Marine Environmental Quality Plan

Port Hedland Spoilbank Marina

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TEAL SOLUTIONS environmental advisory

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Acronyms and Abbreviations

Acronyms/Abbreviation	Description
ANZECC	Australia and New Zealand Environment Conservation Council
ANZG	Australia and New Zealand Guidelines for Fresh and Marine Water Quality
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
BOM	Bureau of Meteorology
BTEXN	Benzene, toluene, ethylbenzene, xylenes and naphthalene
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DEC	Department of Environment and Conservation
DER	Department of Environmental Regulation
DGV	Default Guideline Value
DoH	Department of Health
DoE	Department of Environment
DoT	Department of Transport
EMS	Environmental Management System
EPA	Environmental Protection Authority
EQMF	Environmental Quality Management Framework
EQI	Environmental Quality Indicator
EQC	Environmental Quality Criteria
EQO	Environmental Quality Objective
EQG	Environmental Quality Guideline
EQS	Environmental Quality Standard
EVs	Environmental Values
LEP	Level of Environmental Protection
NWQMS	National Water Quality Management Strategy
NTU	Nephelometric turbidity units
OEMP	Operational Environmental Management Plan
PAH	Polycyclic Aromatic Hydrocarbons
PPA	Pilbara Ports Authority
PHMEQSAP	Port Hedland Marine Environmental Quality Sampling and Analysis Plan
SAP	Sampling and Analysis Plan
SPL	Species Protection Level
SWQMS	State Water Quality Management Strategy No 6
TBT	Tributyltin
TOC	Total organic carbon
TRH	Total recoverable hydrocarbons
TSS	Total suspended solids

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1. Introduction

1.1. Background

The Town of Port Hedland, together with LandCorp and the Pilbara Development Commission, are proposing to develop of a marina in Port Hedland. The Spoilbank Marina (the Marina) will be located on the western side of the Spoilbank, adjacent to the Port Hedland Yacht Club and will include a four-lane boat ramp, up to 80 boat pens and a ~1 km channel to provide access to the Port Hedland Outer Channel (**Figure 1-1**).

In 2006, the Department of Environment (DoE) published the *Pilbara Coastal Water Quality Consultation Outcomes* to provide an Environmental Quality Management Framework (EQMF) for protecting the marine environmental quality of Pilbara coastal waters. In 2020, the Pilbara Ports Authority (PPA) developed the Port of Port Hedland Marine Environmental Quality Sampling and Analysis Plan (PHMEQSAP) (O2 Marine 2020) in accordance with the EPA's *Technical Guidance for Protecting the Quality of Western Australia's Marine Environment* (EPA 2016). The PHMEQSAP provides an update of the original DoE (2006) EQMF and recognises the significant development within the Port of Port Hedland since 2006.

1.2. Project Description

The Marina will be located on Lot 5751 and Lot 5550 on a site commonly known as the 'Spoilbank' which is an artificial coastal landform created in the late-1960s/early-1970s from the disposal of material dredged from Port Hedland's inner harbour and shipping channel. The Project will replace the existing Richardson Street boat ramp (which will be closed) and redirect boating activities away from the commercial operations of Port Hedland's inner harbour and navigation channel (Town of Port Hedland 2019). The Marina will include a four lane boat ramp, 80 boat pens, 208 trailer and 86 car parking bays, dry dock area for commercial vessels, public and pen holder amenities, public open space, and recreation and event space (**Figure 1-1)**.

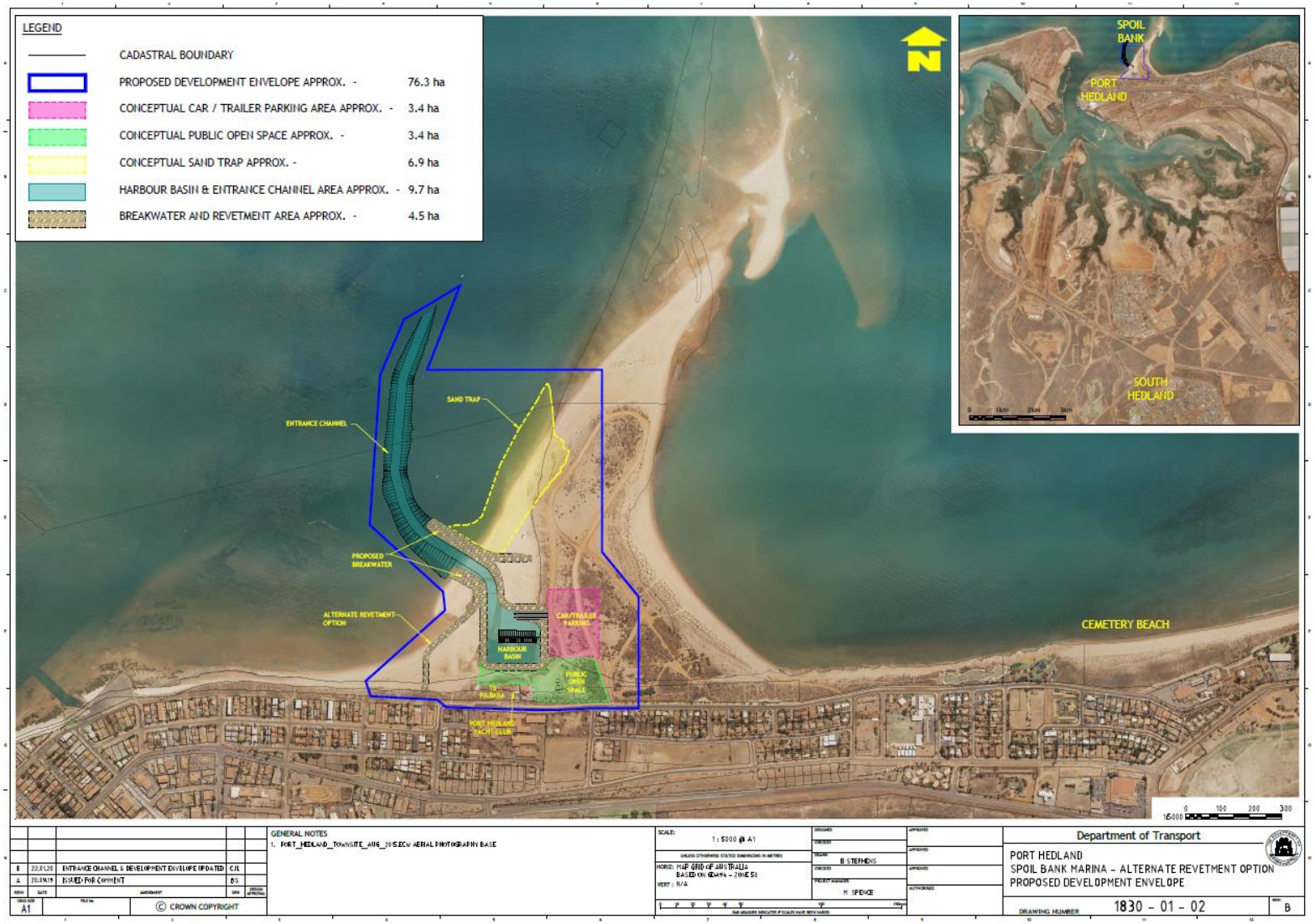


Figure 1-1 Spoilbank Marina concept design

1.3. Purpose

The purpose of this Marine Environmental Quality Plan (MEQP) is to manage the marine environmental quality adjacent to the Marina to ensure that the operation of the Marina does not adversely affect marine water quality in the Port Hedland area. The MEQP provides a framework to monitor, characterise and report long-term trends in marine water and sediment quality within the Marina and surrounding waters and the document forms part of the Operational Environmental Management Plan (OEMP) for the proposed Marina.

This MEQP aligns with the PHMEQSAP developed by the Pilbara Ports Authority to manage marine water quality in the Port of Port Hedland and surrounding waters.

1.4. Scope and Objectives

This Plan has been developed to achieve the following specific objectives:

- Briefly summarise the EQMF for the Port of Port Hedland as described in the PHMEQSAP;
- Outline the proposed changes to the Environmental Quality Plan (i.e. Spatial Levels of Ecological Protection) to account for the Marina design footprint;
- Outline the water and sediment quality sampling and analysis procedures to:
    - Ensure collection, analysis and reporting of water and sediment quality data in a consistent and robust manner;
    - Facilitate the development of an appropriate baseline dataset that effectively characterises water and sediment quality in the Marina and surrounding waters;
    - Provides a suitable basis on which to inform future management strategies to maintain and/or improve water and sediment quality in the Marina and surrounding waters.

This Plan will be implemented in the following in two phases:

- Phase I (Years 0-3) – Initial Baseline Data Collection; and
- Phase II (Ongoing) – Monitor, Investigate and Review.

No management actions are included during Phase I which is dedicated to baseline data collection. This data will then be used to determine management thresholds for action during Phase II. The monitoring and management during Phase II is designed to detect spatial and/or temporal changes within marine environmental quality and ensure identified Environmental Values are being achieved throughout the life of the marina.

1.5. Approach

The approach to development of the EQMF for the Port of Port Hedland was undertaken in a manner consistent with the EPAs technical guidance (EPA 2016) and is described in the PHMEQSAP. The approach included the identification of Environmental Values (EVs), Environmental Quality Objectives (EQOs), Level of Environmental Protection (LEP) and Environmental Quality Criteria (EQC).This

approach was based on the principles and guidelines of the National Water Quality Management Strategy (NWQMS) (2018), with particular regard to the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG 2018). The focus of the approach is on maintaining existing environmental quality, identifying where management and/or remediation actions may be required and to measure the effectiveness of these actions.

As the proposed Marina is located within the Port of Port Hedland waters, this EQMF has adopted the EQMF as applied within the PHMEQSAP. The EQMF is described in further detail in Section 2.

The structure of this Plan is outlined in **Table 1-1**.

Table 1-1 Structure of the Plan

Section	Heading	Description
Section 1	Introduction	Background to the Plan, including the purpose and scope relevant to the Plan.
Section 2	Environmental Quality Management Framework	Summary of the EQMF and definition of the EVs, EQOs and LEPs.
Section 3	Environmental Quality Criteria	Defines the Environmental Quality Criteria as they relate to the EQOs.
Section 4	Monitoring	Identifies the monitoring and methodologies to be undertaken.
Section 5	Assessment of Monitoring Results	Describes how monitoring data should be assessed in the context of the EQMF.
Section 6	Review	Describes requirements for review of the Plan.

2. Environmental Quality Management Framework

Environmental Quality Management Frameworks (EQMF) are a mechanism to enable the National Water Quality Management Strategy Guidelines No. 4 and 7 (ANZECC/ARMCANZ 2000). In Western Australia, this approach has been incorporated into the State Water Quality Management Strategy No.6 (SWQMS) (GWA 2004). The EPA offers further guidance on the development and application of this framework approach to ensure a consistent and standardised approach for measuring and reporting on marine environmental quality across Western Australia (EPA 2016).

EVs, EQOs and LEP areas were determined for all Pilbara coastal waters, including Port Hedland in 2006, by the Department of Water and Environmental Regulation (previously Department of Environment). Subsequently, this approach has been applied to specific development projects within the Port of Port Hedland and endorsed through the State Government's environmental approvals process.

The *Pilbara Coastal Water Quality - Consultation Outcomes Study* (DoE, 2006) undertook a comprehensive community and stakeholder consultation process in 2006 to seek public input on how the EQOs and their LEP areas should be allocated spatially throughout the region so as to protect EVs held by the community. During 2015 the Port Hedland Industry Council commissioned a review and revision of the framework to cover the 'whole of Port' operations and activities (O2 Marine 2016). Extensive stakeholder consultation was undertaken during this process to ensure the EVs, EQOs and boundaries of the LEP areas were aligned to meet the expectations of the community (O2 Marine 2016).

This 'whole of Port' framework was further revised and refined for implementation by PPA in the current version of the PHMEQSAP (O2 Marine 2020). The EVs and EQOs defined herein are consistent with those presented in the PHMEQSAP. However, the boundaries of the LEP areas proposed in this Plan are slightly modified to accommodate the proposed Marina footprint. The approach to the development of the EQMF is outlined below and summarised in **Figure 2-1**.

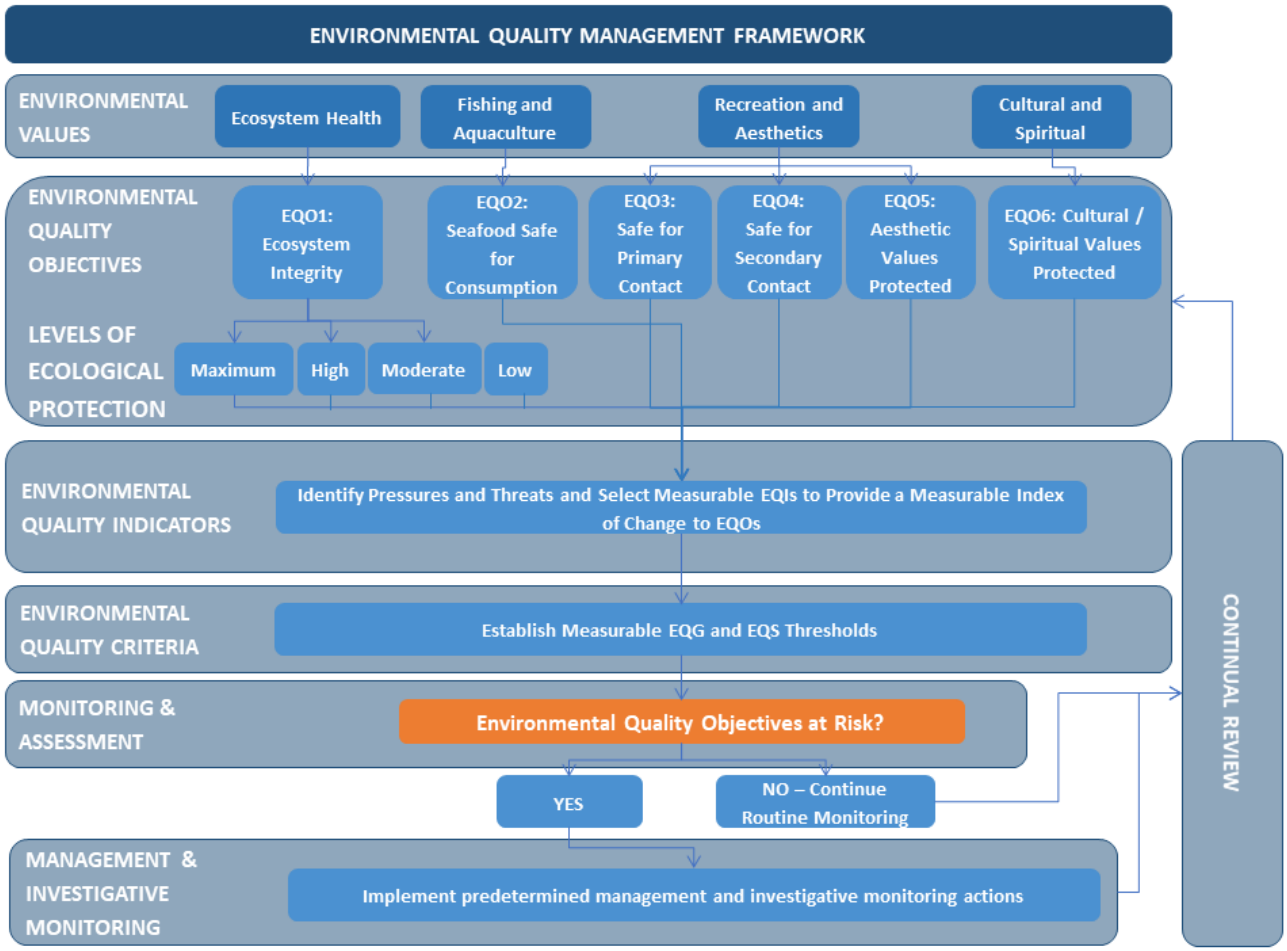


Figure 2-1 Overview of the Environmental Quality Management Framework applied within this Plan

2.1. Environmental Values and Environmental Quality Objectives

Environmental Values (EVs) are defined as 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 (ANZG 2018). The Environmental Quality Objectives (EQOs) are high-level management objectives that describe what must be achieved to protect each EV (EPA 2016).

The EVs and associated EQOs for Port Hedland have been established in the PHMEQSAP (O2 Marine 2020) and the EVs and associated EQOs relevant to the Marina are presented in **Table 2-1**.

Table 2-1 Environmental Values and Environmental Quality Objectives applicable for the Marina and surrounding waters

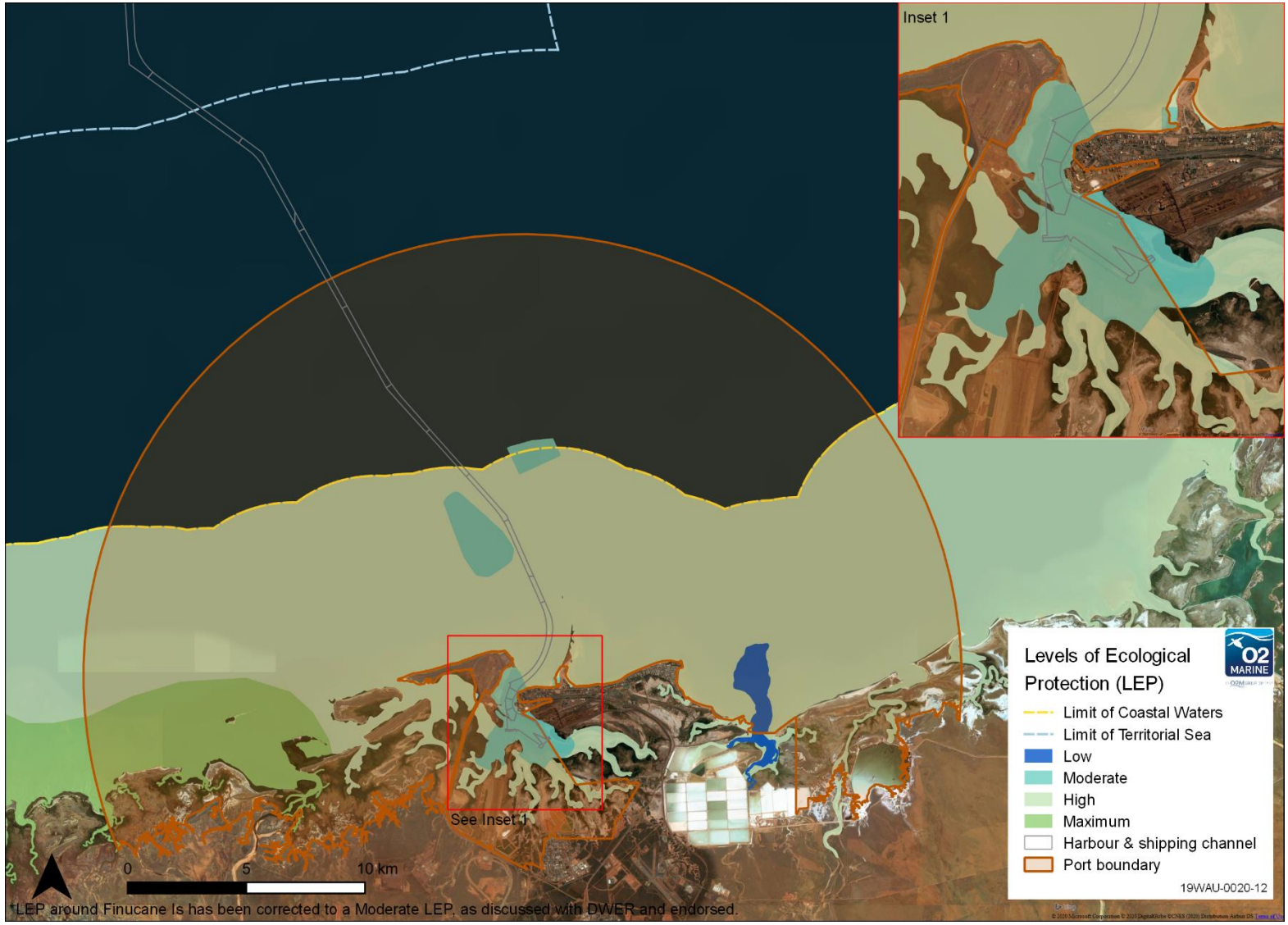
Environmental Values	Environmental Quality Objectives
Ecosystem Health	EQO1: Maintenance of ecosystem integrity. EQO1 is split into four sub-objectives, being: Maximum, High, Moderate and Low Levels of Ecological Protection (LEPs) (Refer Section 2.2 below).
Fishing & Aquaculture	EQO2: Seafood (caught) is of a quality safe for human consumption.
Recreation & Aesthetics	EQO3: Water quality is safe for primary contact recreation (e.g. swimming and diving). EQO4: Water quality is safe for secondary contact recreation (e.g. fishing and boating). EQO5: Aesthetic values of the marine environment are protected.
Cultural & Spiritual	EQO6: Cultural and spiritual values of the marine environment are protected.

2.2. Levels of Ecological Protection

The 'Ecosystem Health' Environmental Quality Objective is divided into four Levels of Ecological Protection (LEP): Maximum, High, Moderate and Low which are spatially delimited. Each LEP area is assigned an acceptable limit of change, allowing for areas important for conservation to be maintained in areas of Maximum LEP, whilst recognising that societal uses may preclude either a 'Maximum' or 'High' LEP from being achieved in other areas.

LEP areas have been defined for Port Hedland and surrounding waters in the Pilbara Coastal Water Quality Consultation Outcomes (DoE 2006) and in the PHMEQSAP (**Figure 2-2**). A consolidated LEP spatial dataset was also accessed through the DWER website on the 27th November 2019, which includes the most recent LEP areas as approved by the EPA in accordance with Part IV of the EP Act.

To accommodate the proposed Marina it is proposed to modify the existing Moderate LEP area in the vicinity of the Spoilbank (**Figure 2-3).** As appropriate to the proposed Marina and this EQMF, only Moderate and High LEP areas are spatially applied, whereas the PHMEQP establishes Low and Maximum LEP areas as relevant to Port operations.



Note: LEP boundaries shown are based on DWER spatial data accessed on 27/11/2019

Figure 2-2 Spatial LEPs as presented within the PHMEQSAP

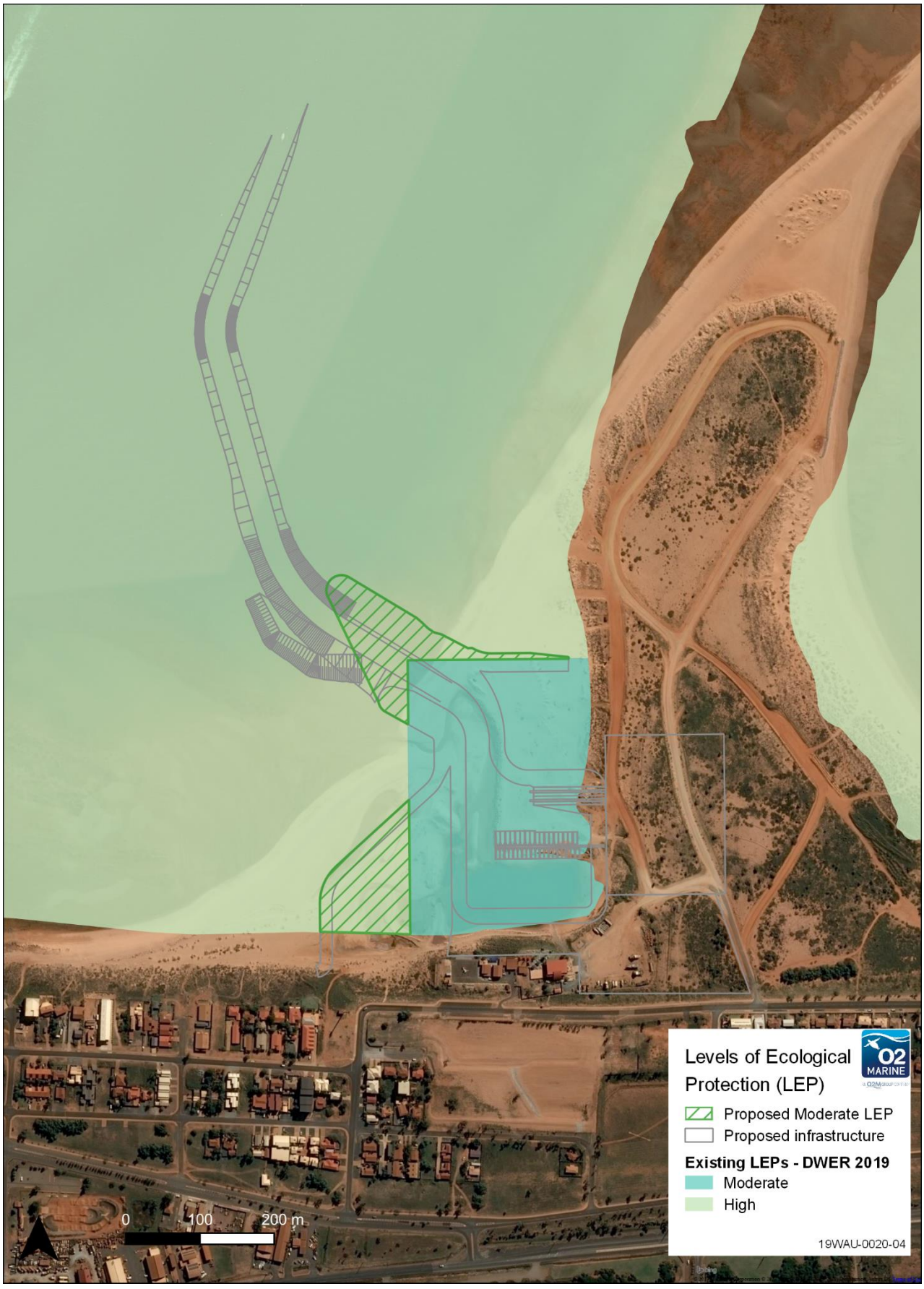


Figure 2-3 Proposed Spatial Levels of Ecological Protection to accommodate the proposed Marina

3. Environmental Quality Criteria

Environmental quality criteria (EQC) are quantitative benchmarks used to measure the performance of environmental management action in achieving the EQOs, and thereby protecting the corresponding EVs. The EQC for the Marina are adopted from the PHMEQSAP which were established via the following steps:

1. Identifying the pressures and threats to the quality of the marine environment in the Port of Port Hedland and surrounding waters;
2. Developing a conceptual model to demonstrate the pressure response relationship of the key threats to environmental quality;
3. Selecting the relevant Environmental Quality Indicators (EQI); and
4. Defining specific EQC to identify early-warning and unacceptable changes to EQI specific for each EQO.

Section 3.1 provides a summary of those EQIs described in the PHMEQSAP, which are relevant to the Marina, whilst the remainder of this chapter describes the EQC applicable to each EQI.

3.1. Environmental Quality Indicators

Environmental Quality Indicators (EQIs) are measurable parameters selected to monitor changes in environmental quality for each EQO. The proposed EQIs for the Marina have been adopted from the PHMEQSAP and are presented in **Table 3-1**. Further details regarding how and why these EQI were selected for the Port of Port Hedland are described in Appendix C of the PHMEQSAP (O2 Marine 2020).

Table 3-1 Environmental Quality Indicators for the Marina

Ecosystem Health (EQO1)	Recreation and Aesthetics (EQO3, EQO4 & EQO5)
< Toxicants in water	< Pathogenic bacteria
< Toxicants in sediment	< Nuisance Organisms
< Toxicants in biota	< Faunal Deaths
< Physico-chemical water constituents	< Visual Clarity & Reflectance
	< pH
	< Oil/Debris/Wrack
	< Odour

Note: EQI are not specified for the EVs '*Fishing and Aquaculture'* and '*Cultural and Spiritual'* as these are considered to be protected through monitoring EQI for the EVs *'Ecosystem Health'* and *'Recreation and Aesthetics'*.

3.2. Environmental Quality Criteria

EQC are generally quantitative thresholds which comprise Environmental Quality Guidelines (EQG) and more robust Environmental Quality Standards (EQS).

> ***Environmental Quality Guidelines (EQG)*:** Threshold numerical values (or narrative statements) which if met, indicate that there is a high degree of certainty that the associated EQO has been achieved. If the EQG is not met, then there is uncertainty as to whether the associated EQO has been achieved, and a more detailed assessment against an 'Environmental Quality Standard' (EQS) is triggered. This assessment is risk-based and investigative in nature.
>
> ***Environmental Quality Standards (EQS)*:** Threshold numerical values (or narrative statements) that indicate a level beyond which there is a significant risk that the associated EQO has not been achieved and a management response is triggered. The response would normally focus on identifying the cause/source of the exceedance and eradicating or reducing the contaminant of concern.

Site specific EQG are defined for the Port of Port Hedland in the PHMEQSAP and summarised in the remainder of this chapter. Note that the EQS are not finalised in the PHMEQSAP, as the intention of the Phase I monitoring program is to collection sufficient baseline data to enable the EQS to be defined. The EQS for the Marina will be defined once sufficient baseline data has been collected to define the natural background water and sediment quality of the Port of Port Hedland and surrounding waters through co-implementation of this Plan and the PHMEQSAP.

3.2.1. Environmental Quality Guidelines

Environmental Quality Guidelines summarised below accord with the EQGs established within the PHMEQSAP. These values were typically derived from ANZG (2018), however CSIRO (2006), DEC (2006), WP (2012) and DoH (2017) were also applied in lieu of available guidelines or where site specific information was available. These are discussed in more detail in the PHMEQSAP.

At the completion of the baseline collection phase, and in accordance with the PHMEQSAP, site specific EQGs will be derived for ongoing monitoring.

Ecosystem Health

EQGs for Ecosystem Health have been developed largely on pre-existing guideline trigger values and unimpacted background levels for marine waters and sediments in the area. The proposed EQGs applicable to the EV *'Ecosystem Health'* and corresponding EQO1 *'Maintenance of ecosystem integrity'* are presented below.

In respect of EQO1, EQGs have been derived for the following EQI constituents (**Table 3-1**):

- Toxicants in water (see **Table 3-2)**;
- Toxicants in sediments (see **Table 3-3)**; and
- Physico-chemical constituents in water (**Table 3-4)**.

Toxicants in Water

EQG for toxicants in water are summarised in **Table 3-2.**

Table 3-2 Environmental Quality Guidelines for Toxicants in Water.

EQI	Units	EQG	
		Moderate	High
Aluminium	(µg/L)	Impact < reference 95th percentile	0.5
Antimony		Impact < reference 95th percentile	Impact < reference 95th percentile
Arsenic (III/V)	(µg/L)	Impact < reference 95th percentile	Impact < reference 95th percentile
Cadmium	(µg/L)	14	0.7
Chromium III/VI	(µg/L)	49/20	7.7/0.14
Copper	(µg/L)	3	0.3
Iron	(µg/L)	Impact < reference 95th percentile	Impact < reference 95th percentile
Lead	(µg/L)	6.6	2.2
Manganese	(µg/L)	Impact < reference 95th percentile	Impact < reference 95th percentile
Mercury	(µg/L)	0.7	0.1
Nickel	(µg/L)	200	7
Silver	(µg/L)	1.8	0.8
Vanadium	(µg/L)	160	50
Zinc	(µg/L)	23	7
TRH C6-C14	(µg/L)	25	25
TRH C15-C36	(µg/L)	100	100
BTEXN - Benzene - Toluene - Ethylbenzene - Xylene[1] - Napthalene	(µg/L)	 900 230 110 100 90	 500 110 50 50 50
TBT	(µgSn/L)	0.02	0.0004

Notes:

[1] Xylene based upon m-Xylene from ANZG (2018)

Toxicants in Sediments

EQGs for toxicants in sediment are summarised in **Table 3-3**.

Table 3-3 Environmental Quality Guidelines for toxicants in Sediment

EQI	Units		
		Moderate	High
Aluminium[1]	mg/kg	4100	4100
Antimony	mg/kg	2	2
Arsenic[1]	mg/kg	20	20
Cadmium	mg/kg	1.5	1.5
Chromium	mg/kg	80	80
Copper	mg/kg	65	65
Iron[1]	mg/kg	13300	13300
Lead	mg/kg	50	50
Manganese[3]	mg/kg	170	170
Mercury	mg/kg	0.15	0.15
Nickel[2]	mg/kg	21	21
Silver	mg/kg	1	1
Vanadium[1]	mg/kg	36	36
Zinc	mg/kg	200	200
TRH[4] Total C6-C14 C15-C36	mg/kg	 250 25 100	 250 25 100
Low Molecular weight PAHs[5]	µg/kg	552	552
High Molecular weight PAHs[6]	µg/kg	1700	1700
Total PAHs	µg/kg	4000	4000
TBT	µg/kg Sn	5	5

[1] Derived using baseline data from DEC (2006)
[2] Derived from baseline data collected from Port Hedland reference sites in 2012 (WP 2012)
[3] Derived using baseline data collected from Port Hedland reference sites in 2010 (WP 2012a)
[4] Derived using the lowest limits of reporting available
[5] Low molecular weight PAHs are the sum of acenaphthalene, anthracene, fluorene, 2-methylnaphthalene, naphthalene and phenanthrene
[6] High molecular weight PAHs are the sum of benzo(a)anthracene, benzo(a)pyrene, chrysene, dibenzo(a,h)anthracene, fluoranthene and pyrene

Physico-chemical Water Constituents

EQG for physico-chemical constituents in water are summarised in **Table 3-4**Error! Reference source not found..

Table 3-4 Environmental Quality Guidelines for physico-chemical water quality constituents

EQI	Units	EQG	
		Moderate	High
Dissolved oxygen	% saturation	80%	90%
Temperature	°C	Impact median between reference 5th & 95th percentiles	Impact median between reference 20th & 80th percentiles
Salinity	o/oo		
pH			
Turbidity	NTU		
Chlorophyll-α	µg/L		

Fishing and Aquaculture

Fishing is a popular recreational activity within the waters surrounding the Marina and the EV '*Fishing and Aquaculture'* and the corresponding EQO2: *'Seafood (caught) is of a quality safe for human consumption'* are applicable to Port waters.

The primary threats to human consumers of seafood are considered to relate to contamination of filter feeding shellfish by faecal pathogens (e.g. bacteria), the accumulation of biotoxins from toxic algae and/or the accumulation of toxic chemicals in the flesh of the shellfish (EPA 2015). Filter feeding shellfish filter large quantities of water to obtain their food which has the potential to result in the accumulation of significant quantities of pathogens and other contaminants that can cause serious illness in humans (EPA 2015).

For people that collect and eat wild shellfish the DoH suggests that they may be putting their health at risk and recommends that the public only eat shellfish harvested commercially under strict quality assurance monitoring programs. It should be noted that EQC for toxic algae and bacteria do not protect the fish populations themselves. To protect the wild seafood populations from the effects of environmental contamination the environmental quality guidelines and standards for maintaining ecosystem integrity (EQO1) are recommended. These should aim to protect the harvested species as well as the food webs, habitats and other environmental processes that support them. For these reasons, under the scope of this Plan, the EQO for Fishing and Aquaculture (EQO2) is deemed to be met if the EQOs for Ecosystem Health (EQO1), and Recreation & Aesthetics (EQO, EQO4 and EQO5) are achieved.

Recreation and Aesthetics

The proposed EQG applicable to the EV of *'Recreation & Aesthetics'* and the corresponding EQOs of '*Water quality is safe for primary contact recreation (e.g. swimming and diving)' (EQO3)*, '*Water quality is safe for secondary contact recreation (e.g. fishing and boating)' (EQO4*), and '*Aesthetic values of the marine environment are protected'* (*EQO5*) are presented in **Table 3-5**.

Table 3-5 Environmental Quality Guidelines for the Protection of the EV '*Recreational and Aesthetics*'

EQI	Safe for Primary contact (EQO3)	Safe for Secondary contact (EQO4)	Aesthetic Values Protected (EQO5)
Pathogenic Bacteria	The 95th percentile^ bacterial content of marine waters should not exceed 200 enterococci/100 mL	The 95th percentile^ bacterial content of marine waters should not exceed 2,000 enterococci/100 mL	NA
Nuisance Organisms$	The toxic phytoplankton cell count* from a single site, should not: – Exceed 10 000 cells/mL; or – Detect DoHWA watch list species or exceed their trigger levels. OR There should be no reports of skin, eye or respiratory irritation or potential algal poisoning of recreational users considered by a medical practitioner as potentially resulting from toxic algae when less than 10 000 cells/mL is present in the water column.	The median toxic phytoplankton cell count* for a defined sampling area (either from one sampling run or from a single site over an agreed period of time) should not exceed 25 000 cells/mL. OR There should be no reports of skin, eye or respiratory irritation or potential algal poisoning of recreational users considered by a medical practitioner as potentially resulting from toxic algae when less than 25 000 cells/mL is present in the water.	Phytoplankton scums, filamentous algal mats, blue-green algae and sewage fungus should not be present in excessive amounts (i.e. Moderate/High levels as defined in Table 3-7).
pH	The median of the depth profile should not exceed the range of 5–9 pH units.	The median of the depth profile should not exceed the range of 5–9 pH units.	NA
Fauna Deaths	NA	NA	There should be no reported incidents of large-scale deaths of marine organisms resulting from un-natural causes.
Oil/Debris/Wrack	NA	NA	Oil and petrochemicals should not be noticeable as a visible film on the water nor should they be detectable by odour. Water surfaces should be free of floating debris, dust and other objectionable matter, including substances that cause foaming. Floating seagrass / macroalgal wrack should not exceed 25% surface coverage.
Odour	There should be no objectionable odour.		

^ The Department of Health Western Australia (DoHWA) has produced The Enterotester for calculating 95th percentile statistics from five consecutive years of data for enterococci bacteria.
* Phytoplankton cell counts include cyanobacteria and eukaryotic organisms.
† Algal scums are defined as dense accumulations of algal cells at or near the surface of the water forming a layer of distinct discolouration (green, blue, brown or red) (Gov QLD, 2002).
$ See Table 3-6 and Table 3-7 for more details on nuisance organisms and algal scums.

The DoH watch list species and associated trigger levels that are defined as EQG for the EQI *'Nuisance Organisms'* are documented in **Table 3-6**. DoH (2017) has also developed a risk assessment for algal scum in marine waters shown in **Table 3-7** and these have been adopted as EQGs to ensure EQO5 is met.

Table 3-6 DoH watch list for potentially toxic algae in recreational waters

Algal Group	Algal Genus/Complex	Key Species	EQG (DoH Watch List Trigger Levels) (cells/L)	EQS (DoH Watch List Action Levels) (cells/L)
Cyanobacteria	*Lyngbya*	*L. majuscula*	≥0.01	Relatively widespread visible presence of algal filaments (NHMRC 2008)
	Trichodesmium		Detected	Presence of algal scums (NHMRC 2008)
	Other		≥5,000	≥15,000
Dinoflagellates	*Karenia*	*K. brevis*	≥5,000	≥10,000*
		Other sp.	≥50,000	≥100,000*
	Pfiesteria		≥0.01	Presence of algal scums (NHMRC 2008)

* This is a temporarily assigned action level for which the DoH may consider it appropriate to issue a public health warning and/or provide information/advice, having consideration for the specific monitoring event and result in the overall situation/context.

Table 3-7 DoH risk assessment for algal scum in marine waters to inform aesthetic EQG assessment for EQO5

Algal Scum		~ Total Area of Scum (m^2)			
Characteristics	**Location**	**1 to 25**	**25 to 100**	**>100**	
patchy/sporadic in nature	1. along shoreline at recreational beach/area	Moderate	High	High	Risk Level
	2. within swimming zone at recreational beach (< 500m from shoreline)	Low	Moderate	High	
	3. > 500m offshore	Low	Low	Moderate	
	4. along shoreline (nonrecreational area) e.g. rocky outcrop, boat harbour/marina.	Low	Low	Moderate	
	5. < 500m from shoreline (nonrecreational area) e.g. rocky outcrop, boat harbour/marina	Low	Low	Moderate	
Continuous aggregation	1. along shoreline at recreational beach/area	Moderate	High	High	
	2. within swimming zone at recreational beach (< 500m from shoreline)	Moderate	High	High	
	3. > 500m offshore	Low	Low	Moderate	
	4. along shoreline (non-recreational area) e.g. rocky outcrop, boat harbour/marina.	Low	Low	Moderate	
	5. < 500m from shoreline (non-recreational area) e.g. rocky outcrop, boat harbour/marina	Low	Low	Moderate	

Cultural and Spiritual

Inclusion of the EV, *'Cultural and Spiritual Values'* in this Plan recognises the cultural and spiritual values of Port Hedland and surrounding waters to the indigenous people of the area. However, consistent with EPA (2016) and ANZG (2018), no specific EQC are provided for assessment against the environmental quality objective that *'Cultural and spiritual values of the marine environment are protected'* (EQO7). It is considered that ensuring that the quality of these waters is sufficient to maintain ecosystem integrity (EQO1), protect the quality of seafood (EQO2), allow people to recreate safely (EQO3 & EQO4), and maintain aesthetic values (EQO5) will protect the cultural and spiritual values (EQO6).

4. Monitoring

4.1. Monitoring Objectives

The proposed monitoring program aligns with the PHMEQSAP with respect to methods, timing, data analysis and reporting and is intended to:

- Ensure collection, analysis and reporting of water and sediment quality data in a consistent and robust manner;
- Facilitate the development of an appropriate baseline dataset that effectively characterises water and sediment quality in the Marina and surrounding waters;
- Provides a suitable basis on which to inform future management strategies to maintain and/or improve water and sediment quality in the Marina and surrounding waters.

4.2. Monitoring Program Overview

The Marina project monitoring and management program has been divided into two phases as presented in **Table 4-1**.

Table 4-1 Marina monitoring program

Phase	Type	Period	Rationale
I	Initial Baseline Data Collection	Baseline	Phase I is aimed at collection of representative site-specific data to facilitate the derivation of site specific EQG and EQS through which operational impacts can be assessed within the designated LEP boundaries
II	Monitor, Investigate and Review	Ongoing	Phase II monitoring will be less intensive, risk-based and will be informed by an environmental review and assessment of the Phase I monitoring results

4.3. Sampling Frequency

4.3.1. Phase 1 (Baseline) Monitoring

The baseline data collection monitoring program includes quarterly water quality sampling and annual sediment quality sampling. Where it is practical, sampling should be undertaken near to the same date each sampling round to allow for consistent comparison of seasonal trends. An indicative sampling schedule is provided in **Table 4-2**.

Table 4-2 Overview of sampling events to be undertaken during phase I

Sampling event	Water	Sediment	Program Year	Season	Month
1	X		1	Winter	July
2	X		1	Spring	October
3	X		1	Summer	January
4	X	X	1	Autumn	April
5	X		2	Winter	July
6	X		2	Spring	October
7	X		2	Summer	January
8	X	X	2	Autumn	April
9	X		3	Winter	July
10	X		3	Spring	October
11	X		3	Summer	January
12	X	X	3	Autumn	April

4.3.2. Phase II (Ongoing) Monitoring

Phase II will include annual water and sediment quality sampling, along with a reactive monitoring program (response to incidents or notifications) and tiered assessment against the derived EQC. Where practical, sampling should be undertaken on or near to the same date each sampling round to allow for consistent comparison of annual trends.

4.4. Sampling Locations

Sampling locations are proposed to be the same during both baseline (Phase 1) and Ongoing (Phase II) and will incorporate the following sites within the monitoring program:

- One within the High LEP; and
- One within the Moderate LEP.

Details of the monitoring locations and associated routine sampling tasks to be completed at each location are provided in **Table 4-3** and illustrated in **Figure 4-1.**

It is noted that suitable reference site data is being collected as part of the PHMEQSAP implementation and the data will be made available to support this monitoring program. However, in the event that PHMEQSAP data is not available for any reason in the future then appropriate reference monitoring locations will need to be established as part of this monitoring program.

Table 4-3 Monitoring locations and sampling tasks

Site Name	Site Reference	Level of Ecological Protection	Easting	Northing	Routine Sampling Tasks					
					Aesthetic Observations	Physico-chemical Water Column Profiling	Water Sample Collection			Sediment Sampling
							General Water Sample Analysis	Bacterial Sample Analysis	Phytoplankton Sample Analysis	
SBM1	This site is located within the Marina north of the vessel pens and adjacent to the recreational launching ramp	Moderate	666047	7753746	X	X	X	X	X	X
SBM2	This site is located to the north-west of the marina within the channel	High	665686	7754176	X	X	X	X	X	X

Coordinate reference system EPSG:7850 - GDA2020 / MGA Zone 50

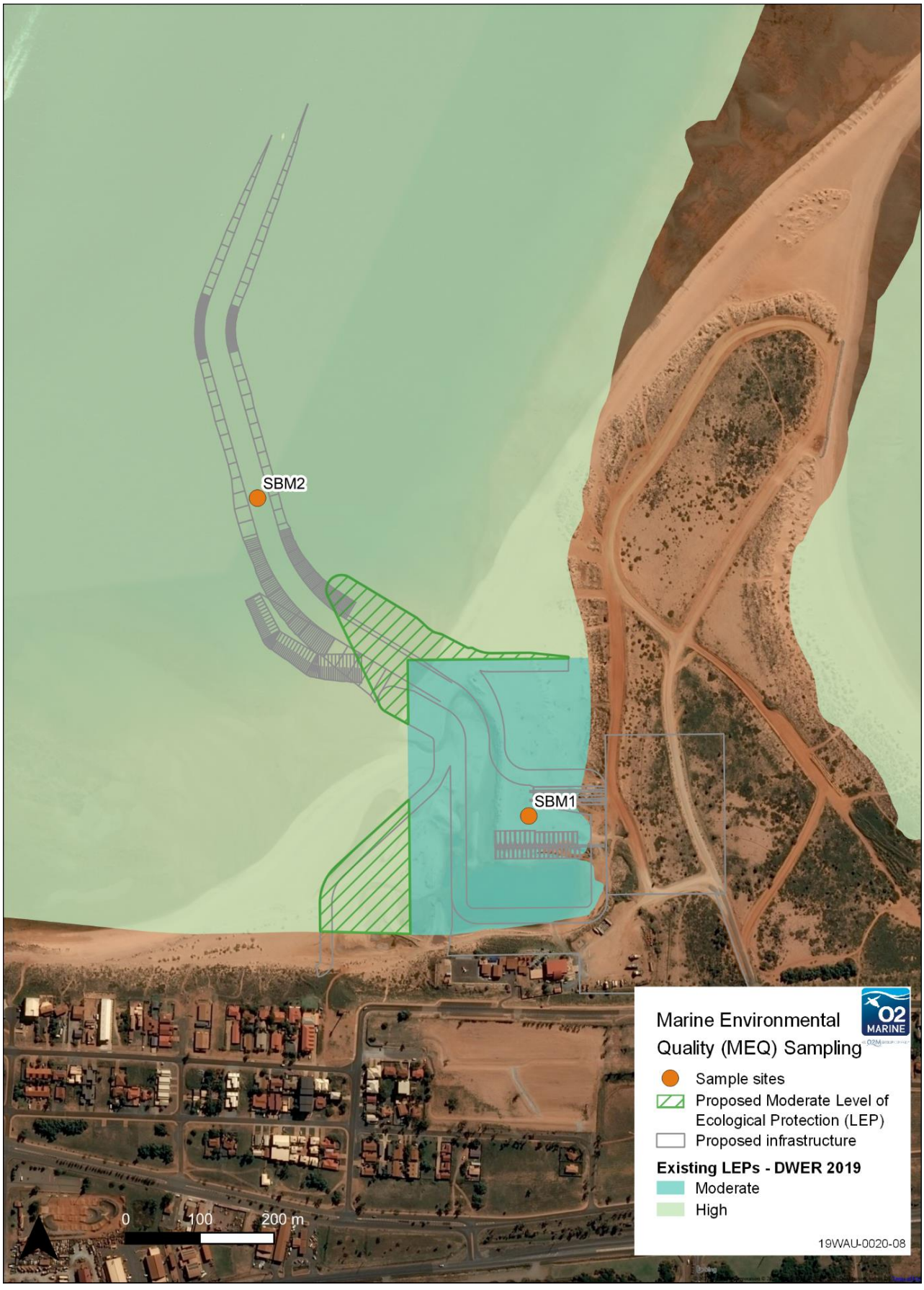


Figure 4-1 Sampling locations

4.5. Water Quality Sampling

The water quality sampling will consist of multiple environmental quality indicators to measure the impact of multiple pressures in the Marina and surrounding waters. The environmental indicators proposed for the water quality program include:

- General water quality observations and aesthetic assessment;
- Physico-chemical parameters (profiling);
- Toxicants and nutrients in water; and
- Pathogens in water.

Water quality sampling will be implemented in accordance with frequencies identified for Phase I or Phase II and at all sites outlined in **Table 4-3**.

4.5.1. Observations

General Observations

The following field observations are to be recorded at each location during each sampling event:

- Date and time of sampling at each location;
- Person conducting sampling;
- Site reference;
- GPS coordinates of sampling location;
- Tides and water depth at the time of sampling;
- Wind speed (km/hr) and direction;
- Air temperature (oC) – recorded using a digital thermometer;
- Sea state (i.e. wave and swell heights); and
- General weather conditions (rain, storms, cloud cover, etc).

Digital photographs should also be taken throughout the monitoring event as weather conditions change and as required to document any notable site observations. Field logs are to be scanned and stored in PPA's records management system and attached as an appendix in the quarterly and annual reports.

Aesthetic Observations

At each sampling location, observations of aesthetic water quality parameters should be recorded for each of the quick reference guide categories provided in **Table 4-4**. Aesthetic observations are to consider waters within an approximate 50 metre radius of the survey vessel.

Table 4-4 Aesthetic observations quick reference guide

Parameter	REF	1	2	3	4	5
Nuisance organisms (Surface coverage %)	A	Nil	1-10	11-50	51-80	100+
Large-scale deaths (Marine fauna)	B	Nil	1-10	11-51	51-81	100+
Oil/Film (Surface coverage)	C	Nil	1-10%	11-50%	51-80%	81-100%
Natural reflectance (Diminished)	E	81-100%	51-80%	11-50%	1-10%	Nil
Seagrass Wrack (Surface coverage)	F	Nil	1-10%	11-50%	51-80%	81-100%
Objectionable odour	F	Nil	Slight	Moderate	Strong	Offensive

4.5.2. Physico-chemical Water Column Profiles

A pre-calibrated, Water Quality Sonde (i.e. YSI ProDSS or equivalent) should be used to collect physico-chemical water quality profiles at all 12 sampling locations. As a minimum, the following parameters should be measured at 0.5 metre (m) intervals throughout the water column:

- Depth (m);
- Water temperature (oC);
- pH;
- Salinity (ppt);
- Electrical Conductivity (mS/cm);
- Turbidity (NTU); and
- Dissolved oxygen (% saturation & mg/L).

All recorded measurements should be stored on the sonde hand-held unit and downloaded to a secure server within 24 hours. The data should be immediately assessed to ensure validity and, any erroneous data should be removed from the analysis as appropriate.

4.5.3. Water Sample Collection

Water samples will be collected at each routine sampling location identified in **Table 4-3** and presented in **Figure 4-1**. Water samples are collected using a depth-integrated water sampler[1] to pump the required volume of water evenly from the water column between 0.5 m below the surface to 0.5 m above the seabed.

The water sampler should be rinsed with Decon solution (or equivalent) between samples. Water samples will be collected in suitable (laboratory supplied) bottles and immediately stored on ice for transport to a National Association of Testing Authorities (NATA) accredited laboratory for analysis.

[1] If a depth-integrated water sampler is not available, a pole sampler or niskin bottle (or equivalent) may be used to sample at a depth of 0.5m below the surface. Near-surface sampling is generally considered to be representative of water quality at the sample sites as waters in Port Hedland experience a high degree of mixing.

All sample containers will be marked with a unique identifier, the date/time and the sampler's name and clarification that the samples are *marine water* using a waterproof permanent maker. All samples should then be listed on a Chain of Custody (CoC) form and that form will be included with the samples sent to the laboratories.

4.5.4. Laboratory Analysis

General water sample analysis will be performed on samples collected from each routine monitoring location. These samples should be sent to the NATA-accredited laboratory for analysis of:

- Heavy Metals (Ag, Al, Cd, Cr, Cu, Fe, Pb, Mn, Hg, Ni, Sb, Zn, As, V);
- Total Recoverable Hydrocarbons (TRH);
- Benzene, toluene, ethylbenzene, xylene, napthalene (BTEXN);
- Polyaromatic Hydrocarbons (PAHs);
- TBTs;
- Nutrients (Total nitrogen, Nitrate/Nitrite, Ammonia, Total Phosphorus and Orthophosphorus); Chlorophyll-α);
- Phytoplankton identification and enumeration; and
- Bacterial analysis (i.e. Thermotolerant coliforms, E. coli & Enterococci).

4.5.5. Quality Assurance & Quality Control (QA/QC)

Field QA/QC

All water quality instruments are to be calibrated prior to use. If monitoring equipment is hired, calibration certificates are to be provided from the supplier. Calibration records are to be saved and attached as an appendix to the annual report.

The following QA/QC Sample should be collected as described below:

- A ***replicate sample*** is collected at the same site as one of the primary monitoring samples. The purpose of the sample is to confirm that the primary laboratory is able to produce consistent results when analysing the same sample. The site where it was taken is to be recorded but not reported to the laboratory. Ideally it should be collected at a site that is expected to have higher levels of contamination (based on historic data and potential sources of contamination) as this will confirm a wider range of analytes and reduce the level of instrument error when comparing larger concentrations.

Replicate sampling is not required for bacteriological analysis (i.e. *E.coli*, Enterococci and thermotolerant coliforms) or for phytoplankton identification and enumeration.

Laboratory QA/QC

Comprehensive 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).

4.6. Sediment Quality Sampling

4.6.1. Sediment Sample Collection

Sediment samples should be collected at each of the routine sampling locations identified in **Table 4-3** and presented in **Figure 4-1**. Sediment samples should be collected using a 'van Veen' grab or equivalent. The grab, plastic tray and other equipment in contact with the sediment should be rinsed with Decon solution and seawater prior to sampling each site to reduce potential for contamination. Where insufficient sediment is collected (i.e. less than 1/3rd of grab volume), the grab should be redeployed. Estimate and record volume of sediment collected and empty the grab into a plastic tray to mix and homogenise the sediment. Photograph each sample once emptied into the plastic tray. Place sample into sample jars/ containers provided by laboratory. Containers should be refrigerated or placed into an esky with ice bricks before frozen on return to port and sent to a NATA approved laboratory.

All samples containers should be marked with a unique identifier, the date/time and the sampler's name and clarification that the samples are *marine water* using a 'Wet-write' permanent maker. All samples should then be listed on a Chain of Custody (CoC) form and that form should be included with the samples sent to the laboratories.

4.6.2. Laboratory Analysis

Sediment samples collected from each routine sampling locations, should be sent to the NATA-accredited laboratory for analysis of:

- Heavy metals (Al, Sb, As, Cd, Cr, Cu, Fe, Pb, Mn, Hg, Ni, Ag, V, Zn);
- Total Recoverable Hydrocarbons (TRH);
- Organotins (TBT, DBT and MBT);
- Polyaromatic Hydrocarbons (PAH);
- Benzene, toluene, ethylbenzene, xylene & Napthalene (BTEXN);
- Total Organic Carbon (TOC); and
- Particle size distribution.

4.6.3. Sediment Sampling QA/QC

Field QA/QC

Disposable nitrile gloves should be used during handling of the sediment sample and all equipment in contact with the sediment should be washed down with Decon solution prior to each sample being taken. The following QA/QC Samples should be collected as described below:

- A ***triplicate sample*** (i.e. three separate samples taken with the sediment grab at the same location) should be taken at one (1) site to determine the variability of the sediment physical and chemical characteristics.
- A ***field split sample*** (i.e. one sediment grab sample thoroughly mixed and then split into three sub-samples) should be collected at collected at one (1) site to assess inter and intra-laboratory variation, with one of the three samples sent to a second laboratory.

- A ***transport blank*** (acid-washed silica sand) in a sealed jar should be provided by the laboratory and taken to site but not opened. The transport blank is sent back to the laboratory with the other samples and analysed. This blank is used to assess if any contamination is already present in the acid-washed sand or container.
- A ***method blank*** (acid-washed silica sand) should be used to assess the potential for contamination during the sampling process. The method blank should be placed into the 'van Veen' grab and processed identically to the usual sediment samples. The method blank should be sent to the laboratory and analysed with the other samples to assess presence of contamination during the processing procedures.

Laboratory QA/QC

Laboratories used for sediment sample analysis must be NATA accredited. Comprehensive QA/QC testing of sediment samples should 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).

4.7. Phase II Additional Monitoring (As Required)

Monitoring for Phase II routine water and sediment quality sampling will be undertaken in accordance with the methods identified for Phase I, including any revised processes associated with the Phase I review. However, if required, additional Phase II monitoring may also include:

- Reactive monitoring programs to be developed in response to observed or notified incidents, such as: oil spill, algae bloom, fish kills and/or nuisance odours; and/or
- Targeted investigations in the event routine sampling indicates exceedances of the EQGs. Investigation should facilitate assessment against EQS and ultimately assess impacts against EQOs.

5. Assessment of Monitoring Results

Monitoring results are to be assessed to enable determination of whether the EQOs are being achieved, and hence whether the EVs for the Marina and surrounding waters are protected. Assessment of the monitoring results is to be undertaken in the following two phases, described in **Table 5-1**:

- Phase I – Initial Baseline Data Collection; and
- Phase II – Monitor, Investigate and Review.

Table 5-1 Phases for assessment of monitoring results

Phase	Timing	Assessment of Monitoring Results
Phase I – Initial Baseline Data Collection	Baseline data collection	Monitoring results are to be assessed and reported against the EQCs presented herein. However, these results should be treated with caution and will ultimately be used to review and refine the EQCs after the completion of Phase I.
Phase II – Monitor, Investigate & Review	Ongoing monitoring	Monitoring results which exceed the EQG shall be investigated. Any EQS exceedance shall be reported and an appropriate management response should be considered in accordance with Operational Environmental Management Plan. Biennial review of the Plan and monitoring data shall be undertaken and shall inform future monitoring requirements (e.g. sampling frequency, analytical suite).

The EQC presented in **Section 3.2** provide a basis upon which to assess marine environmental quality monitoring results and subsequently determine whether or not the EQOs have been achieved. A traffic light assessment of the monitoring results should be made for each EQI, at each site, and for each sampling event. The Phase II monitoring and assessment program shall include (**Figure 5-1**):

- Routine annual monitoring;
- Reactive monitoring; and
- Investigative monitoring (see also **Figure 5-2**).

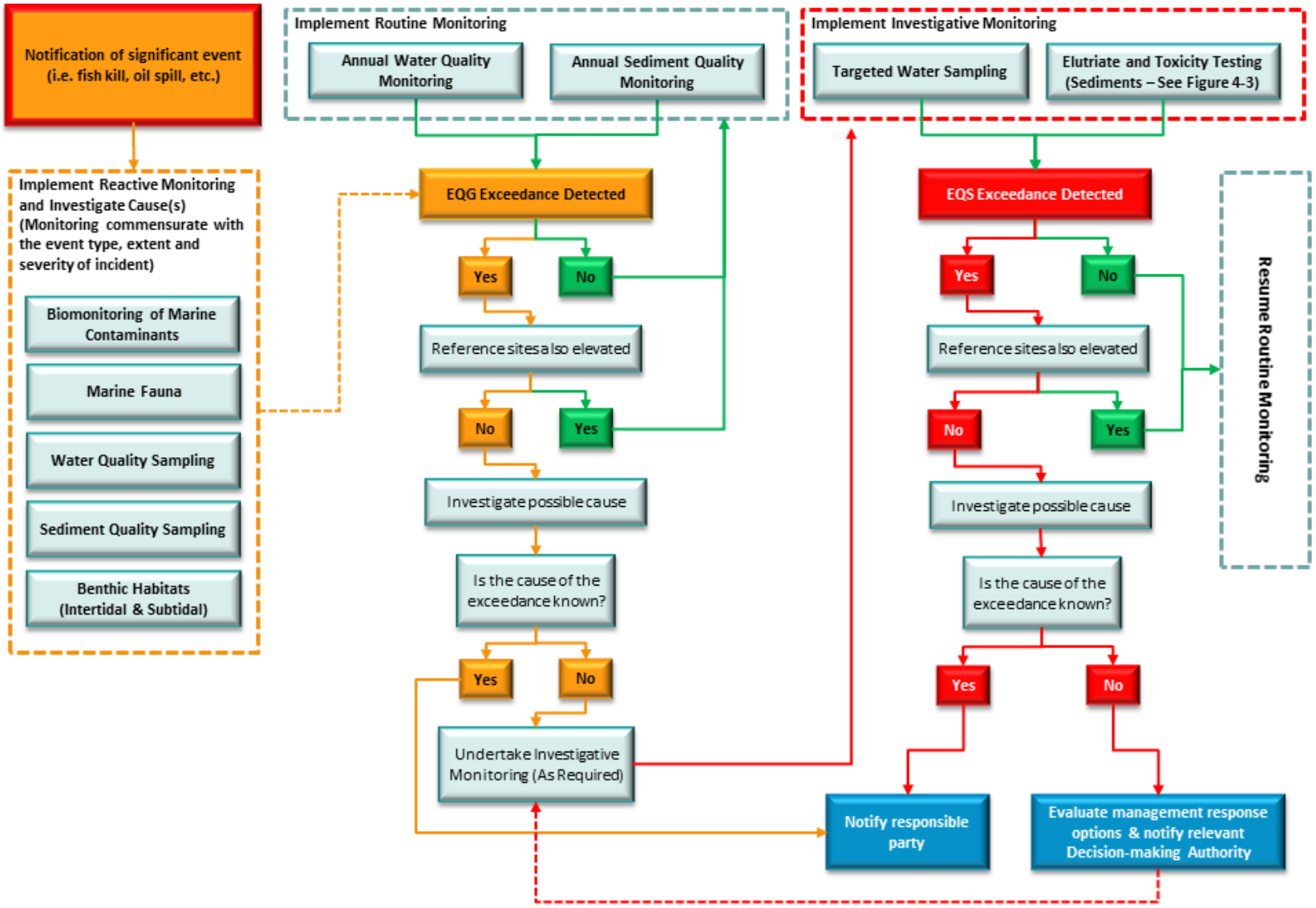


Figure 5-1 Framework for monitoring, assessment and management actions during Phase II program

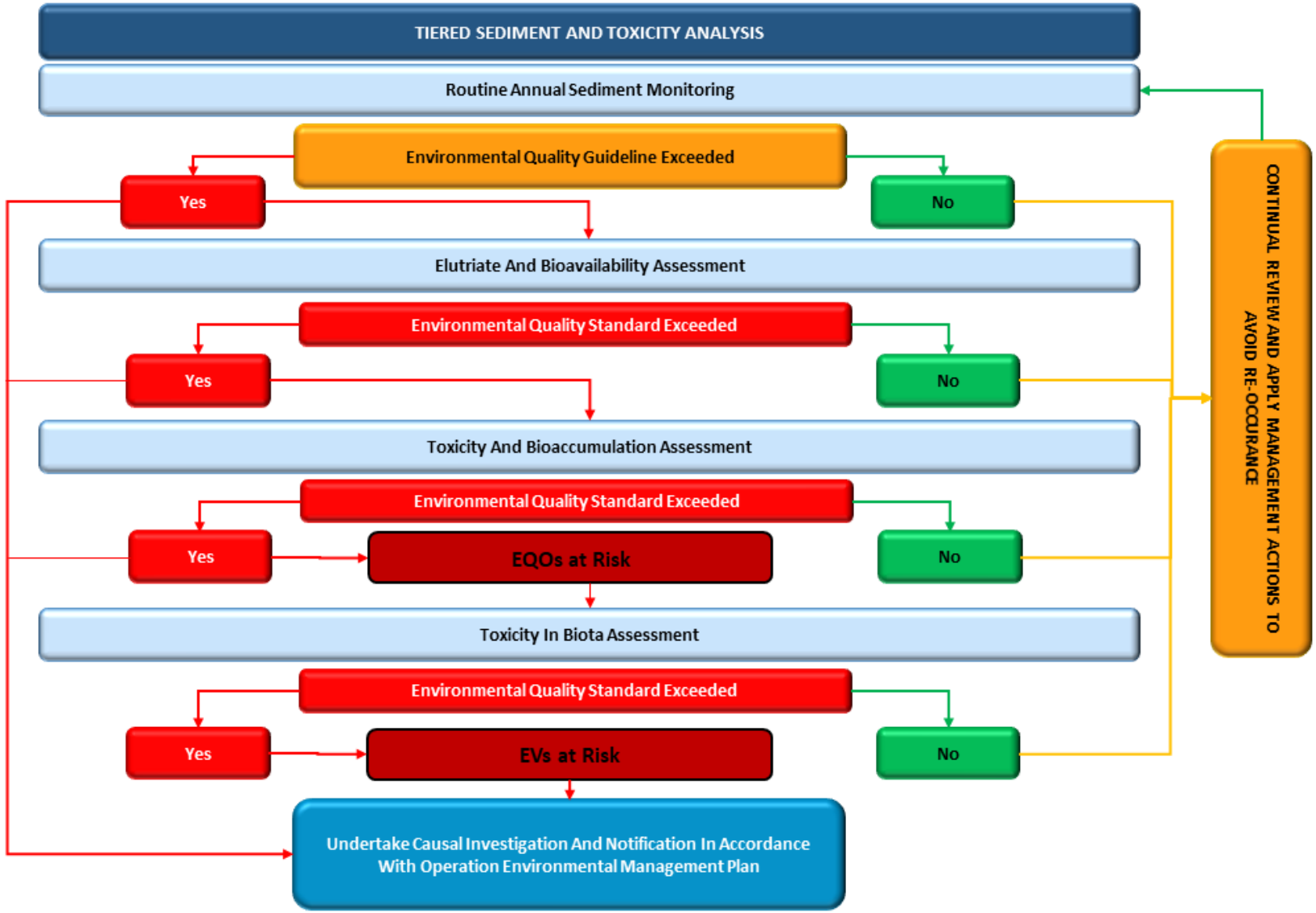


Figure 5-2 Tiered assessment and management actions required for sediment quality monitoring under the Phase II program

A 'traffic light system' shall be used to report the results (**Table 5-2)**. Green shall signify that the EQG have been met, indicating there is a high degree of certainty that an EQO has been achieved. 'Amber' shall signify that the results do not meet the EQG and there is uncertainty as to whether an EQO is likely to be achieved. Red shall indicate that the results do not meet the EQS and that the EQO is not likely to be achieved and the respective EV may be at risk.

Table 5-2 Traffic light assessment of monitoring results

Traffic Light Assessment	Green	Amber	Red
Monitoring Results	**EQG Met**	**EQG Not Met**	**EQS Not Met**
Risk of Harm to Environmental Values			
Environmental Quality Objectives	**EQO Achieved**	**EQO At Risk**	**EQO Not Achieved**
Outcome: Baseline Monitoring	**Continue Routine Monitoring**		
Outcome: Ongoing Marine Monitoring	**Continue Routine Monitoring**	**Monitor & Investigate**	**Evaluate Management Response Options**

6. Review

DoT is committed to conducting activities in an environmentally responsible manner and aims to implement reviews of its environmental management as part of a program of continual improvement. In keeping with this commitment to continual improvement, this Marine Environmental Quality Plan shall be reviewed at the completion of each Monitoring and Management Phase or following any major changes within Marina waters that could affect the EVs. During each review consideration shall be given to:

- Overall effectiveness of this Marine Environmental Quality Plan;
- Appropriateness of the EVs, EQOs, LEPs, and EQC;
- New threats to marine environmental quality within and adjacent to the Marina;
- Lessons learned during sampling or analysis;
- Review of the EQC as the baseline dataset grows;
- Changes in industry best practice, environmental risk profile, policy or legislation, and
- Any improvement in methods or equipment used.

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