



## Response to public submissions on draft default guideline values for copper in marine water

September 2025

Draft default guideline values (DGVs) for copper in marine water were published on the Water Quality Guidelines website for a 3-month public consultation period. During this period, comments for the draft DGVs for copper in marine water were received via public submission.

Responses to comments and any associated edits to the draft DGV technical brief are outlined in this report, de-identified for public record. The responses and revisions have been approved by the original peer reviewers and the jurisdictional technical and policy oversight groups, and noted by the National Water Reform Committee.

The default guideline values for copper in marine water are now published as final. For additional information on the publication process, please refer to the [pathway for toxicant default guideline value publication](#).

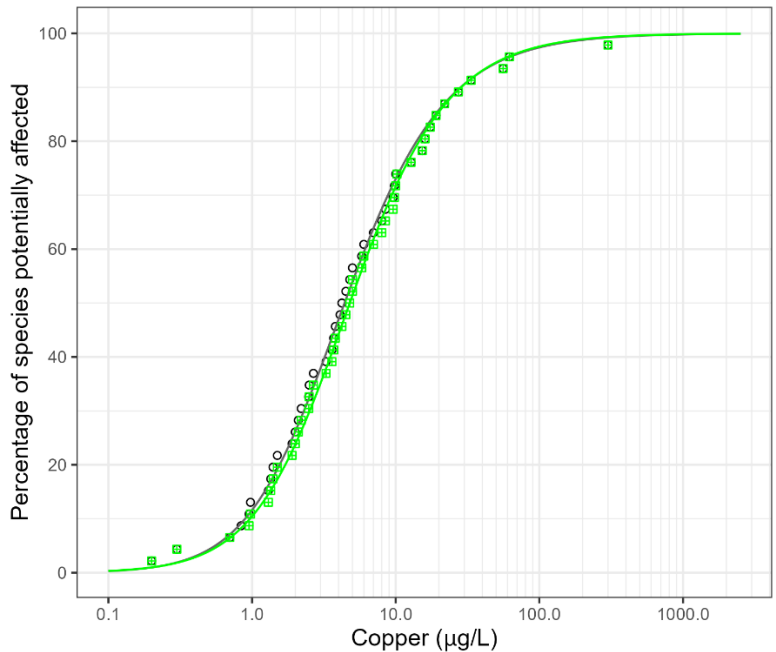
The Water Quality Guidelines Improvement Program thanks all submissions for their valuable contribution to the development of default guideline values for the protection of aquatic ecosystems.

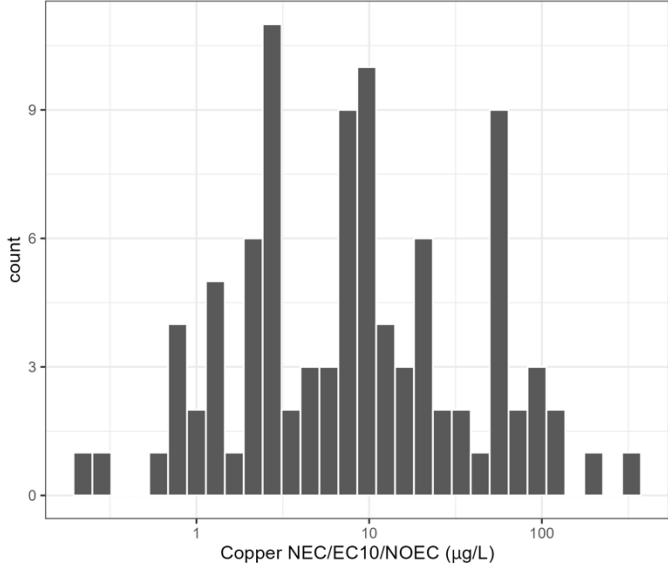
## Response to public submissions on draft default guideline values

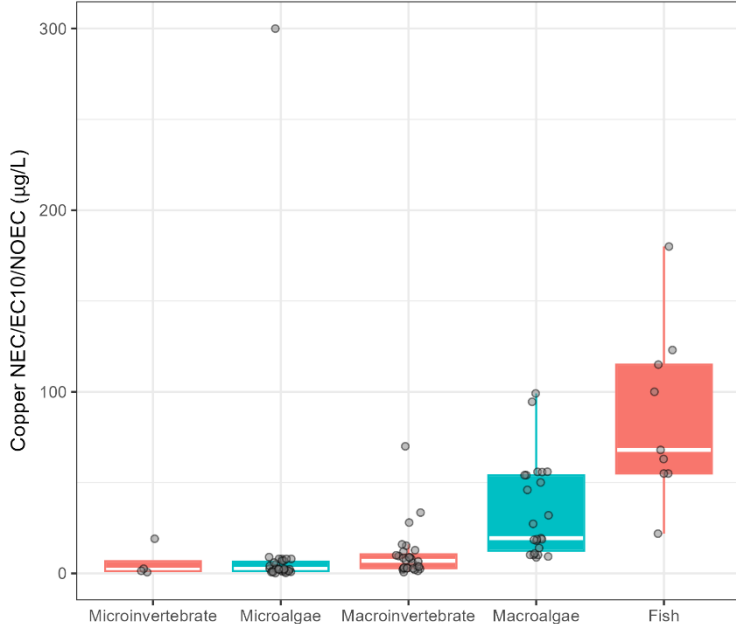
### Toxicant: Copper in marine water

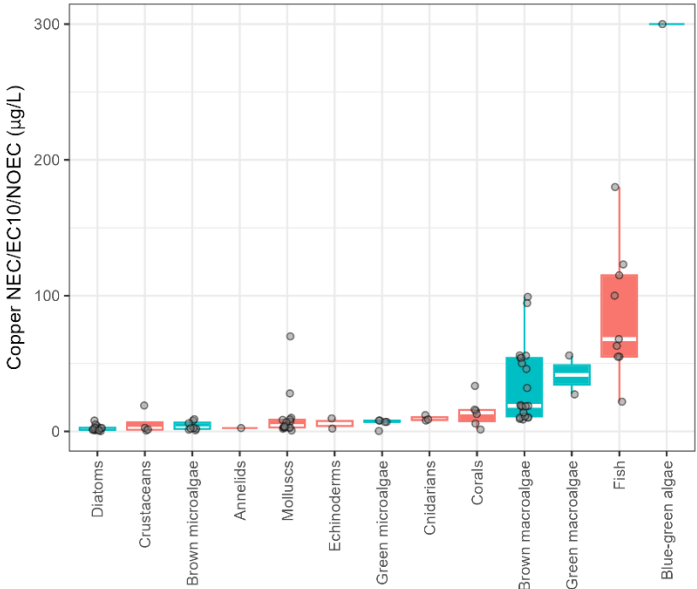
Comment	Response	Action taken
<b>Submission A (Points below represent a summary of the comments).</b>		
1. A dominance of algae within the dataset, which are as a taxonomic group known to be particularly copper sensitive.	<p>Thirteen additional species have been added to the dataset used for the DGV derivation, based on the public submissions and associated approvals process, all of which are <i>Animalia</i>. This means there are now 16 algae (including macroalgae), 27 invertebrates and two fish, with the algae comprising 36% of the dataset. There is a clear paucity of data for fish.</p> <p>Algae do dominate the toxicity dataset when compared to some estimates of diversity of organisms in the marine environment (e.g., in the NZ EEZ there are an estimated 2,900 described cyanobacteria, plant, protozoa and chromista species compared with 9,863 described animal species (Gordon et al. 2010)), even when undescribed species are included.</p> <p>On the other hand, algae, as primary producers, are at the base of the food chain including in rocky reefs (see Truong et al. 2017) and are responsible for the transfer of energy to all of the higher trophic levels. Ecological theory and food web studies show that species diversity is highest at low trophic levels (i.e., primary producers such as algae) and decreases at higher trophic levels (Turney 2016). This suggests that there should be more algae in the species sensitivity distribution (SSD) than invertebrates and fish if the SSD is to represent the ecosystem.</p> <p>Furthermore, the algal species included in the SSD also represent several different groups – cyanobacteria, diatoms, golden and green microalgae, and macroalgae. These species may be present in different locations around the coast or may dominate at different times of year. If such species are not protected (for example, if a guideline value was based on animals only) then the ecosystem would not be protected.</p> <p>While there are some algae in the toxicity dataset that are very sensitive to copper, there are also several species that are not sensitive (i.e., the cyanobacterium which is the least sensitive species) or of only moderate sensitivity (e.g., 3 species in the middle of the range). Further, of the 5 most sensitive species, 3 are algae and 2 are invertebrates (one crustacean, one mollusc).</p>	Section 4.2 of the technical brief has been updated to reflect the response to the comment.

Comment	Response	Action taken																				
2. Seemingly arbitrary inclusion and exclusion of 'non-preferred' ecotoxicological data (i.e. No Observed Effect Concentration - NOEC and converted- NOEC) despite the dataset being classified as "preferred" (highest rating) in the absence of 'non-preferred' data.	<p>The inclusion of non-preferred ecotoxicological data was not arbitrary but was based on a philosophy of deriving guideline values suitable for the Australia and New Zealand region – with species from these regions dominating the dataset. Therefore, NOEC values were accepted where these were the only data available for species found in the region.</p> <p>There were also four values where NOEC data were available but not in a form suitable for inclusion – this is where the converted NOEC data were accepted. These data were each carefully considered to determine a suitable value for each for inclusion in the SSD. Justification for the data selection decisions was documented.</p> <p>An alternative derivation is to use all the values directly from data reported as &lt; values (i.e. with no conversion). DGVs derived on this basis are presented in the table below, compared to the DGVs presented in the draft technical brief and compared to the updated version including 13 new animal species.</p> <p>For the original toxicity dataset, the 99% species protection value decreases slightly while the 80% species protection value increases (compared to the dataset with converted NOEC data) due to a slightly different shape of the model fit through the toxicity data (see SSD plot below). However, overall, the values do not differ markedly between the datasets, especially for the updated dataset. Through this re-assessment, the approach for <i>Hydroides elegans</i> used in the draft DGV released for public comment (value of 2.5 µg/L calculated by dividing the LOEC of 6.2 µg/L by 2.5), was considered too conservative and was replaced with the value 6.2 µg/L (based on the reported NOEC of &lt;6.2 µg/L).</p> <table><tr><th colspan="5">DGV for copper in marine water (µg/L)</th></tr><tr><th>Level of species protection (%)</th><th>Draft DGV for public submission</th><th>Using NOEC values with no conversion of &lt;NOEC values</th><th>Updated draft DGV including new data</th><th>Updated draft DGV including new data but no conversion</th></tr><tr><td>No. species</td><td>32</td><td>32</td><td>45</td><td>45</td></tr><tr><td>99</td><td>0.12</td><td>0.08</td><td>0.19</td><td>0.20</td></tr></table>	DGV for copper in marine water (µg/L)					Level of species protection (%)	Draft DGV for public submission	Using NOEC values with no conversion of <NOEC values	Updated draft DGV including new data	Updated draft DGV including new data but no conversion	No. species	32	32	45	45	99	0.12	0.08	0.19	0.20	A sensitivity assessment section has been added as an appendix to the DGV technical brief, which includes this information; and reference to that appendix has been added to Section 4.2.
DGV for copper in marine water (µg/L)																						
Level of species protection (%)	Draft DGV for public submission	Using NOEC values with no conversion of <NOEC values	Updated draft DGV including new data	Updated draft DGV including new data but no conversion																		
No. species	32	32	45	45																		
99	0.12	0.08	0.19	0.20																		

Comment	Response	Action taken															
	<table><tr><td>95</td><td>0.40</td><td>0.39</td><td>0.55</td><td>0.59</td></tr><tr><td>90</td><td>0.72</td><td>0.81</td><td>0.91</td><td>0.97</td></tr><tr><td>80</td><td>1.4</td><td>1.8</td><td>1.60</td><td>1.70</td></tr></table>  <p>Black = new DGV data set, with 2x converted NOEC data values Green = new DGV data set, with 2x values set at the &lt;NOEC value</p>	95	0.40	0.39	0.55	0.59	90	0.72	0.81	0.91	0.97	80	1.4	1.8	1.60	1.70	
95	0.40	0.39	0.55	0.59													
90	0.72	0.81	0.91	0.97													
80	1.4	1.8	1.60	1.70													
3. The conduction of modality and taxa-specific sensitivity assessments that does not account for	<p>The modality and sensitivity assessments are not designed to address the inherent variability between data points for the same species. For toxicity values from the same species, endpoint and test duration, we use the geometric mean of those values to deal with the inherent variability. This is an</p>	<p>Additional analysis has been added to Appendix F, modality assessment.</p>															

Comment	Response	Action taken
<p>the inherent variability between individual datapoints (studies) of the same species.</p>	<p>accepted way to get data that is representative of a single species (see Warne et al. (2018) for the hierarchy of selecting the toxicity data that represents a single species).</p> <p>A full assessment has been undertaken with the individual datapoints for each species.</p> <p>The bimodality coefficient based on the individual data points was 0.39, which does not indicate a bimodal distribution.</p> <p>The histogram for all data (below) does not indicate a bimodal distribution, although the distribution also does not suggest a normal distribution.</p>  <p>The comparisons between taxonomic groups (see two box plots below) showed that marine fish, macroalgae and blue-green algae are generally less sensitive to copper than other groups, including microalgae. However, while there is clear taxa-specific sensitivity (something very common for toxicants), this does not</p>	<p>There was no change to the conclusion of the modality assessment.</p>

Comment	Response	Action taken																																				
	<p>result in a bimodal toxicity relationship, as evidenced by the high degree of overlap in sensitivity of different taxa groups and trophic levels.</p>  <table border="1"><caption>Approximate data from Copper toxicity box plot</caption><thead><tr><th>Taxa Group</th><th>Median (µg/L)</th><th>Q1 (µg/L)</th><th>Q3 (µg/L)</th><th>Min (µg/L)</th><th>Max (µg/L)</th></tr></thead><tbody><tr><td>Microinvertebrate</td><td>~5</td><td>~2</td><td>~8</td><td>~0</td><td>~20</td></tr><tr><td>Microalgae</td><td>~5</td><td>~2</td><td>~8</td><td>~0</td><td>~300</td></tr><tr><td>Macroinvertebrate</td><td>~5</td><td>~2</td><td>~8</td><td>~0</td><td>~70</td></tr><tr><td>Macroalgae</td><td>~20</td><td>~10</td><td>~55</td><td>~0</td><td>~100</td></tr><tr><td>Fish</td><td>~70</td><td>~55</td><td>~115</td><td>~20</td><td>~180</td></tr></tbody></table>	Taxa Group	Median (µg/L)	Q1 (µg/L)	Q3 (µg/L)	Min (µg/L)	Max (µg/L)	Microinvertebrate	~5	~2	~8	~0	~20	Microalgae	~5	~2	~8	~0	~300	Macroinvertebrate	~5	~2	~8	~0	~70	Macroalgae	~20	~10	~55	~0	~100	Fish	~70	~55	~115	~20	~180	
Taxa Group	Median (µg/L)	Q1 (µg/L)	Q3 (µg/L)	Min (µg/L)	Max (µg/L)																																	
Microinvertebrate	~5	~2	~8	~0	~20																																	
Microalgae	~5	~2	~8	~0	~300																																	
Macroinvertebrate	~5	~2	~8	~0	~70																																	
Macroalgae	~20	~10	~55	~0	~100																																	
Fish	~70	~55	~115	~20	~180																																	

Comment	Response	Action taken
	 <p>A box plot showing the distribution of Copper NEC/EC10/NOEC (µg/L) for various marine organisms. The y-axis ranges from 0 to 300. The x-axis lists organisms: Diatoms, Crustaceans, Brown microalgae, Annelids, Molluscs, Echinoderms, Green microalgae, Cnidarians, Corals, Brown macroalgae, Green macroalgae, Fish, and Blue-green algae. Most organisms have low values (below 50), with Fish showing a higher median around 70 and Blue-green algae showing a single high outlier at 300.</p>	
<p>4. The suitability of the proposed DOC correction at the 'ecosystem' scale given it has been developed from responses of two non-Australasian (northern hemisphere) species.</p>	<p>Unfortunately, there is a lack of relevant data for Australasian species in order to check the proposed DOC correction.</p> <p>There are data related to the estimation of bioavailable copper (e.g., as measured with DGTs or voltammetry) that can be used to assess the suitability of the correction. Samples collected off the Hauraki Gulf of New Zealand, and in the Tasman Sea indicate less than 1% of the copper is in bioavailable forms (Zitoun 2019, Thompson 2014). At sites affected by shipwreck-related copper contamination, where total and dissolved copper concentrations were in the range 0.3-80 µg/L, bioavailable copper remained a low proportion of dissolved copper (i.e. 1-9%) (Hartland 2019).</p>	<p>Text has been added to Appendix G to reflect this issue.</p>
<p>5. A lack of information on whether non-natural forms of DOC such as hydrocarbons and surfactants (detergents) which are common in</p>	<p>There have been many studies into the quality of DOM and the effects of different sources of DOM on metal complexation. Although relationships have been demonstrated between Cu complexation (and reduced toxicity) and humic acid content (e.g. through measures of UV absorbance at specific wavelengths</p>	<p>Text has been added to Section 3.2 and Appendix G to reflect this issue.</p>

Comment	Response	Action taken
<p>industrial ports/zones are likely to bias the DOC correction.</p>	<p>or other indicators of humic acid), there is large variation in those relationships, and non-humic substances can also complex copper.</p> <p>The general consensus is that although there is variation in the complexation between sources, DOM from anthropogenic sources may complex just as much Cu as that from natural sources. Baken et al. (2011) found higher complexation with DOM from anthropogenic sources, particularly where there was EDTA in the samples. Though this work was undertaken in freshwater, testing with wastewater effluents in marine waters also demonstrates Cu complexation with the effluent-associated DOM.</p> <p>The DOC correction recommended for this DGV is based on the US EPA draft BLM. This BLM was derived using data from samples collected at multiple sites in San Diego Bay and Pearl Harbour. These sites can be expected to include both natural and anthropogenic sources of DOM. Therefore, the correction is not expected to over-estimate the Cu toxicity reduction in the presence of anthropogenic DOM.</p>	
<p>6. A lack of standardisation in correcting/accounting for DOC within the existing dataset and the implementation of a seemingly arbitrary DOC cutoff of 2 mg/L which has the potential to significantly bias the DGV generation process.</p>	<p>Copper bioavailability is influenced by DOC. There are three possible ways to deal with this within the SSD:</p> <ol style="list-style-type: none"> <li>1) Only accept toxicity data from tests undertaken in conditions that represent high bioavailability (the option used in the draft DGV document)</li> <li>2) Ignore it and use all available data regardless of DOC</li> <li>3) Use a bioavailability model to normalise all toxicity data used in the SSD to a standard DOC concentration</li> </ol> <p>The first option was used for the derivation of the marine copper DGVs. The other two options were assessed as part of this response to the public submission.</p> <p>Option 1: There was originally a total of 32 species included from 95 acceptable test values, where DOC ranged from 0.2 to 2 mg/L. DOC was not reported in 34 of the 95 tests. This has been increased to 45 species, based on the new data provided during the public submission process, which were from tests with DOC &lt; 2 mg/L.</p> <p>Option 2: This resulted in a total of 45 species, with data from 130 tests (many of which were repeated tests on same species, by same authors) where DOC</p>	<p>Text has been added to a new Appendix H to reflect this issue.</p>

Comment	Response	Action taken																				
	<p>measured 0.009 to 21.6 mg/L. These values included additional data from tests on two species (<i>Mytilus galloprovincialis</i> and <i>M. trossolus</i>) where DOC was varied to assess the effect on copper toxicity.</p> <p>Option 3: This also resulted in a total of 45 species, with data from tests where DOC measured 0.009 to 21.6 mg/L. In 68 of the 130 tests, DOC was not reported. It was assumed to be 0.5 mg/L for the purposes of adjusting the toxicity data to the standard DOC (thus resulting in no adjustment for those values). The linear model recommended for the DGV adjustment was not appropriate for this adjustment. The linear model implies there is a consistent absolute increase in EC10 value for a given increase in DOC. This was not appropriate when applying to species where the sensitivity ranged from an EC10 of 0.2 µg/L to 30 µg/L, as it resulted in large adjustments for the very sensitive species, at times resulting in negative values. A power model was instead used to adjust the toxicity data. The power model assumed that there is a consistent proportional increase in the EC10 for each increase in DOC (i.e. the slopes are the same between species). The power model was based on the same data as the linear adjustment model and had a slope of 0.6136.</p> <p>The DGVs calculated for all different options are compared in the table below. There is minimal difference between the values, particularly for the 95% level of protection. Based on the lack of difference between options 1 and 2, the assumptions required to normalise toxicity data based on a DOC power model, the original method was retained.</p> <table><tr><th colspan="5">DGV for copper in marine water (µg/L) <sup>a, b</sup></th></tr><tr><th>Level of species protection (%)</th><th>Option 1: Draft DGV for public submission</th><th>Option 1: Updated draft DGV including new data</th><th>Option 2: Including all data regardless of DOC</th><th>Option 3: Normalising data to DOC 0.5 mg/L</th></tr><tr><td>No. species</td><td>32</td><td>45</td><td>45</td><td>45</td></tr><tr><td>99</td><td>0.12</td><td>0.19</td><td>0.20</td><td>0.22</td></tr></table>	DGV for copper in marine water (µg/L) <sup>a, b</sup>					Level of species protection (%)	Option 1: Draft DGV for public submission	Option 1: Updated draft DGV including new data	Option 2: Including all data regardless of DOC	Option 3: Normalising data to DOC 0.5 mg/L	No. species	32	45	45	45	99	0.12	0.19	0.20	0.22	
DGV for copper in marine water (µg/L) <sup>a, b</sup>																						
Level of species protection (%)	Option 1: Draft DGV for public submission	Option 1: Updated draft DGV including new data	Option 2: Including all data regardless of DOC	Option 3: Normalising data to DOC 0.5 mg/L																		
No. species	32	45	45	45																		
99	0.12	0.19	0.20	0.22																		

Comment	Response	Action taken															
	<table><tr><td>95</td><td>0.40</td><td>0.55</td><td>0.66</td><td>0.53</td></tr><tr><td>90</td><td>0.72</td><td>0.91</td><td>0.92</td><td>0.83</td></tr><tr><td>80</td><td>1.4</td><td>1.60</td><td>1.63</td><td>1.42</td></tr></table>	95	0.40	0.55	0.66	0.53	90	0.72	0.91	0.92	0.83	80	1.4	1.60	1.63	1.42	
95	0.40	0.55	0.66	0.53													
90	0.72	0.91	0.92	0.83													
80	1.4	1.60	1.63	1.42													
7. Finally, these DGVs have the potential to be impractical given that most commercial labs in WA will struggle to accurately/reliably determine the 95% - 99% protection concentrations (in the absence of DOC correction). This has the potential to increase the costs associated with monitoring due to a combination of increased analytical requirements, the need to transport samples outside of Western Australia for analysis and also the potential implementation of extensive biological/ecological monitoring programs.	Many commercial laboratories offer analyses with detection limits of 1 µg/L, which will be below the 95% species protection concentrations at most environmental DOC concentrations (e.g. >1 mg/L DOC). Moreover, some laboratories can obtain lower detection limits using ultratrace methods, which could be used if copper concentrations of <1 µg/L in seawater needed to be detected.	Text reflecting this issue has been added to section 4.4.															
Submission B																	
1. The proposed marine 99% species protection DGV for copper (0.12 µg/L) is lower than or equal to the accepted background concentration for WA's _North West Shelf (0.165 µg/L; Wenziker et al. 2006), Dampier Archipeligo (0.12 µg/L; Wenziker et al 2006) and the relevant (E2) zone of Cockburn Sound (0.14 µg/L; Mc Alpine et al. 2004). A revised trigger that routinely falls below background does not work operationally and is unlikely to be ecologically relevant.  Wenziker K, McAlpine K, Apte S, Masini R (2006) Background quality for coastal marine waters of the North West Shelf, Western Australia. North West Shelf Joint Environmental Management Study Technical Report  McAlpine KW, Wenziker KJ, Apte SC, Masini RJ (2004) Background quality for coastal marine waters of Perth,	It is correct that DGVs should not be set lower than background concentrations: See Warne et al. (2018):  “The GV for naturally occurring elements (for example metals) and compounds (for example some hydrocarbons and polycyclic aromatic hydrocarbons, PAHs) should be checked against background concentrations to ensure that unrealistically low GV (lower than the background concentration) are not derived. A default set of background data for metals and metalloids is presented in the 2000 Guidelines (Table 8.3.2, ANZECC/ARMCANZ 2000b). Alternatively, site-specific or regional GV based on background concentrations could be derived; however, this is not a trivial task.”  However, this may not always be possible. We agree that the 99% species protection DGV at the default DOC concentration of 0.5 mg/L is very low and will be both analytically challenging and close to background levels. However, our understanding is that the DGVs will be above background levels in most locations. The “accepted background concentrations for Western Australia” as reported in the public submission are higher than values reported for background/off-shore waters more generally around Australia and New Zealand. For example, sampling in the Tasman Sea indicates concentrations	Text reflecting this issue has been added to section 4.4.															

Comment	Response	Action taken
Western Australia. Department of Environment Perth, Western Australia Technical Series 117	around ~0.03 µg/L, increasing to 0.1 µg/L or more at a depth of 1500 m (Thompson and Ellwood 2014). At sites in the Hauraki Gulf, New Zealand, dissolved copper concentrations ranged from 0.02 to 0.07 µg/L, reaching 0.2 µg/L at a depth of 2000 m (Zitoun 2019). At a location off-shore of Bay of Plenty, New Zealand, total copper concentrations measured 0.07 to 0.17 µg/L (Hartland, Zitoun et al. 2019). Once DOC is taken into account, the DGVs are likely to be above background concentrations. Nevertheless, a sentence has been added, advising readers that ANZG (2018) provides guidance in the event that a DGV is below natural background concentrations.	
2. The DGVs were derived from toxicity data from 32 species, of these half (four diatoms, four brown microalgae, one blue–green alga, three green microalgae, two green macroalgae, two brown macroalgae) were plants and half (four cnidarians, two echinoderms, one annelid, one crustacean, six molluscs and two fish) were animals. The plants (median final toxicity value of 3.35 µg/L) are more sensitive than the animals (median final toxicity value of 3.35 µg/L). In turn, the plants were overrepresented by microalgae (14 of the 16 species) which are more sensitive (median final toxicity value of 2.15 µg/L) than the plants as a whole. It is recommended that the ANZG research the potential for bias due to species selection and, if necessary, establish associated criteria to ensure final guidelines accurately reflect the risk of toxicity and remain ecologically relevant.	The issue of algal data dominance and overall species/taxonomic group bias was addressed in relation to comments 1 and 3 from submission A.	See action taken for comments 1 and 3 from submission A.
<b>Submission C</b>		
1. <i>Limit of reporting/analytical capabilities</i> The common limit of reporting (LOR) for copper in most environmental water samples is 0.001 mg/L (i.e. 1 µg/L) particularly for seawater. The proposed DGV for copper in seawater is 0.0004	It is acknowledged that this can be difficult, however it is expected that many coastal waters will have DOC > 0.5 mg/L, and the associated DGV for the measured DOC concentration should be above the limit of reporting. Furthermore, laboratories often improve methods where there is demand – this	See action taken for comment 7 from submission A.

Comment	Response	Action taken
<p>mg/L (i.e. 0.4 µg/L). There were already issues in confidently demonstrating that a water body contained copper in compliance with the existing DGV – i.e. 0.0013 mg/L. With this reduction in the value, the issue of what the laboratories can actually achieve is critical in considering the practicality of this DGV. This does not appear to be covered/discussed in the technical brief. It is noted that a search for the term quantitation or PQL indicates these terms are not used in the technical brief.</p> <p>Pricing of analysis is also an important consideration. If the laboratories are required to use ultra trace techniques to provide a limit of reporting at around 0.0004 mg/L, this will cost significantly more than the standard analysis. If there had been a significant change due to significant new data, this could be justified. However, the situation seems to be a slight tweaking of the SSD. In addition, the potential for cross contamination in the laboratory greatly increases when doing ultra trace work.</p> <p>Another issue in relation to analysis is the measurement error when concentrations are close to the LOR. The error at concentrations around the LOR is large, so it is important to consider whether the laboratories can really determine if a sample measured at 0.0004 mg/L is really different from one measured at 0.0013 mg/L. It is likely the labs would not be confident that such results are actually different.</p>	<p>may occur in the case of seawater analyses. Also see response to comment 7 for submission A.</p>	
<p>2. <i>Significance of change</i></p> <p>When the National Environment Protection Measure for the Assessment of Site Contamination (ASC NEPM) was updated in 2013, one of the considerations as to whether a health</p>	<p>This issue was considered by the ANZG jurisdictional committees. It was agreed that it is not appropriate to adopt a 'significance of change' rule such as that included in the ASC NEPM. From a technical perspective, and while acknowledging the issues of uncertainty and sampling/measurement error when comparing two similar guideline values, newly-derived DGVs will typically</p>	<p>No action taken.</p>

Comment	Response	Action taken
<p>investigation level (HIL) would change or not was the size of the change between the original HIL from 1998 and the newly calculated HIL using more comprehensive and standardised calculations and the most recent information on toxicity and background exposure. If the change between the 1998 value and the newly calculated value was not great, then no change to the HIL value was made in the updated NEPM.</p> <p>There should be some consideration of a similar approach here for DGVs. If such a recalculation does not change the value significantly, especially when the analytical error at concentrations around the LOR are considered, then no change to the current value should be made.</p> <p>It is also noted that the change in the DGV for copper in marine waters would be within the sampling error for many situations.</p>	<p>carry greater confidence than older DGVs as they will be based on (i) updated knowledge of the toxicant, (ii) usually more toxicity data, and (iii) a more robust derivation method. Thus, even if the final DGVs are similar to older DGVs (e.g. from ANZECC/ARMCANZ 2000), there will typically be greater stakeholder confidence in the newer DGVs, and it is appropriate that these should take precedence over older DGVs. Moreover, there is a comprehensive peer and stakeholder review process that scrutinises and helps ensure the high rigour of revised DGVs.</p>	
<p>3. <i>Essentiality of copper</i></p> <p>The fact that copper is an essential micronutrient is mentioned on a number of occasions in the technical brief but there is no information provided as to whether the newly proposed DGV would actually provide sufficient copper for many species. There is also not much information provided as to whether the effects on the various algal/diatom species (most sensitive species type) are due to too much or too little copper. The same effects might be observed in the study (i.e. lack of population growth) but the cause may be too little copper rather than too much. The data quality assessment should be expanded in the case of essential micronutrients to include a check as to whether the studies considered this aspect and to ensure that the dose response in the study clearly demonstrates that the effects are due to too</p>	<p>The most sensitive microalgae include <i>Minutocellus polymorphus</i> (0.2 µg/L), <i>Micromonas pusilla</i> (0.3 µg/L), <i>Proteomonas sulcata</i> (0.84 µg/L); all from a paper by Levy et al. (2007), and <i>Phaeodactylum tricornutum</i> (0.7 µg/L) from a paper by Angel et al. (2015).</p> <p>Neither of these papers discuss essentiality of copper to these algal species. However, if there was an issue with insufficient copper limiting the algal growth, this would be expected to be observable through higher growth rates at moderate copper concentrations (indicating preferred conditions), before a reduction in growth rates at higher concentrations (where it becomes toxic) (i.e. a hormetic effect). There was no discussion of this occurring in Levy et al. (2007) and no evidence of such an effect in the concentration-response relationships shown in Angel et al. (2015).</p> <p>A further possible issue that has been suggested in toxicity testing relates to the culturing of organisms in low metal concentrations in the laboratory, resulting in higher sensitivity in toxicity tests. The algae used in these tests are all from cultures maintained in the laboratory, suggesting this is a possible mechanism for the high sensitivity. However, copper is a component of the culture media</p>	<p>Text has been added to Section 4.2 and section 4.4 to reflect this issue.</p>

Comment	Response	Action taken
much of the micronutrient. Some discussion of this aspect and how it has been considered to ensure that less sensitive species are not subject to conditions that could result in deficiency has been addressed.	used for each (f medium or half strength f medium, with copper concentration around 2-3.5 µg/L based on instructions for preparation of media), indicating that copper is unlikely to have been limiting in the culture medium. These concentrations are at, or higher than the range that might be expected in coastal waters.  Consequently, it is considered unlikely that the DGVs will be below limits of essentiality.	
<p><i>4. Ambient levels of copper</i></p> <p>Another important consideration in setting guideline values is the ambient concentrations for naturally occurring chemicals. In this case, geology in Australia means that copper is almost always reported at detectable levels in soil in all locations. This results in copper levels in surface and groundwaters being close to or above the existing water quality guideline values for copper in both fresh and marine situations especially those near urban (or mineralised) areas. There should be some discussion included in the document about what to do when normal ambient levels (in reference locations) are already above the new guideline value as this will be the case in most locations. This change in guideline value will mean that all sites will now have copper levels in excess so there needs to be information provided about how to address that matter in environmental studies and site investigations.</p>	The issue of background concentrations being higher than the DGVs was addressed in the response to comment 1 from submission B. As noted in this response, ANZG (2018) provides guidance in the event that a DGV is below natural background concentrations.	See action taken for comment 1 from submission B.
<b>Submission D</b>		
1. The use of a DOC correction is a sensible addition to the default guideline value given the known influence of DOC on the toxicity of dissolved copper.	Thank you for this comment	No action taken.
2. A table is provided .... that contains copper toxicity data for Australian marine organisms that may not have been considered in the derivation of the DGV. Some of the provided references report chronic toxicity data for copper as part of	Thank you for the provision of the additional data. Some of the data have been added to the copper dataset. Some of the values were already included in the database but not included in the SSD as copper was not measured in the test solutions or DOC concentrations were above the threshold used in the derivation. In some cases the accepted names have changed from the reported	New data from Gissi et al. (2017; 2018) and Stone et al. (2021) have been

Comment	Response	Action taken
reference toxicity tests adjacent to studies on other contaminants. As such they may not have been identified if the search terms were specific to copper toxicity. <i>See Attachment A for supporting information provided with the submission.</i>	names. In the case of <i>Acropora longicyathus</i> the data was erroneously flagged as nominal rather than measured, so this is now included in the derivation.	added to the dataset and used in the derivation.
3. It is unclear whether toxicity data was screened based on the habitat (tropical/temperate/polar) or a temperature range. Consideration could be given to the references given on page 4 that report copper toxicity to Antarctic species. This may be relevant to the Australian and New Zealand Antarctic territories and sub-Antarctic islands whose marine environments are managed by the Commonwealth and Tasmanian governments (for Australia), respectively. If these environments are not included in the DGV, this should be stated in the technical brief.	Noted.	A sentence added to Section 4.4.

## References

Bar-On YM & Milo R 2019. The Biomass Composition of the Oceans: A Blueprint of Our Blue Planet. *Cell* 179(7): 1451-1454.

Gordon D P, Beaumont J, MacDiarmid A, Robertson DA & Ahyong ST 2010. Marine Biodiversity of Aotearoa New Zealand. *PLOS ONE* 5(8): e10905.