Harvey Water

Harvey Water - EPA Referral
Discharge Monitoring and Management Plan

March 2022

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Acronyms

Abbreviation	Definition
ANZECC	Australian and New Zealand Environment and Conservation Council
ANZG	Australian and New Zealand Governments
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
As	Arsenic
Cd	Cadmium
COC	Chain of Custody
Cr	Chromium
CTD	Conductivity Temperature Depth profiler
Cu	Copper
DMMP	Discharge Monitoring and Management Plan
DWER	Department of Water and Environmental Regulation
EPA	Environmental Protection Authority
EQC	Environmental Quality Criteria
EQG	Environmental Quality Guideline
EQMF	Environmental Quality Management Framework
EQO	Environmental Quality Objective
EQS	Environmental Quality Standard
EV	Environmental Value
HEPA	High Ecological Protection Area
Hg	Mercury
ISQG	Interim Sediment Quality Guideline
km	kilometres
KSIA	Kemerton Strategic Industrial Area
L	Liter
LEP	Level of Ecological Protection
LEPA	Low Ecological Protection Area
LoR	Limit of Reporting
m	Meter
mg	Milligrams
MEPA	Moderate Ecological Protection Area
NATA	National Association of Testing Authorities
NH_4^+	Ammonium
Ni	Nickel
NO_X	Inorganic Oxidised Nitrogen
NTU	Nephlometric Units
Pb	Lead
PO_4^{3-}	Phosphate
PSU	Practical Salinity Units
QA/QC	Quality Assurance/ Quality Control
RPD	Relative Percentage Difference
RO	Reverse Osmosis
SDS	Safety Data Sheet
sec	Second
SSDP	Southern Seawater Desalination Plant
TBA	To Be Advised
TDS	Total Dissolved Solids

Abbreviation	Definition
TN	Total Nitrogen
TP	Total Phosphorus
UM3	Update Merge 3
WA	Western Australia
WET	Whole Effluent Testing
$DS_{HEPA-LEPA}$	Salinity difference at HEPA-LEPA boundary site relative to the reference site
µg	Micrograms

1. Introduction

1.1 The Harvey Water KSIA Project

Harvey Water supplies non-potable water to rural areas in the south-west region primarily for agricultural industry use. Water is drawn under license from Waroona, Drakesbrook, Logue Brook, Harvey and Wellington Dams, and the Wokalp pipe head. Water is piped under gravity pressure through 495 kilometres (km) of closed pipelines and 256 km of open channels to its customers (Harvey Water 2020).

As part of expansion, Harvey Water is constructing enabling infrastructure at the Kemerton Strategic Industrial Area (KSIA), Western Australia (WA) to provide wastewater disposal services to customers established in the KSIA. This enabling infrastructure consists of a pipeline, approximately 12 km in length, which will transfer the wastewater from the KSIA to the Indian Ocean. The proposed pipeline route and ocean outfall are shown in Figure 1-1.

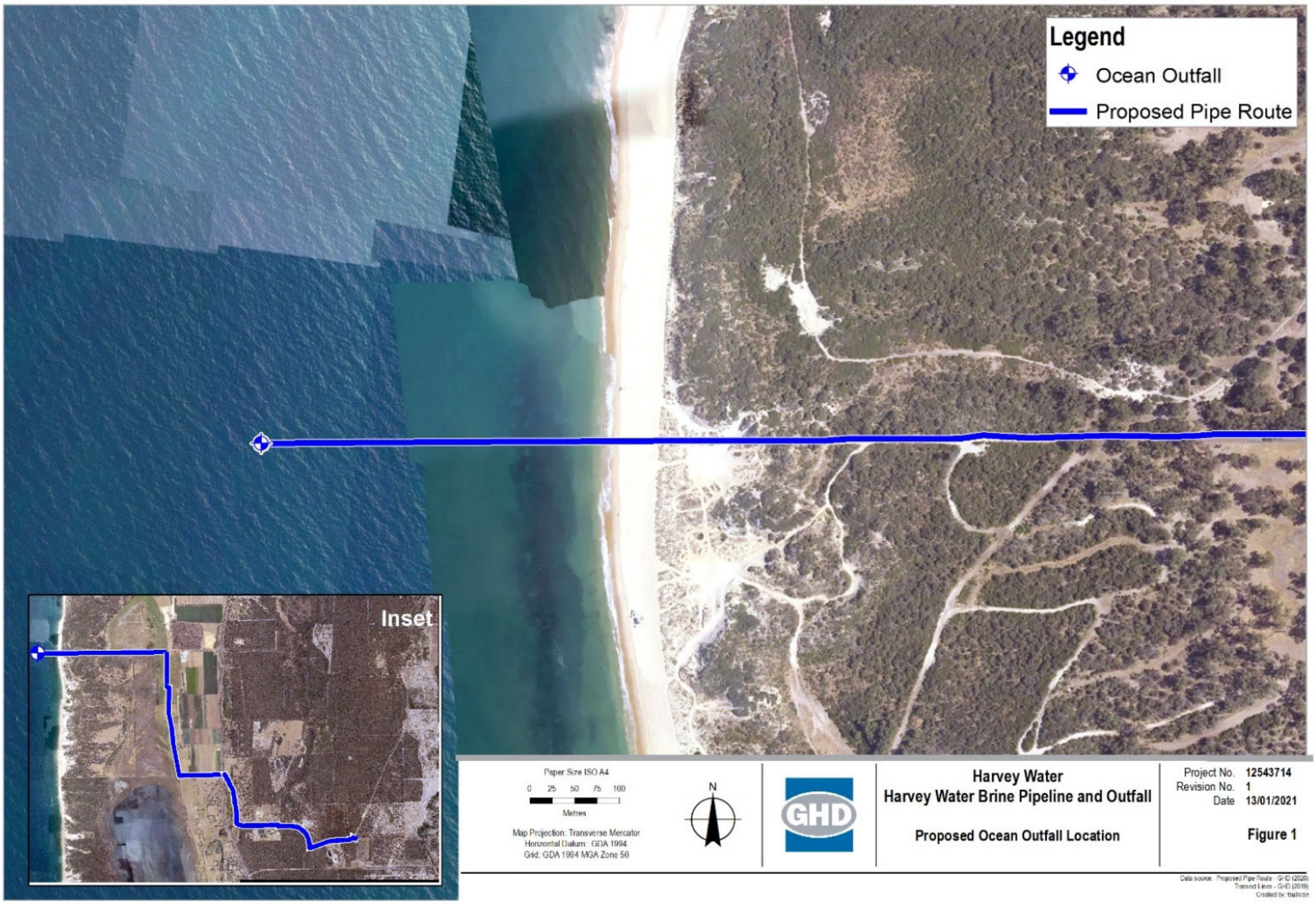

Figure 1-1 Proposed wastewater pipeline and ocean outfall location

1.2 Document Purpose

Harvey Water has a planning proposal for the construction of the KSIA pipeline and marine outfall that will be submitted to the responsible authority (Shire of Harvey Planning and Environment Department). Harvey Water has chosen to self-refer the planning proposal to the Environmental Protection Authority (EPA) under Section 38 of the *Environmental Protection Act 1986* (Government of Western Australia 2020).

The EPA has stated that a Discharge Monitoring and Management Plan (DMMP) will be required, due to proposed increases in wastewater discharge flow rates to those initially expected. The increase in capacity is proposed to take account of any future expansion of the customer base, noting that the initial flow rates once commissioned and operational, will likely be in line with the original stated number (i.e. ~15 litres per second [L sec^{-1}]).

The purpose of this document is to satisfy the above requirement and provide the foundation for a long-term monitoring and management framework.

1.3 Project Description

The scope of this DMMP is for the proposed KSIA pipeline outfall at the location shown in Table 1-1 and Figure 1-1, which lies 3.3 km west of Parkfield, and approximately 3 km south of Binningup, WA. The outfall will be buried and will extend from the shoreline to approximately 350 metres (m), where it will emerge from the seabed. The outfall will lie on the seabed in approximately 8 m of water.

Table 1-1 Location of proposed Harvey Water KSIA outfall

	Easting	Northing	Geodetic Reference
Proposed Harvey Water KSIA outfall location	115.678997	-33.175668	GDA94, MGA Zone 50

This DMMP covers the monitoring and management of discharge into the Indian Ocean from this specific location from the proposed KSIA pipeline outfall.

1.4 Limitation of Liability

This report: has been prepared by GHD for Harvey Water and *may only be used and relied on by Harvey Water for the purpose agreed between GHD and Harvey Water as set out in Section 1.2 of this report.*

GHD otherwise disclaims responsibility to any person other than Harvey Water arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by Harvey Water and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

2. Existing Marine Environment

2.1 Bathymetry

The marine component of the KSIA pipeline extends over a simple offshore bathymetry that is oriented approximately north-south with the absence of an offshore limestone ridge. Hence the nearshore waters are fully exposed to offshore wind, wave and current regime influences.

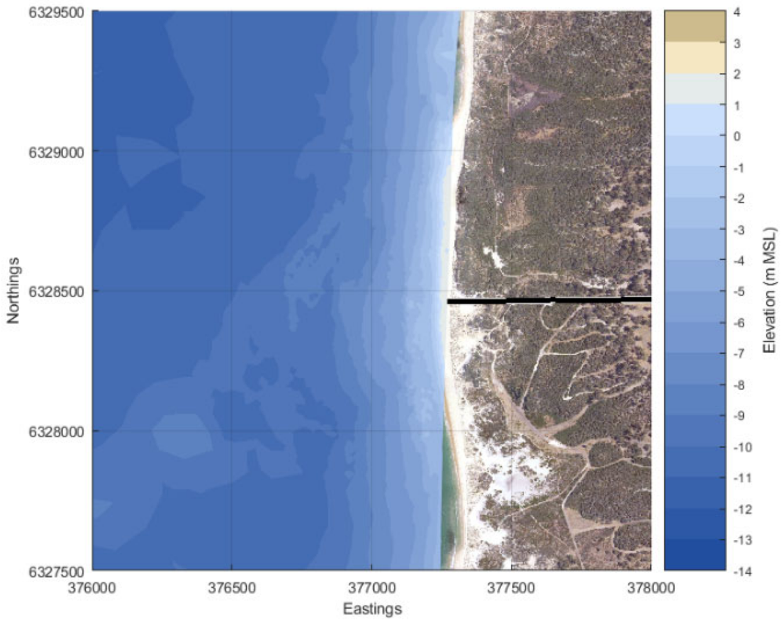

Figure 2-1 Bathymetry in locale of KSIA pipeline outfall (GHD 2021)

2.2 Oceanography

Tides along the coastline are relatively minor with a maximum tidal range of 1.2 m (difference between highest and lowest astronomical tides) (GHD, 2021a).

Oceanica (2008) found that the wave climate of the wider Binningup region is dominated by swell and wind waves. The waters are open to the west and north-west and it is waves travelling from these directions that reach the Binningup region as they are less affected by shoaling and refraction. Wind waves from these directions are generated by low pressure systems and associated cold fronts, which are common during the winter months. If they occur at the same time, swells from this direction may combine with existing wind waves to produce higher resultant waves.

Summer winds are predominantly from the southwest (afternoons) to east (mornings) with lower winds typically during April (GHD 2021a). Peak wind speeds occur typically during the winter from the west (GHD 2021a). Winds are one of the most dominant factors that govern the dispersion of brine discharge from the Southern Seawater Desalination Plant (SSDP) at nearby Binningup (KBR 2008, Oceanica 2008). Measured currents at the nearby SSDP site were below 0.15 m/s for 95% of the time (UWA 2008).

2.3 Temperature, Salinity and Turbidity

Temperature and salinity measurements for the SSDP baseline data set on the basis of CTD profiling, several seaglider deployments and conductivity sensors at fixed heights indicate a range in:

- Salinity of 34.5 PSU in winter-spring to 36.5 PSU in summer.

- Water temperature of 15°C in winter-spring to 24°C in summer-autumn.

Additionally, SSDP baseline measurements of turbidity and dissolved oxygen ranged from 1-4 NTU and 6.5-8.5 mg/L, respectively.

2.4 Water Quality

Baseline site BY-5000S for the SSDP is near the proposed KSIA pipeline outlet and had mean annual background levels as summarised in Table 2-1.

Table 2-1 Mean annual background nutrient levels of site BY-5000S (KBR 2008) and default guideline values

	NH_4^+ (µg/L)	NO_X (µg/L)	TN (µg/L)	PO_4^{3-} (µg/L)	TP (µg/L)
ANZECC & ARMCANZ (2000) Default Guideline Value	5	5	230	5	20
ANZG (2018) Default Guideline Value	-	2.6 (spring)-7.5 (winter) (NO_3^-)	-	5.9 (spring)-16.5 (winter)	-
BY-5000S	8	6	88	4	9

KBR (2008) found oil and grease and total petroleum hydrocarbons below the limits of reporting (LoR)for the SSDP baseline. Further, KBR also found that heavy metals and metalloids were below the ANZECC & AMRCANZ (2000) 99% species protection level with the exception of chromium (IV) and lead in winter, and copper in autumn and winter.

2.5 Benthic Communities and Habitat

A benthic habitat survey was carried out on 15 November 2019 with a towed underwater video system to assess habitat type or dominant species in the vicinity of the proposed pipeline and outlet location and to identify any potential sensitive habitats or species (GHD 2021b). The two major substrate types were unconsolidated sand and consolidated reef/hard rock/boulders. Reef types identified included low relief (<1 m) dominated by algae, and low/moderate relief (1-3 m) with mixed algal and epifauna assemblages. Reef structure and assemblages changed with distance from shore, where sandy patches became more frequent.

A summary of the benthic organisms identified include:

- Seagrass in the area was *Amphibolis spp.* Seagrass was observed in the nearshore waters (combined with macroalgae), but not observed in the offshore transects (including the proposed outlet location) (Figure 2-2). The seagrass identified during the underwater video transects were not at a density and coverage considered to constitute a seagrass meadow.
- Few species of macroalgae could be identified to species level, however there appeared to be high diversity and abundance throughout all transects ranging from filamentous to large canopy forming, with moderate to dense coverage across the survey area (Figure 2-3). Large macroalgae (e.g. *Ecklonia spp*.) dominated the nearshore waters and macroalgae reduced in size with distance offshore.
- Epifauna were observed on most consolidated substrate; however, given the density of macroalgae, coverage was rarely estimated to be >30%.
- Sponges were the dominant benthic macro-organism and appeared relatively diverse, ranging in colour from encrusting to erect forms.
- The sea tulip (*Pyura spp.*), a sessile ascidian, was also observed regularly.

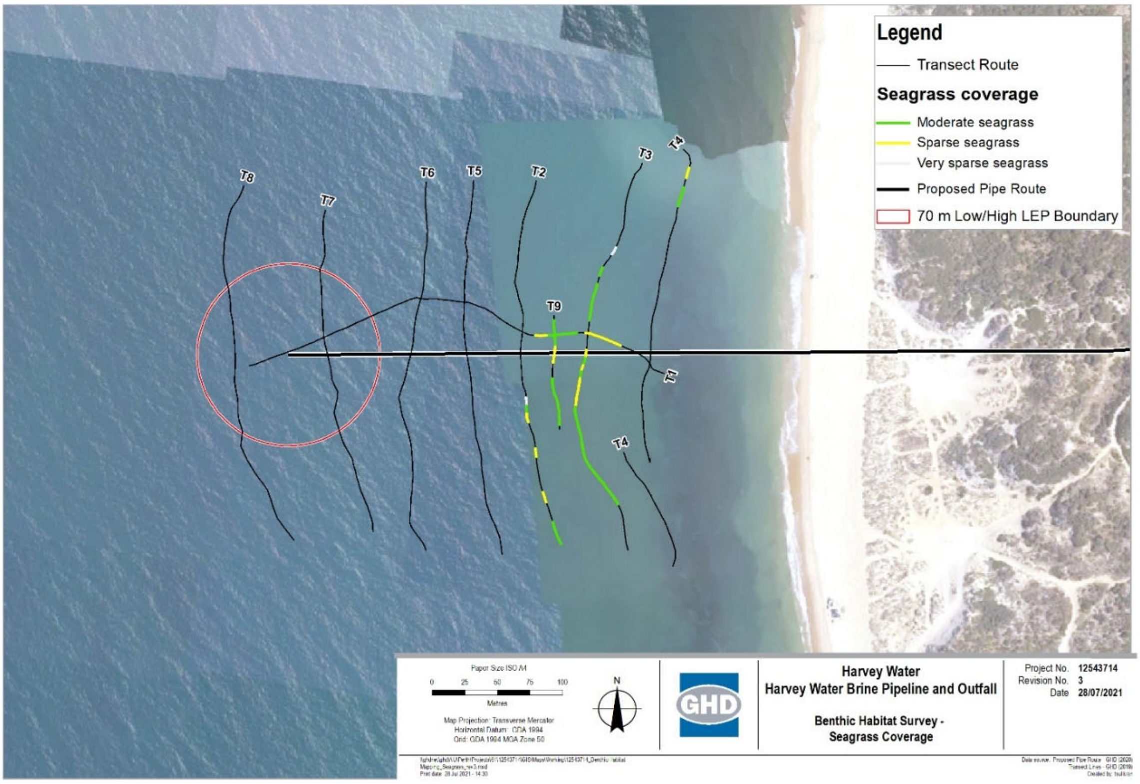

Figure 2-2 Seagrass distribution along the underwater video survey transect lines (actual) (GHD 2021b)

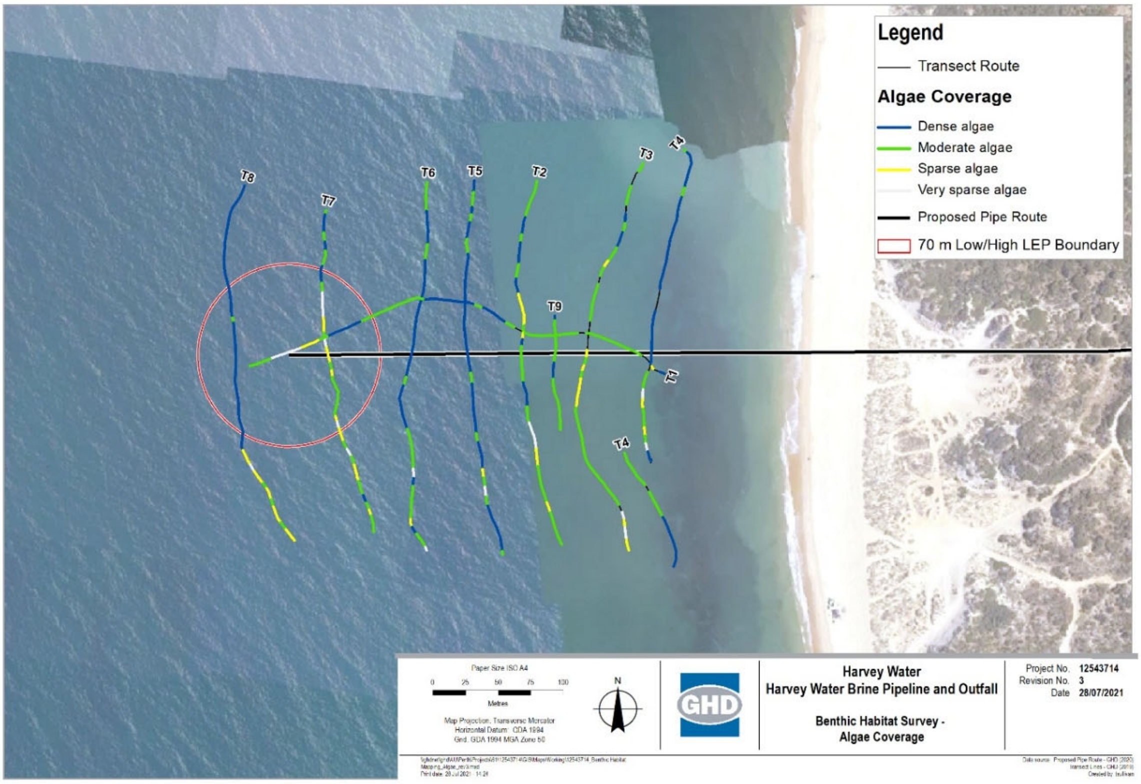

Figure 2-3 Macroalgae distribution along the underwater video survey transect lines (actual) (GHD 2021b)

2.6 Primary and Secondary Contact

The nearshore marine waters in the vicinity of the proposed KSIA pipeline and outlet are used for a range of human activities that involve primary and secondary contact including, but not limited to:

- Swimming and wading at beaches.
- Recreational boating.
- Paddle craft.
- Fishing.

2.7 Fisheries

Fisheries in the proximal coastal waters to the proposed KSIA outlet include:

- Recreational and commercial fishers for crabbing, handheld line fishing and beach seining for whitebait and herring.
- WA State Fisheries that operate within or immediately adjacent to the project area include the blue swimmer crab and the whitebait fishery. The key areas in the region that used by commercial fishers include from Forest Beach to Binningup.

2.8 Marine Fauna

Though the Whale Shark, Great White Shark, Grey Nurse Shark and Mackerel Shark are listed or protected fish potentially found within the project area, all are unlikely to be present except the Great White Shark sporadically, particularly during periods of whale migration.

Though the Loggerhead Turtle, Green Turtle, Leatherback Turtle and Flatback Turtle are listed or protected marine reptiles potentially found within the vicinity of the proposed KSIA pipeline and outlet, all are unlikely to be present.

The Australian Sea Lion is the only listed or protected pinnepid potentially found within the vicinity of the proposed KSIA pipeline and outlet, though it is unlikely to be present as there are no proximal breeding colonies, haul-out sites or foraging areas.

Though the Pygmy Blue Whale, Southern Right Whale, Humpback Whale, Bryde's Whale, Pygmy Right Whale, Killer Whale, Dusky Dolphin and Spinner Dolphin are listed or protected cetaceans potentially found within the vicinity of the proposed KSIA pipeline and outlet, the occurrence of these species is:

- Unlikely for the Pygmy Blue Whale, Bryde's Whale, Pygmy Right Whale, Killer Whale and Dusky Dolphin.
- Likely for the Southern Right Whale during winter, and Humpback Whale during summer in the deeper waters.

3. Environmental Quality Plan

3.1 Environmental Protection Act 1986

The Environmental Protection Authority exercises its powers under the *Environmental Protection Act 1986* (Government of Western Australia 2020). Section 44 (2) establishes that the EPA must make references to key environmental factors when assessing the potential environmental impacts of a referred proposal.

Environmental factors are those parts of the environment that may be impacted by an aspect of a proposal or scheme. The EPA has 14 environmental factors, organised into five themes: Sea, Land, Water, Air and People. The factors and objectives for sea are set out in Table 3-1.

Table 3-1 Environmental factors and objectives for theme 'Sea' (EPA 2020)

Theme	Factor	Objective
Sea	**1. Benthic Communities and Habitats**	To protect benthic communities and habitats so that biological diversity and ecological integrity are maintained.
	2. Coastal Processes	To maintain the geophysical processes that shape coastal morphology so that the environmental values of the coast are protected.
	3. Marine Environmental Quality	To maintain the quality of water, sediment and biota so that environmental values are protected.
	4. Marine Fauna	To protect marine fauna so that biological diversity and ecological integrity are maintained.

Of particular relevance to this DMMP is the factor marine environmental quality. This is the key EPA consideration around which the monitoring programme of this DMMP has been designed (Section 4).

3.1.1 Marine Environmental Quality

Environmental quality refers to the level of contaminants in water, sediments or biota or to changes in the physical or chemical properties of waters and sediments relative to a natural state. In the context of marine water quality, emissions or discharges that can cause water quality deterioration are the key considerations. For the proposed KSIA outfall discharge, potential impacts to water quality will be monitored and managed by this DMMP.

3.1.2 Coastal Processes

No effect on the coastal processes will be caused by the project as horizontal directional drilling of the marine segment of the KSIA pipeline below the supra- and inter- tidal regions of the shoreline will occur.

3.1.3 Benthic Communities and Habitats

The proposed KSIA outfall discharge is buoyant and will not impact benthic communities and habitats during operations. Direct and indirect impacts in the vicinity of the outlet where the KSIA pipeline emerges from construction activities may occur. Pre- and post- construction surveys of the benthic communities and habitats are (will be) stipulated in the Construction Environmental Management Plan.

3.1.4 Marine Fauna

No or negligible effect on marine fauna will be caused through operations of the project. Direct (collision with vessel) or indirect (construction noise) impacts in the vicinity of the outlet where the KSIA pipeline emerges may occur during construction of the outlet. Standard controls to prevent (collision) and mitigate (underwater noise) will be implemented for any short-term and minor outlet construction activities.

3.2 Environmental Quality Management Framework

This DMMP adopts the Environmental Quality Management Framework (EQMF) of EPA (2016) for Western Australian marine waters as illustrated in Figure 3-1.

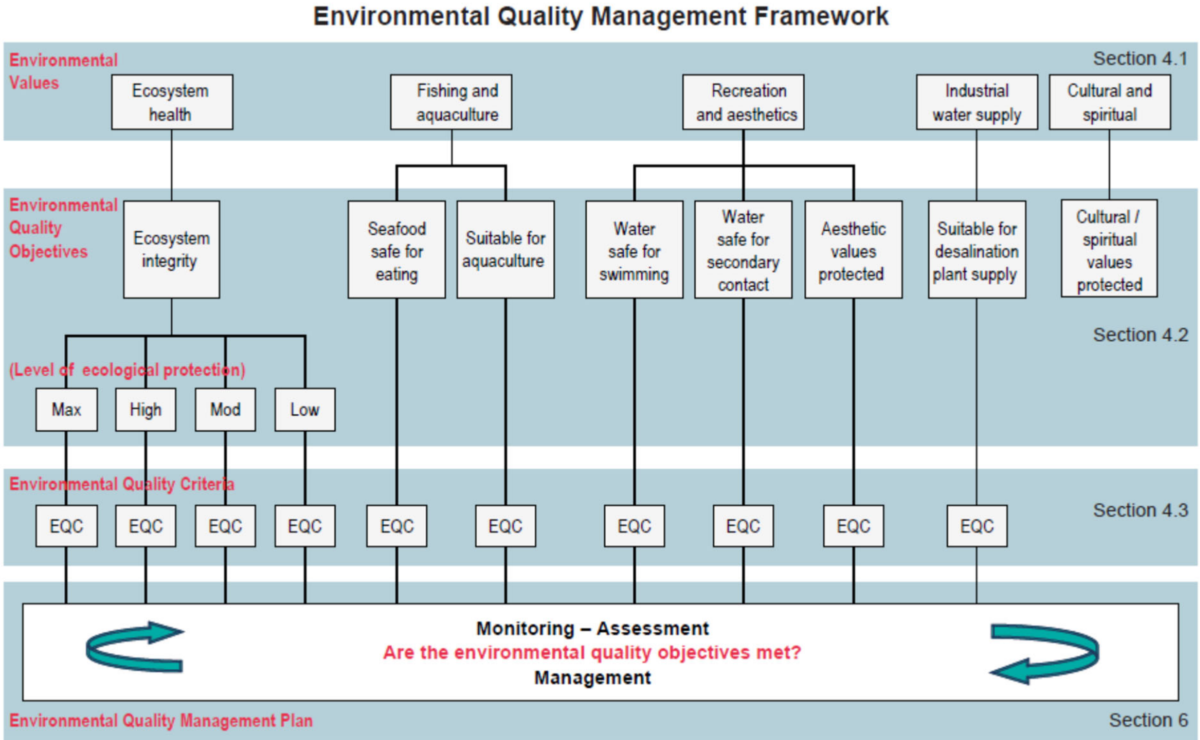

Figure 3-1 EQMF for Cockburn Sound (EPA 2016)

The key elements of the EQMF are Environmental Values (EVs), Environmental Quality Objectives (EQOs) and Environmental Quality Criteria (EQC) as described in Table 3-2.

Table 3-2 Framework for target setting

Element	Description
Environmental Value (EV)	Establish a broad area of ecological or social importance to the stakeholders
Environmental Quality Objective (EQO)	Specify the stakeholder aspirations for specific management objectives for each Value
Environmental Quality Criteria (EQC)	Benchmarks that indicate level of performance in meeting objectives as monitored outputs or measured inputs

3.2.1 Environmental Values and Objectives

EVs and EQOs identified for the proposed KSIA pipeline outfall are summarised in Table 3-3. This EQP explicitly identifies different areas of ecological protection, specifically the EV of ecosystem health and the EQO of maintenance of ecosystem integrity. All other relevant EVs (Fishing and Aquaculture, Recreation and Aesthetics, Cultural and Spiritual, Industrial Water Supply) will be protected everywhere outside of the low ecological protection area (LEPA, refer to Section 3.2.3).

Table 3-3 EVs and EQOs for coastal waters in vicinity of KSIA pipeline outfall

EVs	EQOs and Descriptions
Ecosystem Health	**Maintenance of ecosystem integrity** Marine ecosystem integrity is considered in terms of structure (e.g. the biodiversity, biomass and abundance of biota) and function (e.g. food chains and nutrient cycles) to an appropriate level.
Fishing and Aquaculture	**Maintenance of seafood safe for human consumption** Seafood is safe for human consumption when collected.
Recreation and Aesthetics	**Maintenance of primary contact recreation values** Primary contact recreation (e.g. swimming) is safe to undertake.
	Maintenance of secondary contact recreation values Secondary contact recreation (e.g. boating) is safe to undertake.
	Maintenance of aesthetic values The aesthetic values are protected.
Cultural and Spiritual	**Cultural and spiritual values of the marine environment are protected** Indigenous cultural and spiritual values are not compromised.
Industrial Water Supply	**Maintenance of water quality for industrial use** Water quality is suitable for *potential future* industrial use.

3.2.2 Environmental Quality Criteria

While the EQOs are qualitative with narrative descriptions, the EQC are quantitative and provide a basis to measure environmental quality performance. The EQC define the limits of acceptable change to environmental quality (expressed narratively as the EQOs), whereby EQC compliance assumes EQO achievement. The two types of EQC are:

- **Environmental Quality Guideline (EQG)**: Threshold numerical value(s) or narrative statement(s) when satisfied indicate a high degree of certainty that the associated EQO is achieved. If not satisfied then assessment against an environmental quality standard(s) (EQS) is triggered because of uncertainty as to whether the associated EQO has been achieved.
- **Environmental Quality Standard (EQS)**: Threshold numerical value(s) or narrative statement(s) when not satisfied indicate a significant risk that the associated EQO is not achieved, and with continued EQS exceedance a management response is triggered.

EQG and EQS use indicators closer to the pressure and response ends of the pressure-response relation, respectively. The conceptual framework for applying EQC is illustrated in Figure 3-2.

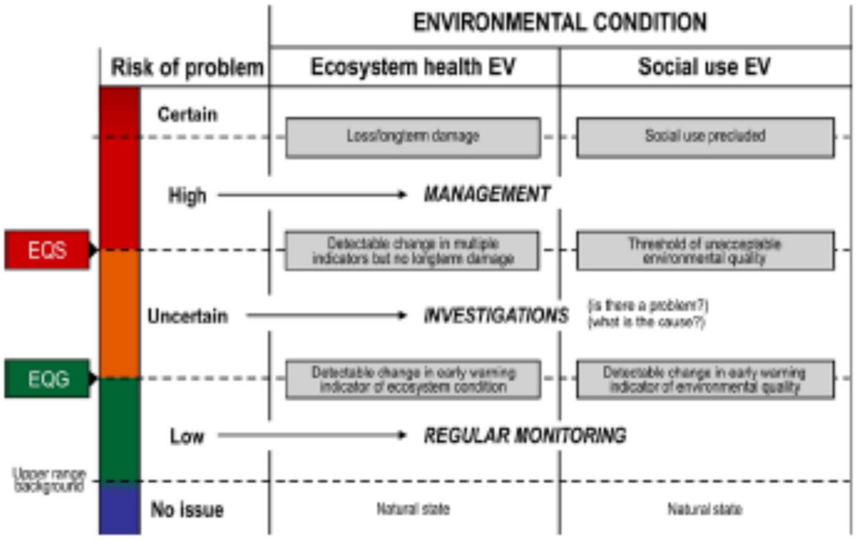

Figure 3-2 Conceptual diagram showing relation between two types of EQC (EQG and EQS shown on left) and associated environmental condition (shown on the right) (EPA 2016)

3.2.3 Levels of Ecological Protection for the Ecosystem Health Environmental Value

Four levels of ecological protection (LEPs) can be spatially applied to represent the minimum acceptable level of MEQ to be achieved through management:

- **Maximum LEP Area (Maximum Ecological Protection Area)**: Allowance for no changes in the quality of water, sediment or biota (e.g. no changes in contaminant concentrations with no resultant detectable changes beyond natural variation in the diversity of species and biological communities, ecosystem processes and abundance/biomass of marine life).
- **High LEP Area (High Ecological Protection Area or HEPA)**: Allowance for small changes in the quality of water, sediment or biota (e.g. small changes in contaminant concentrations with no resultant detectable changes beyond natural variation in the diversity of species and biological communities, ecosystem processes and abundance/biomass of marine life).
- **Moderate LEP Area (Moderate Ecological Protection Area or MEPA)**: Allowance for moderate changes in the quality of water, sediment and biota (e.g. moderate changes in contaminant concentrations that cause small changes beyond natural variation in ecosystem processes and abundance/biomass of marine life, but no detectable changes from the natural diversity of species and biological communities).
- **Low LEP Area (Low Ecological Protection Area or LEPA)**: Allowance for large changes in the quality of water, sediment and biota (e.g. large changes in contaminant concentrations causing large changes beyond natural variation in the natural diversity of species and biological communities, rates of ecosystem processes and abundance/biomass of marine life, but which do not result in bioaccumulation/ biomagnification in near-by high ecological protection areas).[1]

[1] The fourth category of LEP, namely ‘Low’, in the Western Australia context generally only occurs in the immediate region of outfalls (e.g. wastewater or desalination) such as the proposed KSIA pipeline outfall.

As described in EPA (2017), ANZECC (2000) (now ANZG (2018)) recognises and provides guidelines for three of the four LEP types (noting no change allowed in Maximum Ecological Protection Area) that are the basis for the EGQs, namely:

- Undisturbed (i.e. HEPA) where:
  - Recommended 99% species protection guideline trigger levels for toxicant in waters.
  - Interim Sediment Quality Guideline (ISQG) -low guideline trigger levels for toxicants in sediments.
  - The 80th percentile and/or 20th percentile of the data distribution for a suitable relatively unmodified reference site for the physical and chemical stressors or the default guideline trigger value provided.
- Slightly to moderately disturbed (i.e. MEPA) where
  - Recommended 90% species protection guideline trigger levels for toxicant in waters.
  - ISQG-low guideline trigger levels for toxicants in sediments.
  - The 95th percentile and/or 5th percentile of the data distribution for a suitable relatively unmodified reference site for the physical and chemical stressors.
- Highly disturbed (i.e. LEPA).
  - For toxicants with potential to adversely bioaccumulate or biomagnify, the recommended 80% species protection guideline trigger levels for toxicant in waters.

3.3 EQMF Implementation

3.3.1 Contaminants of Concern

Harvey Water identified the contaminants of concern in the KSIA outlet and provided estimates of their concentrations as reported in GHD (2021a) and reproduced in Table 3-4. For the water treatment chemicals, concentrations were given for the feedwater to the reverse osmosis (RO) plant (not the outlet concentrations) that is to be operated by Harvey Water on behalf of MARBL Lithium and were estimated by GHD (2021a) on the following basis:

- The treatment chemical was assumed to be conserved (i.e. not degraded) throughout the RO process and within the brine holding tanks and discharge pipe. This assumption is very conservative, as these chemicals are highly reactive.
- The entire mass of the chemical is assumed to be removed from the RO product water and transmitted entirely to the brine wastewater stream (i.e. the outlet). The concentration in the RO feed water (provided by Harvey Water) was therefore assumed to increase in the wastewater discharge (i.e. outlet) proportionally to the ratio of RO feedwater flowrate to the brine discharge flowrate (i.e. a factor of 7.7).

No other discharges from the Lithium plant will be discharged into the pipeline other than the current single discharge from the RO plant operated by Harvey Water on behalf of MARBL Lithium. Any additional client discharges will be direct from their treatment plant, which will be monitored in line with this DMMP.

For each new industry that discharges into the pipeline, contaminants of concern in Table 3-4 and other relevant aspects of this DMMP will be updated accordingly.

Table 3-4 Estimated water quality of KSIA outfall and required dilution to meet environmental criteria (GHD 2021a)

Analyte	Units	$C_{Outfall}$	Required Dilution (GHD 2021a)
pH	unitless	8.51	2
Nitrate	mg/L	2.8	4
Salinity	PSU	11.93[2]	92
Sodium Molybdate	mg/L	152.7[3]	3
THPS (Biocide)	mg/L	381.7[17]	25
Phosphonates (PBTC)	mg/L	77.4[17]	2
Phosphonates (HEDP)	mg/L	77.4[17]	27
Polyacrylate	mg/L	2.9[17]	$C_{Outfall}$ < criterion
Azole	mg/L	38.2[17]	$C_{Outfall}$ < criterion
Molybdate	mg/L	119.1[17]	3

3.3.2 Pressure-Response Considerations

Pressure-response considerations for operational activities associated with the KSIA outlet are summarised in this section.

Pressure: Increased Nutrients

The discharge from the proposed KSIA outlet can potentially stimulate phytoplankton growth that can cause shading (decreases in water clarity) and potentially yield impacts to benthic primary producers (EQO Maintenance of Ecosystem Integrity) and increase visual blight (EQO Maintenance of Aesthetic Quality). The combination of a buoyant plume and rapid dispersion of nutrients and algal levels will occur in this open nearshore environment with negligible risk to HEPA benthic primary producers.

Pressure: Increased Toxicants

Operations can potentially result in toxicant levels that may lead to increased risks to primary and secondary recreational contact, tainting of seafood, and impacts to marine organisms. This DMMP has been designed to demonstrate that potential impacts to marine organisms are limited to within the LEPA, which have more stringed environmental performance criteria than those for primary contact values (e.g. As, Cd, Cr, Cu, Pb, Hg, Ni).

Pressure: Increased Microbiological Contaminants

Microbiological contaminants will not be discharged so there are no concomitant risks to primary and secondary recreation, and tainting of seafood.

3.3.3 Environmental Quality Criteria

HEPA EQGs

Four EQGs were developed to allow detection of whether the multiple stressors to the marine environment (e.g. salinity, metals and metalloids, nitrate, production chemicals) are limited with potential effect within the LEPA. These include:

EQG 1: *The concentration of each toxicant in the waste water stream prior to discharge is below the level to achieve 99% species protection (95% for cobalt) (ANZG 2018).*

The specified levels need to be determined with calculations based on the following equation:

[2] Salinity (PSU, or ppt) is calculated from the TDS concentration
[3] Outlet concentration estimated as 7.7 x the RO feedwater concentration as described in GHD .(2021a).

$C_O = D \times (C_t - C_a) + C_a$

where:

- C_O=allowable upper limit of outlet concentration to achieve EQG 1.
- D=75 fold dilution factor based on the plume centreline dilution for Stage 1 peak flow rate of 15 L/s.
- C_t=Target toxicant concentration to achieve a 99% species protection level (95% for cobalt).
- C_a=Ambient concentration for each toxicant determined from baseline monitoring or, if unavailable, based on Table 12 of DoE (2004).

Table 3-5 provides example calculation of the upper concentration of C_O for a number of toxicants to meet EQG 1.

Table 3-5 Calculated C_o to meet EQG 1

Toxicant	D	C_t (mg/L)	C_a (Table 12 of DoE (2004)) (mg/L)	Co (mg/L)
NO_3	75	0.7[4]	0.1[5]	45.1
V	75	0.05	TBD[6]	TBC[7]
Cr (VI)	75	0.00014	TBD[6]	TBC[7]
Cr (III)	75	0.0077	TBD[6]	TBC[7]
Cr	75	0.0044[8]	0.0002	0.315
Co	75	0.001[9]	0.00001	0.074
Ni	75	0.007	TBD[6]	TBC[7]
Cu	75	0.0003	0.00008	0.017
Zn	75	0.0033	0.00015	0.236
Ag	75	0.0008	0.0000007	0.060
Cd	75	0.0007	0.000005	0.052
Pb	75	0.0022	0.00002	0.164
Hg	75	0.0001	0.0000004	0.007

EQG 2: *The salinity differential in marine waters at the LEPA/HEPA boundary and the reference site is 0.25 PSU or less.*

EQG 2 to be revised as the 20th percentile of different seasons of the natural background over a two year baseline period at the site (EPA 2016). Other data from nearby operations (e.g. Binningup waste water treatment plant) may be suitable to serve as background data.

EQG 3: *The number of dilutions between the outlet and the LEPA/HEPA boundary is greater than XX (to be determined).*

The number of dilutions of the waste stream with ambient marine waters to achieve a 99% species protection level will be determined via whole effluent testing (WET) with eight marine species on two occasions during the first two months of operation or a substantive change in the

[4] ANZG (2018) does not have any marine trigger values for nitrate, whereas ANZECC & ARMCANZ (2000) does have low reliability trigger values that are used in this DMMP.

[5] Ambient background level for NO_3 of 0.1 mg/L much higher than actual as a conservative measure to estimated EQG 1 criterion.

[6] To be determined on basis of baseline data, no default value from DoE (2004).

[7] To be calculated after establishment of ambient background value.

[8] 99% species protection level for Cr(VI) below DoE (2004) default background value, so 95% species protection level for Cr(VI) adopted for dissolved Cr.

[9] 95% species protection level.

wastewater stream (i.e. addition of waste stream). The maximum dilution of these two WET tests will be adopted at the EQG 3 value. Measurements of salinity to demonstrate EQG 2 environmental performance will also be used to determine the number of dilutions at the HEPA-LEPA boundary satisfies EQG 3. Any substantive changes to the water quality of the wastewater stream (i.e. addition of new waste stream) will trigger a re-evaluation of this EQG 3 value. A WET approach has been adopted recognising that production chemical use in the desalination plant and other industrial processes (e.g. blowdown water) that contribute to the waste streams may not be reliably measured by laboratories. Further, synergistic (additive) effects of multiple contaminants in waste streams are implicitly accounted for with this approach.

EQG 4: *The concentration of each process chemical (or analogue) prior to discharge is below the concentration that was WET tested in EGG 3.*

Where possible, direct measurement of concentrations of process chemicals in waste water streams will be targeted during routine monitoring. If not possible or reliable to measure directly, then suitable analogue analytes of process chemicals will be measured during routine monitoring. The maximum allowable outlet concentration of a process chemical (or analogue) will be determined as EQG 1 where:

- C_T for each process chemical (or analogue) will be based on a 75 fold dilution factor (based on the plume centre line for Stage 1 peak flow rate of 15 L/s similar to EG1).
- C_a will be 0 mg/L.

HEPA EPS

EQS: The number of dilutions with ambient marine waters required to meet a 99% species protection level as determined through eight species WET testing of the comingled/combined wastewater stream is less than the calculated dilution at the HEPA-LEPA boundary.

An EQG non-compliance at the HEPA-LEPA boundary will trigger evaluation of the EQS on the basis of an eight species WET testing of the comingled/combined wastewater stream sample to determine the number of dilutions with ambient marine waters required to meet a 99% species protection level. This will be compared to the calculated dilution at the HEPA-LEPA boundary. If dilution at the HEPA-LEPA boundary is less than the required safe dilutions, then the EQS is exceeded and identification of the problem wastewater stream and associated management actions will be triggered.

3.3.4 LEPA Spatial Extent

The EQO for maintenance of ecosystem integrity requires the spatial classification of two LEPs in the immediate locale of the proposed KSIA outlet, namely:

- The LEPA in a confined area surrounding the with a permitted reduction in MEQ. For marine areas adjacent to wastewater discharges, EPA (2016) recommends establishment of a LEPA that encompasses the ‘zone of initial dilution’. Discharged water from the KSIA outfall may temporarily alter salinity and water quality from background levels. The LEPA for the KSIA outlet has been defined with consideration of the GHD (2021) modelling of the outlet discharge over a range of short- and long-term projected wastewater flow rates (Appendix A). A **70 m radius around the outlet** will be established as the LEPA for compliance monitoring purposes, which is aligned with typical LEPA sizes for marine areas adjacent to wastewater discharges (EPA 2016). Outside of this area, the HEPA EQGs are predicted to be achieved (Appendix A).
- A HEPA will cover all of the proximal coastal waters outside of the LEPA in the vicinity of the KSIA outlet.

Figure 3-3 illustrates the spatial configuration of the LEPA as a 70 m radius of the outlet with as surrounding marine water classification as HEPA.

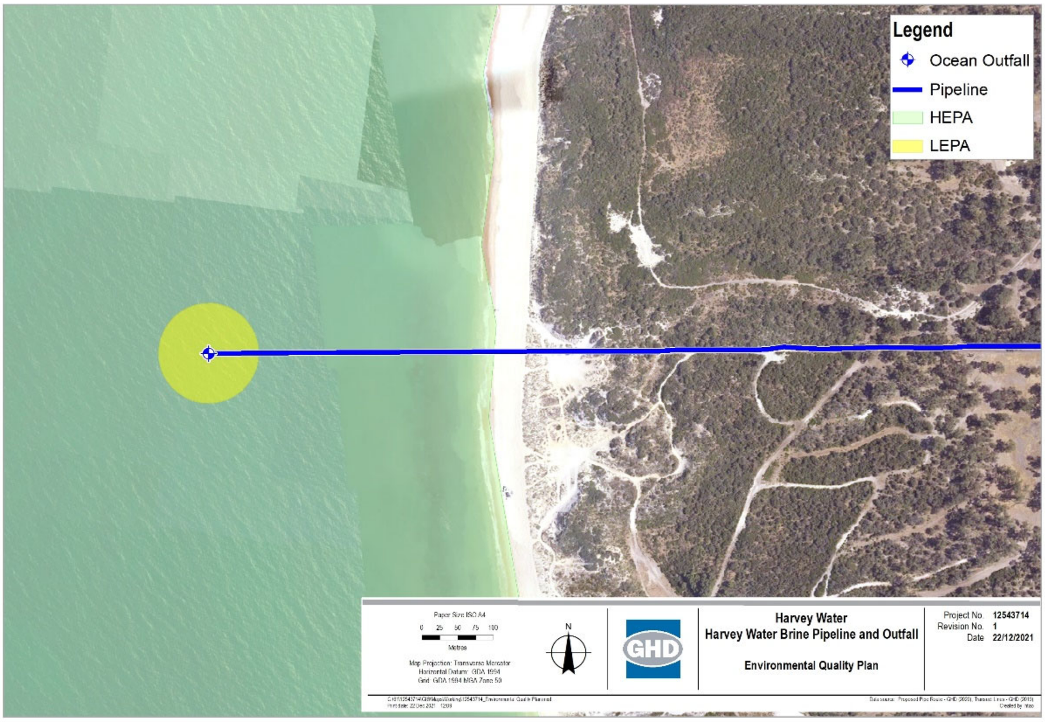

Figure 3-3 Spatial representation of the Environmental Quality Plan.

4. Monitoring

This section describes the routine monitoring to verify whether the EQGs for the EQOs are met.

4.1 Sites

4.1.1 Marine

A schematic representation of the marine monitoring sites is illustrated in Figure 4-1.

The procedure to establish the monitoring sites for a particular survey will be to:

- Carry out the survey during worst case tidal conditions that will be determined with the GHD (2021a) hydrodynamic model as per commitment in Section 6.1.
- Deploy a drogue at the outlet location and determine the surface current direction and speed.
- Supposing the current direction is to the south, then the following monitoring sites will be established:
  - Two reference sites 500 m to the north and south of the KSIA outlet.
  - One LEPA site ~25 m to the south along the prevailing current direction of the KSIA outlet, which is beyond the zone of initial dilution (up to 10 m, see Appendix A).
  - Three sites at 70 m from the KSIA outlet on the HEPA-LEPA boundary of which:
    - One site is directly south along the prevailing current direction.
    - Two sites 15 m to either side of the site directly south.

As illustrated in Figure 1-1 for a northerly current (as determined by a drogue deployment) the one LEPA site and the three HEPA-LEPA boundary sites would be placed to the north of the outlet.

4.1.2 Wastewater

Sampling sites of the wastewater stream are to be collected at the following locations:

- The comingled wastewater stream prior to the outlet after inputs from all of the individual waste streams.
- Each individual user wastewater stream immediately prior to discharge into the primary comingled pipeline (note for the initial proposal there is only one wastewater stream emanating from the desalination plant).

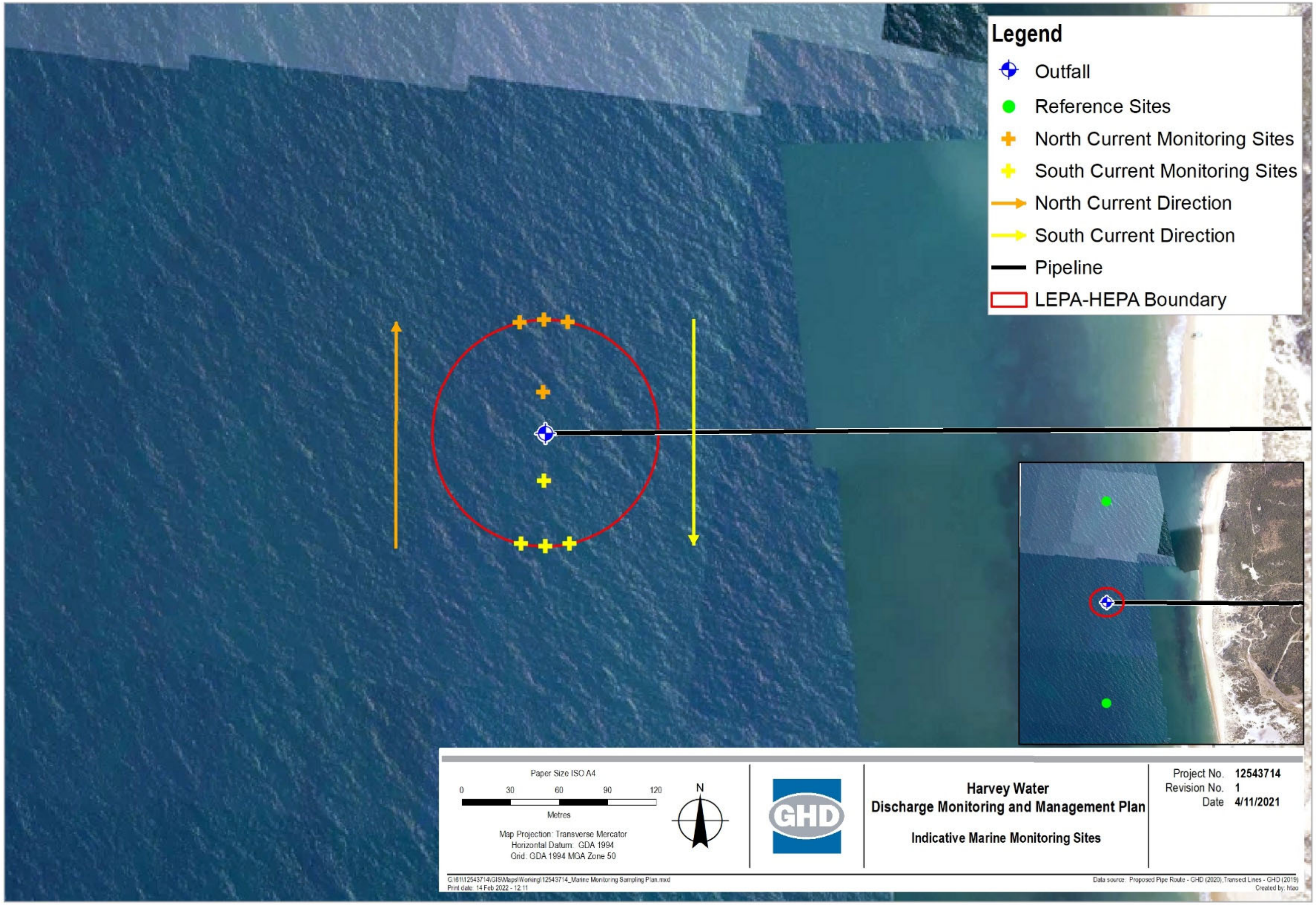

Figure 4-1 Indicative marine monitoring sites

4.2 Samples

The following section outlines the number of samples to collect.

4.2.1 Marine

Sample collection at marine monitoring sites are to include:

- Two surface water samples will be collected at 0.5 m below the surface. This depth is consistent with EPA (2017) specifications to monitor buoyant plumes for comparison to EQGs. Both samples will be analysed at the same time by the laboratory(s) where the second sample can be evaluated to confirm any EQG non-compliances.
- At one monitoring site an additional sample will be collected for QA/QC purposes (i.e. a replicate). The purpose of the replicate sample is to confirm that the laboratory(s) is able to produce consistent results. The replicate sample site will be recorded but not reported to the laboratory. Ideally it will be collected at a marine monitoring site that is expected to have higher levels of contamination as this will confirm a wider range of analytes and reduce the level of instrument error through comparison of higher concentrations

Field sampling, transport and storage procedures will follow EPA (2005) protocols.

4.2.2 Waste Streams

Sample collection at the waste stream sites will be as follows:

- Two waste stream samples will be collected at each site (i.e. each individual waste stream). Both samples will be analysed in the laboratory and the average of the measurements adopted as the representative sample concentrations.
- For the wastewater stream prior to discharge to the outlet (and after the individual wastewater streams) a sufficiently large sample to carry out WET testing will be collected and stored.

Field sampling procedures, transport and storage procedures will follow Department of Water Field Sampling Guidelines (Government of Western Australia 2009).

4.3 Measurements

4.3.1 Vertical CTD Profiles of the Water Column

A Sea-Bird SBE 19 conductivity-temperature-depth (CTD) profiler (or equivalent) will be used to collect water profiles through the water column of temperature and salinity at <1 m depth intervals at each station. In addition, the CTD will collect continuous measurements at ~0.5 m below the surface at each marine monitoring site for at least 10 seconds to allow accurate characterisation of the salinity to allow robust calculations of the salinity at the HEPA-LEPA boundary.

4.3.2 CTD Measurement of Wastewater Sample(s)

Temperature and salinity of sufficient sample from the wastewater stream will be measured with the CTD for at least 10 seconds to allow accurate characterisation of the salinity at the HEPA-LEPA boundary.

4.3.3 Marine and Wastewater Samples: Laboratory Analysis

Marine water and wastewater stream(s) samples will be sent to a NATA certified laboratory(s) for analysis of analytes shown in Table 4-1. Where relevant EQG concentrations are provided along with LoRs to demonstrate EQG can be assessed. Additionally, other uses of analytes for this DMMP are also summarised.

Table 4-1 Analytes, EQG concentrations (where relevant), other use, limits of reporting (LoRs), whether water samples only from wastewater stream or marine waters as well, and if analytes are evaluated for QA/QC

Analyte	EQG	Other Use	LoR	Laboratory	Seawater	Wastewater	QA/QC
EQG 1. *The concentration of each toxicant in the waste water stream prior to discharge is below the level to achieve 99% species protection (95% for cobalt) (ANZG 2018). (values from Table 3-5)*							
Nitrate	45.1 mg/L	-	0.002 mg/L	MAFRL	No	Yes	Yes[10]
Dissolved V	TBC[7]	-	0.0003 mg/L				
Dissolved Cr(VI)	TBC[7]		0.002 mg/L (Cr(VI))				
Dissolved Cr(III)	TBC[7]		0.002 mg/L				
Dissolved Cr	0.315 mg/L		0.0002 mg/L (MAFRL, Cr) 0.0001 mg/L (ALS, Cr)				
Dissolved Co	0.074 mg/L		0.00005 mg/L				
Dissolved Ni	TBC[7]		0.0003 mg/L				
Dissolved Cu	0.017 mg/L		0.0002 mg/L				
Dissolved Zn	0.236 mg/L		0.001 mg/L				
Dissolved Ag	0.06 mg/L		0.0001 mg/L				
Dissolved Cd	0.052 mg/L		0.0001 mg/L				
Dissolved Pb	0.164 mg/L		0.0001 mg/L				
Dissolved Hg	0.007 mg/L		0.0001 mg/L				
EQG 2. *The salinity differential in marine waters at the LEPA/HEPA boundary and the reference site is 0.25 PSU or less.*							
Salinity	DS<0.25 PSU (for HEPA-LEPA boundary dilution estimate)	HEPA-LEPA boundary dilution estimate Verify CTD salinity	CTD:0.01 PSU Lab: TBA	MAFRL	Yes	Yes	Yes
Chloride	None	HEPA-LEPA boundary dilution estimate	1 mg/L				
EQG 3. *The number of dilutions between the outlet and the LEPA/HEPA boundary is greater than XX (to be determined from WET testing).*							
Salinity	Dilution estimate at HEPA-LEPA boundary < XX	HEPA-LEPA boundary dilution estimate Verify CTD salinity	CTD:0.01 PSU Lab: TBA	MAFRL	Yes	Yes	Yes
Chloride		HEPA-LEPA boundary	1 mg/L				

[10] Second sample collected, both samples reported as averages. Relative percentage differences of both measurements to be reported.

Analyte	EQG	Other Use	LoR	Laboratory	Seawater	Wastewater	QA/QC
		dilution estimate					
EQG 4. *The concentration of each process chemical (or analogue) prior to discharge is below the concentration that was WET tested.*							
Process chemicals[11]							
Sodium Molybdate	TBD[12]		TBA[11]				
THPS (Biocide)	TBD[12]		TBA[11]				
Phosphonates (PBTC)	TBD[12]		TBA[11]				
Phosphonates (HEDP)	TBD[12]	-	TBA[11]	TBA	No	Yes	Yes[10]
Polyacrylate	TBD[12]		TBA[11]				
Azole	TBD[12]		TBA[11]				
Molybdate	TBD[12]		TBA[11]				

4.3.4 WET Testing

WET testing will be undertaken on wastewater samples with eight marine ecotoxicity tests on eight different species to allow estimates of the 99% species protection level via species sensitivity distribution statistics. The number of dilutions with ambient seawater to achieve a 99% species protection level is a key EQG and EQS to account for uncertainty in the additive (synergistic) effects of water treatment chemical and other potential contaminants in the wastewater stream on the marine environment. Additionally, WET testing is used to establish EQG numeric dilution criterion at the HEPA/LEPA boundary for EQG 3. Chemical analyses of the waste water and background ambient marine waters are to be undertaken for analytes in Table to develop numeric criterion for EQG 4. Preliminary specifications of the eight species WET tests that are in line with ANZG (2018) guidance are summarised in Table 4-2.

Table 4-2 Preliminary eight species ecotoxicology tests for WET

Ecotoxicity Test	Test Species
72 hour Microalgal Growth Bioassay	*Nitzschia closterium*
48 hour Copepod Survival Bioassay	TBA
5-7 day Copepod Larval Development Bioassay	TBA
72 hour Sea Urchin Larval Development Bioassay	TBA
1 hour Sea Urchin Fertilisation Bioassay	TBA
48 hour Mollusc Larval Development Bioassay	TBA
96 hour Fish Larval Imbalance Bioassay	TBA
7 day Fish Larval Development test	TBA

Three of the eight species tests that are rapid (≤2 days) are to be used to identify a problematic individual waste stream(s) in the event of an EQS non-compliance. Note that the proposal is currently for only one wastewater stream, so a rapid ecotoxicity assessment on the basis of three toxicity tests will not be necessary in the near term.

4.4 Schedules

The monitoring program consists of two schedules:

[11] Process treatment chemicals (or analogues) and LoRs to be advised.

[12] EQGs to be developed over the first 2 months after start-up operations.

- Schedule 1: To be implemented during start-up operations or a substantive change in wastewater stream flow or water quality (i.e. new wastewater stream).
- Schedule 2: Routine monitoring procedure.

4.4.1 Schedule 1 (Start-Up Operations or New Wastewater Stream)

Schedule 1 is illustrated schematically in Figure 4-2, which is comprised of the following procedure during start-up operations or at the start of a new waste stream (regardless of whether discharges occurs to the RO plant or directly to the pipeline):

- Determine 99% species protection level on the basis of a species sensitivity distribution from eight WET tests and concentrations of contaminants of concern of waste water stream samples during weeks 1 (WET_1) and 5 (WET_2).
- Verify GHD (2021) dilution predictions in the LEPA with CTD transects. Refer to Appendix B for preliminary summary of CTD verification procedure of GHD (2021a) dilution predictions during weeks 1 and 5.
- Carry out laboratory measurements of waste water samples of the analytes in Section 4.3.3 on two occasions per week over the initial 8 weeks to allow characterisation of the chemical composition of each individual and the comingled waste water streams. Additionally, the following analytes are to be monitored for the first 4 weeks (8 sampling rounds) to determine if additional contaminants of concern are to be incorporated into the DMMP:
  - Full suite of metals and metalloids.
  - Nutrients: TP, TN, FRP, NO_X, NH_X.
  - Total recoverable hydrocarbons, BTEX and PAHs.
  - Biocides.
  - Anti-corrosive chemicals.

  The DMMP is to be updated with any additional contaminants of potential concern, particularly Table 3-5 and Table 4-1.
- Evaluate the environmental performance of the comingled waste water discharge via Schedule 2 routine noting that during the first month of start-up operations EQG 3 is equal to safe dilutions of the WET testing from week 1 (WET_1).

4.4.2 Schedule 2 (Routine Monitoring and Management)

Schedule 2 is illustrated schematically in Figure 4-3, which is comprised of the following procedure:

- Evaluation of the following four EQG types for the monitoring round:
- If an EQG non-compliance then carry out EQS evaluation via WET testing of comingled wastewater sample to confirm if sufficient dilutions estimated at the HEPA-LEPA boundary.
- If EQS non-compliance then compare individual waste stream chemical concentrations. Note for the current proposal there is only one wastewater stream, so this step would be skipped.
- Carry out management actions until EQS compliance.

If a EQS non-compliance occurs then monthly monitoring to occur for three consecutive months of EQG compliance.

Routine monitoring to occur on a:

- Monthly frequency for the first two years after start-up operations. A reduction in the frequency of monitoring (e.g. monthly to quarterly) after two years can be requested of DWER through submission of monitoring data, a monitoring report of the previous two years, and a revised DMMP.
- A monthly monitoring will be carried over the first year after incorporation of a new wastewater stream. A reduction in the frequency of monitoring (e.g. monthly to quarterly) after one year can be requested of DWER through submission of monitoring data, a monitoring report of the previous year, and a revised DMMP

Monitoring Round 1 (Month 1: within 1 week of start-up OR new waste water stream discharge to the RO plant or the pipeline)

- Determine 99% species protection level with 8 species WET testing of comingled waste stream (WET_1)
- Chemical measurements of waste water stream
- Verify dilution predictions of LEPA with CTD salinity transects
- Carry out Schedule 2 procedure except if start-up operations during month 1 EQG 3 = WET_1

↓

Individual and Comingled Waste Water Streams Characterisation (~twice per week during month 1 with ≥ 6 samples)

- Chemical measurements of waste water stream(s)

↓

Monitoring Round 2 (Month 2: Week 5)

- Determine 99% species protection level with 8 species WET testing of comingled waste stream (WET_2)
- Chemical measurements of waste water stream(s)
- Verify dilution predictions of LEPA with CTD salinity transects
- Carry out Schedule 2 procedure

↓

Individual and Comingled Waste Water Streams Characterisation (~twice per week during month 2 with ≥ 6 samples)

- Chemical measurements of waste water stream(s)

↓

Establishment of EQG

- Establish required dilution for EQG 3 as maximum of WET_1 and WET_2 safe dilutions
- Verify and/or update salinity EQG 2 (Section 3.3.2)
- Establish concentrations for EQG 4
- Schedule 1 Monitoring Report

↓

Management Plan Update and DWER Review

- Update DMMP for changes to analytes and EQC (e.g. Table 3-4, Table 3-5, Table 4-1)
- Submit to DWER for review and approval

↓

START SCHEDULE 2 MONITORING PROGRAM

Figure 4-2 Schedule 1 monitoring program: start-up operations or new wastewater stream addition

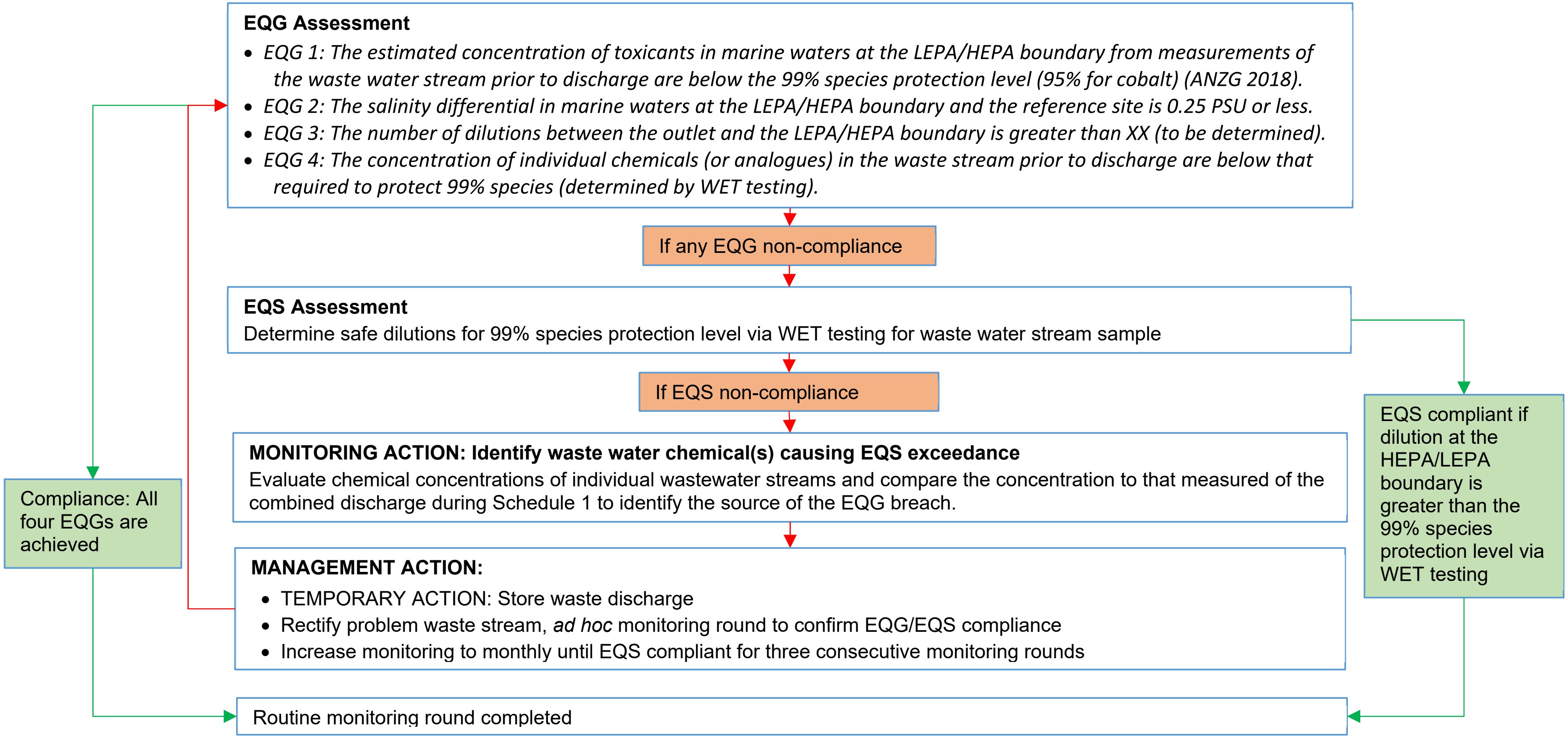

Figure 4-3 Schedule 2: routine monitoring program

4.5 Data Collection and Recording

4.5.1 Field Measurements

Marine Sites

Profiles of temperature and salinity as each sites as per Section 4.3.1. Field measurements will be recorded within the CTD memory with the operator periodically checking that measurements have been recorded successfully.

Accurate sampling of the surface waters is a key requirement of the KSIA outlet monitoring program. Disturbance of the surface waters by the monitoring vessel can heavily bias results, particularly at the HEPA-LEPA boundary. To minimise this effect as far as reasonably practicable, the vessel will move at a 'dead-slow' speed to minimise disturbance to the surface of the seawater, where permitted by navigational safety.

Wastewater sites

CTD Measurements of temperature and salinity at each site as per Section 4.3.2.

Data Storage

At the end of the field monitoring activities, the field measurement data will be downloaded from the device onto a laptop as soon as practicable to minimise the risk of data loss. A connection to a server is to be established as soon as practicable and the data copied to the server to ensure it is securely backed up.

4.5.2 Water Samples

Water samples will be collected as specified in Sections 4.1 and 4.2, and dispensed into laboratory provided bottles. Sampling of marine waters at 0.5 m below the surface and wastewater will be in accordance with EPA (2005) and Government of Western Australia (2009), respectively. Samples will be carefully packaged in the field in a chilled thermal box (e.g. Esky or similar) to minimise transient temperature effects during transit. Chain of custody (COC) documentation will be completed for all samples as per Government of Western Australia (2009).

4.6 Quality Assurance and Quality Control (QA/QC)

4.6.1 Field QA/QC

The CTD is to be in calibration for temperature and salinity prior to use.

The replicate marine water sample (Section 4.2.1) will be analysed by the laboratory(s) for the analytes specified in Table 4-1. QA/QC of the replicate water sample will be based on acceptable relative percentage difference (RPD), nominally <50%.

4.6.2 Laboratory QA/QC

QA/QC testing of water samples will be undertaken in accordance with NATA accreditation and include testing of laboratory control samples, method blanks, matrix spikes, laboratory duplicates and surrogate recovery outliers (where applicable).

5. Assessment and Management

Monitoring results are to be assessed to enable determination of whether the EQOs are being achieved, and hence whether the EVs for the surrounding waters of KSIA outlet are protected. Assessment of the monitoring results are to be evaluated as outlined in Schedule 1 (Start-Up Operations or New Wastewater Stream) and Schedule 2 (Routine Monitoring and Management) in Sections 4.4.1 and 4.4.2, respectively.

5.1 EQG Compliance

Evaluation of EQG's 1-4 for compliance (Section 3.3.3) are to be carried out following receipt of laboratory measurements. If EQGs met then monitoring round completed. The EQGs are:

EQG 1: *The concentration of each toxicant in the waste water stream prior to discharge is below the level to achieve 99% species protection (95% for cobalt) (ANZG 2018).*

EQG 2: *The salinity differential in marine waters at the LEPA/HEPA boundary and the reference site is 0.25 PSU or less.*

EQG 3: *The number of dilutions between the outlet and the LEPA/HEPA boundary is greater than XX (to be determined).*

EQG 4: *The concentration of each process chemical (or analogue) prior to discharge is below the concentration that was WET tested in EGG 3.*

5.2 EQS Compliance

If an EQG(s) are non-compliant then evaluate EQS (Section 3.3.3). If EQS met then monitoring round completed. The EQS is:

EQS: The number of dilutions with ambient marine waters required to meet a 99% species protection level as determined through eight species WET testing of the comingled/combined wastewater stream is less than the calculated dilution at the HEPA-LEPA boundary.

5.3 Identification of Problematic Wastewater Stream(s)

Only one wastewater stream will be discharged to the system initially. Skip this step until the additional waste streams discharge into the pipeline.

5.4 Management

The key management actions following EQS non-compliance and identification of the problematic individual wastewater stream are:

- Implement temporary measures which may include:
  - Store waste discharge (~3 days storage for 5 operating trains, ~15 days storage for 1 operating train).
- Corrective management actions include, but are not limited to:
  - Amendment to chemicals and/or dosing concentrations.
  - Changes to operational protocols/procedures.
  - Changes to operations and maintenance activities.
  - Modification of the outlet (e.g. incorporation of a diffuser).

6. Review and Reporting

6.1 DWER Review and Approval

6.1.1 Initial Implementation

Prior to implementation of this DMMP, this Plan will be submitted to DWER with the following final updates for regulatory review and approval:

- Finalisation of the 'process chemical' analytes (or analogues) (including LoRs and associated EQGs) in Table 4-1.
- Finalise worst case tidal condition(s) in which to carry out monitoring on the basis of model predictions in Section 4.1.1.
- Finalise list of WET test species in Table 4-2.

6.1.2 Updates

The DMMP will be updated upon discharge commencing and each time a new waste water discharge to the RO plant or the pipeline occurs.

The DMMP may also be updated following annual reviews (Section 6.4).

All updates to the DMMP will be submitted to DWER for review and approval prior to implementation.

6.2 Reporting on EQS Exceedances

In the event of an EQS non-compliance, DWER will be notified within two (2) days of identification of the exceedance with the following information:

- Which EQG exceeded.
- Monitoring data along the HEPA-LEPA boundary, reference sites and wastewater stream.
- Identification of the potential cause of the exceedance.
- The proposed management response.

A follow-up report will be provided to DWER within one (1) month with the following information:

- Corrective actions to meet EQC at the HEPA-LEPA boundary.
- All monitoring data collected since the exceedance including demonstration that corrective management has been effective.

6.3 Schedule 1 Monitoring Report

At the completion of a Schedule 1 monitoring program, a report will be submitted to DWER within two months that includes:

- A summary of all monitoring results of marine waters and the wastewater stream(s).
- Verification of the modelling predictions in regards to near-field mixing and the appropriateness of the LEPA spatial extent.
- A summary of the adopted EQGs.
- A summary of the two WET tests and the adopted EQS.
- An overview of the environmental performance of the outlet discharge at the HEPA-LEPA boundary.

6.4 Annual Review

On an annual basis the DMMP will undergo a review by 1 February to maintain continual improvement with consideration of the following:

- Appropriateness of the EVs, EQOs, LEPs and EQC.
- New threats to MEQ from potential future waste streams and other activities/proposal in proximity to outlet.
- Lessons learned from past monitoring and management actions.
- Review of the EQC as additional data is accrued of the wastewater stream(s) and marine waters.
- Proposed updates to the DMMP (if any) for submission to and review by DWER.

6.5 Schedule 2 Annual Report

At the completion of each calendar year for the Schedule 1 monitoring program, an annual report will be submitted to the DWER by 1 March that includes:

- A summary of all monitoring results of marine waters and the wastewater stream(s).
- An overview of the environmental performance of the outlet discharge at the HEPA-LEPA boundary.
- A summary of the annual review of the DMMP.
- Documentation of any management actions undertaken over the previous year and that may be extending into the next annual reporting period.

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Appendix A – GHD (2021) Basis of LEPA Spatial Extent

To define the spatial extent of the LEPA surrounding the KSIA outfall, modelling was undertaken for three flow rates that included stage 1 moderate flow (5 L sec^{-1}), stage 1 peak design flow (15 L sec^{-1}) and stage 2 peak design flow (72 L sec^{-1}) (GHD, 2021a).

Near-field dilution of the ocean outfall wastewater plume was simulated with Update Merge 3 (UM3). To predict additional dilution due to natural mixing processes beyond the near-field zone, a far-field assessment with the three-dimensional (3D) MIKE3 FM (flexible mesh) hydrodynamic model was used to simulate wind and tide-induced currents.

The dilution factors to define the edge of the mixing zone were calculated with the following formula:

$$D = \frac{C_O - C_A}{C_T - C_A}$$

where:

D = Target dilution factor to achieve EQG

C_O = Outlet concentration

C_T = Target concentration to achieve the EQG

C_A = Ambient (background) concentration

At the time of the modelling assessment, no site specific ambient data at the outfall site was available, therefore dilution targets were calculated with assumed ambient concentrations on the basis of professional judgement.

Concentrations for each analyte (Table 7-1) were provided by Harvey Water. For the water treatment chemicals, concentrations were given for the feedwater to the reverse osmosis (RO) plant, outlet concentrations were estimated as follows:

- The treatment chemical is assumed to be conserved (i.e. does not degrade or transform) throughout the RO process and within the wastewater holding tanks and discharge pipe. This assumption is very conservative, as these chemicals are highly reactive.
- The entire mass of the chemical is assumed to be removed from the RO product water and transmitted entirely to the wastewater stream and discharged through the outlet. The concentration in the RO feed water (provided by Harvey Water) was therefore assumed to increase in the wastewater discharge proportionally to the ratio of RO feedwater wastewater flow rates (a factor of 7.7).

The calculated dilution targets for the analytes of concern are summarised in Table 7-1 .

The most stringent dilution target is **92-fold** for salinity, so achieving this dilution of the wastewater plume at the HEPA-LEPA boundary will ensure adequate dilution of all other parameters to meet the EQGs or all analytes of concern in Table 3-4. As the wastewater salinity is approximately one third of seawater, upon discharge from the outlet it forms a buoyant plume that rises to the surface.

Table 7-1 Summary of water quality data and dilution calculations (GHD 2021a)

Parameter	Units	C_O	C_T	C_A	D
Nitrate	mg/L	2.8	0.70	0.0025[13]	4
Boron	mg/L	2.0	5.10	NA	NA[14]
Salinity	PSU	11.93[15]	34.75[16]	35[16]	**92**
Water Treatment Chemicals					
Sodium Molybdate	mg/L	152.7[17]	50 (*Acohs, 2014*)	0	3
THPS (Biocide)	mg/L	381.7[17]	15 (*Frayne, 2017*)	0	25
Phosphonates (PBTC)	mg/L	77.4[17]	33.3 (*NM&C Co., 2015*)	0	2
Phosphonates (HEDP)	mg/L	77.4[17]	3 (*SPE Chemicals, 2020*)	0	26
Polyacrylate	mg/L	2.9[17]	100 (*Recyc PHP, 2020*)	0	No dilution required
Azole	mg/L	38.2[17]	100 (*Ibis Water, 2019*)	0	No dilution required
Molybdate	mg/L	119.1[17]	41 (*HACH, 2017*)	0	3
Colour Legend:					
ANZECC & ARMCANZ (2000) Physical and Chemical Stressors for Inshore Marine Water – south-west Australia.					
ANZECC & ARMCANZ (2000) Low reliability trigger value for marine waters.					
Conservative mixing zone target of <0.25 PSU change from ambient conditions.					
Lowest toxic concentration reported in the SDS.					

The near-field and far-field dispersion modelling were used to predict the spatial extent that a 92-fold dilution occurs over a range of flow rates from 5 L sec^{-1} (estimate of initial flow rate upon commissioning) to 72 L sec^{-1} (estimate of potential maximum flow rate in future) from the KSIA outfall to inform the size of the LEPA on the basis of the salinity EQG.

Near field modelling predicted that the buoyant plume reaches the sea surface at a horizontal distance of 6-9 m from the outlet, so the near-field zone is estimated to be within 10 m of the discharge point. The average plume dilution (i.e. average dilution across the plume width) at the end of the near-field zone was 480-fold for the stage 1 moderate flow rate (5 L sec^{-1}), 197-fold for the stage-1 peak flow rate (15 L sec^{-1}) and 58-fold for the stage 2 peak flow rate (72 L sec^{-1}). The plume centreline dilution (i.e. lowest dilution in the centre of the plume centre where a lower degree of mixing with ambient waters occurs) was 137-fold, 75-fold and 28-fold for the stage 1 moderate, stage 1 peak and stage 2 peak flow rates, respectively. The stage 1 moderate flow rate of 5 L sec^{-1} is predicted to achieve the target dilution of 92-fold in close proximity to the outlet (i.e. within 5 m) for both the average and centreline plume dilution. The average plume dilution for the stage 1 peak flow (15 L sec^{-1}) was predicted to meet the 92-fold dilution target, however the centreline of the plume is predicted to require additional far-field dilution to achieve the dilution target to meet the HEPA EQG for salinity. Both the average and centreline plume dilution are predicted to not meet the 92-fold dilution target in the near-field for the state 2 peak flow rate of 72 L sec^{-1}, thereby additional far-field dilution is required to meet the HEPA EQG for salinity.

Far-field modelling with MIKE3 FM predicts that the 92-fold dilution target (i.e. achievement of the HEPA salinity EQG) for the stage 1 peak flow of 15 L sec^{-1} will be achieved within ~20 m of

[13] Ambient concentration assumed to be 50% of the ANZECC & ARMCANZ (2000) default guideline trigger value for physical and chemical stressors (not toxicants) in inshore marine waters of south-west Australia.

[14] Outlet concentration below mixing zone criterion – no dilution required.

[15] Salinity (PSU, or ppt) is calculated from the TDS concentration.

[16] LEPA salinity target of 34.75 PSU represents a salinity change of 0.25 PSU from ambient (ambient assumed to be 35 PSU, which is standard for marine water in south-west Australia).

[17] Outlet concentration estimated as 7.7 x the RO feedwater concentration as described in bullet-point two of this appendix.

the outlet for summer and winter conditions (Figure 7-1). In contrast the substantially higher stage 2 peak discharge of 72 L sec^{-1} is predicted to extend up to 100 m from the outlet for the summer case to meet the HEPA salinity EQG requirement of a 92-fold dilution (Figure 7-1).

On the basis of the far-field predictions a **70 m radius around the outlet** is recommended as the LEPA. This aligns with typical LEPA sizing for marine areas adjacent to wastewater discharges as outlined in the technical guidance (*EPA, 2016c*). Marine waters outside of the 70 m radius around the outlet (i.e. the LEPA) are to be classified as HEPA. Further rationale for a 70 m radius around the outlet as the spatial extent of the LEPA includes:

- Ability to accommodate potential future changes in wastewater quality relative to those evaluated in this assessment that may require greater dilution (e.g. future waste streams from additional users of the marine outfall pipe).
- In the event a stage 2 peak discharge of 72 L sec^{-1}, the 92-fold dilution requirement is predicted to not be met within 70 m of the outlet with the current single discharge nozzle. It is recommended that a second outlet (or nozzle) spaced approximately 10-20 m to the west of the stage 1 outlet to meet a 92-fold dilution requirement.

This modelling assessment will be updated as the comingled water quality and flow rates have greater certainty to assess the adequacy of the 70 m radius around the outlet for the LEPA.

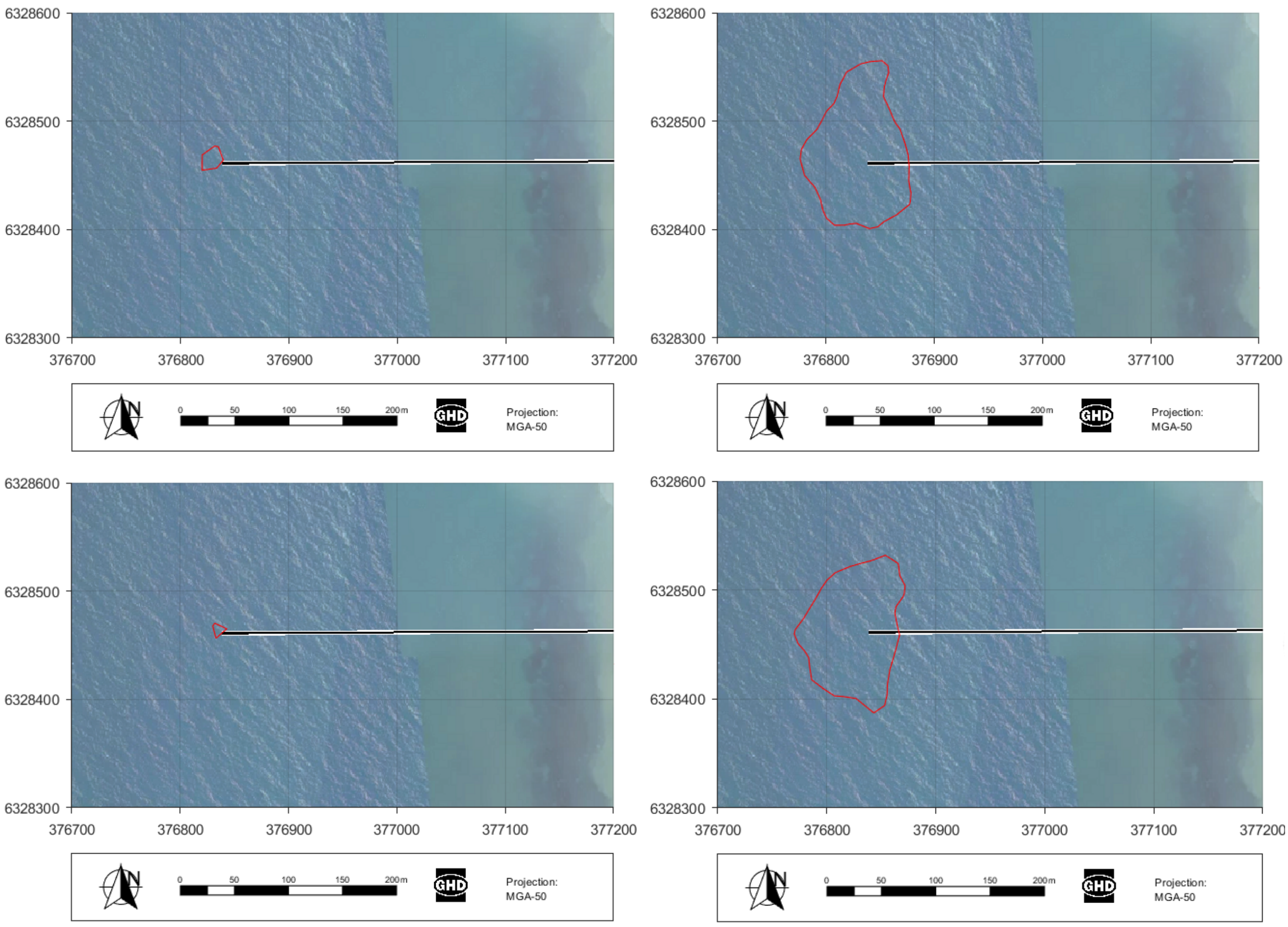

Figure 7-1 Maximum predicted extent to achieve a dilution of 92-fold or greater for the summer simulation (top) and winter simulation (bottom) for Stage 1 peak flow of 15 L sec^{-1} (left) and Stage 2 peak flow of 72 L sec^{-1} (right) (*GHD, 2021a*)

Appendix B – CTD Verification Procedure of GHD (2021a) LEPA Predictions

The following procedure is recommended to verify the GHD (2021a) predictions of the spatial extent of water quality degradation from the proposed KSIA outlet waters:

- This procedure is to be carried out in addition to a routine monitoring survey as specified in Section 4.
- Additionally CTD profiles through the water column will be acquired as follows:
  - Directly over the outlet.
  - At 10 m intervals along transects from the outlet locations towards each of the three down-current sites at the LEPA-HEPA boundary that are established as per Section 4.1.1. Because the discharge is a buoyant plume, particular attention to proper surface CTD measurements is imperative.
- Salinity is the primary tracer. Calculate the dilution of the wastewater with marine waters using the following formula:

$$D_{iz} = \frac{S_O - S_A}{S_{iz} - S_A}$$

  where:

  D_{iz} = Dilution estimate at CTD measurement at transect site i and depth z

  S_O = Outlet salinity (measured as per Section 4.3.2)

  S_{iz} = Transect site salinity (measured as per Section 4.3.1)

  S_A = Ambient (background) salinity (measured as per Section 4.3.2 at the reference sites)

  Assess whether dilution (D) greater than the 92-fold target is achieved at the HEPA-LEPA boundary.

- Verify model predictions in Appendix A where for:
  - Stage 1 with a moderate outlet discharge of 5 L/s that at least a 92-fold dilution occurs within a 10 m horizontal distance of the outlet.
  - Stage 1 with a peak outlet discharge of 15 L/s that at least a 92-fold dilution occurs within a 20 m horizontal distance of the outlet.
- Reporting:
  - If the model predictions are satisfactory (i.e. accurate or conservative) then report in the Schedule 2 Annual Report (Section 6.5).
  - If the model predictions of dilution are too high, then notify DWER of non-compliance within two (2) days and provide a non-compliance report within one (1) month as per EQS exceedance reporting specifications in Section 6.1.

GHD

Level 10
999 Hay Street
T: OfficeTelephone F: OfficeFax E: OfficeEmail

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