Environmental Protection Policy (Water) 2009

Mapping procedural guide

Management intent and water type mapping methodology

March 2018

Queensland Government

Prepared by: Department of Environment and Science

March 2018

Contents

1 Introduction

This document outlines the process used to develop mapping products pursuant to the Environmental Protection (Water) Policy 2009, – the EPP (Water). The EPP (Water) is subordinate legislation under the *Environmental Protection Act 1994*, and provides a framework for:

- identifying environmental values (EVs)[1] for Queensland waters, and deciding the water quality objectives (WQOs)[2] to protect or enhance those EVs
- spatially identifying locations of EVs, water types, and management intent on mapping products derived from geographic information systems (GIS)
- including the identified EVs, WQOs and mapping under Schedule 1 of the EPP (Water), available from the department's website.

EPP (Water) schedule 1 documents and mapping are available from the department's website. EVs, water types and aquatic ecosystem management intent (level of protection) depicted in the EPP (Water) mapping are stored in electronic form as part of the Queensland Environmental Values Schedule 1 Geodatabase. Spatial (GIS) datasets can be downloaded free of charge in common GIS formats from the Queensland Spatial Catalogue (QSpatial) at http://qldspatial.information.qld.gov.au/catalogue/custom/index.page. The data is published on QSpatial in state-wide datasets that are divided into the guideline regions as illustrated in Figure 1 (From Queensland Water Quality Guidelines).

Currently, there is data published for the South-east, Central Coast and Wet Topics regions. Data for other regions will be added to QSpatial as they are scheduled. For each region, four polygon feature classes are supplied in the database. These link to the EVs and WQOs described in the EPP (Water) schedule 1 documents.

- Schedule outline – describes which geographic area is scheduled in each document. These are usually based on drainage basins and (where applicable) adjacent Queensland coastal waters.
- Subcatchments – outlines of the subcatchments to which EVs and WQOs apply. The EVs are shown in both the schedule document and the schedule map. WQOs are available in the schedule document. Subcatchments are areas within a basin, usually based on, but not limited to, topography and hydrology, and may also be delineated by property boundaries, tenure or land/water uses, e.g. national parks and urban areas, and in coastal marine waters by bays and other spatially defined areas.
- Management intent /level of protection – describes waters of High Ecological Value (HEV), Slightly Disturbed (SD) and Highly Disturbed (HD). Some Moderately Disturbed (MD) subzones may be included where they have different WQOs from the already attributed areas. All areas that are shown without a management intent are by default classified as moderately disturbed. Aquatic ecosystem WQOs may vary according to the management intent of a waterway.
- Water type – describes whether the water is fresh, estuarine or marine water; or where water chemistry data indicates further delineation of these water types is necessary, such as in the Queensland Murray-Darling Basin (QMDB) ground water mapping product (For full description see Appendix A). Aquatic ecosystem WQOs typically apply to particular water types.

[1] Environmental value (EV) is a quality or physical characteristic of the environment that is conducive to ecological health or public amenity or safety; or another quality of the environment identified and declared to be an EV under an Environmental Protection Policy or Regulation. EVs for waters include aquatic ecosystems, cultural and spiritual values, industry, agriculture (e.g. stock watering, irrigated crops, aquaculture), recreation, human consumption and drinking water.

[2] WQOs are long-term goals for water quality management. They are numerical concentration levels or narrative statements of indicators (e.g. toxicants, nutrients, biological indicators) established for receiving waters to support and protect the designated EVs for those waters.

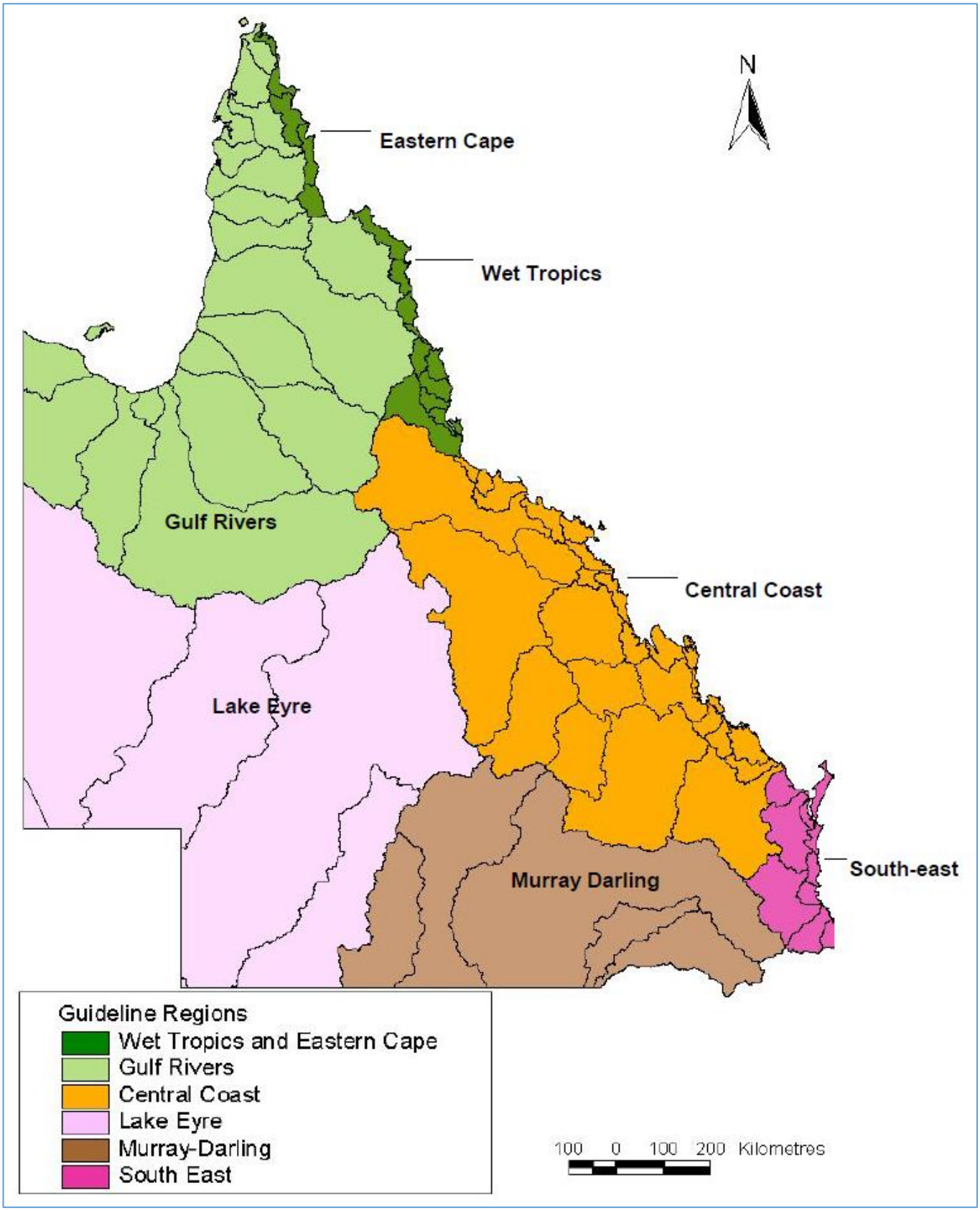

Figure 1: EPP (Water) mapping regions adopted for the Queensland Water Quality Guidelines

2 Methodology

2.1 Schedule outline

The schedule outline is a description of the spatial extent of the schedule document and map. It is usually based on Queensland river basins, delineated *in Australia's River Basins 1997—Product User Guide* ((3rd edition, 2004, Published by Geoscience Australia. Canberra, ACT), as shown in figure 2.3.2 of the Queensland Water Quality Guidelines. Small basins may be combined, or larger, more complex basins may be split into sub-basins in order to make each schedule document consistent in size. In some areas (e.g. Southeast Queensland, Fitzroy) the basin may be split into sub-basins.

Each schedule outline feature is assigned a name and an identifier, which forms the title of the map shown on the website. The identifier is prefixed with "WQ" (for water quality), then composed of the basin number (e.g. 119) and then a sequential number for each catchment, from north to south (e.g. WQ1191).

Feature class name: ENVHW.XX_EPP_SCHEDULE_OUTLINE (where XX is the region identifier, e.g. CQ for Central Queensland)

Fields:

Field name	Field description
SCHEDULE	Schedule document and map name
PLAN_ID	Schedule map identifier

2.2 Subcatchments

The subcatchments describe areas to which a set of EVs and WQOs apply. They are usually based on topography and hydrology, typically being a subset of the larger basin or catchment. In some areas, human use features, such as land or water use, may be applied to delineate subcatchments where this has an effect on waterway uses and values or water quality. Subcatchments may also be supplied by regional Natural Resource Management (NRM) groups if they are an established management unit for the region. Symbols are shown on the map indicating which EVs apply in which subcatchments.

Feature class name: ENVHW.XX_EPP_SUBCATCH

Fields:

Field name	Field description
SCHEDULE	Schedule document and map name
SUBCATCH	Subcatchment name

2.3 Management intent

The management intent feature class describes the ecosystem condition and management intent/level of protection afforded to all waters area under the EPP (Water). There are four levels of aquatic ecosystem protection: High Ecological Value (HEV), Slightly Disturbed (SD), Moderately Disturbed (MD) and Highly Disturbed (HD). **A rules-based approach is adopted to derive draft management intent levels from legislative protection and related conservation layers as described in Table 1. However, levels of protection are revised and ultimately determined from local water quality analysis, supported by technical reporting and local consultation**.

Table 1 EPP (Water) Management Intent: default rules-based approach to mapping (subject to validation and revision)

Source	Dataset	Query	Draft status (subject to revision) [1, 2]
National Park	Protected Areas of Queensland	EST_TENURE = 'NP'	HEV
National Park (Scientific)	Protected Areas of Queensland	EST_TENURE = 'NS'	HEV
Conservation Park	Protected Areas of Queensland	EST_TENURE = 'CP'	SD
CYPAL	Protected Areas of Queensland	EST_TENURE = 'NY'	SD
State Forests	Protected Areas of Queensland	EST_TENURE = 'SF'	SD
Nature Refuges	Queensland Nature Refuges		SD
Coordinated Conservation Areas	Queensland Coordinated Conservation Areas		SD
State Marine Parks	State Marine Parks (QLD)	ZONE IN ('Buffer Zone', 'Marine National Park Zone', 'Preservation Zone', 'Estuarine Conservation Zone', 'Scientific Research Zone')	Outside plume: HEV Inside plume: SD
GBRMPA Marine Parks	Great Barrier Reef Marine Park Authority Zones	TYPE IN ('Buffer', 'Preservation', 'Marine National Park', 'Scientific Research' , 'Scientific Research (closed to public access)')	Outside plume: HEV Inside plume: SD
Fish Habitat Areas (Type A)	Fish Habitat Areas	TYPE_ABBR = 'FHAA'	SD
Wet Tropics World Heritage Area	Wet Tropics World Heritage Area Zoning Scheme	Name IN ('A', 'B')	HEV
World Heritage Areas	Queensland World Heritage Area Boundaries	NAME IN('Fraser Island' , 'Gondwana Rainforests of Australia')	HEV
Ramsar	Ramsar Sites Queensland	RAMSAR_NAME <> 'not in RAMSAR'	HEV
Strategic Environmental Areas	Regional Planning Interests - Strategic Environmental Areas		SD
Dugong Protection Areas (Type A)	Dugong Protection Areas	DPA_TYPE = 'A'	SD
Plume line	GBRMPA plume	Outside plume	HEV

Note:

1. All draft status mapping subject to local review and revision based on water quality data, local technical studies and reporting, stakeholder inputs.

2. Review of additional layers (e.g. Fish Habitat B, Dugong Protection Area B, wetland mapping, DIWA, NRM body water quality planning, technical biodiversity assessments, Council planning scheme conservation zones, etc.) also informs mapping.

The Great Barrier Reef Marine Park Authority (GBRMPA) supplies a plume line which indicates estuarine and marine waters that are affected by flood plumes. All waters seaward of this line are designated as HEV and confirmed by review of respective water quality data. Marine waters landward of this line that otherwise meet the criteria for HEV designation are given the SD designation.

There is no default objective criteria for HD waters. Local water quality data / tests, regional studies and local consultation information will directly determine the location of SD areas, if any.

Where designations overlap, the rules are processed in the following order: HD, HEV, SD, and MD. Therefore if an area of HEV overlaps with an area of SD, then the resulting designation is HEV.

HEV, SD and HD waters are stipulated on the EPP Water schedule 1 map plans.

Waters that have not been assigned HEV, SD or HD under this process are assigned as MD. These are shown in the GIS layer (management intent feature class), but not highlighted on the EPP Water schedule 1 plans unless they have local WQOs different from other MD waters in the subcatchment (in which case they are identified as MD subzones).

Management intent areas are assigned an identifier. The identifier is prefixed with the management intent type, e.g. 'HEV' and the respective region number (Table 2).

Table 2 EPP (Water) region numbering classification

Region name	Region number
Southeast	1
Central Coast	2
Wet Tropics	3
Murray-Darling	4
Lake Eyre	5
Gulf Rivers	6

Each map is then assigned a range of three-digit numbers, resulting in an identifier with the following format: HEV1301. Typically, all areas with the same management intent in the same subcatchment will be given the same identifier. The management intent identifiers correspond with WQOs in the schedule document. If different WQOs apply to separate HEV areas within a subcatchment, more than one identifier may be used.

For some areas (SEQ and Fitzroy), a slightly different nomenclature was used for the management intent type in the past. This results in areas being designated as 'maintain' (HEVm) or 'achieve' (HEVa). This can be interpreted as HEV and SD respectively. Further, some areas were given a suffix of 'fw' or 'mar' for freshwater and marine respectively.

Feature class name: ENVHW.XX_EPP_MAN_INTENT_WATER

Fields:

Field name	Field description
MI_TYPE	Management intent type, e.g. HEV, SD, MD or HD
MI_ID	Management intent identifier, e.g. "HEV2385"

2.4 Water types

Draft water types are compiled according to the rules-based approach shown in Table 3 below.

Note: Not all water types are found in each waterway, catchment or region. For a more comprehensive definition and information on region-specific water types and the methods used to derive them, please refer to Appendix A.

Table 3 EPP (Water) types: rules-based approach to mapping (subject to local review and refinement)

Water group	Water type	Definition	Source name	Source location on SIR	Query
Fresh water	Upland	>150m elevation			
	Lowland	<150m elevation			
	Lakes / reservoirs		Queensland Wetland Data	SWS.QLD_WETLAND_AREAS	LEGEND = 'L_WB' AND WETLAND_AREA >=8
			Lakes Queensland	NAT.Waterbodies \ NAT.Lakes	DIMENSION >=80000
			Reservoirs Queensland	NAT.Waterbodies \ NAT.Reservoirs	DIMENSION >=80000
	Wetlands (palustrine)		Queensland Wetland Data	SWS.QLD_WETLAND_AREAS	WETCLASS = 'P'
	Wallum / Tannin	Sandy, tea coloured stained water, low pH coastal streams draining through Wallum vegetation	Queensland Wetland Data	SWS.QLD_WETLAND_AREAS	RE1 IN ('12.2.15', '12.2.9', '12.3.4', '12.3.4a', '12.3.5', '12.3.6', '12.3.14', '12.3.13', '12.2.6', '12.3.5', '3.3.66b', '3.2.27a')
			Queensland Regional Ecosystems Data	HERB.QLD_REG_ECO_REMNANT	WETRE IN ('12.2.15', '12.2.9', '12.3.4', '12.3.4a', '12.3.5', '12.3.6', '12.3.14', '12.3.13', '12.2.6', '12.3.5', '3.3.66b', '3.2.27a')

Water group	Water type	Definition	Source name	Source location on SIR	Query
Estuarine waters	Upper estuary	Upper 15 % of estuary length if total estuary length >15km and is not well flushed. Outside Wet Tropics. Upper 10% of estuary length if estuary length <15km and is not well flushed. Outside Wet Tropics.	Queensland Wetland Data	SWS.QLD_WETLAND_AREAS	WETCLASS = 'E' AND HAB_ = 'Estuarine - water' Manual edit for upper 15% and 10%.
	Middle estuary		Queensland Wetland Data	SWS.QLD_WETLAND_AREAS	WETCLASS = 'E' Manual edit to remove upper and lower estuary
	Lower estuary	Lower 10% of estuary length from mouth of river to inland estuary limit.	Queensland Wetland Data	SWS.QLD_WETLAND_AREAS	WETCLASS = 'E' AND HAB_ = 'Estuarine - water' Manual edit for lower 10%
	Tidal canals / constructed estuaries / marinas / boat harbours		Queensland Wetland Data	SWS.QLD_WETLAND_AREAS	WETCLASS = 'E' AND HYDROMOD_ = 'Artificial wetlands - channel, canal'
			Canal areas Queensland	NAT.Waterbodies\Nat.CanalAreas	
Marine waters	Enclosed coastal		Queensland Wetland Data	SWS.QLD_WETLAND_AREAS	WETCLASS = 'E' AND WETRE = 'estuary'
			GBRMPA Marine Water Bodies		MarineWate IN('Enclosed Coastal' , 'Macro Tidal Enclosed Coastal')
	Open coastal		Queensland Wetland Data	SWS.QLD_WETLAND_AREAS	WETCLASS = 'M' To limit of state waters
			GBRMPA Marine Water Bodies		MarineWate IN('Open Coastal', 'Macro Tidal Open Coastal')
	Midshelf		GBRMPA Marine Water Bodies		MarineWate = 'Midshelf'

Water group	Water type	Definition	Source name	Source location on SIR	Query
	Offshore		GBRMPA Marine Water Bodies		MarineWate = 'Offshore'

Feature class name: ENVHW.XX_EPP_WATERTYPES

Fields:

Field name	Field description
WATER_TYPE	Water type

3 Glossary

Acronym	Name
DIWA	Directory of Important Wetlands Australia
DNRME	Department of Natural Resources, Mines and Energy
EPP (Water)	Environmental Protection (Water) Policy 2009
EV	Environmental Value
GBRMPA	Great Barrier Reef Marine Park Authority
GIS	Geographic Information Systems
HD	Highly Disturbed
HEV	High Ecological Value
MD	Moderately Disturbed
NRM	Natural Resource Management
SD	Slightly Disturbed
QWQG	Queensland Water Quality Guidelines
WQO	Water Quality Objective

4 Appendix A - Definitions of water types according to Queensland Water Quality Guidelines (QWQG) 2009 and implemented to the EPP (Water) mapping program

The aim of defining water types is to create groupings within which water quality (or biological condition) is sufficiently consistent that a single guideline value can be applied to all waters within each group or water type, including:

- upland freshwaters;
- lowland freshwaters;
- lakes;
- wetlands (palustrine);
- estuaries; and
- marine – inshore and offshore.

The following definitions are provided to describe the water types adopted in the mapping products supporting the EPP (Water). Note that not all water types are found in each waterway, catchment or region.

The definitions include qualitative descriptions of each type, as well as default objective criteria to decide where the cut-offs are between different types. The objective criteria allow waters to be categorised according to the physical, chemical or biological attributes listed.

Note: For example, in the Queensland Murray-Darling Basin (QMDB), the water types established using the methods below were further refined to reflect the variations in water quality throughout the catchments. The water chemistry data from QMDB waters, in conjunction with local expert knowledge of soil type, geology, topography and rainfall, was used to delineate water type zones that best represent ecologically relevant spatial areas for key water quality parameters.

4.1 Freshwaters

This category includes all freshwaters except those that experience regular tidal influence. The tidally influenced waters are included in the upper estuary category, where present.

4.1.1 Upland freshwaters

Defined as all (freshwater) streams or stream sections above 150m.

Mapping source for this water type

A 150m contour surrogate is used to differentiate upland freshwaters from lowland freshwaters (i.e. waters above 150m are identified as upland freshwater). Mapping uses a ‘zonal’ approach to show all areas above 150m as upland freshwater. This allows for the capture of streams independently of the scale and quality of waterway/wetland mapping available, and the intent is that a water type ‘zone’ is to be interpreted as inclusive of all riverine waters within it.

4.1.2 Lowland freshwaters

Defined as all freshwater streams or stream sections below 150m.

Note: In the SEQ region, a region specific lowland sub-type (wallum/tannin freshwater) was integrated into the EPP (Water) mapping. Table 3 describes the rules-based approach for mapping this water type.

Mapping source for this water type

A 150m contour surrogate is used to differentiate lowland freshwaters from upland freshwaters (i.e. waters below 150m are identified as lowland freshwater). Mapping uses a ‘zonal’ approach to show all areas below 150m as lowland freshwater. This allows for the capture of streams independently of the scale and quality of waterway/wetland mapping available, and the intent is that a water type ‘zone’ be interpreted as including all riverine waters within it.

4.1.3 Lakes

For the purposes of this method the lacustrine system includes wetlands and deep water habitats with all of the following characteristics:

- situated in a topographic depression or dammed river channel;
- lacking trees, shrubs, persistent emergents, emergent mosses, or lichens with greater than 30 percent area coverage; and
- total area exceeds 8ha (20 acres).

Mapping source for this water type

Mapping is based on lacustrine systems identified in Queensland Wetlands Program, as updated by most recent DERME dams and weirs layer.

4.1.4 Wetlands (palustrine)

The palustrine system includes all non-tidal wetlands dominated by trees, shrubs, persistent emergents, emergent mosses or lichens, and all such wetlands that occur in tidal areas where salinity due to ocean-derived salts is below 0.5%. It also includes wetlands lacking such vegetation which have the following three characteristics:

(a) where active waves are formed or bedrock features are lacking;
(b) where the water depth in the deepest part of the basin is less than 2m at low water; and
(c) the salinity due to ocean-derived salts is still less than 0.5%.

Mapping source for this water type

Mapping of palustrine systems is not undertaken in waterway mapping under the QWQG/EPP (Water); however, considerable detail on these systems is provided in mapping by the Queensland Wetlands Program based on interpretation of satellite imagery, regional ecosystems and other data sources. Refer to WetlandInfo website for access to mapping data sets and products.

4.2 Estuaries

The following definition has been adopted for estuaries:

An estuary is:

(a) the mouth of a river where tidal effects are evident and where freshwater and seawater mix; and/or

(b) the part of a tidal river that widens out as it approaches the coastline; and/or

(c) a body of water semi-enclosed by land with sporadic access to water from the open ocean, and where ocean water is at least occasionally diluted by freshwater runoff from land; and/or

(d) a body of water where salinity is periodically increased by evaporation to a level above that of the open ocean (such a water body is termed a reverse estuary).

This definition is open to some degree of interpretation and therefore some more precise delineation of the upper and lower boundaries is provided below. For estuaries, there is sufficient local water quality data in some regions to distinguish multiple water types within the ANZECC 2000 Guidelines base estuary type. These include upper estuary, middle estuary and enclosed coastal/lower estuary.

4.2.1 Limits of estuaries

Upstream limit of estuary

For the purposes of this document, the upstream boundary of the estuary is taken as the upstream limit of tidal influence at mean high water spring (MHWS). This is the primary definition. The MHWS is the theoretical upstream limit for the mixing of salt water (see (a) above). However, in some large estuaries, slow rates of mixing and the constant inflow of freshwater means there is a permanent body of freshwater in the upper tidal reaches. This creates an anomaly if estuaries are taken to be where salt and freshwater mix. However, for water quality purposes, the tidal upper reaches are much more akin to an estuarine environment than a riverine environment.

If the MHWS mark is not defined for an estuary, the following surrogates are used:

- the inland extent of the estuary as shown in Queensland Wetlands Program mapping;
- the declared downstream limit (DDL) or coastal management district (CMD) lines (officially determined estuary/freshwater cut-offs);
- a barrier or barrage that prevents movement of any saline waters upstream;
- the upstream extent of the saline vegetation distribution along a stream;
- the limit of saltwater influence as determined by water quality (salinity or conductivity) measurements; and
- local hydrological studies to estimate the MHWS mark.

Mapping source for estuarine water type (including sub-types)

Mapping uses a stream network derived from Geoscience Australia, with base stream layer varying according to the region under consideration. Cut-offs between estuarine sub-types (upper – mid – lower) are based on the processes outlined in this Appendix.

4.2.2 Upper estuary

This is the most upstream of all estuarine waters. In the uppermost reaches of some estuaries, there is a stagnant, lake-like zone that has limited flushing from either freshwater inflows or tidal exchange. Water in this zone typically has a long residence time, moving backwards and forwards in much the same place with successive tides. Water quality in this zone is naturally poorer – as a result of poor flushing – than in the better-flushed downstream areas, and would often fail guideline values appropriate to the main body of the estuary.

Upper estuary zones only apply to some estuaries. For example, they do not apply to Wet Tropics streams, where there are generally substantial freshwater flows resulting in rapid flushing of the uppermost estuarine areas. In other regions the presence or absence of an upper estuarine zone should be determined on a case-by-case basis. An upper estuary is typically present only in long estuaries, or in shorter estuaries with low freshwater inputs and weak tidal flushing. The decision tree below (Figure 2) can be used to determine whether an upper estuarine zone is present in any particular stream.

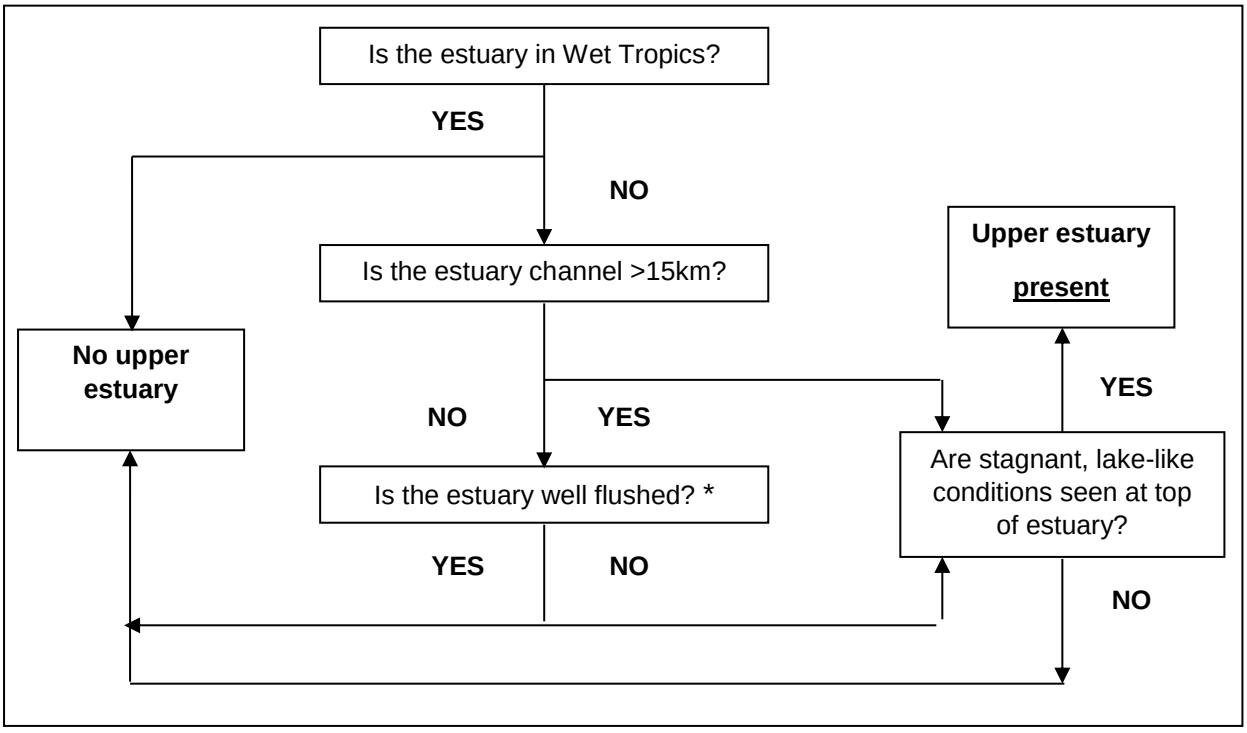

Figure 2: Upper estuary presence/absence decision tree

Note: *: Well flushed refers to typical freshwater inflows greater than 0.2 cumecs and/or tidal range greater than 2.5m.

Source: Adapted from Department of Environment and Heritage Protection (2009) *Queensland Water Quality Guidelines*, Version 3, ISBN 978-0-9806986-0-2. Queensland Government. Re-published July 2013

Guidelines for upper estuaries allow for poorer water quality than guidelines for the other estuarine zones because water quality is naturally poorer in upper estuaries. Therefore, if there is a lack of information, or doubt about whether an estuary has an upper estuarine zone after following the decision tree in Figure 2, the default approach should be that there is no upper estuarine zone. This conservative approach will ensure that middle estuarine sites, which should have better water quality, are not compared to upper estuarine guidelines, which would allow poorer water quality in the middle estuary than is appropriate.

Upstream limit of upper estuary

The upper limit of the upper estuary is the upper limit of the whole estuary, as defined above.

Lower limit of upper estuary

For a stream where an upper estuary is present, the length of the upper estuary should be determined by observation and/or local hydrological studies. The aim of such studies should be to identify a cut-off at a certain distance downstream from the top of the estuary, above which there is a noticeable increase in stagnant, lake-like conditions, or water-residence time. That cut-off would mark the boundary between the upper and middle estuarine water types.

In the absence of any local studies to define the cut-off, in estuaries where an upper estuary zone is deemed to be present, the default length of the upper estuary zones for these guidelines is the upper 15 percent of the channel length of long estuaries (>15 km), or the upper 10 percent of the channel length of short estuaries (<15 km). For long estuaries, the default proportion of the overall channel length comprising the upper estuary is higher, because there is greater dissipation of tidal energy away from the coast. Therefore, there is generally a larger zone at the top of long estuaries where tidal water movement is restricted.

For these guidelines any estuarine sections of tributaries that drain into an upper estuarine zone of the main estuary channel are themselves defined as upper estuarine.

4.2.3 Middle estuary

The middle-estuary water type covers the majority of the length of most estuaries. The middle estuary begins below the upper estuary, if present, or from below the freshwater/estuarine cut-off if there is no upper estuarine zone. The mid-estuarine zone extends downstream to near the mouth of the estuary at the coast. It excludes the small section just upstream from and including, the mouth that is well flushed each tide with incoming marine waters. The middle estuary has a moderate amount of water movement and salt and fresh water mixing.

Upstream limit of middle estuary

For long or poorly flushed estuaries with an upper estuarine zone, the top of the middle estuary is the lower limit of that upper estuarine zone.

For short or well flushed estuaries, with no upper estuarine zone, the upper limit of the middle estuary corresponds to the upper limit of the whole estuary.

Lower limit of middle estuary

The lower limit of the middle estuary is essentially a boundary between estuarine waters that have a significant residence time within the estuary, and those waters near the mouth of the estuary that are rapidly exchanged with adjacent coastal waters. The degree and rapidity of exchange between the estuary and the marine dominated coastal water is the principal driver of differences in water quality. The influence of freshwater inflows on the estuary is also a factor, in that these have more impact in the main body of the estuary than in the well flushed areas near the mouth of the estuary.

The most direct and appropriate way to define such a boundary would be on the basis of hydrodynamic modelling of the exchange between coastal and estuary waters. However, in most situations, such models are not available and therefore surrogate approaches are required. One such approach is the use of a salinity boundary.

- Mid estuarine waters – salinity equivalent to full marine salinity (approximately 34–36 parts per thousand, or an electrical conductivity of approximately 52–54 mS/cm) for <20% of the time; and
- Enclosed coastal/lower estuarine waters – salinity equivalent to full marine salinity (approximately 34–36 parts per thousand, or an electrical conductivity of approximately 52–54 mS/cm) for >20% of the time.

Where estuaries flow into coastal water bodies that do not have fully marine salinities (for example, narrow straits or enclosed bays) the salinity cut-off may actually occur below the mouth of the main estuary channel, out in the coastal water zone.

In most estuaries, the enclosed coastal/lower estuarine zone would not extend further than 10 per cent of the total length of the main estuary channel regardless of the salinity. In small estuaries or those with significant natural barriers near the mouth (e.g. a well-developed bar), the boundary would be closer to the estuary mouth. In estuaries flowing into very enclosed coastal waters, the boundary may be set beyond the mouth of the main estuary channel.

Tributaries entering the middle estuary

For these guidelines, any estuarine sections of tributaries that drain into a mid-estuarine zone of the main estuary channel are themselves defined as mid-estuarine.

Some tributaries of the main estuary channel may also have an upper estuarine zone. The criteria for deciding whether there is an estuary, and where the mid-estuarine/upper estuarine cut-off lies, are the same as those above. The length of the estuarine section of such tributaries is the distance from the mouth at the main estuary channel to the estuarine/freshwater cut-off.

Tidal canals, constructed estuaries, marinas and boat harbours

For these guidelines, tidal canals, constructed estuaries, marinas and boat harbours adjacent to mid estuary waters have water quality characteristics in common with the corresponding mid-estuary waters. Water characteristics of these waters depend on their characteristics and location, and may be more in common with other estuary or coastal water types (subject to review of local data and consultation). Depending on the region, these may be shown as a distinct water type (for example in the Gold Coast).

4.2.4 Enclosed coastal / lower estuary

Enclosed coastal / lower estuarine waters lie at or near the mouth of an estuary channel, and are frequently subject to some degree of residual mixing with inflowing fresh water. As such, they fall within the broad definition of an estuary. They include shallow coastal waters in straits or enclosed bays adjacent to the mouth of inflowing streams or estuaries. They also include the most downstream reach of the main channel of the estuary, which exchanges with coastal waters on every tide.

Upstream limit of enclosed coastal/lower estuary

The upper limit of the enclosed coastal water type is the lower limit of the middle estuary. This is typically a short distance upstream of the mouth of the main estuary channel.

Lower (seaward) limit of enclosed coastal/lower estuary

The lower limit of the enclosed coastal water type is the cut-off between shallow, enclosed waters near the estuary mouth and deeper, more oceanic waters further out. For estuaries that flow directly into open oceanic waters or for passages (e.g. Pumicestone Passage), the lower limit for these guidelines is defined as the mouth of the estuary or passage, enclosed by adapting the semicircle bay rule (6.1, Article 7, *Maritime Limits and Baselines*, 1978). The semicircle rule adapted to close a passage or estuary is:

'*A passage or estuary is closed by a semicircle, with its diameter at the natural entrance(s) to the passage or estuary, drawn to extend beyond the entrance(s).*'

- Generally, the entrance is defined by the downstream limits of the drainage catchment of the passage or estuary (the heads). Where the heads are undefined, the catchment limits will need to be estimated using other landscape elements.
- Within an enclosed bay or strait, the lower limit may be much further out from the mouth, depending on local hydrological and topographic conditions.
- For estuaries flowing into an enclosed bay or strait, the lower limit of the enclosed coastal water type should ideally be determined by site-specific studies.

If absolutely no additional information is available, the default lower limit may be based on the more landward boundary of:

- the seaward extent of the estuary shown in Queensland Wetlands Program mapping, or
- the 6m depth contour below lowest astronomical tide (LAT). This marks the outward extent of coastal wetlands according to the Ramsar wetland definition which was amended in 2003 to include*: 'may incorporate riparian and coastal zones adjacent to wetlands, and islands or bodies or marine water deeper than six metres at low tide lying within the wetlands*.'

Tributaries entering the lower estuary

For these guidelines, any estuarine sections of tributaries that drain into a lower estuarine zone of the main estuary channel are defined as lower estuary.

Some tributaries of the main estuary channel may also have a middle estuarine zone. The criteria for deciding whether there is an estuary, and where the lower estuary/middle estuary cut-off lies, are the same as those outlined in mid and upper estuary sections above. The length of the estuarine section of such tributaries is the distance from the mouth at the main estuary channel to the estuarine/freshwater cut-off.

4.3 Marine waters

Marine waters are part of the ocean, which covers almost three-quarters of the earth's surface. They extend out from, or near, the coastline. They have a uniform salinity of about 34–36 parts per thousand (52–54 mS/cm conductivity), and are not influenced by terrestrial freshwater inputs, except during large flood events.

4.3.1 Open coastal waters

Open coastal waters include all coastal waters except those with some residual influence from inflowing streams (enclosed coastal waters). Therefore, open coastal waters extend outwards from the outer limit of enclosed coastal waters, or directly out from the coastline if there are no enclosed coastal waters nearby, to the three nautical mile limit of the state.

The Great Barrier Reef Marine Park Authority (GBRMPA) Guidelines define four water types for waters offshore from the enclosed coastal zone. See next section for detail.

4.3.2 Great Barrier Reef Marine Park water types

The whole of this section is an extract from the GBRMPA Guidelines that describes the water types or bodies that have been defined for the GBR Marine Park and implemented to the EPP (Water) mapping program. It includes further description of the demarcation between the QWQG and the GBRMPA guidelines.

Following the GBRMPA guidelines, five distinct water bodies have been defined:

- enclosed coastal
- open coastal
- midshelf
- offshore
- the Coral Sea.

The approximate distances of the water body delineations for each of the natural resource management regions are discussed in the following paragraphs, and are presented in Table 4.

Table 4 Great Barrier Reef Marine waters: Approximate water body delineations of open coastal, midshelf and offshore marine water bodies

NRM region	Open coastal *(km)*	Midshelf *(km)*	Offshore *(km)*
Burnett-Mary	EC* - 7	7 - 28	28 - 270
Fitzroy	EC* - 20	20 -80	80 – 340
Mackay-Whitsunday	EC* - 15	15 – 60	60 – 280
Burdekin	EC* - 12	12 – 48	48 – 180
Wet Tropics	EC* - 6	6 – 24	24 – 170
Cape York	EC* - 6	6 - 24	24 - 250

EC The seaward edge of the enclosed water body as described above.*

Source: Adapted from Water Quality Guidelines for the Great Barrier Reef Marine Park. Great Barrier Reef Marine Park Authority, Townsville. Revised edition, 2010

4.4 Groundwaters

Groundwater types are defined by zones of similar groundwater chemistry divided into aquifer types; three sub-artesian types to represent alluvial and fractured rock systems, and the overlying deposits. Due to the complex organisation of layered and interfingering aquifers and aquitards, a range of different layers can be developed to represent the underlying structure of specific artesian basins.

For a more comprehensive definition and information on groundwater types mapping and their derivation methods please refer to the 'Regional groundwater chemistry zones: Queensland Murray-Darling Basin 2017' report.