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Your ref:
Our Ref: Gunss/LH/05062007

5 June 2007.

Gunns Limited,
East Tamar Highway,
Long Reach,
Tasmania 7253,
Australia.

To: Lawson Harding

Dear Lawson,

Commentary/Review of Request for Information No. 029

Please find attached a short report outlining my thoughts on SWECO PIC's questions to the DTAE to enable an assessment under Section D3.18 of the Guidelines relating to the edge of the mixing zone. I have given answers (where relevant to my expertise) or else referred the commentary/review to one of Gunns other experts.

I have addressed the bullet points under subheading 1 as requested.

Sorry for the short report, as I only received the request one and a half days ago.

Yours sincerely,

David Balloch,
Managing Director.
EnviroGulf Consulting

Attachment(s): David Balloch – Request for Information No. 029

1. Introduction

1.1 Background

Gunns Limited ('Gunns') requested Mr. David Balloch of EnviroGulf Consulting to provide comments on, or review of, Request for Information No. 029, which specifically relates to colour of the effluent to be discharged in Bass Strait and its impact on the marine environment at the 'edge of the mixing zone' and beyond.

[DB note: this Request for Information was delivered with less than 2 day's notice – so I have prepared preliminary notes that may be of some assistance]

1.2 The Tasmanian Guidelines

Tasmanian Emission Limits Guidelines

Part D.3.18 of the Tasmanian Emission Limit Guidelines (RPDC, 2004) state that a mixture of effluent and receiving water, in a proportion equal to the agreed minimum dilution at the edge of the mixing zone, should have the following properties in comparison to the receiving water alone:

(a) Colour:

- (i) the visual clarity is not reduced by more than 20%.
- (ii) the hue is not reduced by more than 10 points on the Munsell Scale.
- (iii) the reflectance is not changed by more than 50%.
- (iv) the horizontal sighting of a 200 mm black Secchi disc is more than 1.6 m.

(b) Optical quality:

- (i) natural euphotic depth: no more than 10% change.
- (ii) seasonal mean nephelometric turbidity: no more than 10% change.

In addition, the Tasmanian Emission Limit Guidelines (RPDC, 2004) also state, notwithstanding the recommended colour limits set out above, that colour emissions must not affect visual amenity of the local beaches and environ

2. Commentary and Review

2.1 Requested Information

The following questions in the bullet points of subheading 1 in the request for Information No. 029 were raised:

- Colour intensity, and justification that this is adequately low to ensure no significant restriction of light to marine organisms.

- Visual clarity.
- Background hue and the expected maximum hue.
- Maximum expected reflectance.
- Minimum expected horizontal sighting of a 200 mm Secchi disc.
- Natural euphotic depth (background and minimum expected).
- Seasonal mean nephelometric turbidity (background and maximum expected).

These questions or point raised are dealt with below.

2.2 Colour Intensity

Requested Information:

Colour intensity, and justification that this is adequately low to ensure no significant restriction of light to marine organisms.

DB Response:

This is covered further in Section 2.5 below (Euphotic zone).

- For the purposes of hydrodynamic modelling and defining a mixing zone if it were based on colour, GHD (2007) used the 50-percentile value of 1 mg Pt/L as the background colour level and the 80-percentile value of 2 mg Pt/L as the trigger value. Under these assumptions, a 493-fold dilution of the effluent would be required to meet the WQO of 2 mg Pt/L.
- Table 2 (p. 26 of GHD (2007) states that predicted concentrations of colour are 493 mg Pt/L, background is 1 mg Pt/L and the proposed trigger level is 2 mg Pt/L, requiring a target dilution factor of 493.
- Colour was modelled as a conservative, non-decaying substance. It is assumed that a linear relationship exists between colour concentration measured in mg Pt/L and mg/L.
- The predicted concentration of colour marginally exceeds the 2 mg Pt/L proposed trigger level. Based on the 2 mg Pt/L contour the required mixing zone is 430 m by 400 m (W x H).
- Background colour is assumed to be 1 mg Pt/L. GHD (2007) states that the background range for Bass Strait is <1 to 7 mg Pt/L.
- Based on the predicted 95%-ile concentration, Figure E-8 in GHD (2007) indicates the following.
 - colour at the surface within the 430 by 400 mixing zone exceeds 2 mg Pt/L.
 - colour at the surface within a 280 by 280 m inside the mixing zone exceeds 2.2 mg Pt/L.

- colour at the surface within a 230 by 230 m inside the mixing zone exceeds 2.4 mg Pt/L.
 - colour at the surface within a 125 by 125 m inside the mixing zone exceeds 2.6 mg Pt/L.
 - the above predicted low concentrations of colour (range 2.0 to 2.6 mg Pt/L) are conservative as the 95%-ile concentration values would only be expected to occur for 5% of the time during the year and more likely discontinuously. The 50%-ile value, which occurs for half the time (i.e., 182 days per year) may be more relevant as potential effects on the growth and productivity bottom-living seagrasses macroalgae are time-concentration dependent. If 50%-ile concentrations were used, the colour values would result in a much smaller mixing zone [DB note: Ron Fryar to confirm].
- In addition, Cuthbert and del Giorgio (11992) state that measuring colour in Pt units overestimate the concentrations of humic compounds (e.g., tannins) in water, precluding their use in mass balance calculations.

2.3 Visual clarity

Requested Information:

Visual clarity.

DB Response:

- Visual clarity is addressed under ‘colour’ in Part D.3.18 of the Tasmanian Emission Limit Guidelines (RPDC, 2004) and states that:
 - the visual clarity is not reduced by more than 20%.
- I presume ‘visual clarity’ relates to amenity and recreational values or uses of coastal marine waters in the vicinity of the outfall.
- In the ANZECC/ARMCANZ (2000) guidelines for marine waters, recreational guideline for visual clarity is a Secchi disc depth >1.6 m.

I have addressed visual clarity under Sections 2.5 (Secchi disc) and 2.6 (Euphotic zone) below.

2.4 Background hue and Expected Maximum Hue

Requested Information:

Background hue and the expected maximum hue.

DB Response:

- Hue, which most people call ‘colour’ in ordinary language. This topic is outside my field of expertise and relates to amenity and recreational uses of coastal marine waters.

- I presume hue if present will be different from surrounding seawater and would be restricted to surface waters within the mixing zone. This would represent a small area of potentially affected water located about 3 km offshore and, under typical surface waves, unlikely to be visible to onshore viewers. [DB note: Ron Fryar may have more information].

2.5 Horizontal Secchi Disc

Requested information:

Minimum expected horizontal sighting of a 200 mm Secchi disc.

DB Response:

I presume this request relates to Part D.3.18 of the Tasmanian Guidelines (RPDC, 2004) which states that at the edge of the mixing zone “the horizontal sighting of a 200 mm black Secchi disc is more than 1.6 m”.

Observations:

- The Draft IIS (Appendix 24) states that the ‘vertical’ Secchi disc depths at the diffuser site averaged 8.63 ± 1.17 m (range 7 to 11 m).
- ANZECC/ARMCANZ (2000) recreational guidelines for marine waters is for a visual clarity as assessed by a Secchi disc depth >1.6 m. The 1.6-m value indicates that the Tasmanian Guidelines relate to amenity and recreational use of coastal waters, rather than relating to marine primary production. For example, this 1.6-m value relates to ensuring water clarity, such that some one diving into water can see submerged objects.

Comments:

- One purpose of the diffuser design is to reduce colour by having twenty 1-m high ports spaced 10 m apart to increase dispersion of colour-producing material in the effluent.
- The location of the diffuser outfall also serves to reduce the impact of discolouration of marine surface waters and reduce the size of visible plume from an aesthetic point of view.
- Effluent-derived colour at the edge of the mixing zone is not uniform from surface to bottom. The diluted effluent forms a surface plume, which moves in the direction of prevailing wind-driven waves and currents. Therefore, the use of a horizontal Secchi disc measurement is relevant to measuring the degree of dilution achieved but is not relevant to the water column and as a measure of light penetration or attenuation with depth. The latter is relevant to bottom-living photosynthesising plants, such as seagrasses and algae.
- At the edge of the mixing zone and beyond, a lens of slightly more coloured diluted effluent will overly clearer (less coloured) waters of seawater (free of effluent) beneath the surface plume.

- Secchi depth is an approximate measure of the depth to which light penetrates the water column. Therefore, the use of Secchi disc measurements in the water column (i.e., vertical rather than horizontal) at the edge of the mixing zone is more relevant to assessing light attenuation effects (i.e., reduction in photosynthetically active light) on bottom living macroalgae and seagrasses in the vicinity of the diffuser site.
- Secchi depth approximates the depth at which about 5% of transmitted light remains.
- In general, the depth of euphotic zone is about 2 to 3 times the Secchi depth.

2.6 Natural Euphotic Zone Depth

Requested Information:

Natural euphotic depth (background and minimum expected).

DB Response:

- The depth of the euphotic zone is a useful index of the penetration of diffuse sunlight into the sea and represents the depth at which photosynthetically active radiation (PAR) is reduced to about 1% of the level at the water surface.
- Kenworthy and Fonseca (1996) determined that the minimum light requirements of seagrass ranged from 24% to 37% of the light just beneath the water surface which is much higher than the euphotic zone depth for many phytoplankton and macroalgae (1–5% incident light).
- The depth of water in the vicinity of the diffuser outfall site is about 24 to 26 m, which is less than the depth of the euphotic zone. The virtual depth of the euphotic zone is anticipated to be much greater (i.e., deeper), as patches of seagrasses (and benthic green algae) are present at depths of about 30 m (Draft IIS, Appendix 24) and which require minimum light requirements of between 34% and 37% of surface irradiance (see above). Therefore, minimum light levels of at least 34% of surface irradiance are present at the seafloor at 30 m.
- Since the minimum incident light requirements for seagrass ranges from 24 to 37% of the level at the water surface, then the depth of the virtual euphotic zone may be expected to be around 35 to 50 m.
- Given that, at the edge of the mixing zone, the colour of the diluted effluent is predicted to be around 2 mg Pt/L (compared to a background colour of 1 mg Pt/L with a range of <1 to 7 mg Pt/L for Bass Strait) in a surface lens of 1 to a few metres depth, then I would expect that the depth of the euphotic zone would remain unchanged, that is, >1% incident light will be achieved on the seafloor. This would allow the continuation of benthic macroalgal productivity and growth.
- There is no seagrass present in the vicinity of the diffuser outfall, so reduced light incidence, would not affect seagrass.

2.7 Turbidity

Requested information:

Seasonal mean nephelometric turbidity (background and maximum expected).

DB Response:

- The Draft IIS (Appendix 24) gave a series of turbidity data at sampling stations offshore of Five Mile Bluff, including in the vicinity of the diffuser outfall site.
- Turbidity values average around 0.54 NTU at the diffuser outfall site and ranged from 7 to 11 NTU. Overall, water clarity is high.
- The baseline, construction and operational water quality monitoring programs will provide a more robust dataset, including seasonal data.

3. References

Cuthbert, I.D. and del Giorgio, P. 1992. Toward a standard method of measuring color in freshwater. *Limnol. Oceanogr.* 37(6):1319-1326.

Kenworthy, W.J., and Fonseca, M.S. 1996. Light requirements of seagrasses *Halodule wrightii* and *Syringodium filiforme* derived from the relationship between diffuse light attenuation and maximum depth distribution. *Estuaries* 19:740-750.

