water quality guidelines; ID – insufficient data. Will be updated if information becomes available; HEV – high ecological value; SD – slightly disturbed; MD – moderately disturbed.

Indicators: Na – sodium; Ca – calcium; Mg – magnesium; HCO_3 – bicarbonate; Cl – chloride, SO_4 – sulfate; NO_3 – nitrate; EC – electrical conductivity, SiO_2 – silica

Units: mg/L – milligrams per litre, µS/cm – microsiemens/centimetre

Notes:

1. Percentiles: The intent for most groundwaters is that *groundwater quality should be maintained within the natural range of variability*. This is reflected in the table by provision of 20th, 50th and 80th percentiles of water quality data from the Burdekin-Don-Haughton region (Refer McNeil et al. for details). Aquatic ecosystem WQOs for nitrate in lower Burdekin, Haughton alluvium groundwaters are set to at least maintain water quality or, where water quality exceeds ANZG guidelines, to achieve the 95% species protection values under ANZG (NO_3: equivalent: 10.6mg/L). Other alluvium indicators are set to maintain existing quality.

2. Groundwaters management intent: The following national groundwater sources provide policy guidance on the management of groundwater, which is to retain natural groundwater quality and variability.

Guidelines for groundwater quality protection in Australia: '*Protection of groundwater quality is imperative to ensure the protection of healthy ecosystems and maintenance of environmental values as well as for future economic and population growth*.' The guidelines also note that '*In some circumstances, the natural groundwater quality will exceed some of the water quality guideline values for the agreed environmental value category. In this case, the groundwater quality should be maintained within the natural range of variability. This approach would require a detailed baseline assessment to establish natural groundwater quality and variability upon which the water quality objectives and guideline values can be based.' (2013; 20).*

ANZG Application of the Water Quality Guidelines to groundwater: '*groundwater should be managed in such a way that when it comes to the surface, whether from natural seepages or from bores, it will not cause the established water quality objectives for these waters to be exceeded, nor compromise their designated community values. In addition to this, underground aquatic ecosystems and any novel fauna also need to be protected. Relatively little is still known of the lifecycles and environmental requirements of groundwater communities. Where potentially high conservation values are identified, the groundwater upon which the communities depend should be afforded the highest level of protection, at least until further knowledge is gained. Basing groundwater quality objectives on data from groundwater reference condition locations is recommended to achieve this protection. It is important to note that different biological, physical and chemical conditions and processes operate in groundwater compared with surface waters, and these can affect the fate and transport of many chemicals. This may have implications for the application of guideline values and overall management of groundwater quality*.'

The GAB strategic management plan provides a framework achieve economic, environmental, cultural and social outcomes for the Great Artesian Basin (the Basin) and its users. *'The Plan envisages that scientifically defensible limits relating to both quantity of water take and water quality will be established and adhered to*' and includes a strategic outcome to '*set out scientifically defensible water quality limits and extraction impact management measures that minimise impacts on the Basin resources, its users and dependent ecosystems'*.

For some indicators and water types, WQOs correspond with a 'slightly to moderately disturbed' (SMD) level of protection, based on management intent categories specified in source technical guidelines, in particular the Australian water quality guidelines (ANZG, 2018). This document and accompanying mapping include these within the MD level of protection.

3. In relation to Stygofauna, Hose et al. note that: *Stygofauna are generally adapted to stable environmental conditions, including water quality. Changes to water quality that are beyond the range of conditions normally experienced by stygofauna pose a threat to their survival*.' (2015; 40); '*Importantly, it is changes to pH away from the typical background level that are likely to be problematic for stygofauna, as they are for other freshwater invertebrates…. thus requiring understanding the local conditions in order to assess the risks associated with changed in water quality*.' (Hose et al., 2015; 42). For salinity '*Field studies…suggest that the salinity tolerance of most stygofauna is limited to salinity level (measured by water electrical conductivity) less than 5000 µS/cm…. It might be expected then that changes to salinity of groundwater above 5000 µS/cm may by (sic) toxic to stygofauna. However, this threshold does not indicate the sensitivity of stygofauna to changes in salinity; those inhabiting and adapted to relatively fresh groundwater will be potentially sensitive to changes well below this level. It is likely that stygofauna are adapted to local conditions so that changes from background salinity could be deleterious*.' (Hose et al., 2015; 41)

Sources / references:

ANZG (2018, as amended) *Australian and New Zealand guidelines for fresh and marine water quality*.

Australian Government (2020) *GAB strategic management plan*

Australian Government (2013) *Guidelines for groundwater quality protection in Australia*: National Water Quality Management Strategy, Department of Agriculture and Water Resources, Canberra, March. CC BY 3.0.

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Department of Environment and Science (2022) *Guideline: Environmental Protection (Water) Policy 2019 - Deciding aquatic ecosystem indicators and local water quality guidelines*. March.

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Hose GC, J Sreekanth, Barron O, Pollino C, 2015 *Stygofauna in Australian Groundwater Systems: Extent of knowledge*. CSIRO, Australia

King et al (2017, as amended) Proposed aquatic ecosystem protection guideline values for pesticides commonly used in the Great Barrier Reef catchment area (Parts 1 and 2). Department of Environment and Science. Brisbane, Queensland, Australia (available from Queensland Government publications)

McNeil, V.H., Thames, D., Vaca, F., Bennett, L. & McGregor, G.B. 2018. Regional groundwater chemistry zones: Fitzroy-Capricorn-Curtis Coast and Burdekin-Haughton-Don regions: Summary and results. Draft for consultation. Water Planning Ecology: Department of Environment and Science, Queensland Government

NQ Dry Tropics (2016) *Burdekin Region Water Quality Improvement Plan*, NQ Dry Tropics, Townsville

NQ Dry Tropics (2013) *Community draft environmental values for the waters of the Burdekin Dry Tropics Region*, June (Ed: R Kerr)

Unpublished water quality datasets

3.2 State planning policy – (state interest – water quality)

The State Planning Policy (SPP) defines the Queensland Government's policies about matters of state interest in land use planning and development (a state interest is defined under the *Planning Act 2016*).

Water quality is a state interest. The SPP (state interest – water quality) seeks to ensure that 'the environmental values and quality of Queensland waters are protected and enhanced'. It includes provisions relating to receiving waters, acid sulfate soils and water supply buffer areas.

The provisions of the SPP are applied through their 'integration' into local government planning schemes. Planning schemes adopt measures prescribed in the SPP that ensure development is planned, designed, constructed and operated to manage stormwater and wastewater in ways that support the protection of environmental values and meet the water quality objectives identified in the Environmental Protection (Water and Wetland Biodiversity) Policy 2019.

This is achieved by compliance with the policy provisions of the SPP (state interest – water quality).

Stormwater management design objectives for construction include developments using measures to manage the velocity of stormwater flows and prevent erosion, sediment, litter and other contaminates entering waterways while construction is occurring. Post construction stormwater management design objectives generally apply to lots over 2500m^2 that results in six or more dwellings or lots. The objectives seek to limit the amount of nutrients and litter, including nitrogen, phosphorus and suspended sediments, entering waterways from the operation of the development.

The SPP is supported by guidance materials which include Integrating state interests in a planning scheme – guidance for local governments (by Department of State Development, Infrastructure, Local Government and Planning). These and other SPP materials are available from the State Planning Policy website. Supplementary guidance is available from the Department of Environment and Science website on post construction phase stormwater management (phase 5b).

WATER QUALITY OBJECTIVES
for
HUMAN USE ENVIRONMENTAL VALUES

4 Water quality objectives for human use environmental values (EVs)

This section outlines water quality objectives (WQOs) to protect human use environmental values (EVs), which comprise those EVs (e.g. recreation, stock watering, aquaculture and crop irrigation) other than the aquatic ecosystem EV. The table in section 2 of this document outlines the EVs that have been identified for different waters. Where a human use EV has been identified, the following tables can be used to identify the WQOs to support that EV. Where more than one EV applies to a given water (for example aquatic ecosystem and recreational use), the adoption of the most stringent WQO for each water quality indicator will then protect all identified EVs. Note that human use WQOs tables in this section are provided for all potentially applicable human use EVs. As the range of human use EVs varies by water, reference to section 2 is required to identify the human use EVs stated for a particular water, from which the corresponding human use WQOs tables in this section can then be identified.

WQOs in this section are, unless otherwise specified, based on relevant national water quality guidelines including ANZG (2018, as amended) and the Australian Drinking Water Guidelines (ADWG). Where national guidelines or other codes remain the primary source for WQOs, reference to those national guidelines or codes is necessary to obtain comprehensive listings of all indicators and corresponding WQOs.

Note that requirements relating to recycled water (e.g. for drinking water and irrigation) are addressed under the *Public Health Act 2005*, Public Health Regulation (2018) and *Water Supply (Safety and Reliability) Act 2008*. Further information, including guideline on low exposure recycled water schemes, is available from the Queensland Health and Business Queensland websites.

4.1 Human use EVs water quality objectives

The following table summarises WQOs for human use EVs. More details are provided in subsequent sections by human use EV.

Table 4 Human use EVs water quality objectives

Environmental value	Water type/area	Water quality objective to protect EV (refer to specified codes and guidelines for full details)
Suitability for drinking water supply	All fresh waters including groundwaters	The Australian Drinking Water Guidelines (NHMRC, 2011, as amended) provides a framework for catchment management and source water protection for drinking water supplies. Quality of raw water (prior to treatment) should consider the requirements of water supply operators, and their capacity to treat the water to make it safe for human consumption. Also refer to Table 5. Whether water is drawn from surface catchments or underground sources, it is important that the local catchment or aquifer is understood, and that the activities that could lead to water contamination are identified and managed. See the *State Planning Policy 2017* and the interactive mapping system for assessment benchmarks around development in water supply buffer areas. Effective catchment management and source water protection include development of a catchment management plan, with the commitment of land use planning authorities to prevent inappropriate development and to enforce relevant planning regulations. Note: For water quality after treatment or at point of use refer to legislation and guidelines, including: • *Public Health Act 2005* and Regulation (2018), • *Water Supply (Safety and Reliability) Act 2008*, including the relevant drinking water quality management plan and, where applicable, the recycled water management plan for augmenting a drinking water supply under the Act and the published Drinking Water Quality Management Plan Guideline • *Water Fluoridation Act 2008* and Regulation (2020) • *Australian Drinking Water Guidelines* (ADWG, 2011, as amended). • Safe Water on Rural Properties (Queensland Health, 2015)

Environmental value	Water type/area	Water quality objective to protect EV (refer to specified codes and guidelines for full details)
Protection of the human consumer for oystering	Estuarine and coastal waters	As per ANZG and Australia New Zealand Food Standards Code, Food Standards Australia New Zealand, as amended. (refer Food Standards Australia New Zealand website)
Protection of the human consumer	Fresh waters, estuarine and coastal waters	As per ANZG and Australia New Zealand Food Standards Code, Food Standards Australia New Zealand, as amended. (refer Food Standards Australia New Zealand website)
Protection of cultural and spiritual values	Fresh waters (including groundwaters), estuarine and coastal waters	Protect or restore indigenous and non-indigenous cultural heritage consistent with relevant policies and plans.
Suitability for industrial use	Fresh waters, estuarine and coastal waters	None provided. Water quality requirements for industry vary within and between industries. The ANZG do not provide guidelines to protect industries, and indicate that industrial water quality requirements need to be considered on a case-by-case basis. This EV is usually protected by other values, such as the aquatic ecosystem EV.
Suitability for aquaculture	Fresh waters, estuarine and coastal waters	As per: • Tables 6–8 • ANZG and Australia New Zealand Food Standards Code, Food Standards Australia New Zealand, as amended
Suitability for irrigation	All fresh waters including groundwaters	Pathogens and metal WQOs are provided in Tables 9 and 10 (based on ANZG). For all other indicators, such as salinity, sodicity, sodium adsorption ratio (SAR), and herbicides, refer ANZG.
Suitability for stock watering	All fresh waters including groundwaters	As per ANZG, including median faecal coliforms <100 organisms per 100 mL. For total dissolved solids and metals, refer Tables 11 and 12, based on ANZG. For other indicators, such as cyanobacteria and pathogens, see ANZG.
Suitability for farm supply/use	All fresh waters including groundwaters	As per ANZG. Also refer to Safe Water on Rural Properties (Queensland Health, 2015)
Suitability for primary contact recreation	Fresh waters, estuarine and coastal waters	Note: at time of publication the NHMRC guidelines for recreational water quality were under review, and updates may supersede the following. Refer to NHMRC website for latest information and updated guidelines. As per NHMRC (2008 – refer NHMRC website) including: • water free of physical (floating and submerged) hazards. Where permanent hazards exist (e.g. rips and sandbars), appropriate warning signs should be clearly displayed. • temperature range: 16–34°C • pH range: 6.5–8.5 • DO: >80% • faecal contamination: designated recreational waters are protected against direct contamination with fresh faecal material, particularly of human or domesticated animal origin. Two principal components are required for assessing faecal contamination: - assessment of evidence for the likely influence of faecal material - counts of suitable faecal indicator bacteria (usually *enterococci*) These two components are combined to produce an overall microbial classification of the recreational water body. • direct contact with venomous or dangerous aquatic organisms should be avoided. Recreational water bodies should be reasonably free of, or protected from, venomous organisms (e.g. box jellyfish and bluebottles) • waters contaminated with chemicals that are either toxic or irritating to the skin or mucous membranes are unsuitable for recreational purposes. Also refer to Safe Water on Rural Properties (Queensland Health, 2015)

Environmental value	Water type/area	Water quality objective to protect EV (refer to specified codes and guidelines for full details)
Suitability for primary contact recreation	Fresh waters	Note: at time of publication the NHMRC guidelines for recreational water quality were under review, and updates may supersede the following. Refer to NHMRC website for latest information and updated guidelines. • cyanobacteria/algae: Recreational water bodies should not contain: - level 1[1]: ≥ 10 µg/L total microcystins; or ≥ 50 000 cells/mL toxic *Microcystis aeruginosa*; or biovolume equivalent of ≥ 4 mm^3/L for the combined total of all cyanobacteria where a known toxin producer is dominant in the total biovolume or - level 2[1]: ≥ 10 mm^3/L for total biovolume of all cyanobacterial material where known toxins are not present - where *Cylindrospermopsis caciborskii* is the dominant species present, advice should be sought for an appropriate guideline for cylindrospermopsin or - cyanobacterial scums consistently present. Further details are contained in NHMRC (2008) and section 4.6 (Table 13). Also refer to Safe Water on Rural Properties (Queensland Health, 2015)
	Estuarine, coastal waters	• cyanobacteria/algae: Recreational water bodies should not contain ≥ 10 cells/mL *Karenia brevis* and/or have *Lyngbya majuscula* and/or *Pfiesteria* present in high numbers[2]. Further details are contained in NHMRC (2008) and section 4.6 (Table 13).
Suitability for secondary contact recreation	Fresh waters, estuarine and coastal waters	As per NHMRC (2008), including: • intestinal enterococci: refer primary recreation above • cyanobacteria/algae—refer primary recreation, NHMRC (2008) and section 4.6 (Table 13).
Suitability for visual recreation	Fresh waters, estuarine and coastal waters	As per NHMRC (2008), including: • recreational water bodies should be aesthetically acceptable to recreational users. The water should be free from visible materials that may settle to form objectionable deposits; floating debris, oil, scum and other matter; substances producing objectionable colour, odour, taste or turbidity; and substances and conditions that produce undesirable aquatic life. • cyanobacteria/algae—see, NHMRC (2008) and section 4.6 (Table 13).

Notes:

1. Level 1 recognises the probability of adverse health effects from ingestion of known toxins, in this case based on the toxicity of microcystins. Level 2 covers circumstances in which there are very high cell densities of cyanobacterial material, irrespective of the presence of toxicity or known toxins. Increased cyanobacterial densities increase the likelihood of non-specific adverse health outcomes, principally respiratory, irritation and allergy symptoms. (NHMRC, 2008; 8).
2. The NHMRC states that its guidelines are concerned 'only with risks that may be associated with recreational activities in or near coastal and estuarine waters. This includes exposure through dermal contact, inhalation of sea-spray aerosols and possible ingestion of water or algal scums, but does not include dietary exposure to marine algal toxins.' (NHMRC, 2008; 121).

Sources:

The WQOs were determined from a combination of sources, including:

- Technical review and advice from Queensland Health and Department of Regional Development, Manufacturing and Water (2020-2022)
- Australian Drinking Water Guidelines (NHMRC, 2011, as amended), available from NHMRC website
- Australia New Zealand Food Standards Code (Australian Government: Food Standards Australia New Zealand), available from Food Standards Australia New Zealand website
- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG, 2018, as amended)
- Guidelines for Managing Risks in Recreational Water (NHMRC, 2008, as amended), available from NHMRC website. At time of publication the NHMRC guidelines were under review. Refer to NHMRC website for latest information and updated guidelines.
- Safe Water on Rural Properties (Queensland Health, 2015)

4.2 Drinking water EV water quality objectives

Table 5 Drinking water EV: Priority water quality objectives for drinking water supply in the vicinity of off-takes, including groundwater, before treatment

Indicator	Water quality objective [1]
Giardia	No guideline value set due to the lack of a routine method to identify human infectious strains in drinking water. A multiple barrier approach from catchment to tap is recommended to minimise the risk of *Giardia* contamination. Protection of catchments from human and animal wastes is a priority. Operation of barriers should be monitored to ensure effectiveness (ADWG). If *Giardia* is detected in treated drinking water then the Water Supply Regulator, DRDMW must and Queensland Health should be notified immediately and an investigation of the likely source of contamination undertaken.
Cryptosporidium	No guideline value set due to the lack of a routine method to identify human infectious strains in drinking water. A multiple barrier approach from catchment to tap is recommended to minimise the risk of *Cryptosporidium* contamination. Protection of catchments from human and animal wastes is a priority. Operation of barriers should be monitored to ensure effectiveness (ADWG). If *Cryptosporidium* is detected in treated drinking water then the Water Supply Regulator, DRDMW must and Queensland Health should be notified immediately and an investigation of the likely source of contamination undertaken.
E. coli	Well designed treatment plants with effective treatment barriers and disinfection are designed to address faecal contamination. *E. coli* or thermotolerant coliforms should not be present in any 100 mL sample of (treated) drinking water (ADWG). If *E. coli* is detected in treated drinking water, the Water Supply Regulator, DRDMW must and Queensland Health should be notified immediately and an investigation of the likely source of contamination undertaken.
Algal toxin	<1.3 µg/L Microcystin (ADWG)
pH	6.5–8.5 (ADWG)
Total dissolved solids (TDS)	<600mg/L The concentration of total dissolved solids in treated drinking water should not exceed 600 mg/L (ADWG, based on taste considerations).
Sodium	General [2]: The concentration of sodium in reticulated drinking water supplies should not exceed 180 mg/L (ADWG, based on threshold at which taste becomes appreciable). At-risk groups (medical) [2]: The concentration of sodium in water supplies for at-risk groups should not exceed 20 mg/L (ADWG).
Sulfate	The concentration of sulfate in drinking water should not exceed 250 mg/L (ADWG), based on taste/aesthetic considerations. ADWG health guideline: <500mg/L
Dissolved oxygen	>85% saturation (ADWG)
Pesticides	With good water quality management practices, pesticides should not be detected in source waters used for drinking water supplies (ADWG). Raw supplies: Refer to ADWG. Treated drinking water: Refer to ADWG.

Indicator	Water quality objective [1]
PFAS	Per- and poly-fluoroalkyl substances (PFAS) are manufactured chemicals that do not occur naturally in the environment. PFAS chemicals include perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA) and perfluorohexane sulfonate (PFHxS) amongst a large group of other compounds. PFAS are persistent in the environment, show the potential for bioaccumulation and biomagnification, and are toxic in animal studies (potential developmental, reproductive and systemic toxicity). (ADWG)
PFOS+PFHxS	<0.07 µg/L (ADWG health guideline).
PFOA	<0.56 µg/L (ADWG health guideline).
Other indicators (including physico-chemical indicators)	Refer to ADWG.

Source: Australian Drinking Water Guidelines (NHMRC, 2011, as amended). Technical review and advice from Queensland Health and Department of Regional Development, Manufacturing and Water (2020-2022).

Notes:

1. This table outlines WQOs for water **before treatment**, unless otherwise stated (e.g. ADWG). For water quality after treatment or at the point of use, refer to relevant legislation and guidelines, including *Public Health Act 2005* and Regulation, *Water Supply (Safety and Reliability) Act 2008 and* Regulation, including any approved drinking water management plan under the Act, *Water Fluoridation Act 2008*, the Australian Drinking Water Guidelines (ADWG, 2011, as amended), and the Safe Water on Rural Properties guideline (Queensland Health, 2015).
2. The ADWG notes that 50 mg/L is a '*typical value*' in reticulated supplies. The ADWG value for sodium is 180 mg/L (based on level at which taste become appreciable) however '*sodium salts cannot be easily removed from drinking water*' and '*any steps to reduce sodium concentrations are encouraged'*. It further notes that '*medical practitioners treating people with severe hypertension or congestive heart failure should be aware if the sodium concentration in the patient's drinking water exceeds 20 mg/L*' (ADWG; sodium factsheet).

4.3 Aquaculture EV water quality objectives

The following tables outline WQOs for aquaculture, depending on water type and species.

Table 6 Aquaculture EV: General water quality objectives for tropical aquaculture

Water parameter	Recommended range		Water parameter	Recommended range
	Fresh water	Marine		General aquatic
Dissolved oxygen	>4 mg/L	>4 mg/L	**Arsenic**	<0.05 mg/L
Temperature	21–32˚C	24–33˚C	**Cadmium**	<0.003 mg/L
pH	6.8–9.5	7–9.0	**Calcium/Magnesium**	10–160 mg/L
Ammonia (TAN, total ammonia-nitrogen)	<1.0 mg/L	<1.0 mg/L	**Chromium**	<0.1 mg/L
Ammonia (NH_3, un-ionised form)	<0.1 mg/L	<0.1 mg/L	**Copper**	<0.006 mg/L in soft water
Nitrate (NO_3)	1–100 mg/L	1–100 mg/L	**Cyanide**	<0.005 mg/L
Nitrite (NO_2)	<0.1 mg/L	<1.0 mg/L	**Iron**	<0.5 mg/L
Salinity	0–5 psu	15–35 psu	**Lead**	<0.03 mg/L
Hardness	20–450 mg/L	ID	**Manganese**	<0.01 mg/L
Alkalinity	20–400 mg/L	>100 mg/L	**Mercury**	<0.00005 mg/L
Turbidity	<80 NTU	ID	**Nickel**	<0.01 mg/L in soft water <0.04 mg/L in hard water
Chlorine	<0.003 mg/L	ID	**Tin**	<0.001 mg/L
Hydrogen sulphide	<0.002 mg/L	ID	**Zinc**	0.03–0.06 mg/L in soft water 1–2 mg/L in hard water

Indicator: psu – practical salinity unit, NTU - nephelometric turbidity units, ID – Insufficient data

Note: The table provides indicative water requirements for a range of aquaculture species (fresh and/or marine), recognising that not all listed species will occur in a given area, and that potential exists for changes in species under culture.

Source: Department of Primary Industries and Fisheries—Water Quality in Aquaculture—DPI Notes April 2004 (as amended) and DAF 2019-2020 technical review and advice.

Table 7 Aquaculture EV: Water quality objectives for optimal growth of particular freshwater species

WATER QUALITY TARGET VALUES FOR AQUACULTURE						
Water parameter	Barramundi	Eel	Silver perch	Jade perch	Sleepy cod	Red-claw
Dissolved oxygen	4–9 mg/L	>3 mg/L	>4 mg/L	>3 mg/L	>4.0 mg/L	>4.0 mg/L
Temperature	26–32˚C	23–28˚C	23–28˚C	23–28˚C	22–31˚C	23–31˚C
pH	7.5–8.5	7.0–8.5	6.5–8.5	6.5–8.5	7.0–8.5	7.0–8.5
Ammonia (TAN, Total ammonia–nitrogen)	ID	<1.0 mg/L	ID	ID	<1.0 mg/L	<1.0 mg/L
Ammonia (NH_3, un–ionised form)	<0.46 mg/L	<0.1 mg/L	<0.1 mg/L	<0.1 mg/L	<0.1 mg/L	<0.1 mg/L
Nitrate (NO_3)	ID	ID	<100 mg/L	ID	ID	ID
Nitrite (NO_2)	<1.5 mg/L	<1.0 mg/L	<0.1 mg/L	ID	<1.0 mg/L	<1.0 mg/L
Salinity (extended periods)	0–35 psu	ID	<5 psu	<5 psu	ID	<4 psu
Salinity bath (short term treatment)	0–35 psu	ID	5–10 psu for 1 hour	ID	max. 20 psu for 1 hour	ID
Hardness ($CaCO_3$)	50-100 mg/L	ID	>50 mg/L	>50 mg/L	>40 mg/L	>40 mg/L
Alkalinity	>50 mg/L	ID	100–400 mg/L	100–400mg/L	>40 mg/L	>40 mg/L
Chlorine	<0.04 mg/L	ID	ID	ID	<0.04 mg/L	ID
Hydrogen sulphide	<0.3 mg/L	ID	ID	ID	<0.3 mg/L	ID
Iron	<0.1 mg/L	ID	<0.5 mg/L	<0.5 mg/L	<0.1 mg/L	<0.1 mg/L
Spawning temperature	marine	ID	23–28	23–28	>24 for more than 3 days	ID

Indicator: psu – practical salinity unit, ID – Insufficient data

Note: The table provides indicative water requirements for a range of aquaculture species (fresh and/or marine), recognising that not all listed species will occur in a given area, and that potential exists for changes in species under culture.

Source: Department of Primary Industries and Fisheries—Water Quality in Aquaculture—DPI Notes April 2004 (as amended) and DAF 2019-2020 technical review and advice.

Table 8 Aquaculture EV: Water quality objectives for optimal growth of particular marine species

Water parameter	Barramundi		Black tiger prawn (*Penaeus monodon*)	
	Hatchery	**Grow out**	**Hatchery**	**Grow out**
Dissolved oxygen	saturation	>4 mg/L	>4 mg/L	>3.5 mg/L
Temperature	28–30˚C optimum 25–31˚C range	28–30˚C optimum	28-30˚C	26–32˚C
pH	approx. 8	approx. 8	7.8-8.2	7.5–8.5
Ammonia (TAN, total ammonia-nitrogen)	ID	0.1–0.5 mg/L	ID	<3 mg/L
Ammonia (NH_3, un-ionised form)	<0.1 mg/L	<0.1 mg/L	<0.1 mg/L	<0.1 mg/L
Nitrate (NO_3)	<1.0 mg/L	<1.0 mg/L	<1.0 mg/L	<1.0 mg/L
Nitrite (NO_2)	<0.2 mg/L	<1.0 mg/L	<0.2 mg/L	<0.2 mg/L
Salinity	28–31psu	0–35psu	30-35psu	10–25 psu optimum
Alkalinity	ID	105–125 mg/L $CaCO_3$	ID	>80 mg/L
Clarity	ID	<10mg/L	ID	30–40cm secchi disk
Hydrogen sulphide	ID	<0.3 mg/L	<0.1 mg/L	<0.1 mg/L
Iron	ID	<0.02 mg/L	<1 mg/L	<1.0 mg/L
Spawning temperature	ID	28–32˚C	ID	27–32˚C

Indicator: psu – practical salinity unit, ID – Insufficient data

Note: The table provides indicative water requirements for a range of aquaculture species (fresh and/or marine), recognising that not all listed species will occur in a given area, and that potential exists for changes in species under culture.

Source: Department of Primary Industries and Fisheries—Water Quality in Aquaculture—DPI Notes April 2004 (as amended) and DAF 2019-2021 technical review and advice.

4.4 Irrigation EV water quality objectives

The following tables outline WQOs for irrigation, based on relevant national guidelines. The tables relate to water sourced from Queensland waters, rather than a potable water source or from a treated effluent source, for which a range of national and state guidance material is available. Note that requirements relating to recycled water are addressed under the *Public Health Act 2005*, Public Health Regulation (2018) and *Water Supply (Safety and Reliability) Act 2008*. Further information on recycled water is available from the Queensland Health and Business Queensland websites.

Specific guidelines for irrigation of public spaces with water sourced from Queensland waters are not available, though guidance on microbial quality and managing risks can be taken from the 'Guideline for low-exposure recycled water schemes' (available from the Queensland Health website).

Note that at time of publication of this document, national irrigation water quality guidelines are under review as part of ANZG (2018, as amended), and readers should refer to the ANZG website for the most up-to-date version.

The values in the following tables pertain to water suitability for irrigation with regard to criteria such as maintaining soil quality, plant phytotoxicity, minimisation of toxic metal update into food crops, and impact on farm infrastructure (ANZECC 2000, Section 9.2.5.1). These guideline values are not set to account for effects on aquatic ecosystems in source waters, or human health impacts of contact with the water. For these, reference should be made to relevant WQOs for aquatic ecosystem protection, and WQOs for other human use EVs elsewhere in this document. For safety of food for human consumption, refer to Food Standards Australia New Zealand.

The water quality objective values for thermotolerant coliforms in irrigation water are sourced from Section 4.2.3 of ANZECC 2000 Vol 1. As values may have been updated since time of publication, readers should refer to the ANZG 2018 website for the most up-to-date values to be applied as objectives.

Table 9 Irrigation EV: Water quality objectives for thermotolerant (faecal) coliforms in irrigation waters used for food and non-food crops[1]

Intended use	Median values of thermotolerant coliforms (colony forming units—cfu)[2]
Raw human food crops in direct contact with irrigation water (e.g. via sprays, irrigation of salad vegetables)	<10 cfu/100 mL
Raw human food crops not in direct contact with irrigation water (edible product separated from contact with water, e.g. by peel, use of trickle irrigation); or crops sold to consumers cooked or processed	<1000 cfu/100 mL
Pasture and fodder for dairy animals (without withholding period)	<100 cfu/100 mL
Pasture and fodder for dairy animals (with withholding period of five days)	<1000 cfu/100 mL
Pasture and fodder (for grazing animals except pigs and dairy animals, such as cattle, sheep and goats)	<1000 cfu/100 mL
Silviculture, turf, cotton, etc. (restricted public access)	<10 000 cfu/100 mL

Notes:

1. Adapted from ARMCANZ, ANZECC and NHMRC (2000).
2. Refer to ANZECC (2000), Volume 1, Section 4.2.3.3 for advice on testing protocols.

Source: ANZECC (2000), Volume 1, Section 4.2.3.3, Table 4.2.2. Refer to ANZG (2018, as amended) for updates to irrigation guidelines.

Table 10 Irrigation EV: Water quality objectives for heavy metals and metalloids in agricultural irrigation water— soil cumulative contamination loading limit (CCL), long-term trigger value (LTV) and short-term trigger value (STV)[1]

The water quality objectives for heavy metals and metalloids for soil cumulative load and irrigation water quality provided in the following table are sourced from Section 9.2.5 of ANZECC 2000 Vol 3. As values may have been updated since the time of publication, readers should refer to the ANZG 2018 website for the most up-to-date values to be applied as objectives.

Element	Soil cumulative contaminant loading limit (CCL)[2] (kg/ha)	Long-term trigger value (LTV) in irrigation water (up to 100 years) (mg/L)	Short-term trigger value (STV) in irrigation water (up to 20 years) (mg/L)
Aluminium	ND[2]	5	20
Arsenic	20	0.1	2.0
Beryllium	ND	0.1	0.5
Boron	ND	0.5	Refer to AWQG, Vol 3, Table 9.2.18
Cadmium	2	0.01	0.05
Chromium	ND	0.1	1
Cobalt	ND	0.05	0.1
Copper	140	0.2	5
Fluoride	ND	1	2
Iron	ND	0.2	10
Lead	260	2	5
Lithium	ND	2.5 (0.075 for citrus crops)	2.5 (0.075 for citrus crops)
Manganese	ND	0.2	10
Mercury	2	0.002	0.002
Molybdenum	ND	0.01	0.05
Nickel	85	0.2	2
Selenium	10	0.02	0.05
Uranium	ND	0.01	0.1
Vanadium	ND	0.1	0.5
Zinc	300	2	5

Notes:

1. Concentrations in irrigation water should be less than the trigger values. Trigger values should only be used in conjunction with information on each individual element and the potential for off-site transport of contaminants (refer ANZECC, Volume 3, Section 9.2.5).

2. ND = Not determined; insufficient background data to calculate CCL.

Source: ANZECC (2000), Volume 1, Section 4.2.6, Table 4.2.10. Refer to ANZG (2018, as amended) for updates to irrigation guidelines.

4.5 Stock watering EV water quality objectives

The following tables outline WQOs for stock watering, according to stock type (cattle, sheep etc.) for salinity (Table 11) and metals and metalloids (Table 12). These are sourced from sections 4.3.3 and 4.3.4 of ANZECC 2000 Vol 1. The source material should be referred to for additional relevant water quality parameters and guideline values for stock watering. Note that at time of publication of this document, national stock watering guidelines are under review as part of ANZG (2018, as amended), and readers should refer to the ANZG website for the most up-to-date values to be applied as objectives.

Table 11 Stock watering EV: Water quality objectives for tolerances of livestock to salinity, as total dissolved solids, in drinking water[1]

Livestock	Total dissolved solids (TDS) (mg/L)		
	No adverse effects on animals expected.	Animals may have initial reluctance to drink or there may be some scouring, but stock should adapt without loss of production	Loss of production and decline in animal condition and health would be expected. Stock may tolerate these levels for short periods if introduced gradually
Beef cattle	0–4000	4000–5000	5000–10 000
Dairy cattle	0–2500	2500–4000	4000–7000
Sheep	0–5000	5000–10 000	10 000–13 000[2]
Horses	0–4000	4000–6000	6000–7000
Pigs	0–4000	4000–6000	6000–8000
Poultry	0–2000	2000–3000	3000–4000

Notes:

1. From ANZECC (1992), adapted to incorporate more recent information.
2. Sheep on lush green feed may tolerate up to 13 000 mg/L TDS without loss of condition or production.

Source: ANZECC (2000), Volume 1, Section 4.3.3.5, Table 4.3.1. Note that a review of stock watering tolerances under the ANZG (2018) may lead to revised values from those in this table. Refer to ANZG (2018, as amended) for further details.

Table 12 Stock watering EV: Water quality objectives (low risk trigger values) for heavy metals and metalloids in livestock drinking water

Metal or metalloid	Trigger value (low risk)[1,2] (mg/L)
Aluminium	5
Arsenic	0.5 (up to 5[3])
Beryllium	ND
Boron	5
Cadmium	0.01
Chromium	1
Cobalt	1
Copper	0.4 (sheep), 1 (cattle), 5 (pigs), 5 (poultry)
Fluoride	2
Iron	not sufficiently toxic
Lead	0.1
Manganese	not sufficiently toxic
Mercury	0.002
Molybdenum	0.15
Nickel	1
Selenium	0.02
Uranium	0.2
Vanadium	ND
Zinc	20

Notes:

1. Higher concentrations may be tolerated in some situations (further details provided in ANZECC (2000), Volume 3, Section 9.3.5).
2. ND = not determined, insufficient background data to calculate.
3. May be tolerated if not provided as a food additive and natural levels in the diet are low.

Source: ANZECC (2000), Volume 1, Section 4.3.4, Table 4.3.2. Note that a review of stock watering tolerances under the ANZG (2018) may lead to revised values from those in this table. Refer to ANZG (2018, as amended) for further details.

4.6 Recreation EV water quality objectives - cyanobacteria

When cyanobacteria are present in large numbers they can present a significant hazard, particularly to primary contact users of waters. Water quality guidelines for cyanobacteria in recreational waters are provided below. Monitoring and action requirements relative to cyanobacteria 'alert' levels are summarised below, and are explained more fully in the Guidelines for Managing Risks in Recreational Water (NHMRC, 2008). Further details on the process to determine suitability of waters for recreation, relative to historical cyanobacterial levels and susceptibility to cyanobacterial contamination, are contained in sections 6 and 7 of the NHMRC guidelines.

Note: at time of publication the NHMRC guidelines for recreational water quality were under review, and updates may supersede the following. Refer to NHMRC website for latest information and updated guidelines.

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Table 13 Recreational waters: Alert levels and corresponding actions for management of cyanobacteria

Green level surveillance mode[1]	Amber level alert mode[1]	Red level action mode[1]
Fresh waters		
≥ 500 to <5000 cells/mL *M. aeruginosa* or biovolume equivalent of >0.04 to <0.4 mm^3/L for the combined total of all cyanobacteria.	≥ 5000 to <50 000 cells/mL *M. aeruginosa* or biovolume equivalent of ≥ 0.4 to <4 mm^3/L for the combined total of all cyanobacteria where a known toxin producer is dominant in the total biovolume[2]. or[3] ≥ 0.4 to <10 mm^3/L for the combined total of all cyanobacteria where known toxin producers are not present.	Level 1 guideline[4]: ≥ 10 µg/L total microcystins or ≥ 50 000 cells/mL toxic *M. aeruginosa* or biovolume equivalent of ≥ 4 mm^3/L for the combined total of all cyanobacteria where a known toxin producer is dominant in the total biovolume. or[3] Level 2 guideline[4]: ≥ 10 mm^3/L for total biovolume of all cyanobacterial material where known toxins are not present. or cyanobacterial scums are consistently present[5].
Coastal and estuarine waters		
Karenia brevis		
≤ 1 cell/mL	> 1– < 10 cells/mL	≥ 10 cells/mL
Lyngbya majuscula, Pfiesteria spp.		
History but no current presence of organism	Present in low numbers	Present in high numbers. (For *Lyngbya majuscula* this involves the relatively widespread visible presence of dislodged algal filaments in the water and washed up onto the beach)
Nodularia spumigena: See NHMRC, Chapter 6 (Cyanobacteria and algae in fresh water) for details.		

Notes:

1. Recommended actions at different alert levels are outlined below (based on NHMRC, 2008, Table 6.6—fresh waters. Similar actions are outlined for coastal/estuarine waters in NHMRC Table 7.6):

   a. **Green**: Regular monitoring. Weekly sampling and cell counts at representative locations in the water body where known toxigenic species are present (i.e. *Microcystis aeruginosa, Anabaena circinalis, Cylindrospermopsis raciborskii, Aphanizomenon ovalisporum, Nodularia spumigena*); or fortnightly for other types including regular visual inspection of water surface for scums.

   b. **Amber**: Notify agencies as appropriate. Increase sampling frequency to twice weekly at representative locations in the water body where toxigenic species (above) are dominant within the alert level definition (i.e. total biovolume) to establish population growth and spatial variability in the water body. Monitor weekly or fortnightly where other types are dominant. Make regular visual inspections of water surface for scums. Decide on requirement for toxicity assessment or toxin monitoring.

c. **Red**: Continue monitoring as for (amber) alert mode. Immediately notify health authorities for advice on health risk. ('In action mode the local authority and health authorities warn the public of the existence of potential health risks; for example, through the media and the erection of signs by the local authority.' NHMRC, 2008; 114). Make toxicity assessment or toxin measurement of water if this has not already been done. Health authorities warn of risk to public health (i.e. the authorities make a health risk assessment considering toxin monitoring data, sample type and variability).

2. The definition of 'dominant' is where the known toxin producer comprises 75 per cent or more of the total biovolume of cyanobacteria in a representative sample.
3. This applies where high cell densities or scums of 'non toxic' cyanobacteria are present i.e. where the cyanobacterial population has been tested and shown not to contain known toxins (mycrocystins, nodularian, cylindrospermopsin or saxitoxin).
4. Health risks and levels: Level 1 is developed to protect against short-term health effects of exposure to cyanobacterial toxins ingested during recreational activity, whereas the Level 2 applies to the circumstance where there is a probability of increased likelihood of non-specific adverse health outcomes, principally respiratory, irritation and allergy symptoms, from exposure to very high cell densities of cyanobacterial material irrespective of the presence of toxicity or known toxins (NHMRC, 2008;114).
5. This refers to the situation where scums occur at the recreation site each day when conditions are calm, particularly in the morning. Note that it is not likely that scums are always present and visible when there is a high population as the cells may mix down with wind and turbulence and then reform later when conditions become stable.

Source: Based on NHMRC (2008) Guideline for Managing Risks in Recreational Water (tables 6.2, 6.6, 7.3).

5 Ways to improve water quality

The following sources are relevant in considering ways to improve water quality. The list below is additional to the plans, guidelines and other sources referred to in previous sections, **and is provided for information only**.

Groundwater policy references

- Guidelines for groundwater quality protection in Australia
- Great Artesian Basin Strategic Management Plan

Local plans, studies

- Council planning schemes and supporting codes, policies, available from council websites

Regional plans, studies

- North Queensland Regional Plan
- Burdekin Region Water Quality Improvement Plan (WQIP, 2016), available from the NQ Dry Tropics

State plans, policies, guidelines, agreements

- Burdekin Basin Water Plan
- Water Plan (Great Artesian Basin and Other Regional Aquifers)
- State Planning Policy (state interest – water quality)
- Queensland Coastal Management Plan
- Reef 2050 Long-term Sustainability Plan
- Reef 2050 Water Quality Improvement Plan

Water quality guidelines

- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG) including Application of the Water Quality Guidelines to groundwater
- Queensland Water Quality Guidelines (QWQG)
- Queensland Monitoring and Sampling Manual
- Department of Environment and Science (2021). *Using monitoring data to assess groundwater quality and potential environmental impacts*. Version 2. Queensland Government, (DES) Brisbane
- Water quality guidelines for the Great Barrier Reef Marine Park 2010, available on the Great Barrier Reef Marine Park Authority's website

Other supporting technical information

- Information on PFAS in Queensland, including access to PFAS national environmental management plan
- Salinity Management Handbook – available on the Queensland Government Publications website
  - Chapter 10 – Waters
  - Chapter 11 – Water Quality
- Soil conservation guidelines for Queensland – available on the Queensland Government Publications website
  - Chapter 10 – Land management on flood plains
  - Chapter 11 – Stream stability
  - Chapter 13 – Gully Erosion
- Department of Environment and Science, Queensland (2021) Treatment systems, Wetland*Info* website, accessed 18 June 2022
- Farming in the Great Barrier Reef catchments | Business Queensland
- Healthy Waterways Incorporated – Water by Design: resources and information available on the Water by Design website, including content on the Reef Urban Stormwater Management Improvement Group (RUSMIG)

6 Dictionary

AMTD means the adopted middle thread distance which is the distance in kilometres, measured along the middle of a watercourse, that a specific point in the watercourse is from the watercourse's mouth or junction with the main watercourse (definition based on Water Regulation 2002).

ANZECC means the Australian and New Zealand Environment and Conservation Council.

ANZECC Guidelines mean the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (recently updated to become ANZG, 2018), prepared by the Australian and New Zealand Environment and Conservation Council (ANZECC) and the Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ).

Aquatic ecosystem (defined in the ANZG) any watery environment from small to large, from pond to ocean, in which plants and animals interact with the chemical and physical features of the environment.

Aquatic ecosystem (defined in the EPP (Water and Wetland Biodiversity)) means a community of organisms living within or adjacent to water, including riparian or foreshore areas.

Basin means the basin name and number provided by Geoscience Australia, Canberra (3rd edition, 2004).

Biological Integrity (defined in the EPP (Water and Wetland Biodiversity)) for water or a wetland, means the ability of the water or wetland to support and maintain a balanced, integrative, adaptive community of organisms having a species composition, diversity and functional organisation comparable to that of the natural habitat of the locality in which the water or wetland is situated.

Catchment means the total area draining into a river, creek, reservoir or other body of water. The limits of a given catchment are the heights of land (such as hills or mountains) separating it from neighbouring catchments. Catchments can be made up of smaller sub-catchments.

Ecological integrity (health) (defined in the ANZG) means the 'health' or 'condition' of an ecosystem. The ability of an ecosystem to support and maintain key ecological processes and organisms so that their species compositions, diversity and functional organisations are as comparable as possible to those occurring in natural habitats within a region.

Environmental value (EV) means:

(a) a quality or physical characteristic of the environment that is conducive to ecological health or public amenity or safety; or

(b) another quality of the environment identified and declared to be an environmental value under an Environmental Protection Policy or Regulation (e.g. water suitable for swimming in or drinking).

The EVs for water that can be identified for protection are outlined in the accompanying table.

Highest astronomical tide (HAT) (defined in Marine Parks (Declaration) Regulation 2006) means the highest level of the tides that can be predicted to occur under average meteorological conditions and under any combination of astronomical conditions.

High water mark (defined in *Coastal Protection and Management Act 1995*) means the ordinary high water mark at spring tides.

Mean high water spring refer high water mark.

Queensland waters (as defined in *Acts Interpretation Act 1954*): means all waters that are a) within the limits of the state; or b) coastal waters of the state.

Sub-basin means part of a basin.

Sub-catchment means part of a catchment.

Toxicant (defined in the ANZG): means a substance capable of producing an adverse response (effect) in a biological system, which may seriously injure structure or function or produce death at sufficiently high concentration.

Table 14 Environmental values that can be identified for protection

Environmental values and definitions	ICON (as shown on plans)
Aquatic ecosystem 'A community of organisms living within or adjacent to water, including riparian or foreshore area.' (EPP (Water and Wetland Biodiversity), schedule 2 - Dictionary) The intrinsic value of aquatic ecosystems, habitat and wildlife in waterways and riparian areas, for example, biodiversity, ecological interactions, plants, animals, key species (such as turtles, platypus, seagrass and dugongs) and their habitat, food and drinking water. Waterways include perennial and intermittent surface waters, groundwaters, tidal and non-tidal waters, lakes, storages, reservoirs, dams, wetlands, swamps, marshes, lagoons, canals, natural and artificial channels and the bed and banks of waterways. (This EV incorporates the 'wildlife habitat' EV used in the South East Queensland Regional Water Quality Management Strategy). See below for more details on aquatic ecosystems, based on the EPP (Water and Wetland Biodiversity).	
High ecological/conservation value waters 'Waters in which the biological integrity of the water is effectively unmodified or highly valued.' (EPP (Water and Wetland Biodiversity), schedule 2).	None
Slightly disturbed waters 'Waters that have the biological integrity of high ecological value waters with slightly modified physical or chemical indicators but effectively unmodified biological indicators.' (EPP (Water and Wetland Biodiversity), schedule 2).	None
Moderately disturbed waters 'Waters in which the biological integrity of the water is adversely affected by human activity to a relatively small but measurable degree.' (EPP (Water and Wetland Biodiversity), schedule 2).	None
Highly disturbed waters 'Waters that are significantly degraded by human activity and have lower ecological value than high ecological value waters or slightly or moderately disturbed waters.' (EPP (Water and Wetland Biodiversity), schedule 2).	None

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Environmental values and definitions	ICON (as shown on plans)
Irrigation Suitability of water supply for irrigation, for example, irrigation of crops, pastures, parks, gardens and recreational areas.	
Farm water supply/use Suitability of domestic farm water supply, other than drinking water. For example, water used for laundry and produce preparation.	
Stock watering Suitability of water supply for production of healthy livestock.	
Aquaculture Health of aquaculture species and humans consuming aquatic foods (such as fish, molluscs and crustaceans) from commercial ventures.	
Human consumers of aquatic foods The suitability of the water for producing aquatic foods (fish, shellfish, other animals, plants) that are safe and suitable for human consumption; and having aquatic foods that are safe and suitable for human consumption taken from it.	
Primary recreation Means a use that involves the following types of contact with the water—full body contact, frequent immersion by the face and trunk, frequent contact with spray by the face where it is likely some water will be swallowed or inhaled, or come into contact with ears, nasal passages, mucous membranes or cuts in the skin. Examples–diving, swimming, surfing (EPP (Water and Wetland Biodiversity), section 6).	
Secondary recreation Means a use that involves the following types of contact with the water—contact in which only the limbs are regularly wet, and other contact, including the swallowing of water, is unusual (examples—boating, fishing, wading) or occasional inadvertent immersion resulting from slipping or being swept into the water by a wave. (EPP (Water and Wetland Biodiversity), section 6).	
Visual recreation Means a use that does not ordinarily involve any contact with the water—for example angling from the shore, sunbathing near water (EPP (Water and Wetland Biodiversity), section 6).	
Drinking water supply Suitability of the water for supply as drinking water having regard to the level of treatment of the water.	

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Environmental values and definitions	ICON (as shown on plans)
Industrial use Suitability of water supply for industrial purposes, for example, food, beverage, paper, petroleum and power industries, mining and minerals refining/processing. Industries usually treat water supplies to meet their needs.	
Cultural and spiritual values Means scientific, social or other significance to the present generation or past or future generations, including Aboriginal people or Torres Strait Islanders (EPP (Water and Wetland Biodiversity)), section 6), for example: • custodial, spiritual, cultural and traditional heritage, hunting, gathering and ritual responsibilities • symbols, landmarks and icons (such as waterways, turtles and frogs) • lifestyles (such as agriculture and fishing).	

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