

# Default Guideline Values (DGVs) for Aquatic Ecosystems of the Welcome Catchment

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## Introduction

Water quality management, determination of water quality guideline values, and the setting of water quality objectives is guided by the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2018 (ANZG 2018)* and the *National Water Quality Management Strategy 1994 (NWQMS)*.

The *State Policy on Water Quality Management 1997 (SPWQM)* establishes a framework that is compatible and consistent with these national guidelines.

The default guideline values (DGVs) for aquatic ecosystems presented herein have been derived for the Welcome Catchment in accordance with the *NWQMS*.

## Protected Environmental Values (PEVs) – Community Values

As part of the implementation of the State Policy, protected environmental values for inland waters were determined through extensive stakeholder consultation and identification of community values and uses. The PEVs for inland waters were set for 22 areas on the basis of catchment boundary or municipal boundary. These are available via the [EPA website](#).

The current PEVs for inland waters for the protection of aquatic ecosystems provide options for both pristine and modified systems:

### A: Protection of Aquatic Ecosystems

- (i) Pristine or nearly pristine ecosystems

(Having regard for the management objectives for nature recreation areas, conservation areas and game reserves outlined in Schedule 4 of the *National Parks and Wildlife Act 1970*.)

OR

- (ii) Modified (not pristine) ecosystems
  - (i) from which edible fish, shellfish and crustacea are harvested

OR

- (ii) from which edible fish, shellfish and/or crustacea are not harvested

### B. Recreational Water Quality & Aesthetics

- (i) Primary contact water quality (specify sites)
- (ii) Secondary contact water quality
- (iii) Aesthetic water quality

### C. Raw Water for Drinking Water Supply

- (i) Subject to coarse screening plus disinfection

### D. Agricultural Water Uses

- (i) Irrigation
- (ii) Stock watering

### E. Industrial Water Supply

That is, as a minimum, water quality management strategies should seek to provide water of a physical and chemical nature to support a pristine/modified aquatic ecosystem from which edible fish, crustacea and shellfish may be harvested; that is suitable as a raw water for drinking water supply subject to coarse screening plus disinfection; that is acceptable for irrigation and stock watering purposes; which will allow people to safely engage in primary contact recreation activities such as swimming at specific sites (refer to Appendix B) and secondary contact recreation activities such as paddling or fishing in aesthetically pleasing waters; and which is suitable for industrial water supply, e.g., use by aquaculture (shellfish farms) in marine farming zones.

For a detailed explanation on the PEVs as they relate to land tenure and a spatial presentation of the land tenure refer to the [Environmental Management Goals for Tasmanian Surface Waters Catchments within the Circular Head and Waratah/Wynyard Municipal Areas January, 2000](#) and [PEVs map](#), respectively.

## Default Guideline Values

Guideline values apply to key indicators and are numerical concentrations or descriptive statements recommended for the support and maintenance of the designated water use or value, i.e. the Protected Environmental Value (PEV).

Tasmania refers to the following national level guideline values for the relevant key indicators.

- [Water Quality management Framework](#)
- [Toxicant DGVs in freshwater and marine water](#)
- [Water quality for primary industries](#)
- [Australian guidelines for water recycling](#)
- [Australian Drinking Water guidelines](#)
- [Guidelines for Managing Risks in Recreational water](#)
- [Cultural and spiritual values of waterways](#)
- [Food Standards](#)

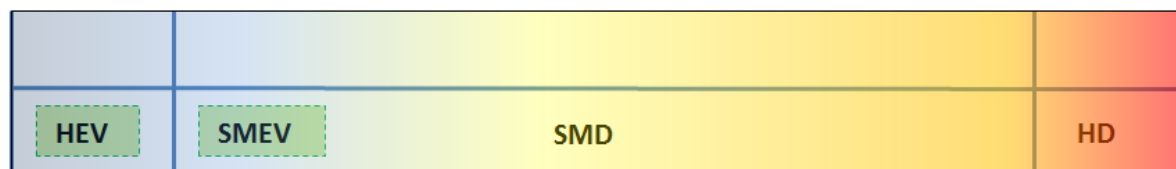
The primary focus within Tasmania has been the derivation of guideline values for Aquatic Ecosystems based on Tasmanian data for key indicators of interest. This is as the protection of aquatic ecosystems is a PEV common to all water types. In addition, the trigger values for aquatic ecosystems from the ANZECC 2000 water quality guidelines were based on a very limited quantity of Tasmanian data.

## Ecosystem Condition

The ANZG 2018 provides a framework for developing water quality guideline values based on the water type, health of aquatic ecosystems or ecosystem condition. Ecosystem condition can be viewed as a continuum ranging from natural to highly disturbed or artificial. The ANZG 2018 identifies three broad categories of ecosystem: High Ecological Value (HEV), Slightly to Moderately Disturbed (SMD) and Highly Disturbed (HD). To better characterise Tasmanian ecosystems the SMD category has been further divided into Slightly Modified Ecological Value (SMEV) and Moderately Disturbed (MD) (Figure 1).

For the decision process and selection criteria for identifying ecosystem condition refer to the EPA document, [Technical Guidance for Water Quality Objectives \(WQOs\) Setting for Tasmania](#).

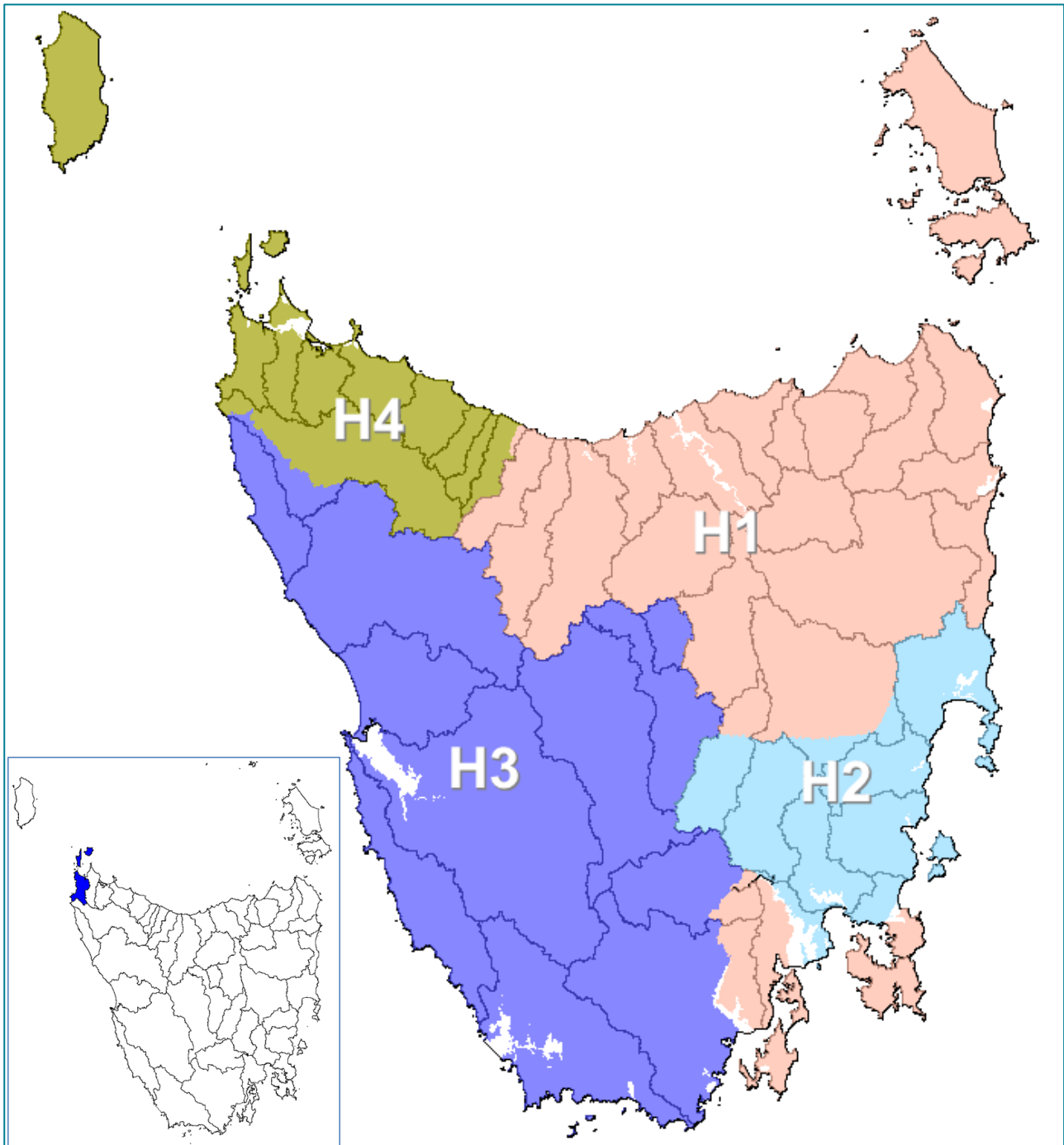
### Ecosystem condition continuum



**Figure 1.** Ecosystem condition continuum showing HEV and SMEV reference categories.

## Regionalisation of inland waters by Surface Water Catchment

The state water quality DGVs for aquatic ecosystems are based on data from across the entire state. To refine this a hydrological regionalisation approach as been adopted that is based on river flow information (Hughes, 1987). This has been further refined by regionalisation based on surface water catchment. The hydrologically distinct groupings (Figure 2). Links to regional documents are provided in and the associated surface water catchments are listed in Table I.



**Figure 2.** Hydrological regions (Hughes, 1987) and topographic catchments (Welcome highlighted on inset).

**Table 1. Hydrological region and associated catchments**

Hydrological Region	Catchment
<u>Hydrological Region 1 (H1)</u>	The Leven, Mersey, Meander, Rubicon, Tamar Estuary, Brumbys-Lake, South Esk, North Esk, Pipers, Little Forester, Great Forester-Brid, Ringarooma, Boobyalla-Tomahawk, George, Great Musselroe-Ansons, and Scamander-Douglas catchments are entirely within the H1 hydrological region. The Macquarie, Tasman, Huon, Clyde, Lower Derwent and Derwent Estuary-Bruny catchments are deemed to be partly within the H1 and partly within the H3 or H2 Hydrological regions.
<u>Hydrological Region 2 (H2)</u>	The Swan-Apsley, Little Swanport, Prosser, Pitt water-Coal and Jordan catchments are entirely within the hydrological region. The Tasman, Derwent Estuary – Bruny, Clyde and Macquarie catchments are deemed to be partly within the H2 and partly within the H1 Hydrological region. The Lower Derwent catchment is predominantly within the H3 region, but also has river sections that have been deemed to belong to the H1 and H2 hydrological regions. The river sections of the Lower Derwent catchment belonging to the H2 hydrological region are between Upper Dromedary and Bridgewater.
<u>Hydrological Region 3 (H3)</u>	The Ouse, Great Lake, Upper Derwent, Gordon-Franklin, Port Davey, Wanderer-Giblin, King-Henty and Pieman catchments are entirely within the hydrological region. The Huon and Lower Derwent catchments are predominately within H3 but also partly within the H1 hydrological region. While the Arthur catchment is only partly within H3 and predominantly within the H4 hydrological region.
<u>Hydrological Region 4 (H4)</u>	The Blythe, Emu, Cam, Inglis-Flowerdale, Black-Detention, Duck, Montagu, Welcome and King Island catchments are entirely within the hydrological region. The Arthur catchment is deemed to be predominantly within the H4 and only partly within the H3 hydrological region.

### Deriving DGVs for aquatic ecosystems of the Welcome Catchment

For the development of water quality DGVs no sites were available with the Welcome Catchment and for this reason sites within the H4 hydrological region were used. Within the H4 hydrological region a total of 25 locations were used. Of these 8 sites were within the HEV ecosystem category, and 17 sites are within the SMD ecosystem category. For the development of biological DGVs no sites were available within the Welcome Catchment and for this reason biological information was used from 26 sites across Hydrological Region 4. Of these 17 sites were within the HEV ecosystem category and 9 within the SMD ecosystem category.

The parameters or indicators measured at a site are dependent on the water type and the question being asked by the monitoring program. For inland water the indicators that were widely monitored (spatially and temporally) were selected for the derivation of DGVs for aquatic ecosystems (Table 2.).

**Table 2. Indicators for which DGVs were derived for inland waters**

Water Type	Indicator
Inland	<ul style="list-style-type: none"> <li>• Physico-chemical: Dissolved Oxygen, Conductivity pH, Turbidity and, Water Temperature.</li> <li>• Nutrients: TAN (NH<sub>3</sub> and NH<sub>4</sub><sup>+</sup>), Nitrate, Nitrite, Total Nitrogen, Dissolved Reactive Phosphorus, Total Phosphorus and, Total Suspended Solids (TSS).</li> <li>• Biological: AUSRIVSA Band, OE50, OE50Signal, Signal Index, Taxon Diversity, EPT Diversity, and Macroinvertebrate Composition, Fish O/E, Fish O/P, Proportion native fish abundance, proportion native fish species, proportion native biomass, Chlorophyll a, algal cover and riparian shading*</li> </ul>

Where possible water quality data collected at times of no flow or during times of flood (over bank full) have been excluded in the derivation of the water quality DGVs. On this basis it can be taken that the WQ DGVs represent base flow conditions, i.e. flow conditions that occur 98 percent of the time within waterways. For the decision process and selection criteria for identifying flow conditions refer to the EPA document, [Technical Guidance for Water Quality Objectives \(WQOs\) Setting for Tasmania](#).

The minimum sample number required to determine percentile values with at least 95% confidence for WQ DGVs are as follows: 6 samples for 50<sup>th</sup> percentile; 14 samples for 20<sup>th</sup> and 80<sup>th</sup> percentiles; 29 samples for 10<sup>th</sup> and 90<sup>th</sup> percentiles; and 35 samples for 5<sup>th</sup> and 95<sup>th</sup> percentiles. In instances where there is insufficient data for a given key indicator the national WQ DGVs can be used.

For biological indicators a minimum of six combined season AUSRIVAS outputs have been used to generate percentile values to provide a level of statistical robustness for biological DGVs. For details on biological indicators for inland waters refer to the EPA document, [Technical Guidance for Water Quality Objectives \(WQOs\) Setting for Tasmania](#)

The tables overleaf of physico-chemical indicators report the DGVs for aquatic ecosystems of the Welcome Catchment (shaded values) for HEV and SMD ecosystem categories on an annual and seasonal basis. Additional percentile values have been included for comparative purposes. The DGVs are summarised in Appendix A.



## HEV DGVs for aquatic ecosystems of the Welcome Catchment

The HEV water quality DGVs (Tables 3 to 7 shaded values) have been derived from 8 HEV sites across the H4 region.

**Table 3 Full year**

Parameter	5 <sup>th</sup> %ile	10 <sup>th</sup> %ile	20 <sup>th</sup> %ile	Median	80 <sup>th</sup> %ile	90 <sup>th</sup> %ile	95 <sup>th</sup> %ile	Sample Number
Dissolved Oxygen mg/L <sup>^</sup>	6.9	7.8	8.7	9.9	10.9	11.4	11.9	439
Dissolved Oxygen % Saturation <sup>^</sup>	56.2	65.7	78.4	94.7	100.4	102.6	106.7	68
Field Cond @ TRef25 µS/cm <sup>^</sup>	58.2	66.5	75.0	101.6	178.6	357.3	462.6	428
pH field - sensor TC <sup>^</sup>	4.6	4.8	5.3	6.6	7.2	7.4	7.7	439
Turbidity NTU <sup>^</sup>	1.6	1.9	2.4	4.1	8.8	15.0	21.4	447
Temperature (Celsius) <sup>^</sup>	6.8	7.6	8.7	11.0	14.0	15.9	16.6	448
TAN as N mg/L <sup>^</sup>	0.014	0.017	0.021	0.033	0.051	0.071	0.096	38
Nitrate as N mg/L <sup>^</sup>	0.021	0.025	0.042	0.082	0.136	0.173	0.269	54
Nitrite as N mg/L <sup>^</sup>	0.001	0.001	0.002	0.004	0.008	0.010	0.010	38
Total Nitrogen as N mg/L <sup>^</sup>	0.025	0.025	0.197	0.549	0.706	0.842	0.991	95
Phosphorus, Dissolved Reactive as P mg/L <sup>^</sup>	0.001	0.001	0.002	0.003	0.004	0.004	0.005	38
Total Phosphorus as P mg/L <sup>^</sup>	0.006	0.007	0.009	0.013	0.025	0.069	0.102	93
Total Suspended Solids (1.5µm) mg/L <sup>^</sup>	5.000	5.000	5.000	5.000	5.000	5.000	5.000	15
Total Suspended Solids (0.45µm) mg/L <sup>*</sup>	0.500	0.500	0.500	0.500	3.000	7.000	10.150	358

\* State derived values, <sup>^</sup>Hydrological region values, TAN=Total Ammonia Nitrogen (NH<sub>3</sub> and NH<sub>4</sub><sup>+</sup>).

**Table 4 Summer**

Parameter	5 <sup>th</sup> %ile	10 <sup>th</sup> %ile	20 <sup>th</sup> %ile	Median	80 <sup>th</sup> %ile	90 <sup>th</sup> %ile	95 <sup>th</sup> %ile	Sample Number
Dissolved Oxygen mg/L <sup>^</sup>	5.7	6.8	7.6	9.1	10.0	10.2	10.7	117
Dissolved Oxygen % Saturation <sup>^</sup>	58.0	73.9	89.7	98.2	104.5	111.0	114.9	16
Field Cond @ TRef25 µS/cm <sup>^</sup>	55.1	61.0	75.0	100.9	172.3	352.0	474.5	111
pH field - sensor TC <sup>^</sup>	4.8	5.0	5.6	6.9	7.4	7.7	7.8	117
Turbidity NTU <sup>^</sup>	1.5	1.7	2.3	3.8	7.1	11.3	15.5	117
Temperature (Celsius) <sup>^</sup>	11.0	11.6	12.7	14.5	16.6	17.5	18.3	117
TAN as N mg/L <sup>^</sup>	0.008	0.013	0.019	0.025	0.048	0.055	0.056	8
Nitrate as N mg/L <sup>^</sup>	0.060	0.075	0.081	0.127	0.172	0.193	0.253	14
Nitrite as N mg/L <sup>^</sup>	0.001	0.001	0.001	0.004	0.007	0.007	0.007	8
Total Nitrogen as N mg/L <sup>^</sup>	0.025	0.047	0.195	0.589	0.662	0.764	0.792	25
Phosphorus, Dissolved Reactive as P mg/L <sup>^</sup>	0.001	0.002	0.002	0.003	0.005	0.005	0.006	8
Total Phosphorus as P mg/L <sup>^</sup>	0.010	0.010	0.011	0.018	0.024	0.025	0.077	25
Total Suspended Solids (1.5µm) mg/L <sup>^</sup>	5.000	5.000	5.000	5.000	5.000	5.000	5.000	4
Total Suspended Solids (0.45µm) mg/L <sup>*</sup>	0.500	0.500	0.500	0.500	3.000	7.000	8.000	101

\* State derived values, <sup>^</sup>Hydrological region values, TAN=Total Ammonia Nitrogen (NH<sub>3</sub> and NH<sub>4</sub><sup>+</sup>).

**Table 5 Autumn**

Parameter	5 <sup>th</sup> %ile	10 <sup>th</sup> %ile	20 <sup>th</sup> %ile	Median	80 <sup>th</sup> %ile	90 <sup>th</sup> %ile	95 <sup>th</sup> %ile	Sample Number
Dissolved Oxygen mg/L <sup>^</sup>	6.4	7.4	8.3	9.8	10.6	11.2	11.8	109
Dissolved Oxygen % Saturation <sup>^</sup>	37.4	53.1	64.2	92.6	101.3	103.7	105.1	16
Field Cond @ TRef25 $\mu$ S/cm <sup>^</sup>	61.0	68.8	84.8	111.4	187.6	485.7	507.1	112
pH field - sensor TC <sup>^</sup>	5.0	5.2	5.6	6.8	7.2	7.5	7.6	114
Turbidity NTU <sup>^</sup>	1.4	1.8	2.3	4.0	7.3	12.1	22.0	118
Temperature (Celsius) <sup>^</sup>	8.0	8.6	9.2	11.1	13.1	13.8	15.3	118
TAN as N mg/L <sup>^</sup>	0.017	0.020	0.025	0.037	0.070	0.088	0.136	10
Nitrate as N mg/L <sup>^</sup>	0.016	0.022	0.026	0.077	0.130	0.208	0.289	14
Nitrite as N mg/L <sup>^</sup>	0.001	0.002	0.003	0.004	0.007	0.009	0.010	10
Total Nitrogen as N mg/L <sup>^</sup>	0.025	0.095	0.133	0.540	0.643	0.774	0.842	32
Phosphorus, Dissolved Reactive as P mg/L <sup>^</sup>	0.001	0.001	0.002	0.003	0.004	0.004	0.005	10
Total Phosphorus as P mg/L <sup>^</sup>	0.007	0.008	0.009	0.014	0.029	0.047	0.106	32
Total Suspended Solids (1.5 $\mu$ m) mg/L <sup>^</sup>	5.000	5.000	5.000	5.000	5.000	5.000	5.000	3
Total Suspended Solids (0.45 $\mu$ m) mg/L <sup>*</sup>	0.500	0.500	0.500	0.500	5.000	7.600	17.300	95

\* State derived values, <sup>^</sup>Hydrological region values, TAN=Total Ammonia Nitrogen (NH<sub>3</sub> and NH<sub>4</sub><sup>+</sup>).

**Table 6 Winter**

Parameter	5 <sup>th</sup> %ile	10 <sup>th</sup> %ile	20 <sup>th</sup> %ile	Median	80 <sup>th</sup> %ile	90 <sup>th</sup> %ile	95 <sup>th</sup> %ile	Sample Number
Dissolved Oxygen mg/L <sup>^</sup>	8.6	9.4	9.7	10.6	11.6	11.9	12.1	113
Dissolved Oxygen % Saturation <sup>^</sup>	69.5	73.4	77.0	89.6	95.3	97.4	98.5	18
Field Cond @ TRef25 $\mu$ S/cm <sup>^</sup>	64.2	70.1	75.7	97.9	216.6	330.1	360.3	108
pH field - sensor TC <sup>^</sup>	4.3	4.5	4.8	6.2	6.8	7.1	7.2	113
Turbidity NTU <sup>^</sup>	1.6	2.0	2.7	4.2	11.0	17.8	29.7	112
Temperature (Celsius) <sup>^</sup>	5.6	6.5	7.0	8.6	9.9	10.6	11.2	113
TAN as N mg/L <sup>^</sup>	0.013	0.017	0.021	0.033	0.055	0.089	0.113	11
Nitrate as N mg/L <sup>^</sup>	0.022	0.027	0.036	0.054	0.091	0.128	0.129	11
Nitrite as N mg/L <sup>^</sup>	0.001	0.001	0.002	0.003	0.008	0.010	0.012	11
Total Nitrogen as N mg/L <sup>^</sup>	0.025	0.025	0.100	0.600	0.825	0.952	1.158	23
Phosphorus, Dissolved Reactive as P mg/L <sup>^</sup>	0.002	0.002	0.002	0.002	0.004	0.004	0.004	11
Total Phosphorus as P mg/L <sup>^</sup>	0.004	0.005	0.006	0.010	0.065	0.097	0.106	21
Total Suspended Solids (1.5 $\mu$ m) mg/L <sup>^</sup>	5.000	5.000	5.000	5.000	5.000	5.000	5.000	5
Total Suspended Solids (0.45 $\mu$ m) mg/L <sup>*</sup>	0.500	0.500	0.500	0.500	3.000	4.700	8.350	74

\* State derived values, <sup>^</sup>Hydrological region values, TAN=Total Ammonia Nitrogen (NH<sub>3</sub> and NH<sub>4</sub><sup>+</sup>).

**Table 7 Spring**

Parameter	5 <sup>th</sup> %ile	10 <sup>th</sup> %ile	20 <sup>th</sup> %ile	Median	80 <sup>th</sup> %ile	90 <sup>th</sup> %ile	95 <sup>th</sup> %ile	Sample Number
Dissolved Oxygen mg/L <sup>^</sup>	8.2	8.5	8.9	10.3	10.9	11.4	12.0	100
Dissolved Oxygen % Saturation <sup>^</sup>	58.0	72.7	79.7	95.1	98.5	100.6	101.5	18
Field Cond @ TRef25 $\mu$ S/cm <sup>^</sup>	54.0	61.5	72.3	93.0	170.8	313.0	373.6	97
pH field - sensor TC <sup>^</sup>	4.7	4.8	5.2	6.4	7.0	7.3	7.6	95
Turbidity NTU <sup>^</sup>	1.7	2.2	2.7	4.2	11.7	15.6	19.6	100
Temperature (Celsius) <sup>^</sup>	7.2	7.8	8.9	10.7	12.6	14.3	15.5	100
TAN as N mg/L <sup>^</sup>	0.022	0.023	0.024	0.031	0.043	0.044	0.044	9
Nitrate as N mg/L <sup>^</sup>	0.023	0.032	0.046	0.067	0.087	0.131	0.251	15
Nitrite as N mg/L <sup>^</sup>	0.003	0.003	0.004	0.007	0.009	0.010	0.011	9
Total Nitrogen as N mg/L <sup>^</sup>	0.274	0.395	0.496	0.533	0.717	0.975	1.250	15
Phosphorus, Dissolved Reactive as P mg/L <sup>^</sup>	0.001	0.002	0.002	0.003	0.004	0.004	0.005	9
Total Phosphorus as P mg/L <sup>^</sup>	0.004	0.005	0.007	0.012	0.018	0.025	0.084	15
Total Suspended Solids (1.5 $\mu$ m) mg/L <sup>^</sup>	5.000	5.000	5.000	5.000	5.000	5.000	5.000	3
Total Suspended Solids (0.45 $\mu$ m) mg/L <sup>*</sup>	0.500	0.500	0.500	0.500	3.000	6.000	9.650	88

\* State derived values, <sup>^</sup>Hydrological region values, TAN=Total Ammonia Nitrogen (NH<sub>3</sub> and NH<sub>4</sub><sup>+</sup>).

The HEV biological DGVs detailed in Table 8 have been derived from 17 HEV sites across the H4 Region.

**Table 8 Data Summary and biological DGVs (shaded) for HEV ecosystems of the Welcome Catchment**

Parameter	5 <sup>th</sup> %ile	10 <sup>th</sup> %ile	20 <sup>th</sup> %ile	Median	80 <sup>th</sup> %ile	90 <sup>th</sup> %ile	95 <sup>th</sup> %ile	Sample Number
AUSRIVAS Band# <sup>^</sup>	B	A	A	A	A	X	X	37
OE50# <sup>^</sup>	0.85	0.88	0.92	1.05	1.13	1.14	1.15	37
OE50Signal# <sup>^</sup>	0.96	0.97	0.98	0.99	1.00	1.01	1.02	37
Signal Index <sup>^</sup>	5.7	5.8	5.9	6.2	6.4	6.4	6.5	37
Taxon Diversity <sup>^</sup>	20	22	23	26	29	32	33	37
EPT Diversity <sup>^</sup>	7	7	8	11	13	13	14	37
Macroinvertebrate composition <sup>^</sup>	0.30	0.33	0.36	0.40	0.44	0.46	0.50	37

# Based on combined season AUSRIVAS outputs, <sup>^</sup> Hydrological region values.

## SMD DGVs for aquatic ecosystems of the Welcome Catchment

The SMD water quality DGVs (Tables 9 to 13 shaded values) have been derived from 17 SMEV sites across the H4 region.

**Table 9 Full year**

Parameter	5 <sup>th</sup> %ile	10 <sup>th</sup> %ile	20 <sup>th</sup> %ile	Median	80 <sup>th</sup> %ile	90 <sup>th</sup> %ile	95 <sup>th</sup> %ile	Sample Number
Dissolved Oxygen mg/L <sup>^</sup>	7.9	8.4	9.0	10.1	10.9	11.4	11.8	656
Dissolved Oxygen % Saturation <sup>^</sup>	80.2	83.0	88.0	94.2	100.0	105.0	114.2	312
Field Cond @ TRef25 µS/cm <sup>^</sup>	46.0	52.7	64.0	101.6	144.0	174.8	221.0	662
pH field - sensor TC <sup>^</sup>	5.7	6.1	6.4	6.8	7.2	7.4	7.6	652
Turbidity NTU <sup>^</sup>	1.7	2.2	3.0	4.9	8.6	11.8	16.2	666
Temperature (Celsius) <sup>^</sup>	7.0	7.8	8.8	11.5	15.1	16.7	18.4	666
TAN as N mg/L <sup>^</sup>	0.004	0.006	0.009	0.015	0.038	0.063	0.080	212
Nitrate as N mg/L <sup>^</sup>	0.001	0.006	0.018	0.052	0.187	0.317	0.389	225
Nitrite as N mg/L <sup>^</sup>	0.001	0.001	0.001	0.001	0.004	0.005	0.006	212
Total Nitrogen as N mg/L <sup>^</sup>	0.098	0.129	0.191	0.421	0.663	0.832	0.943	248
Phosphorus, Dissolved Reactive as P mg/L <sup>^</sup>	0.001	0.001	0.002	0.003	0.005	0.006	0.008	212
Total Phosphorus as P mg/L <sup>^</sup>	0.005	0.007	0.009	0.014	0.025	0.038	0.053	248
Total Suspended Solids (1.5µm) mg/L <sup>^</sup>	5.000	5.000	5.000	5.000	5.000	11.100	20.000	60
Total Suspended Solids (0.45µm) mg/L <sup>*</sup>	0.500	0.500	0.500	3.000	11.000	20.700	33.750	134

\* State derived values, <sup>^</sup>Hydrological region values, TAN=Total Ammonia Nitrogen (NH<sub>3</sub> and NH<sub>4</sub><sup>+</sup>).

**Table 10 Summer**

Parameter	5 <sup>th</sup> %ile	10 <sup>th</sup> %ile	20 <sup>th</sup> %ile	Median	80 <sup>th</sup> %ile	90 <sup>th</sup> %ile	95 <sup>th</sup> %ile	Sample Number
Dissolved Oxygen mg/L <sup>^</sup>	7.2	7.9	8.3	9.2	10.0	10.5	11.3	161
Dissolved Oxygen % Saturation <sup>^</sup>	80.3	82.1	85.2	94.5	105.0	114.9	126.8	85
Field Cond @ TRef25 µS/cm <sup>^</sup>	55.0	60.4	68.8	105.0	145.0	171.0	200.0	161
pH field - sensor TC <sup>^</sup>	5.9	6.4	6.6	6.9	7.2	7.4	7.5	160
Turbidity NTU <sup>^</sup>	1.3	1.9	2.7	4.4	6.4	8.4	10.0	161
Temperature (Celsius) <sup>^</sup>	11.7	12.3	13.4	15.5	18.4	20.6	22.1	161
TAN as N mg/L <sup>^</sup>	0.005	0.006	0.010	0.018	0.030	0.051	0.062	51
Nitrate as N mg/L <sup>^</sup>	0.001	0.001	0.006	0.029	0.136	0.229	0.275	56
Nitrite as N mg/L <sup>^</sup>	0.001	0.001	0.001	0.002	0.004	0.005	0.006	51
Total Nitrogen as N mg/L <sup>^</sup>	0.114	0.149	0.217	0.449	0.591	0.712	0.896	61
Phosphorus, Dissolved Reactive as P mg/L <sup>^</sup>	0.001	0.001	0.002	0.004	0.005	0.006	0.006	51
Total Phosphorus as P mg/L <sup>^</sup>	0.005	0.007	0.009	0.016	0.024	0.034	0.038	61
Total Suspended Solids (1.5µm) mg/L <sup>^</sup>	5.000	5.000	5.000	5.000	5.000	5.000	6.500	15
Total Suspended Solids (0.45µm) mg/L <sup>*</sup>	0.650	1.600	3.000	9.000	15.200	20.400	42.900	27

\* State derived values, <sup>^</sup>Hydrological region values, TAN=Total Ammonia Nitrogen (NH<sub>3</sub> and NH<sub>4</sub><sup>+</sup>).

**Table 11 Autumn**

Parameter	5 <sup>th</sup> %ile	10 <sup>th</sup> %ile	20 <sup>th</sup> %ile	Median	80 <sup>th</sup> %ile	90 <sup>th</sup> %ile	95 <sup>th</sup> %ile	Sample Number
Dissolved Oxygen mg/L <sup>^</sup>	7.9	8.6	9.2	10.2	10.8	11.1	11.7	167
Dissolved Oxygen % Saturation <sup>^</sup>	81.7	84.1	88.1	93.1	99.8	103.2	113.8	79
Field Cond @ TRef25 µS/cm <sup>^</sup>	51.9	62.0	74.1	108.0	155.3	179.6	210.4	173
pH field - sensor TC <sup>^</sup>	6.1	6.2	6.5	7.0	7.4	7.5	7.6	167
Turbidity NTU <sup>^</sup>	1.6	2.0	2.8	4.3	7.8	10.8	21.5	173
Temperature (Celsius) <sup>^</sup>	7.8	8.8	9.3	11.3	14.1	15.6	16.4	173
TAN as N mg/L <sup>^</sup>	0.004	0.007	0.010	0.016	0.044	0.062	0.067	57
Nitrate as N mg/L <sup>^</sup>	0.001	0.005	0.009	0.038	0.125	0.170	0.199	59
Nitrite as N mg/L <sup>^</sup>	0.001	0.001	0.001	0.001	0.003	0.004	0.005	57
Total Nitrogen as N mg/L <sup>^</sup>	0.025	0.091	0.158	0.373	0.525	0.664	0.728	73
Phosphorus, Dissolved Reactive as P mg/L <sup>^</sup>	0.001	0.001	0.001	0.003	0.005	0.005	0.006	57
Total Phosphorus as P mg/L <sup>^</sup>	0.007	0.008	0.010	0.016	0.027	0.050	0.128	73
Total Suspended Solids (1.5µm) mg/L <sup>^</sup>	5.000	5.000	5.000	5.000	5.000	5.000	11.750	12
Total Suspended Solids (0.45µm) mg/L <sup>*</sup>	0.500	0.500	0.500	5.000	12.000	16.600	25.650	28

\* State derived values, <sup>^</sup>Hydrological region values, TAN=Total Ammonia Nitrogen (NH<sub>3</sub> and NH<sub>4</sub><sup>+</sup>).

**Table 12 Winter**

Parameter	5 <sup>th</sup> %ile	10 <sup>th</sup> %ile	20 <sup>th</sup> %ile	Median	80 <sup>th</sup> %ile	90 <sup>th</sup> %ile	95 <sup>th</sup> %ile	Sample Number
Dissolved Oxygen mg/L <sup>^</sup>	8.6	9.7	10.0	10.8	11.4	11.8	12.5	165
Dissolved Oxygen % Saturation <sup>^</sup>	68.5	82.6	86.8	93.5	98.0	102.4	106.9	66
Field Cond @ TRef25 µS/cm <sup>^</sup>	38.7	44.0	56.0	88.1	143.9	174.6	341.5	162
pH field - sensor TC <sup>^</sup>	5.3	5.7	6.2	6.7	7.0	7.2	7.4	164
Turbidity NTU <sup>^</sup>	2.3	2.9	3.6	6.0	10.9	14.5	16.3	165
Temperature (Celsius) <sup>^</sup>	5.5	6.3	7.1	8.5	9.9	10.7	11.4	165
TAN as N mg/L <sup>^</sup>	0.006	0.007	0.008	0.013	0.023	0.043	0.076	49
Nitrate as N mg/L <sup>^</sup>	0.019	0.022	0.039	0.090	0.353	0.418	0.464	50
Nitrite as N mg/L <sup>^</sup>	0.001	0.001	0.001	0.001	0.003	0.005	0.007	49
Total Nitrogen as N mg/L <sup>^</sup>	0.113	0.150	0.201	0.521	0.742	0.913	0.956	54
Phosphorus, Dissolved Reactive as P mg/L <sup>^</sup>	0.001	0.001	0.002	0.003	0.005	0.009	0.017	49
Total Phosphorus as P mg/L <sup>^</sup>	0.003	0.005	0.007	0.012	0.026	0.037	0.050	54
Total Suspended Solids (1.5µm) mg/L <sup>^</sup>	5.000	5.000	5.000	5.000	8.000	13.200	19.400	23
Total Suspended Solids (0.45µm) mg/L <sup>*</sup>	0.500	0.500	0.500	3.000	7.000	15.200	22.100	39

\* State derived values, <sup>^</sup>Hydrological region values, TAN=Total Ammonia Nitrogen (NH<sub>3</sub> and NH<sub>4</sub><sup>+</sup>).

**Table 13 Spring**

Parameter	5 <sup>th</sup> %ile	10 <sup>th</sup> %ile	20 <sup>th</sup> %ile	Median	80 <sup>th</sup> %ile	90 <sup>th</sup> %ile	95 <sup>th</sup> %ile	Sample Number
Dissolved Oxygen mg/L <sup>^</sup>	8.2	8.7	9.2	10.1	10.8	11.2	11.5	163
Dissolved Oxygen % Saturation <sup>^</sup>	83.1	86.3	90.7	95.4	100.0	101.4	103.0	82
Field Cond @ TRef25 $\mu$ S/cm <sup>^</sup>	43.2	49.2	59.1	102.7	135.3	164.8	266.5	166
pH field - sensor TC <sup>^</sup>	5.8	6.0	6.3	6.7	7.2	7.5	7.7	161
Turbidity NTU <sup>^</sup>	1.7	2.3	3.1	5.1	10.0	12.6	18.0	167
Temperature (Celsius) <sup>^</sup>	8.3	8.8	9.7	11.8	14.0	15.5	16.6	167
TAN as N mg/L <sup>^</sup>	0.004	0.007	0.009	0.013	0.055	0.079	0.103	55
Nitrate as N mg/L <sup>^</sup>	0.017	0.021	0.028	0.077	0.299	0.358	0.434	60
Nitrite as N mg/L <sup>^</sup>	0.001	0.001	0.001	0.001	0.004	0.005	0.005	55
Total Nitrogen as N mg/L <sup>^</sup>	0.126	0.157	0.190	0.426	0.780	0.892	1.080	60
Phosphorus, Dissolved Reactive as P mg/L <sup>^</sup>	0.001	0.001	0.002	0.003	0.005	0.007	0.008	55
Total Phosphorus as P mg/L <sup>^</sup>	0.008	0.009	0.011	0.014	0.025	0.033	0.041	60
Total Suspended Solids (1.5 $\mu$ m) mg/L <sup>^</sup>	5.000	5.000	5.000	5.000	11.200	12.900	16.950	10
Total Suspended Solids (0.45 $\mu$ m) mg/L <sup>*</sup>	0.500	0.500	0.500	2.250	8.200	22.100	41.400	40

\* State derived values, <sup>^</sup>Hydrological region values, TAN=Total Ammonia Nitrogen (NH<sub>3</sub> and NH<sub>4</sub><sup>+</sup>).

The SMD biological DGVs detailed in Table 14 have been derived from 9 sites across the H4 Region.

**Table 14 Data Summary and biological DGVs (shaded) for SMD ecosystems of the Welcome Catchment**

Parameter	5 <sup>th</sup> %ile	10 <sup>th</sup> %ile	20 <sup>th</sup> %ile	Median	80 <sup>th</sup> %ile	90 <sup>th</sup> %ile	95 <sup>th</sup> %ile	Sample Number
AUSRIVAS Band# <sup>^</sup>	B	B	A	A	A	A	X	42
OE50# <sup>^</sup>	0.84	0.84	0.90	1.03	1.06	1.09	1.15	42
OE50Signal# <sup>^</sup>	0.92	0.93	0.95	0.97	1.00	1.01	1.02	42
Signal Index <sup>^</sup>	5.6	5.7	5.8	6.0	6.3	6.4	6.4	42
Taxon Diversity <sup>^</sup>	21	23	24	27	30	31	32	42
EPT Diversity <sup>^</sup>	8	9	10	11	13	13	13	42
Macroinvertebrate composition <sup>^</sup>	0.33	0.36	0.38	0.42	0.44	0.47	0.50	42

# Based on combined season AUSRIVAS outputs, <sup>^</sup> Hydrological region values.

The SMD DGVs may represent aspirational DGVs for moderately disturbed ecosystems, but apply when site-specific guideline values consistent with the NWQMS are not available.

Information from the Tasmanian River Condition Index (TRCI) project has been incorporated into the biological DGVs in order to provide guideline values for key biological indicators relating to invertebrate abundance, native fish, and algae. Details are provided in the EPA document, [Technical Guidance for Water Quality Objectives \(WQOs\) Setting for Tasmania](#).

A summary of the HEV and SMD DGVs from Table 3 to Table 14 are provided in Appendix A.

## Appendix A: DGVs summary for aquatic ecosystems of the Welcome Catchment.

HEV	Physico-chemical indicators and water quality DGVs for Aquatic Ecosystems																	
	DO (mg/L) <sup>^</sup>		DO (% sat) <sup>^</sup>		Cond <sup>^</sup>	pH <sup>^</sup>		Turb <sup>^</sup>	Temp (°C) <sup>^</sup>		TAN as N <sup>^</sup>	NO <sub>3</sub> as N <sup>^</sup>	NO <sub>2</sub> as N <sup>^</sup>	Total N as N <sup>^</sup>	DRP as P <sup>^</sup>	Total P as P <sup>^</sup>	TSS <sup>^</sup> (1.5 µm)	TSS* (0.45 µm)
	lower	upper	lower	upper	(µs/cm)	lower	upper	NTU	lower	upper	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)
Annual	8.7	10.9	78.4	100.4	178.6	5.3	7.2	8.8	8.7	14.0	0.051	0.136	0.008	0.706	0.004	0.025	5.00	3.00
Summer	7.6	10.0	89.7	104.5	172.3	5.6	7.4	7.1	12.7	16.6	0.048~	0.172	0.007~	0.662	0.005~	0.024	5.00~	3.00
Autumn	8.3	10.6	64.2	101.3	187.6	5.6	7.2	7.3	9.2	13.1	0.070~	0.130	0.007~	0.643	0.004~	0.029	5.00~	5.00
Winter	9.7	11.6	77.0	95.3	216.6	4.8	6.8	11.0	7.0	9.9	0.055~	0.091~	0.008~	0.825	0.004~	0.065	5.00~	3.00
Spring	8.9	10.9	79.7	98.5	170.8	5.2	7.0	11.7	8.9	12.6	0.043~	0.087	0.009~	0.717	0.004~	0.018	5.00~	3.00

NB: DO (dissolved oxygen), Cond (electrical conductivity), Turb (turbidity), TAN (total ammonia nitrogen), DRP (dissolved reactive phosphorus), TSS (total suspended solids) filtered through, e.g., 1.5 µm. \* State derived values, ^ Hydrological region values, ~ <95% confidence. Figures shown above are based on data from 8 HEV site across the H4 Hydrological region unless noted otherwise in the table.

SMD	Physico-chemical indicators and water quality DGVs for Aquatic Ecosystems																	
	DO (mg/L) <sup>^</sup>		DO (% sat) <sup>^</sup>		Cond <sup>^</sup>	pH <sup>^</sup>		Turb <sup>^</sup>	Temp (°C) <sup>^</sup>		TAN as N <sup>^</sup>	NO <sub>3</sub> as N <sup>^</sup>	NO <sub>2</sub> as N <sup>^</sup>	Total N as N <sup>^</sup>	DRP as P <sup>^</sup>	Total P as P <sup>^</sup>	TSS <sup>^</sup> (1.5 µm)	TSS* (0.45 µm)
	lower	upper	lower	upper	(µs/cm)	lower	upper	NTU	lower	upper	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)
Annual	9.0	10.9	88.0	100.0	144.0	6.4	7.2	8.6	8.8	15.1	0.038	0.187	0.004	0.663	0.005	0.025	5.00	11.00
Summer	8.3	10.0	85.2	105.0	145.0	6.6	7.2	6.4	13.4	18.4	0.030	0.136	0.004	0.591	0.005	0.024	5.00	15.20
Autumn	9.2	10.8	88.1	99.8	155.3	6.5	7.4	7.8	9.3	14.1	0.044	0.125	0.003	0.525	0.005	0.027	5.00~	12.00
Winter	10.0	11.4	86.8	98.0	143.9	6.2	7.0	10.9	7.1	9.9	0.023	0.353	0.003	0.742	0.005	0.026	8.00	7.00
Spring	9.2	10.8	90.7	100.0	135.3	6.3	7.2	10.0	9.7	14.0	0.055	0.299	0.004	0.780	0.005	0.025	11.20~	8.20

NB: DO (dissolved oxygen), Cond (electrical conductivity), Turb (turbidity), TAN (total ammonia nitrogen), DRP (dissolved reactive phosphorus), TSS (total suspended solids) filtered through, e.g., 1.5 µm. \* State derived values, ^ Hydrological region values, ~ <95% confidence. Figures shown above are based on data from 17 SMEV sites across the H4 Hydrological region unless noted otherwise in the table.

Biological Condition	Biological indicators and biological DGVs for Aquatic Ecosystems													
	AUSIVAS band		OE50		OE50 Signal		Signal Index		Taxon Diversity		EPT Diversity		Macroinvertebrate Composition	
	lower	upper	lower	upper	lower	upper	lower	upper	lower	upper	lower	upper	lower	upper
HEV^	A	A	0.92	1.13	0.98	1.00	5.9	6.4	23	29	8	13	0.36	0.44
SMD^	A	A	0.90	1.06	0.95	1.00	5.8	6.3	24	30	10	13	0.38	0.44

^ Hydrological region values. Figures shown above are based on data from 17 HEV sites and 9 SMEV sites across the H4 Hydrological region.



## **Appendix B: Precautionary approach for recreational waters microorganisms**

For recreational waters microorganisms are used as a regulatory parameter of public health significance. The indicator organism used for microbiological water quality assessment is intestinal enterococci and is related to a risk matrix which uses sanitary inspection of potential faecal contamination sources and 95th percentile levels of enterococci/100mL. The Public Health Act 1997 Recreational Water Quality Guidelines (Tasmania 2007) for a general water body (where no sanitary risk assessment has been undertaken) has determined microbial levels for investigation and action to informing the public of the elevated public health risk. These levels are at enterococci counts in a single water sample greater than 140 enterococci/100mL and when two consecutive water samples results are greater than 280 enterococci/100mL.

A precautionary approach is however recommended by the EPA, being that microbial levels should be at 40 enterococci/100mL or less and this should be the DGV for this key indicator. Refer to the Australian Government Guidelines for Managing Risk in Recreational Water for more detail on the classification matrix for faecal pollution of recreational water and other key indicators DGVs.



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