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Subject: Assessment of Aquaculture and Water-based Recreation Beneficial Uses
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Introduction

The State environment protection policy (Waters) October 2018 ('SEPP Waters') provides guidance and direction for the protection of aquatic ecosystems and species that inhabit Victorian waters. A range of beneficial uses are described in SEPP Waters that must be protected to support their use or value. Waters within Victoria must be a suitable quality and quantity for the protection of the beneficial uses. SEPP Waters has drawn on water quality guidelines outlined in ANZECC & ARMCANZ (2000) National Water Quality Management Strategy to inform its environmental objectives.

Purpose

The Yumbah environment approvals documents have described measures that will be employed during construction and operation to protect beneficial uses listed in SEPP.

This memo provides an evaluation of the potential impacts/effects of the proposed Yumbah Nyamat facility on the following beneficial uses:

- Saltwater aquaculture
- Shellfishing
- Water based recreation - Primary contact (eg. Swimming, diving, water skiing), secondary contact (boating and fishing) and aesthetic enjoyment.

Guideline Values

A range of environmental quality objectives or guideline values exist to protect the beneficial uses of aquaculture and water-based recreation.

The guideline values utilised in the assessment were from the following sources:

- Saltwater aquaculture:
 - ANZECC & ARMCANZ (2000) Table 4.4.2 Physico-chemical stressor guidelines for the protection of aquaculture species (specifically dissolved oxygen, suspended solids and pH).
 - ANZECC & ARMCANZ (2000) Table 4.4.3 Toxicant guidelines for the protection of aquaculture species (specifically ammonia).
 - SEPP Waters (2018) Table 12 Environmental Quality Indicators and Objectives for Aquaculture
- Shellfishing:
 - ANZECC & ARMCANZ (2000) Table 4.4.4 Guidelines for the protection of human consumer of fish and other aquatic organisms from bacterial infection.
- Water-based recreation primary and secondary contact:
 - ANZECC & ARMCANZ (2000) Section 5.2.3.1 Sub-Section Primary Contact for faecal coliforms and enterococci.

- SEPP Waters (2018) Table 14 Short-Term Environmental Quality Indicators and Objectives for Water-based Recreation. SEPP Waters state *for marine and estuarine segments, only the environmental quality indicator of enterococci can be used to assess risk to this beneficial use.*

A summary of these guideline values is presented in Table 2 as black bold numbers.

Microbial Water Quality

There are a large number of water quality measurements from Yumbah Narrawong (n >150 for quarterly sampling from November 2001-March 2018) of discharge water for ammonia, suspended solids, dissolved oxygen and pH as these parameters require sampling in the EPA Licence. Data presented previously indicates concentrations are well within ANZECC and SEPP Waters environmental objectives. Microbial concentrations are not generally monitored at Yumbah Narrawong as the risk from abalone farming had been deemed low and analysis is not required in the EPA licence.

In August 2018, water collected at Yumbah Narrawong and also the proposed receiving environment for Yumbah Nyamat was analysed for microbial content. Results for this sampling event are presented in Table 1. The following is concluded from these measurements:

- The reported coliforms are likely total coliforms, and not specifically faecal coliforms. The increase in total coliforms presumably is associated with abalone waste, and not associated with human waste. Total coliforms include a range of bacteria including *E.coli* and enterococci that are deemed of concern to human health when present in elevated concentrations.
- *E. coli* and faecal coliforms typically have very similar measurements within a sample. *E. coli* is the appropriate proxy for faecal coliforms and is utilised as such here. Enterococci is the more representative microbe in both marine and freshwaters, while *E.coli* is primarily of concern in freshwaters.
- Characteristic ambient values of <10 CFU/100 ml and 20 MPN/100 ml are adopted for *E. coli* and enterococci, respectively.
- The single outlet measurements of 20 CFU/100 ml and 30 MPN/100ml for *E. coli* and enterococci, respectively are the representative outlet concentration for the microbial parameters from Yumbah.

Table 1 Microbial measurements during August 2018.

Parameter	Nyamat Ambient (offshore from site)	Narrawong Ambient (Inlet pipe)	Narrawong Ambient 2 (QAQC)	Narrawong SEC out (DP3B)
Coliforms (CFU/100 ml)	<10	41	52	1000
<i>E.coli</i> (CFU/100 ml)	<10	<10	<10	20
Enterococci (MPN/100 ml)	<10	20	<10	30

Existing Narrawong Facility Assessment of Outlet Waters

The performance of the outlet water quality for the existing Narrawong facility relative to the beneficial use guideline values are summarised in Table 2.

The following key conclusions follow from this evaluation:

- Saltwater aquaculture:
 - Ammonia, suspended solids and dissolved oxygen meet the saltwater aquaculture guideline values in ANZECC & ARMCANZ (2000) for at least 80%, 90% and 95% of the time, respectively.
 - pH always is within the saltwater aquaculture guideline range.

- Shellfishing:
 - The one (1) measurement of *E. coli* (proxy for faecal coliforms) at the point of discharge from Narrawong is above 14 org/ml which is the guideline value for shellfishing in ANZECC & ARMCANZ (2000) and also the aquaculture objective in SEPP Waters. The concentration in ANZECC & ARMCANZ (2000) is derived for the protection of human consumers of aquatic foods.
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- Primary contact (swimming):
 - The one (1) measurement of *E. coli* (proxy for faecal coliforms) and enterococci are below the ANZECC & ARMCANZ (2000) median value, however these single measurements are below the minimum requirement of 5 samples.
 - The one (1) measurement of *E. coli* and enterococci are well below the SEPP Waters short term environmental quality indicator for primary recreation. There are insufficient measurements (only 1 measurement) to compare to the SEPP Waters long-term microbial quality indicators on the basis of enterococci.

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Table 2 Relevant guideline values (BOLD) for aquaculture, shellfishing and primary contact and comparison to quarterly Narrawong outlets monitoring and Nyamat median estimates.

	ANZECC & ARMCANZ (2000) Saltwater Aquaculture	ANZECC & ARMCANZ (2000) Shellfishing Water	SEPP Waters Aquaculture	ANZECC & ARMCANZ (2000) Primary Contact (minimum 5 samples per month in bathing season)		SEPP Waters Short- Term for Water Based Recreation	SEPP Waters Long-Term for Primary Contact
Chemical/ Analytes	Guidelines		Median	Median	Maximum	Single Sample	95th Percentile of Rolling Data
Ammonia (mg/L)	<p><0.1</p> <p>Narra Max 0.65</p> <p>Narra 98th %ile 0.2</p> <p>Narra 90th %ile 0.12</p> <p>Narra 80th %ile 0.095</p> <p>Nyamat 50th %ile Est 0.07</p>						
Suspended Solids (mg/L)	<p><10</p> <p>Narra Max 70</p> <p>Narra 98th %ile 18.9</p> <p>Narra 90th %ile 9.8</p> <p>Nyamat 50th %ile Est 3.9</p>						
Dissolved Oxygen (mg/L)	<p>>5</p> <p>Narra Min 4.3</p> <p>Narra 5th %ile 5.1</p> <p>Narra 10th %ile 5.8</p>						
pH	<p>6-9</p> <p>Narra Max 8.2</p> <p>Narra 90th %ile 8.1</p> <p>Narra 10th %ile 7.8</p> <p>Narra Min 6.6</p> <p>Nyamat 50th %ile Est 7-9</p>						

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	ANZECC & ARMCANZ (2000) Saltwater Aquaculture	ANZECC & ARMCANZ (2000) Shellfishing Water	SEPP Waters Aquaculture	ANZECC & ARMCANZ (2000) Primary Contact (minimum 5 samples per month in bathing season)		SEPP Waters Short-Term for Water Based Recreation	SEPP Waters Long-Term for Primary Contact
Chemical/ Analytes	Guidelines		Median	Median	Maximum	Single Sample	95th Percentile of Rolling Data
Total Faecal Coliforms (CFU/100 ml)		14 ¹ Narrawang Outlet (<i>E. coli</i>) 20	14 Narrawang Outlet (<i>E. coli</i>) 20	<150 Narrawang Outlet (<i>E. coli</i>) 20	<600 (4 out of 5 samples) Only 1 sample so not evaluated		
Enterococci (MPN/100 ml)				<35 Narrawang Outlet 30	60-100 Narrawang Outlet 30	<500 Narrawang Outlet 30	<200 Only 1 sample so not evaluated
<i>E. coli</i> (CFU/100 ml)						<550 Narrawang Outlet 20	

Red text represents exceedance of guideline values.

Green, yellow and orange shading represent whether outlet quality always meets, generally meets or often does not meet the relevant guideline value, respectively.

- Guidelines for the protection of human consumers of fish and other aquatic organisms from bacterial infection

Mixing Zone Evaluation

On the basis of adopted ambient concentrations, outlet concentrations and guideline values, Table 3 outlines whether the estimated dilution requirement of the outlet waters (5:1) is met for the beneficial uses of saltwater aquaculture, shellfishing and primary contact.

The beneficial use of shellfishing in ANZECC & ARMCANZ (2000) has the most stringent requirement given the assumptions with a 5 fold dilution. All other concentrations are aligned with the objectives to protect the beneficial uses discussed.

The risk of outlet waters impacting either of the aquaculture facilities via short-circuiting or primary recreational contact is low. The ~1.5-2.5 fold dilution requirement is readily met between the outlet/intake structures and the proximal shorelines for the beneficial uses of aquaculture and primary recreational contact, respectively.

In regards to water-based recreation, and primary and secondary contact, Nyamat poses no risk to the following (as outlined in SEPP Waters):

- Chemical contamination - chemicals are rarely used and are not deemed contaminants in the marine environment
- pH – discharge water is within the range of 6.5-8
- discharge waters will be free of visible materials, floating debris, scum, substances producing objectionable colour, odour, taste, turbidity and substances and conditions that produce undesirable aquatic life.

Conclusion

As outlined in SEPP Waters, the unattainment of an environmental quality objective indicates that the beneficial uses may be at risk, and further investigation is required to assess the level of risk. Information presented in this memo indicates that the environmental quality objectives in both ANZECC and SEPP Waters will be achieved at Yumbah Nyamat for both the Aquaculture and Water-based recreation beneficial uses.

In concluding, water quality from Yumbah Nyamat will not compromise existing aquaculture activities in Portland Bay and will not result in impact to recreational uses including swimming, fishing and boating.

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Table 3 Estimates of the dilution requirement of the outlet waters with the ambient waters to meet the guideline values for the various beneficial uses.

Beneficial Value	Chemical/Analytes	Ambient (Intake)	Outlet Concentration	Guideline Value	Dilution Achieved with 5:1	Comment
Saltwater Aquaculture	Ammonia (mg/L)	0.01	0.2	0.1	Yes	98th percentile ammonia used as maximum value. Risk of ammonia from Nyamat to aquaculture BU low due to dilution factor of 5:1 and Nyamat >5km from Narrawong
	Suspended Solids (mg/L)	3.05	18.9	10	Yes	98th percentile suspended solids used as maximum value. Risk of suspended solids to aquaculture BU from Nyamat low due to dilution factor of 5:1
	Dissolved Oxygen (mg/L)	8	4.3	5	Yes	Dissolved oxygen risk to aquaculture BU is low due to efficient mixing
	pH	8.1	6.6	>6	Yes	No risk to ambient pH
Shellfishing and SEPP Waters	Faecal Coliforms (CFU/100 ml)	<10	20	14	Yes	The dilution in the mixing zone should protect aquaculture BU in accordance with the Mixing Zone Predictions report.
Primary Contact	Faecal Coliforms (CFU/100 ml)	41	1000*	150	Yes	Faecal coliforms are a proportion of the total coliforms, including <i>E.coli</i> and enterococci.
	Enterococci (MPN/100 ml)	20	30	35 ¹ <550 ²	1.5	There is negligible risk from Nyamat to water-based recreation, including both primary and secondary contact. Bacteria concentrations are within criteria. The dilution of discharge water

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Beneficial Value	Chemical/Analytes	Ambient (Intake)	Outlet Concentration	Guideline Value	Dilution Achieved with 5:1	Comment
	<i>E. coli</i> (CFU/100 ml)	<10	20	150 ¹ <500 ¹	-	will quickly reduce enterococci well below ANZECC criteria of 35 org/100ml. There is no objective in SEPP Waters for <i>E.coli</i> as this is deemed concern in freshwater.
Secondary Contact	Enterococci (MPN/100 ml)	20	30	40-200 ²	-	
	<i>E. coli</i> (CFU/100 ml)	<10	20	1000 faecal coliforms ¹	-	

* Reported by laboratory as total coliforms which include *E.coli* and Enterococci are a component.

1. ANZECC & ARMCANZ (2000) Table 5.2.2
2. SEPP Waters Table 13 and 14