BMT Oceanica

Sepia Depression Ocean Outlet Monitoring and Management Plan

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Sepia Depression Ocean Outlet

Monitoring and Management Plan

Prepared for

Water Corporation

Prepared by

BMT Oceanica Pty Ltd

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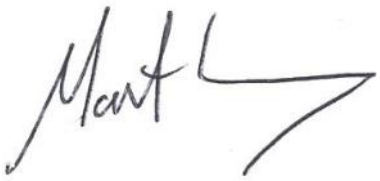

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Cover

Main image: Sea lion at Sepia Depression (BMT Oceanica Pty Ltd);
Minor images: Sepia Depression wastewater outlet (BMT Oceanica Pty Ltd)
Mussel cages deployed for sentinel mussel monitoring, Sepia Depression(BMT Oceanica Pty Ltd);

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List of Acronyms

ANZECC	Australian and New Zealand Environment and Conservation Council
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
BOD	Biological oxygen demand
CTWWC	Comprehensive treated wastewater characterisation
DER	Western Australian Department of Environment Regulation
DoH	Western Australian Department of Health
End of pipe	For the industry participants: at the industry connection to the SDOOL or at the industries diffuser in Cockburn Sound immediately prior to the discharge to the environment. For the Water Corporation: at the SDOOL diffuser immediately prior to the discharge to the environment
EC10	Concentration expected to produce an effect in 10% of the population
EC50	Concentration expected to produce an effect in 50% of the population
EPA	Environmental Protection Authority of Western Australia
EQC	Environmental Quality Criteria
EQG	Environmental Quality Guideline
EQMF	Environmental Quality Management Framework
EQO	Environmental Quality Objective
EQS	Environmental Quality Standard
HEPA	High Ecological Protection Area
KWRP	Kwinana Water Reclamation Plant
LEPA	Low Ecological Protection Area
LOEC	Lowest Observable Effects Concentration
Mg	Milligram, or one thousandth of a gram
µg	Microgram, or one millionth of a gram
ML	Megalitre, or one million litres
M&MP	Monitoring and Management Plan
MS 665	Ministerial Statement 665
NOEC	No observed effect concentration
OEPA	Office of the Environmental Protection Authority
PLOOM	Perth Long-term Ocean Outlet Monitoring Program
SDOOL	Sepia Depression Ocean Outlet Landline
SHEZ	Shellfish Harvesting Exclusion Zone
TN	Total nitrogen
TP	Total phosphorus
TRE	Toxicity Reduction Evaluation
TSS	Total suspended solids
TTC	Thermo-tolerant coliforms
WET testing	Whole-of-effluent toxicity testing
WWTP	Wastewater treatment plant

1. Purpose of this Document

1.1 Objectives

On 28 October 2004, the use of the Sepia Depression Ocean Outlet Landline (SDOOL) to dispose of up to 30 megalitres per day (ML day^{-1}) of industrial wastewater to the Sepia Depression was approved by the Minister for the Environment (Ministerial Statement 665; hereafter MS 665). The specified sources of the industrial wastewater are the Kwinana Water Reclamation Plant (KWRP), BP Refinery (Kwinana), CSBP Limited and the Kwinana Cogeneration Plant. This is in addition to the discharge of treated wastewater via the SDOOL from the Water Corporation's domestic wastewater treatment plants at Woodman Point and Point Peron, and water from the Jervoise Bay Groundwater Recovery Scheme.

Industrial wastewater will only be accepted if the quality of the combined wastewater stream meets the ANZECC/ARMCANZ (2000) 80% species protection guidelines for bioaccumulating toxicants at discharge, and the ANZECC/ARMCANZ (2000) 99% species protection guidelines for toxicants (with the exception of cobalt, where the 95% species protection guideline will apply) at 100 m from the diffuser. The proposal does not allow any of the specified industries to increase their discharge of current toxicant loads to the marine environment without prior referral to the Environmental Protection Authority (EPA).

Condition 6 of MS 665 sets out the requirements for monitoring and management of the SDOOL to be addressed in a Monitoring and Management Plan (M&MP; this document).

The objective of this M&MP is to meet Condition 6.1 of MS 665, which is to ensure that agreed ecological and social environmental values for marine waters in the vicinity of the Sepia Depression are maintained. Condition 6.1 requires the M&MP to include:

1. the monitoring and evaluation of the environmental effects of discharging industrial effluent into the Sepia Depression
2. long-term Environmental Quality Objectives and their spatial application consistent with the EPA's (2000) objectives as described in the publication Perth's Coastal Waters – Environmental Values and Objectives
3. a program to achieve long-term Environmental Quality Objectives through short- to medium-term targets
4. agreed trigger levels for further investigations (Environmental Quality Guidelines)
5. agreed trigger levels for remedial and/or preventative actions to protect the water quality and the environment of the Sepia Depression (Environmental Quality Standards)
6. management actions to be taken in the event that Environmental Quality Guidelines or Environmental Quality Standards are not met.

1.2 This document

This document outlines the monitoring and management framework for the discharge of industrial and urban wastewater from the Sepia Depression Ocean Outlet. The relevant components of the framework are summarised and discussed, as follows:

- Environmental Management Framework (Chapter 3)
- Environmental Objectives, Quality Criteria and management responses (Chapter 4)
- Environmental Monitoring Program (Chapters 5–8)
- Review and reporting requirements (Chapter 9)
- Public consultation (Chapter 10).

1.3 Implementation of Ministerial Statement 665

Ministerial Statement 665 (Appendix A) includes a number of conditions and commitments relating to the monitoring and reporting, further investigations, remedial and/or preventative actions and management actions. In particular, MS 665 includes Ministerial Conditions regarding bioaccumulating contaminants[1], other contaminants, nitrogen loads and sediment quality, in relation to the disposal of industrial wastewater to the SDOOL (refer to Table 1.1 and Table 1.2).

All Conditions of MS 665 relevant to the impacts of industrial wastewater discharge are met by this M&MP. These include Conditions 6.1, 6.2, 6.3, 7.1, 7.2, 7.3, 7.4, 7.5, 7.6, 9.1, 10.1, 10.2, 11.1, 11.2 and 11.3 (see Appendix A) and the Water Corporation's Environmental Management Commitments 1, 3, 4, 5, 6, 7, 8 and 9 (Table 1.2).

Table 1.1 Summary of monitoring, investigation and management responses in Ministerial Conditions from Ministerial Statement 665 for the SDOOL

Parameter	Monitoring	Investigation	Management Response
Discharge Quality	**Condition 1.1**: As detailed in Schedule 1 of MS 665, the proponent shall undertake monitoring to derive monthly estimates for total suspended solids (TSS), biochemical oxygen demand (BOD) and total phosphorus (TP) to ensure concentrations in the combined treated wastewater quality do not exceed wastewater targets on more than one occasion in a calendar year. See Section 5.3	In the event that TSS, BOD or TP exceed the targets detailed in Schedule 1 of MS 665 on more than one occasion in a calendar year, the Water Corporation is to investigate each of the participants to the SDOOL, to determine the cause and origin of the exceedance. See Section 4.1.2	In the event that TSS, BOD or TP exceed the targets detailed in Schedule 1 of MS 665 on more than one occasion, the Water Corporation will report the exceedance and the outcome of the subsequent investigations in the annual report. See Section 4.1.2
Bioaccumulating Toxicants	**Condition 7.1**: Determine and report whether the concentrations of bioaccumulating toxicants in the effluent at the diffuser exceed the ANZECC/ARMCANZ (2000) 80% species protection guideline trigger levels. See Section 5.3	**Condition 7.2**: In the event that a guideline trigger level for a bioaccumulating toxicant is exceeded, there is a requirement to report the matter within one working day of determining that an exceedance has occurred and to initiate an investigation against the Environmental Quality Standards and into the cause of the exceedance in accordance with the Environmental Quality Management Framework developed in the *Environmental Quality Criteria Reference Document for Cockburn Sound (2003–2004)* (EPA 2005a). See Section 4.1.3	**Condition 7.3**: If an Environmental Quality Standard for a bioaccumulating toxicant is exceeded, there is a requirement to initiate a management response to determine the cause and remedy the exceedance in accordance with the implementation framework for the *National Water Quality Management Strategy* (EPA 2002). See Section 4.1.3

[1] *Although Ministerial Statement 665 uses the word 'toxicant', this document preferentially uses the word 'contaminant'. A contaminant is a substance that is present in amounts above natural background levels, but it only becomes a toxicant when it is present at levels that cause toxicity in organisms.*

Parameter	Monitoring	Investigation	Management Response
Toxicants	**Condition 7.4**: Determine and report whether the ANZECC/ARMCANZ (2000) 99% species protection guideline trigger levels for toxicants (with the exception of cobalt, where the 95% guideline will apply) are being exceeded within the High Ecological Protection Zone (i.e. beyond a 100 m radius of the diffuser). See Section 5.3	**Condition 7.5**: In the event that a guideline trigger level for a toxicant is exceeded, there is a requirement to report the matter within one working day of determining that an exceedance has occurred and to initiate an investigation against the Environmental Quality Standards and into the cause of the exceedance in accordance with the Environmental Quality Management Framework developed in the *Environmental Quality Criteria Reference Document Cockburn Sound (2003–2004)* (EPA 2005a). See Section 4.1.3	**Condition 7.6**: If an Environmental Quality Standard for a toxicant is exceeded, there is a requirement to initiate a management response to determine the source and remedy the exceedance in accordance with the implementation framework for the *National Water Quality Management Strategy* (EPA 2002). See Section 4.1.3
Nitrogen Loads	**Condition 10.1**: Operate the SDOOL so that the annual nitrogen load to the Sepia Depression does not exceed the nitrogen load discharged from the outlet in 1994 (1778 t). See Section 5.3		**Condition 10.2**: In the event that subsequent monitoring shows an adverse environmental impact at the 1994 nitrogen load, there is a requirement to reduce the annual nitrogen load to 75% of the load discharged from the outlet in 1994. See Section 4.1.2
Sediment Quality	**Condition 11.1**: Monitor sediment quality within and at the boundary of the Low Ecological Protection Zone and report on whether sediments exceed the ANZECC/ARMCANZ (2000) Interim Sediment Quality Guidelines-low “trigger” levels. See Section 5.5	**Condition 11.2**: In the event that a guideline trigger level for sediment is exceeded, there is a requirement to report the matter within one working day of determining that an exceedance has occurred and to initiate an investigation against the Environmental Quality Standards and into the cause of the exceedance in accordance with the Environmental Quality Management Framework developed in the *Environmental Quality Criteria Reference Document Cockburn Sound (2003–2004)* (EPA 2005a). See Section 4.1.3	**Condition 11.3**: If an Environmental Quality Standard for sediment quality is not met, there is a requirement to initiate a management response to determine the cause and act to prevent further sediment quality degradation. See Section 4.1.3

Table 1.2 Summary of Water Corporation commitments from Ministerial Statement 665 for the SDOOL

Commitment	SDOOL M&MP Section	Action
No. 1	4.1 5.3 5.3.4	Attain an average dilution of the SDOOL wastewater stream of at least 1:300, with dilution being above 1:200 at least 99% of the time within 100 m of the diffuser. Dilution will be demonstrated by modelling and monitoring.
No. 3	4.1 5.3 5.3.4	Manage the discharge of treated waster to the Sepia Depression, including that accepted from industrial participants and future expansion of the wastewater treatment system, to ensure that the concentration of toxicants meets agreed Environmental Quality Criteria 100 m from the diffuser. Compliance will be demonstrated by modelling and monitoring.
No. 4	9.1	Conduct specific investigations and annually report the effects of wastewater discharge to the Sepia Depression through the Perth Long-term Ocean Outlet Monitoring (PLOOM) Program or other agreements. Reporting will be through the Compliance Report.
No. 5	5.3	Conduct specific investigations in the event that toxicants in the treated wastewater exceed concentrations which will result in the Environmental Protection Authority's relevant high protection Environmental Quality Guidelines being exceeded following 1:200 initial dilution, with the relevant industrial participant(s) and in consultation with the Department of Environment and Conservation to identify the source and cause of the identified condition. Report any exceedances in the Compliance Report.
No. 6	4.1.3	Undertake assessment of the risk presented to the ecological processes in the Sepia Depression by the exceedance in Commitment No. 5, and undertake measures necessary to mitigate those risks. Report mitigation measures taken in the Compliance Report.
No. 7	5.3.7	Undertake Whole-Effluent-Toxicity (WET) testing using a method agreed with the Department of Environment and Conservation following the principles contained in the USEPA, APHA and ASTM protocols, at a NATA-accredited laboratory in accordance with the protocols set out in ANZECC/ARMCANZ (2000) and in accordance with the *SDOOL Monitoring and Management Plan*. Report results in the Compliance Report.
No. 8	4.2 5.4.2	Participate in close consultation with the Department of Health and the Department of Environment and Conservation to further refine the notional social Environmental Quality Objectives for the maintenance of seafood for human consumption and recreation and aesthetic Environmental Quality Criteria values and boundaries for treated wastewater discharge to the marine environment. Deploy sentinel mussels to monitor tissue coliform levels in accordance with the *SDOOL Monitoring and Management Plan*. Report results in the Compliance Report.
No. 9	4.2 4.3	Notify the Department for Planning and Infrastructure of the spatial extent of the area in proximity to the Sepia Depression Ocean Outlet where primary contact recreation and taking of seafood is not recommended, with a request for inclusion on relevant Maritime Charts. Provide evidence of the notification.

Commitment	SDOOL M&MP Section	Action
No. 10	This Report	Prepare a Wastewater Monitoring and Management Plan to address the receipt and discharge of wastewater from the SDOOL, including: • The monitoring and evaluation of combined treated wastewater and industrial effluent into the Sepia Depression. The Monitoring will include as far as practicable: • Real-time monitoring of all streams of wastewater returned to the SDOOL and combined streams prior to discharge. Routine monitoring is to include flow-rate, pH, conductivity, turbidity and temperature; and • Routine monitoring of prescribed contaminant levels in all streams of wastewater returned to the SDOOL and combined streams prior to discharge. Prescribed contaminants are those agreed from time to time under this Plan. • Procedures required to be implemented by the Water Corporation and Kwinana Water Reclamation Plant participants if the wastewater contamination has the potential to cause specified toxicant concentrations and loads to be exceeded. • Mode of operation of the SDOOL to attain an average dilution of the combined wastewater stream of at least 1:300, with the dilution being above 1:200 at least 99% of the time within 100 m of the diffuser. Submit framework and plan to Audit Branch (Department of Environment and Conservation).
No. 11	9.1	Finalise the Wastewater Monitoring and Management Plan (see Commitment 10). Submit Plan to Audit Branch (Department of Environment and Conservation).
No. 12	9.1	Implement the Wastewater Monitoring and Management Plan (see Commitments 10 and 11). Report in the Compliance Report.
No. 13	10	Develop a Stakeholder Consultation Strategy. The Strategy will include commitments to: • Identify relevant stakeholders including community groups, environmental groups, local governments (including the City of Rockingham) and government agencies; • Describe stakeholder consultation measures; • Require stakeholder input into the Plans and Strategies required to be prepared by these commitments; • Describe opportunities to publicly review annual reports and data on the Sepia Depression Ocean Outlet environmental performance and monitoring programs; • Make reports on Kwinana Water Reclamation Plant environmental performance readily available to the public and advertise their availability; • Make the results of the Perth Long-term Ocean Outlet Monitoring (PLOOM) Program readily available to the public and advertise their availability; • Maintain a complaints/response record of actions taken to address matters arising; • Present up-to-date information and data, consult on and receive input on current and possible future industry participations prior to any referral under s.38 of the *Environmental Protection Act 1986*. • Implement the Stakeholder Consultation Strategy. Report monitoring results, complaints and responses in the Compliance Report.

The SDOOL M&MP addresses the potential impacts of industrial wastewater discharge into the Sepia Depression. The M&MP has been specifically developed to meet the requirements of Ministerial Conditions 7.1, 7.4, 10.1 and 11.1 and Water Corporation commitments 1, 4, 6 and 8, and consists of two distinct components:

Monitoring of the contaminant source to provide information on contaminant inputs, comprising:

- real-time monitoring
- wastewater characterisation and initial dilution modelling
- whole-of-effluent toxicity (WET) testing.

Monitoring of the quality of the ambient environment, comprising:

- sentinel mussel monitoring
- sediment quality monitoring.

Monitoring of the long-term effects of the wastewater discharge on the Sepia Depression has primarily occurred through the Perth Long-term Ocean Outlet Monitoring (PLOOM) Program. The relationship between the SDOOL and PLOOM monitoring programs is discussed in Section 2.5. Operationally, monitoring will continue to be conducted as a part of PLOOM but is now formalised and driven by the content of this M&MP.

In addition to the Conditions and Commitments listed in Table 1.1 and Table 1.2, the Water Corporation is committed to the actions outlined in Table 1.3 to account for outstanding items. These actions are to be implemented as a condition of M&MP approval.

Table 1.3 Additional actions required to be conducted to address outstanding items and complete this plan

Action	Purpose	Estimated completion date
Create a validated and calibrated three dimensional hydrodynamic model to determine dilution at the LEPA boundary.	• To provide evidence that commitment 1 of Ministerial Statement 665 is being met • To justify the use of 1:200 or suggest an alternative number of dilutions used to correct waste stream toxicant concentrations for dilution at the LEPA boundary • To provide data to help determine whether EQG are met during balancing dam flushing events	Within 9 months of acceptance of the plan to allow for autumn current meter deployments, subsequent modelling, interpretation and reporting
The model will be calibrated with ADCP data collected from the Sepia Depression and validated against solute fields from the plume monitoring data collected in situ during the summer field campaigns. The ADCP deployments will be conducted during the low energy April–May period. The validation sampling will be conducted to capture low energy conditions.	• To calibrate the model relative to conservative (low energy) conditions encountered during April–May). • To validate the model against appropriate solute fields (i.e. encountered during low energy periods)	Within 9 months of acceptance of the plan to allow for autumn current meter deployments, subsequent modelling, interpretation and reporting
Use the improved understanding of dilution as well as estimates of the magnitude and duration of contaminant and TSS spikes to determine whether balancing dam flushing exceeds ANZECC/ARMCANZ (2000a) guidelines	To derive a management system to ensure when the balancing dam is flushed, dilution at the diffuser is sufficient to meet the relevant ANZECC/ARMCANZ species protection guideline values at the edge of the LEPZ (particularly for ammonia)	Within 9 months of acceptance of the plan to allow for autumn current meter deployments, subsequent modelling, interpretation and reporting

2. Background

2.1 Wastewater discharge in Perth's metropolitan coastal waters

The Water Corporation operates three major wastewater treatment plants (WWTPs) within metropolitan Perth, at Beenyup, Subiaco and Woodman Point. The bulk of the treated wastewater is discharged to the sea through ocean outlets located at Ocean Reef, Swanbourne and Sepia Depression, respectively.

The Water Corporation has undertaken monitoring of the environmental effects of treated wastewater discharge into Perth's coastal waters since the construction of the ocean outlets at Swanbourne in 1963, Sepia Depression in 1984 and Ocean Reef in 1978 (Outlet A) and 1992 (Outlet B).

The Woodman Point WWTP services the southern Perth metropolitan area and predominantly receives domestic wastewater (from kitchen, bathroom, toilet and laundry uses), with approximately 8% received from light industrial wastewater. In 2002, the Woodman Point WWTP was upgraded from primary to advanced secondary level treatment. Currently, the plant produces secondary treated wastewater using an activated sludge process with nitrification and denitrification stages for nutrient removal (Figure 2.1).

In 2012-2013, the Woodman Point WWTP discharged approximately 132 ML d^{-1} of secondary treated wastewater to the sea through the Sepia Depression ocean outlet. Approximately 24 ML day^{-1} of this secondary treated wastewater is further treated at the Kwinana Water Reclamation Plant into high-grade industrial processing water for use by industries in the Kwinana area. Following industrial processing, this water is then redirected back into the SDOOL (Figure 2.2). An additional 18 ML d^{-1} of primary treated wastewater was discharged through the same outlet from the smaller Point Peron WWTP, downstream of the Woodman Point WWTP (Figure 2.2).

The Sepia Depression ocean outlet discharges approximately 4 km offshore into the Sepia Depression (refer Figure 2.1 and Figure 2.2), into a water depth of 20 m. The ocean outlet has an overall (offshore) length of 4.2 km and a diffuser length of 324 m.

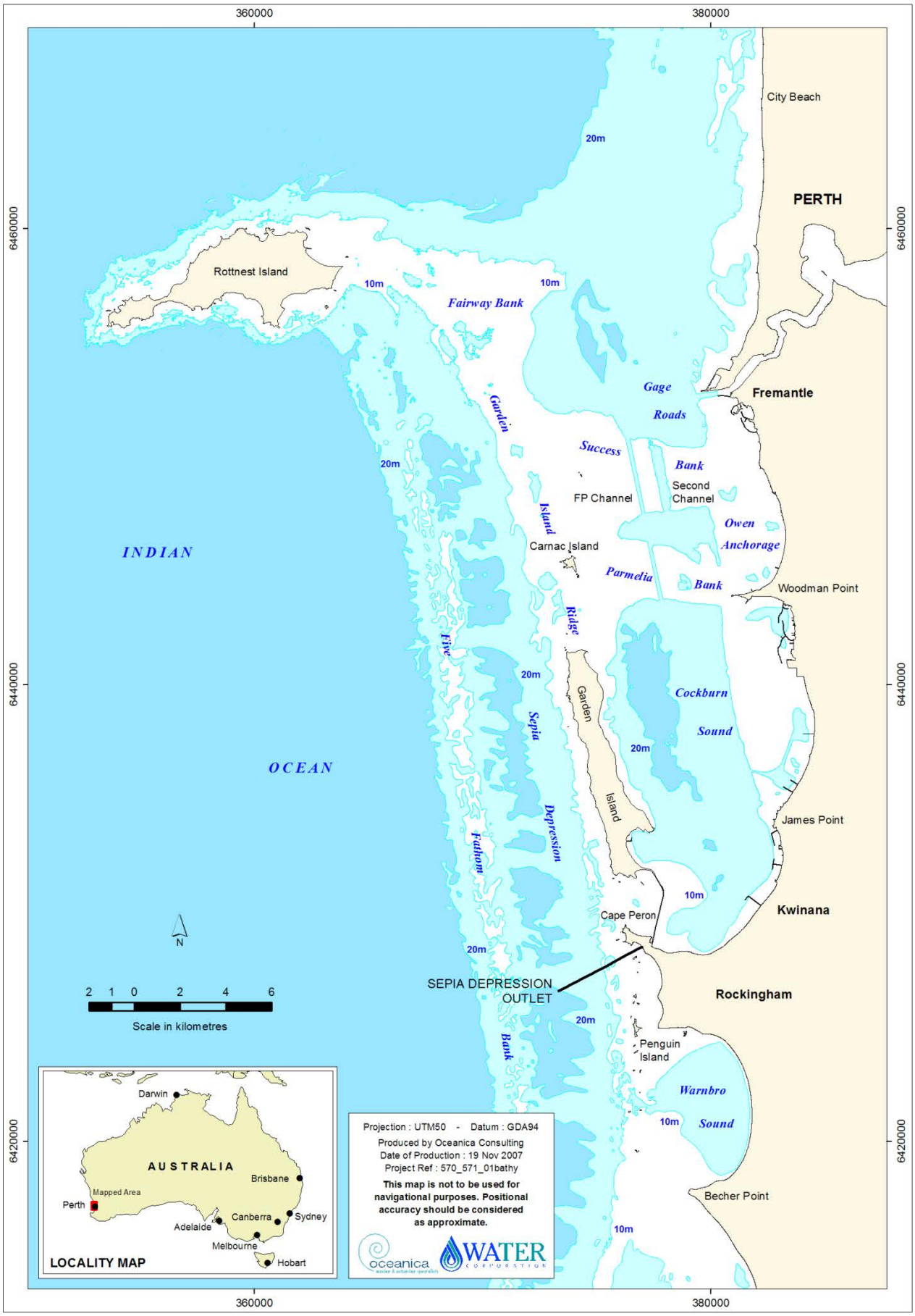

Figure 2.1 Location of Sepia Depression Ocean Outlet

Figure 2.2 Contributors into the Sepia Depression Ocean Outlet

2.2 Receiving environment of the Sepia Depression

Sepia Depression is a natural channel approximately 5 km long and 20 m deep (Figure 2.1), with the seabed (including the area around the outlet) largely consisting of fine to coarse unvegetated sand. The western boundary of the Sepia Depression is the reef line of Five Fathom Bank, which lies roughly parallel to the coastline, while the eastern boundary is the Garden Island reef line of rocky islands, channels and gaps that also runs parallel to the coastline. Garden Island separates Sepia Depression from Cockburn Sound, although the southern opening of Cockburn Sound provides a channel between the Sound and Sepia Depression.

Coastal hydrodynamics and circulation

The offshore wave climate of Perth is dominated by a persistent low-to moderate-energy wave regime, and is generally far more variable in winter than in summer. The summer swell arrives from the west to south-west and is typically 1–2 m in height. Winter swell arrives from almost due west and is typically 1–3 m in height. During summer, the afternoon sea breeze results in the development of local seas (typical wave heights are 0.5–1.5 m) that are superimposed upon the swell regime. Local seas are also generated by the passage of winter storms; wave height and direction varies considerably from storm to storm, but the wave heights often exceed 4 m (7 m or more in severe storms).

The offshore reef chains dissipate the wave energy received inshore. The Five Fathom Bank reef line varies in depth to a maximum of 10 m and is sufficiently shallow to cause some attenuation of the swell wave energy within the Sepia Depression, but the shallower Garden Island Ridge results in far greater attenuation. Therefore, the waters of the Sepia Depression are of higher wave energy than most of the inshore waters of Perth.

Wind is the main factor influencing coastal circulation in the inshore waters, particularly in summer when up to 60% of the variation in the ocean currents can be explained by the wind field (Pattiaratchi & Knock 1995). The prevailing summer winds drive northward-flowing littoral currents, although periods of current reversal can occur when winds come from the north, particularly in winter. Currents are strongly influenced by the inshore bathymetry, and the offshore reef line channels water flow parallel to the shore.

In the Sepia Depression the seasonal distribution of mid-depth current direction is bimodal, with northward flows predominating in summer and southward flows in winter. Ambient current velocities are typically 5–20 cm/s. A year of current measurements recorded in the Sepia Depression in 1993 (deemed a ‘typical’ year in terms of winds and currents) showed that current speed equals or exceeds 5 cm/s for 97.5% of the time, and averages 13 cm/s (Bailey et al. 2003).

Marine ecology

Perth’s submerged offshore reefs support extensive stands of macroalgae, predominantly larger species of brown algae (*Ecklonia radiata*, *Scytothalia dorycarpa* and *Sargassum* spp.) but also mixed assemblages of smaller species of red, green and brown algae, particularly on areas of limestone pavement. A diverse assemblage of sponges, gorgonians and other invertebrates also inhabits the reefs. In shallow (<10 m deep) sheltered waters inshore of the reef lines, seagrass habitats typically occupy a larger area than the macroalgal-covered reefs (Oceanica & CRC 2005).

Unlike the western coastlines of the other southern continents, Western Australia lacks any major oceanic upwelling and consequently does not have the highly productive plankton food chains that support the large finfish fisheries of the west coasts of South America and southern Africa. The fish populations in the nutrient-poor nearshore waters of Perth depend largely on benthic-based food chains in the seagrass meadows, macroalgal-dominated reef systems and detritus-

enriched basins. The Sepia Depression, although relatively deep, experiences too much wave energy for the accumulation of detritus from adjoining reefs. The relatively high wave energy experienced in the Sepia Depression is also evident in its' coarse, sandy, nutrient-poor sediments. Consequently, the benthic fauna of the Sepia Depression is naturally low in biomass and species diversity (Bailey et al. 2003).

2.3 Potential environmental impacts of WWTP discharge

The Water Corporation acknowledges that treated wastewater will contain elevated concentrations of nutrients, metals and organic particulates. Herbicides and pesticides may also be present in the wastewater discharge, but long-term monitoring has demonstrated that the concentration of these substances is very seldom higher than detection limits. Discharge from WWTPs contains three classes of materials of potential environmental concern:

- Pathogenic organisms from faecal material: these are a potential threat to human health via accidental swallowing of contaminated waters during recreational activities or via consumption of uncooked seafood (note: cooking destroys enteric bacteria). Bacterial groups typically monitored are faecal streptococci (to assess recreational suitability) and thermo-tolerant coliforms (to assess suitability for shellfish consumption)
- Metals and persistent organic compounds: these may accumulate in biota at concentrations sufficient to be a concern for human consumption of seafood. As the Woodman Point WWTP is not a combined system (i.e. it does not collect stormwater runoff) and accepts no heavy industrial waste, the persistent organic compounds of potential concern are mainly trace concentrations of pesticides and do not include substances such as polychlorinated biphenyls (PCBs) or petroleum hydrocarbons.
- Nutrients: dissolved inorganic forms make up the majority of nitrogen and phosphorus discharged from outlets. These nutrients enhance the growth of aquatic plants in the water column (i.e. phytoplankton) and on the seabed (e.g. reef algae, seagrass epiphytes), which may lead to changes in the abundance and species composition of aquatic plant communities if some species are favoured more than others by the increased nutrient supply. Particulate organic material can also accumulate in sediments and the resultant increased food supply may cause alterations to benthic fauna abundance and species composition.

Examples of the direct and indirect effects of the construction and operation of the Sepia Depression wastewater outlet on the marine environment are described in the Public Environmental Review (PER) for disposal of industrial wastewater via the SDOOL (Bailey et al. 2003). The Water Corporation has monitored the effects of wastewater discharge on the marine environment since the commissioning of the Sepia Depression Ocean Outlet in 1984, with monitoring expanding and evolving into the PLOOM program in 1996. Since 1984 there have been very few exceedances of any of the relevant contaminant guidelines, and the receiving environment is considered to have undergone no adverse impacts (Oceanica 2010b).

Best practice environmental management depends on knowledge of the potential effects of ocean wastewater disposal together with an understanding of the receiving environment, including the extent of natural environmental variation. To ensure that the effects (if any) of ocean disposal are detected early, the Water Corporation has committed to an extensive program of environmental monitoring, the details of which are included in this M&MP.

2.4 Environmental commitment

The Water Corporation has carefully considered the potential for environmental impacts of WWTP discharge into the Sepia Depression, and all reasonable actions have been taken to mitigate impacts through effective and integrated management. Environmental modelling was used to predict the likely effect of the treated wastewater plume, including the likely zone of influence and the expected concentrations of contaminants following initial dilution (Bailey et al. 2003).

Results of the modelling indicated that the physical oceanographic characteristics (i.e. the exposed coastline and high wave energy conditions) of the Sepia Depression are likely to facilitate effective dilution and dispersal of the treated wastewater, thus limiting the potential for detrimental effects. For example, the average dilution of treated wastewater (even under worst-case conditions) will dilute contaminants to levels below the ANZECC/ARMCANZ (2000) trigger values for protection of 99% of species..

To ensure that the effects (if any) of ocean disposal are detected early, the Water Corporation has committed to an extensive and ongoing program of environmental monitoring across all Perth metropolitan WWTPs, presently implemented via the Perth Long-term Ocean Outlet Monitoring (PLOOM) Program. The components of the PLOOM program conducted under the EQMF framework have now been incorporated into this SDOOL M&MP.

2.5 Relationship of this M&MP to the PLOOM Monitoring Program

The Perth Long-term Ocean Outlet Monitoring (PLOOM) Program formally commenced in 1996. The program is based on an understanding of the environmental processes that occur as a consequence of the discharge of treated wastewater, with regards to potential effects on the marine environment and human health. PLOOM was designed as a long-term program, monitoring any potential chronic problems resulting from the three metropolitan ocean outfalls (Ocean Reef, Swanbourne and Sepia Depression).

The PLOOM Program has historically included monitoring components relevant to the SDOOL wastewater outlet:

- **Annual summer water quality surveys**: As a requirement under the licence conditions for the Woodman Point and Point Peron WWTPs, the Water Corporation conducts comprehensive annual summer surveys of water quality in the vicinity of the Sepia Depression ocean outlet. The annual summer water quality surveys are not conducted in a manner consistent with the EQMF framework and have not been incorporated into this management plan. However, as a licence condition they will continue to be conducted regardless.
- **Seasonal water quality monitoring**: Seasonal sampling of water column physical-chemical characteristics, nutrients and primary productivity (chlorophyll-a) at four sites near the Sepia Depression ocean outlet. This was discontinued in 2008.
- **PLOOM Compliance monitoring**: A period of intensive summer water quality monitoring at compliance monitoring sites and reference sites near the Sepia Depression ocean outlet. The core components of the compliance monitoring program are:
  i. physical stressor monitoring (i.e. salinity and dissolved oxygen)
  ii. nutrient and phytoplankton monitoring
  iii. public health monitoring.

Ministerial Condition 6.1 requires that the SDOOL M&MP include the monitoring and evaluation of the effects of discharging treated wastewater into the Sepia Depression. Operational procedures for monitoring some of these effects have historically been incorporated, and will remain a component of PLOOM. However, the long-term environmental quality objectives and environmental quality criteria relevant to managing these effects that are managed by PLOOM are formalised and set out via this SDOOL M&MP (Section 4). In the unlikely event that PLOOM or components of PLOOM ceases, monitoring will continue at Sepia Depression in the manner described in this M&MP.

3. Environmental Management Framework

3.1 Environmental management framework background

The EPA is implementing an Environmental Quality Management Framework (EQMF) for Perth's coastal waters (EPA 2000, 2005a; Govt of WA 2005). This EQMF is based on:

- Identifying **Environmental Values**[2]
- Establishing and spatially defining **Environmental Quality Objectives (EQOs)**[3] that need to be maintained to ensure the associated Environmental Values are protected
- **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 bench marks or 'trigger values' against which monitoring results can be compared.

According to the EQMF, the extent to which the Environmental Values and EQOs are met is assessed against a suite of appropriate EQC. There are two levels of EQC; Environmental Quality Guidelines and Environmental Quality Standards (refer to Section 5):

Environmental Quality Guidelines (EQGs) — quantitative, investigative triggers which signify low risk of an environmental effect if they are met, and trigger further investigations if an exceedance occurs

Environmental Quality Standards (EQSs) — management triggers based on multiple lines of evidence, which if exceeded signify that the Environmental Quality Objective is not being met and that a management response is required.

3.2 SDOOL environmental management framework

The SDOOL M&MP is based on the EQMF for Perth's coastal waters, as outlined above (Section 3.1). This section (3.2) describes the environmental management process that underpins the M&MP; the Environmental Values and EQOs specific to the Sepia Depression are described in Sections 3.2.1 and 3.2.2, respectively. A Compliance Monitoring program, incorporating Environmental Quality Indicators and EQC that are compared against relevant EQOs, is described in Section 3.2.3.

In the event that an EQC is exceeded, the Water Corporation will initiate the appropriate management responses. Management responses will range from continued monitoring through to investigations into management interventions, which would include cessation of industrial wastewater acceptance into the SDOOL if necessary.

The level of management response will depend upon the nature of the exceedance, and would include consideration of the background levels, guideline or standard criteria and/or the severity of observed environmental conditions. The management response will be consistent with the risk management framework outlined in the Environmental Quality Criteria Reference Document for Cockburn Sound 2003-04 (EPA 2005a, Figure 3.1).

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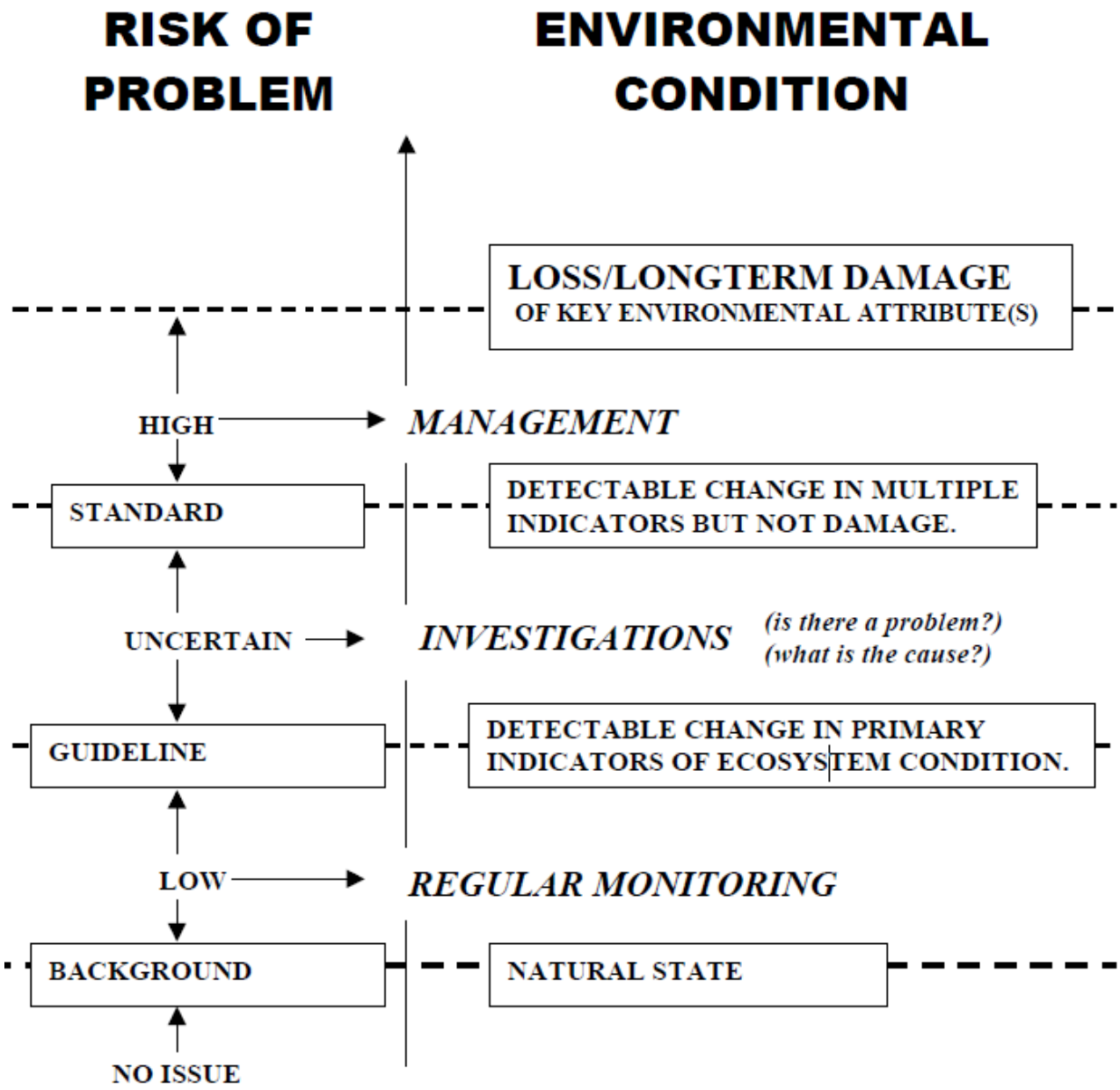
[2] *Particular values or uses of the environment that are important for a healthy ecosystem or for public benefit, welfare, safety or health, and which require protection from the effects of pollution, waste discharges and deposits.*

[3] *More specific than EVs and representing management goals for maintaining environmental quality to protect particular aspects of the EVs from the effects of wastes.*



Source: EPA (2005a)

Figure 3.1 Environmental Risk/Management Response

To establish the level of compliance required to meet the identified EQOs, the monitoring results will be compared against the EQC. As noted above, there are two levels of EQC: Environmental Quality Guidelines (EQGs) and Environmental Quality Standards (EQSs), and these demarcate three levels of management response:

- If monitored values are below the EQG then the EQO are considered to have been met and the Environmental Values protected, routine monitoring then continues as per the M&MP.
- If an EQG is exceeded it is considered there is an increased risk that the associated EQO may not be achieved. This triggers the need for a more comprehensive assessment against the EQS. A more comprehensive assessment against an EQS involves a risk-based approach that considers multiple lines of evidence and integrates more refined measures of the surrogate indicators with more direct measures of the EQO (EPA 2005a).
- If an EQS is exceeded it is considered there is a significant risk that the associated EQO has not been achieved. This triggers a detailed investigation, including an adaptive management response to ensure the EQO is achieved and the exceedance does not occur again. The Office of the Environmental Protection Authority (OEPA) will be notified when an EQS is exceeded, and advice will be sought on management actions to complement those outlined in this M&MP.

3.2.1 Sepia Depression Environmental Values

Three Environmental Values have been identified for the Sepia Depression (EPA 2004):

- Ecosystem Health (an ecological value)
- Fishing and Aquaculture (a social value)
- Recreation and Aesthetics (a social value).

3.2.2 Sepia Depression Environmental Quality Objectives

There are five EQOs that must be achieved at the ocean outfall in order to maintain the Environmental Values at the Sepia Depression (EPA 2000). The EQOs need to be sustained for the long term by achieving the short- to medium-term targets described in this M&MP.

The EQOs for the SDOOL ocean outfall are:

- Maintenance of Ecosystem Integrity (EQO1)
- Maintenance of Aquatic Life for Human Consumption (EQO2)
- Maintenance of Primary Contact Recreation Values (EQO3)
- Maintenance of Secondary Contact Recreation Values (EQO4)
- Maintenance of Aesthetic Values (EQO5).

3.2.3 Sepia Depression Environmental Quality Criteria

EQC have been defined for key indicators of environmental health for each of the Environmental Quality Objectives 1 to 5 (Section 3.2.2) relevant to the Sepia Depression. As per EPA (2005a), EQC have been set at two levels: Environmental Quality Guidelines (EQGs) and Environmental Quality Standards (EQSs). These are set out in Section 4.

4. Environmental Quality Objectives and Criteria

4.1 Maintenance of Ecosystem Integrity (EQO1)

4.1.1 Objective

The EQO for the Environmental Value 'Ecosystem Health' is aimed at maintaining ecosystem integrity and biodiversity, thereby ensuring the continued health and productivity of Perth's coastal waterways (EPA 2000). To ensure this EQO is being met, monitoring programs have been developed to measure compliance against EQC set for waste stream monitoring, toxicants in treated wastewater, receiving water physio/chemical measures, receiving water direct biological measures and toxicants in sediments (Figure 4.1).

The requirement is that ecosystem integrity, considered in terms of structure (e.g. biodiversity) and function (e.g. trophic links), will be maintained in the vicinity of the Sepia Depression wastewater outlet. The level of protection around the outlet will remain high (i.e. small changes from natural variation) except in a Low Ecological Protection Area (LEPA), where large changes from natural variation are permitted. The LEPA has been defined for toxicants (Figure 4.2) and includes waters within a 100 m radius around the diffuser (an area of approximately 10.5 ha). The diffuser location is 373340 E and 6426510 N (MGA94 Zone 50) with waters outside this zone to be managed as a High Ecological Protection Area (HEPA).

Contaminants will be monitored in the treated wastewater prior to discharge, as well as within the receiving environment near the SDOOL ocean outlet. The primary contaminants of concern are nutrients (principally nitrogen and phosphorus) and toxicants (i.e. metals, herbicides, pesticides and organic particulates).

The concentration of nutrients in receiving waters will be managed via the SDOOL EQC for physico-chemical parameters (see Section 3.2.3), which are described in full in Table 4.1 with results reported annually. The required management response following any exceedances of these EQC is set out in Table 4.2.

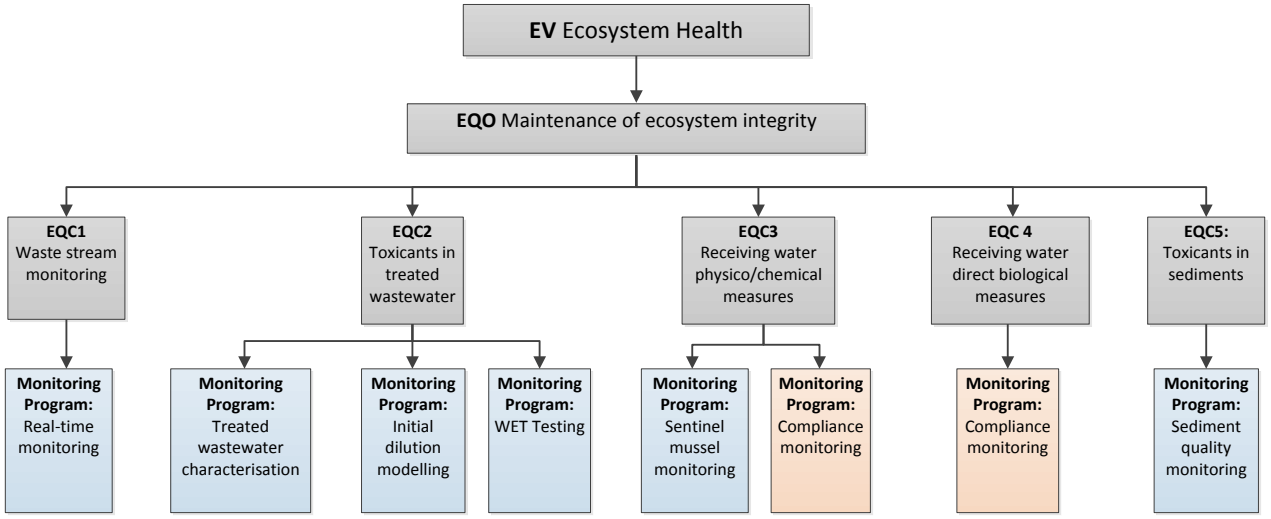
Toxicant characteristics are also defined within MS 665 (Schedule 1; see below) and EQC defined and described in full (Table 4.1). Within the LEPA, an average dilution of the wastewater stream of at least 300-fold, and above 200-fold 99% of the time, is to be achieved. With a 200-fold dilution at the edge of the LEPA, the ANZECC/ARMCANZ (2000) 99% species protection guidelines for toxicants (with the exception of cobalt, for which the 95% species protection guideline will apply) will be met under both typical and worst-case discharge concentrations.

4.1.2 Schedule 1 monitoring and management requirements

Key proposal characteristics (Table 1 in Schedule 1 of MS 665) have been adopted as TWW targets. Water Corporation and industry participants will undertake monthly monitoring to ensure concentrations in their combined treated wastewater do not exceed the targets for total suspended solids (TSS), biochemical oxygen demand (BOD) and total phosphorus (TP). The monthly average contributions from each industry participant will be flow-weighted and pooled to derive an estimate of monthly concentrations in the combined TWW stream. The monthly TWW stream estimates for 1 calendar year will be compared to the operational targets. In the event that TSS, BOD or TP exceed the targets detailed in Schedule 1 of MS 665 on more than one occasion, the Water Corporation will investigate each of the participants to the SDOOL, to determine the cause and origin of the exceedance. If the investigation of the SDOOL participants cannot identify the cause of and correct an exceedance, an appropriate management response will be initiated. A wastewater characterisation will be conducted to determine whether the

conditions that have generated an exceedance of the schedule 1 targets have also introduced unidentified toxicants to the waste stream. The characterisation will be conducted as described in section 5.3.2). Dilution determined by modelling (Appendix C) will be applied to determine the concentrations of contaminants, toxicants and potential stressors at the HEPA/LEPA boundary for comparison to triggers. A 1-hour urchin fertilization toxicity test will also be conducted to determine the overall toxicity of the discharge. The results will be assessed against the EQG and, if necessary EQS for treated wastewater characterisation and WET testing as defined in Table 4.1. Any exceedance and the outcome of the subsequent investigation will be reported in the annual report.

The annual nitrogen load to the Sepia Depression must not exceed the nitrogen load discharged from the outlet in 1994 (1778 t). In 2013, the annual nitrogen load was 1,110 t. In the event that subsequent monitoring shows an adverse environmental impact at the 1994 nitrogen load, there is a requirement to reduce the annual nitrogen load to 75% of the load discharged from the outlet in 1994.



Note:

1. Components managed by the SDOOL and PLOOM monitoring programs are highlighted in blue and orange, respectively.

Figure 4.1 Environmental quality objectives, criteria and monitoring programs for maintaining the environmental value Ecosystem Health

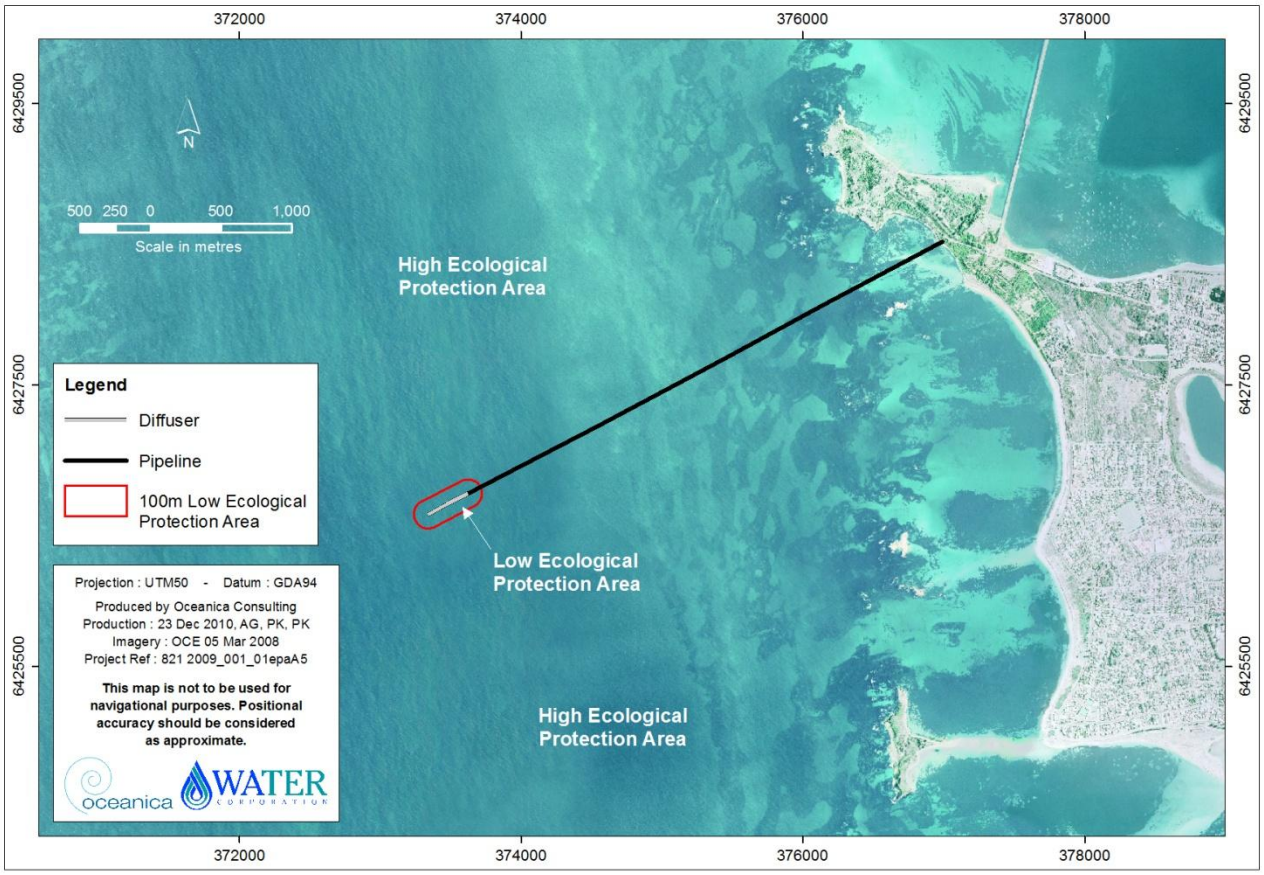


Figure 4.2 Sepia Depression ocean outlet ecological protection boundaries

4.1.3 Environmental quality criteria

Table 4.1 Environmental Quality Criteria for the EQO of Maintenance of Ecosystem Integrity (EQO1)[1]

Environmental Quality Indicator	Environmental Quality Criteria[2]	
	Environmental Quality Guideline	**Environmental Quality Standard**
Toxicants in Treated Wastewater • Ammonia • Metals • Pesticides • Herbicides • Other chemicals	**Treated wastewater characterisation – bioaccumulating toxicants** Concentrations of contaminants will not exceed the ANZECC/ARMCANZ (2000) 80% species protection guideline trigger levels for bioaccumulating toxicants at the diffuser (Figure 4.2)	**Sentinel mussel monitoring** The EQS will be met if median concentrations of metals that may bioaccumulate (cadmium and mercury) within mussel tissue from sites at the boundary of the Low/High Ecological Protection Areas are lower than or equal to the 80th percentile of mussel tissue concentrations from reference sites.
	Treated wastewater characterisation – non bioaccumulating toxicants The information on wastewater quality corrected for minimum dilution at the LEPA boundary will be compared with Table 5.1 and Table 5.2 to determine whether: 1. 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) (Figure 4.2). 2. The total toxicity of the mixture (TTM) for the additive effect of ammonia, copper and zinc (as per ANZECC/ARMCANZ (2000) guidelines) is less than 1.0 (refer to Section 5.3.6). Note that for metals, the assessment is to be based on bioavailable concentrations of metals in the wastewater (i.e. concentrations after filtering through a 0.45 µm filter). Table 5.2 list the main toxicants of concern in relation to the predominant waste stream, i.e. treated wastewater: ammonia, copper and zinc are considered to be the major cause of toxicity effects. If any EQGs are exceeded, assessment against the EQS will commence.	**Whole-of-effluent toxicity (WET) testing** Undertake the full suite of WET testing of the waste stream in accordance with ANZECC/ARMCANZ (2000) guidelines. The EQS will be exceeded where: $\frac{DALEPA}{DR99\%BurrliOZ} \leq 1$ Where *DALEPA* = Dilutions achieved at the boundary of the LEPA; *DR99%BurrliOZ* = Number dilutions required to achieve the 99% species protection guideline specific to treated wastewater that is calculated with BurrliOZ software using the results of the full suite of WET tests, as per ANZECC/ARMCANZ (2000).
	Whole-of-effluent toxicity (WET) testing 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 200-fold dilution) DRNOEC = Number of dilutions required to achieve the No Observed Effects Concentration (NOEC). Breaching the above triggers investigations against the EQS, and would comprise the full suite of WET tests (minimum of five species from four trophic groups).	**Whole-of-effluent toxicity (WET) testing** As per EQS above.
Receiving Water Physical Chemical Measures • Nutrient enrichment • Light attenuation • Dissolved oxygen • Salinity	**Nutrient enrichment** 1. Ambient value[4] of defined area[5] during non river-flow period[6] not to exceed chlorophyll-a: 80th percentile of reference sites data. 2. Ambient value[4] of defined area[5] during non river-flow period[6] not to exceed light attenuation: 80th percentile of reference sites data.	Not applicable. No suitable EQS available.
	Organic enrichment Ambient value[4] for dissolved oxygen in bottom waters (0–0.5 m above the sediment surface) greater than 90% saturation at any site for a defined period of not more than six weeks.	**Organic enrichment** Ambient value[4] for dissolved oxygen in bottom waters (0–0.5 m above the sediment surface) greater than 60% saturation at any site for a defined period of not more than six weeks. No deaths of marine organisms resulting from de-oxygenation.
	Salinity Median salinity (0.5 m below the water surface) at an individual site over any period not to deviate beyond the 20th and 80thile of natural salinity range over the same period.	**Salinity** No deaths of marine organisms resulting from anthropogenically-sourced salinity stress.
Receiving Water Direct Biological Measures (Algal growth potential) • Phytoplankton biomass (Chlorophyll-a)	**Phytoplankton blooms** 1. Ambient value[4] for phytoplankton biomass measured as chlorophyll-a not to exceed 3 times median chlorophyll-a concentration of reference sites, on any occasion during non river-flow period[6]. 2. Phytoplankton biomass measured as chlorophyll-a at any site does not exceed 3 times median chlorophyll-a concentration of reference sites, on 25% or more occasions during the non river-flow period[6]. If either of these EQGs are exceeded, assessment will proceed against the EQS.	**Phytoplankton blooms** 1. Ambient value[4] for phytoplankton biomass measured as chlorophyll-a not to exceed 3 times median chlorophyll-a concentration of reference sites, on more than one occasion during non river-flow period[6] and in two consecutive years. 2. Phytoplankton biomass measured as chlorophyll-a at any site does not exceed 3 times median chlorophyll-a concentration of reference sites, on 25% or more occasions during the non river-flow period[6] and in two consecutive years.

Environmental Quality Indicator	Environmental Quality Criteria[2]	
	Environmental Quality Guideline	**Environmental Quality Standard**
Toxicants in Sediments • Metals • Pesticides • Herbicides	**Sediment quality monitoring** A. Median sediment total contaminant concentration from a defined sampling area should not exceed the environmental quality guideline value for high, moderate and low ecological protection areas. (Table 5.5) B. Total contaminant concentration at individual sample sites should not exceed the environmental quality guideline re-sampling trigger (Table 5.5). If so, repeat sampling will be conducted to define the extent of the contamination which will assessed as in point A	**Sediment quality monitoring** A. The 80%ile of bioavailable metal or metalloid concentrations (e.g. dilute acid extractable metals, SEM/AVS analysis) from the defined sampling area should not exceed the EQG. or B. The median bioavailable concentration for non-metallic contaminants (e.g. OC normalisation) from the defined sampling area should not exceed the EQG C. The 95%ile of bioavailable contaminant concentrations in porewater samples from the defined sampling area should not exceed high protection water quality guideline values (Table 2a of EQC Reference document). D. Sediment toxicity tests should not result in a statistically significant effect ($P < 0.05$) on sublethal chronic or lethal acute endpoints for any species, compared to a matched reference sediment E. No significant change in any biological or ecological indicator beyond natural variation that can be demonstrably linked to a contaminant F. Where TBT concentrations exceed the guideline the incidence of imposex in *Thais orbita* should be ≤ 5%. G. The median tissue concentration of chemicals that can adversely bioaccumulate or biomagnify should not exceed the 80th percentile of tissue concentrations from a suitable reference site.

Notes:
1. Based on the *Environmental Quality Criteria Reference Document for Cockburn Sound (2003–2004)* (EPA 2005a).
2. Where there is more than one Environmental Quality Criteria for an indicator, each one is to be considered individually. If any one of these is exceeded then the guideline or standard for that indicator has not been met.
3. Ambient Value = median value of individual sample data for a defined area.
4. Defined Area = area to be characterised for environmental quality against pre-determined Environmental Quality Objectives and levels of ecological protection.
5. Non River-flow Period = period December–March inclusive, when river and estuarine flows are weak.

Table 4.2 Management response following exceedances of EQC for the EQO of Maintenance of Ecosystem Integrity (EQO1)

Environmental Quality Indicators	Management response following trigger level exceedance	
	Environmental Quality Guideline	**Environmental Quality Standard**
Toxicants in Treated Wastewater	**Treated wastewater characterisation – bioaccumulating toxicants** In the event that concentrations of contaminants exceed the ANZECC/ARMCANZ (2000) 80% species protection guideline trigger levels for bioaccumulating toxicants at the diffuser the Water Corporation will report the exceedance to the OEPA and Department of Environment Regulation (DER) within one working day of determining that it has occurred. Assessment against the EQS will then commence.	**Sentinel mussel monitoring** The EQS requires that median concentrations of metals that may bioaccumulate (cadmium and mercury) within mussel tissue from sites at the boundary of the Low/High Ecological Protection Areas will be compared to 80th percentile of values from reference sites. Any instances of an exceedance of the EQGS will be reported to the DER and the OEPA within one working day of determining that this has occurred. The significance of the exceedance, and any required investigation/action will be discussed with the OEPA. If required, a detailed risk assessment to indicate potential risk to the environment will be conducted. Toxicity Reduction Evaluation (TRE) will be undertaken, to identify the contaminant(s) of concern, and the management required to reduce them to acceptable levels. This would include a detailed examination of the contributor's waste streams. Management measures to reduce the contaminant(s) of concern will be implemented and ongoing wastewater characterisation will be conducted to confirm that the required results are being achieved.
	Treated wastewater characterisation – non bioaccumulating To determine whether the EQG for treated wastewater characterisation is exceeded, check whether the EQGs are met at the edge of the LEPA using measured contaminant concentrations corrected for minimum dilution at the LEPA boundary. If the EQGs are met, then no further work is required. If an EQG is exceeded, the first step will be to immediately collect and re-analyse a further sample of wastewater. If the EQG is still exceeded, initiate the Water Corporation will report the exceedance to OEPA and DER within one working day of determining that this has occurred and assessment against the EQS will commence.	**Whole-of-Effluent-Toxicity (WET) testing** If the EQG is exceeded the Water Corporation will undertake the full suite of Whole-of-Effluent-Toxicity testing of the treated wastewater in accordance with ANZECC/ARMCANZ (2000) guidelines. A sample will also be collected for comprehensive treated wastewater analysis. To meet the EQS the number of dilutions required to be protective of least 99% of species (calculated using BurrliOz software on sub-lethal chronic endpoints for five species from a minimum of four taxonomic groups) should be less than the number of dilutions attained at the boundary of the LEPA. The proposed management response based on an exceedance of the EQS is: 1. A Toxicity Reduction Evaluation (TRE) will be undertaken to identify the contaminant(s) of concern and the management required to reduce them to acceptable levels. This would include a detailed examination of the treated wastewater and potentially include a Stage 1 Toxicity Identification Evaluation. 2. Management measures to reduce the contaminant(s) of concern will be implemented, along with monitoring to confirm that the required results are being achieved. The monitoring could include wastewater characterisation, further WET tests, and *in situ* monitoring, subject to further consultation with the OEPA. The Water Corporation will report annually to the OEPA on any management initiated as a result of the WET tests outcomes. The Water Corporation will report any instances of an exceedance of the EQG or EQS to the OEPA and DER within <u>one</u> working day of determining that this has occurred.
Physical Chemical Measures	**Nutrient enrichment, organic enrichment and salinity** If nutrient enrichment (chlorophyll-a), light attenuation, dissolved oxygen or salinity EQGs are exceeded, then an assessment will proceed against the EQS, as per Appendix B. The Water Corporation will report any instances of an exceedance of the EQG or EQS to the OEPA and DER within <u>one</u> working day of determining that this has occurred.	**Nutrient enrichment, organic enrichment and salinity** If the EQS is exceeded, a management response will be initiated in consultation with the OEPA and other relevant regulatory agencies to investigate potential effects on algal community structure and whether it has shifted by a margin beyond that expected due to natural processes alone. The Water Corporation will report any instances of an exceedance of the EQG or EQS to the OEPA and DER within <u>one</u> working day of determining that this has occurred. The Alkimos WWTP management plan (Oceanica 2010a) provides an indicative monitoring plan to demonstrate whether a change in the macroalgal community structure can be attributed to the SDOOL wastewater discharge. If so, the Water Corporation will take specific management actions to address nutrient loading due to the wastewater discharge. One of the specific management actions may include the option of modifying the diffuser to increase dilution, such as utilising extra contingency ports and/or increasing the velocity of the wastewater stream.
Direct Biological Measures	**Phytoplankton blooms** If the algal growth potential EQGs are exceeded, assessment will proceed against the EQS. The Water Corporation will report any instances of an exceedance of the EQG or EQS to the OEPA and DER within <u>one</u> working day of determining that this has occurred.	See exceedance of EQS for nutrient enrichment

Environmental Quality Indicators	Management response following trigger level exceedance	
	Environmental Quality Guideline	**Environmental Quality Standard**
Toxicants in Sediments	**Sediment quality monitoring** In the event that an ISQG-Low trigger level (ANZECC/ARMCANZ 2000) for sediment quality is exceeded, the Water Corporation will report the matter to the DER and the OEPA within <u>one</u> working day of determining that this has occurred. An investigation of the exceedance will be conducted in accordance with the framework developed in the *Environmental Quality Criteria Reference Document for Cockburn Sound (2003-2004)* (EPA 2005a) (see also Appendix B). In the event that an ISQG-High trigger level (ANZECC/ARMCANZ 2000) for sediment quality is exceeded, the Water Corporation will report the matter to the DER and the OEPA within <u>one</u> working day of determining that this has occurred. An investigation of the exceedance will be conducted in accordance with the framework developed in the *Environmental Quality Criteria Reference Document for Cockburn Sound (2003-2004)* (EPA 2005a).	**Sediment quality monitoring** The proposed management response based on an exceedance of the EQS is: 1. A Toxicity Reduction Evaluation (TRE) will be undertaken to identify the contaminant(s) of concern and the management required to reduce them to acceptable levels. This would include a detailed examination of the treated wastewater and potentially include a Stage 1 Toxicity Identification Evaluation. 2. Management measures to reduce the contaminant(s) of concern will be implemented, along with monitoring to confirm that the required results are being achieved. The monitoring could include wastewater characterisation, further WET tests, and in situ monitoring, subject to further consultation with the OEPA.

4.2 Maintenance of Aquatic Life for Human Consumption (EQO2)

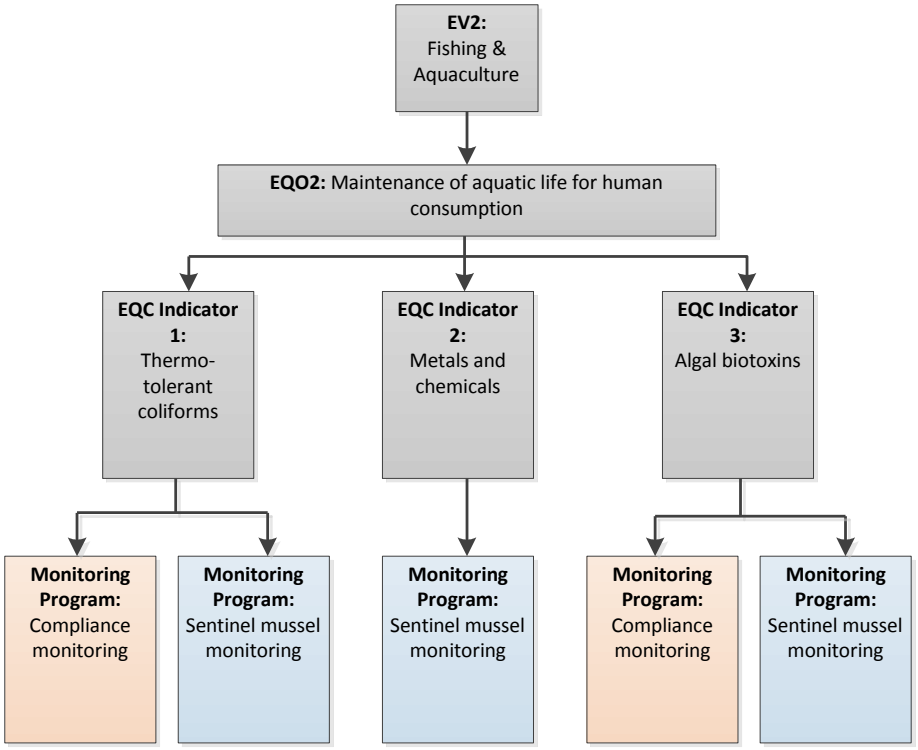
4.2.1 Objective

The EQO for the Environmental Value 'Fishing and Aquaculture' is aimed at ensuring the addition of industrial wastewater discharge (which contains contaminants but no measurable level of bacteria) will not affect the long-term EQO within the area around the ocean outlet. To ensure this EQO is being met, monitoring programs have been developed to measure compliance against EQC set for thermo-tolerant coliforms, metals and chemicals and algal biotoxins (Figure 4.3).

As the wastewater discharge from the Sepia Depression ocean outlet travels in a northerly direction due to prevailing longshore currents (Bailey et al. 2003), the wastewater is not considered to pose a risk to shellfish quality in Cockburn Sound (DoF 2007). However, the area immediately adjacent to the outlet (See *Proposed Closed Safety Zone,* Figure 4.4) is considered unsuitable for seafood harvesting due to the bacterial content of the treated domestic wastewater component of the effluent (DoF 2007). Consequently, a proposed mussel aquaculture closed safety zone has been established in an area surrounding the outfall (DoF 2007), with boundaries illustrated in Figure 4.4 (noting that coordinates differ slightly to DoF (2007), due to inaccuracies with the zone boundaries). Shellfish are not harvested from around the outlet due to the very sparse natural populations of targeted shellfish in the area.

With respect to toxicants, the EQGs and EQSs for maintaining ecosystem integrity, as outlined in the Cockburn Sound SEP, are considered protective of wild seafood populations from the effects of environmental contamination (Govt of WA 2005). EQC for the EQO of Maintenance of Aquatic Life for Human Consumption are shown in Table 4.3. The required management response following any exceedances of these EQC is set out in Table 4.4

The EPA (2004) notes that discharge of industrial wastewater will not prevent attainment of the EPA objective to protect the social environmental values of recreation, fishing, aquaculture and aesthetics for marine waters in the future.



Note:

1. Components managed by the SDOOL and PLOOM monitoring programs are highlighted in blue and orange, respectively.

Figure 4.3 Environmental quality objectives, criteria and monitoring programs for maintaining the environmental value Fishing and Aquaculture

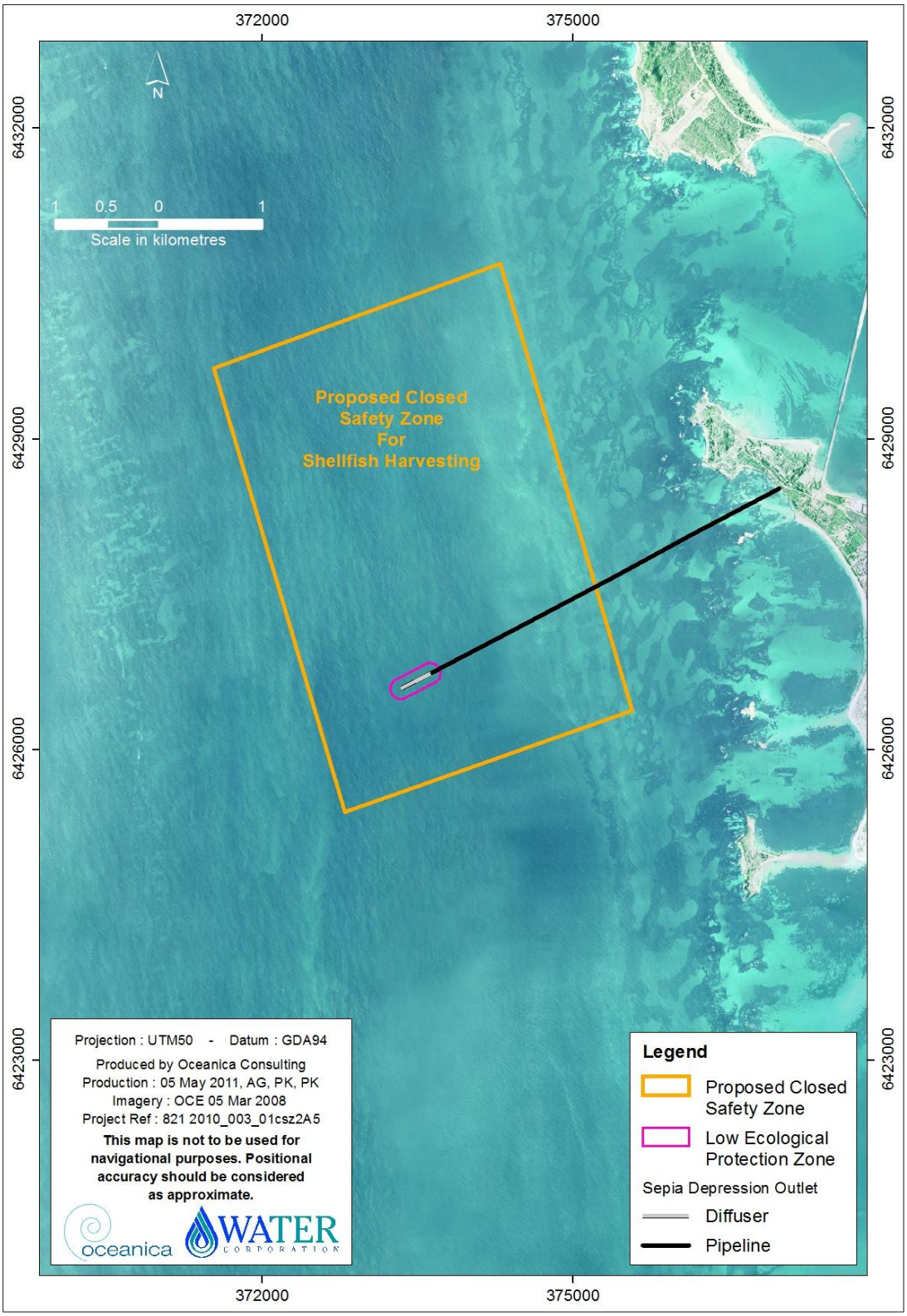


Figure 4.4 Proposed Closed Safety Zone for shellfish harvesting

4.2.2 Environmental Quality Criteria

Table 4.3 Environmental Quality Criteria for the EQO of Maintenance of Seafood for Human Consumption (EQO2)

Environmental Quality Indicators	Environmental Quality Criteria	
	Environmental Quality Guideline	**Environmental Quality Standard**
Thermo-tolerant Coliforms	Median thermo-tolerant coliform counts at sites at the boundary of the Shellfish Harvesting Exclusion Zone (SHEZ) are not to exceed 14 CFU 100 mL^{-1}, with no more than 10% of the samples exceeding 21 CFU 100 mL^{-1} as measured using the membrane filtration method. If this EQG is exceeded, assessment will proceed against the EQS for coliforms in both water and sentinel mussel tissues.	Median thermo-tolerant coliform counts at sites at the boundary of the SHEZ not to exceed 70 CFU 100 mL^{-1}, with no more than 10% of the samples exceeding 85 CFU 100 mL^{-1} as measured using the membrane filtration method.
		Sentinel mussel monitoring Median thermo-tolerant coliform counts at sites at the boundary of the SHEZ not to exceed 2.3 MPN *E. coli*/g of flesh (wet wt.) in four out of five representative samples, and the fifth sample should not exceed 7 MPN *E. coli*/g of flesh (wet wt.), with a maximum total plate count of 250,000 organisms/g (EPA 2005a).
Metals & Chemicals	**Sentinel mussel monitoring** Median concentrations of potentially contaminating metals in the flesh of shellfish deployed at sites at the boundary of the SHEZ are not to exceed the EQG for metals in molluscs published in Table 4 of EPA (2005a).	**Sentinel mussel monitoring** 1. Concentrations of potentially contaminating metals and organic chemicals in the flesh of shellfish deployed at sites at the boundary of the SHEZ are not to exceed the EQS for metals and organic chemicals in molluscs published in Table 4 of EPA (2005a) (see also Appendix B). 2. Pesticide residue concentrations in the flesh of shellfish deployed at sites at the boundary of the SHEZ should not exceed the maximum residue limits and extraneous residue limits as set out in FSANZ (2006)[2].
Algal Biotoxins	Concentrations of potentially toxic algae at sites at the boundary of the SHEZ 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 acuminta (3000 cells/L); • *Prorocentrum* spp. (500 cells/L); • *Psuedo-nitzschia* spp. (250000 cells/L); • *Gonyaulax* cf. *spinifera* (100 cells/L); and • Protoceratium reticulatum (Gonyaulax grindleyi) (500 cells/L). If this EQG is exceeded, assessment will proceed against the EQS for sentinel mussel tissues.	Toxin concentrations in seafood not to exceed EQS in any sample at the boundary of the SHEZ[3]: • Paralytic shellfish poison (0.8 mg Saxitoxin eq./kg); • Diarrhoetic shellfish poison (0.2 mg/kg); • Neurotoxic shellfish poison (200 mouse units/kg); and • Amnesic shellfish poison (domoic acid; 20 mg/kg).

Notes:
1. Western Australian Shellfish Quality Assurance Program (DoF 2007).
2. As set out in the Australian New Zealand Food Standards Code (FSANZ 2006).
3. Western Australian Shellfish Quality Assurance Program (WASQAP) Operations Manual (DoF 2007).

Table 4.4 Management response following exceedances of EQC for the EQO of Maintenance of Seafood for Human Consumption (EQO2)

Environmental Quality Indicators	Management following trigger level exceedance	
	Environmental Quality Guideline	**Environmental Quality Standard**
Thermo-tolerant coliforms	In the event of an EQG being exceeded, an investigation into the cause of the exceedance will commence. This is to include the deployment of sentinel mussels at the boundary of the Shellfish Harvesting Exclusion Zone (SHEZ) (see also Appendix B). Any instances of an exceedance of the EQG will be reported to the DoH, the DER and the OEPA within one working day of determining that this has occurred.	If the EQS is exceeded, the Department of Health (DoH) will be contacted and a management response determined based on DoH advice in consultation with the OEPA. Management actions will be taken to reduce the concentration to a level where the EQOs assigned to the receiving waters are achieved (see also Appendix B). Any instances of an exceedance of the EQS will be reported to the DoH, the DER and the OEPA within one working day of determining that this has occurred. **Sentinel mussel monitoring** If the EQS is exceeded, Water Corporation will notify DoH, the DER and the OEPA within one working day of determining that this has occurred. Management actions will be taken to reduce the concentration to a level where the EQO assigned to the receiving environment is achieved, and will include (see also Appendix B) • An investigation into the conditions prevailing (metocean conditions and plant operations) during the summer period; and then • Development of a management response on advice of the DoH and in consultation with the OEPA, considering all relevant information collected.
Metals & chemicals	An exceedance of the EQG value will result in further assessment against the EQS. Any instances of an exceedance of the EQG will be reported by the Water Corporation to the DoH, the DER and the OEPA within one working day of determining that this has occurred.	**Sentinel mussel monitoring** As above.
Algal biotoxins	An exceedance of a algal biotoxin EQG value at the boundary of the SHEZ will result in further assessment against the EQS (see also Appendix B). Any instances of an exceedance of the EQG will be reported by the Water Corporation to the DoH, the DER and the OEPA within one working day of determining that this has occurred.	**Sentinel mussel monitoring** As above.

4.3 Maintenance of Primary and Secondary Contact Recreation Values (EQO3 and EQO4)

4.3.1 Objective

The EQO for the Environmental Value 'Recreation' ['and Aesthetics'] is aimed at ensuring Perth's coastal waters are safe for primary and secondary contact recreation activities such as swimming and boating. In order to meet this objective, water quality around the SDOOL ocean outlet will be maintained so that:

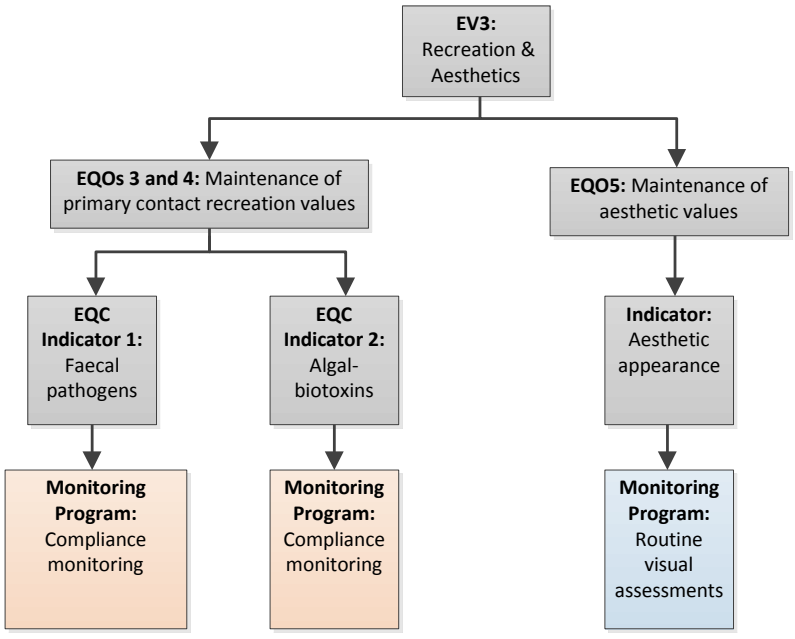
- primary contact recreation (e.g. swimming) is safe in all waters except areas designated otherwise (see Figure 4.5)
- secondary contact recreation (e.g. boating) is safe in all waters except areas designated otherwise (see Figure 4.5).

The addition of industrial wastewater discharge that does not contain measurable levels of bacteria will not affect the area around the SDOOL ocean outlet, which is considered unsuitable for primary (whole-body, i.e. swimming) contact recreation due to the bacterial content of the treated wastewater from the WWTPs. Boundaries where contact recreation is not recommended near the SDOOL ocean outlet have been identified, based on the estimated median faecal streptococci count (Figure 4.6).

The long-term EQOs for the maintenance of primary and secondary contact recreation values and their spatial application will not change due to additional industrial wastewater discharge.

Trial EQC for the EQOs of Maintenance of Primary and Secondary Contact Recreation are shown in Table 4.6 and Table 4.7, respectively. The required management response following any exceedances of these EQC is set out in Table 4.8.

Compliance with the relevant primary and secondary contact recreation guidelines (ANZECC/ARMCANZ 2000) will be reported in the Water Corporation Annual Report.



Note:

1. Components managed by the SDOOL and PLOOM monitoring programs are highlighted in blue and orange, respectively.

Figure 4.5 Environmental quality objectives, criteria and monitoring programs for maintaining the environmental value Recreation and Aesthetics

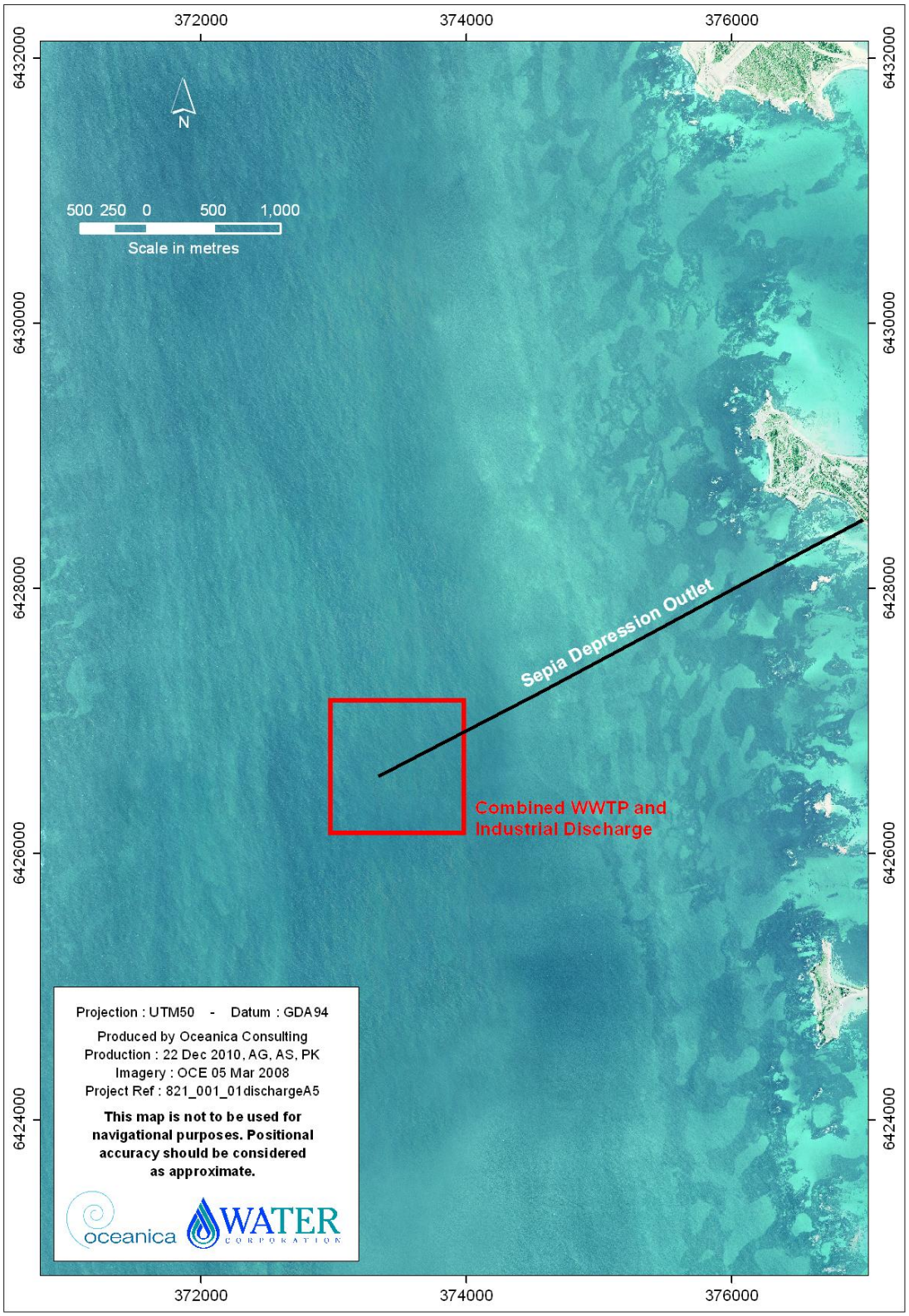


Figure 4.6 Boundary of area surrounding the SDOOL ocean outlet where primary and secondary contact recreation is not recommended

Table 4.5 Boundary coordinates for the area surrounding the SDOOL ocean outlet where primary and secondary contact recreation is not recommended

Coordinate	Description	Easting	Northing
1	North-west corner	372979	6427159
2	North-east corner	373979	6427159
3	South-east corner	373979	6426159
4	South-west corner	372979	6426159

4.3.2 Environmental quality criteria

Table 4.6 Environmental Quality Criteria for the EQO of Maintenance of Primary Contact Recreation (EQO3)

Environmental Quality Indicators	Environmental Quality Criteria	
	Environmental Quality Guideline	Environmental Quality Standard
Faecal pathogens	The 95th percentile value of *Enterococci* taken over the bathing season not to exceed 200 MPN/100 mL, outside the post-upgrade boundary (Figure 4.6).	The 95th percentile value of *Enterococci* taken over the bathing season not to exceed 500 MPN/100 mL, outside the post-upgrade boundary (Figure 4.6).
Algal biotoxins	Median total phytoplankton cell count for the area of concern (either from one sampling run or from a single site over agreed period of time) should not exceed 15 000 cells/mL. OR There should be no reports of skin or eye irritation or potential algal poisoning in swimmers considered by a medical practitioner as potentially resulting from toxic algae when less than 15 000 cells/mL is present in the water column.	There should be no confirmed incidences (by the DoH) of skin or eye irritation caused by toxic algae, or of algal poisoning in recreational users.
pH	No EQG presently developed.	The median of the sample concentrations from the area of concern (either from one sampling run or from a single site over an agreed period of time) should not exceed the range of 5–9 pH units.
Water clarity	To protect the visual clarity of waters used for swimming, the vertical sighting of a 200 mm diameter black disc should exceed 1.6 m.	No EQS presently developed.
Toxic Chemicals	Concentrations of contaminants will not exceed the recreational guidelines for toxic chemicals at the post-upgrade boundary	No suitable EQS available

Notes:
1. Guidelines are from EPA (2005a).
2. DoH = Department of Health

Table 4.7 Environmental Quality Criteria for the EQO of Maintenance of Secondary Contact Recreation (EQO4)

Environmental Quality Indicators	Environmental Quality Criteria	
	Environmental Quality Guideline	**Environmental Quality Standard**
Faecal pathogens	The 95th percentile value of *Enterococci* taken over the bathing season not to exceed 2000 MPN/100 mL, outside the post-upgrade boundary	The 95th percentile value of *Enterococci* taken over the bathing season not to exceed 5000 MPN/100 mL, outside the post-upgrade boundary
Algal biotoxins	Median total phytoplankton cell count for the area of concern (either from one sampling run or from a single site over agreed period of time) should not exceed 15 000 cells/mL. OR There should be no reports of skin or eye irritation or potential algal poisoning in swimmers considered by a medical practitioner as potentially resulting from toxic algae when less than 15 000 cells/mL is present in the water column.	There should be no confirmed incidences (by the DoH) of skin or eye irritation caused by toxic algae, or of algal poisoning in recreational users.
pH	No EQG presently developed.	The median of the sample concentrations from the area of concern (either from one sampling run or from a single site over an agreed period of time) should not exceed the range of 5–9 pH units.

Notes:
1. Guidelines are from EPA (2005a).
2. DoH = Department of Health

Table 4.8 Management response following exceedances of EQC for the EQOs of Maintenance of Primary and Secondary Contact Recreation (EQO3 and EQO4)

Environmental Quality Indicators	Management following trigger level exceedance	
	Environmental Quality Guideline	**Environmental Quality Standard**
Faecal pathogens	An exceedance of a microbial EQG outside the post-upgrade boundary (Figure 4.6), will result in further assessment against the EQS. Any instances of an exceedance of the EQG will be reported by the Water Corporation to the DoH, the DER and the OEPA within one working day of determining that this has occurred.	If the EQS is exceeded, the DoH will be contacted and a management response determined based on DoH advice in consultation with the OEPA. Management actions will be taken to reduce the concentration to a level where the EQOs assigned to the receiving waters are achieved (see also Appendix B) Any instances of an exceedance of the EQS will be reported to by the Water Corporation to the DoH, the DER and the OEPA within one working day of determining that this has occurred.
Algal biotoxins	An exceedance of an algal biotoxin EQG value will result in further assessment against the EQS. Any instances of an exceedance of the EQG will be reported by the Water Corporation to the DoH, the DER and the OEPA within one working day of determining that this has occurred.	If the EQS is exceeded, Water Corporation will notify the DER and the OEPA within one working day of determining that this has occurred. Management actions will be taken to reduce the concentration to a level where the EQO assigned to the receiving environment is achieved (see also Appendix B): • An investigation into the conditions prevailing (metocean conditions and plant operations) during the summer period; and then • Development of a management response on advice of the DoH and in consultation with the OEPA, considering all relevant information collected.
pH		If the EQS is exceeded, Water Corporation will notify the DER and the OEPA within one working day of determining that this has occurred. Management actions will be taken to change the concentration to a level where the EQO assigned to the receiving environment is achieved: • An investigation into the conditions prevailing (metocean conditions and plant operations) during the summer period; and then • Development of a management response on advice of the DoH and in consultation with the OEPA, considering all relevant information collected.
Water clarity	Any instances of an exceedance of the EQG will be reported by the Water Corporation to the DoH, the DER and the OEPA within one working day of determining that this has occurred.	
Toxic chemicals	If the Environmental Quality Guideline is exceeded the Department of Health will be contacted by Water Corporation for advice on further investigations/response required to protect recreational users	No suitable Environmental Quality Standard available

Notes:

1. DoH = Department of Health; DER = Department of Environment Regulation; OEPA = Office of the Environmental Protection Authority

4.4 Maintenance of Aesthetic Values (EQO5)

4.4.1 Objective

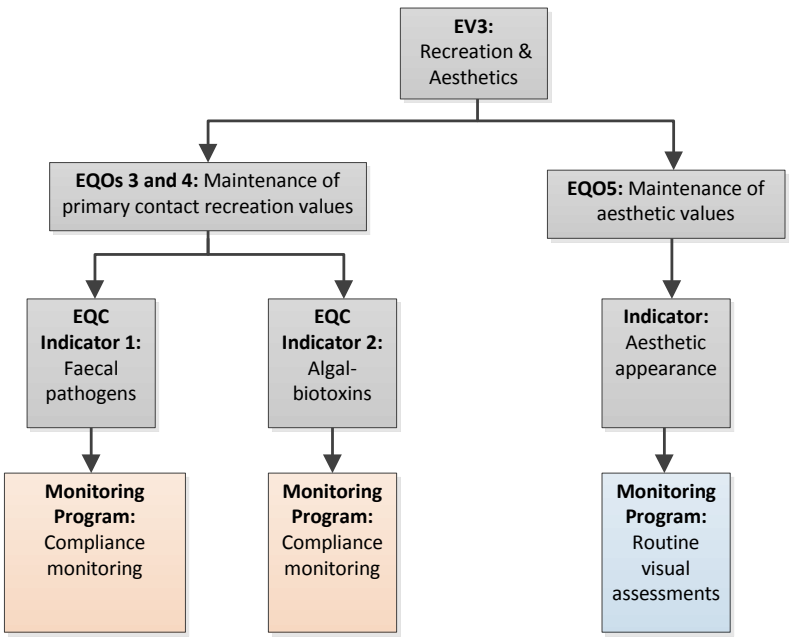
The EQO for the Environmental Value ['Recreation and] Aesthetics' is to ensure that Perth's coastal waters are aesthetically pleasing and that the aesthetic value is protected. To ensure this EQO is being met, monitoring will routinely assess the quality of surface water appearance (Figure 4.7).

4.4.2 Environmental quality criteria

Since the discharge to Sepia Depression is 4 km offshore, any effect on the aesthetic values of the area would be limited to aerial views and those associated with secondary recreation activities. For most of the time, any plume associated with the wastewater discharge would not be noticeable.

From time to time particular activities associated with the wastewater treatment plants may result in a visible plume at the Sepia Depression. Fortunately, such activities do not occur often and considering the distance from shore, any risk to aesthetic values is considered minimal. Consequently, environmental quality criteria are only set at the level EQG only, and not EQS. Aesthetic quality will be routinely assessed against EQC set out in Table 4.9. Any instances of an exceedance of the EQG will be reported by the Water Corporation to the Department of Health (DoH), the Department of Environment Regulation (DER) and the OEPA within five working days of determining that this has occurred, as per Table 4.10.

Monitoring will be undertaken in conjunction with the Compliance Monitoring Program. This allows for visual assessment of the water surface and measurement of Secchi disk depth at each site and is consistent with requirements set out in EPA (2005b) for assessing aesthetic values. However, since a pre-discharge baseline has not been established, water clarity around the outlet (mean Secchi depth at 350 m from the diffuser, pooled from all days) will instead be compared against water clarity at distance of the outlet (mean Secchi depth at 1500 m from the diffuser from all days pooled) to assess whether differences exist.



Note:

1. Components managed by the SDOOL and PLOOM monitoring programs are highlighted in blue and orange, respectively.

Figure 4.7 Environmental quality objectives, criteria and monitoring programs for maintaining the environmental value Recreation and Aesthetics

Table 4.9 Environmental Quality Criteria for the EQO of Maintenance of Recreation and Aesthetics (EQO5)

Environmental Quality Indicators	Management following trigger level exceedance	
	Environmental Quality Guideline	Environmental Quality Standard
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 communities 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 odours	
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

Table 4.10 Management response following exceedances of EQC for the EQOs of Maintenance of Aesthetic values (EQO5)

Environmental Quality Indicators	Management following trigger level exceedance	
	Environmental Quality Guideline	Environmental Quality Standard
Fish tainting substances	Any instances of an exceedance of the EQG will be reported by the Water Corporation in the annual report.	Water Corporation will undertake examination users waste streams to identify the source of the contaminant(s) of concern and inform the management required to reduce them to acceptable levels. Water Corporation will implement management measures to reduce the contaminant(s) of concern, and monitor to confirm that the required results are being achieved.
All other instances	Any instances of an exceedance of the EQG will be reported by the Water Corporation in the annual report.	If a significant increase in complaints are recorded, Water Corporation will contact and consult with the OEPA to determine an appropriate management response.

5. Monitoring to Maintain Ecosystem Integrity

5.1 Overview

A monitoring framework was developed for the SDOOL to enable close supervision of wastewater inputs and allow identification of the sources of contaminants in the event of an incident, using electronic real-time monitoring instruments.

In particular, a sampling and analysis plan was developed with the individual waste producers (refer Figure 5.1), including the following:

1. Each waste producer is required to fulfil its obligations in regard to monitoring and reporting its emissions, as required by their respective Environmental Protection Act Licences.
2. Each waste producer must provide a point from which samples may be taken for analysis at the point of discharge to the SDOOL (at points A1 to A5).
3. Additional sampling points are provided to enable determination of the KWRP process concentrate (point B), the collective industrial effluent quality (post re-use) where it enters the SDOOL (point C), downstream of the Woodman Point WWTP (point E) as well as the composite SDOOL sample point (point D), prior to discharge to the Sepia Depression ocean outlet (see Figure 5.1).

The monitoring framework is made up of two distinct elements that together consist of seven monitoring programs.

First Element – Waste Stream Monitoring consisting of:

- real-time monitoring (Section 5.2)
- treated wastewater characterisation (Section 5.3)
-
- whole-of-effluent toxicity (WET) testing (Section 5.3.7).

Second Element – Receiving Environment Monitoring consisting of:

- compliance monitoring (5.4.1)
- sentinel mussel monitoring (Section 5.4.2)
- sediment quality monitoring (Section 5.5).

Each element is described within the following sections of this M&MP.

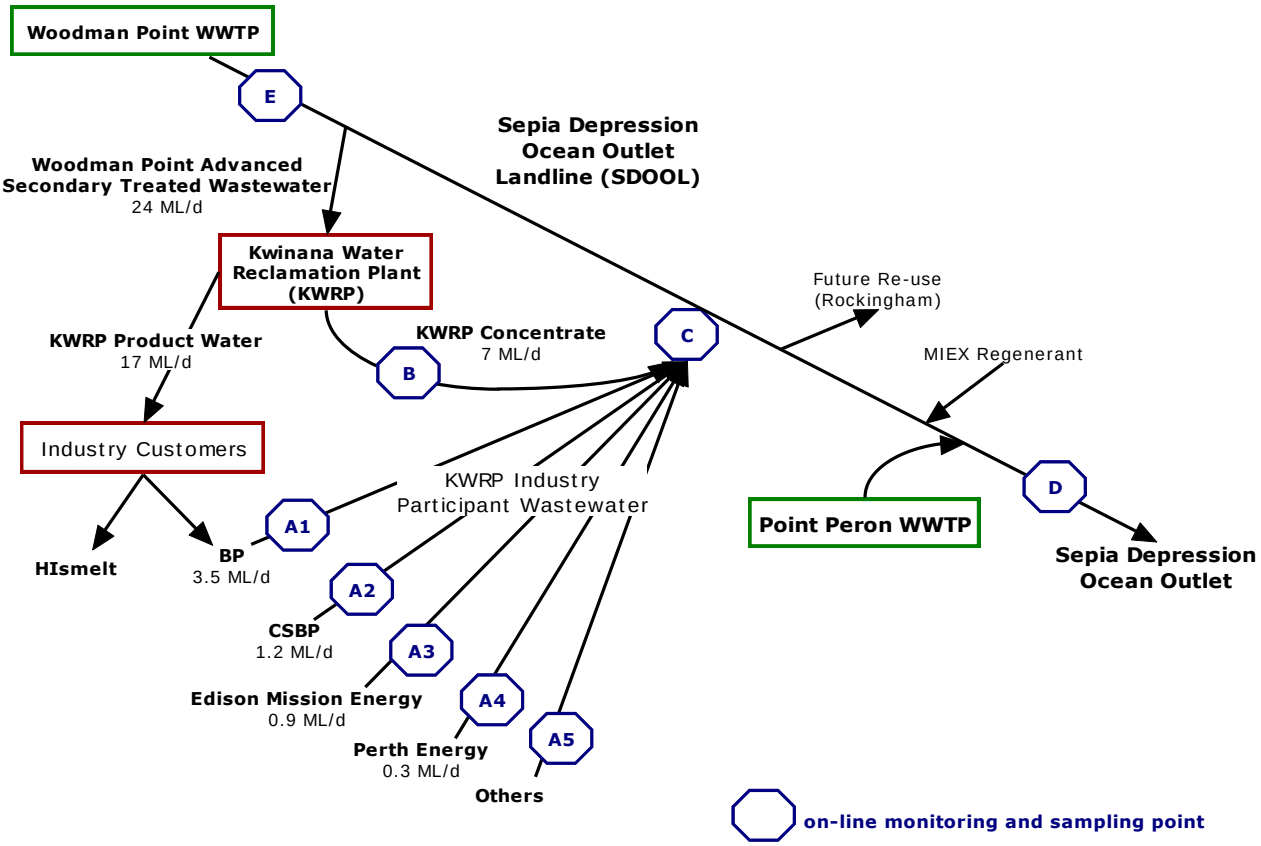


Figure 5.1 Sepia Depression Ocean Outlet Landline (SDOOL) on-line monitoring and sampling points

5.2 Waste stream monitoring

5.2.1 Operational monitoring

Inputs into SDOOL to be monitored for flow rate, pH, conductivity, turbidity and temperature to enable operational control of the system and will provide early indications of any abnormal conditions developing. Analysers will monitor the quantity and the quality of the waste stream with upper limits for:

- conductivity (20 000 µS/cm)
- turbidity (200 NTU)
- temperature (40°C)
- pH (6–9).

These are operational triggers set by the plant managers as indicators of a deviation from normal wastewater conditions. The triggers were informed by long-term experience in wastewater treatment. Where variations in flow rates or the limits for conductivity, turbidity, temperature and/or pH occur for the combined SDOOL discharge, the Water Corporation will report the exceedance to the DER and OEPA and investigate to ensure they do not cause adverse impacts on the receiving environment. Specifically, a comprehensive wastewater characterisation will be conducted to determine whether the conditions that have modified the physical parameters measured have also introduced toxicants to the waste stream. The comprehensive treated wastewater characterisation will be conducted as described in section 5.3.3). A 1:200 dilution will be applied (mandated worst case conditions in MS655) to determine the concentrations of contaminants, toxicants and potential stressors at the HEPA/LEPA boundary for comparison to triggers. Dilution will be confirmed by modelling (Appendix C). A 1-hour urchin fertilization toxicity test will also be conducted to determine the overall toxicity of the discharge. The results will be assessed against the EQG and, if necessary EQS for comprehensive treated wastewater

characterisation and WET testing as defined in Table 4.1. Subsequent reporting and management responses are detailed in Table 4.2.

In addition, the participating industries will be responsible for monitoring their waste stream discharge into the SDOOL and ensuring it is within agreed criteria that meet the requirements of their individual Environmental Protection Act Licences. Prescribed notification procedures in relation to changes in the waste stream are detailed in individual contracts with industry participants, as well as a requirement of their Environmental Protection Act Licences.

5.2.2 Nitrogen loads

The Water Corporation shall operate the SDOOL so that the annual nitrogen load to the Sepia Depression does not exceed the nitrogen load discharged from the outlet in 1994 (1,778 t). Nitrogen concentrations in the TWW are estimated for point D monthly and combined with the corresponding flow rates to yield an estimate of the monthly nitrogen load. Monthly loads are scaled up to an annual estimate (generally covering the preceding financial year for reporting purposes) for comparison to the 1994 load figure.

In the event that subsequent monitoring shows an adverse environmental impact at the 1994 nitrogen load, the Water Corporation shall reduce the annual nitrogen load to 75% of the load discharged from the outlet in 1994. Notification to the DER will also be a required management response.

5.2.3 Diffuser verification

In situ verification of the diffuser performance will be undertaken annually. The concentration of a suitable tracer will be determined at a number of sites downstream of the outlet diffuser. These data will be used in conjunction with CTD profiles to determine the actual rate of dilution by the diffuser. While the nature of field surveys precludes an absolute assurance regarding targeting specific meteorological conditions, sampling is biased towards calm conditions due to OSH constraints and the fact that monitoring is conducted in the mornings prior to establishment of the sea breeze. All practicable measures will be undertaken to ensure that monitoring will be conducted under as calm conditions as possible.

5.3 Toxicants in treated wastewater

5.3.1 Treated wastewater characterisation

The treated wastewater stream will be monitored by the Water Corporation to characterise the concentration of metals, organics, nutrients and bacteria. Comprehensive treated wastewater characterisation, involving the full suite of contaminants (Table 5.2), will be conducted annually. Quarterly wastewater sampling will determine concentrations of ammonia and filtered (bioavailable) metal (copper and zinc) concentrations in the treated wastewater as part of routine testing undertaken by Water Corporation. Following the introduction of new industrial facilities to the wastewater outlet, the Water Corporation will also undertake regular screening/analysis of treated wastewater inputs, including for new non-negligible contaminants

Timing

Treated wastewater characterisation will involve both quarterly and annual monitoring. The quarterly sampling will monitor a subset of the full suite of parameters that will be measured annually.

5.3.2 Quarterly treated wastewater characterisation

The Water Corporation will undertake quarterly sampling of the wastewater stream for oil and grease, arsenic, cadmium, copper, chromium, lead, mercury, nickel and zinc. Additional toxicants that are likely to be industrial by-products or in elevated concentrations from domestic use within the wastewater stream, and which are potentially toxic to human or marine life, include molybdenum (Opresko 1993), cyanide, phenols (Eklund & Kautsky 2003), vanadium (Barceloux 2000) and selenium (Kathrine et al. 2006).

Each of the contributing industrial waste streams and the combined discharge will be sampled quarterly for the toxicants listed in Table 5.1. In addition, for potential physio-chemical stressors, including nutrients, pH, biochemical oxygen demand (BOD) and conductivity (mS/cm), samples will be collected from each of the waste streams on the same day, including a combined composite sample (time-weighted) of all the waste streams from sample point D (Table 5.1; Figure 5.1). Quarterly treated wastewater characterisation will take place at the same time as the 1-hour sea urchin fertilisation tests (refer to Section 5.3.7). Modelling will be used to determine the number of dilutions at the LEPA boundary (Appendix C). Until the modelling is complete an interim dilution factor of 1:200 will be applied. Contaminant concentrations will be corrected for a 1:200 dilution and compared to the ANZECC/ARMCANZ (2000) 99% species protection guideline trigger levels (95% for cobalt).

Quarterly testing focuses only on the key contaminants of concern, and includes the contaminants most likely to be present in the waste stream at concentrations that are above their limit of reporting from samples collected over the last five years (Table 5.2). The full suite of parameters (Table 5.2) will be monitored annually, as described in section 5.3.3.

Table 5.1 Parameters to be measured quarterly in the SDOOL wastewater stream and the ANZECC/ARMCANZ (2000) guideline trigger values for toxicants in marine waters to achieve various levels of species protection

Parameter	ANZECC/ARMCANZ (2000) guideline trigger values (µg L^{-1})[1]			
	Level of Protection (% Species)[2]			Low Reliability Values[3]
	99%	95%	80%	
Total Suspended Solids	n/a[4]	n/a	n/a	n/a
Total Nitrogen	n/a	n/a	n/a	n/a
Ammonia-Nitrogen	500	910	1,700	-
Total Phosphorus	n/a	n/a	n/a	n/a
Arsenic (As)	ID[5]	ID	ID	2.3 (As III) 4.5 (As V)
Cadmium (Cd)	**0.7**	5.5	**36**	-
Chromium (Cr)	**7.7 (Cr III)** **0.14 (Cr VI)**	27.4 (Cr III) 4.4 (Cr VI)	90.6 (Cr III) 85 (Cr VI)	-
Cobalt (Co)	0.005	**1**	150	-
Copper (Cu)	**0.3**	1.3	8	-
Lead (Pb)	**2.2**	4.4	12	-
Mercury (Hg)	**0.1**	0.4	**1.4**	-
Molybdenum (Mo)	ID	ID	ID	23
Nickel (Ni)	**7**	70	560	-
Selenium (Se)	ID	ID	ID	3
Silver (Ag)	**0.8**	1.4	2.6	-
Vanadium (V)	**50**	100	280	-
Zinc (Zn)	**7**	15	43	-
Cyanide	**2**	4	14	-
Phenol	**270**	400	720	-
Total Petroleum Hydrocarbons	ID	ID	ID	n/a
Methylene Blue Active Substances	n/a	n/a	n/a	0.1[4]

Notes:

1. Trigger values for marine water (Table 3.4.1; ANZECC/ARMCANZ (2000)).
2. Values in shaded cells are the ANZECC/ARMCANZ (2000) guideline trigger values that must be met for each parameter. The majority must meet the 99% species protection guidelines at the boundary of the LEPA (95% for cobalt). Cadmium and mercury (two bioaccumulating toxicants) must meet the 80% species protection guidelines at the diffuser.
3. For many contaminants there are insufficient data to derive reliable national guidelines, thus Low Reliability Value have been derived using conservative assessment factors—with the caveat that Low Reliability Values should not be used as default guidelines but as indicative working levels, until more data are available to derive reliable guidelines.
4. The LRV is for linear alkylbenzene sulfonates (LAS). The MBAS assay detects all inorganic surfactants. Applying the LRV for LAS to measured MBAS concentrations is likely to be conservative
5. n/a = ANZECC/ARMCANZ (2000) guidelines or Low Reliability Values not available for this parameter.
6. ID = insufficient data to derive a reliable national trigger value.

5.3.3 Comprehensive treated wastewater characterisation

Comprehensive treated wastewater characterisation (CTWWC) will be undertaken annually and each of the parameters listed in Table 5.2. CTWWC will also be undertaken within 3 months following material process or volume changes (i.e. with the addition of a new industry client). The CTWWC sample will be an average of the final treated wastewater discharge from sample point D (Figure 5.1) for the 24-hour period prior to and during the sample collection (i.e. a one litre sample is collected every hour over 24-hours, which provides a composite sample of 24 L from which sub-samples are analysed and an average calculated). A separate grab sample for microbiological parameters will be collected as 24-hour composites are not suitable for microbiological parameters.

The bulk sample will be homogenised (agitated) and divided into separate sample containers. Samples will be collected, stored and transported according to the relevant parts of Australian Standard AS/NZS 5667.1:1998 and all analyses will be undertaken by laboratories with NATA-accredited methods. Samples for bioavailable metals will be passed through a 0.45 µm filter prior to analysis.

These parameters were selected through ongoing internal review of the current Australian and international contaminants of concern in treated municipal wastewaters, as well as through consultation with industry. The suite of parameters to be monitored annually also took into consideration the wastewater supply and wastewater treatment plant operating conditions specific to the SDOOL.

Table 5.2 Parameters to be measured annually in the SDOOL wastewater stream and the ANZECC/ARMCANZ (2000) guideline trigger values for toxicants in marine waters to achieve various levels of species protection

Parameter	Max (last 5 years)	Approx after 1:200 dilution (worst case)	ANZECC/ARMCANZ (2000) guideline trigger values (µg L^{-1})[1]				
			Level of protection				Low Reliability Value (LRV)
			99%	95%	90%	80%	
Microbiological							
Confirmed *Enterococci*[2]	>24,000	<120	n/a[3]	n/a	n/a	n/a	n/a
Presumptive thermo-tolerant Coliforms (TTC)[4]	>1,000,000	<5000	n/a	n/a	n/a	n/a	n/a
Confirmed thermo-tolerant Coliforms (TTC)[4]	>1,000,000	<5000	n/a	n/a	n/a	n/a	n/a
Escherichia coli	>1,000,000	<5000	n/a	n/a	n/a	n/a	n/a
Nutrients (µg L^{-1})							
Ammonia-N	**37000**	185	500	910	1,200	1,700	-
Nitrate-N+ Nitrite-N	7500	37.5	ID[5]	ID	ID	ID	13,000
Nitrogen-Total N	55000	275	n/a	n/a	n/a	n/a	n/a
Phosphate-Ortho as P	8400	42	n/a	n/a	n/a	n/a	n/a
Phosphorus-Total P	17000	85	n/a	n/a	n/a	n/a	n/a
Metals and Metalloids (µg L^{-1})							
Arsenic (As)	2	0.01	ID	ID	ID	ID	2.3 (As III) 4.5 (As V)
Cadmium (Cd)	<0.1	<0.0005	0.7	5.5	14	36	-

Parameter	Max (last 5 years)	Approx after 1:200 dilution (worst case)	ANZECC/ARMCANZ (2000) guideline trigger values (µg L^{-1})[1]				
			Level of protection				Low Reliability Value (LRV)
			99%	95%	90%	80%	
Chromium (Cr)	3	0.015	7.7 (Cr III) 0.14 (Cr VI)	27.4 (Cr III) 4.4 (Cr VI)	48.6 (Cr III) 20 (Cr VI)	90.6 (Cr III) 85 (Cr VI)	-
Lead (Pb)	<1	<0.005	2.2	4.4	6.6	12	-
Mercury (Hg)	<0.1	<0.0005	0.1	0.4	0.7	1.4	-
Nickel (Ni)	9.9	0.0495	7	70	200	560	-
Selenium (Se)	<1	<0.005	ID	ID	ID	ID	3
Silver (Ag)	<0.8	<0.004	0.8	1.4	1.8	2.6	-
Zinc (Zn)	68	0.34	7	15	23	43	-
Triazine herbicides (µg L^{-1})							
Atrazine	1.4	0.007	ID	ID	ID	ID	13
Hexazinone	<0.1	<0.0005	ID	ID	ID	ID	75
Metribuzine	<0.1	<0.0005	n/a	n/a	n/a	n/a	n/a
Prometryne	<0.1	<0.0005	n/a	n/a	n/a	n/a	n/a
Simazine	0.58	0.0029	ID	ID	ID	ID	3.2
Phenoxy-acid herbicides (µg L^{-1})							
Dicamba[6]	<1	<0.005	n/a	n/a	n/a	n/a	n/a
MCPA	13	0.065	ID	ID	ID	ID	1.4
Dichlorprop	<1	<0.005	n/a	n/a	n/a	n/a	n/a
2,4-D	68	0.34	ID	ID	ID	ID	280
2,4,5-T	<1	<0.005	n/a	n/a	n/a	n/a	n/a
2,4,5-TP	<1	<0.005	n/a	n/a	n/a	n/a	n/a
2,4-DB	<1	<0.005	n/a	n/a	n/a	n/a	n/a
MCPP	<1	<0.005	n/a	n/a	n/a	n/a	n/a
Triclopyr[7]	<1	<0.005	n/a	n/a	n/a	n/a	n/a
Organophosphate pesticides (µg L^{-1})							
Azinphos-Methyl	<0.2	<0.001	ID	ID	ID	ID	0.01
Azinphos-Ethyl	<0.2	<0.001	n/a	n/a	n/a	n/a	n/a
Chlorpyrifos	<0.2	<0.001	0.0005	0.009	0.04	0.3	-
Chlorpyrifos Methyl	<0.2	<0.001	n/a	n/a	n/a	n/a	n/a
Chlorfenvinphos (E)	<0.2	<0.001	n/a	n/a	n/a	n/a	n/a
Chlorfenvinphos (Z)	<0.2	<0.001	n/a	n/a	n/a	n/a	n/a
Demeton-S-Methyl	<0.2	<0.001	ID	ID	ID	ID	4
Dichlorvos	<0.2	<0.001	n/a	n/a	n/a	n/a	n/a
Diazinon	<0.2	<0.001	ID	ID	ID	ID	0.01
Dimethoate	<0.2	<0.001	ID	ID	ID	ID	0.15
Ethion	<0.2	<0.001	n/a	n/a	n/a	n/a	n/a
Fenthion	<0.2	<0.001	n/a	n/a	n/a	n/a	n/a
Fenitrothion	<0.2	<0.001	ID	ID	ID	ID	0.001
Malathion	<0.2	<0.001	ID	ID	ID	ID	0.05
Parathion (Ethyl)	<0.2	<0.001	ID	ID	ID	ID	0.004
Parathion Methyl	<0.2	<0.001	n/a	n/a	n/a	n/a	n/a
Pirimiphos-Ethyl[8]	<0.2	<0.001	n/a	n/a	n/a	n/a	n/a

Parameter	Max (last 5 years)	Approx after 1:200 dilution (worst case)	ANZECC/ARMCANZ (2000) guideline trigger values (µg L^{-1})[1]				
			Level of protection				Low Reliability Value (LRV)
			99%	95%	90%	80%	
Pirimiphos-Methyl[9]	<0.2	<0.001	n/a	n/a	n/a	n/a	n/a
Organochlorine pesticides (µg L^{-1})							
Aldrin	<0.05	<0.00025	ID	ID	ID	ID	0.003
trans-Chlordane[10]	<0.05	<0.00025	ID	ID	ID	ID	0.001
cis-Chlordane[10]	<0.05	<0.00025	ID	ID	ID	ID	0.001
Oxychlordane[10]	<0.05	<0.00025	ID	ID	ID	ID	0.001
gamma-BHC (Lindane)	<0.05	<0.00025	ID	ID	ID	ID	0.007
alpha-BHC	<0.05	<0.00025	n/a	n/a	n/a	n/a	n/a
beta-BHC	<0.05	<0.00025	n/a	n/a	n/a	n/a	n/a
delta-BHC	<0.05	<0.00025	n/a	n/a	n/a	n/a	n/a
p,p-DDD	<0.05	<0.00025	n/a	n/a	n/a	n/a	n/a
p,p-DDE	<0.05	<0.00025	ID	ID	ID	ID	0.0005
p,p-DDT	<0.05	<0.00025	ID	ID	ID	ID	0.0004
Dieldrin	<0.05	<0.00025	ID	ID	ID	ID	0.01
Endrin	<0.05	<0.00025	0.004	0.008	0.01	0.02	-
Endrin Aldehyde	<0.05	<0.00025	n/a	n/a	n/a	n/a	n/a
Endrin Ketone	<0.05	<0.00025	n/a	n/a	n/a	n/a	n/a
alpha-Endosulfan	<0.05	<0.00025	ID	ID	ID	ID	0.0002
beta-Endosulfan	<0.05	<0.00025	ID	ID	ID	ID	0.007
Endosulfan Sulfate[11]	<0.05	<0.00025	0.005	0.01	0.02	0.05	-
HCB (Hexachlorobenzene)	<0.05	<0.00025	ID	ID	ID	ID	0.05
Heptachlor	<0.05	<0.00025	ID	ID	ID	ID	0.0004
Heptachlor epoxide	<0.05	<0.00025	n/a	n/a	n/a	n/a	n/a
Methoxychlor	<0.05	<0.00025	ID	ID	ID	ID	0.004
Phenols (µg L^{-1})							
Phenol	16	0.08	270	400	520	720	-
Nonylphenol	<1	<0.005	ID	ID	ID	ID	1
2-Chorophenol	<1	<0.005	ID	ID	ID	ID	340
2-Methylphenol	0.29	0.00145	n/a	n/a	n/a	n/a	n/a
2,4-Dichlorophenol	2.1	0.0105	ID	ID	ID	ID	120
2-Nitrophenol	<1	<0.005	n/a	n/a	n/a	n/a	n/a
4-Chloro-3-methylphenol	<2	<0.01	n/a	n/a	n/a	n/a	2
2,4,6-Trichlorophenol	<2	<0.01	ID	ID	ID	ID	34
4-Nitrophenol	<1	<0.005	ID	ID	ID	ID	2
2,4,5-Trichlorophenol	<2	<0.01	n/a	n/a	n/a	n/a	n/a
2,3,4,6-Trichlorophenol	<0.2	<0.001	ID	ID	ID	ID	10
Pentachlorophenol (PCP)	<2	<0.01	11	22	33	55	-
Phthalates (µg L^{-1})							
Dimethyl phthalate	<10	<0.05	ID	ID	ID	ID	3700
Diethyl phthalate	<10	<0.05	ID	ID	ID	ID	900
Di-n-butyl phthalate	<10	<0.05	ID	ID	ID	ID	25
Benzyl butyl phthalate	<10	<0.05	n/a	n/a	n/a	n/a	n/a
Bis(2-ethylhexyl)phthalate	<20	<0.1	ID	ID	ID	ID	1

Parameter	Max (last 5 years)	Approx after 1:200 dilution (worst case)	ANZECC/ARMCANZ (2000) guideline trigger values (µg L^{-1})[1]				
			Level of protection				Low Reliability Value (LRV)
			99%	95%	90%	80%	
Di-n-octyl phthalate	<10	<0.05	n/a	n/a	n/a	n/a	n/a
PCB Aroclors (µg L^{-1})							
Aroclor 1016	<0.1	<0.0005	ID	ID	ID	ID	0.009
Aroclor 1221	<0.1	<0.0005	ID	ID	ID	ID	1.0
Aroclor 1232	<0.1	<0.0005	ID	ID	ID	ID	0.3
Aroclor 1242	<0.1	<0.0005	ID	ID	ID	ID	0.3
Aroclor 1248	<0.1	<0.0005	ID	ID	ID	ID	0.03
Aroclor 1254	<0.1	<0.0005	ID	ID	ID	ID	0.01
Aroclor 1260	<0.1	<0.0005	ID	ID	ID	ID	25
Total PCB's (as above)[12]	<0.1	<0.0005	ID	ID	ID	ID	n/a
Chlorinated hydrocarbons (µg L^{-1})							
2-Chloronaphthalene	<20	<0.1	n/a	n/a	n/a	n/a	n/a
1,4-Dichlorobenzene	<20	<0.1	ID	ID	ID	ID	60
1,2-Dichlorobenzene	<20	<0.1	ID	ID	ID	ID	160
1,3-Dichlorobenzene	<20	<0.1	ID	ID	ID	ID	260
Hexachlorobenzene	<20	<0.1	ID	ID	ID	ID	0.05
1,2,4-Trichlorobenzene	<20	<0.1	20	80	140	240	-
Hexachloroethane	<20	<0.1	ID	ID	ID	ID	290
Hexachlorocyclopentadiene	<20	<0.1	ID	ID	ID	ID	0.05
Hexachloro-1,3-butadiene[13]	<20	<0.1	ID	ID	ID	ID	0.03
Ethers (µg L^{-1})							
4-Bromophenyl phenyl ether[14]	<20	<0.1	n/a	n/a	n/a	n/a	n/a
4-Chlorophenyl phenyl ether	<20	<0.1	n/a	n/a	n/a	n/a	n/a
Bis(2-chloroethyl)ether	<20	<0.1	n/a	n/a	n/a	n/a	n/a
Bis(2-chloroethoxy)methane	<20	<0.1	n/a	n/a	n/a	n/a	n/a
Bis(2-chloroisopropyl)ether	<20	<0.1	n/a	n/a	n/a	n/a	n/a
Amines, Nitroaromatics & Nitrosamines (µg L^{-1})							
Azobenzene	<20	<0.1	n/a	n/a	n/a	n/a	n/a
2,4-Dinitrotoluene	<20	<0.1	ID	ID	ID	ID	16
2,6-Dinitrotoluene	<10	<0.1	n/a	n/a	n/a	n/a	0.3
Nitrobenzene	<20	<0.1	ID	ID	ID	ID	550
N-Nitrosodimethylamine	<20	<0.1	n/a	n/a	n/a	n/a	n/a
N-Nitrosodiphenylamine	<20	<0.1	ID	ID	ID	ID	6
N-Nitrosodi-n-propylamine	<20	<0.1	n/a	n/a	n/a	n/a	n/a
Aniline	<20	<0.1	ID	ID	ID	ID	8
4-Chloroaniline	<20	<0.1	n/a	n/a	n/a	n/a	n/a
2-Nitroaniline	<20	<0.1	n/a	n/a	n/a	n/a	n/a
3-Nitroaniline	<20	<0.1	n/a	n/a	n/a	n/a	n/a
4-Nitroaniline	<20	<0.1	n/a	n/a	n/a	n/a	n/a
Other organics (µg L^{-1})							
Dichlorobenzidine[15]	<20	<0.1	ID	ID	ID	ID	0.5
2-Methylnaphthalene	<10	<0.05	n/a	n/a	n/a	n/a	n/a

Parameter	Max (last 5 years)	Approx after 1:200 dilution (worst case)	ANZECC/ARMCANZ (2000) guideline trigger values (µg L^{-1})[1]				
			Level of protection				Low Reliability Value (LRV)
			99%	95%	90%	80%	
Isophorone	<20	<0.1	ID	ID	ID	ID	130
Benzyl alcohol	<20	<0.1	n/a	n/a	n/a	n/a	n/a
Carbazole	<20	<0.1	n/a	n/a	n/a	n/a	n/a
Dibenzofuran	<20	<0.1	n/a	n/a	n/a	n/a	n/a
BTEX (µg L^{-1})							
Benzene	<1.0	<0.005	500	700	900	1300	-
Toluene	<1.0	<0.005	ID	ID	ID	ID	180
Ethylbenzene	<1.0	<0.005	ID	ID	ID	ID	5
Xylene[16]	<2.0	<0.1	ID	ID	ID	ID	75
Total BTEX[12]	<5.0	<0.025	n/a	n/a	n/a	n/a	n/a
TPH (µg L^{-1})							
TPH C6 - C9[17]	<25	<0.125	ID	ID	ID	ID	n/a
TPH C10 - C14[17]	41	0.205	ID	ID	ID	ID	n/a
TPH C15 - C28[17]	330	1.65	ID	ID	ID	ID	n/a
TPH C29 - C36[17]	480	2.4	ID	ID	ID	ID	n/a
Total TPH[17,18]	740	3.7	ID	ID	ID	ID	n/a
PAHs (µg L^{-1})							
Naphthalene	0.011	0.000055	50	70	90	120	-
Acenaphthylene	<10	<0.05	n/a	n/a	n/a	n/a	n/a
Acenaphthene	<10	<0.05	n/a	n/a	n/a	n/a	n/a
Fluorene	<10	<0.05	n/a	n/a	n/a	n/a	n/a
Phenanthrene	0.01	0.00005	ID	ID	ID	ID	2
Anthracene	<10	<0.05	ID	ID	ID	ID	0.4
Fluoranthene	<10	<0.05	ID	ID	ID	ID	1.4
Pyrene	<10	<0.05	n/a	n/a	n/a	n/a	n/a
Benz(a)anthracene	<10	<0.05	n/a	n/a	n/a	n/a	n/a
Chrysene	<10	<0.05	n/a	n/a	n/a	n/a	n/a
Benzo(b)&(k)fluoranthene	<20	<0.1	n/a	n/a	n/a	n/a	n/a
Benzo(a)pyrene	<10	<0.05	ID	ID	ID	ID	0.2
Indeno(1,2,3-cd)pyrene	<10	<0.05	n/a	n/a	n/a	n/a	n/a
Dibenz(ah)anthracene	<10	<0.05	n/a	n/a	n/a	n/a	n/a
Benzo(ghi)perylene	<10	<0.05	n/a	n/a	n/a	n/a	n/a
Surfactants (mg L^{-1})							
Methylene Blue Active Substances (MBAS)[19]	1.2	0.006	n/a	n/a	n/a	n/a	0.0001[19]
Miscellaneous Other (mg L^{-1} except pH)							
Chlorine-Free	<0.02	<0.0001	ID	ID	ID	ID	3
Chlorine-Total	<0.02	<0.0001	ID	ID	ID	ID	3
Dissolved Organic Carbon (DOC)	20	0.1	n/a	n/a	n/a	n/a	n/a
Total Organic Carbon (TOC)	38	0.19	n/a	n/a	n/a	n/a	n/a
Total Suspended Solids (TSS)[20]	121	0.605	n/a	n/a	n/a	n/a	n/a

Parameter	Max (last 5 years)	Approx after 1:200 dilution (worst case)	ANZECC/ARMCANZ (2000) guideline trigger values (µg L^{-1})[1]				
			Level of protection				Low Reliability Value (LRV)
			99%	95%	90%	80%	
Biological Oxygen Demand (BOD)	51	0.255	n/a	n/a	n/a	n/a	n/a
pH[21]	7.5		n/a	n/a	n/a	n/a	n/a

Notes:

1. Trigger values for marine water (Table 3.4.1; ANZECC/ARMCANZ (2000)).
2. Seafood safe for human consumption guideline for recreational marine waters the 95th percentile value of *Enterococci* taken over the bathing season not to exceed 200 MPN/100 mL (EPA 2005).
3. n/a = ANZECC/ARMCANZ (2000) Guideline or Low Reliability Value not available for this parameter.
4. Primary contact guideline for recreational marine waters 150 faecal coliforms 100 mL^{-1} (ANZECC/ARMCANZ 2000), but now superseded by NHMRC (2008).
5. ID = insufficient data to derive a reliable national trigger value.
6. Recreational guideline for Dicamba = 1000 µg L^{-1} (Table 9.3; NHMRC (2008)).
7. Recreational guideline for Triclopyr = 100 µg L^{-1} (Table 9.3; NHMRC (2008)).
8. Recreational guideline for Pirimiphos-ethyl = 5 µg L^{-1} (Table 9.3; NHMRC (2008)).
9. Recreational guideline for Pirimiphos-methyl = 500 µg L^{-1} (Table 9.3; NHMRC (2008)).
10. Recreational guideline for Chlordane = 10 µg L^{-1} (Table 9.3; NHMRC (2008)).
11. Values for Endosulphan, not Endosulphan sulfate (Table 3.4.1; ANZECC/ARMCANZ (2000)).
12. ANZECC/ARMCANZ (2000) recommends using a formula to calculate total toxicity of the mixture if using total PCBs and BTEX (page 8.3-65; ANZECC/ARMCANZ (2000)).
13. Environmental Concern Level (ECL) for Hexachloro-1,3-butadiene (not LRV) (definition of ECL on page 8.3-35; page 8.3-231; ANZECC/ARMCANZ (2000)).
14. Recommended ECL for 4-Bromophenyl phenyl ether = 12 µg L^{-1} (page 8.3-232; ANZECC/ARMCANZ (2000)).
15. ECL for Dichlorobenzidine (not LRV) (page 8.3-187; ANZECC/ARMCANZ (2000)).
16. Guideline for o-Xylene = 350 µg/L, for m-xylene = 75 µg/L and for p-xylene = 200 µg L^{-1} (ANZECC/ARMZANC (2000)).
17. Guideline values are for generic oils and petroleum hydrocarbons (Table 3.4.1; ANZECC/ARMCANZ (2000)).
18. A generic estimate of 7 µg L^{-1} for a total petroleum hydrocarbon chronic value has been estimated using USEPA methods (page 8.3-297; ANZECC/ARMCANZ (2000)).
19. LRV is for linear alkylbenzene sulfonates (LAS). The MBAS assay detects all inorganic surfactants. Applying the LRV for LAS to measured MBAS concentrations is likely to be conservative .
20. Suspended solids guidelines for the protection of saltwater aquaculture species = <10,000 µg L^{-1} (Table 4.4.2; ANZECC/ARMCANZ (2000)).
21. pH guideline range for slightly disturbed inshore marine ecosystems in south-west Australia = 8.0 to 8.4 (Table 3.3.6; ANZECC/ARMCANZ (2000)).

5.3.4 Bioaccumulating toxicants

Contaminant concentrations are compared directly to the ANZECC/ARMCANZ (2000) 80% species protection guidelines.

5.3.5 Dilution calculations

Contaminants measured in the quarterly wastewater characterisation analysis (see Section 5.3.3) must meet the ANZECC/ARMCANZ (2000) 99% species protection guideline trigger levels (95% for cobalt), at the boundary of the LEPA. Modelling will be used to determine the number of dilutions at the LEPA boundary (Appendix C). Until the modelling is complete an interim dilution factor of 1:200 will be applied. Contaminant concentrations will be corrected for dilution and compared to the ANZECC/ARMCANZ (2000) 99% species protection guideline trigger levels (95% for cobalt). The formula used to correct contaminants for dilution is:

$$[\text{After Dilution}] = \left(\frac{[\text{Undiluted Toxicant}]}{\text{Number of Dilutions}}\right) + [\text{Background}]$$

5.3.6 Total toxicity calculations

Total toxicity calculation is an additional interpretative tool used for estimating the potential toxicity of treated wastewater, where the effects are 'additive'. The potential toxicity of treated wastewater to marine biota after initial mixing at the ocean outlet (i.e. after dilution of the

wastewater with seawater) is assessed as per the ANZECC/ARMCANZ (2000) guidelines, based on the effects of ammonia, copper and zinc. These are the three contaminants identified as most likely to cause toxicity effects based on the degree to which they exceed ANZECC/ARMCANZ (2000) guidelines in undiluted wastewater. It is important to note, however, that the formula is only meant to be used for simple mixtures where the interactions are simple and predictable. The approach does not account for synergistic and/or antagonistic effects, or complex mixtures. It is noted that the effects of ammonia, copper and zinc (or other metals) in combination is assumed to be additive. If the mixture is complex (i.e. >5 components and/or has uncertain mixture effects), ANZECC/ARMCANZ (2000) recommends proceeding to direct toxicity assessment (refer to Section 5.3.7).

The formula used to calculate the total toxicity of the mixture is:

$$\text{Total Toxicity of Mixture} = \frac{[\text{ammonia}]}{[\text{Trigger Value}]} + \frac{[\text{copper}]}{[\text{Trigger Value}]} + \frac{[\text{zinc}]}{[\text{Trigger Value}]}$$

The total toxicity of the mixture needs to be less than 1 in order to meet the total toxicity criteria, in accordance with ANZECC/ARMCANZ (2000) guidelines. An interim dilution of 200-fold will be applied until minimum levels of dilution are determined.

A total toxicity calculation is undertaken quarterly, using the results from the quarterly wastewater characterisation analysis (see Section 5.3.2)

5.3.7 Whole-of-effluent toxicity (WET) testing

The Water Corporation's commitment 7 (Appendix A) requires that whole-of-effluent toxicity (WET) testing be implemented as part of the SDOOL M&MP. WET testing involves exposing organisms to different concentrations of an effluent (treated wastewater) and then measuring growth or reproduction characteristics after a selected period of time.

The objectives of WET testing are to:

- determine whether further investigation of the potential toxicity of treated wastewater to marine biota is required
- establish the potential toxicity to marine biota of the wastewater discharge using a full suite of WET tests, as and when required
- ensure that the dilution of the wastewater at the boundary of the HEPA is protective of 99% of species, as calculated using National (ANZECC/ARMCANZ 2000) protocols.

To meet commitment 7, two types of WET tests are to be carried out:

- quarterly 1-hour sea urchin fertilisation test [interim test]
- full suite of WET testing.

1-hour sea urchin fertilisation test

The 1-hour sea urchin fertilisation test will measure the rate of sea urchin sperm and egg fertilisation when exposed to a range of salt-adjusted treated wastewater solutions. The utility of this test lies in its fast turn-around time (3 days) together with its sensitivity to surfactants (i.e. detergents; one of the key constituents of domestic wastewater). This test is more sensitive than most other WET tests and consequently provides an early warning indication of potential toxicity concentrations of contaminants with wastewater (Appendix D). Triggering of this test results in further more detailed levels of assessment (see *Full suite of WET testing*).

Full suite of WET testing

The full suite of WET testing is a more comprehensive assessment of the potential effects of the wastewater on marine organisms. WET testing measures the responses of a number of biota (from a number of trophic levels) to a range of salt-adjusted treated wastewater solutions. Data generated by WET testing are used to calculate the dilutions of treated wastewater required to protect 99% of species, using the BurrliOZ software, as per ANZECC/ARMCANZ (2000). The full suite of WET testing will use a selection of five of the available tests described below. All WET tests are chronic short-term tests with a sub-lethal endpoint.

Microtox test

The Microtox test involves the use of luminescent bacteria, *Vibrio fischeri*, to determine toxicity in environmental samples. Bacterial luminescence is directly related to cell respiration, and hence any toxicity that inhibits cellular activity results in a decreased rate of respiration and a corresponding decrease in the rate of luminescence.

The test involves exposing the bacteria to selected concentrations of wastewater for 15 min. Luminescence is measured at the beginning (T0) and end (T15) in a Microtox Model M500 analyser and any decrease in cellular activity is calculated by comparing the two readings. Results are then used to calculate the NOEC, LOEC and EC50.

*Algae growth inhibition test (***Nitzschia closterium *and* Isochrysis *sp.)***

This test determines the inhibition and the stimulation of growth rate (expressed as cell yield) of the marine alga *Nitzschia closterium* and *Isochrysis* sp. over 72 hours. Known concentrations of the algae are added to the test chambers and dilute wastewater is added to the algae. The algae are incubated at 22°C for 72 hours. Growth is either measured by the amount of chlorophyll present (as absorbance at 750 nm wavelength) in the test chambers and comparing this to growth in the control chambers, or by cell density. The results are used to calculate the NOEC, LOEC and EC50.

Copepod 21–28 day reproduction test

This test uses copepods (*Gladioferens imparipes*) collected from the Swan River. The copepods are exposed to dilute wastewater as neonates. Mature copepods are then paired (male and female) and the number of offspring produced is recorded and compared to the controls. These results are used to calculate the NOEC, LOEC and EC50.

Fish 7-day larval growth test

This test is based on the growth of larval pink snapper (*Pagrus auratus*) after 7 days exposure to dilute wastewater. Larval pink snapper are placed in dilute wastewater and after 7 days the length of each larva is measured and compared to the growth of the controls. The NOEC, LOEC and EC50 are calculated.

Ecklonia *(macroalga) 48-hour germination test*

This test uses a macroalga (*Ecklonia radiata*) collected from an uncontaminated site, dried and then the gametes collected from the alga's blades. Male and female gametes are collected separately and placed together in selected concentrations of wastewater, left for 48 hours and then the percentage of zygotes with germination tubes are assessed. The percentages are compared with control results and the EC50, LOEC and NOEC are calculated.

Mussel larval development test

This test uses fertilised eggs obtained from adult molluscs (*Mytilus edulis*), induced to spawn as required, which are exposed to a series of concentrations of wastewater and allowed to develop for 48 hours under controlled conditions. One hundred larvae are counted and the numbers of abnormal and normal larvae are recorded. Abnormal larvae are considered to be any larvae not exhibiting the classic D-shaped veliger. The percentages are compared with control results and the EC50, LOEC and NOEC are calculated.

Sea urchin fertilisation test

The sea urchin fertilisation test determines the success of sea urchin fertilisation over a 1-hour period using the gametes of the sea urchin *Heliocidaris tuberculata*. The sperm of the sea urchin are exposed to dilute wastewater for a 1 hour period and then added to an egg suspension. The fertilised eggs are counted and the percent fertilisation calculated. These results are used to calculate the NOEC, LOEC and EC50.

Doughboy scallop 48-hour larval development test

This test is a 48-hour larval development (abnormality) test that uses the gametes of *Mimachlamys* (*Chlamys*) *asperrima*. Fertilised eggs of the scallop are exposed to dilute wastewater for 48 hours. The larvae are then examined to determine the percentage of abnormal larvae. These results are used to calculate the NOEC, LOEC and EC50.

Timing

The 1-hour sea urchin fertilisation WET tests will be conducted quarterly to yield results from a range of production conditions that may arise over a 12-month period. Sampling will coincide with the quarterly wastewater characterisation to yield concurrent information on the composition of the wastewater sample to aid the interpretation of results.

The full suite of WET testing of the combined wastewater stream was undertaken after commencement of the discharge from the KWRP, following the discharge of wastewater from CSBP Ltd and again in 2009 following the inclusion of BP to the waste stream (Oceanica 2010c). A full suite of WET testing (combined with a comprehensive treated waste water characterisation for all parameters listed in Table 5.2) will be carried out when other approved industry participants begin discharging wastewater into the SDOOL.

The full suite of WET testing (combined with a comprehensive treated waste water characterisation for all parameters list in Table 5.2) will also be carried out if there is an exceedance of the EQG for wastewater characterisation, if quarterly wastewater characterisation indicates an exceedance of the trigger for the combined toxicity of ammonia, copper and zinc in the wastewater stream and/or from the trigger for the 1 hour sea urchin (*Heliocidaris tuberculata*) EC50 fertilisation test.

Previous waste stream characterisation data has identified concentrations of methylene blue activated substances (MBAS), an indicator of surfactants, and nonylphenol, a by-product of surfactants. ANZECC/ARMCANZ (2000) guidelines provide no reliable guideline for surfactants; an assessment will be made against the low reliability value but the LRV will not form an EQG trigger. In the absence of a reliable trigger, WET testing will be applied as an alternate line of evidence for the toxicity of the waste stream as suggest by EPA (2005a). The quarterly sea urchin fertilisation test provides a sensitive (and efficient) tests for the routine screening of surfactants and its quick turn-around time (days) allows for rapid management responses.

If the 1-hour WET testing EQG is exceeded, the first step will be to immediately collect and reanalyse a further sample of wastewater. If the trigger is exceeded in the repeat sampling exercise, then a full set of WET tests will be undertaken. The proposed triggers and details on WET testing are described below.

Sampling regime

Samples of the combined wastewater stream collected from sample point D (Figure 5.1) will be sent to the relevant laboratories for analysis. All samples will be stored and transported according to the protocols stipulated by the relevant laboratories. Seawater (for use as the dilution water in the WET tests) will be provided by the laboratory undertaking the WET test (QA/QC of seawater is routinely undertaken under controlled conditions, as part of this process).

The WET tests that will be undertaken are short-term chronic tests with sub-lethal end points. The ANZECC/ARMCANZ (2000) guidelines require the use of a suite of chronic tests using at least five different species representing at least four different taxonomic groups to obtain reliable trigger values. A variety of test statistics, including NOEC, LOEC, EC/IC10 and EC/IC50 values, will be generated from the proposed tests to determine (in discussion with the DER) which derivation protocol will be used to obtain a reliable guideline to ensure a high level of ecological protection outside the mixing zone, considering the level of dilution that occurs. It will therefore be important to ensure that the test statistics generated are as accurate as possible, via careful choice of the test concentrations used.

Samples of 0.45 µm filtered Perth seawater will also be analysed for the same suite of contaminants (note that concentrations of pesticides and herbicides will not be analysed as these contaminants are likely to be present in very low concentrations, i.e. below analytical limits of reporting).

The chemical characterisation of the combined wastewater stream will be undertaken using standard laboratory analytical procedures. Laboratories with NATA-accredited methods or appropriate QA/QC standards in place will undertake the analyses. Sample analysis will report against the lowest feasible analytical limits but where concentrations are reported as less than this limit, limits of reporting will be used in the calculations.

The dilutions of wastewater used will typically be 0.5%, 6.25%, 12.5%, 25%, 50% and 100%, but may vary slightly for each WET test. All test dilutions for wastewater will be salt-adjusted (using artificial sea salts) to achieve marine salinities, so that only the toxicity due to the presence of contaminants is examined and not the toxic effect of freshwater on the marine organism. Testing will also be undertaken on a seawater control, and an artificial sea salt (brine) control.

5.4 Receiving waters: physico-chemical and direct biological measures

5.4.1 Compliance monitoring

The objective of the compliance monitoring (CM) program, first introduced in 2003, was to meet the future requirement to develop an appropriate environmental monitoring program capable of measuring environmental quality against the EQOs. The overarching objectives of the CM program are:

1. to assess the environmental impacts of the treated wastewater discharge through regular and intensive water quality monitoring
2. to compare the results with relevant Environmental Quality Criteria (EQC).

Timing

Fortnightly sampling will be conducted over a 4-month period between December and March. Sampling is conducted during the summer to avoid potential confounding effects of riverine and groundwater discharge.

Sampling regime

On each sampling occasion, a surface drogue will be deployed over the centre of the operational ocean outlet diffuser and retrieved approximately 30 min later. The time and location of the drogue at deployment and retrieval will be recorded using an on-board GPS. This information will be used to derive a directional vector along which sampling will be undertaken. These data will also provide an accurate estimate of surface current speed at the time of sampling. On each sampling occasion, samples will be collected at four reference sites and five compliance sites located at intervals of 0, 100, 350, 1000 and 1500 m down-current of the outlet.

At each of the compliance and reference sites, the physico-chemical parameters measured are:

- irradiance
- salinity-depth profile
- temperature-depth profile
- dissolved oxygen depth profile.

Irradiance measurements will be undertaken with one sensor positioned 1 m below the surface and a second sensor 7 m below the surface and the light attenuation coefficient calculated as follows:

$$\textit{Light Attenuation Coefficient} = \frac{\log_{10} I_1 - \log_{10} I_7}{6}$$

A composite sample representative of the top half of the water column will be collected from each of the sites (Figure 5.2) for analysis of chlorophyll-a and nutrients. Two 10 mL filtered (on-site through a 45 µm filter) samples will be collected in polypropylene tubes for ortho-phosphate, ammonia and nitrate + nitrite analysis and 4–10 L of sample will be filtered (on-site through a Grade GF/C filter) and the filter retained for chlorophyll-a (and phaeophytin) analysis.

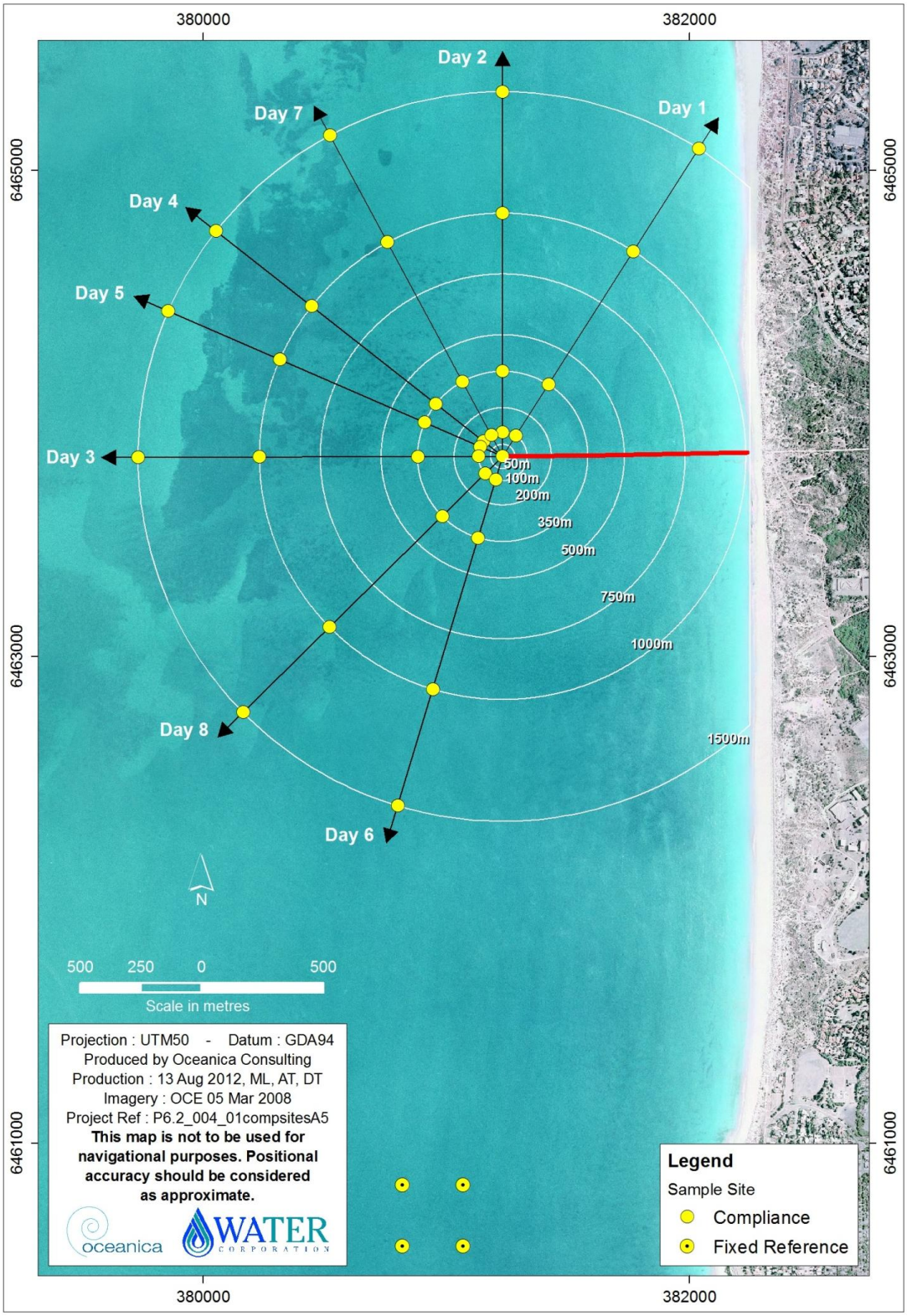


Figure 5.2 **Conceptual diagram of the Compliance Monitoring program showing hypothetical compliance sites and their relative distances from the outlet diffuser**

5.4.2 Sentinel mussel monitoring

Sedentary, filter-feeding shellfish (such as mussels) are often used as biomonitors. Filter-feeding shellfish process large volumes of water at a fixed location and have the tendency to accumulate a wide range of toxicants in their tissues. Shellfish therefore provide an integrated measure of the bioavailable portion of toxicants in the water column at a particular site, and consequently toxicant levels in shellfish provide a good proxy for overall levels in the surrounding water column. For many toxicants, shellfish are good indicators of toxicant transfer between the water column and the food web. The objective of the sentinel mussel monitoring program is to assess the risks to:

- EQO1 (Maintenance of Ecosystem Integrity)
- EQO2 (Maintenance of Aquatic Life for Human Consumption).

Sentinel mussels will be deployed to monitor the assimilation of microbial organisms, bioaccumulating heavy metals and pesticides. *Mytilus edulis* mussels will be used, which have a number of features that make them suitable as biomarkers, including:

- their biology is well understood
- they are inexpensive and easily obtained
- they are easy to handle and process
- they are ecologically important
- they are frequently used in similar monitoring programs both nationally and internationally.

Timing

Deployment of sentinel mussels at Sepia Depression Ocean Outlet was last undertaken in late summer 2010. Sentinel mussel deployment will be undertaken at 5-yearly intervals thereafter, unless annual wastewater characterisation results indicate that the concentrations of contaminants exceed ANZECC/ARMCANZ (2000) guidelines after 200-fold initial dilution: if this occurs, the sampling frequency will be reviewed in consultation with the DER.

Results of previous sentinel mussel surveys at Sepia Depression (Oceanica 2007, Oceanica unpublished field data) and Ocean Reef (Oceanica 2010d) have indicated negligible bioaccumulation of heavy metals and pesticides by sentinel mussels deployed along the edge of the LEPA (only one analyte exceedance for metals) with results most often below analytical limits of detection. Consequently, a recommendation arising from the metals and pesticides survey for mussels at Ocean Reef and Sepia Depression (Oceanica 2010d) was to reduce the frequency of the surveys from 3- to 5-yearly, unless major changes in the quality or quantity of treated wastewater discharge warranted more frequent monitoring.

Sampling regime

To address EQO1 (maintenance of ecosystem integrity), mussels will be deployed (Figure 5.3 and Table 5.4) at a site located in the immediate vicinity of the SDOOL ocean outlet (i.e. within the LEPA), at sites located 100 m upstream and downstream of the outlet (i.e. at the LEPA/HEPA boundary; Figure 5.3), and at a reference site located 4 000 m south of the outlet (Figure 5.3and Table 5.4).

To address EQO2 (maintenance of aquatic life for human consumption), mussels will be deployed at the boundary of the proposed closed safety zone for aquaculture (Figure 5.3 and Table 5.4). Mussels of uniform size (50–70 mm in length) will be obtained from commercially cultured stocks. The use of a consistent size of mussel will reduce any influence of mussel size on bioaccumulation of toxicants.

At each monitoring site, replicate mussel lines will be deployed. On each line, mussels will be suspended 2-3 m below the surface and just above the seafloor (i.e. at approximately 18 m depth). Approximately 60 mussels will be suspended in mesh baskets on each of the mussel lines at each site.

Mussels equilibrate with environmental conditions after a period of 4 weeks. To ensure equilibrium is met during SDOOL monitoring, the mussels will be deployed for a 6-week period (Regoli & Orlando 1994). The mussels and mesh baskets will be cleaned after 3 weeks to prevent the accumulation of algal growth that could smother and kill the mussels. After the 6 week deployment period, the mussels will be retrieved and the number of live mussels recorded. The live mussels will be placed into sterile bags and kept on ice while in transit to the analytical laboratory.

Mussels from the same batch deployed on the mussel lines will be stored frozen prior to analysis to provide an indication of the initial toxicant load of the mussels. These will be the control mussels.

Samples will be kept frozen until analysis. Samples for metal analysis will be thawed, the shells shucked and the soft tissue homogenised, and the samples freeze-dried and ground. Mussel tissue will be analysed for:

- metals: inorganic arsenic, cadmium, chromium, cobalt, copper, lead, mercury, nickel, selenium, silver, zinc
- pesticides and herbicides: organochlorine pesticides, organophosphate pesticides, triazine herbicides
- bacteriological indicators: *E. coli*, total plate counts.

Standard laboratory analytical procedures will be employed throughout and laboratories with NATA-accredited methods or appropriate QA/QC standards in place will undertake the analyses.

Environmental quality and food health safety standards

For EQO1 (Maintenance of Ecosystem Integrity), the median of data from mussels at site M1, M2 and M3 will be compared with the 80th percentile of data from the reference site R1. For EQO2 (Maintenance of Aquatic Life for Human Consumption), mussels from sites S1, S2 and S3 will be compared with the EQG and EQC in Table 5.3.

Table 5.3 EQG and EQS values for metal concentrations for the maintenance of seafood safe for human consumption

Metals	Al	As	Cd	Cr	Co	Cu	Pb	Hg	Ni	Se	Ag	Zn
LOR[1]	<20	<1	<0.06	<0.5	<0.2	<0.2	<1	<0.01	<0.4	<0.1	<1	<2
Units	ug/g (wet wt)											
EQG	na	na	na	na	na	30	na	na	na	1.0	na	290
EQS	na	1.0	2.0	na	na	na	2.0	0.5	na		na	na

Notes:

1. Limit of reporting (LOR).

Source: EPA (2005a)

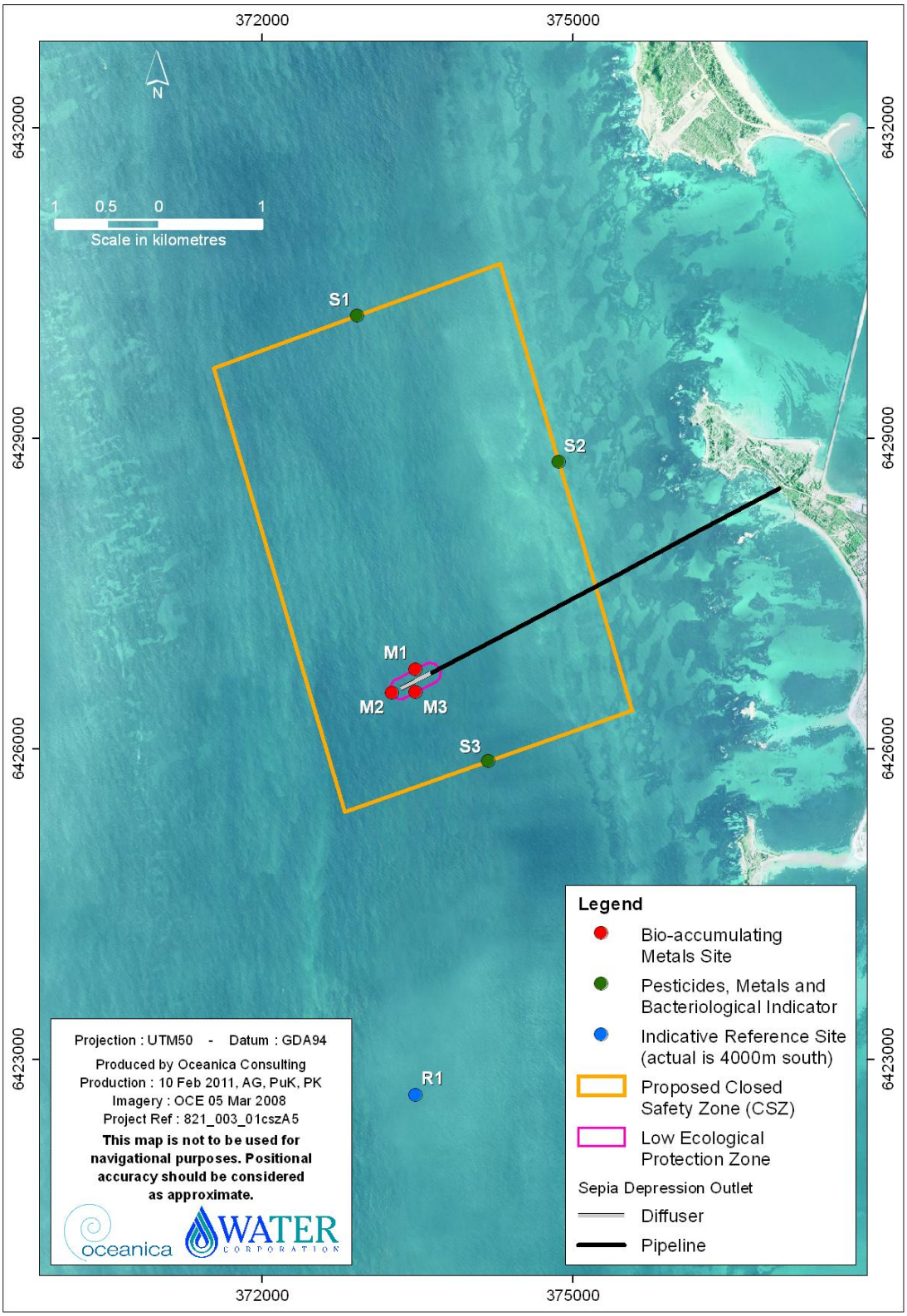


Figure 5.3 Sentinel mussel and sediment sampling sites

Table 5.4 Sentinel mussel and sediment sampling site coordinates

Coordinate	Description	Easting	Northing
Proposed Closed Safety Zone for Shellfish Harvesting			
1	North-west	371534	6429679
2	North-east	374297	6430691
3	South-east	375568	6426374
4	South-west	372797	6425393
Pesticides, metals and bacteriological monitoring sites			
S1	Pesticides, Metals and Bacteriological monitoring site – north	372916	6430185
S2	Pesticides, Metals and Bacteriological monitoring site – east	374862	6428773
S3	Pesticides, Metals and Bacteriological monitoring site – south	374182	6425884
Bio-accumulating metals monitoring site			
M1	Bio-accumulating metals monitoring site - north	373479	6426772
M2	Bio-accumulating metals monitoring site - west	373247	6426541
M3	Bio-accumulating metals monitoring site - south	373479	6426546
Reference site			
R1	Reference location	373479	6422659

5.5 Toxicants in sediments

5.5.1 Sediment quality monitoring

Concentrations of potential contaminants in the sediments can be a useful time-integrated measurement of the distribution and accumulation of toxicants from marine wastewater outlets. These measurements have particular applicability to the accumulation and/or toxicological effects of contaminants on benthic organisms in the vicinity of outlets.

It should be noted, however, that the wastewater plume is positively buoyant and therefore rises rapidly to the surface and dissipates rapidly within the boundary of the mixing zone. There will, therefore, be limited contact of any components of the plume with the sediments before considerable dilution has occurred. Furthermore, sediments around the ocean outlet are generally fine/coarse-grained sands with a low capacity to bind contaminants, thus the potential for the accumulation of toxicants in the sediments is considered to be extremely low.

The objective of the sediment surveys at Sepia Depression is to determine the spatial variability in concentrations of potential wastewater contaminants in sediments at sites in the vicinity of the SDOOL ocean outlet.

Timing

Sediments will be collected every 5 years. The last sediment survey was undertaken in 2009 (Oceanica 2010d) with the next one scheduled for summer 2014/15.

Sampling regime

Sediment samples will be collected from a site located in the immediate vicinity of the SDOOL ocean outlet (i.e. within the LEPA), at sites located 100 m upstream and downstream of the outlet (i.e. at the LEPA/HEPA boundary; labelled as bioaccumulating metals sites in Figure 5.3), and at a reference site located 4 000 m south of the outlet (labelled as R1 in Figure 5.3). At each site, five replicate surface sediment samples will be collected by divers using 9.5 cm diameter polycarbonate corers (according to the procedures set out in Australian Standard AS/NZS 5667.12:1999). Corers will be pre-rinsed with dilute acid, deionised water and a suitable solvent. The corers will be washed between sampling sites with site water before re-sampling.

Each replicate sample will comprise a composite from five sub-samples of the top 2 cm of sediment obtained from the four corners and the centre of a 1 m^2 quadrat, in accordance with the *Manual of Standard Operating Procedures for Cockburn Sound* (EPA 2005b). Although five replicate samples will be taken at each site, only three samples from each site are to be analysed initially, in accordance with the minimum replicates for analysis (EPA 2005b).

Sediment samples will be kept on ice and then frozen prior to analysis. Analyses will be undertaken by analytical laboratories with NATA-accredited methods. Sample analysis will report against the lowest practical analytical limits from a NATA commercial laboratory, and where possible analytical limits will achieve the guidelines in Table 5.5. Where concentrations are reported as less than this limit, the limits of reporting will be used in the calculations.

Sediment samples will be analysed for:

- grain-size distribution (laser diffraction and sieving)
- organic matter content (loss on ignition at 550°C)
- carbonate content (loss on ignition at 1000°C)
- nutrients (TKN, TKP)
- metals (aluminium [Al], arsenic [As], cadmium [Cd], cobalt [Co], copper [Cu], lead [Pb], mercury [Hg], nickel [Ni], selenium [Se], silver [Ag], zinc [Zn]).

If the comprehensive treated wastewater characterisation (Section 5.3.3) reveals that pesticide and herbicides levels are below limits of reporting, these contaminants will not be measured in sediment samples. Recent and previous sediment sampling in the vicinity of Sepia Depression and Ocean Reef ocean outlets have consistently shown pesticide and herbicide levels to be below detection or at very low levels (Oceanica 2007, 2010d). If, on the other hand, treated wastewater characterisation shows an increases in pesticide and herbicide levels relative to the previous year's analysis, then additional testing will be undertaken in the sediment surveys for organochlorine pesticides, organophosphate pesticides and triazine herbicides[4].

Additional testing will be undertaken under the following conditions:

- for pesticides/herbicides with guideline triggers >LOR: If concentrations exceed the ANZECC/ARMCANZ (2000) guidelines following worst-case initial dilution
- for pesticides/herbicides with trigger values <LOR: If concentrations exceed the LOR following worst case initial dilution.

[4] *Organochlorine pesticides [e.g. aldrin, dieldrin, heptachlor,], organophosphate pesticides [e.g. chloropyrifos, malathion, parathion] and triazine herbicides [e.g. atrazine, metribuzine, simazine]).*

Table 5.5 Sediment quality criteria

Parameter	Value (high, moderate and low protection)[1]	Re-sampling trigger[1]
Metals (mg/kg dry weight)		
Arsenic	20	70
Cadmium	1.5	10
Chromium	80	370
Copper	65	270
Lead	50	220
Mercury	0.15	1
Nickel	21	52
Silver	1	37
Zinc	200	410
Organics (µg/kg dry weight)[2]		
Acenaphthene	16	500
Acenaphthalene	44	640
Anthracene	85	1100
Fluorene	19	540
Naphthalene	160	2100
Phenanthrene	240	1500
Benzo(a)anthracene	261	1600
Benzo(a)pyrene	430	1600
Dibenzo(a,h)anthracene	63	260
Chrysene	384	2800
Fluoranthene	600	5100
Pyrene	665	2600
Total Polycyclic Aromatic Hydrocarbons	4000	45000
Total DDT	1.6	46
pp-DDE	2.2	27
op-+pp-DDD	2	20
Chlordane	0.5	6
Dieldrin	0.02	8
Endrin	0.02	8
Lindane	0.32	1
Total Polychlorinated Biphenyls	23	180

Notes:

1. Values derived from Table 3 in EPA (2005a)
2. Sampling for organochlorine pesticides [e.g. aldrin, dieldrin and heptachlor], organophosphate pesticides [e.g. chloropyrifos, malathion and parathion] and triazine herbicides [e.g. atrazine, metribuzine and simazine]) will only be undertaken if these contaminants are above detection in annual comprehensive treated wastewater characterisation.

5.6 Dam flushing events

This document mostly addresses the effect of operations under normal operating conditions. The monitoring and management approach for short term/contingency events such as dam flushing requires a slightly different approach.

Recognising that any exceedances of the continuous waste stream triggers during dam flushing events are not an indicator of upset plant conditions, the application of those triggers and subsequent management responses to an exceedance will be suspended during dam flushing events. All other EQG will be met during dam flushing events or associated management responses will be applied.

5.6.1 Interim measures

A management system is required to ensure that when the balancing dam is flushed, dilution at the diffuser is sufficient to meet the relevant ANZECC/ARMCANZ species protection guideline values at the edge of the LEPA (particularly for ammonia). It is not yet clear whether dilution is sufficient for this purpose. The Water Corporation will provide evidence of the overall dilution at the edge of LEPZ during dam flushing events via modelling to determine whether they are sufficient to meet the relevant ANZECC/ARMCANZ species protection guidelines (including ammonia) (Appendix C).

Measurements from wastewater characterisations collected during dam flushing (additional to the quarterly TWW characterisations) will be used to better identify maximum contaminant concentrations and will be used to determine whether the ANZECC/ARMCANZ guidelines are being met at the LEPA boundary. The outcome of this investigation will guide the management protocol that is derived but the protocol will ensure that EQG will be met during dam flushing events or associated management responses will be applied.

5.6.2 Ongoing monitoring

After confirmation of the dilutions required to meet the ANZECC/ARMCANZ Species Protection Guidelines, ongoing diffuser validation (section 5.2.3) will serve as an annual check that dilution at the LEPA boundary remains adequate to achieve the guidelines during dam flushing events.

Water Corporation will determine whether spikes in suspended solids are having an unacceptable impact on aesthetic values by monitoring the magnitude and distribution of any suspended sediment plumes arising from one dam flushing event per annum.

Such an investigation would involve:

- timing one of the eight summer water quality sampling events to coincide with a dam flushing discharge event
- measuring suspended solids, turbidity (light attenuation and secchi disk), ammonia and other parameters in a down-current direction from the diffuser (but including the LEPA and post upgrade boundary)
- Making a direct comparison between the relevant guidelines (i.e. ammonia at the LEPA boundary) or the 80th percentile of reference data (suspended solids and turbidity at the post upgrade boundary)

6. Monitoring to Maintain Seafood Safety

6.1 Overview

This EQO for the Environmental Value Fishing and Aquaculture is aimed at ensuring seafood is safe for human consumption. To meet this objective, water quality around the Sepia Depression ocean outlet is to be maintained so that seafood is safe for consumption in all waters except areas designated otherwise. To ensure this EQO is being met, monitoring programs have been developed to measure compliance against EQC set for thermo-tolerant coliforms, metals, chemicals and algal biotoxins that may be a component of, or stimulated by, the treated wastewater discharged into the Sepia Depression.

6.2 Thermo-tolerant coliforms (TTC)

6.2.1 Microbial contaminant monitoring

Many disease-causing organisms are transferred from human and animal faeces to water via sewage effluent, from where they can be ingested by marine fauna and infect them, adversely affecting their suitability for human consumption. Thermo-tolerant coliforms (TTC) are one such group of bacteria that primarily originate in the intestines of warm-blooded animals. By testing for TTC, it can be determined whether the ocean water around the Sepia Depression has potentially been exposed to faecal contamination.

To adequately assess the risk to human health based on ingestion of infected seafood and to determine whether the EQC for maintenance of aquatic life for human consumption have been met numbers of TTC will be monitored at the boundary of the pre-designated Shellfish Harvesting Exclusion Zone (SHEZ; see Figure 4.4). As we are primarily considering contamination of bottom-dwelling sessile filter-feeding marine organisms seawater samples will be collected at the bottom of the water column. Samples will be collected on eight occasions during the non-river flow period at five fixed sites at the boundary of the SHEZ located immediately down-current of the diffuser (Figure 6.1 and Figure 6.2). The five monitoring sites are selected based on the current direction as indicated by the drogue release during compliance monitoring. Near-bottom water samples for microbiological contaminants will be collected in pre-sterilised bottles before being chilled in the dark to 4°C. Samples will then be transferred to a laboratory (e.g. Pathwest) and analyses for TTC undertaken according to NATA-accredited methods.

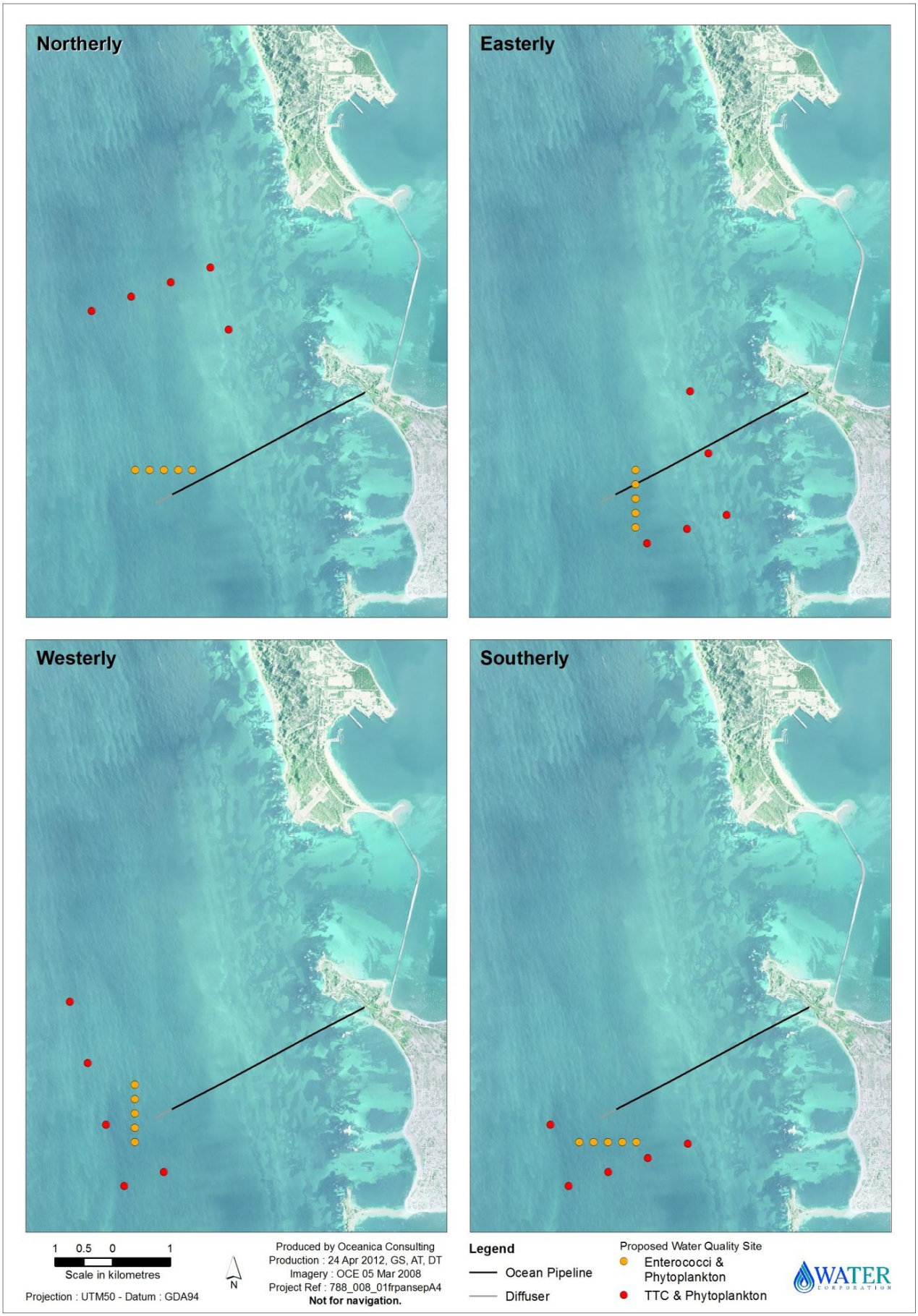


Figure 6.1 **Fixed sites around the Sepia Depression outlet sampled for thermo-tolerant coliforms (TTC), *Enterococci* spp. and phytoplankton during periods with northerly, easterly, westerly and southerly currents**

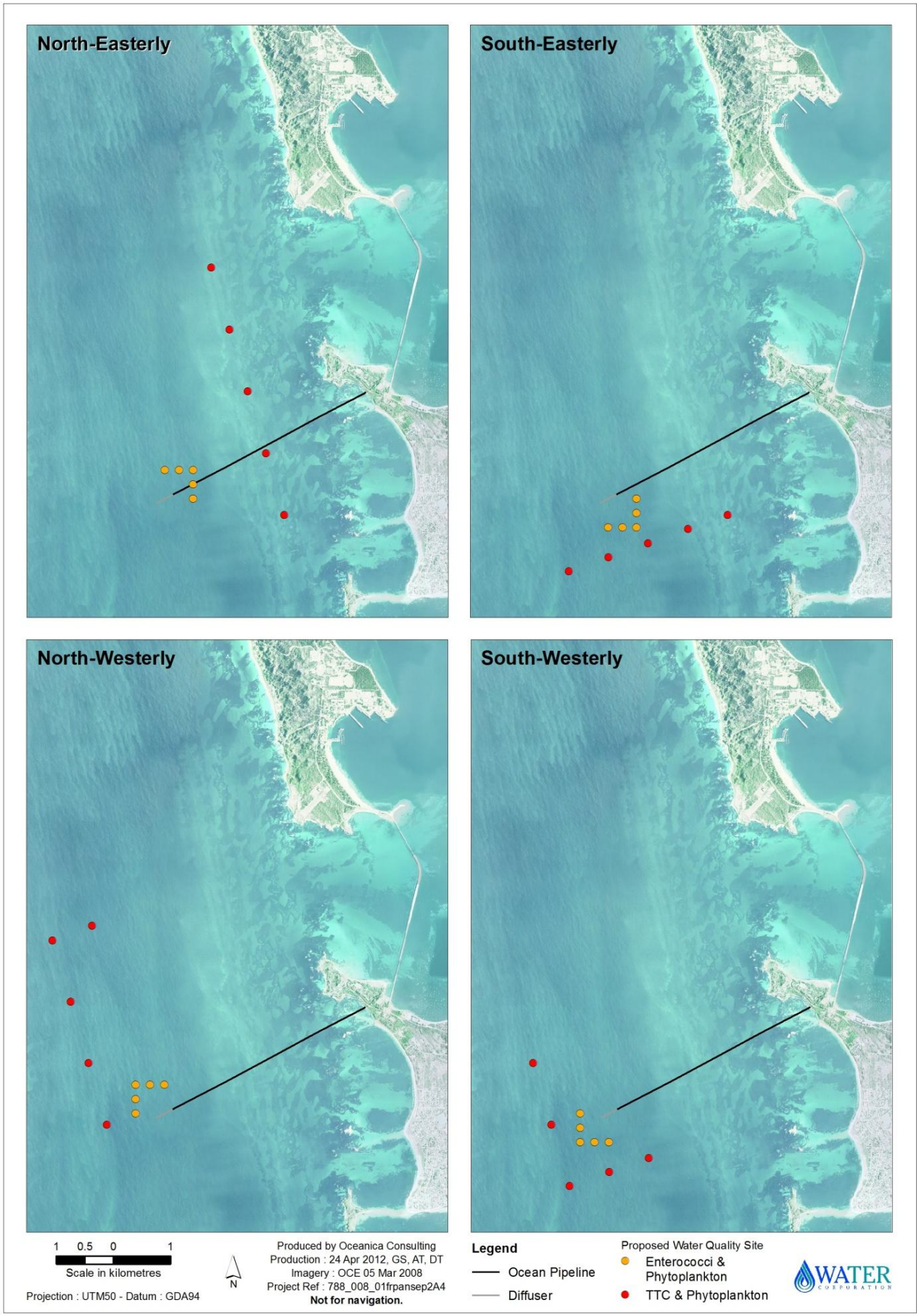


Figure 6.2 **Fixed sites around the Sepia Depression outlet sampled for thermo-tolerant coliforms (TTC), *Enterococci* spp. and phytoplankton during periods with north-easterly, south-easterly, north-westerly and south-westerly currents**

To ensure the maintenance of safe seafood for human consumption around the Sepia Depression ocean outlet, the EQG requires that the median TTC counts must not 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. If this EQG is not met, assessment will proceed against the EQS for TTC (see below). The EQS requires that median TTC counts in seawater (outside of the SHEZ) are not to exceed 70 CFU/100 mL, with no more than 10% of the samples exceeding 85 CFU/100 mL.

6.2.2 Sentinel mussel monitoring

See section 5.4.2.

6.3 Metals and chemicals

6.3.1 Sentinel mussel monitoring

See section 5.4.2.

6.4 Algal biotoxins

6.4.1 Phytoplanktion community composition

Blooms of planktonic algae, or 'red tides', are naturally-occurring events. Most of these blooms contain species of algae that are considered harmless and result only in water discolouration. However, other algal species can produce toxins that have a serious effect on the surrounding marine life. Some algae are capable of secreting compounds into the water that are toxic to filter-feeders and to planktivorous fish that may ingest the toxic algal cells directly from the water column and retain the toxins in their viscera (internal organs). Monitoring of algal biotoxins aims to target concentrations of species most likely to occur in local waters and involves a staged process, whereby water quality is assessed in the first instance (i.e. the EQG), and if this does not meet the required quality standards, a secondary assessment is required to assess toxin concentrations within sentinel mussels (i.e. EQS).

Table 6.1 EQG and EQS for the maintenance of seafood for human consumption

EQG	EQS
Concentrations of potentially toxic algae at sites at the boundary of the SHEZ must not to exceed the WASQAP[1] guideline concentrations for any of the following: • *Alexandrium* spp. (100 cells L^{-1}) • *Gymnodinium* spp. (1000 cells L^{-1}) • *Karenia* spp. (1000 cells L^{-1}) • *Dinophysis* spp. (500 cells L^{-1}) • *Dinophysis acuminta* (3000 cells L^{-1}) • *Prorocentrum* spp. (500 cells L^{-1}) • *Psuedo-nitzschia* spp. (25 000 cells L^{-1}) • *Gonyaulax* cf. *spinifera* (100 cells L^{-1}) • *Protoceratium reticulatum* (*Gonyaulax grindleyi*) (500 cells L^{-1}) If this EQG is not met, assessment will proceed against the EQS for sentinel mussel tissues.	Toxin concentrations in seafood not to exceed EQS[2] in any sample at the boundary of the SHEZ[3]: • Paralytic shellfish poison (0.8 mg Saxitoxin eq. kg) • Diarrhoetic shellfish poison (0.2 mg kg) • Neurotoxic shellfish poison (200 mouse units kg) • Amnesic shellfish poison (domoic acid; 20 mg kg)

Notes:

1. Western Australian Shellfish Quality Assurance Program (DoF 2007).
2. As set out in the Australian New Zealand Food Standards Code (FSANZ 2006).
3. Western Australian Shellfish Quality Assurance Program (WASQAP) Operations Manual (DoF 2007).

Phytoplankton samples are collected at the same sites and same occasions as thermo-tolerant coliforms (Figure 6.1 and Figure 6.2). Composite water samples representative of the top half of the water column will be preserved in Lugol's iodine solution and transported to a laboratory (i.e. Dalcon Environmental) for phytoplankton identification using the Utermöhl method. Phytoplankton will be identified to the lowest taxonomic level possible. On each sampling occasion only one sample (i.e. in the direct path of the drogue) will initially be analysed with the remaining four samples archived. In the event that toxic phytoplankton species are present in the sample analysed at concentrations that exceeded the recommended WASQAP guideline concentrations (DoF 2007), the archived phytoplankton samples collected on that sampling occasion will also be analysed (Table 6.2).

Table 6.2 Protocols for analysis of archived phytoplankton samples

Outcome of initial analysis	Further action
No exceedance of WASQAP[1] guideline concentrations	No analysis of archived samples
Exceedance of WASQAP guideline concentrations at both the reference site and the CM site	No analysis of archived samples
Exceedance of WASQAP guideline concentrations at the reference site, but not at the CM site	No analysis of archived samples
Exceedance of WASQAP guideline concentrations at the CM site but not at the reference site.	Additional samples analysed

Note:

1. Western Australian Shellfish Quality Assurance Program (DoF 2007)

6.4.2 Sentinel mussel monitoring

See section 5.4.2.

7. Monitoring to Maintain Contact Recreation

7.1 Overview

This EQO for the Environmental Value Recreation and Aesthetics is aimed at ensuring Perth's coastal waters are safe for primary and secondary contact recreation activities such as swimming and boating. To meet this objective, water quality around the Sepia Depression ocean outlet is to be maintained so that typical recreation activities can be conducted in all waters except areas designated otherwise. To ensure this EQO is being met, monitoring programs have been developed to measure compliance against EQC set for *Enterococci* spp. and algal biotoxins that may be a component of, or stimulated by, the treated wastewater discharged into the Sepia Depression. As the maintenance of primary contact recreation EQO requires a higher water quality standard to be maintained than secondary contact recreation EQO, by default, it is assumed that if primary contact recreation EQC are met, secondary contact recreation EQC will also be achieved.

7.2 Faecal pathogens (*Enterococci* spp.)

Disease-causing microorganisms (pathogens) associated with bathing areas include salmonellae, shigellae, enteropathogenic *Escherichia coli*, cysts of *Entamoeba histolytica*, parasite ova, enteroviruses and infectious hepatitis. Generally, the most common types of diseases that have been associated with swimming areas are eye, ear, nose and throat infections, skin diseases and gastrointestinal disorders.

Direct detection of pathogens is not a feasible option for routine assessment, since they occur intermittently and are difficult to recover from water. For this reason, indicator microorganisms are generally used to assess the health risks associated with pathogens in recreational waters (Elliot & Colwell 1985). A number of organisms have been considered as indicators of health risks for swimming areas (Daly 1991).

To determine whether the EQC for primary and secondary contact recreation have been met faecal streptococci (*Enterococci* spp.) samples will be collected on eight occasions at the boundary of the area where primary and secondary contact recreation is not recommended (Figure 4.6). Depth-integrated samples for analysis of *Enterococci* spp. will be collected from the top half of the water column from five sites selected based on the current direction indicated by a drogue (Figure 6.1 and Figure 6.2). *Enterococci* spp. samples will be collected in pre-sterilised bottles before being chilled to 4°C and placed in the dark. On completion of sampling, the samples will be transferred to a laboratoriy (e.g. Pathwest) and analysed according to NATA-accredited methods.

The EQG for faecal pathogens (*Enterococci* spp.) requires that the 95th percentile of *Enterococci* spp. not exceed 200 MPN/100 mL at the boundary of the contact recreation zone.

7.3 Algal biotoxins

Algal blooms (stimulated by nutrient inputs) can be harmful to human/animal health if encountered via ingestion or skin contact. For this reason, phytoplankton cell counts are monitored over the summer period to ensure concentrations are within acceptable limits (EPA 2005a). Phytoplankton samples (as an indicator of algal biotoxins present in certain phytoplankton) will be collected, preserved and analysed in the manner described in Section 6.4.1.

7.4 Toxic chemicals

Toxic chemicals will be determined directly in the waste stream on an annual basis (Section 5.3.3). The list captures the relevant contaminants most likely to be present in the waste stream based (Appendix E). The recreational guidelines for toxic chemicals are high compared to the guidelines for ecosystem protection. An initial assessment for toxic chemicals will be made against the most sensitive guideline (the ecosystem protection guidelines) in the first instance. If the requirements of the most sensitive guidelines for ecosystem protection are met then the human health guidelines are also met. Further assessment against subsequent guidelines (Table 7.1) will only be made in the event of an exceedance of the most sensitive guideline. The recreational guidelines will apply at the post upgrade boundary. However, in the absence of dilution factors that apply at that boundary the concentrations of toxic chemicals will be corrected based on minimum dilutions achieved at the LEPA boundary in the first instance. If the recreational guidelines are exceeded at the LEPA boundary, dedicated modelling will be conducted to determine concentrations at the relevant management boundary to allow direct comparison against the guidelines.

Table 7.1 Parameters to be measured annually in the SDOOL wastewater stream and the EPA (2005a) recreational guidelines

Parameter	Max (last 5 years)	After 1:200 dilutions	Recreational Guidelines
Nutrients (µg L^{-1})			
Nitrate-N+ Nitrite-N	7500	37.5	1 000 000
Metals and Metalloids (µg L^{-1})			
Arsenic (As)	2	0.01	140
Cadmium (Cd)	<0.1	<0.0005	40
Chromium (Cr)	3	0.015	1000
Copper (Cu)	11	0.055	40 000
Lead (Pb)	<1	<0.005	200
Mercury (Hg)	<0.1	<0.0005	20
Nickel (Ni)	9.9	0.0495	400
Selenium (Se)	<1	<0.005	200
Silver (Ag)	<0.8	<0.004	2000
Triazine herbicides (µg L^{-1})			
Atrazine	1.4	0.007	400
Hexazinone	<0.1	<0.0005	6000
Metribuzine	<0.1	<0.0005	1000
Simazine	0.58	0.0029	400
Phenoxy-acid herbicides (µg L^{-1})			
Dicamba	<1	<0.005	2000
2,4-D	68	0.34	600
2,4,5-T	<1	<0.005	2000
Triclopyr	<1	<0.005	200
Organophosphate pesticides (µg L^{-1})			
Azinphos-Methyl	<0.2	<0.001	60
Chlorfenvinphos (E)	<0.2	<0.001	200
Chlorfenvinphos (Z)	<0.2	<0.001	200
Dichlorvos	<0.2	<0.001	20
Diazinon	<0.2	<0.001	60
Dimethoate	<0.2	<0.001	6000

Parameter	Max (last 5 years)	After 1:200 dilutions	Recreational Guidelines
Ethion	<0.2	<0.001	60
Fenitrothion	<0.2	<0.001	200
Parathion (Ethyl)	<0.2	<0.001	200
Parathion Methyl	<0.2	<0.001	2000
Pirimiphos-Ethyl	<0.2	<0.001	10
Pirimiphos-Methyl	<0.2	<0.001	1000
Organochlorine pesticides (µg L^{-1})			
Aldrin	<0.05	<0.00025	6
trans-Chlordane	<0.05	<0.00025	20
cis-Chlordane	<0.05	<0.00025	20
gamma-BHC (Lindane)	<0.05	<0.00025	400
p,p-DDT	<0.05	<0.00025	400
Dieldrin	<0.05	<0.00025	6
alpha-Endosulfan	<0.05	<0.00025	600
beta-Endosulfan	<0.05	<0.00025	600
Heptachlor	<0.05	<0.00025	6
Methoxychlor	<0.05	<0.00025	6000
Phenols (µg L^{-1})			
2-Chorophenol	<1	<0.005	6000
2,4-Dichlorophenol	2.1	0.0105	4000
2,4,6-Trichlorophenol	<2	<0.01	400
Pentachlorophenol (PCP)	<2	<0.01	200
Phthalates (µg L^{-1})			
Bis(2-ethylhexyl)phthalate	<20	<0.1	200
Chlorinated hydrocarbons (µg L^{-1})			
1,4-Dichlorobenzene	<20	<0.1	800
1,2-Dichlorobenzene	<20	<0.1	30 000
Hexachloro-1,3-butadiene	<20	<0.1	14
BTEX (µg L^{-1})			
Benzene	<1.0	<0.005	20
Toluene	<1.0	<0.005	16 000
Ethylbenzene	<1.0	<0.005	6000
PAHs (µg L^{-1})			
Benzo(a)pyrene	<10	<0.05	0.2
Miscellaneous Other (mg L^{-1} except pH)			
Chlorine-Total	<0.02	<0.0001	100

8. Monitoring to Maintain Aesthetic Values

8.1 Overview

This EQO for the Environmental Value Recreation and Aesthetics ensures that Perth's coastal waters are aesthetically pleasing and that the aesthetic value is protected. To ensure this EQO is being met, monitoring will routinely assess the quality of surface water appearance.

8.2 Aesthetic appearance

Aesthetic appearance will be determined via a questionnaire supplied to field personnel (Table 8.1). It will be determine on eight occasions during the non-river flow period (see Section 5.4.1). On each occasion, the questionnaire will be completed at one location on the post upgrade boundary down-current of the diffuser (Figure 6.1 and Figure 6.2).

Table 8.1 Field sheet for demonstrating compliance with EQG for aesthetics

Site: Date:	Recorder:	Comments
Environmental Quality Guideline		
Algal/plant material visible on surface?	Yes/No	
Dead marine organisms visible?	Yes/No	
Water clarity (light attenuation)	Metres	
Noticeable colour variation?	Yes/No	
Oil or other films visible on surface?	Yes/No	
Floating debris visible on the surface?	Yes/No	
Noticeable odour associated with water?	Yes/No	

A complaints register will be established that will be accessible via an email contact and phone number published on the Water Corporation website. The register will be monitored for complaints and a summary of those complaints (if any) reported in the Annual Report.

8.3 Fish tainting substances

Fish tainting chemicals will be determined directly in the waste stream on an annual basis (Section 5.3.3). The guidelines for fish tainting substances are generally high compared to the guidelines for ecosystem protection. An initial assessment for fish tainting substances will be made against the most sensitive guideline (the ecological guidelines) in the first instance. If the requirements for the most sensitive guideline are met then it will be assumed that the aesthetics guidelines are also met. Further assessment against subsequent guidelines (Table 8.2) will only be made in the event of an exceedance of the most sensitive guideline. The aesthetics guidelines will apply at the post upgrade boundary. However, in the absence of dilution factors that apply at that boundary the concentrations of toxic chemicals will be corrected based on minimum dilutions achieved at the LEPA boundary in the first instance. If the aesthetics guidelines are exceeded at the LEPA boundary, dedicated modelling will be conducted to determine concentrations at the relevant management boundary to allow direct comparison against the guidelines.

Table 8.2 Parameters to be measured annually in the SDOOL wastewater stream and the EPA (2005a) guidelines for fish tainting substance

Parameter	Max (last 5 years)	After 1:200 dilutions	Aesthetics Guidelines
Metals and Metalloids (µg L^{-1})			
Copper (Cu)	11	0.055	1000
Zinc (Zn)	68	0.34	5000
Phenols (µg L^{-1})			
Phenol	16	0.08	300
2,4-Dichlorophenol	2.1	0.0105	0.3
2,4,6-Trichlorophenol	<2	<0.01	2
Pentachlorophenol (PCP)	<2	<0.01	30
Chlorinated hydrocarbons (µg L^{-1})			
Hexachlorocyclopentadiene	<20	<0.1	1
Ethers (µg L^{-1})			
Nitrobenzene	<20	<0.1	30
BTEX (µg L^{-1})			
Toluene	<1.0	<0.005	250
Ethylbenzene	<1.0	<0.005	250
PAHs (µg L^{-1})			
Napthalene	0.011	0.000055	1000
Acenaphthene	<10	<0.05	20

9. Implementation

9.1 Reporting and auditing

A SDOOL Monitoring Program Report will be produced annually. The Annual Report will include:

- **Executive Summary**: a brief summary that can be read as a stand-alone document.
- Introduction and Background: description of the SDOOL and current operating parameters; history of the SDOOL Monitoring Program.
- **Management of the SDOOL**: description of the Ministerial Statement Conditions and the Water Corporation's Environmental Management Commitments; the current status of management of the SDOOL, including the Environmental Quality Management Framework in place for the SDOOL.
- **Methods**: details of sampling frequency, sampling locations, sample collection protocols, parameters monitored and laboratory analyses undertaken.
- **Presentation, Interpretation and Discussion of Key Findings**: presentation, interpretation and discussion of the key findings from each of the studies managed under the SDOOL Monitoring Program and the studies relevant to the SDOOL which have been managed by the Perth Long-Term Ocean Outlet Monitoring (PLOOM) Program including the characterisation of wastewater, the results from the initial dilution modelling and water quality monitoring. The data will be tabulated and presented graphically where appropriate to assist with interpretation.
- **Compliance with Environmental Quality Criteria/Ministerial Statement Conditions/Water Corporation's Environmental Management Commitments**: comparison of the results of the SDOOL Monitoring Program with the Environmental Quality Criteria, including presentation of the results from the SDOOL Monitoring Program in a summary compliance 'Report Card'.
- **Program Review and Recommendations**: assessment of all aspects of the SDOOL Monitoring Program and recommendations for any changes to the Program.

The SDOOL Monitoring Program Annual Report will be presented to the SDOOL Stakeholder Liaison Group for discussion prior to submission to the DER. In addition, the SDOOL Monitoring Program Annual Report will be publicly available via the Water Corporation's web-site (http://www.watercorporation.com.au).

9.2 Monitoring and revision

The requirements of this M&MP may be reviewed from time to time. Any change to the requirements of this plan resulting from such reviews will be determined by the Water Corporation on advice of the OEPA.

All components of the monitoring and management program will be reviewed to ensure that meaningful results are obtained, that the objectives are still appropriate and the program is relevant. The review will consist of the continuous aggregation and consolidation of information collected throughout the conduct of the monitoring program and will be reported to the OEPA and the SDOOL Stakeholder Liaison Group.

10. Stakeholder consultation

The Water Corporation undertook considerable community consultation on environmental aspects of the Sepia Depression WWTP during the development of the KWRP proposal, which commenced in December 1999. The approach to consultation was more formalised in late 2000, and a summary of community consultation carried out since December 2000 is fully described by Bailey et al. (2003) and provided in Appendix G. Further, ongoing liaison between the Water Corporation and a stakeholder reference group has been maintained, during which the outcomes of monitoring are reported annually (Appendix H). Informal consultation with a range of experts and the OEPA was undertaken in the development of EQC.

11. References

ANZECC, ARMCANZ (2000) Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Volume 1: The Guidelines. Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, Canberra, ACT, October 2000

Bailey MC, Hillman K, Baker A, Humphries R, Luketina D (2003) Kwinana water reclamation plant (KWRP): Expanding Perth's water options – use of Cape Peron outlet pipeline to dispose of industrial wastewater to sepia depression – Kwinana – Public environmental review. Prepared by Water Corporation of Western Australia, Perth, Western Australia, November 2003

Barceloux DG (2000) Vanadium. Journal of Toxicology - Clinical Toxicology 37:265–278

DAL (2001) Perth Long-Term Ocean Outlet Monitoring (PLOOM) Programme: Location of Water Quality Monitoring Sites. Prepared for Water Corporation of Western Australia by DA Lord & Associates, Report No 95/015/13, Perth, Western Australia, December 2001

Daly H (1991) Recreational water quality indicators: A brief discussion paper. Information Bulletin WQ2/91. Victorian Environment Protection Authority, Melbourne, Victoria

DoF (2007) Western Australian Shellfish Quality Assurance Program (WASQAP) Operations Manual. Department of Fisheries, Perth, Western Australia

Eklund BT, Kautsky L (2003) Review on toxicity testing with marine macroalgae and the need for method standardization-exemplified with copper and phenol. Marine Pollution Bulletin 46:171–181

Elliot EL, Colwell RR (1985) Indicator organisms for estuarine and marine waters. Federation of European Microbiological Societies Microbiology Reviews 32:61–79

EPA (2000) Perth Coastal Waters – Environmental Values and Objectives – the position of the EPA – a working document. Environmental Protection Authority, Perth, Western Australia, February 2000

EPA (2002) Implementation Framework for Western Australia for the Australian and New Zealand Guidelines for Fresh and Marine Water Quality and Water Quality Monitoring and Reporting (Guidelines Nos 4 & 7: National Water Quality Management Strategy). Environmental Protection Authority, Report No 1078, Perth, Western Australia, November 2002

EPA (2004) Use of the Cape Peron outlet pipeline to dispose of industrial wastewater, Kwinana. Prepared for Water Corporation by Environmental Protection Authority, Report No 1135, Perth, Western Australia, May 2004

EPA (2005a) Environmental Quality Criteria Reference Document for Cockburn Sound (2003–2004) – A supporting document to the State Environmental (Cockburn Sound) Policy 2005. Environmental Protection Authority, Report No 20, Perth, Western Australia

EPA (2005b) Manual of Standard Operating Procedures – For Environmental Monitoring against the Cockburn Sound Environmental Quality Criteria (2003–2004) – A supporting document to the State Environmental (Cockburn Sound) Policy 2005. Environmental Protection Authority, Report No 21, Perth, Western Australia, January 2005

FSANZ (2006) Safe Seafood Australia – A guide to the Australian Primary Production and Processing Standard for Seafood. Food Standards Australian New Zealand, Canberra, ACT, April 2006

Govt of WA (2005) State Environmental (Cockburn Sound) Policy 2005, Prepared by Government of Western Australia, Perth, Western Australia, January 2005

Kathrine KA, Lavercombe PS, Dillon J, Ginsberg J (2006) Accidental death from acute selenium poisoning. Medical Journal of Australia 185:388–389

McAlpine K, Wenziker K, Apte SC, Masini RJ (2005) Background quality for coastal marine waters of Perth, Western Australia. Department of Environment, Report No 117, Perth, Western Australia, March 2005

NHMRC (2008) Guidelines for Managing Risks in Recreational Water. National Health and Medical Research Council, Canberra, ACT, February 2008

Oceanica, CRC (2005) Benthic Habitat Mapping Owen Anchorage 2004. Prepared for Cockburn Cement Limited by Oceanica Consulting Pty Ltd and Cooperative Research Centre for Coastal Zone, Estuary and Waterway Management, Report No 344/1, Perth, Western Australia, December 2005

Oceanica (2007) Perth Long Term Ocean Outlet Monitoring (PLOOM) 4.2 – 2006/2007 Metals and Pesticides Survey at Ocean Reef and Sepia Depression Ocean Outlets. Prepared for Water Corporation of Western Australia by Oceanica Consulting Pty Ltd, Report No 562/1, Perth, Western Australia, June 2007

Oceanica (2009) PLOOM 5 Annual Reporting 2008 – Sepia Depression. Prepared for Water Corporation by Oceanica Consulting Pty Ltd, Report No 628_004/3, Perth, Western Australia, August 2009

Oceanica (2010a) Alkimos Wastewater Treatment Plant – Environmental management of temperate macroalgal communities exposed to treated domestic wastewater: developing appropriate triggers for action. Prepared for Water Corporation by Oceanica Consulting Pty Ltd, Report No 790_002/1, Perth, Western Australia, September 2010

Oceanica (2010b) Sepia Depression Ocean Outlet Landlines (SDOOL) – Annual Report 2010. Prepared for Water Corporation by Oceanica Consulting Pty Ltd, Report No 821_004/2, Perth, Western Australia, November 2010

Oceanica (2010c) Sepia Depression Ocean Outfall Landline (SDOOL) – Treated Wastewater Characterisation and Ecotoxicological (WET) testing of wastewater discharged through the SDOOL (September 2009 & March 2010). Prepared for Water Corporation by Oceanica Consulting Pty Ltd, Report No 821_002/1, Perth, Western Australia, July 2010

Oceanica (2010d) Perth Long Term Ocean Outlet Monitoring (PLOOM) 6.0 – 2009/10 Metals and Pesticides Survey at Ocean Reef and Sepia Depression Ocean Outlets. Prepared for Water Corporation of Western Australia by Oceanica Consulting Pty Ltd, Report No 834_001/1, Perth, Western Australia, June 2010

Opresko DM (1993) Toxicity summary for molybdenum. Report prepared for Oak Ridge Reservation Environmental Restoration Program Chemical Hazard Evaluation Group, Biomedical and Environmental Information Analysis Section, Health and Safety Research Division, Oak Ridge, Tennessee

Pattiaratchi C, Imberger J, Zaker N, Svenson T (1995) Perth Coastal Waters Study - Physical Measurements, Prepared for Water Authority of Western Australia by Centre for Water Research University of Western Australia, Perth, Western Australia, January 1995

Pattiaratchi C, Knock C (1995) Perth Coastal Waters Study – Model Tuning and Validation. Prepared for Water Authority of Western Australia by Centre for Water Research University of Western Australia, Perth, Western Australia, January 1995

Regoli F, Orlando E (1994) Accumulation and subcellular distribution of metals (Cu, Fe, Mn, Pb and Zn) in the Mediterranean mussel *Mytilus galloprovincialis* during a field transplant experiment. Marine Pollution Bulletin 28:592–600

Appendix A

Ministerial Statement 665

MINISTER FOR THE ENVIRONMENT

Statement No. 000665

STATEMENT THAT A PROPOSAL MAY BE IMPLEMENTED (PURSUANT TO THE PROVISIONS OF THE ENVIRONMENTAL PROTECTION ACT 1986)

USE OF THE CAPE PERON OUTLET PIPELINE TO DISPOSE OF INDUSTRIAL WASTEWATER TO THE SEPIA DEPRESSION, KWINANA

Proposal: To dispose of up to 30 megalitres per day of industrial effluent in addition to treated wastewater from the Water Corporation's wastewater treatment plants and water from the Jervoise Bay Groundwater Recovery Scheme, up to a combined maximum of 208 megalitres per day through the Sepia Depression Ocean Outlet Landline, into the Sepia Depression, 4.1 kilometres offshore west-south-west of Point Peron, as documented in schedule 1 of this statement.

Proponent: Water Corporation

Proponent Address: 629 Newcastle Street, LEEDERVILLE WA 6007

Assessment Number: 1471

Report of the Environmental Protection Authority: Bulletin 1135

The proposal referred to above may be implemented by the proponent subject to the following conditions and procedures:

1 Implementation

1-1 The proponent shall implement the proposal as documented in schedule 1 of this statement subject to the conditions of this statement.

2 Proponent Commitments

2-1 The proponent shall implement the environmental management commitments documented in schedule 2 of this statement to the requirements of the Minister for the Environment on advice of the Environmental Protection Authority.

Published on

28 OCT 2004

29th FLOOR, ALLENDALE SQUARE, 77 ST GEORGE'S TERRACE, PERTH 6000 TELEPHONE: (08) 9220 5050 FACSIMILE: (08) 9221 4665/8
E-MAIL: judy-edwards@dpc.wa.gov.au

3 Proponent Nomination and Contact Details

3-1 The proponent for the time being nominated by the Minister for the Environment under section 38(6) or (7) of the *Environmental Protection Act 1986* is responsible for the implementation of the proposal until such time as the Minister for the Environment has exercised the Minister's power under section 38(7) of the Act to revoke the nomination of that proponent and nominate another person as the proponent for the proposal.

3-2 If the proponent wishes to relinquish the nomination, the proponent shall apply for the transfer of proponent and provide a letter with a copy of this statement endorsed by the proposed replacement proponent that the proposal will be carried out in accordance with this statement. Contact details and appropriate documentation on the capability of the proposed replacement proponent to carry out the proposal shall also be provided.

3-3 The nominated proponent shall notify the Department of Environment of any change of contact name and address within 60 days of such change.

4 Commencement and Time Limit of Approval

4-1 The proponent shall substantially commence the proposal within five years of the date of this statement or the approval granted in this statement shall lapse and be void.

Note: The Minister for the Environment will determine any dispute as to whether the proposal has been substantially commenced.

4-2 The proponent shall make application for any extension of approval for the substantial commencement of the proposal beyond five years from the date of this statement to the Minister for the Environment, prior to the expiration of the five-year period referred to in condition 4-1.

The application shall demonstrate that:

1. the environmental factors of the proposal have not changed significantly;

2. new, significant, environmental issues have not arisen; and

3. all relevant government authorities have been consulted.

Note: The Minister for the Environment may consider the grant of an extension of the time limit of approval not exceeding five years for the substantial commencement of the proposal.

5 Compliance Audit and Performance Review

5-1 The proponent shall prepare an audit program and submit compliance reports to the Department of Environment which address:

1. the status of implementation of the proposal as defined in schedule 1 of this statement;

2. evidence of compliance with the conditions and commitments; and

3. the performance of the environmental management plans and programs.

Note: Under sections 48(1) and 47(2) of the *Environmental Protection Act 1986*, the Chief Executive Officer of the Department of Environment is empowered to monitor the compliance of the proponent with the statement and should directly receive the compliance documentation, including environmental management plans, related to the conditions, procedures and commitments contained in this statement.

5-2 The proponent shall submit a performance review report every five years after the start of operations, to the requirements of the Minister for the Environment on advice of the Environmental Protection Authority, which addresses:

1. the major environmental issues associated with the project; the targets for those issues; the methodologies used to achieve these; and the key indicators of environmental performance measured against those targets;

2. the level of progress in the achievement of sound environmental performance, including industry benchmarking, and the use of best available technology where practicable;

3. significant improvements gained in environmental management, including the use of external peer reviews;

4. stakeholder and community consultation about environmental performance and the outcomes of that consultation, including a report of any on-going concerns being expressed; and

5. the proposed environmental targets over the next five years, including improvements in technology and management processes.

5-3 The proponent may submit a report prepared by an auditor approved by the Department of Environment under the "Compliance Auditor Accreditation Scheme" to the Chief Executive Officer of the Department of Environment on each condition/commitment of this statement which requires the preparation of a management plan, programme, strategy or system, stating that the requirements of each condition/commitment have been fulfilled within the timeframe stated within each condition/commitment.

6 Monitoring and Management of the Outlet

6-1 Prior to the acceptance of industrial effluent into the Sepia Depression Ocean Outlet Landline, the proponent shall prepare a Preliminary Sepia Depression Ocean Outlet Monitoring and Management Plan to the requirements of the Minister for the Environment on advice of the Environmental Protection Authority and the Department of Conservation and Land Management.

The objective of this Plan is to ensure that both ecological and social environmental values for marine waters in the vicinity of the Sepia Depression are maintained.

This Plan shall include:

1 the monitoring and evaluation of the environmental effects of discharging treated wastewater into the Sepia Depression;
2 long-term environmental quality objectives and their spatial application consistent with the Environmental Protection Authority's objectives as described in the publication "Perth's Coastal Waters, Environmental Values and Objectives", Environmental Protection Authority, February 2000;
3 a programme to achieve long-term environmental quality objectives through short to medium term targets;
4 agreed "trigger" levels for further investigations (environmental quality guidelines);
5 agreed "trigger" levels for remedial and/or preventative actions to protect the water quality and the environment of the Sepia Depression (environmental quality standards); and
6 management actions to be taken in the event that environmental quality guidelines or environmental quality standards are not met.

6-2 Within twelve months following the acceptance of industrial effluent into the Sepia Depression Ocean Outlet Landline, the proponent shall prepare a Sepia Depression Ocean Outlet Monitoring and Management Plan to the requirements of the Minister for the Environment on advice of the Environmental Protection Authority and the Department of Conservation and Land Management.

This Plan shall address items 1 to 6 of condition 6-1 and any matters arising during the twelve months of operation, and shall be subject to amendment from time to time.

6-3 The proponent shall implement the Sepia Depression Ocean Outlet Monitoring and Management Plans, required by conditions 6-1 and 6-2, to the requirements of the Minister for the Environment on advice of the Environmental Protection Authority.

6-4 The proponent shall make the Sepia Depression Ocean Outlet Monitoring and Management Plan, required by condition 6-2 publicly available, to the requirements of the Minister for the Environment on advice of the Environmental Protection Authority.

7 Ecological Protection Zones and Toxicant Criteria

7-1 During operation, the proponent shall determine and report to the Department of Environment whether the concentrations of bio-accumulating toxicants in the effluent at the diffuser exceed the ANZECC & ARMCANZ[1] 80% species protection guideline "trigger" levels (as published from time to time) for bio-accumulating toxicants in accordance with the Sepia Depression Ocean Outlet Monitoring and Management Plans required by conditions 6-1 and 6-2, to the requirements of the Minister for the Environment on advice of the Environmental Protection Authority.

7-2 In the event that a guideline "trigger" level for a bio-accumulating toxicant, referred to in condition 7-1, is exceeded, the proponent shall report the matter to the Department of Environment within one working day of determining that this has occurred, and shall initiate an investigation against the environmental quality standards and into the cause of the exceedance in accordance with the framework developed in Revised Environmental Quality Criteria Reference Document (Cockburn Sound)[2], to the requirements of the Minister for the Environment on advice of the Environmental Protection Authority.

7-3 If an environmental quality standard for a bio-accumulating toxicant, referred to in condition 7-2, is exceeded, the proponent shall initiate a management response to determine the cause and remedy the exceedance in accordance with the implementation framework for the National Water Quality Management Strategy[3], to the requirements of the Minister for the Environment on advice of the Environmental Protection Authority.

7-4 During operation, the proponent shall determine and report to the Department of Environment whether the ANZECC & ARMCANZ 99% species protection guideline "trigger" levels (as published from time to time) for toxicants (with the exception of cobalt, where the 95% guideline shall apply), identified in accordance with the Sepia Depression Ocean Outlet Monitoring and Management Plans required by conditions 6-1 and 6-2, are being exceeded within the Zone of High Ecological Protection (i.e. beyond a 100 metre radius of the diffuser), to the requirements of the Minister for the Environment on advice of the Environmental Protection Authority.

7-5 In the event that a guideline "trigger" level for a toxicant, referred to in condition 7-4 is exceeded, the proponent shall report the matter to the Department of Environment within one working day of determining that this has occurred, and shall initiate an investigation against the environmental quality standards and into the cause of the exceedance in accordance with the framework developed in Revised Environmental Quality Criteria Reference Document (Cockburn Sound)[2], to the requirements of the Minister for the Environment on advice of the Environmental Protection Authority.

7-6 If an environmental quality standard for a toxicant, referred to in condition 7-5, is exceeded, the proponent shall initiate a management response to determine the source and remedy the exceedance in accordance with the implementation framework for the National Water Quality Management Strategy[3], to the requirements of the Minister for the Environment on advice of the Environmental Protection Authority.

Note:

1 ANZECC & ARMCANZ guidelines are published in *Australian and New Zealand Guidelines for Fresh and Marine Water Quality.*

2 *Revised Environmental Quality Criteria Reference Document (Cockburn Sound), A supporting document to the draft Environmental Protection (Cockburn Sound) Policy 2002*, Environmental Protection Authority Report 20, November 2002.

3 *Implementation framework for Western Australia for the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (Guidelines Nos 4 & 7:*

National Water Quality Management Strategy), Report of the Environmental Protection Authority, Bulletin 1078, November 2002.

8 New Discharges and Changes to Industrial Wastewater Discharge

8-1 The proponent shall not accept industrial effluent from industries not specified in schedule 1 unless a proposal has been referred to the Environmental Protection Authority.

9 Toxicant Loads

9-1 The proponent shall only accept and convey effluent from the industry participants to the Sepia Depression where industrial toxicant loads to be discharged do not exceed those authorised for discharge into Cockburn Sound by the relevant individual industry *Environmental Protection Act* Part V licences.

9-2 The proponent shall not accept discharges which are not licensed under Part V of the *Environmental Protection Act 1986* into the Sepia Depression Ocean Outlet Landline for disposal to the Sepia Depression.

10 Nitrogen Loads

10-1 The proponent shall operate the Sepia Depression Ocean Outlet Landline so that the annual nitrogen load to the Sepia Depression does not exceed the nitrogen load discharged from the outlet in 1994.

10-2 In the event that subsequent monitoring shows an adverse environmental impact at the 1994 nitrogen load, the proponent shall reduce the annual nitrogen load to 75% of the load discharged from the outlet in 1994.

11 Sediment Quality

11-1 During operation, the proponent shall monitor sediment quality within and at the boundary of the Zone of Low Ecological Protection, and report to the Department of Environment on whether sediments exceed the ANZECC & ARMCANZ[1] Interim Sediment Quality Guidelines-low "trigger" levels, to the requirements of the Minister for the Environment on advice of the Environmental Protection Authority.

11-2 In the event that a guideline "trigger" level for sediment quality, referred to in condition 11-1, is exceeded, the proponent shall report the matter to the Department of Environment within one working day of determining that this has occurred, and shall initiate an investigation against the environmental quality standards and into the cause of the exceedance in accordance with the framework developed in Revised Environmental Quality Criteria Reference Document (Cockburn Sound)[2], to the requirements of the Minister for the Environment on advice of the Environmental Protection Authority.

11-3 If an environmental quality standard for sediment quality referred to in condition 11-2 is not met, the proponent shall initiate a management response to determine the cause and act to prevent further sediment quality degradation, to the requirements of the Minister for the Environment on advice of the Environmental Protection Authority.

Note:

1 ANZECC & ARMCANZ guidelines are published in *Australian and New Zealand Guidelines for Fresh and Marine Water Quality.*

2 *Revised Environmental Quality Criteria Reference Document (Cockburn Sound), A supporting document to the draft Environmental Protection (Cockburn Sound) Policy 2002*, Environmental Protection Authority Report 20, November 2002.

12 Decommissioning Plans

12-1 Within six months following the issuing of the notice to the decision-making authorities under section 45(7) of the *Environmental Protection Act 1986*, the proponent shall prepare a Preliminary Decommissioning Plan which provides the framework to ensure that the site is left in an environmentally acceptable condition to the requirements of the Minister for the Environment on advice of the Environmental Protection Authority.

The Preliminary Decommissioning Plan shall address:

1 conceptual plans for the removal or, if appropriate, retention of infrastructure; and

2 long-term management of systems affected by the discharge of waste.

12-2 At least 12 months prior to the anticipated date of decommissioning, or at a time agreed with the Environmental Protection Authority, the proponent shall prepare a Final Decommissioning Plan designed to ensure that the site is left in an environmentally acceptable condition to the requirements of the Minister for the Environment on advice of the Environmental Protection Authority.

The Final Decommissioning Plan shall address:

1 conceptual plans for the removal or, if appropriate, retention of infrastructure; and

2 long-term management of systems affected by the discharge of waste.

12-3 The proponent shall implement the Final Decommissioning Plan required by condition 12-2 until such time as the Minister for the Environment determines, on advice of the Environmental Protection Authority, that the proponent's decommissioning responsibilities have been fulfilled.

Procedures

1 Where a condition states "to the requirements of the Minister for the Environment on advice of the Environmental Protection Authority", the Environmental Protection Authority will provide that advice to the Department of Environment for the preparation of written notice to the proponent.

2 The Environmental Protection Authority may seek advice from other agencies or organisations, as required, in order to provide its advice to the Department of Environment.

3 Where a condition lists advisory bodies, it is expected that the proponent will obtain the advice of those listed as part of its compliance reporting to the Department of Environment.

4 To ensure that discharge loads are not increased, the Chief Executive Officer of the Department of Environment will review from time to time the *Environmental Protection Act* Part V licences issued to industries which discharge into the Sepia Depression Ocean Outlet Landline to set appropriate load limits on toxicants and on any other contaminants which may have an adverse impact on the marine environment.

Notes

1 The Minister for the Environment will determine any dispute between the proponent and the Environmental Protection Authority or the Department of Environment over the fulfilment of the requirements of the conditions.

Dr Judy Edwards MLA
MINISTER FOR THE ENVIRONMENT

28 OCT 2004

Schedule 1

The Proposal (Assessment No. 1471)

The proposal is to discharge up to 30 megalitres per day (ML/day) of industrial wastewater, in addition to treated wastewater from Woodman Point and Cape Peron wastewater treatment plants and water from the Jervoise Bay Groundwater Recovery Scheme, to the Sepia Depression via the Cape Peron outlet line from the following specified sources and further unspecified sources:

- the Kwinana Wastewater Reclamation Plant (KWRP);
- BP Refinery (Kwinana);
- CSBP Limited; and
- Edison Mission Energy.

The proposal takes into account the cumulative environmental impacts of replacing the Cape Peron Wastewater Treatment Plant with a new East Rockingham Wastewater Treatment Plant.

The Sepia Depression Ocean Outlet is situated 4.1 kilometres offshore west-south-west of Point Peron (Figure 1). The proposal does not involve any construction or marine ecological disturbance. The existing pipeline and diffuser will be used. The proposal includes the instruments and controls, telemetry and shutdown systems between industries and the Kwinana Wastewater Reclamation Plant and Sepia Depression Ocean Outlet Landline as described in Section 2 of the Public Environmental Review, which are relevant to monitoring and controlling wastewater input to the Sepia Depression.

Industrial wastewater will only be accepted if the quality of the combined wastewater stream meets the ANZECC & ARMCANZ 80% species protection guidelines for toxicants at discharge and the ANZECC & ARMCANZ 99% species protection guidelines for toxicants (excepting cobalt where the 95% species protection guideline will apply) at 100 metres from the diffuser (Figure 2).

The proposal does not allow any of the specified industries to increase their discharge of current contaminant loads to the marine environment without prior referral to the Environmental Protection Authority.

The key characteristics of the proposal are set out in Table 1.

Table 1 – Key Proposal Characteristics (Assessment no. 1471)

Parameter	Description		
Location	Sepia Depression Ocean Outlet; approximately 4.1 kilometres offshore west-south-west of Point Peron		
	Current (2003)	**Current plus initial KWRP (2004)**	**Possible expansion (2019)**
Industry Reclaimed Water Reuse	0	17 ML/day	up to 27 ML/day
Industry Wastewater Discharge to SDOOL			
Typical	0	6 ML/day	up to 30 ML/day
Maximum	0	13 ML/day	
Combined Treated Wastewater Quantity and Quality			
Average Volume			
Typical*	124 ML/day	113 ML/day	up to 200 ML/day
Maximum**	124 ML/day	122 ML/day	up to 208 ML/day
Suspended Solids	34 mg/L	39 - 42 mg/L	35** mg/L
Biochemical Oxygen Demand (BOD_5)	22 mg/L	24 - 32 mg/L	16** mg/L
Total Nitrogen (TN)	18 mg/L	22 - 32 mg/L	22* -27** mg/L
Total Phosphorus (TP)	10 mg/L	11 - 12 mg/L	11* - 12** mg/L
Dilutions	~	Average dilution of the SDOOL wastewater stream will be at least 1:300 with the dilution being above 1:200 99% of the time within 100 metres of the Sepia Depression Ocean Outlet (SDOO) diffuser.	
Annual Toxicant Loads from Industrial Participants		Toxicant loads from industries nominated in this proposal, will not increase beyond that currently permitted to be discharged to Cockburn Sound, unless the proposal for a change to loads is referred to the EPA.	New proposals or proposals to increase toxicant loads for discharges to the Sepia Depression Ocean Outlet Landline will be referred to the EPA.
Toxicant Concentrations	as per PLOOM reporting, 1992 to 2002	Projected loads and flows will result in toxicant concentrations meeting the ANZECC & ARMCANZ 80% species protection guideline values for bio-accumulating toxicants at the diffuser.	
	as per PLOOM reporting, 1992 to 2002	Projected loads and flows will result in toxicant concentrations meeting the ANZECC & ARMCANZ 99% species protection guideline values (with the exception of cobalt, where the 95% guideline will apply) beyond 100 metres from the Sepia Depression Ocean Outlet diffuser.	

Nutrient Loads	Nutrient loads from the SDOO to the Sepia Depression will be no greater than 1994 loads, and should subsequent monitoring show an adverse environmental impact at that level, it will be reduced to 75% of 1994 loads.
Sediment	ANZECC & ARMCANZ Interim Sediment Quality Guideline-low levels to be used as trigger for management action and investigation for bio-accumulating substances within the Zone of Low Ecological Protection, and generally outside the Zone of Low Ecological Protection.
Protection of Social Values	
Contact recreation	The area not meeting the guidelines for contact recreation due to domestic wastewater discharge will not increase because of the addition of industrial effluent.
Aesthetic value	Visual amenity will not deteriorate because of the addition of industrial effluent.
Seafood for Human Consumption	The industrial wastewater discharge will not increase area not meeting the guidelines for seafood harvesting due to domestic wastewater discharge.

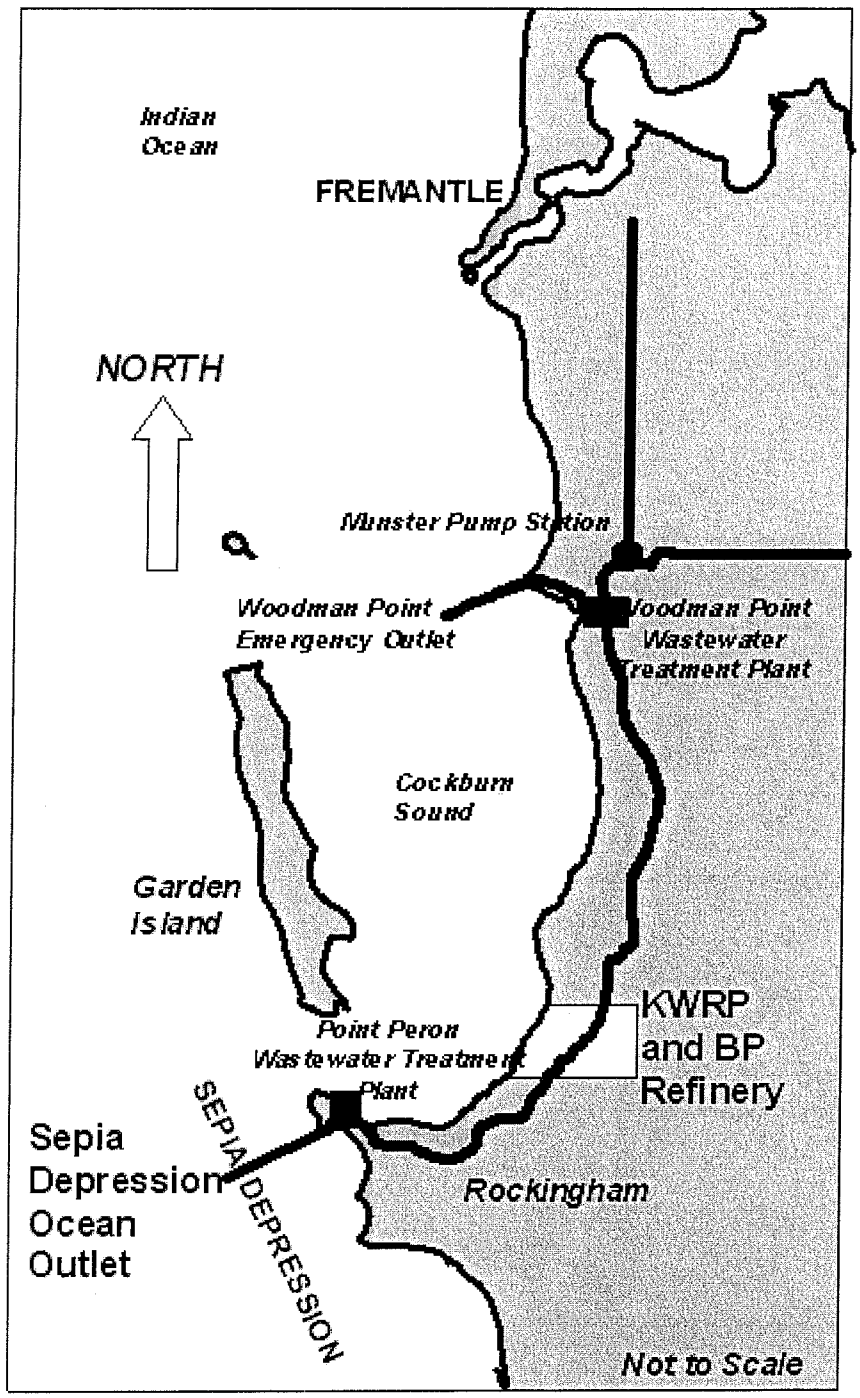
* Typical means the expected average daily operating parameter.
** Maximum means the expected infrequent highest (peak) operating condition reflecting "normal" operational variability.

Abbreviations:

KWRP Kwinana Water Reclamation Plant
ML/day Megalitres per day
mg/L milligrams per litre
SDOOL Sepia Depression Ocean Outlet Landline
PLOOM Perth Long-term Ocean Outlet Monitoring
ANZECC & ARMCANZ *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*.

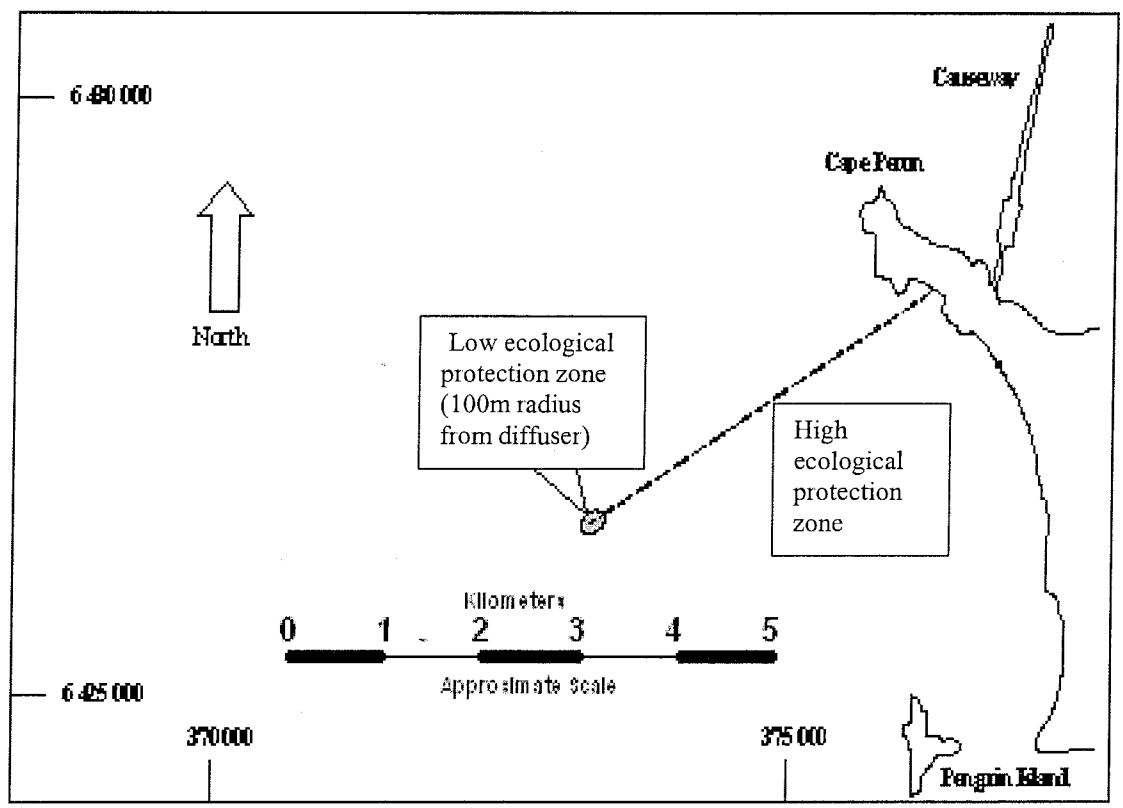
Figures (attached)

Figure 1 – Location of the Sepia Depression Ocean Outlet, and
Figure 2 – Sepia Depression Ocean Outlet Toxicant Boundary.



(Source: Water Corporation)

Figure 1. ***Location of the Sepia Depression Ocean Outlet***



(Source: Water Corporation)

Figure 2 Sepia Depression Ocean Outlet Toxicant Boundary

Schedule 2

Proponent's Environmental Management Commitments

September 2004

USE OF THE CAPE PERON OUTLET PIPELINE TO DISPOSE OF INDUSTRIAL WASTEWATER TO THE SEPIA DEPRESSION, KWINANA

(Assessment No. 1471)

Water Corporation

Proponent's Environmental Management Commitments - September 2004

USE OF THE CAPE PERON OUTLET PIPELINE TO DISPOSE OF INDUSTRIAL WASTEWATER TO THE SEPIA DEPRESSION, KWINANA (Assessment No. 1471)

Note: The term "commitment" as used in this schedule includes the entire row of the table and its six separate parts as follows:

- a commitment number;
- a commitment topic;
- the objective of the commitment;
- the 'action' to be undertaken by the proponent;
- the timing requirements of the commitment; and
- the body/agency to provide technical advice to the Department of Environment.

No.	Topic	Objective	Action	Timing	Advice
1.	Marine Environmental Values	To minimise impact on the marine environment.	Attain an average dilution of the Sepia Depression Ocean Outlet Landline (SDOOL) wastewater stream of at least 1:300 with the dilution being above 1:200 at least 99% of the time within 100 metres of the Sepia Depression Ocean Outlet (SDOO) diffuser. Dilution will be demonstrated by modelling and monitoring.	During Operation	
2.	Marine Environmental Values	-	Accept only wastewater from industrial participants whose discharge is authorised by the relevant licence and/or Ministerial conditions issued to them, or as otherwise authorised in writing by the DoE from time to time. Keep a Register of relevant industries' licences or Ministerial Statement numbers.	During Operation	

No.	Topic	Objective	Action	Timing	Advice
3.	Marine Environmental Values	To minimise impact on the marine environment.	Manage the discharge of treated wastewater to the Sepia Depression, including that accepted from industrial participants and future expansion of the wastewater treatment system to ensure that the concentration of toxicants meets agreed EQC 100 metres from the diffuser. Compliance will be demonstrated by modelling and monitoring.	During Operation	
4.	Protection of Marine Flora and Fauna	To monitor for, and respond to potentially significant impacts to marine flora and fauna from discharges from SDOOL.	Conduct specific investigations and annually report the effects of wastewater discharge to the Sepia Depression through the Perth Long-term Ocean Outlet Monitoring programme or other agreements. Reporting will be through the Compliance Report.	During Operation	
5.	Protection of Marine Flora and Fauna	To monitor for, and respond to potentially significant impacts to marine flora and fauna from discharges from SDOOL.	Conduct specific investigations in the event that toxicants in the treated wastewater exceed concentrations which will result in the EPA's relevant high protection EQG being exceeded following 1:200 initial dilution, with the relevant industrial participant/s and in consultation with the DoE to identify the source and cause of the identified condition. Report any exceedances in the Compliance Report.	During Operation	Industry Participants
6.	Protection of Marine Flora and Fauna	To respond to potentially significant impacts to marine flora and fauna from discharges from SDOOL.	Undertake assessment of the risk presented to the ecological processes in the Sepia Depression by the exceedance in commitment 5, and undertake measures necessary to mitigate those risks. Report mitigation measures taken in the Compliance Report.	During operation	

No.	Topic	Objective	Action	Timing	Advice
7.	Protection of Marine Flora and Fauna	To demonstrate that the diluted effluent quality meets EQC's	Undertake Whole Effluent Toxicity (WET) testing using a method agreed with the DoE following the principles contained in the USEPA, APHA and ASTM protocols at a NATA accredited laboratory in accordance with the protocols set out in ANZECC/ARMCANZ 2000 and in accordance with the Monitoring Program specified in *Plan for Monitoring and Management of SDOO.* Report results in the Compliance Report.	During operation	
8.	Public Health Values	To establish the relevant Social EQC's for discharge of treated wastewater to the Sepia Depression.	Participate in close consultation with the Department of Health, the Department of Conservation and Land Management and DoE to further refine the notional social environmental quality objectives for the maintenance of seafood for human consumption and recreation and aesthetic EQC values and boundaries for treated wastewater discharge to the marine environment. Deploy sentinel mussels to monitor tissue coliform levels in accordance with the Monitoring Program specified in *Plan for Monitoring and Management of SDOO.* Report results in the Compliance Report.	During operation	Department of Health Department of Conservation and Land Management
9.	Public Health Values	To delineate the area where primary contact recreation and the taking of seafood is not recommended	Notify the Department for Planning and Infrastructure of the spatial extent of the area in proximity to the Sepia Depression Ocean Outlet where primary contact recreation and taking of seafood is not recommended, with a request for inclusion on relevant Maritime Charts. Provide evidence of the notification.	Prior to industrial wastewater discharge and following any change to spatial extent of area	

No.	Topic	Objective	Action	Timing	Advice
10.	Environmental Management	To minimise environmental impacts from the implementation of the proposal, and to ensure that environmental approval requirements are met.	Prepare a Wastewater Monitoring and Management Plan to address the receipt and discharge of wastewater from the SDOOL, including: 1. The monitoring and evaluation of combined treated wastewater and industrial effluent into the Sepia Depression. The monitoring will include as far as practicable: • Real-time monitoring of all streams of wastewater returned to the SDOOL and combined streams prior to discharge. Routine monitoring is to include flow-rate, pH, conductivity, turbidity and temperature; and • Routine monitoring of prescribed contaminant levels in all streams of wastewater returned to the SDOOL and combined streams prior to discharge. Prescribed contaminants are those agreed from time to time under this Plan. 2. Procedures required to be implemented by the proponent and KWRP participants if the wastewater contamination has the potential to cause the toxicant concentrations and loads specified in Table 1 of schedule 1 to be exceeded; and 3. Mode of operation of the SDOOL to attain an average dilution of the combined wastewater stream of at least 1:300 with the dilution being above 1:200 at least 99% of the time within 100 metres of the diffuser. Submit framework and plan to Audit Branch, Department of Environment.	Framework of the management plan agreed prior to industrial wastewater acceptance	Water Corporation Industry Participants

No.	Topic	Objective	Action	Timing	Advice
11.	Environmental Management	To minimise environmental impacts from the implementation of the proposal, and to ensure that environmental approval requirements are met.	Finalise the Plan referred to in commitment 10. Submit plan to Audit Branch.	Plan finalised within 6 months of commencement of acceptance of Wastewater to SDOOL	Water Corporation Industry Participants
12.	Environmental Management	To minimise environmental impacts from the implementation of the proposal, and to ensure that environmental approval requirements are met.	Implement the Plan referred to in commitments 10 and 11. Report in the Compliance Report.	During operation	
13.	Stakeholder Consultation Strategy	To formalise and document the purpose, role and functions of the SLG group. To ensure that the public has open access to information regarding the environmental performance of SDOOL and KWRP, and an avenue to address any significant issues arising.	Develop a Stakeholder Consultation Strategy. The Strategy will: • Identify relevant stakeholders including community groups, environmental groups, local governments (including the City of Rockingham) and government agencies; • Describe stakeholder consultation measures, having regard for the Government's consultation strategy; • Require stakeholder input into the Plans and Strategies required to be prepared by these commitments; • Describe opportunities to publicly review annual reports and data on the Sepia Depression Ocean Outlet environmental performance and monitoring programs;	At least six months prior to industrial wastewater discharge.	

No.	Topic	Objective	Action	Timing	Advice
			• Make reports on Kwinana Water Reclamation Plant environmental performance readily available to the public and advertise their availability; • Make the results of the Perth Long-term Ocean Outlet Monitoring programme readily available to the public and advertise their availability; • Maintain a complaints/response record of actions taken to address matters arising from the project; and • Present up to date information and data, consult on and receive input on current and possible future industry participation prior to any referral under section 38 of the *Environmental Protection Act 1986.* Implement the Stakeholder Consultation Strategy. Report monitoring results, complaints and responses in the Compliance Report.	During Operation. During Operation.	

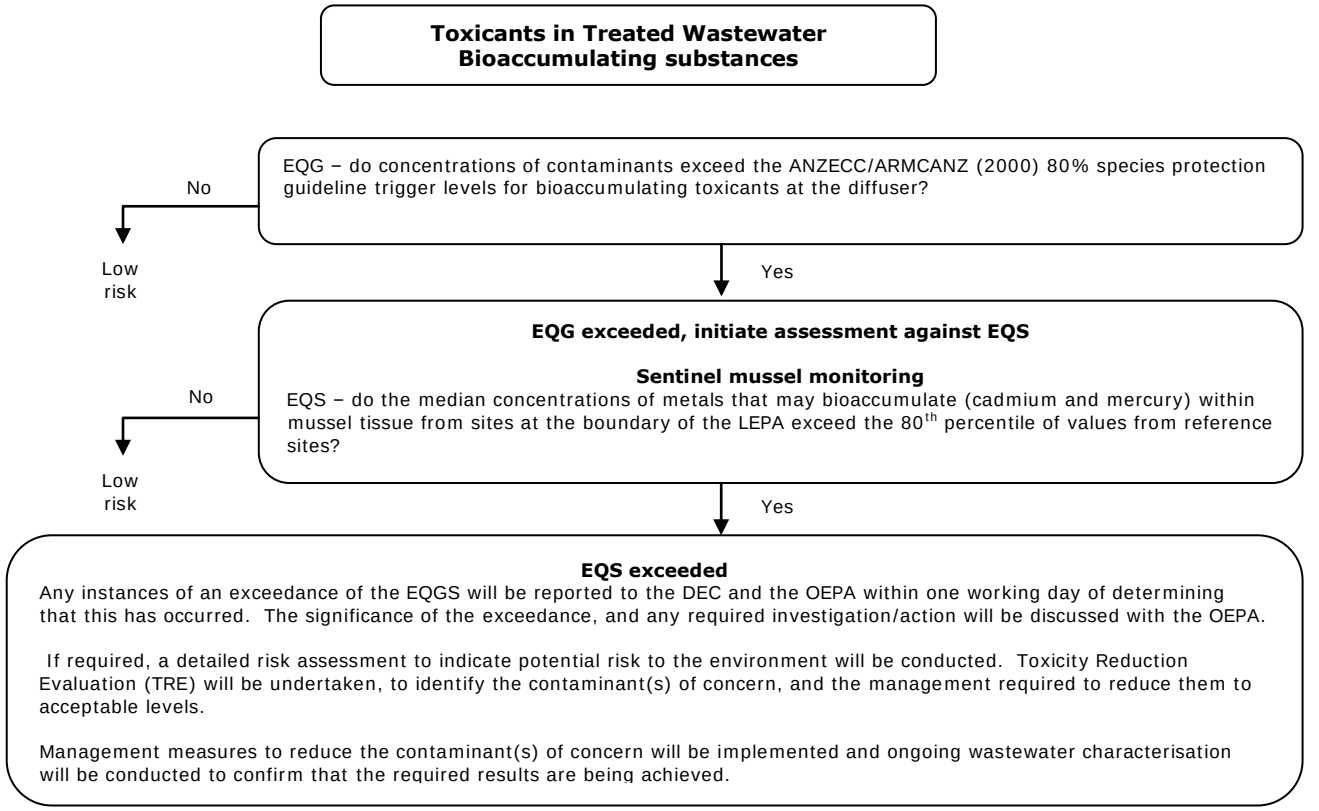
Abbreviations

ANZECC/ARMCANZ 2000 : *Australian and New Zealand Guidelines for Fresh and Marine Water Quality, 2000.*
APHA : American Public Health Association
ASTM : The American Society for Testing and Materials
DoE : Department of Environment
EPA : Environmental Protection Authority

EQC : Environmental Quality Criteria
EQG : Environmental Quality Guidelines
EQO : Environmental Quality Objectives
KWRP : Kwinana Water Reclamation Plant
NATA : National Association of Testing Authorities
SDOO : Sepia Depression Ocean Outlet
SDOOL : Sepia Depression Ocean Outlet Landline
USEPA : United States Environmental Protection Agency

Appendix B

Management Response Framework flow diagrams



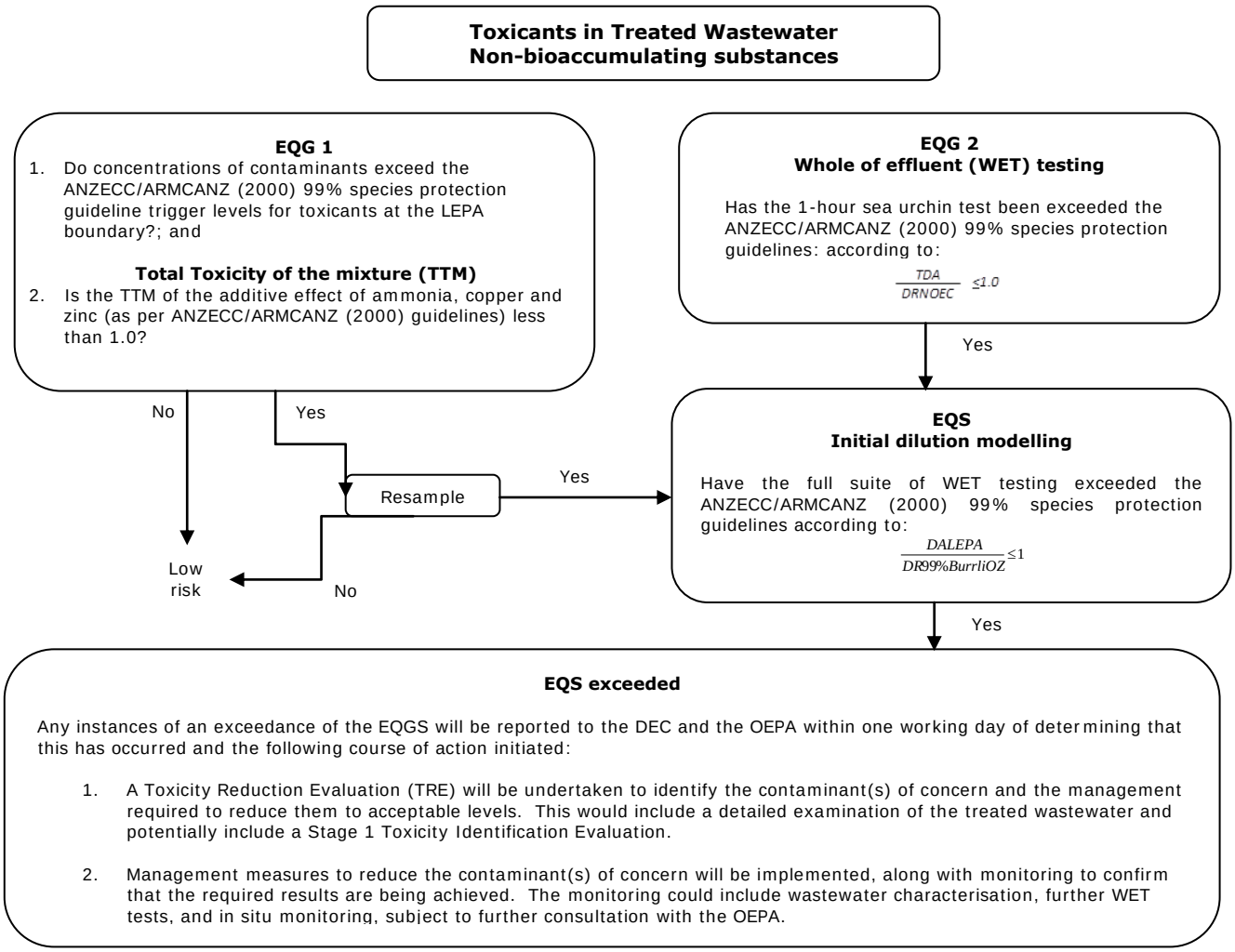
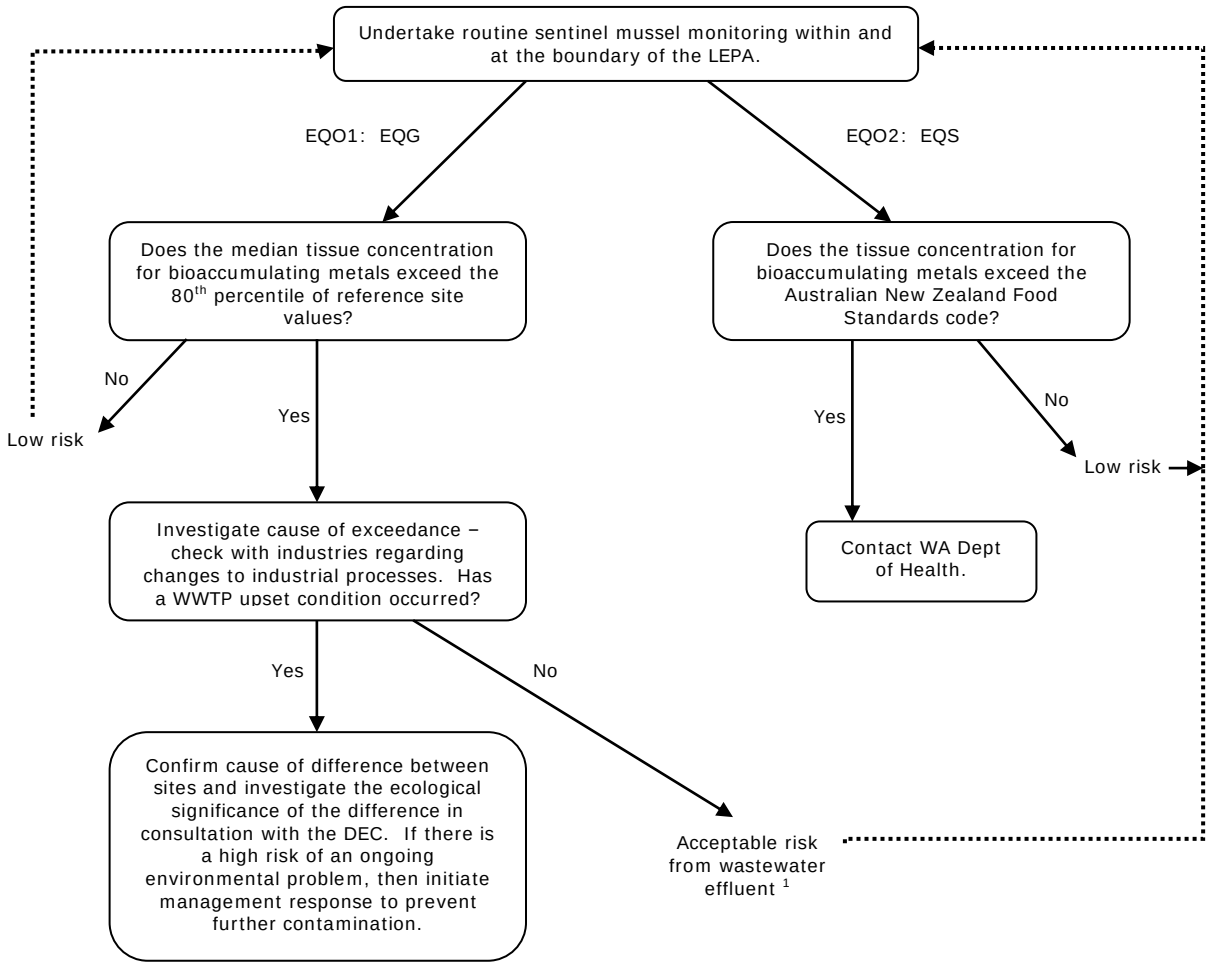


Figure B 1 ANZECC/ARMCANZ (2000) guidelines decision tree for toxicants in treated wastewater



[1] If investigations fail to establish a link between industrial processes associated with the SDOOL and exceedances of bioaccumulating metals in mussel tissues, then it is assumed that results reflect natural variation, or an independent influence, and the risk posed by the wastewater effluent is considered negligible.

Figure B 2 Management response framework in the event of an exceedance of the EQC for bioaccumulating metal concentrations in sentinel mussel tissues

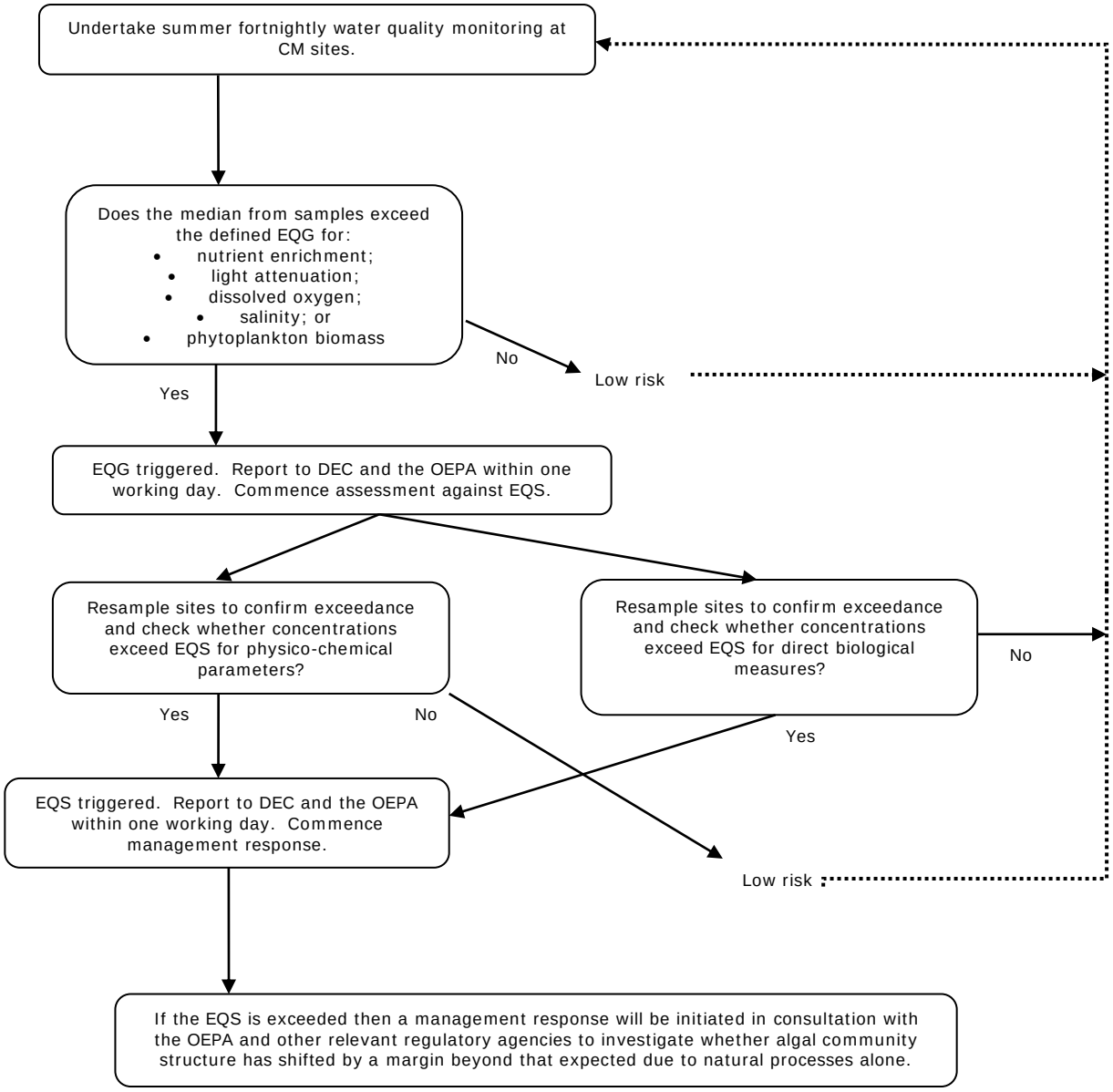


Figure B 3 Management response framework in the event of an exceedance of EQC triggers levels for receiving water quality: physico-chemical parameters and nutrient enrichment)

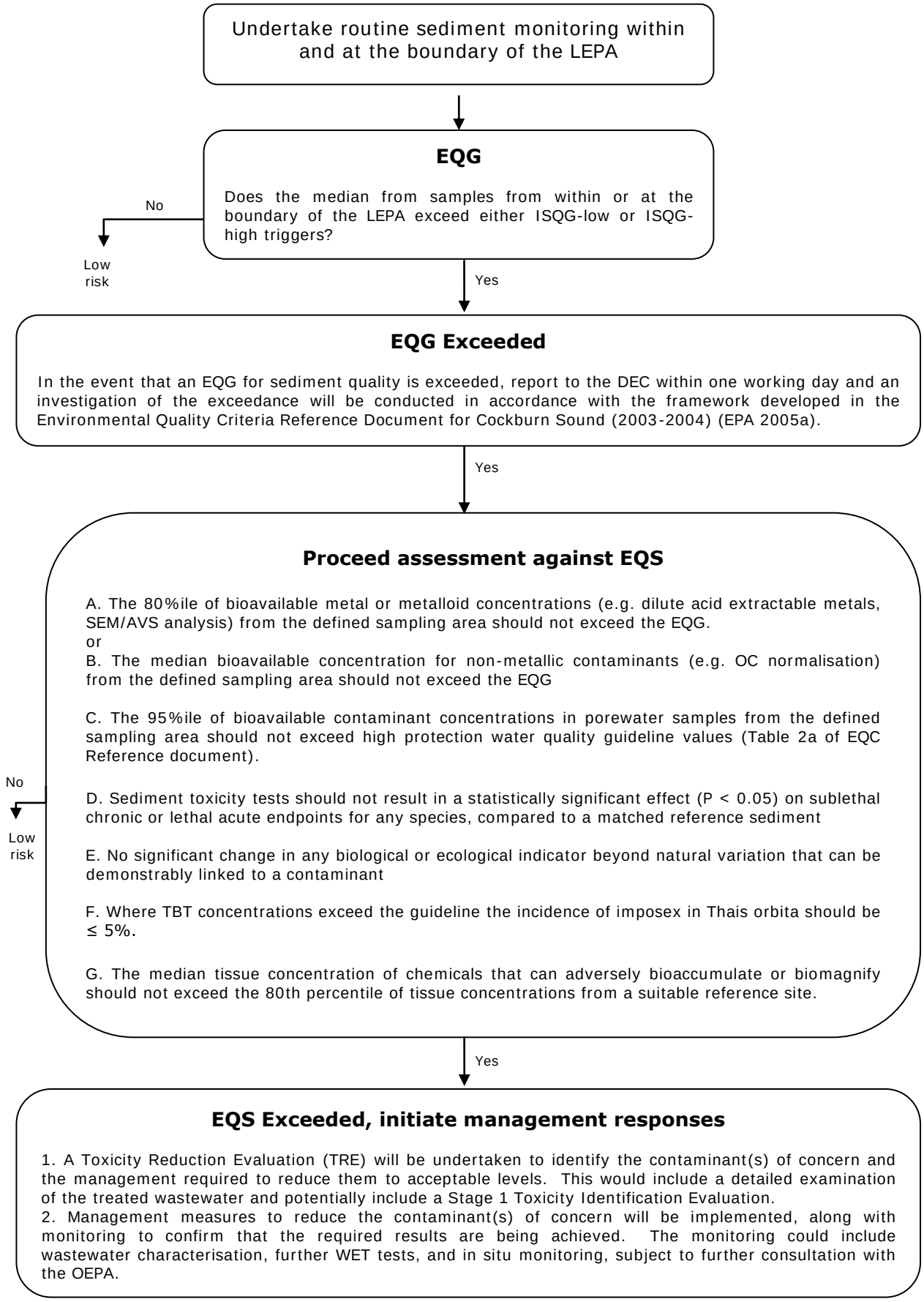


Figure B 4 Management response framework in the event of an exceedance of EQG (ISQG-low) triggers levels for sediment quality

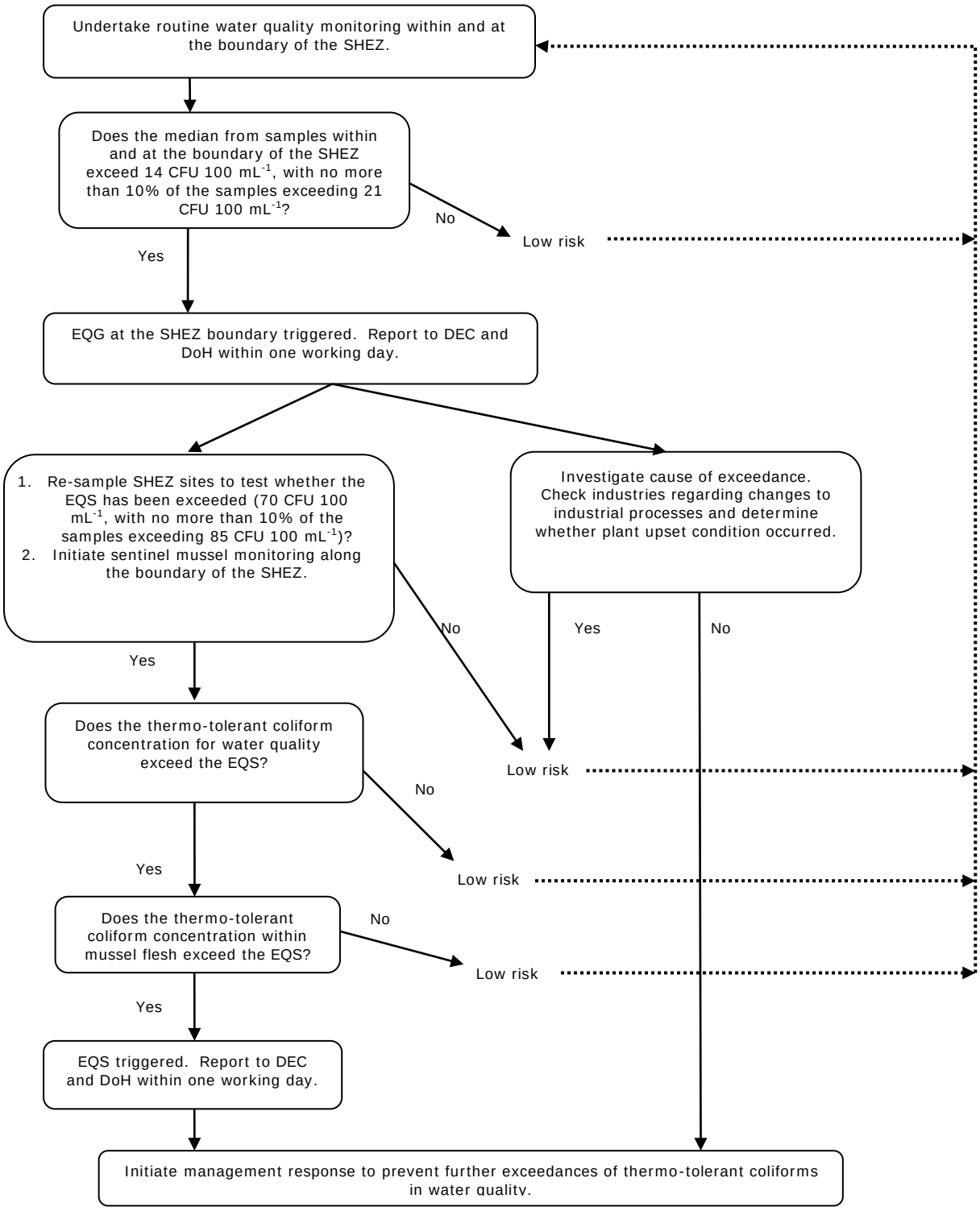


Figure B 5 Management response framework in the event of an exceedance of the EQC for thermo-tolerant coliforms in water and sentinel mussel tissues

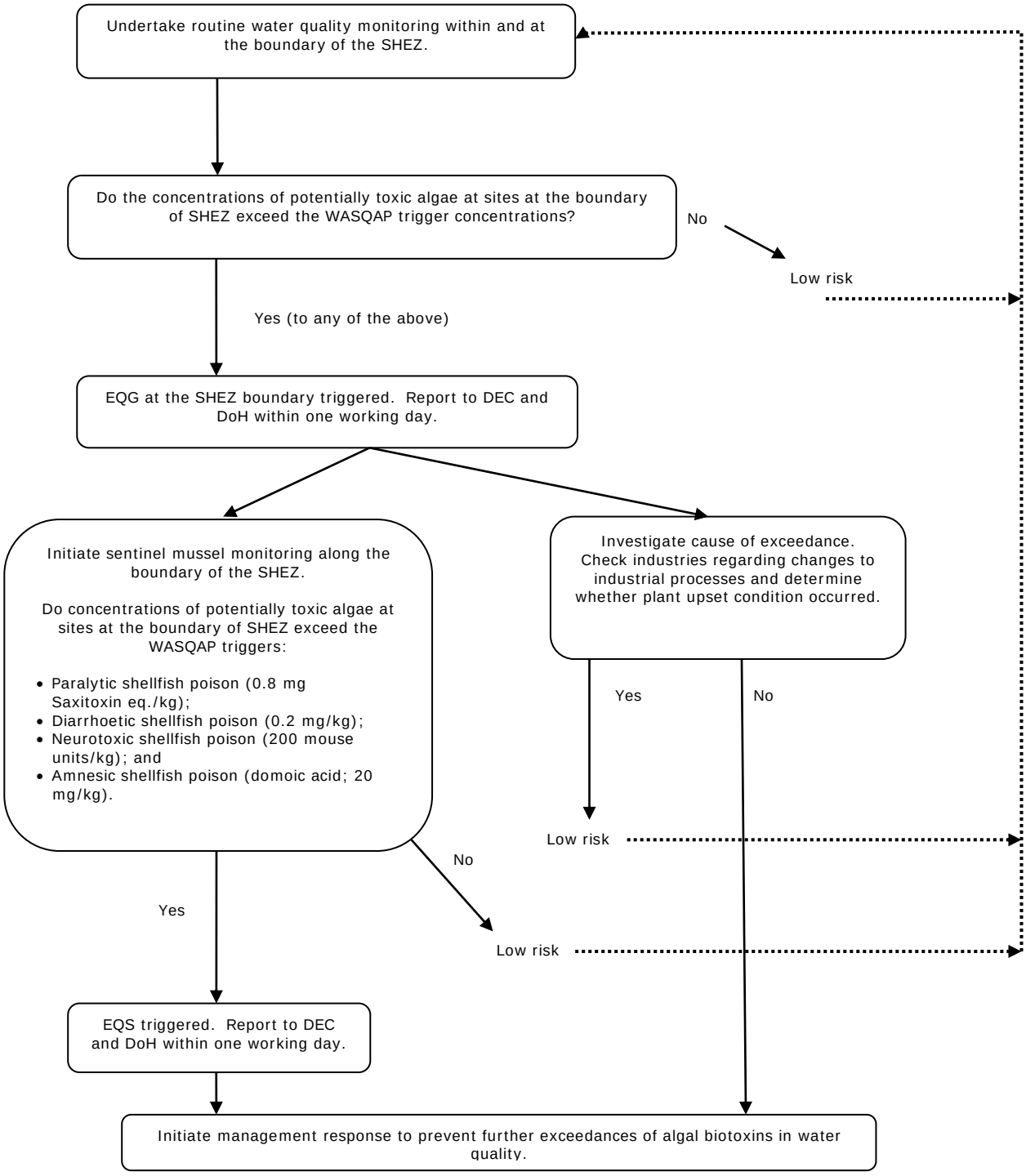


Figure B 6 Management response framework in the event of an exceedance of the EQC for algal biotoxins in water and sentinel mussel tissues

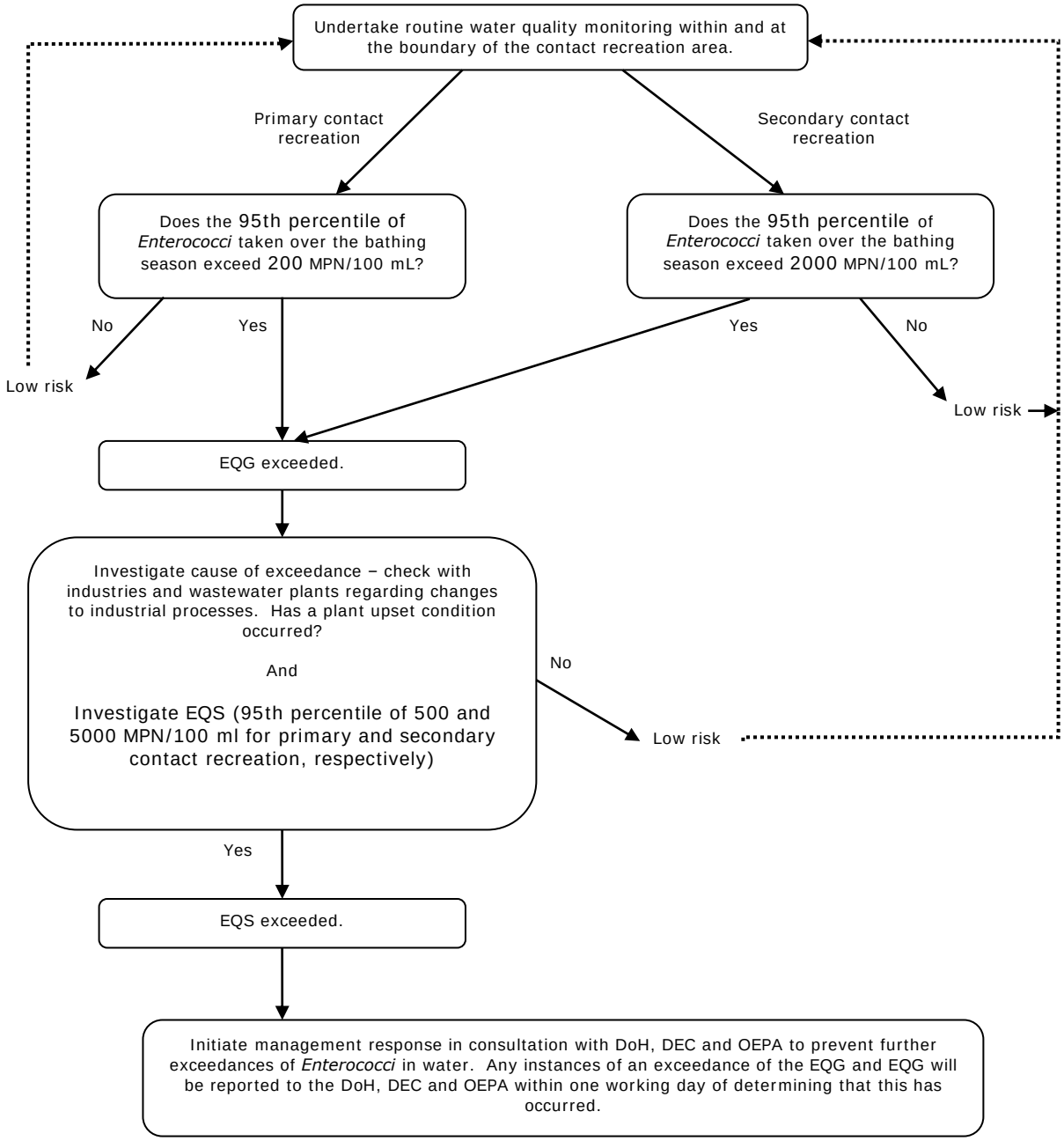


Figure B 7 Management response framework in the event of an exceedance of the EQC for faecal pathogens for the EQOs of Maintenance of Primary and Secondary Contact Recreation

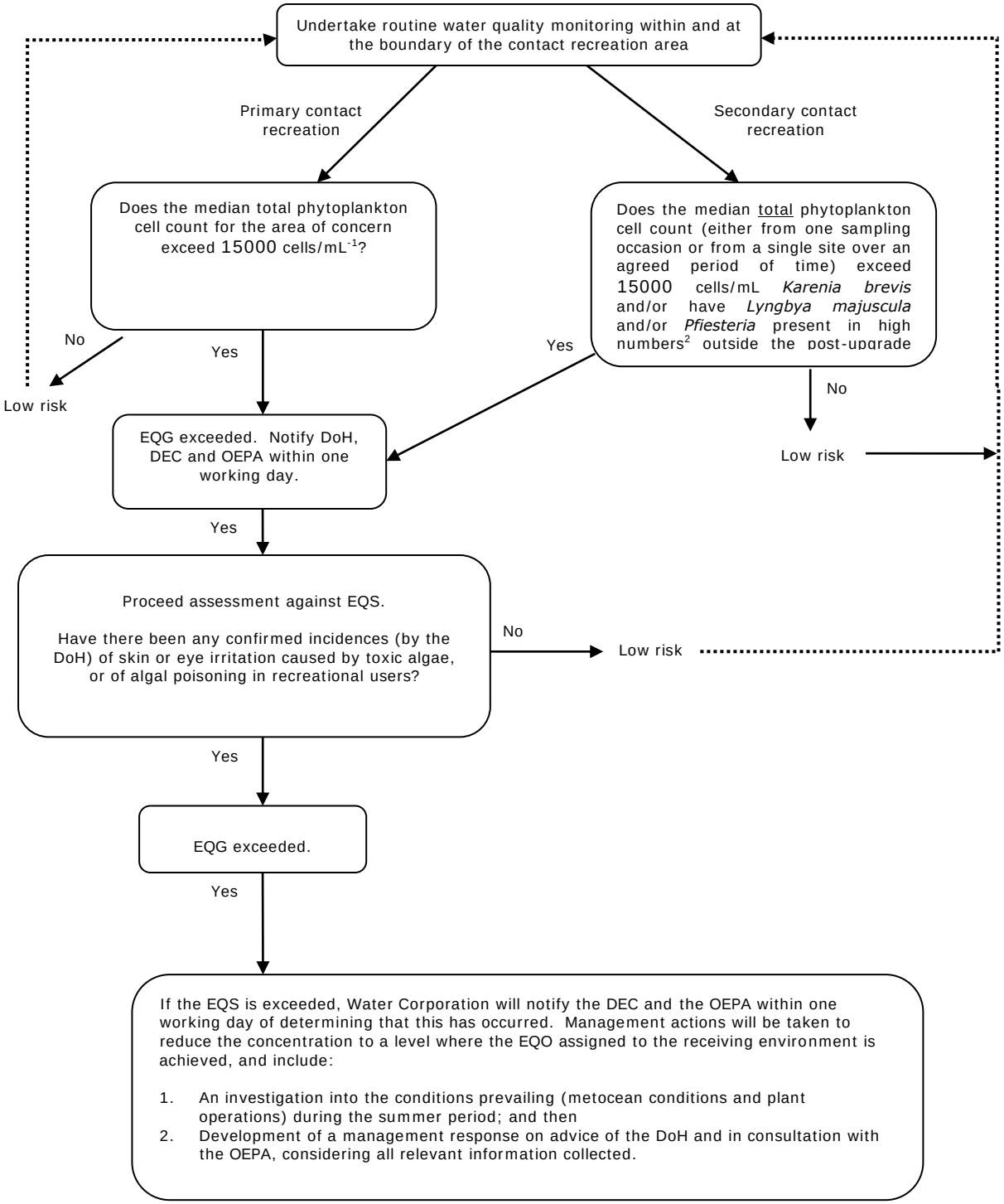


Figure B 8 Management response framework in the event of an exceedance of the EQC for algal biotoxins for the EQOs of Maintenance of Primary and Secondary Contact Recreation

Appendix C

Approach for determining LEPA boundary dilution

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MEMORANDUM

ATTN:	Craig Byers	**CC:**	Mark Bailey and Glenn Shiell
ORGANISATION:	Water Corporation	**FROM:**	Martin Lourey
PROJECT NO:	821	**DATE:**	31/03/2014
SUBJECT:	A modelling approach to determine dilution at the LEPA boundary		

Introduction

Water Corporation discharges a combination of industrial wastewater and domestic treated wastewater to the ocean via the Sepia Depression Ocean Outlet Landline (SDOOL). Water Corporation has a Ministerial commitment (proponent commitment number 1 in Ministerial Statement 665) to "attain an average dilution of the Sepia Depression Ocean Outlet Landline (SDOOL) wastewater stream of at least 1:300 with the dilution being above 1:200 at least 99% of the time within 100 meters of the Sepia Depression Ocean Outlet diffuser". Water Corporation are required to demonstrate compliance with this commitment.

The purpose of this document is to summarise the approach to the dilution calculations undertaken to date, and the issues with this method which led the development of a new approach, involving the development of a validated three dimensional hydrodynamic model.

Desktop calculations undertaken to date

Monitoring data from two separate data sets (six years of sampling conducted fortnightly over a period of four months each year as well as 18 consecutive years of annual summer water quality surveys) was used to generate 146 individual estimates of dilution at or near to the LEPA boundary. This analysis, while adequate to show that average dilution is above 1:300, was inadequate to unambiguously determine that dilution is above 1:200 99% of the time. Poor correlation between waste water (quarterly) and field (8 times over summer) sampling and some internal variability in the wastewater composition create uncertainty and likely accounts for most of the ambiguous results.

Proposed modelling approach

To satisfy the requirements of proponent commitment number 1, Water Corporation will conduct three dimensional modelling to determine dilution at the LEPA boundary. A three dimensional hydrodynamic model will be developed to determine dilution 100 m from the Sepia Depression outlet. To produce a conservative estimate of minimum dilution, only worst case conditions (summer and autumn) will be modelled. Periods where dilution is high (winter) will not be considered. The result will be a highly conservative estimate of 1st percentile dilutions at the LEPA boundary.

Oceanica notes that the OEPA require modelling to be calibrated using met-ocean data and validated against the results of the monitoring. For calibration purposes, an ADCP (or equivalent) deployment will be conducted in around 20 m of water in the Sepia Depression. Three instruments will be deployed for a 60 day period during the low energy autumn period (April–May). The model would be calibrated against the collected current meter data but validated against solute fields from the plume monitoring data collected in situ during the summer field campaigns described above. While the validation sampling is occurring during December–March (rather than the low energy autumn period) the sampling will be conducted to capture in low energy conditions.

Issues to be address by modelling

The modelling will serve two separate purposes:

1. provide evidence that Water Corporation meets proponent commitment number 1 in Ministerial Statement 665
2. provide a conservative estimate of minimum dilution at the LEPA boundary that will be used to correct contaminant concentrations measured during quarterly and annual wastewater characterisation surveys.

The current meter deployment will be conducted in autumn (April–May) to ensure validation and modelling coincide with worst case conditions. Model validation will be ongoing using compliance monitoring data.

Appendix D

WET Testing Sensitivity

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MEMORANDUM

ATTN:	Craig Byers	**CC:**	G Shiell and M Bailey
ORGANISATION:	Water Corporation	**FROM:**	Martin Lourey
PROJECT NO:	821	**DATE:**	31/4/2013
SUBJECT:	Selection of species for WET testing		

The sea urchin sperm/fertilization bioassay provides a rapid assessment of toxicity in aqueous samples. The test is conducted worldwide using a variety of species of urchin. It is most commonly used in North America where it is an important component of effluent discharge licensing based on methods in the USEPA's Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to West Coast Marine and Estuarine Organisms (EPA/600/R-95/136). In Australia, gametes of the sea urchin *Heliocidaris tuberculata* has also become widely used in toxicity assessment programs.

Sea urchin sperm are exposed to the sample, and the ability of the sperm to fertilize the egg is evaluated. The short duration of the test (1-hour) and easily identifiable endpoint make the test ideal for rapid turn around and reporting (McGibbon and Moldan 1986). The test turn-around time is approximately 3 days making it a rapid and useful early warning indicator. The rate of fertilisation in urchins is a sensitive indicator of effluent toxicity that is of comparable (or greater sensitivity) to other marine test species and life stages (McGibbon and Moldan 1986; Dinnel et al., 1989). The test has frequently been validated for use on treated wastewater samples (Woodworth et al., 1999; Dinnel and Stober 1987). Sydney Water, responsible for treatment and disposal of domestic wastewater in Sydney and surrounds conducted an extensive study on WET testing and found the sea urchin fertilisation test to be the most sensitive to wastewater. The test has therefore been incorporated into their routine monitoring procedure at a number of plants (Woodworth et al. 1999).

The sea urchin fertilisation test is particularly sensitive to metal contamination (Dinnel et al. 1989) a major source of potential toxicity in Western Australian treated wastewater. Comparisons of sensitivity to surfactants between ecotoxicity tests not been conducted, presumably due to the large number of different surfactant compounds available. Urchin ecotoxicity tests in general appear to be sensitive to surfactants (Bellas et al. 2005) and a comparative investigation of the sensitivity of various urchin stages to a range of chemicals suggests sperm viability/fertilisation is more sensitive to contaminants (including ABS surfactants) than later stages (Kobayashi 1980). The general sensitivity of urchins to surfactants and particular sensitivity of fertilisation to contaminants generally give some confidence that the 1-hour test is likely to be of equal or greater sensitivity to other tests.
In WA, comprehensive WET testing assessments have been made at Beenyup (March 2004), Subiaco (March 2004), Alkimos (May 2011) and the SDOOL (March 2004, November2004, August 2006, September 2009 and March 2010). The most sensitive test varied depending on when the test was conducted and the TWW analysed. Although not all tests were conducted at each time the, the 1 hour urchin fertilisation test was the most (or equal most) sensitive test on the most occasions (5/8) (Table 1). The results of the 1-hour urchin test were also most consistent through time (SDOOL NOECS all 10 or 12.5%) (Table 1). Because of this general sensitivity, constancy, rapid delivery of results and wider use with TWW the 1-hour urchin test is considered an appropriate early warning indicator of toxicity for Perth wastewaters.

References

Bellas J, Beiras R, Marino-Balsa JC, Fernandez N (2005) Toxicity of organic compounds to marine invertebrate embryos and larvae: a comparison between the sea urchin embryogenesis bioassay and alternative test species. Ecotoxicology 14:337−353

Dinnel PA, Link JM, Stober QJ, Letourneau MW, Roberts WE (1989) Comparative sensitivity of sea urchin sperm bioassays to metals and pesticides. Archives of Environmental Contamination and Toxicology 18:748−755

Dinnel PA, Stober QJ (1987) Application of the sea urchin sperm bioassay to sewage treatment efficiency and toxicity in marine waters. Marine Environmental Research 21:121−133

Kobayashi N (1980) Comparative sensitivity of various developmental stages of sea urchins to some chemicals. Marine Biology 58:163−171

McGibbon S, Moldan AGS (1986) Routine toxicity testing of toxicants using a sea urchin gamete bioassay. Marine Pollution Bulletin 17: 68−72

Woodworth JG, King C, Miskiewicz AG, Laginestra E, Simon J (1999) Assessment of the Comparative Toxicity of Sewage Effluent from 10 Sewage Treatment Plants in the Area of Sydney, Australia using an Amphipod and Two Sea Urchin Bioassays. Marine Pollution Bulletin 39:1−12, January, Pages 174-178

Table 1 Results of the historical full suite WET testing

TWW	Date	Microtox[1]	Algae[2]	Macro-algae[3]	Copepod[4]	Amphipod[5]	Fish ()[6]	Fish (imbal)[7]	Urchin (fert.)[8]	Urchin (devel.)[9]	Scallop[10]	Mussel[11]
Beenyup TWW	March 2004		11			100			100	30	30	
Sunbiaco TWW	March 2004		25						10		10	
SDOLL prior to KWRP	March 2004		33			100			10	10	10	
SDOOL KWRP	March 2004		33			30			10	10	3	
SDOOL	Nov 2004	<5.6	<2.5		2.5		3.125		12.5		6.25	
SDOOL	August2006		25	<2.6			2.7		12.5		25	5.2
SDOOL	September 2009		50	50			25		12.5	50	25	12.5
SDOOL	March 2010[12]		12.5	12.5			6.3		12.5		25	12.5
Alkimos	May 2011		100	100				100	25		50	50

Notes:
1. 15 min microtox (*Vibrio fischeri*) test
2. 72 hr *Nitzschia* sp. Algal growth test
3. 72 hr macroalgae (*Ecklonia radiata*) germination test
4. 10 day copepod (*Gladioferens imparipes*) reproduction test
5. 96 hr juvenile amphipod (*Allorchestes compressa*) acute toxicity test
6. 7 day larval fish (*Pagrus auratus*) growth test
7. 48 Hr larval fish (*Argyrosomus japonicus*) imbalance test
8. 1 hr sea urchin (*Heliocidaris tuberculata*) fertilisation test
9. 72 hr sea urchin (*Heliocidaris tuberculata*) larval development test
10. 48 hr doughboy scallop (*Mimachlamys asperrima*) larval development test
11. 48 hr mussel (*Mytilus galloprovincialis*) larval development test
12. Sample collected during balancing dam flushing

Appendix E

Contaminants in Treated Wastewater

Appendix E Composition of secondary TWW relevant to recreational guidelines

Parameter	Recreational guideline	Maximum value in secondary TWW	After 1:200 dilutions
Antimony	60	0.81	
Arsenic	140	Below LoR	
Barium	14 000	140	
Boron	6 000	400	
Bromate	400	Not detected	
Cadmium	40	Below LoR	
Chlorine (total residual)	100 000	300 (Wood Pt mean)	
Chlorine dioxide	20 000	-	
Chlorite	6 000	390	
Chromium	1 000	4	
Copper	40 000	20	
Cyanide	1 600	Not detected	
Fluoride	30 000	880 (Wood Pt mean)	
Iodide	2000	**10 000**	50
Lead	200	2.5	
Manganese	10 000	40	
Mercury	20	Below LoR	
Molybdenum	1 000	5	
Monochloramine	60 000	290 (Wood Pt (mean)	
Nickel	400	6	
Nitrate (as nitrate)	1000 000	4 400(Wood Pt mean)	
Nitrite (as nitrite)	60 000	200 (Wood Pt mean)	
Selenium	200	Below LoR	
Silver	2 000	Below LoR	
Sulfate	10 000 000	63 000	
Organic Chemicals			
Acrylamide	4	-	
Benzene	20	0.11	
Benzo(*a*)pyrene	0.2	0.024	
Carbon tetrachloride	60	Not detected	
Chloroacetic acid	3 000	15	
Chlorobenzene	6 000	Not detected	
1,2-Dichlorobenzene	30 000	3	
1,4-Dichlorobenzene	800	0.12	
Cyanogen chloride (as cyanide)	1 600	-	
Dichloroacetic acid	2 000	2	
Trichloroacetic acid	2 000	3	
1,1-Dichloroethene	600	0.21	
1,2-Dichloroethene	1 200	Not detected	
1,2-Dichloroethane	60	0.06	
Dichloromethane	80	16	
Epichlorohydrin	10	-	

Parameter	Recreational guideline	Maximum value in secondary TWW	After 1:200 dilutions
Ethylbenzene	6 000	Not detected	
Ethylenediamine tetraacetic acid (EDTA)	5 000	185	
Formaldehyde	10 000	-	
Hexachlorobutadiene	14	Not detected	
Nitrilotriacetic acid	4 000	4	
Tetrachloroethene	1 000	32	
Trichloroacetaldehyde (chloral hydrate)	400	0.12	
Trihalomethanes (THMs) (total)	5 000	-	
2-Chlorophenol	6 000	Not detected	
2,4-Dichlorophenol	4 000	0.2	
2,4,6-Trichlorophenol	400	0.12	
Tributyltin oxide	20	-	
Di(2-ethylhexyl) phthalate	200	-	
Styrene (vinylbenzene)	600	0.33	
Toluene	16 000	0.24	
Trichlorobenzenes (total)	600	Not detected	
Vinyl chloride	6	Not detected	
Xylene	12 000	0.06	
Pesticides			
Acephate	200	Not detected	
Aldicarb	20	Not detected	
Aldrin (and Dieldrin)	6	Not detected	
Ametryn	1 000	Not detected	
Amitrole	200	Not detected	
Atrazine	400	144	
Azinphos-methyl	60	Not detected	
Benomyl	2 000	-	
Bentazone	600	Not detected	
Bioresmethrin	2 000	Not detected	
Bromazil	6 000	Not detected	
Bromophos-ethyl	200	Not detected	
Bromoxynil	600	-	
Carbaryl	600	Not detected	
Carbendazim	2 000	Not detected	
Carbofuran	200	Not detected	
Carbophenothion	10	Not detected	
Carboxin	6 000	Not detected	
Chlordane	20	Not detected	
Chlorphenvinphos	100	-	
Chlorothalonil	600	Not detected	
Chloroxuron	200	-	

Parameter	Recreational guideline	Maximum value in secondary TWW	After 1:200 dilutions
Chlorfenvinphos	200	Not detected	
Chlorsulfuron	2 000	Not detected	
Clopyralid	20 000	Not detected	
2,4-D	600	**5400**	27
DDT	400	Not detected	
Diazinon	60	Not detected	
Dicamba	2 000	Not detected	
Dichlobenil	200	Not detected	
Dichlorvos	20	Not detected	
Diclofop-methyl	100	Not detected	
Dicofol	60	Not detected	
Dieldrin (see Aldrin)	6	Not detected	
Difenzoquat	2 000	-	
Dimethoate	1 000	Not detected	
Diphenamid	6 000	Not detected	
Diquat	100	-	
Disulfoton	60	Not detected	
Diuron	600	Not detected	
DPA (2, 2-DPA)	10 000	-	
EDB	20	Not detected	
Endosulfan	600	Not detected	
Endothal	2 000	Not detected	
EPTC	600	Not detected	
Ethion	60	Not detected	
Ethoprophos	20	Not detected	
Etridiazole	2 000	-	
Fenamiphos	6	Not detected	
Fenarimol	600	Not detected	
Fenchlorphos	600	Not detected	
Fenitrothion	200	Not detected	
Fenoprop	200	Not detected	
Fensulphothion	200	Not detected	
Fenvalerate	1 000	Not detected	
Flamprop-methyl	60	Not detected	
Fluometuron	1 000	Not detected	
Formothion	1 000	Not detected	
Fosamine	600	-	
Glyphosate	20 000	-	
Heptachlor (including its epoxide)	6	Not detected	
Hexaflurate	600	-	
Hexazinone	6000	Not detected	
Lindane	400	Not detected	
Maldison	1 000	Not detected	
Methidathion	600	Not detected	
Methiocarb	100	Not detected	
Methomyl	600	Not detected	

Parameter	Recreational guideline	Maximum value in secondary TWW	After 1:200 dilutions
Methoxychlor	6 000	Not detected	
Metolachlor	6 000	1500	
Metribuzin	1000	Not detected	
Metsulfuron-methyl	600	Not detected	
Mevinphos	100	Not detected	
Molinate	100	Not detected	
Monocrotophos	20	-	
Napropamide	20 000	Not detected	
Nitralin	10 000	-	
Norflurazon	1 000	Not detected	
Oryzalin	6 000	Not detected	
Oxamyl	2 000	-	
Paraquat	600	-	
Parathion	200	Not detected	
Parathion-methyl	2 000	Not detected	
Pebulate	600	Not detected	
Pendimethalin	6 000	Not detected	
Pentachlorophenol	200	Not detected	
Permethrin	2 000	Not detected	
Picloram	6 000	Not detected	
Piperonyl butoxide	2 000	0.62	
Pirimicarb	100	Not detected	
Pirimiphos-ethyl	10	Not detected	
Pirimiphos-methyl	1 000	Not detected	
Profenofos	6	Not detected	
Promecarb	600	Not detected	
Propachlor	1 000	Not detected	
Propanil	10 000	Not detected	
Propargite	1 000	Not detected	
Propazine	1 000	Not detected	
Propiconazole	2 000	440	
Propyzamide	6 000	Not detected	
Pyrazophos	600	Not detected	
Quintozene	600	Not detected	
Simazine	400	144	
Sulprofos	200	Not detected	
2,4,5-T	2 000	Not detected	
Temephos	6 000	Not detected	
Terbacil	600	Not detected	
Terbufos	10	Not detected	
Terbutryn	6 000	Not detected	
Tetrachlorvinphos	2 000	Not detected	
Thiobencarb	600	-	
Thiometon	60	Not detected	
Thiophanate	100	Not detected	
Thiram	60	-	
Triadimefon	40	Not detected	

Parameter	Recreational guideline	Maximum value in secondary TWW	After 1:200 dilutions
Trichlorofon	100	Not detected	
Triclopyr	200	5	
Trifluralin	1 000	**1 200**	6
Vernolate	600	Not detected	

Appendix F

Comprehensive Annual Summer Water Quality Survey

Comprehensive annual summer water quality survey

The operation of each of the WWTPs in Perth's metropolitan region and the discharge of treated wastewater to the marine environment is conducted under licence conditions set by the DEC (Appendix A). The licence conditions include a requirement to undertake annual summer surveys of ocean water to examine the effects of discharged treated wastewater on the marine environment and will include the water quality parameters listed in Table C 1.

Table C 1 Parameters to be sampled during comprehensive annual summer water quality surveys

Nutrients	Primary Productivity	Microbiological indicators
Total phosphorus Ortho-phosphate Total nitrogen Ammonium nitrogen Nitrate + nitrite nitrogen	Chlorophyll-a Phaeophytin	*E. coli* *Enterococci*

Objectives

With respect to the SDOOL, the purpose of the comprehensive annual summer water quality surveys is to:

- provide appropriate data on water quality in the vicinity of the SDOOL ocean outlet to ensure compliance with the licence conditions
- assess the performance of the SDOOL ocean outlet by determining the dilution and dispersion characteristics of the treated wastewater
- examine the extent of influence of the wastewater plume
- allow for the ongoing assessment of the environmental impact of the wastewater discharge in relation to the marine water quality and beneficial uses of the area
- provide for ongoing assessment of the level of public health risk associated with ocean disposal of treated wastewater.

Timing

Offshore water samples will be collected annually at the commencement of summer, from surface and bottom waters at 35 offshore sites located within a rectangular sampling grid (Figure F 1). The monitoring requirements for each parameter are described below.

Sampling regime

Wind, wave & tide conditions

Information on the prevailing wind conditions (wind speed and direction) at Sepia Depression immediately prior to and over the duration of each summer water quality survey will be provided by the Bureau of Meteorology.

Information on the significant wave height and wave period will be provided by the Department of Transport (DoT) from a wave rider buoy located south-west of Rottnest Island in a water depth of 48 m. Attenuation of the wave energy, due to refraction and diffraction processes around the offshore reefs, will cause the wave height near the outlet to be considerably lower than that observed offshore of Rottnest Island. Water surface elevations will provided by the DoT from a gauge in Fremantle Fishing Boat Harbour.

This information will be used to characterise the prevailing wind, wave and tide conditions at Sepia Depression immediately prior to the summer water quality surveys. The prevailing flow conditions will determine which sampling grid will be used for each summer water quality survey (eg. Figure F 1; DAL 2001).

Surface drogue movement

At the commencement of the summer water quality survey at each outlet, a surface drogue will be released over the centre of the operational outlet diffuser. The location of the drogue will be recorded at intervals throughout the summer water quality survey using an on-board global positioning system (GPS). Surface drogue tracking will provide an estimate of mean surface currents and this information will be used in the initial dilution modelling (Section 5.3.7).

Water quality sampling

Offshore water samples will be collected from 35 sites located within a rectangular sampling grid appropriate for the prevailing flow conditions at the SDOOL ocean outlet on the day of the survey (Figure F 1; DAL 2001). In addition, nine shoreline sites located along the coast adjacent to each of the ocean outlets will be sampled.

At each offshore site, water samples will be collected from the surface (1 m depth) and the bottom (approximately 2 m above the seafloor) of the water column. Samples will be collected using two electric bilge pumps (one for the surface and one for the bottom samples). Samples are to be obtained in sequence against the prevailing current flow (e.g. during a northerly current flow, samples will be obtained from north to south), to minimise the likelihood of re-sampling the same water mass. Shoreline samples are to be obtained by filling the sample containers directly in waist-deep water.

Nutrient and primary production analyses are to be undertaken by a NATA-accredited laboratory, using the analytical methods detailed in Table C 2.

Table C 2 Analytical methods and reporting limits for each of the water quality parameters to be measured during the comprehensive annual summer water quality surveys

Parameter	Analytical method[1]	Reporting limit	Unit
Nutrients			
Total Phosphorus	Lachat-Automated Flow Injection Analyser (4700)	5[2]	µg P L^{-1}
Ortho-phosphate	Lachat-Automated Flow Injection Analyser (4100)	2[2]	µg P L^{-1}
Total Nitrogen	Lachat-Automated Flow Injection Analyser (2700)	50[2]	µg N L^{-1}
Ammonium	Lachat-Automated Flow Injection Analyser (2000)	3[2]	µg N L^{-1}
Nitrate + Nitrite	Lachat-Automated Flow Injection Analyser (2100)	2[2]	µg N L^{-1}
Primary production			
Chlorophyll a	Fluorometric	0.01[3]	µg L^{-1}
Chlorophyll a	Acetone extraction (3000)	0.1[2]	µg L^{-1}
Phaeophytin	Acetone extraction (3000)	0.1[2]	µg L^{-1}
Microbiological indicators			
Thermo-tolerant coliforms	Membrane filtration	Dilution dependent[4]	CFU/100 mL
Faecal streptococci (as *Enterococci*)	Membrane filtration	Dilution dependent[4]	MPN/100 mL

Notes:
1. Numbers in brackets refers to analysis method number at the Marine and Freshwater Research Laboratory.
2. Method reporting limit determine from 3.2 x standard deviation of ten standard samples.
3. Instrument reporting limit.
4. The upper and lower assay limits for thermo-tolerant coliforms and faecal streptococci are dependent on the dilution of the original sample.

Replicate samples

During each survey, three replicate samples will be obtained from a single offshore site in the sampling grid. The samples will be analysed to identify variability in the measured water quality parameters that may be introduced by small-scale spatial variability.

Water column structure

A multi-parameter water quality sensor will be lowered through the water column at 7 or 8 of the offshore sites in the sampling grid to provide information on the physical structure of the water column, i.e. vertical profiles of temperature, salinity and density. The sites will be located along a north-south transect through the middle of the sampling grid, with additional sites measured around the diffuser.

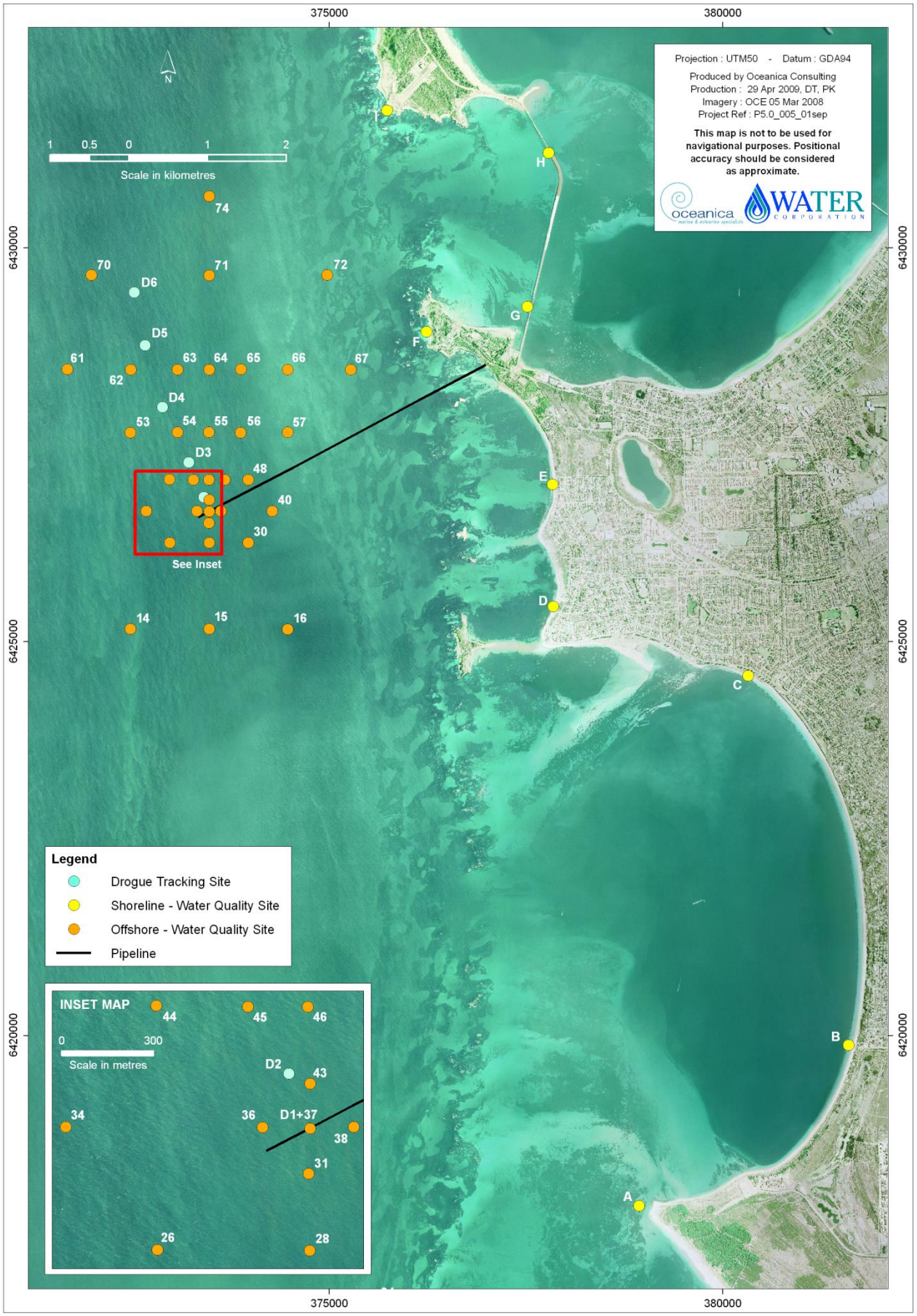

Figure F 1 **Sampling grid for comprehensive annual summer water quality surveys**

Appendix G

Summary of public consultation process

Table 7-1 Kwinana Water Reclamation Plant – Summary of Community Consultation since December 2000

Audience (groups consulted)	Channels	When	Comments / Issues
Kwinana Industries	• Face-to-face • Meetings • Presentations • Information sheets	Ongoing *(Dec 2000 to present)*	Comprehensive communication throughout with KWRP industry partners.
Kwinana Industry Council members and staff	• Meeting progress reports • Fact Sheet	Ongoing *(Dec 2000 to present)*	Broad communication with other industries through KIC executive and monthly Community Relations Advisory Committee meetings.
Community Groups			
3.1 Communities and Industries Forum	• Public meeting • Meeting minutes	December 2000	Positive reaction to the proposal. Questions raised concerning salt content on reverse osmosis process and why the water has to be disposed into the Sepia Depression after use. ie. Why can't the water be continually recycled.
3.2 Rockingham IP14 Community Consultative Network	• Presentation • Personal briefings to members	December 2000	
3.3 Woodman Point (WA21) Community Reference Group	• Presentation	December 2000	
3.4 Cockburn Sound Conservation Committee	• Presentation	December 2000	
Overall Community	• Media releases • Advertising • Market research	December 2000 January 2002 May 2002 September 2002 December 2002	Announcing proposal KIC declares support for the proposal Announcement that the project would soon commence Notice of proposal to construct the plant. Questions on KWRP were incorporated in the KIC's 2000 Community Attitudes

Audience (groups consulted)	Channels	When	Comments / Issues
			survey, conducted immediately after the announcement of the project. Awareness was good and the results indicated overwhelming support for the project.
Government agencies	• Direct mail • Presentations	September 2002	Notice of proposal to construct the plant.
5.1 Cockburn Sound Management Council		December 2000	
5.2 Dept of Environment			
5.3 Environmental Protection Authority			
5.4 Water and Rivers Commission			
Members of Parliament	• Direct mail / e-mail • Stakeholder Mgt meetings	Ongoing	

Note: Consultation also occurred prior to December 2000, before staff changes within the Water Corporation.

Appendix H

Terms of Reference of the public consultation Stakeholder Liaison Group

SDOOL Stakeholder Liaison Group
Terms of Reference

Use of Sepia Depression Ocean Outlet Landline to Discharge Treated Wastewater and Industrial Effluents to Sepia Depression

Context

The Water Corporation is committed and bound by a Ministerial Condition (Statement No. 665), to ensure that the public has open access to information regarding the environmental performance of the Sepia Depression Ocean Outlet Landline (SDOOL) and has an avenue to address any significant issues arising.

The formation of a Stakeholder Liaison Group (SLG) is a vital part of this process.

Purpose

The SLG will assist the Water Corporation in managing concerns regarding the discharging of treated wastewater and industrial effluents to the Sepia Depression, its environmental performance and the processes for identifying and reviewing possible future industry participant access to SDOOL.

Specifically the SLG will;

- Formulate the frequency and means of providing information to the broader community on the operation and performance of SDOOL,
- Review annual reports and data on the SDOOL environmental performance and monitoring programs and provide feedback to the Water Corporation and regulators,
- Provide a forum to review and comment on the results of the Perth Long Term Ocean Outlet Monitoring (PLOOM) program with particular reference to the Sepia Depression,
- Review the complaints/response record of actions taken to address matters arising from the discharge of industrial effluent to Sepia Depression; and
- Provide feedback on possible future Kwinana industry participation prior to any referral under Section 38 of the Environmental Protection Act 1986.

Working Principles

- The SLG will meet at least six monthly unless otherwise agreed. Meetings will generally be outside normal working hours. Ad hoc meetings will be convened based on demand to review and resolve public complaints and provide a review process to address matters arising from the project from time to time.

- The SLG will consist of up to 15 members (independent chair and representatives from the Kwinana User Group, Water Corporation, Department of Environment and Conservation, City of Rockingham, Town of Kwinana, City of Cockburn, Kwinana Industries Council, environmental groups and members of the community).

- Membership of the SLG will nominally be for a period of two years. This term will be flexible where ongoing projects will benefit from continuity of involvement. Terms can be extended with agreement from the SLG.

- Meetings will be chaired by an independent chairperson appointed by the SLG. A member from the Water Corporation will act as the Executive Officer for SLG meetings, taking minutes, distributing agendas, providing information and arranging venues. Minutes will be circulated for electronic endorsement by participants as soon as practicable following the meeting and will be posted on the website following endorsement.

- SLG members will be provided with balanced and objective information to communicate to the organisations they are representing. SLG members are expected to also provide balanced and objective information as required for the SLG.

- SLG members will keep their respective organisations up to date with SDOOL issues via the receipt and distribution of information from the Water Corporation and / or the SLG.

- SLG members will be promptly notified, by email in the first instance, of any unusual occurrence with respect to the performance of the SDOOL.

- In the event that the SLG cannot achieve consensus, the full range of views will be reported.

- Clear and transparent records are to be kept at the SLG meetings which describe in detail how the resolutions have been made.

- Specialist expertise will be seconded into the group as required. Matters can be referred to specialist areas for additional advice as necessary.

- SLG meetings are open to the public for attendance as observers. Members of the public attending meetings in this capacity may raise issues through members of the SLG.

- Agenda items to be circulated to SLG members at least 7 working days prior to the meeting.

- SLG members to fully disclose to the group any potential conflicts of interest.

- Comments made by any group member on behalf of the SLG may only be made after a formal resolution by the group has been made. Comments representing separate interests must be stated as to that fact.

- A quorum of at least 3 members in addition to Water Corporation members and Chairman, must be present for a resolution to be passed by the group.

- Proxies may be used to attend meetings in member’s absence.

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