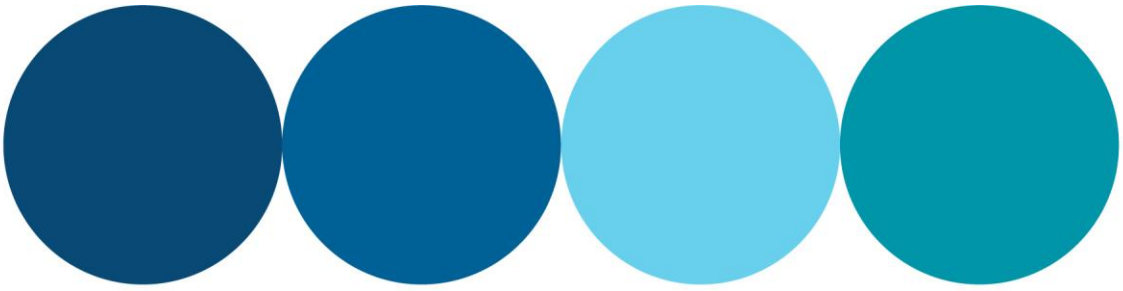
Sepia Depression Ocean Outlet Landline (SDOOL) & Perth Long Term Ocean Outlet Monitoring Program (PLOOM)

2018–2019 Annual Report



WATER CORPORATION

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This report is 'Draft' until approved for final release, as indicated below by inclusion of signatures from: (i) the author and (ii) a Director of BMT Western Australia Pty Ltd (BMT) or their authorised delegate. A Draft report may be issued for review with intent to generate a 'Final' version, but must not be used for any other purpose.

Approved for final release:

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Contents

Acronyms

ANZG	Australian and New Zealand Guidelines for Fresh and Marine Water Quality
CFU	Colony forming unit
DoH	Western Australian Department of Health
EPA	Environmental Protection Authority
EQC	Environmental Quality Criteria
EQG	Environmental Quality Guideline
EQMF	Environmental Quality Management Framework
EQO	Environmental Quality Objective
EQS	Environmental Quality Standard
EV	Environmental Value
HEPA	High ecological protection area
MPN	Most probable number
NATA	National Association of Testing Authorities
NOEC	No observed effect concentration
OZI	Observed zone of influence
PLOOM	Perth Long Term Ocean Outlet Monitoring
TTC	Thermotolerant coliforms
TTM	Total toxicity of the mixture
TWW	Treated wastewater
WASQAP	Western Australian Shellfish Quality Assurance Program
WET	Whole of effluent toxicity
WRRF	Water Resource Recovery Facility
WWTP	Wastewater Treatment Plant

Executive Summary

This report documents the findings of the 2018–2019 Sepia Depression ocean monitoring program. Results are reported in the context of the Environmental Quality Management Framework (EQMF) described in EPA (2017). The results are summarised in Report Card format (Table ES 1). The report card contains colour-coded results, with the individual colours representing the extent to which the Environmental Quality Criteria (EQC) were met Table ES 2–Table ES 4.

Table ES 1 Summary report card legend

Management response	Colour
Monitor: EQG/EQS met (continue monitoring)	
Investigate: EQG exceeded, investigate EQS	
Action: EQS not met (management response required)	

Table ES 2 Summary report card for the Environmental Quality Objective 'Maintenance of Ecosystem Integrity'

Environmental quality indicator		EQC	Comments	Compliance
Toxicants in treated wastewater (TWW)	Bioaccumulating toxicants	EQG	Concentrations of cadmium and mercury in the undiluted TWW stream were below the ANZECC/ARMCANZ (2000) 80% species protection guideline	
	Non-bioaccumulating toxicants and initial dilution	EQG	Contaminant concentrations were lower than the ANZECC/ARMCANZ (2000) triggers for 99% species protection guidelines after dilution equivalent to that expected at the LEPA boundary	
	Total toxicity of the mixture (TTM)	EQG	The TTM for the additive effect of ammonia, copper and zinc after initial dilution (0.51) was below the ANZECC/ARMCANZ (2000) guideline value of 1.0	
	Whole of effluent toxicity testing	EQG	The lowest NOEC during the reporting period was 6.3%. Only 16 dilutions with background seawater are required to achieve this NOEC which is lower than the dilutions typically achieved at the LEPA boundary.	
Nutrient enrichment	Chlorophyll-a	EQG	Median chlorophyll-a concentration within the high	

			ecological protection area (HEPA) was lower than the 80th percentile of historical reference site concentrations	
	Light attenuation coefficient (LAC)	EQG	Median LAC within the HEPA was equal to the 80th percentile of historical reference sites.	■
Phytoplankton blooms	Phytoplankton biomass (measured as chlorophyll-a)	EQG	Median chlorophyll-a concentrations did not exceed three times the median of reference on any sampling occasion.	■
			Median chlorophyll-a at any site did not exceed three times the median of reference sites on any sampling occasion during the summer monitoring period.	■
Physical chemistry	Organic enrichment	EQG	Within the HEPA, dissolved oxygen saturation remained above 90% saturation at all times.	■
	Salinity	EQG	Median salinity at 100 m was below the 20th percentile of the natural salinity range	■
		EQS	There were no reported deaths of marine organisms from anthropogenically sourced salinity stress at Sepia Depression over the summer monitoring period.	■

Notes:

1. Green (■) symbols indicate the Environmental Quality Guideline (EQG) were met; amber (■) and red (■) symbols represent an exceedance of the EQG or Environmental Quality Standard (EQS), respectively.
2. NOEC = no observed effect concentration; the highest concentration of TWW at which there is no statistically significant observed effect on gamete fertilisation.

Table ES 3 Summary report card for the Environmental Quality Objective 'Maintenance for Seafood for Human Consumption

Environmental quality indicator		Comments	Compliance
Microbial contaminants	Thermotolerant coliforms (TTC)	Median TTC concentrations derived from 120 samples collected over the 2016–2017, 2017–2018 and 2018–2019 sampling seasons was at the limit of detection (<10 CFU/100 mL)	
		Over the three sampling periods, there were 9 instances where TTC exceeded 21 CFU/100 mL, representing 7.5% (≤10%).	
Algal biotoxins	Toxic phytoplankton species	Toxic phytoplankton species were not recorded in excess of Western Australian Shellfish Quality Guidelines during 2018–2019 monitoring.	

Notes:

1. Green (■) symbols indicate the Environmental Quality Guideline (EQG) were met; amber (■) and red (■) symbols represent an EQG or Environmental Quality Standard (EQS), respectively.
2. TTC results below the analytical detection limit (<10 CFU/mL) were halved (=5 CFU/mL) to calculate median value.
3. TTC = Thermotolerant coliforms.

Table ES 4 Summary report card for the Environmental Quality Objective 'Maintenance of Primary and Secondary Contact Recreation'

Environmental Quality Indicator		EQC	Comments	Compliance
Faecal streptococci	*Enterococci* spp.	EQG (primary contact; 200 MPN/100 mL)	The 95th percentile of *Enterococci* spp. was 1100 MPN/100 mL	
		EQS (primary contact; 500 MPN/100 mL)	The 95th percentile of *Enterococci* spp. was 1100 MPN/100 mL	
		EQG (secondary contact; 2000 MPN/100 mL)	The 95th percentile of *Enterococci* spp. was 1100 MPN/100 mL	
Algal biotoxins	Phytoplankton (cell concentration)	EQG (15 000 cells/mL)	The median total phytoplankton cell concentration was 82 cells/mL	

Note:

1. Green (■) symbols indicate the Environmental Quality Guideline (EQG) were met; amber (■) and red (■) symbols represent an exceedance of the EQG or Environmental Quality Standard (EQS), respectively.

Table ES 5 Summary report card for the Environmental Quality Objective 'Maintenance of Aesthetic Values'

Environmental Quality Indicator	EQC	Comments	Compliance[1]
Nuisance organisms	EQG	Nuisance organisms were not present in excessive amounts	■
Faunal deaths	EQG	There were no instances of dead marine organisms observed	■
Water clarity	EQG	Measurements of light attenuation determined that the natural visual clarity of the water was reduced by ~10% (i.e. > 20%).	■
Colour	EQG	There was no noticeable colour variation on any of the sampling occasions.	■
Surface films	EQG	Bubbles/surface film were visible on the surface of the water on 14 December 2018. No other surface films were recorded on any sampling occasion.	■
Surface debris	EQG	No floating debris was visible on the surface on any sampling occasion.	■
Odour	EQG	A slight odour was notices on 37.5% of sampling occasions.	■
Surface films and odour	EQS	There was no overall decrease in the aesthetic water quality values of Cockburn Sound using direct measures of the community's perception of aesthetic value.	■
Fish tainting substances	EQG	2,4-Dichlorophenol concentration (3.2 µg/L) exceeded the fish tainting substances guideline (0.3 µg/L) collected on 19 February 2019.	■
	EQS	There was no reported tainting of edible fish harvested outside the SHEZ boundary.	■

Note:

1. Green (■) symbols indicate the Environmental Quality Guideline (EQG) were met; amber (■) and red (■) symbols represent an exceedance of the EQG or Environmental Quality Standard (EQS), respectively.

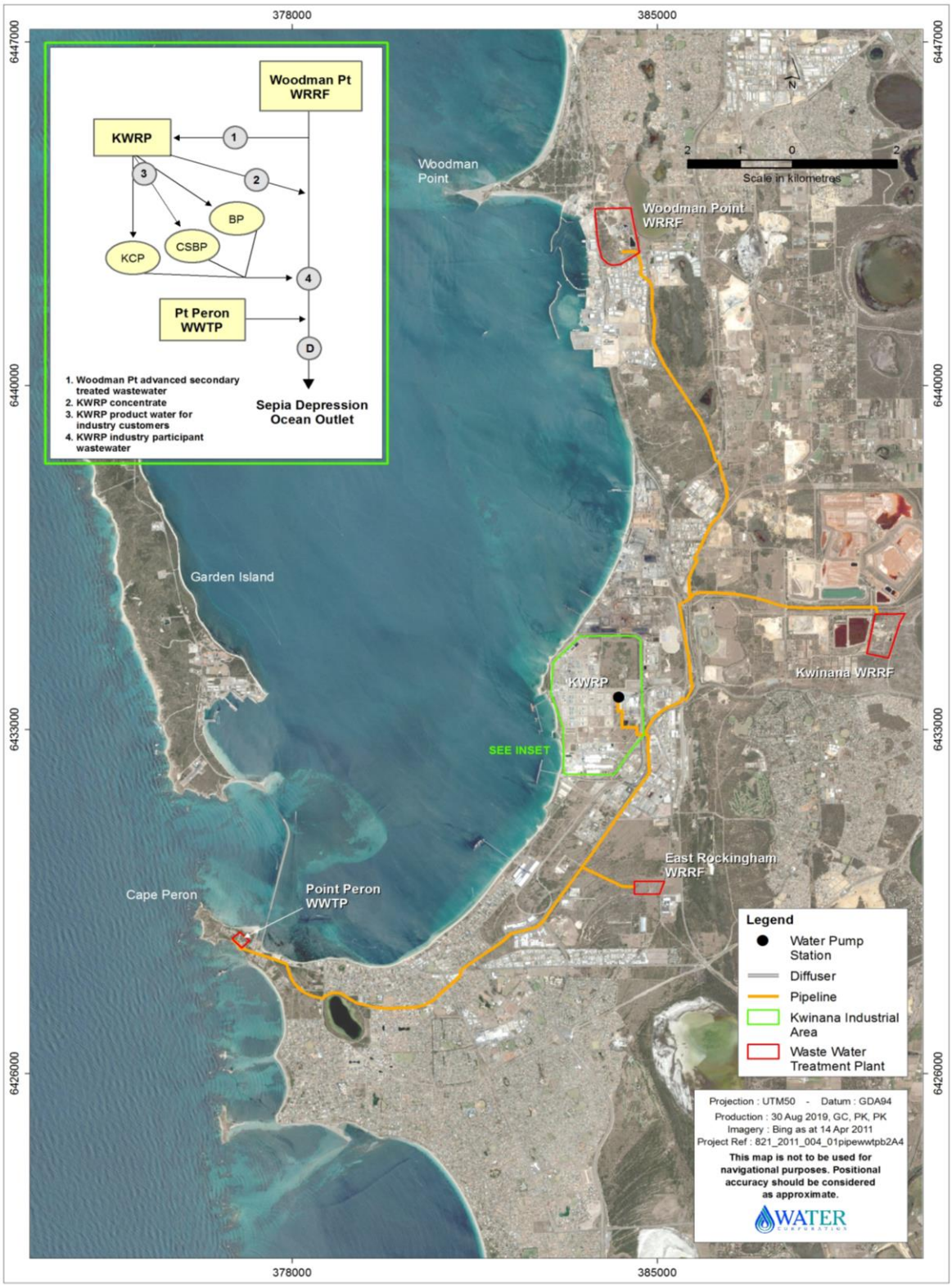
Introduction

Document purpose

This annual report documents the findings of the 2018-2019 ocean monitoring around the Sepia Depression ocean outlet. Monitoring was completed according to the SDOOL Monitoring and Management Plan (SDOOL MMP; BMT Oceanica 2014).

Wastewater treatment plant infrastructure and discharge

Treated wastewater (TWW) discharged to the Sepia Depression ocean outlet comes from the Woodman Point Water Resource Recovery Facility (WRRF), East Rockingham WRRF, Kwinana WRRF, Point Peron Wastewater Treatment Plant (WWTP), and the Kwinana Water Reclamation Plant (KWRP) (Figure 1). The Woodman Point WRRF services southern Perth metropolitan area and receives predominantly domestic wastewater (from kitchen, bathroom, toilet and laundry uses), with ~8% received from light industrial wastewater. Most TWW discharged to the Sepia Depression is from the Woodman Point WRRF. However, a small fraction of primary TWW is from the Point Peron WWTP, located downstream of the Woodman Point WRRF (Figure 1). The KWRP processes secondary TWW from the Woodman Point WRRF to a quality suitable for use as high-grade industrial processing water by industries in the Kwinana industrial area. This high-grade industrial water is supplied to industry participants to reduce consumption of potable scheme water. The KWRP process concentrate is disposed of via the SDOOL (refer to Figure 1).

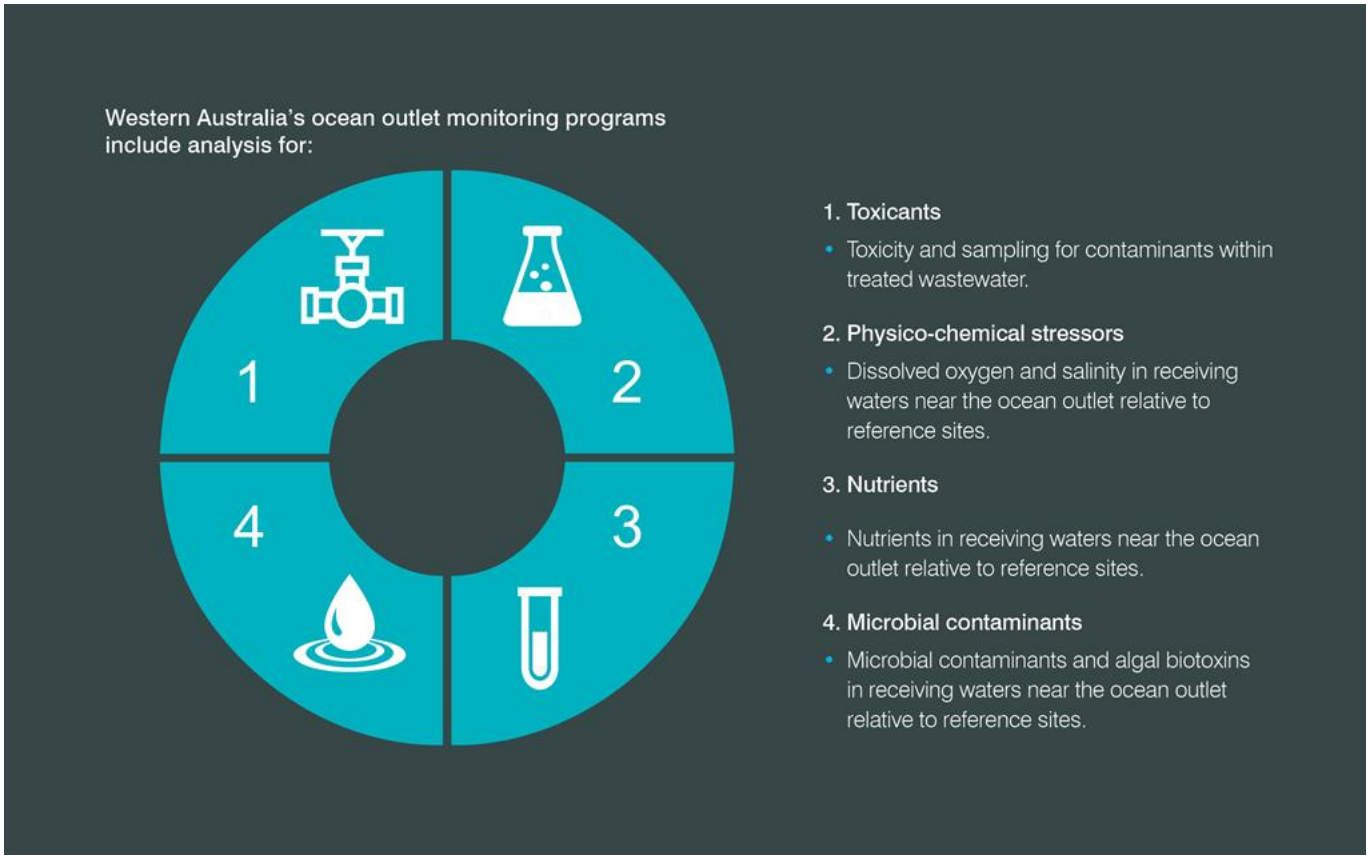


Notes:

1. WWTP = wastewater treatment plant; WRRP = Water Resource Recovery Facility; KWRP = Kwinana Water Reclamation Plant; BP = BP Refinery; KCP = Kwinana Cogeneration Plant; CSBP = CSBP Limited
2. Point D is the composite treated wastewater sample point prior to discharge

Figure 1 Location of the Sepia Depression ocean outlet relative to the SDOOL contributors

Potential stressors in treated wastewater



Toxicants

Metals and persistent organic compounds may be toxic to marine species or accumulate in biota at concentrations sufficient to pose a risk to human health when consumed. TWW is screened for bioaccumulating and non-bioaccumulating toxicants prior to discharge. To account for the synergistic effect of multiple toxicants and toxicants without guidelines, the overall toxicity of the discharge is determine using whole of effluent toxicity (WET) testing (also known as direct toxicity assessment).

Physico-chemical stressors

TWW contains organic matter, decomposition of which by microorganisms uses oxygen. If more dissolved oxygen (DO) is consumed than is produced, DO levels decline. DO saturation in receiving waters near the outfalls provides an indication of the risk posed by deoxygenation.

Reduced salinity near the outfalls, resulting from freshwater in the TWW plume, may cause osmotic stress in marine biota. Salinity in receiving waters near the outfalls is compared to the salinity at appropriate reference sites to determine whether salinity near the outfalls is within the range of natural variability.

Nutrients

TWW contains elevated concentrations of the biologically available nutrients, ammonia, nitrite, nitrate and orthophosphate. At times, the addition of nutrients may stimulate phytoplankton growth beyond natural levels, which can lead to shading of photosynthetic organisms such as seagrasses and macroalgae. The potential for shading is measured using in-water measures of chlorophyll-a (a measure of phytoplankton biomass) and light attenuation (a measure of water clarity).

Although most algal blooms are harmless, some contain species that produce toxins that may be harmful to swimmers (via ingestion or skin contact) or contaminated seafood. Phytoplankton species composition and cell concentrations are monitored to ensure concentrations are within acceptable limits.

Microbial contaminants

Disease-causing organisms in the TWW pose a risk to humans if exposed during primary and/or secondary contact activities (i.e. swimming and boating). The same organisms if ingested by marine fauna may reduce their suitability for human consumption. To assess the risk, concentrations of indicator organisms are routinely compared to the Environmental Protection Authority's (EPA's) criteria for primary and secondary contact, and the criteria for seafood safe for human consumption.

Environmental management approach

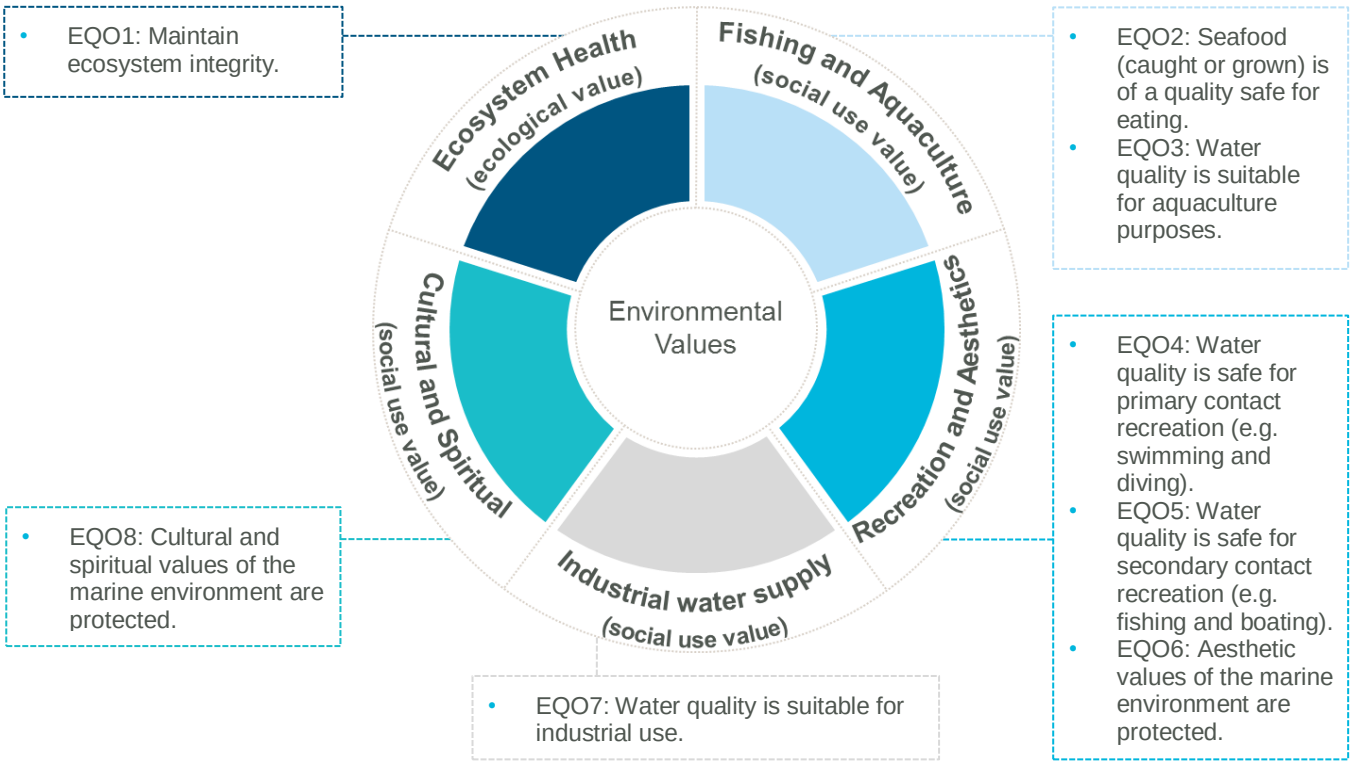
The Sepia Depression Long Term Ocean Outlet (SDOOL) and Perth Long Term Ocean Outlet Monitoring (PLOOM) programs are underpinned by the State Governments Environmental Quality Management Framework (EQMF; EPA 2017).

The EQMF is based on:

- identifying **Environmental Values** (EVs) (Figure 2)
- establishing and spatially defining Environmental Quality Objectives (EQOs) that need to be maintained to ensure the associated EVs are protected (Figure 2)
- monitoring and managing to ensure the EQOs are achieved and/or maintained in the long-term in the areas they have been designated
- establishing Environmental Quality Criteria (EQC), which are quantitative benchmarks or 'trigger values' against which monitoring results can be compared.

There are two levels of EQC:

1. Environmental Quality Guidelines (EQGs) are quantitative, investigative triggers, which if met, indicate there is a high degree of certainty that the associated EQO has been achieved. If the guideline is not met a more detailed assessment against the EQS is triggered.
2. Environmental Quality Standards (EQSs) are management triggers which, if exceeded, signify that the EQO is at risk of not being met and that a management response may be required.



Source: EPA (2016)

Figure 2 Environmental Values and Environmental Quality Objectives (EQO) for the marine waters of Western Australia

Maintenance of Ecosystem Integrity EQO

The intent of this EQO is to maintain a healthy and diverse ecosystem. There are four levels of ecological protection, with each applied depending on the designated level required: low, moderate, high or maximum (Figure 3). A low ecological protection area (LEPA) has been established at the Sepia Depression outfall and occupies the area within a 100 m radius of the diffuser (BMT Oceanica 2014). Waters outside the LEPA are maintained to a high level of ecological protection (HEPA; Figure 4).

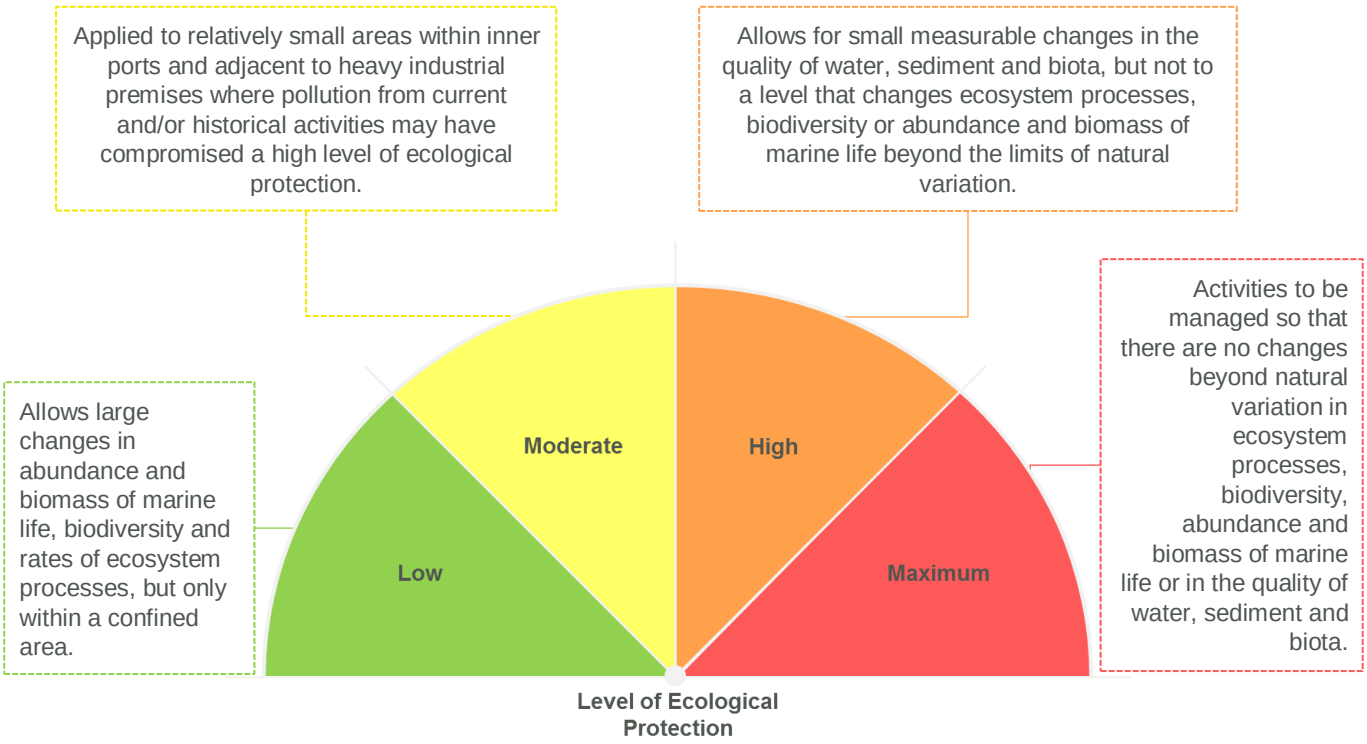


Figure 3 **Level of ecological protection**

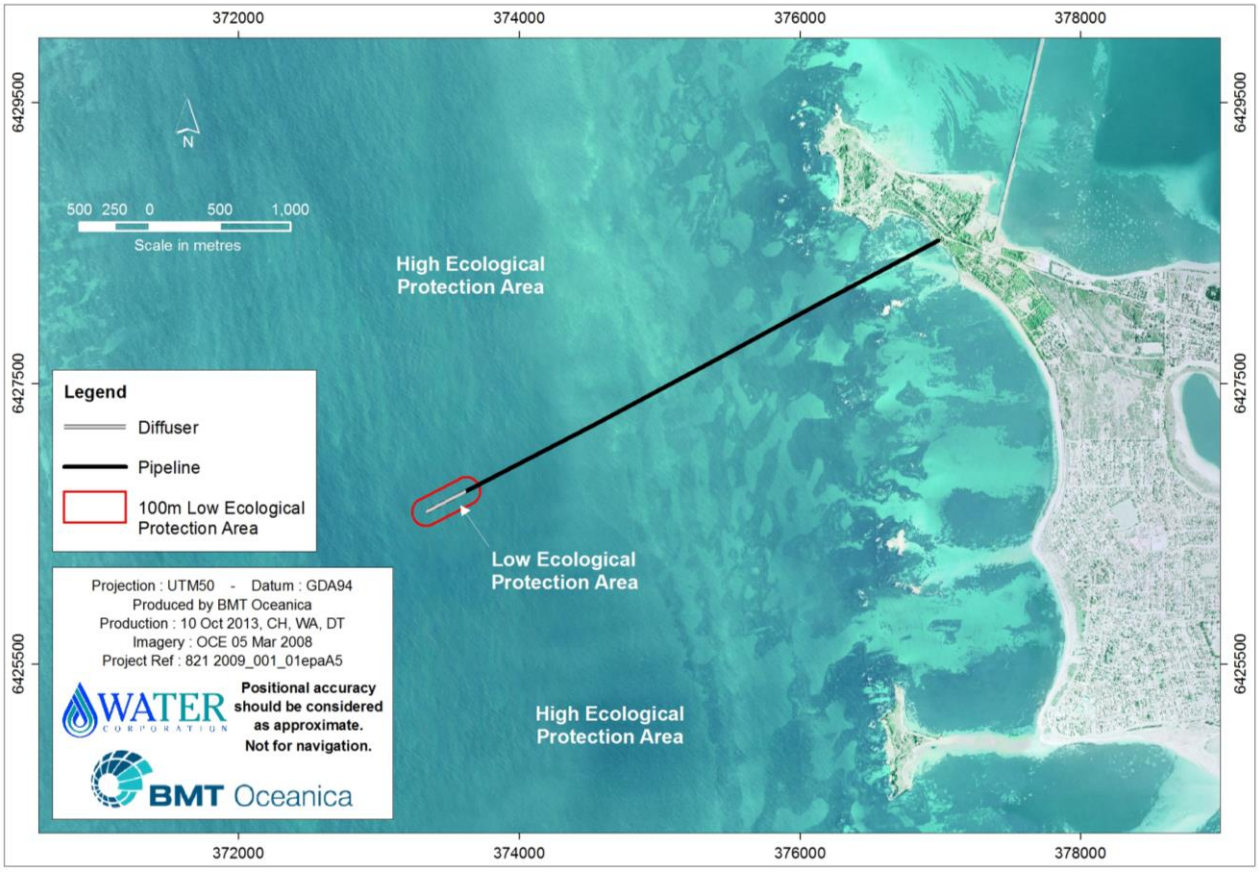


Figure 4 **Sepia Depression ocean outlet ecological protection boundaries**

Maintenance of Seafood Safe for Human Consumption EQO

The intent of this EQO is to maintain seafood safe for human consumption (a social value), with the exception of a small area surrounding the ocean outlet where EQO 2 may not apply as seafood may be unsafe to eat. Formal management zones have been established for the Sepia Depression outlet. Microbiological contaminants and algal biotoxins are monitored at the boundary of the Shellfish Harvesting Exclusion Zone (SHEZ) to ensure the EQO is being met.

Maintenance of Primary and Secondary Contact Recreation EQO

The intent of the primary and secondary contact EQOs are to support swimming and boating activities, respectively. The EQOs apply throughout Perth's coastal waters with the exception of areas around ocean outlets, where water quality may not be suitable for swimming. A formal area where primary contact recreation is not recommended has been established for the Sepia Depression outlet. This is known as the recreational exclusion zone.

As the EQO for maintenance of primary contact recreation requires a higher water quality standard to be maintained than secondary contact recreation, it is assumed that if primary contact criteria are met, then the secondary contact criteria are also met by default.

Maintenance of Aesthetic Value EQO

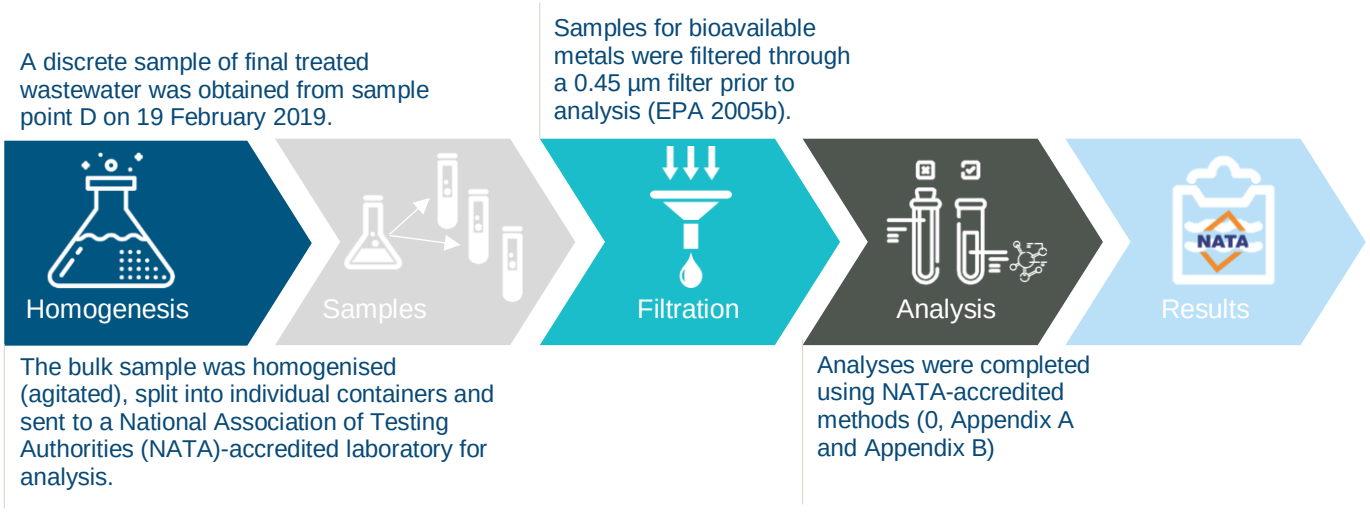
The objective of this EQO is to ensure that the aesthetic value of Perth's coastal waters is protected. To ensure this EQO is being met, monitoring routinely assesses the quality of the surface water appearance.

Toxicants in treated wastewater

Comprehensive treated wastewater characterisation

TWW (final effluent) from the Point Peron WWTP was analysed for a suit of parameters comprising the major contaminants of concern for the Sepia Depression ocean outlet:

- nutrients (total nitrogen, ammonia, nitrate+nitrite (NO_x), total phosphorus, orthophosphate)
- microbiological contaminants (thermotolerant coliforms and *Enterococci* spp.)
- bioavailable metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver and zinc)
- pesticides and herbicides (organophosphate pesticides, organochlorine pesticides, triazine herbicides)
- polyaromatic hydrocarbons
- phthalates
- polychlorinated biphenyls
- benzene, toluene, ethylbenzene, and xylenes
- petroleum hydrocarbons
- surfactants
- dissolved organic carbon



Bioaccumulating toxicants

The EQG for bioaccumulating toxicants (cadmium and mercury) in the TWW is outlined in Table 1.

Table 1 Environmental quality guideline for bioaccumulating toxicants

EQG	Concentrations of contaminants will not exceed the ANZECC/ARMCANZ (2000) 80% species protection guideline trigger levels for bioaccumulating toxicants at the diffuser.

Source: BMT Oceanica 2014

Note:

1. EQG = Environmental Quality Guideline.
2. ANZECC/ARMCANZ (2000) used as specified by Management Plan (Oceanica 2013).

Concentrations of cadmium and mercury (i.e. bioaccumulating toxicants) in the TWW sample were both below the analytical limit of reporting (0.1 µg/L; Table 3) and the EQG for bioaccumulating toxicants was met.

Non-bioaccumulating toxicants

The EQG for non-bioaccumulating toxicants in the TWW is outline in Table 2.

Table 2 Environmental Quality Guideline for non-bioaccumulating toxicants

EQG	Wastewater contaminant concentration corrected for minimum dilution at the LEPA boundary will ensure the ANZECC & ARMCANZ (2000) 99% species protection guideline trigger levels for toxicants (with the exception of cobalt, where the 95% guideline trigger level will apply), are being achieved at the boundary of the Low Ecological Protection Area (LEPA) (i.e. a high level of protection is met beyond a 100 m radius of the diffuser).

Source: BMT Oceanica 2014

Contaminant concentrations were below their waste stream triggers based on the ANZECC/ARMCANZ (2000) 99% species protection guidelines scaled for dilution equivalent to that expected at the LEPA boundary (1:310). Therefore, the EQG was met (Table 3).

Table 3 Toxicants in the Sepia Depression TWW stream compared with relevant trigger levels

Toxicant	Sepia Depression TWW concentration (µg/L)	Waste stream trigger (µg/L)[1,2]
Ammonia-N	**21 000**	154 537
Cadmium*	<0.1	36
Chromium*	<1	43
Copper*	**5.1**	68
Lead*	<1	679
Mercury*	<0.1	1.4
Nickel*	4.5	2016
Silver*	<0.8	248
Zinc*	**60**	2124
Chloropyrifos	<20	0.16
Endrin	<20	1.24
Endosulfan sulfate	<20	1.55
Benzene	<1	110 890
Naphthalene	0.01	15 485
Benzo(g,h,i)perylene	<0.01	15 485

Notes:

1. ANZECC/ARMCANZ (2000) guidelines used as per SDOOL MMP (BMT Oceanica 2014). Assessment against ANZECC/ARMCANZ (2000) 99% species protection guideline values was undertaken only for those toxicants where trigger levels were available.
2. ANZECC/ARMCAMZ (2000) scaled based on 5th percentile dilution at the LEPA boundary.
3. TWW = Treated wastewater.
4. The trigger values for marine waters are from Table 3.4.1 in ANZECC/ARMCANZ (2000). The EPA has provided advice that in WA waters where a high level of protection applies, 99% species protection levels should be used.
5. The bioaccumulating toxicants cadmium and mercury must meet the 80% species protection guidelines at the diffuser (i.e. prior to initial dilution), and therefore a diluted concentration was not calculated.
6. Analytical limits for Chloropyrifos were not low enough to confirm exceedance of, or compliance with, the ANZECC/ARMCANZ (2000) guidelines. Until detection limits required for direct comparison can be attained by commercial laboratories, WET testing will provide a test of the toxicity of the wastewater stream (See Appendix D).
7. Trigger values are for endosulfan, not endosulfan sulfate (Table 3.4.1; ANZECC/ARMCANZ 2000).
8. *= dissolved metals 0.45 µm filtered.

Total toxicity of the mixture (TTM)

The potential for cumulative toxic effect on marine organisms was assessed after initial dilution as per ANZECC/ARMCANZ (2000). The EQG for the total toxicity of the mixture (TTM) is outlined in Table 4.

Table 4 Environmental Quality Guideline for the total toxicity of the mixture

EQG	The total toxicity of the mixture (TTM) for the additive effect of ammonia, copper and zinc, calculated as per ANZECC/ARMCANZ (2000), will not exceed the trigger value of 1.0.

Source: BMT Oceanica 2014

Notes:

1. EQG = environmental quality guideline; TTM = total toxicity of the mixture
2. TTM = Σ(Ci/EQGi) where Ci is the concentration of the 'i'th component in the mixture and the EQGi is the guideline for that component.

The TTM for the combined effect of ammonia, copper and zinc following dilution (0.51; Table 5) was less than the ANZECC/ARMCANZ (2000) guideline value of 1.0 and the EQG for TTM was met.

Table 5 Total toxicity of treated wastewater (TWW) at the edge of the initial mixing zone associated with the Sepia Depression ocean outlet

Toxicant	TWW concentration (µg/L)	Background concentration (µg/L)[1]	Dilution	TTM[2]
Ammonia	21 000	1.5	1:310	0.51
Copper	5.1	0.08		
Zinc	60	0.15		

Notes:

1. Background concentrations for copper and zinc from McAlpine et al. (2005); Perth marine waters (pp.19; Table 10). Surface background concentrations for ammonia calculated as median of reference site data from 2003–2019 (BMT Oceanica, unpublished data).
2. TTM = total toxicity of the mixture = [ammonia]/guideline + [copper]/guideline + [zinc]/guideline.

Quarterly treated wastewater characterisation

Water Corporation conducts quarterly sampling of the final treated wastewater SDOOL waste stream from sample point D (Figure 1). Quarterly samples are analysed for a smaller set of the key contaminants of concern that are most likely to be present in the waste stream. Quarterly sampling occurred on 3 July 2018, 2 October 2018, 8 January 2019 and 2 April 2019.

On each occasion, a composite sample (time weighted) was obtained from sample point D (Figure 1). This sample represents an average of the TWW discharged to the Sepia Depression ocean outlet for the 24 hours prior to and during the sample collection. The bulk sample was homogenised and split into separate sample containers for the various analyte groups. Samples were handled and analysed according to the NATA-accredited laboratory requirements.

The bioaccumulating toxicants cadmium and mercury met the 80% species protection guidelines (36 µg/L and 1.4 µg/L, respectively) in the TWW stream prior to dilution on each sample (Table 6).

Contaminants measured quarterly in the Sepia Depression TWW at sample point D were all below their respective waste stream triggers based on the ANZECC/ARMCANZ (2000) 99% species protection scaled for dilution equivalent to that occurring at the LEPA boundary (Table 6).

Table 6 Toxicants measured quarterly in the Sepia Depression TWW stream compared with relevant guideline trigger levels after initial dilution

Toxicant[1]	Sepia Depression TWW sample point D (µg/L)				Waste Stream Trigger[2] (µg/L)
	July 2018	October 2018	January 2019	April 2019	
Ammonia	NA	17000	9600	59000	154 537
Cadmium[5]	0.05	0.1	0.1	0.1	36
Chromium	NA	NA	2	15	43
Cobalt	0.5	1	1	1	307
Copper	11	3	3	5	68
Lead	0.5	1	1	1	679
Mercury[5]	0.05	0.3	0.1	0.1	1.4
Nickel	4	4	3	7	2016
Silver	0.5	1	1	1	248
Vanadium	5	10	10	10	14 913
Zinc	60	27	89	28	2124
Phenols	25	50	50	120	83 685

Notes:

1. Assessment undertaken only for toxicants with ANZECC & ARMCANZ (2000) guideline values.
2. ANZECC & ARMCANZ (2000) scale based on 5th percentile dilution at the LEPA boundary.
3. NA = no available data.
4. TWW = treated wastewater.
5. Bioaccumulating toxicants cadmium and mercury met the ANZECC & ARMCANZ (2000) 80% species protection guidelines (of 36 and 1.4 respectively) at the diffuser (i.e. prior to dilution).

For the quarterly sampling, TTM was calculated for the additive effects of ammonia, copper and zinc using the dilution of 1:310, based on that expected at the LEPA boundary. The TTM ranged between 0.42 and 0.74 on the four sampling occasions (Table 7); and all were below the ANZECC & ARMCANZ (2000) guideline of 1.0.

Table 7 Total toxicity of the quarterly treated wastewater characterisation for the SDOOL combined waste stream

Quarterly sampling dates	Natural background concentration in Perth's coastal waters (µg/L)[1]			Dilution	Total toxicity of the mixture (TTM)[2]
	Ammonia	Copper	Zinc		
July 2018[3]	1.5	0.08	0.15	1:310	0.62
October 2018					0.42
January 2019					0.43
April 2019					0.74

Notes:

1. Background concentrations for copper and zinc from McAlpine et al (2005); Perth marine waters (p.19; Table 10). Surface concentrations for ammonia calculated as a median of reference site data from 2003–2019 (BMT Oceanica, unpublished data).
2. Total toxicity of mixture = [ammonia]/guideline + [copper]/guideline + [zinc]/guideline.
3. No quarterly ammonia concentration given in July; therefore, in TTM calculation the mean ammonia concentration from October, January and April was used.

Whole of effluent toxicity (WET) testing

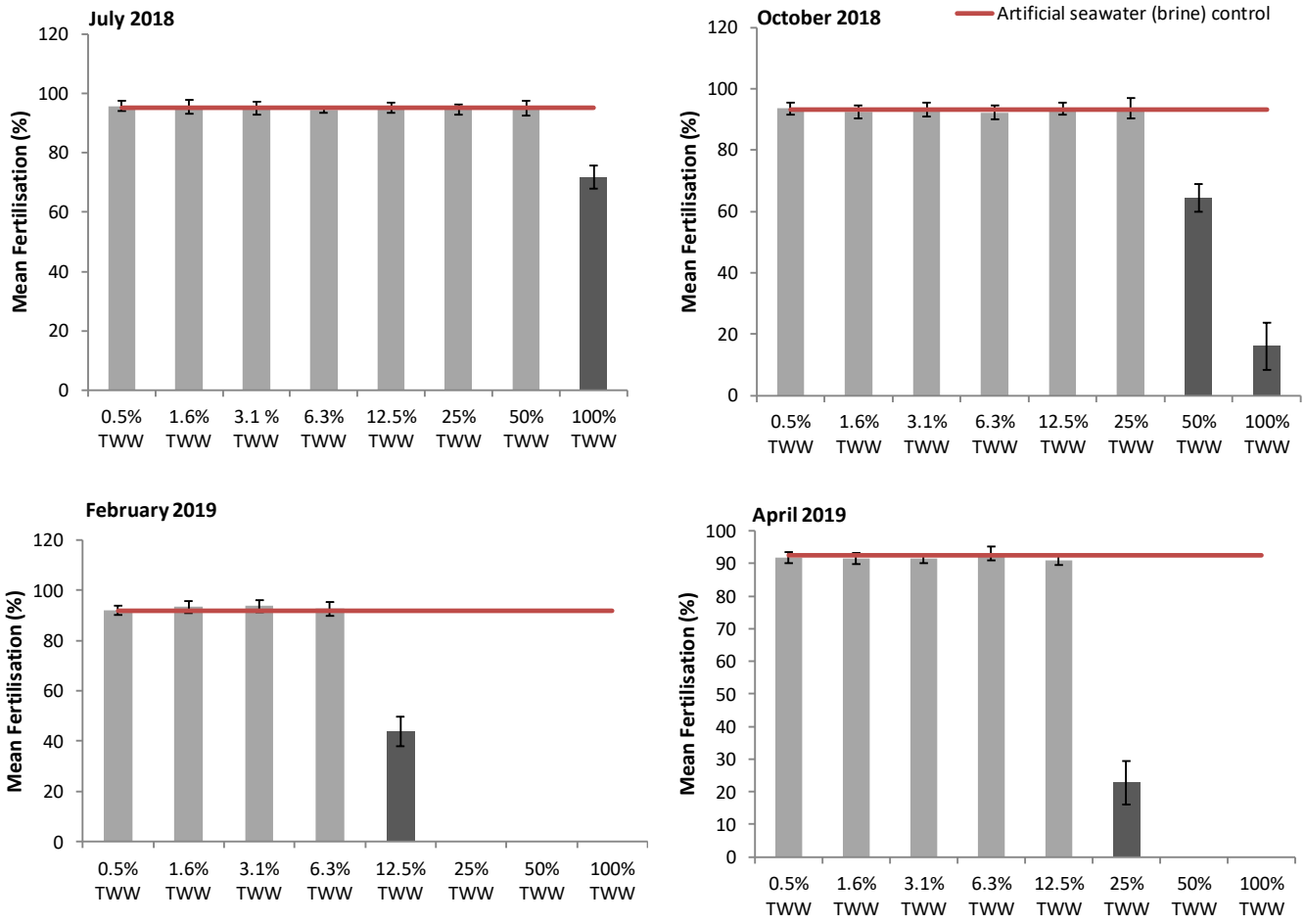
WET testing is useful for assessing toxicity of potential contaminants without guidelines, or where the effects may be cumulative. Fertilisation success in sea urchins (*Heliocidaris tuberculata*) exposed to salt-adjusted dilutions (0.5, 1.6, 3.1, 6.3, 12.5, 25, 50 and 100%) of TWW was used to calculate a No Observed Effect Concentration (NOEC; the highest concentration where no significant effect is observed) (Appendix D). The EQG for the whole of effluent toxicity (WET) testing is outlined in Table 8.

Table 8 Environmental Quality Guideline for whole of effluent toxicity testing

EQG	The EQG will be exceeded if following the 1-hour sea urchin test: $\frac{TDA}{DRNOEC} \leq 1.0$ where TDA = Typical Dilutions Achieved (constant based on 100-fold dilution) DRNOEC = number of dilutions required to achieve the no observed effects concentration (NOEC). Breaching the above triggers investigations against the EQS, which would comprise the full suite of WET tests (minimum of five species from four trophic groups).

Source: BMT Oceanica 2014

In July 2018, sea urchin fertilisation was significantly lower than the artificial seawater control when exposed to 100% TWW concentration, with all other concentrations not significantly different to the control (Figure 5). In October 2018, significantly lower sea urchin fertilisation was reported for the 50% and 100% concentrations, with all other concentrations not significantly different to the control (Figure 5). In February 2019, sea urchin fertilisation success was significantly lower than the artificial seawater control when exposed to TWW concentrations 12.5%, 25%, 50% and 100% (with all other concentrations not significantly different to the control; Figure 5). In April 2019, significantly lower sea urchin fertilisation was reported for the 25%, 50% and 100% concentrations, with all other concentrations not significantly different to the control (Figure 5). For all four sampling dates, the NOEC was greater than 1% TWW (Table 9), and the EQG for WET testing was met.



Notes:

1. Error bars represent ±1 standard deviation.
2. TWW = treated wastewater.
3. Light grey bars represent concentrations of treated wastewater (TWW) at which there is no observed significant effect on fertilisation. Dark grey bars represent concentrations of TWW that acted to significantly reduce the success of sea urchin fertilisation.

Figure 5 Comparison of whole effluent toxicity TWW dilution results to artificial seawater control

Table 9 Calculated parameters from whole of effluent toxicity tests

Indicator	July 2018	October 2018	January 2019	April 2019
NOEC	50%	25%	6.3%	12.5%
Dilutions required to meet the NOEC	2	4	15.9	8
Dilutions required/dilution achieved	0.006	0.013	0.051	0.026
≤1	Yes	Yes	Yes	Yes

Notes:

1. NOEC = no observed effect concentration
2. Calculation based on 310 dilutions achieved, which is expected at the LEPA boundary.

Water quality monitoring – receiving environment

Nutrients, phytoplankton biomass and physical and chemical stressors were monitored approximately fortnightly from the beginning of December 2018 to the end of March 2019 (coinciding the summer non-river flow period) along a down-current gradient away from the diffuser (Table 10; Appendix E).

Table 10 Water quality monitoring dates near the Sepia Depression ocean outlet between December 2018 and March 2019

Sample day	Date
1	05/12/2018
2	14/12/2018
3	09/01/2019
4	29/01/2019
5	04/02/2019
6	21/02/2019
7	07/03/2019
8	26/03/2019

Nutrient enrichment

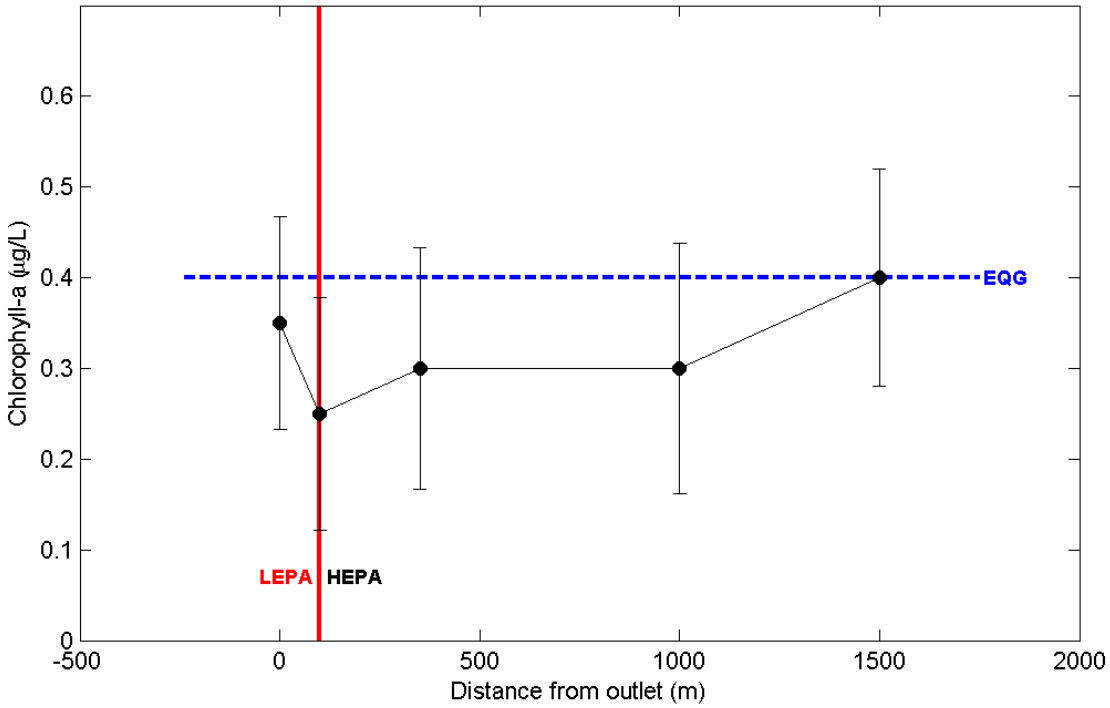
The EQGs for nutrient enrichment in receiving waters are outlined in Table 11.

Table 11 Environmental quality guidelines for nutrients

EQG	The median chlorophyll-a concentration in the HEPA (100 m plus) during the non-river flow period is not to exceed the 80th percentile of historical reference site data.
	The median light attenuation coefficient in the HEPA (100 m plus) during the non-river flow period is not to exceed the 80th percentile of historical reference site data.

Source: BMT Oceanica 2014

The median chlorophyll-a concentration in the Sepia Depression HEPA (≥100 m) was 0.30 µg/L and below the 80th percentile of historical reference site data (0.4 µg/L; Figure 6), meeting the EQG (Table 11, Appendix F).

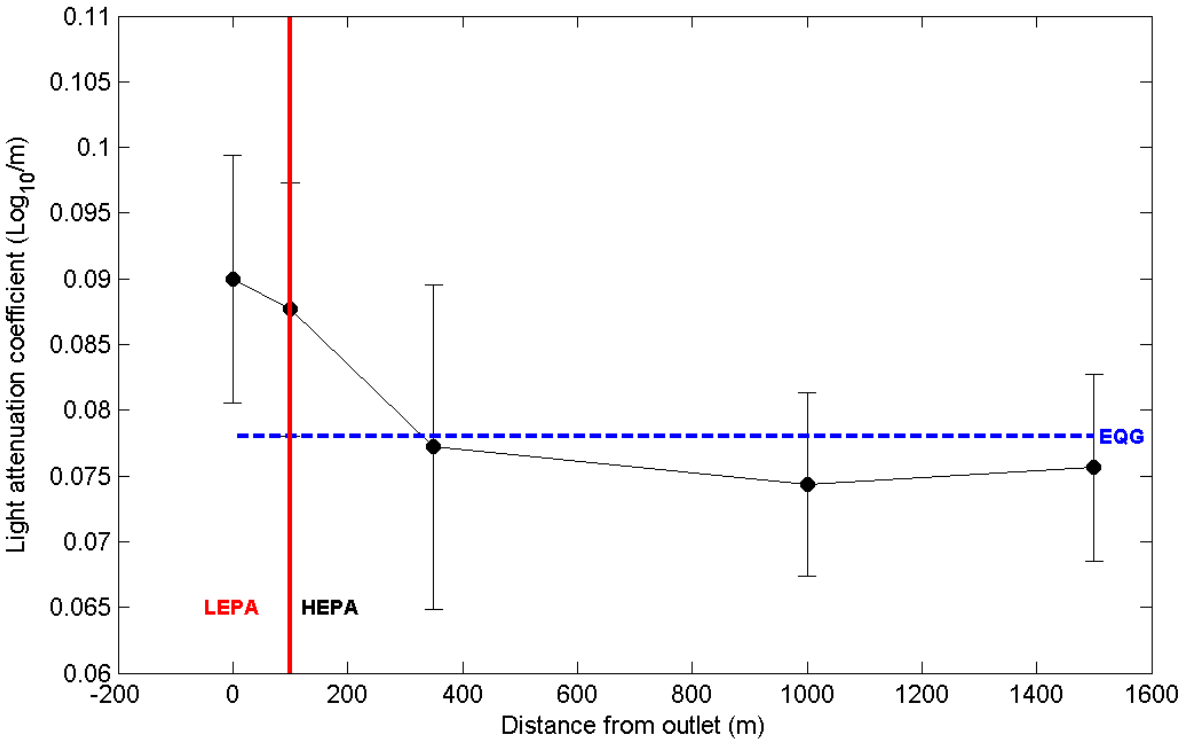


Notes:

1. Error bars represent ±95% confidence intervals
2. Dark blue dashed line = Environmental Quality Guideline (EQG) is the 80th percentile of historical reference site data.
3. LEPA = notional low ecological protection area; HEPA = high ecological protection area.
4. Data were pooled across eight sampling days (n=8) over December 2018 – March 2018.

Figure 6 Median chlorophyll-a concentration obtained at fixed monitoring sites above and down-current of the Sepia Depression outlet during the summer monitoring period

The median light attenuation in the Sepia Depression HEPA (≥100 m) was 0.078 Log_{10}/m and was equal to the 80th percentile of historical reference site data (0.078 Log_{10}/m), meeting the EQG (Figure 7).



Notes:

1. Error bars represent ±95% confidence intervals.
2. Dark blue dashed line = Environmental Quality Guideline (EQG) is the 80th percentile of historical reference site data (0.078 Log_{10}/m).
3. LEPA = notional low ecological protection area; HEPA = high ecological protection area.
4. Data for each distance were pooled across eight sampling occasions (n=8) over December 2018–March 2019.

Figure 7 Median light attenuation coefficient obtained at fixed distances down-current of the Sepia Depression outlet during the summer monitoring period

Phytoplankton blooms

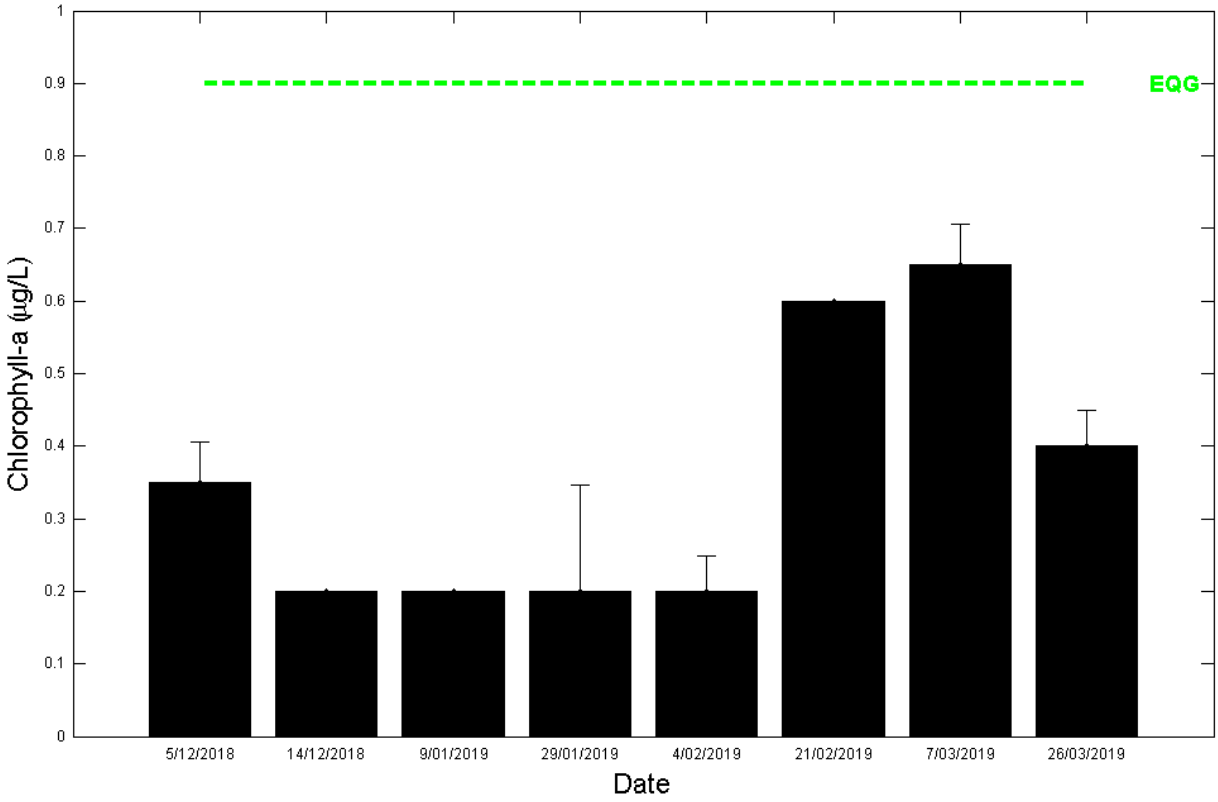
The EQGs for phytoplankton blooms in receiving waters are outlined in Table 12.

Table 12 Environmental Quality Guidelines for phytoplankton in receiving waters

EQG1	Median phytoplankton biomass, measured as chlorophyll-a is not to exceed 3 times the median chlorophyll-a concentration of reference sites, on any occasion during the non-river flow period.
EQG2	Phytoplankton biomass measured as chlorophyll-a at any site does not exceed 3 times the median chlorophyll-a concentration of reference sites, on 25% or more occasions during the non-river flow period.

Median chlorophyll-a concentration within the HEPA did not exceed three times the median of reference sites (0.9 µg/L) on any sampling occasion during the summer monitoring period and EQG1 was met (Figure 8).

Phytoplankton biomass measured as median chlorophyll-a at any site did not exceed three times the median of reference sites, on any sampling occasion during the summer monitoring period (Figure 8), meeting the requirements of EQG2 (<25% of occasions).



Notes:

1. Error bars represent ±95% confidence intervals
2. Green dashed line = Environmental Quality Guideline (EQO) is 3-times the median chlorophyll-a concentration of reference site data
3. Values measured at 0 m are not included in the figure or EQC assessment, as the 0 m site is situated directly above the outlets within the notional low ecological protection area (LEPA)

Figure 8 Median phytoplankton biomass during the summer monitoring period, pooling data from fixed sites ≥100 m down-current of the Sepia Depression outlet

Physical-chemical stressors

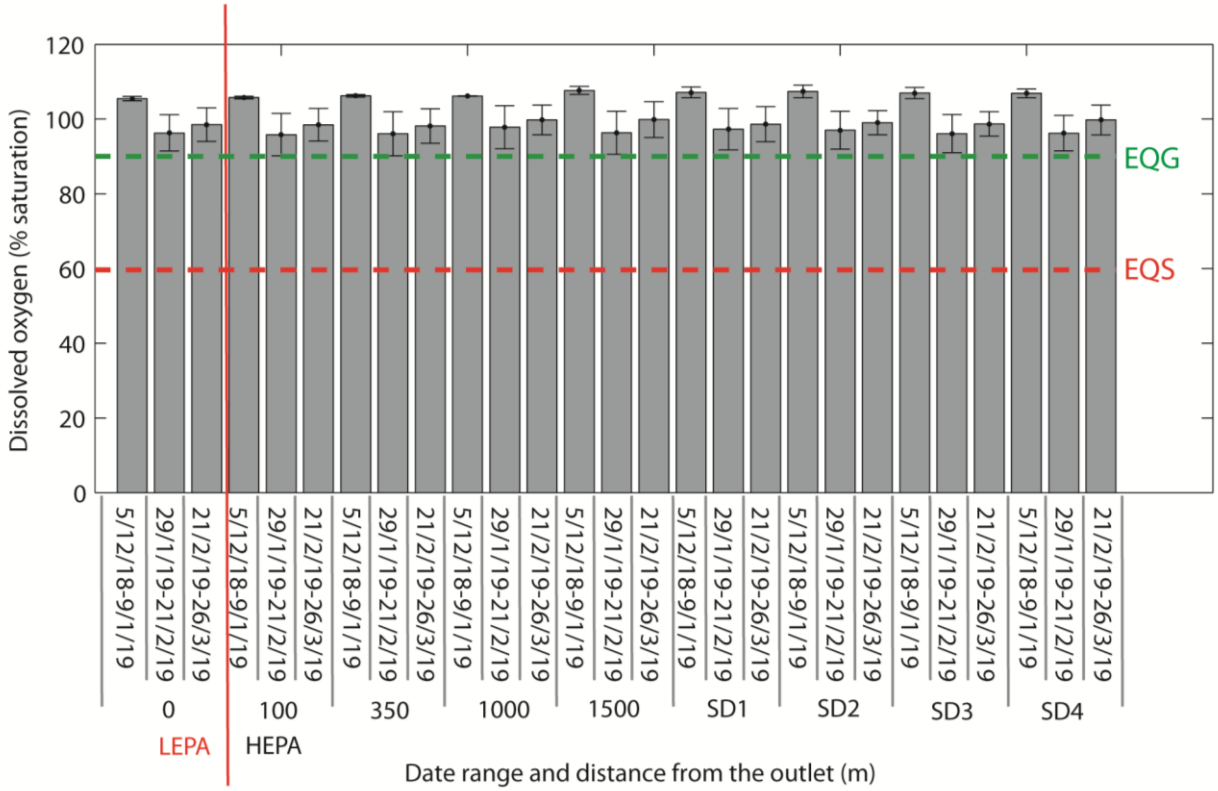
Dissolved oxygen (DO)

The EQG for DO is outlined in Table 13.

Table 13 Environmental Qualit Guideline for dissolved oxygen

EQG	Median dissolved oxygen in bottom waters (0–0.5 m above the sediment surface) must be greater than 90% saturation at any site for a defined period of not more than 6 weeks during the non-river flow period.

Bottom (0–0.5 m) DO saturation levels near the outlet were >90% at all times throughout the summer survey period (Figure 9) and the EQG for organic enrichment was met.



Notes:

1. Error bars ±95% confidence intervals
2. Dissolved oxygen (DO) measured 0–0.5 m above the seabed
3. Green dashed line = Environmental Quality Guideline (EQG) = 90% DO Saturation
4. Red dashed line = Environmental Quality Standard (EQS) = 60% DO saturation.
5. LEPA = low ecological protection area; HEPA = high ecological protection area.
6. Reference site data (SD1–SD4) are compared against EQG for contextual purposes only.

Figure 9 Median dissolved oxygen for defined periods of ≤6 weeks during the summer monitoring period

Salinity

The EQG and EQS for salinity is outline in Table 14.

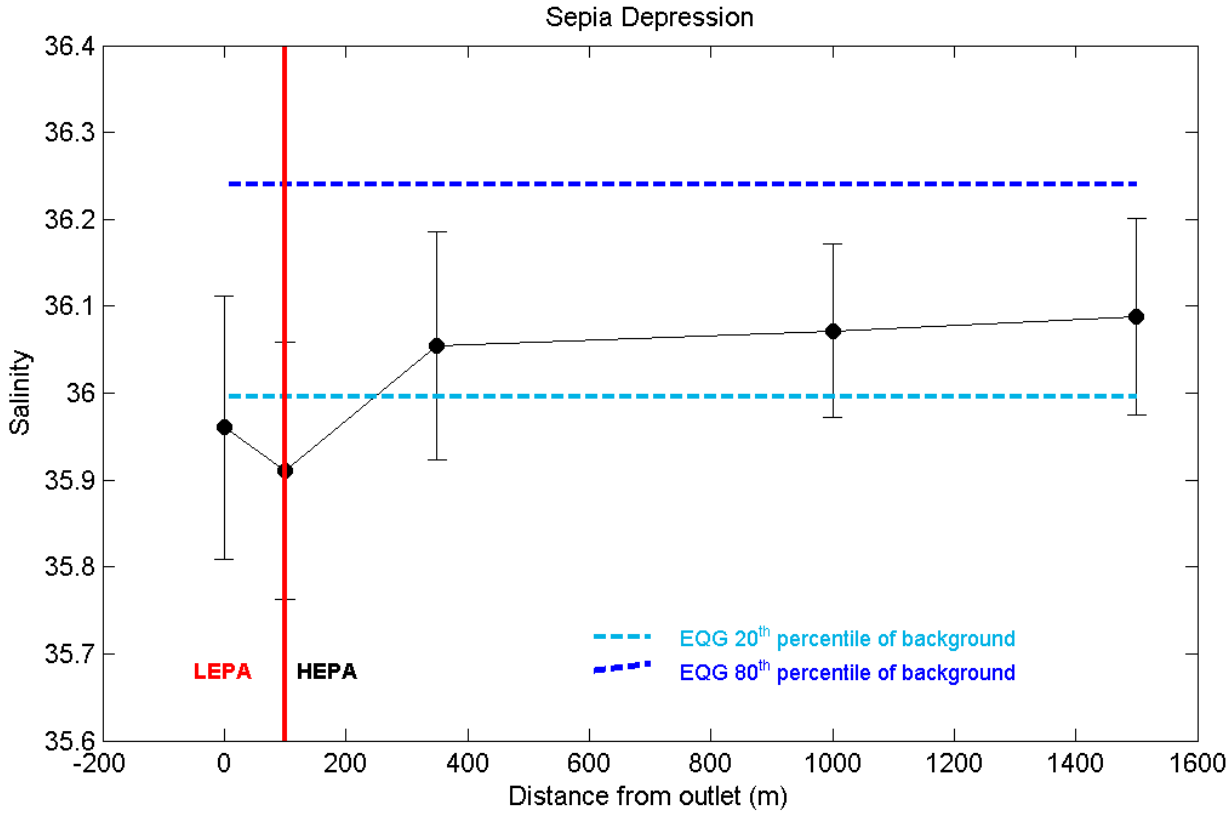
Table 14 Environmental Quality Guideline for salinity

EQG	Median salinity (0.5 m below the water surface) at an individual site over any period is not to deviate beyond the 20th and 80th percentile of natural salinity range over the same period.
EQS	No deaths of marine organisms resulting from anthropogenically sourced salinity stress.

Note:

1. EQG = Environmental Quality Guideline; EQS = Environmental Quality Standard

Median salinity at 100 m was below the 20th percentile of the natural salinity range leading to an exceedance of the EQG (Figure 10). Median salinity at all other sites within the HEPA (350, 1000 and 1500 m from the outlets) was between the 20th and 80th percentile of the natural salinity range as required by the EQG (Figure 10). There were no reported deaths of marine organisms from anthropogenically sourced salinity stress at Sepia Depression over the summer monitoring period, meeting the EQS.



Notes:

1. Error bars represent ±95% confidence intervals
2. Salinity measured 0–0.5 m below the sea surface.
3. Dark blue line = 80th percentile of historical reference sites; light blue dashed line = 20th percentile of historical reference sites
4. LEPA = notional low ecological protection area; HEPA = high ecological protection area.
5. Data for each distance were pooled across eight sampling occasions (n=8) over December 2018–March 2019.

Figure 10 Median salinity compared to the 20th and 80th percentile of reference site data during the summer monitoring period

Microbiological contaminants and algal biotoxins

Thermotolerant coliforms

TTC were sampled eight times over the 2018–2019 summer period (yielding a total of 40 samples; Appendix G). NHMRC (2008) and EPA (2005) guidelines require that a minimum of 100 samples for accurate assessment of the EQC. Data from multiple years can be pooled where there are <100 samples provided local pollution conditions have not changed (NHMRC 2008). Assuming conditions have not changed, data collected over three summers (since summer 2016–17) were pooled to yield 120 samples. The EQG for thermotolerant coliforms is outlined in Table 15.

Table 15 Median thermotolerant coliform concentration at the field monitoring sites for the Sepia Depression outlet for 2016–2019

EQG	Median TTC concentrations at sites at the boundary of the Observed Zone of Influence (OZI) are not to exceed 14 CFU/100 mL with no more than 10% of the samples exceeding 21 CFU/100 mL as measured using the membrane filtration method

Notes:

1. OZI = Observed Zone of Influence; TTC = thermotolerant coliforms.
2. TTC concentrations are measured using the membrane filtration method.

The median concentration of TTC derived from the three years of pooled samples was equal to the limit of detection (<10 CFU/100 mL; Table 16), meeting the EQG criterion for median concentrations (not to exceed 14 CFU/100 mL). Over the three sampling periods, there were 9 instances where TTC exceeded 21 CFU/100 mL, representing 7.5% if samples and meeting the EQG criterion (≤10%) for percentage of samples (Table 17).

Table 16 Thermotolerant coliform abundance for sites at the edge of Sepia Depression SHEZ that exceeded concentrations of 21 CFU/100 mL

Sampling period	Median (CFU/100 mL)	Compliance (EQG)
Dec 2016–Mar 2017 Dec 2017–Mar 2018 Dec 2018–Mar 2019 (n=120)	<10	■

Note:

1. Green (■) symbols indicate the Environmental Quality Criteria (EQC) were met; amber (■) and red (■) symbols represent an exceedance of the Environmental Quality Guideline (EQG) or Environmental Quality Standard (EQS), respectively.

Table 17 Thermotolerant coliform abundance for sites at the edge of the Sepia Depression SHEZ that exceeded concentrations of 21 CFU/100 mL

Sampling season	Date	Site	CFU/100 mL	Compliance
2016-2017	2/02/2017	SD29	200	
	16/02/2017	SD22	50	
	16/02/2017	SD23	150	
2017-2018	4/12/2017	SD30	320	
	4/12/2017	SD31	670	
	4/01/2018	SD23	30	
	13/03/2018	SD29	40	
2018-2019	26/03/19	SD27	130	
	26/03/19	SD28	150	
% total samples (n = 120) > 21 CFU/100 mL (EQG)			7.5	

Notes:

2. Green (■) symbols indicate the Environmental Quality Criteria (EQC) were met; amber (■) and red (■) symbols represent an exceedance of the Environmental Quality Guideline (EQG) or Environmental Quality Standard (EQS), respectively.
3. CFU = colony forming units; EQG = Environmental Quality Guideline.

Toxic phytoplankton species

The EQG for toxic phytoplankton species is outlined in Table 18.

Table 18 Environmental Quality Guideline for toxic phytoplankton species

EQG	Cell counts of potentially toxic algae species at sites at the boundary of the SHEZ are not to exceed the WASQAP[1] trigger concentrations for any of the following: • *Alexandrium* spp. (100 cells/L) • *Gymnodinium* spp. (1000 cells/L) • *Karenia* spp. (1000 cells/L) • *Dinophysis* spp. (500 cells/L) • *Dinophysis acuminata* (3000 cells/L) • *Prorocentrum lima* (500 cells/L) • *Pseudo-nitzchia* spp. (250 000 cells/L) • *Gonyaulax cf. spinifera* (100 cells/L) • *Protoceratium reticulatum (Gonyaulax grindleyi)* (500 cells/L)

Note:

1. Western Australian Shellfish Quality Assurance Program (WASQAP) Operations Manual (DoF 2007), as outlined in the Management Plan (BMT Oceanica 2014).

Cell densities of toxic phytoplankton species were below relevant Western Australian Shellfish Quality Assurance Program (WASQAP; DoF 2007) guidelines (Table 19; Appendix H) meeting the EQG for toxic phytoplankton species.

Table 19 Estimated cell densities of phytoplankton species known to produce toxins

Date	Site[1]	Species	Estimated density	WASQAP Guideline[2]	Compliance
5/12/2018	SD26	*Pseudo nitzschia* “delicatissima group”	558	250 000	■
		Pseudo nitzschia “seriata group”	558	250 000	
	SDR4	*Pseudo nitzschia* “delicatissima group”	2790	250 000	na
		Pseudo nitzschia “seriata group”	372	250 000	
14/12/2018	SD30	*Pseudo nitzschia* “delicatissima group”	4464	250 000	■
		Dinophysis acuminata	186	500	
	SDR1	*Pseudo nitzschia* “delicatissima group”	744	250 000	na
9/01/2019	SD30	*Pseudo nitzschia* “delicatissima group”	3348	250 000	■
		Gymnodinium spp.	744	1000	
	SDR4	*Pseudo nitzschia* “delicatissima group”	1860	250 000	na
		Gymnodinium spp.	558	1000	
29/01/2019	SD19	*Pseudo nitzschia* “delicatissima group”	2790	250 000	■
	SDR1	*Pseudo nitzschia* “delicatissima group”	1674	250 000	na
4/02/2019	SD26	*Pseudo nitzschia* “delicatissima group”	3162	250 000	■
	SDR1	*Pseudo nitzschia* “delicatissima group”	6696	250 000	na
		Gymnodinium spp.	372	1000	
21/02/2019	SD22	*Pseudo nitzschia* “delicatissima group”	2232	250 000	■
	SDR1	*Pseudo nitzschia* “delicatissima group”	372	250 000	na
7/03/2019	SD26	*Pseudo nitzschia* “delicatissima group”	5208	250 000	■
		Gymnodinium spp.	372	1000	
	SDR2	*Pseudo nitzschia* “delicatissima group”	4836	250 000	na
26/03/2019	SD28	*Pseudo nitzschia* “delicatissima group”	6324	250 000	■
	SDR3	*Pseudo nitzschia* “delicatissima group”	6510	250 000	na
		Pseudo nitzschia “seriata group”	558	250 000	

Notes:

1. Samples were analysed for one monitoring site and one reference site per sampling occasion.
2. Western Australian Shellfish Quality Assurance Program (WASQAP) (DoH 2007).
3. – = no toxic species detected, NA = not applicable.
4. Green (■) symbols indicate the Environmental Quality Criteria (EQC) were met.

Faecal streptococci (*Enterococci* spp.)

Samples were collected eight times over the 2018–2019 summer monitoring period (yielding a total of 35 samples) for faecal streptococci analyses. The EQC for primary and secondary contact recreation are outlined in Table 20. NHMRC guideline and EPA (2005) require a minimum of 100 samples over the monitoring period for accurate assessment of the EQC. Data from multiple years can be pooled where there are less than 100 samples provided local pollution conditions have not changed (NHMRC 2008). Assuming conditions have not changed, data from the past three summers were pooled to yield 120 samples.

Table 20 Environmental quality criteria for contact recreation

Primary	EQG	The 95th percentile of bacterial contact of marine waters should not exceed 200 *Enterococci*/100 mL
Primary	EQS	The 95th percentile of bacterial contact of marine waters should not exceed 500 *Enterococci*/100 mL
Secondary	EQG	The 95th percentile of bacterial contact of marine waters should not exceed 2000 *Enterococci*/100 mL

The 95th percentile of *Enterococci* spp. concentrations based on 120 samples was 1100 MPN/100 mL (Table 21), exceeding the EQG for primary contact recreation (200 MPN/100 mL) and triggering assessment against the EQS. The 95th percentile of *Enterococci* spp. (1100 MPN/100 mL) also exceeded the EQS for primary contact recreation (Table 21).

Until 2013/14, primary contact recreation had been managed (albeit informally) against the ANZECC (1992) criteria (median *Enterococci spp*. concentrations <35 MPN/100 mL). Development of the MMP formalised the monitoring regime and updated the approach to the contemporary and best practice environmental quality management framework including adopting the EPA (2005) criteria (the 95th percentile *Enterococci* spp. concentration < 200 MPN/100 mL). The informal management boundaries that applied historically were not altered accordingly and exceedance of the EPA's recreational contact criteria is an artefact of the change of criteria. The historical discharge footprint is unchanged, the exceedances are not indicative of an increased risk to Environmental Quality Objectives.

Exceedance of the EQG and EQS for primary contact recreation was reported to the Department of Health and the Department of Water and Environmental Regulation (previously the Department of Environment Regulation and the Office of the Environmental Protection Authority) as per the SDOOL MMP (BMT Oceanica 2014).

The 95th percentile of *Enterococci* spp. concentrations (1100 MPN/100 mL; Table 21) met the EQG for secondary recreation (≤2000 MPN/100 mL).

Table 21 The 95th percentile of Enterococci spp. Concentrations at the boundary of the primary and secondary contact recreation zone for the Sepia Depression ocean outlet

Date	95th percentile (MPN/100 mL)	Environmental Quality Criteria		Compliance
Dec 2016 – Mar 2017 Dec 2017 – Mar 2018 Dec 2018 – Mar 2019	1100	EQG (primary contact)	95th percentile ≤200 MPN/100 mL	
		EQS (primary contact)	95th percentile ≤500 MPN/100 mL	
		EQG (secondary contact)	95th percentile ≤2000 MPN/100 mL	

Notes:

1. Green symbols (■) indicate Environmental Quality Guideline (EQG) were met, amber (■) and red (■) symbols represent an exceedance of the EQG and Environmental Quality Standard (EQS) respectively.

Phytoplankton cell concentrations

The EQG for phytoplankton cell concentrations are outlined in Table 22.

Table 22 Environmental Quality Guideline for phytoplankton cell count

EQG	Median total phytoplankton cell concentration for the area of concern should not exceed 15 000 cells/mL

The median total phytoplankton cell concentration was 82 cells/mL (Table 23), and therefore the EQG was met.

Table 23 Phytoplankton cell densities collected at fixed monitoring sites for contact recreation down-current of the Sepia Depression outlet

Date	Site	Total density (cells/mL)	Compliance
5/12/2018	SD9	81	
14/12/2018	SD3	67	
9/01/2019	SD14	67	
29/01/2019	SD3	84	
4/02/2019	SD9	130	
21/02/2019	SD7	32	
7/03/2019	SD9	100	
26/03/2019	SD11	214	
Median (all data)		**82**	

Aesthetics

Monitoring routinely assesses the quality of surface water appearance to ensure the aesthetic value is protected. The Environmental Quality Criteria for recreation and aesthetics are outlined in Table 24.

Table 24 Environmental Quality Criteria for Recreation and Aesthetics

Indicator	Environmental Quality Criteria	
	EQG	EQS
Nuisance organisms	Macrophytes, phytoplankton scums, filamentous algal mats, blue-green algae and sewage fungus should not be present in excessive amounts	There should be no overall decrease in the aesthetic water quality values of Cockburn Sound using direct measures of the community's perception of aesthetic value.
Faunal deaths	There should be no reported incidents of large-scale deaths of marine organisms relating from unnatural causes.	
Water clarity	The natural visual clarity of the water should not be reduced by more than 20%	
Colour	The natural hue of the water should not be changed by more than ten points on the Munsell scale.	
Surface films	Oil and petrochemicals should not be noticeable as a visible film on the water or detectable by odour.	
Surface debris	Water surfaces should be free of floating debris, dust and other objectionable matter, including substances that cause foaming.	
Odour	There should be no objectionable odour.	
Fish tainting substances	Concentrations of contaminants will not exceed the aesthetics guidelines for fish tainting substances at the Shellfish Harvesting Safety Zone boundary.	There should be no detectable tainting of edible fish harvested outside the Shellfish Harvesting Safety Zone boundary.

Aesthetic quality was assessed fortnightly via a questionnaire completed by field personnel on eight occasions during the non-river flow period. On each occasion, the questionnaire was completed at one location on the post upgrade boundary down-current of the diffuser. Water clarity around the outlet (mean LAC at 350 m from the diffuser, pooled from all days) was compared against water clarity at a greater distance from the outlet (mean LAC at 1500 m from the diffuser from all days pooled) to assess whether aesthetic differences exist. Water Corporation also maintains a complaints register for the SDOOL program.

The field surveys found algae/plant material visible on the surface on 37.5% of occasions (Table 25). No dead marine organisms or oils or were found on the surface on any occasion (Table 25). Bubbles were visible on the surface of the water on 14 December 2018 (Table 25). There was no noticeable colour variation on any occasion (Table 25). There was no floating debris visible on any occasion (Table 25). A mild wastewater smell was noticeable on 37.5% of occasions (Table 25). There was no overall

decrease in the aesthetic water quality values of Cockburn Sound using direct measures of the community's perception of aesthetic value.

Mean LAC at 350 m from the ocean outlet (0.082 Log_{10}/m) was slightly higher than at 1500 m distance from the outlet (0.075 Log_{10}/m), meaning that light was more quickly attenuated at 350 m than 1500 m (Table 26). Overall water clarity was reduced by ~10%, and therefore the EQG that the natural visual clarity of the water should not be reduced by more than 20% was met.

Fish tainting substances in the comprehensive TWW characterisation sample collected on 19 February 2019 did not exceed the EPA (2005) aesthetic guidelines for fish tainting substances (Table 27), with the exception of 2,4-Dichlorophenol concentration of 3.2 µg/L which did exceed the guideline (0.3 µg/L). However, the exceedance will be negligible after initial dilution. There was no reported tainting of edible fish harvested outside the SHEZ boundary.

Table 25 Aesthetic observations and measurements near the Sepia Depression ocean outlet from December 2018 to March 2019

Date	Site	Algae/plant material visible on surface?	Dead marine organisms visible?	Secchi depth (m)	Noticeable colour variation?	Oil or other films on the surface?	Floating debris visible on the surface?	Noticeable odour associated with the water?
5/12/2018	SD7	No	No	10.0	No	No	No	Yes, very slight wastewater smell
14/12/2018	SD3	Yes, some algae	No	11.5	No	Yes, bubbles/surface film	No	Yes, mild
9/01/2019	SD14	Yes, plant material	No	12.8	No	No	No	No
29/01/2019	SD3	No	No	7.5	No	No	No	No
4/02/2019	SD9	Yes, wrack	No	11	No	No	No	No
21/02/2019	SD6	No	No	11.5	No	No	No	Yes, slight wastewater smell
7/03/2019	SD11	No	No	8.7	No	No	No	No
26/03/2019	SD9	No	No	11.7	No	No	No	No

Table 26 Light attenuation coefficient at sites 350 m and 1500 m from the Seia Depression ocean outlet from December 2018 to March 2019

Date	Light attenuation coefficient (Log10/m)	
	350 m (site SDT-350 m)	1500 m (site SDT – 1500 m)
5/12/2018	0.074	0.077
14/12/2018	0.071	0.062
9/01/2019	0.063	0.061
29/01/2019	0.081	0.091
4/02/2019	0.067	0.074
21/02/2019	0.086	0.072
7/03/2019	0.101	0.084
26/03/2019	0.115	0.082
Mean	**0.082**	**0.075**

Table 27 EPA (2005) guidelines for fish tainting substances and parameters measured on 19 February 2019 in the SDOOL wastewater stream

Parameter (µg/L)	Aesthetics guidelines	2018/2019 treated wastewater sampling
Metals and Metalloids		
Copper (Cu)	1000	5.1
Zinc (Zn)	5000	60
Phenols		
Phenol	300	<0.1
2, 4- Dichlorophenol	0.3	**3.2**
2,4,6 – Trichlorophenol	2	<0.2
Pentachlorophenol (PCP)	30	<0.2
Chlorinated hydrocarbons		
Hexachlorocyclopentadiene	1	<20
Ethers		
Nitrobenzene	30	<20
BTEX		
Toluene	250	<1
Ethylbenzene	250	<1
PAHs		
Naphthalene	1000	0.01
Acenaphthene	20	0.01

Note:

1. BTEX = Benzene, toluene, ethylbenzene and xylene; PAHs = polycyclic aromatic hydrocarbons.

Dam flushing

Routine flushing of the balancing dam at Woodman Point is no longer practiced and no flushing events occurred during the summer sampling period.

References

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The following Appendices are available from Water Corporation on request:

Appendix A Analytical laboratories and methods

Appendix B Treated wastewater results

Appendix C Initial dilution model output

Appendix D Whole of effluent toxicity laboratory results

Appendix E Site coordinates

Appendix F Nutrient results

Appendix G Microbiology results

Appendix H Phytoplankton results