Woodside Energy

PROPOSED BROWSE TO NORTH WEST SHELF PROJECT

ERD RESPONSE TO SUBMISSIONS

APPENDIX B.1 - State Waters Environmental Quality Management Plan

November 2023

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1. SUMMARY

Woodside Energy Ltd (Woodside) is Operator for and on behalf of the Browse Joint Venture (BJV), comprising Woodside Browse Pty Ltd, Shell Australia Pty Ltd (Shell), BP Developments Australia Pty Ltd (BP), Japan Australia LNG (MIMI Browse) Pty Ltd (MIMI), and PetroChina International Investment (Australia) Pty Ltd (PetroChina). The BJV proposes to develop the offshore Brecknock, Calliance, and Torosa fields (collectively known as the Browse hydrocarbon resources) using two 1,100 million standard cubic feet per day (MMscfd) (annual daily export average) Floating Production Storage and Offloading (FPSO) facilities.

The FPSO facilities will be supplied by a subsea production system and will transport gas to the existing North West Shelf (NWS) Project infrastructure via an ~85 km subsea spur line and a ~900 km proposed Browse Trunkline (BTL), which will tie-in near the existing North Rankin Complex (NRC) in Commonwealth waters (Note: The NRC is owned by the North West Shelf Joint Venture (NWSJV) and operated under separate approvals).

The proposed Browse Project is described in the draft Environmental Impact Statement / Environmental Referral Document (draft EIS/ERD). Note that while proposed Browse Project infrastructure and activities will be located in both State and Commonwealth waters, the scope of this Environmental Quality Management Plan (EQMP) is limited to activities that may impact marine environmental quality within the Western Australia state Proposal Area only. As such, only these activities are described in this document (**Section 2.2**). Environment Plans (EPs) for activities in Commonwealth and State waters will also be prepared in accordance with the relevant Commonwealth legislation, and unless potentially affecting the State Proposal Area, are not discussed further in this plan.

This EQMP was prepared in accordance with the Environmental Protection Authority's (EPA) *Instructions on how to prepare Environmental Protection Act 1986 Part IV Environmental Management Plans* (EPA, 2020) and the *Technical Guidance Protecting the Quality of Western Australia's Marine Environment* (EPA, 2016).

Table 1-1 presents the key definitions used within this EQMP, as based on EPA (2016).

Table 1-1: Key definitions

Term	Definition
Environmental Quality Management Framework (EQMF)	The framework adopted by the EPA and described in this guidance for managing the quality for the marine environment to meet the EPA's objectives and the community and stakeholder's long-term desires. The main output of the EQMF is the Environmental Quality Plan and Environmental Quality Management Plan.
Environmental Value (EV)	Particular value or use of the environment that is important for a healthy ecosystem or for public benefit, welfare, safety or health and that requires protection from the effects of pollution, waste discharges and deposits.
Environmental Quality Objective (EQO)	A specific management goal for a designated part of the environment that signals the level of environmental quality needed to protect the environmental value.
Environmental Quality Plan (EQP)	A plan that identifies the environmental values that apply to an area and spatially maps the zones where the environmental quality objectives (including levels of ecological protection) should be achieved.
Level of Ecological Protection (LEP)	A level of environmental quality desired by the community and stakeholders for the EQO maintenance of ecological integrity.
Environmental Quality Criteria (EQC)	Environmental quality guidelines and/or standards.

Term	Definition
Environmental Quality Guideline (EQG)	A threshold numerical value or narrative statement which if met indicates there is a high degree of certainty that the associated environmental quality objective has been achieved.
Environmental Quality Standard (EQS)	A threshold numerical value or narrative statement that indicates a level which if not met indicates there is a significant risk that the associated environmental quality objective has not been achieved and triggers a management response.

This EQMP details the measures that are required to manage the potential impacts to marine environmental quality within the State Proposal Area from the proposed Browse Project. **Table 1-2** summarises the information contained in this EQMP.

Table 1-2: EQMP summary table

Title of Proposal	Proposed Browse Project (State Proposal Area)
Proponent Name	Woodside Energy Ltd (Woodside), as Operator for and on behalf of BJV
Purpose of the EQMP	This Environmental Quality Management Plan (EQMP): • identifies the Environmental Values (EVs) to be protected • establishes the Environmental Quality Objectives (EQOs) to ensure the selected EVs are maintained • establishes Environmental Quality Criteria (EQC) for indicators relevant to the discharges • spatially defines areas of low, moderate, high and maximum Levels of Ecological Protection (LEP), which were developed based on the likely footprint from drilling discharges and changes in water quality from marine discharges including hydrotest fluids and FPSO cooling water discharges • presents an adaptive management program based on the Environmental Quality Management Framework (EQMF as defined in EPA (2016)) designed to ensure the EQOs continues to be achieved in the event of specified changes to the discharge or other factors • presents the proposed management approach for drilling discharges at Torosa drill centres within the State Proposal Area.
EPA's relevant key Environmental Factors and objectives	**Key Environmental Factor: Marine Environmental Quality** **EPA Objective:** To maintain the quality of water, sediment, and biota so that environmental values are protected (EPA, 2018).
Key Provisions in the EQMP	Management of marine discharges to the marine environment to maintain ecosystem integrity.

2. CONTEXT, SCOPE, AND RATIONALE

2.1 Introduction

This section provides an overview of the activities associated with the proposed Browse Project relevant to the State Proposal Area. A full description of the proposed Browse Project is provided in Chapter 3 of the draft EIS/ERD.

As described in Chapter 2 of the draft EIS/ERD, the overall Project Area (encompassing both State and Commonwealth components) comprises:

- the proposed Browse Development Area (in which the Brecknock, Calliance, and Torosa fields, the FPSO facilities and the subsea production systems, including wells, will be located) (Figure 2-1 of the draft EIS/ERD)
- the pipeline corridor within which the proposed BTL and inter-field spur line will be located (Figure 2-2 of the draft EIS/ERD).

The State Proposal Area, which is the subject of the assessment under the *Environmental Protection Act 1986* (WA) (EP Act) and this EQMP, is located within the Browse Development Area and comprises all areas above the low water line (based on mean low water springs (MLWS)) and all waters within 3 nm of the territorial sea baseline, as shown in **Figure 2-1**.

This EQMP will be implemented following receipt of approval under the EP Act and *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth) (EPBC Act) and subject to all necessary regulatory and joint venture approvals and commercial agreements being obtained. It should be noted that this EQMP is expected to be matured and finalised beyond the State Proposal assessment process as the design of the proposed Browse Project matures.

2.2 Proposal

Activities in the State Proposal Area (**Figure 2-1**) comprise a small subset of infrastructure and activities of the proposed Browse Project. Within the State Proposal Area, activities include the development of up to an estimated 20[1] wells and associated subsea infrastructure targeting the hydrocarbon resources within the Torosa reservoir. The remaining facilities and infrastructure will be located in Commonwealth waters. Extracted hydrocarbons will be transferred via subsea infrastructure, including Christmas trees, manifolds and flowlines, to the Torosa FPSO facility, located in Commonwealth waters.

Activities within the State Proposal Area are likely to be most intense during the drilling and completion period, installation period and future decommissioning phases. During this time, a Mobile Offshore Drilling Unit (MODU) and approximately ten vessels may be present simultaneously for a short duration. As all permanent infrastructure within the State Proposal Area is subsea, the operation of the wells will be controlled remotely via the Torosa FPSO facility that is located in Commonwealth waters. Outside of drilling and completion and installation periods, surface activities in the State Proposal Area will comprise periodic inspection, maintenance, monitoring and repair (IMMR) activities involving one or two vessels and later phase well construction and decommissioning (including well plug and abandonment).

It is noted that proposed Browse Project activities in Commonwealth waters may potentially impact on receptors in State waters (e.g. marine discharges), and these are also addressed within this Plan.

[1] The maximum number of wells within State waters has been reduced from 24 to 20 since preparation of the ERD as a result of the removal of the TRE well centre and associated infrastructure from the Proposal.

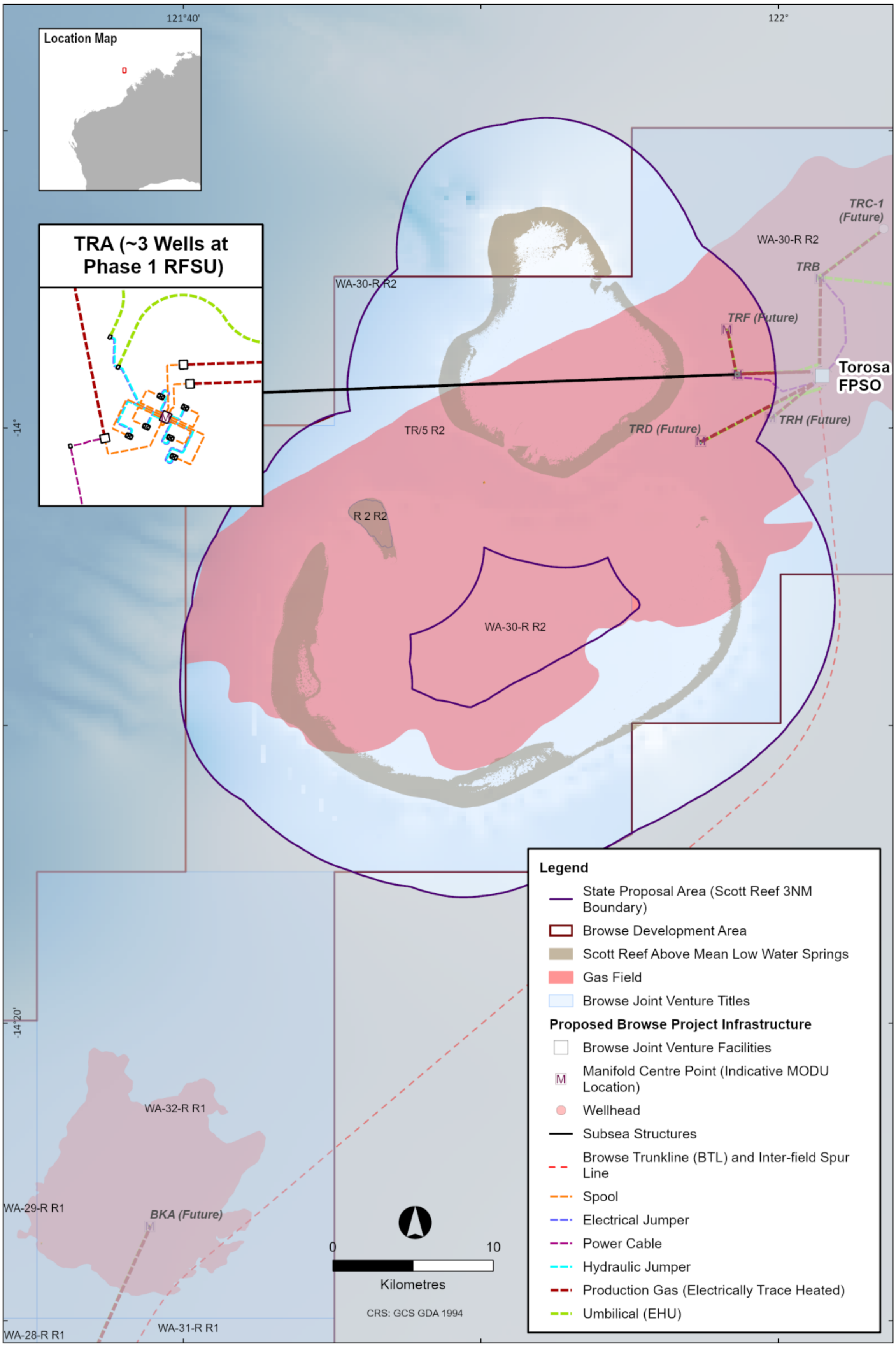

Figure 2-1 State Proposal Area

2.3 Purpose of management plan

This EQMP has been prepared in accordance with the *Technical Guidance Protecting the Quality of Western Australia's Marine Environment* (EPA, 2016). This document sets out an EQMF to achieve the objective of maintaining the EVs of the State Proposal Area. The approach to managing the proposed activities in a way that achieves this objective is based on a combination of impact assessment and early response indicators.

The impact pathways were assessed to determine if there is a risk of the proposed activities impacting the key relevant environmental factor: Marine Environmental Quality. Where the activity required management through design controls the risk was determined to be sufficiently managed.

This EQMP acknowledges that the nature of liquid discharges and the state of the receiving environment may change over the life of the proposed Browse Project. Therefore, this EQMP includes an adaptive management program (**Section 4**) to confirm that the management measures proposed continue to be appropriate and ensure protection of the environment value to be protected.

2.4 Scope of the EQMP

This EQMP specifically addresses the management of potential environmental impacts to the marine environment from planned discharges from the proposed Browse Project during the construction and operation phase in the State Proposal Area. Where discharges in Commonwealth waters may incur into the State Proposal Area, these have been considered within this EQMP. With the exception of produced water discharge from the Torosa FPSO, marine discharges from construction and operation activities that occur in Commonwealth waters that are not predicted to impact the State Proposal Area are outside of the scope of this EQMP. The impacts of all discharges in State and Commonwealth waters and the justification for their inclusion in this plan in terms of a management response is provided in **Section 3.3**.

2.5 EPA environmental factors

Key environmental factors are defined by the EPA as parts of the environment that may be impacted by an aspect of a proposal or scheme. They provide a specific approach to organising environmental information for the purpose of environmental impact assessment and a structure for the assessment report (EPA, 2016). The key environmental factor addressed in this EQMP is summarised in **Table 2-1**.

Table 2-1 The EPA definition and objective for relevant Key Environmental Factors

Key Environmental Factor	EPA Definition	EPA Objective for Environmental Factor
Marine Environmental Quality	The term '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. It does not include noise pollution, which is dealt with separately under the marine fauna factor (EPA, 2016).	To maintain the quality of water, sediment, and biota so that environmental values are protected (EPA, 2018).

2.6 Existing values of the State Proposal Area

A detailed description of the existing environment within the State Proposal Area is provided in Chapter 5 of the draft EIS/ERD. The values relating to the State Proposal Area include the following:

- benthic communities and habitats including:

  - Scott Reef, which encompasses the reef system including all coral habitats and communities (considered as the area above the 75 m bathymetric contour and within the 3 nm State waters boundary)
  - The deepwater benthic communities which are defined as those communities below the 75 m bathymetric contour within the State waters boundary
- plankton communities
- diverse fauna communities including EPBC Act and State *Biodiversity Conservation Act 2016* (BC Act) listed species
- habitat critical to the survival of a species for the green turtle Scott Reef-Browse Island genetic stock
- Biological Important Areas (BIAs) for species including the:
  - green turtle (nesting and internesting)
  - hawksbill turtle (nesting and internesting)
  - little tern (resting)
  - pygmy blue whale (migratory and possible foraging area)
- Key Ecological Features (KEFs) including:
  - Seringapatam Reef and Commonwealth waters in the Scott Reef Complex
  - Continental Slope Demersal Fish Communities KEFs
- socio-economic values including commercial, traditional and recreational fishers and scientific research.

2.7 Rationale and approach

The development of this EQMP follows the EPAs *Instructions on how to prepare Environmental Protection Act 1986 Part IV Environmental Management Plans* (EPA, 2020) and *Technical Guidance – Protecting the Quality of Western Australia's Marine Environment* EPA (2016). EPA (2016) describes an outline of an EQMF. The framework of this EQMP is shown in **Figure 2-2**.

This EQMP:

- identifies the EV(s) relevant to the State Proposal Area and associated EQOs. Maintenance of the EQOs is designed to ensure that the associated EVs are protected (**Section 3.2**)
- where residual risk exists, establishes spatially defined LEP (**Section 3.4.1**)
- establishes EQC for each LEP (**Section 3.4.2**). EQC represent scientifically based limits of acceptable change to a measurable environmental quality indicator that is important for the protection of the associated EV (**Section 3.4.2**). The EQMF requires appropriate EQC to be established to ensure an appropriate framework is in place for measuring the extent to which the EQO is maintained and therefore demonstrating the EV is being protected. Two types of EQC are defined under the EQMF:
  - Environmental Quality Guidelines (EQGs): These are quantitative investigative triggers that, if achieved, indicate there is a low probability that the EQO is not being achieved.
  - Environmental Quality Standards (EQSs): These are management triggers based on multiple lines of evidence, which, if exceeded, signify that the EQO may not be being met and that a management response is required.

- details management provisions (**Section 3.4.3**) and monitoring (**Section 3.5**) with respect to the EQC
- outlines the EQMP adaptive management and review (**Section 4**).

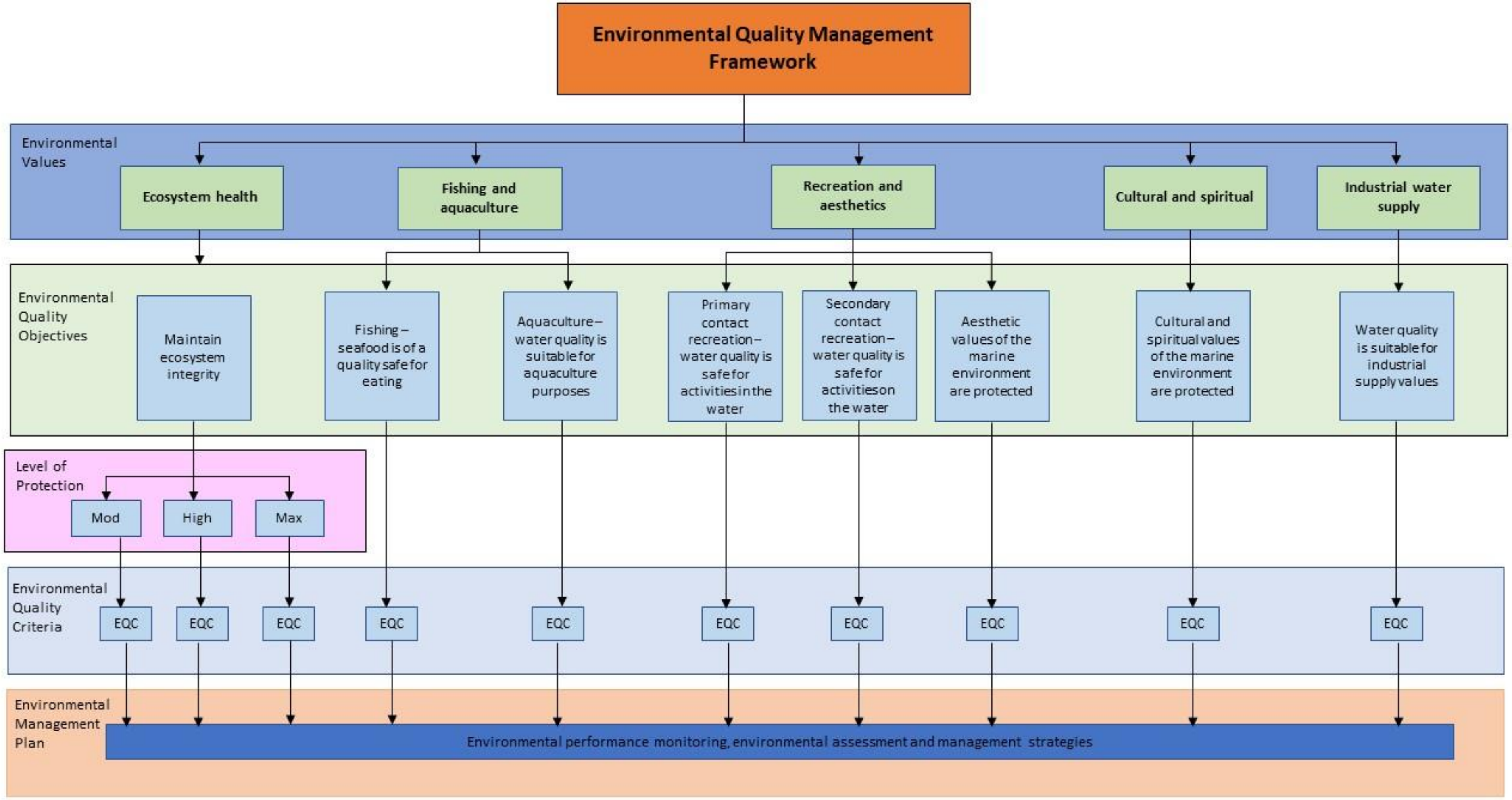

Figure 2-2 Environmental Quality Management Framework for Western Australia Marine Waters (EPA, 2016)

3. ENVIRONMENTAL QUALITY MANAGEMENT FRAMEWORK

3.1 Overview

A summary of the EQMF for the proposed Browse Project is provided in **Figure 3-1**. The following sections outline the rationale for the selection of the EVs, EQOs, relevant aspects, LEP and EQCs.

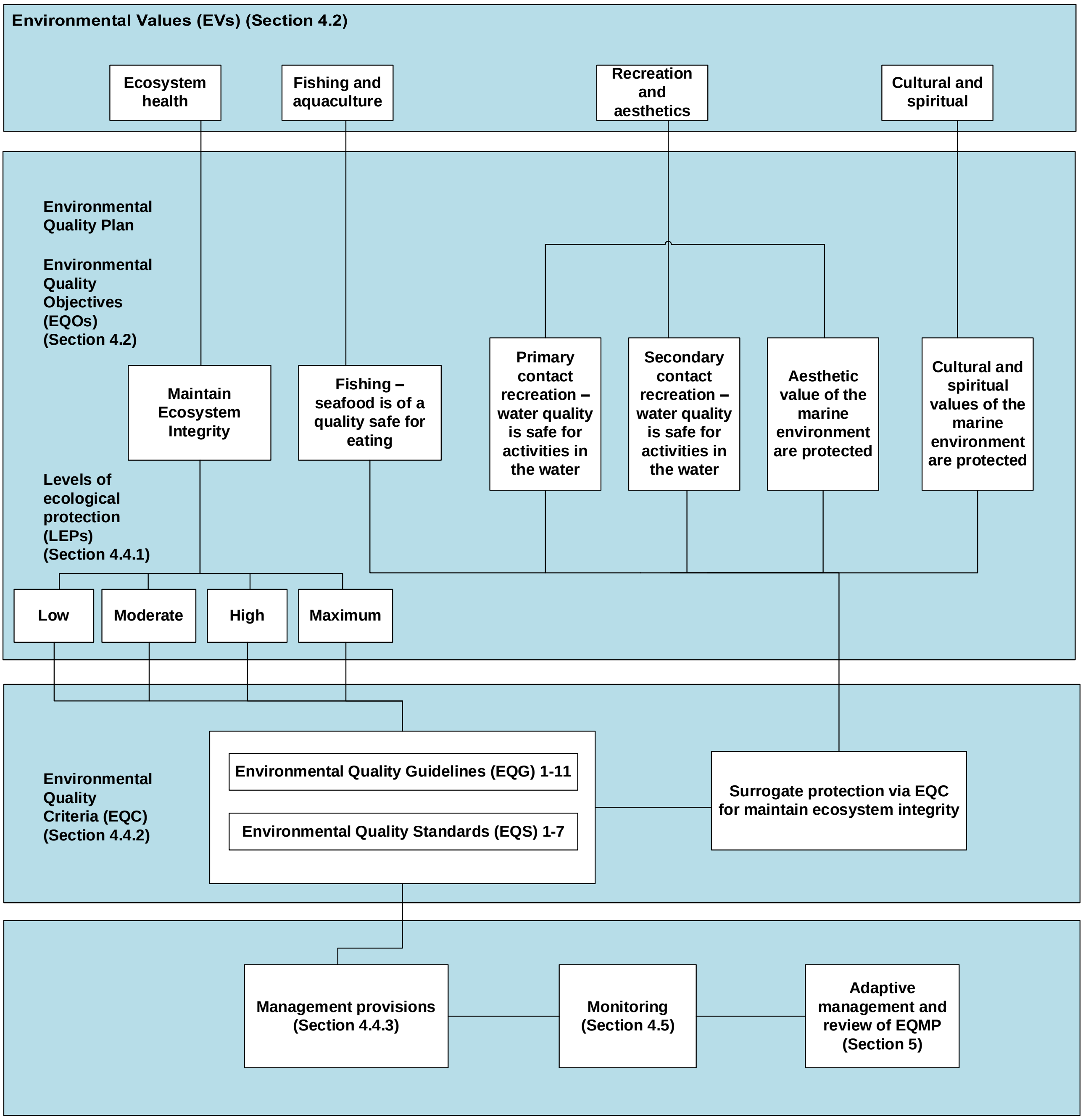

Figure 3-1: Environmental Quality Management Framework for proposed Browse Project

3.2 Establishing State Proposal Area EV and EQO relevant to this EQMP

The first step in the development of the EQMF was to undertake an assessment of the relevance of each EV and EQO identified in the EQMF for Western Australia Marine Waters (EPA, 2016). This assessment is presented in **Table 3-1**.

Table 3-1 EVs and EQOs and their relevant relevance to the proposed Browse Project

EV	Relevance of EV to proposed Browse Project	EQO	Relevance of EQO to proposed Browse Project
Ecosystem health	**Relevant**	Maintain ecosystem integrity	**Relevant**
Fishing and aquaculture	**Relevant**	Fishing – seafood is of a quality safe for eating	**Relevant**
		Aquaculture – water culture is suitable for aquaculture purposes	Not relevant – no aquaculture activities in State Proposal Area.
Recreation and aesthetics	**Relevant**	Primary contact recreation – water quality is safe for activities in the water	**Relevant**
		Secondary contact recreation – water quality is safe for activities in the water	**Relevant**
		Aesthetic value of the marine environment are protected	**Relevant**
Industrial water supply	Not relevant – No industrial water uses within the State Proposal Area	N/A – EV not relevant	N/A – EV not relevant
Cultural and spiritual	**Relevant**	Cultural and spiritual values of the marine environment are protected	**Relevant**

3.3 Assessment of activities potentially impacting identified State Proposal Area EVs

3.3.1 Overview

The second step in the development of the EQMF is to assess the planned discharges in the context of impacts to the EVs of the State Proposal Area (i.e. is there a residual risk for the aspect that potentially compromises the EQOs).

While the impacts of the planned discharges in State and Commonwealth waters have been comprehensively assessed in the draft EIS/ERD, the following provides a high-level summary of the potential impacts within the State Proposal Area and identifies where residual impacts potentially compromising EQOs exist.

3.3.2 Mobilisation of sediments as a result of seabed disturbance

Table 3-2 outlines the assessment of the impact of the mobilisation of sediment as a result of seabed disturbance with respect to achieving the EQOs.

Table 3-2 Assessment of mobilisation of sediments as a result of seabed disturbance in relation to achieving EQO

Discharge	Mobilisation of sediments as a result of seabed disturbance
Description	Seabed disturbance within the State Proposal Area will occur as a result of the installation of subsea infrastructure (including pre-lay activities, placement and post lay rectification of infrastructure), wet storage (which involves temporarily placing equipment on the seabed), anchoring of the MODU and IMMR activities. Within the State Proposal Area, seabed disturbance is planned to occur in deep water (>350 m), with direct seabed disturbance from installation of flowlines of approximately 0.08 km^2 and indirect disturbance (which is considered reversible) of approximately 0.72 km^2 (including contingency).
Draft EIS/ERD reference	• Draft EIS/ERD Section 6.3.1 • State ERD Section 8.2.4.2
Project stage(s)	Construction and operations.
Receptors	The following receptors within the State Proposal Area have been identified as potentially being impacted by mobilisation of sediments associated with seabed disturbance: • sediment quality • water quality • biota.
Potential impacts	Seabed disturbance is likely to result in temporary (ranging in the order of minutes to a few hours) and localised displacement of naturally occurring sediments for the duration of the activity (ranging in the order of minutes to a few hours) and limited to the immediate disturbance area. Seabed disturbance in the State Proposal Area is likely to result in increases in turbidity levels at the seabed in deep water that will quickly disperse in the oceanic marine environment due to prevailing hydrodynamic conditions. As such, any reduction in water quality will be temporary and will be limited to the water column immediately surrounding the disturbance area. The majority of the sediments that may be displaced are naturally occurring and, do not contain any contaminants of concern (Section 5.2.10 of the draft EIS/ERD). It should be noted that drill cuttings discharged during drilling activities may be displaced as a result of seabed disturbance. These drill cuttings may contain contaminants of concern as described in **Section 3.3.6**. It is considered that the potential effects of temporary remobilisation of these sediments are covered in the assessment of drilling discharges. The impact assessment presented in Section 8.2.4.2 of the State ERD found that turbidity and associated sedimentation generated by seabed disturbance are not expected to result in any lasting change to the physical or chemical properties of water or sediments or have any lasting adverse effects on biota. Further, turbidity and associated sedimentation generated by seabed disturbances is expected to be limited to deep-water benthic communities and habitats (>75m bathymetry). Also given the temporary and localised nature of the displacement of sediments, it is not considered credible that seabed disturbance relating to activities in Commonwealth waters will affect the EVs of the State Proposal Area. As such these are not considered further in this plan.
Mitigation and management	The following controls have been adopted in relation to this discharge as per Section 6.3.1 of the draft EIS/ERD: • No infrastructure will be placed on Scott Reef shallow water benthic communities and habitat (<75 m bathymetry).

Discharge	Mobilisation of sediments as a result of seabed disturbance		
	• No moorings for the MODUs will be installed in the Scott Reef shallow water benthic communities and habitat (<75 m bathymetry). • No moorings will be installed within the lagoon at North and South Scott Reef. • For subsea infrastructure, in particular flowlines, seabed preparation and secondary stabilisation requirements will be limited to the level necessary to ensure pipeline integrity.		
Assessment of residual risk to EQO			
EV	**EQO**	**Assessment**	**Residual risk to EQO exists?**
Ecosystem health	Maintain ecosystem integrity	Localised temporary turbidity not predicted to affect ecosystem integrity.	No
Fishing and aquaculture	Fishing – seafood is of a quality safe for eating	Localised temporary turbidity not predicted to affect seafood quality.	No
Recreation and aesthetics	Primary contact recreation – water quality is safe for activities in the water	Localised temporary turbidity not predicted to affect recreational use.	No
	Secondary contact recreation – water quality is safe for activities in the water	Localised temporary turbidity not predicted to affect recreational use.	No
	Aesthetic values of the marine environment are protected	Localised temporary turbidity will not affect aesthetic value of marine environment.	No
Cultural and spiritual	Cultural and spiritual values of the marine environment are protected	As per (EPA, 2016), in the absence of any specific environmental quality requirements for protection of 'Cultural and Spiritual' values, it is assumed that if water quality is managed to protect ecosystem integrity, primary contact recreation, seafood quality safe for eating, and aesthetic values, then this may go some way towards maintaining cultural values.	No

Sewage and sullage discharge

Table 3-3 outlines the assessment of the impact sewage and sullage discharge with respect to achieving the EQOs.

Table 3-3 Assessment of sewage and sullage discharge in relation to achieving EQO

Discharge	Sewage and sullage discharge
Description	There are no planned discharges of untreated sewage or sullage within the State Proposal Area, however, discharges of treated sewage and sullage from project vessels, installation vessels and the MODU within the State Proposal Area will occur. Under normal operating conditions, drilling and vessel activity (and associated marine discharges) will be limited to the deep waters in proximity to the location of the

Discharge	Sewage and sullage discharge
	proposed development wells and subsea infrastructure. Drilling activities are expected to take two to three months per well, with up to 20 wells in the State proposal area. It must be noted that drilling and completions will occur in phases (e.g. Phase 1 RFSU includes three wells at TRA) and therefore not all 20 wells will be drilled in a continuous sequence. A review of current petroleum activities shows that vessels and MODUs typically generate around 5 to 15 m^3 of waste water (consisting of sewage and sullage) per day (National Energy Resources Australia (NERA), 2017). Using a rate of 0.375 m^3/person/day as a guide (NERA, 2017), installation vessels may discharge approximately 22.5 m^3/day, based on 60 persons aboard.
Draft EIS/ERD reference	• Draft EIS/ERD Section 6.3.9 • State ERD Section 8.2.4.4
Project stage (s)	Construction and operations.
Receptors	The following receptors within the State Proposal Area have been identified as potentially being impacted by this planned discharge: • water quality • biota.
Potential impacts	The discharge of treated sewage and sullage has the potential to result in the temporary (ranging in the order of minutes to a few hours) and localised (tens of metres) reduction in water quality via eutrophication as a result of increased nutrient levels (e.g. ammonia, nitrite, nitrate and orthophosphate). Sewage and sullage may also include some particulate matter which can cause an increase in the turbidity of the receiving waters close to the point of discharge. The impact assessment presented in Section 8.2.4.4 of the State ERD found that: • Discharges will disperse and dilute rapidly, with concentrations of wastes significantly dropping with distance from the discharge point. • Monitoring of sewage and sullage discharge during the drilling campaign for the Torosa-6 well in 2008 determined discharges were rapidly diluted in the upper (less than 10 m) water layer to 1% of their original concentration within 50 m, with no elevations above background in nutrients or metals recorded at any sampling station (ERM and SKM, 2008). • Changes to the physical and chemical properties of the marine water as a result of sewage and sullage discharge will be temporary and highly localised. • No change to the physical or chemical properties of sediments are expected due to the bathymetric depth of the water where treated sewage and sullage would be discharged. • Although organic materials from the discharges will likely exert biological oxygen demand on the receiving waters, this is unlikely to reach levels below background ambient dissolved oxygen concentrations. • Similarly, while the nutrient inputs from discharged effluent will rapidly be taken up by phytoplankton, pronounced increases in productivity as evidenced by increased chlorophyll a concentration are not expected. This is largely due to the assimilative capacity of the open ocean, with any additive nutrients not expected to accumulate in the vicinity of the discharge location. • Given the relatively small volume of treated sewage and sullage to be discharged, the distance from the discharge to Scott Reef and the expected rapid dilution of the discharge, the temporary and highly localised changes to water quality are not expected to have any impacts to biota.

Discharge	Sewage and sullage discharge
	The impact assessment as described in Section 6.3.9 of the draft EIS/ERD found that sewage and sullage discharges in Commonwealth waters are not predicted to affect the EVs of the State Proposal Area. As such these are not considered further in this plan.
Mitigation and management	The following controls have been adopted in relation to this discharge: • Project vessels will comply with MARPOL 73/78 Annex IV: Sewage – (as applied in Australia under Commonwealth *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* and Marine Order 96 (Marine pollution prevention—sewage)). • Discharge of sewage will occur in accordance with the WA Department of Transport sewage strategy within State waters. • There will be no discharge of untreated sewage within 3 nm of Scott Reef. • Chemicals that may be operationally released or discharged to the marine environment must be subject to Woodside's chemical selection and assessment process and approved prior to use.

<table>
<tr><th colspan="4">Assessment of residual risk to EQO</th></tr>
<tr><th>EV</th><th>EQO</th><th>Assessment</th><th>Residual risk to EQO exists?</th></tr>
<tr><td>Ecosystem health</td><td>Maintain ecosystem integrity</td><td rowspan="5">Compliance with MARPOL 73/78 Annex IV: Sewage – (as applied in Australia under Commonwealth Protection of the Sea (Prevention of Pollution from Ships) Act 1983 and (Marine pollution prevention—sewage), and WA Department of Transport sewage strategy within the State Proposal Area will ensure EQOs are not compromised.</td><td>No</td></tr>
<tr><td>Fishing and aquaculture</td><td>Fishing – seafood is of a quality safe for eating</td><td>No</td></tr>
<tr><td rowspan="3">Recreation and aesthetics</td><td>Primary contact recreation – water quality is safe for activities in the water</td><td>No</td></tr>
<tr><td>Secondary contact recreation – water quality is safe for activities in the water</td><td>No</td></tr>
<tr><td>Aesthetic values of the marine environment are protected</td><td>No</td></tr>
<tr><td>Cultural and spiritual</td><td>Cultural and spiritual values of the marine environment are protected</td><td>As per (EPA, 2016), in the absence of any specific environmental quality requirements for protection of 'Cultural and Spiritual' values, it is assumed that if water quality is managed to protect ecosystem integrity, primary contact recreation, seafood quality safe for eating, and aesthetic values, then this may go some way towards maintaining cultural values.</td><td>No</td></tr>
</table>

3.3.3 Treated utility water, chemical and deck drainage discharge

Table 3-4 outlines the assessment of the impact treated utility water, chemical and deck drainage discharge with respect to achieving the EQOs.

Table 3-4 Assessment of treated utility water, chemical and deck drainage discharge in relation to achieving EQO

Discharge	Treated utility water, chemical and deck drainage discharge
Description	Within the State Proposal Area, treated utility water, chemical and deck drainage will be limited to deck drainage, treated bilge water and desalination brine from project vessels, installation vessels and the MODU. Potentially contaminated deck drainage discharges would occur from the MODU during periods of heavy rain, with potentially contaminated drainage routed to slops tanks for treatment prior to discharge. Bilge water from within machinery spaces will be captured separately in a bilge tank for treatment. An oil-in-water separator will be available onboard the MODU and vessels (as applicable to vessel class), which will be maintained and operated so that bilge water is treated to reduce hydrocarbon concentrations below 15 ppm in accordance with MARPOL 73/78 Annex. Under normal operating conditions, drilling and vessel activity (and associated marine discharges) will be limited to the deep waters in proximity to the location of the proposed development wells and subsea infrastructure.
Draft EIS/ERD reference	• Draft EIS/ERD Section 6.3.10 • State ERD Section 8.2.4.5
Project stage(s)	Construction and operations.
Receptors	The following receptors within the State proposal area have been identified as potentially being impacted by this planned discharge: • water quality • biota.
Potential impacts	As described in Section 8.2.4.5 of the State ERD, considering the composition of the drain discharges (i.e. small quantities of hydrocarbons and detergents) and assimilative capacity of the receiving environment, it is expected that drain discharges will rapidly dilute within the surrounding waters. As such, these discharges will result in temporary (lasting a few minutes) change to water quality in the immediate vicinity of the discharge. Given the water depth (>300 m) and distance to Scott Reef from where these discharges would occur, this change to water quality is not expected to have any impacts to the EVs of the State Proposal Area. As described in Section 8.2.4.5 of the State ERD, elevated salinity levels (above ambient) as a result of desalination brine discharge from MODU or vessel will be highly localised (within meters) at the discharge point and unlikely to have a perceptible effect on ambient salinity concentrations in the water column. The impact assessment described in Section 6.3.10 of the draft EIS/ERD found that treated utility water, chemical and deck drainage discharges in Commonwealth waters are not predicted to affect the EVs of the State Proposal Area. As such, these are not considered further in this plan.
Mitigation and management	The following controls related to the State Proposal Area have been adopted in relation to this discharge as described in Section 6.3.10 of the draft EIS/ERD: • Areas of potential contamination such as machinery and bulk liquid storage areas will be bunded to capture any spilled chemicals or oil residues. Drainage from these areas will be directed to holding tanks for treatment prior to discharge, subject to overflow arrangements.

Discharge	Treated utility water, chemical and deck drainage discharge		
	• An oil-in-water separator will be available onboard the MODU and vessels (as applicable to vessel class), which will be maintained and operated so that bilge water is treated to reduce hydrocarbon concentrations below 15 ppm in accordance with MARPOL 73/78 Annex I, as applied in Australia under the Commonwealth *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* (Part II Prevention of pollution from oil); Marine Orders 91 (Marine pollution prevention – Oil) as applicable to vessel class; and the WA *Pollution of Waters by Oil and Noxious Substances Act 1987*. • Chemicals that may be operationally released or discharged to the marine environment must be subject to Woodside's chemical selection and assessment process and approved prior to use.		
Assessment of residual risk to EQO			
EV	**EQO**	**Assessment**	**Residual risk to EQO exists?**
Ecosystem health	Maintain ecosystem integrity	Compliance with MARPOL 73/78 Annex I, as applied in Australia under the Commonwealth *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* (Part II Prevention of pollution from oil); Marine Orders 91 (Marine pollution prevention – Oil) as applicable to vessel class; and the WA *Pollution of Waters by Oil and Noxious Substances Act 1987* will ensure EQOs are not compromised.	No
Fishing and aquaculture	Fishing – seafood is of a quality safe for eating		No
Recreation and aesthetics	Primary contact recreation – water quality is safe for activities in the water		No
	Secondary contact recreation – water quality is safe for activities in the water		No
	Aesthetic values of the marine environment are protected		No
Cultural and spiritual	Cultural and spiritual values of the marine environment are protected	As per (EPA, 2016), in the absence of any specific environmental quality requirements for protection of 'Cultural and Spiritual' values, it is assumed that if water quality is managed to protect ecosystem integrity, primary contact recreation, seafood quality safe for eating, and aesthetic values, then this may go some way towards maintaining cultural values.	No

3.3.4 Produced water discharge

Table 3-5 outlines the assessment of the impact of the produced water discharge with respect to achieving the EQOs.

Table 3-5 Assessment of produced water discharge in relation to achieving EQO

Discharge	Produced water discharge
Description	When hydrocarbons are recovered from the reservoir a by-product is produced water (PW), which is separated out from the hydrocarbons during the production process and discharged. This PW may consist of a combination of formation water (water that occurs naturally within the hydrocarbon-bearing geological formations that is drawn into the well during hydrocarbon recovery), and condensed water (water vapour contained in the gaseous phase of the reservoir fluids that condenses out of the gas as the pressure and temperature is reduced when the reservoir fluids are brought up to the surface). For the proposed Browse Project, the primary source of PW discharges will occur from the FPSO facilities in Commonwealth waters, with low levels also discharged from the MODU. PW will be produced during operations where it will be treated, using a tertiary treatment system on board the FPSO facilities prior to discharge to the marine environment in Commonwealth waters. The FPSO PW treatment circuit will be designed for a maximum processing capacity of 5,723 m3/day on each FPSO. At Phase 1 RFSU, actual PW rates are expected to be significantly less than the design, with formation water (and therefore PW) generally expected to increase over time and be highest towards the end of the reservoir life. Low levels of PW may also be discharged from the MODU at the drill centre locations, during well unloading. The estimate of total unloading is anticipated to take 1-2 days per well (i.e. the amount of time that the well is flowing), with PW generally limited to small volumes of condensed water. PW discharged to the marine environment may include: • trace amounts of hydrocarbon compounds • trace amounts of metals • monoethylene glycol (MEG) • naturally occurring radioactive materials (NORMs) • nutrients such as ammonia.
Draft EIS/ERD reference	• Draft EIS/ERD Section 6.3.12 • State ERD Section 8.2.4.6
Project stage(s)	Construction and operations
Receptors	The following receptors within the State Proposal Area have been identified as potentially being impacted by this planned discharge**:** • water quality • sediment quality • biota.
Potential impacts	MODU Low levels of PW may be discharged from the MODU at the well locations, including within deep water areas of the State Proposal Area during well unloading. This PW would be condensed water generated in the hydrocarbon gas stream during well unloading and would be discharged as part of the discharge of well clean up fluids, which would include drilling fluids. The PW component of the discharge will constitute a very small proportion of the discharge stream, with the discharge dominated by suspension fluids and associated PW generally limited to small volumes of condensed water. As such, MODU PW discharge is considered to be

<table>
<tr><th>Discharge</th><th>Produced water discharge</th></tr>
<tr><td></td><td>part of drilling discharges (addressed in Section 3.3.6) and is not considered a separate discharge for the purpose of this plan.
Torosa FPSO
Discharge of PW from the Torosa FPSO (in Commonwealth waters) may change water quality due to thermal impacts (increased water temperature) and toxicity impacts relating to the residual hydrocarbons and chemical concentration within the PW discharge.
Modelling of the FPSO PW discharge (Section 6.3.12.3 of the draft EIS/ERD) indicates:
Within the immediate area of influence of the discharge (in Commonwealth waters), water temperatures will be elevated temporarily impacting water quality. However, as outlined within the modelling results, the temperature differential between the discharge and the ambient water is predicted to achieve the threshold level (3°C above ambient temperature) within the near-field area. Subsequently, such thermal impacts are not predicted to occur outside of a maximum distance of 44 m from the discharge location and are not expected to affect the State Proposal Area.
A change in water quality due to the residual hydrocarbons and chemical concentration of the PW discharge will occur in the vicinity of the PW discharge location. The point at which the 99% species protection level is met for oil in water (333 dilutions) is at a maximum distance of 1,200 m from the Torosa FPSO discharge point, as defined in the modelling as described in Section 6.3.12.3 of the draft EIS/ERD. This modelling indicates that there will be no detectable change to water quality within the State Proposal Area from Torosa FPSO PW discharge.
Given the above, no change to the EVs of the State Proposal Area are predicted as a result of PW discharge.</td></tr>
<tr><td>Mitigation and management</td><td>The following controls and adaptive management approach have been adopted in relation to the discharge of PW as described in Section 6.3.12 of the draft EIS/ERD. Note that as the FPSO PW discharges originate in Commonwealth waters, they will be managed under an accepted FPSO EP to be prepared under the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (OPGGS (E) Regulations).
Where practicable, design of the proposed Browse Project infrastructure will take into consideration opportunities to reduce the need for chemical additives (e.g. the use of active heating for hydrate management).
FPSO PW will be treated prior to being discharged overboard using a tertiary treatment system, such as a Macro Porous Polymer Extraction (MPPE) system that meets Woodside and accepted industry standards.
PW discharge from the FPSO facilities will be conducted below the water surface to promote dispersion and mixing.
For the FPSO PW discharge, the defined threshold values (i.e. 99% species protection or no effect concentrations) will be met at the edge of the mixing zone and the State waters 3 nm boundary, 95% of the time based on dispersion modelling results.</td></tr>
</table>

Discharge	Produced water discharge		
	• Hydrocarbon content in the FPSO PW discharge will be no greater than an average of 30 mg/L over any period of 24 hours during steady state operations (excluding start-up, shut-downs etc.) as demonstrated by monitoring. • Chemicals that may be operationally released or discharged to the marine environment will be subject to Woodside's chemical selection and assessment process and approved prior to use. In the event the FPSO PW discharge does not meet the defined thresholds in the range predicted for any constituent concentrations, an adaptive management strategy will be implemented (and described in subsequent EPs) to mitigate potential risk to the State Proposal Area, and in particular Scott Reef shallow water benthic communities and habitats (<75 m depth) where a maximum LEP is proposed. The strategy is premised on the commitment to meet the 99% species protection or no effect concentrations at the edge of the mixing zone and the State waters 3 nm boundary, 95% of the time based on dispersion modelling results, which will be verified through monitoring. This adaptive management strategy may include actions such as reducing the discharge rate, which increases dilutions in the nearfield or reduces an individual chemical concentration through commingling prior to discharge. It should also be noted that PW will come on slowly so there will be opportunity to sample and adapt before the full rates modelled are experienced. Monitoring to support this adaptive management strategy will include: • During steady state FPSO operations, PW modelling and infield verification will be completed to verify the modelling predictions. This study aims to verify the modelling predictions and in particular the dilutions achieved, which determines the point at which the defined thresholds levels are reached. • Periodic and 'for cause' toxicity testing and characterisation of the physical and chemical composition of the FPSO PW stream prior to discharge will be undertaken. This provides an assessment of the individual constituent chemical concentration and the whole of effluent toxicity at end of pipe. • Baseline and periodic water and sediment quality monitoring at a gradient away from the FPSO facility in the receiving environment will be undertaken to detect changes as a result of FPSO PW discharge. This gradient will extend to the point at which environmental quality meets the guidelines and standards required for the designated LEP in the State Proposal Area are achieved. This monitoring aims to demonstrate no changes in the receiving environment water and sediment quality outside of the defined mixing zone as a result of the FPSO PW discharges.		
Assessment of residual risk to EQO			
EV	**EQO**	**Assessment**	**Residual risk to EQO exists?**
Ecosystem health	Maintain ecosystem integrity	No impacts to ecosystem integrity are predicted.	**No** – note however, that PW monitoring and environmental quality criteria are proposed within the EQMP to address any potential uncertainty in the

Discharge	Produced water discharge		
			PW modelling predictions.
Fishing and aquaculture	Fishing – seafood is of a quality safe for eating	No impact to seafood quality predicted.	No
Recreation and aesthetics	Primary contact recreation – water quality is safe for activities in the water	No change in water quality is predicted.	No
	Secondary contact recreation – water quality is safe for activities in the water	No change in water quality is predicted.	No
	Aesthetic values of the marine environment are protected	No change in water quality is predicted.	No
Cultural and spiritual	Cultural and spiritual values of the marine environment are protected	As per (EPA, 2016), in the absence of any specific environmental quality requirements for protection of 'Cultural and Spiritual' values, it is assumed that if water quality is managed to protect ecosystem integrity, primary contact recreation, seafood quality safe for eating, and aesthetic values, then this may go some way towards maintaining cultural values.	No

3.3.5 Cooling water discharge

Table 3-6 outlines the assessment of the impact of the cooling water discharge with respect to achieving the EQOs.

Table 3-6 Assessment of cooling water discharge in relation to achieving EQO

Discharge	Cooling water discharge
Description	Seawater is used as a cooling media for heat exchangers to remove excess heat from the production processes on the FPSO facilities as well as from machinery systems on: • project vessels • FPSO facilities (in Commonwealth waters) • MODUs. Seawater cooling systems draw seawater from the ocean which is then pumped through heat exchangers where it absorbs heat. It is then discharged at a higher temperature than source. Cooling water is often treated with additives including scale inhibitors and biocide (such as chlorine) to avoid biofouling of pipework. These chemicals are usually added at low dosages, and are typically consumed in the inhibition process, so there is little residual chemical concentration remaining upon discharge. For the proposed Browse Project, the primary source of cooling water discharges will occur from the FPSO facilities in Commonwealth waters. The FPSOs are proposed

Discharge	Cooling water discharge
	to have a cooling water system where seawater is pumped up to the facility, treated with hypochlorite and passed through heat exchangers prior to discharge. The cooling water system consists of both a Process Seawater System and an Essential Seawater System. In addition to passing through heat exchangers, the Process Seawater System will also cool the inlet gas stream although will not cool any process streams with liquid hydrocarbons. It is estimated that the Process Seawater System demand will be in the order of 720,000 m3/day per FPSO facility, which will be routinely discharged overboard below the water line, at a design temperature of approximately 50oC. The Essential Seawater System demand is significantly smaller (expected to be <5% of the Process Seawater System). Cooling water discharges will also occur from the MODUs and vessels operating in both Commonwealth and State waters. However, the discharge volumes are anticipated to be significantly less that than FPSO facilities in the order of approximately 50 m³/day, depending on vessel size. MODU and vessel related cooling water impacts will be primarily limited to the construction phase of the project, with the exception of operations support vessels and IMMR activities.
Draft EIS/ERD reference	• Draft EIS/ERD Section 6.3.13 • State ERD Section 8.2.4.7
Project stage(s)	Construction and operations.
Receptors	The following receptors within the State Proposal Area have been identified as potentially being impacted by this planned discharge**:** • water quality • biota.
Potential impacts	*Vessels and MODU* Cooling water discharge from project vessels and the MODU at the well locations may impact marine environmental quality due to thermal impacts (increased water temperature) and toxicity impacts relating to the residual chlorine concentration within the cooling water discharge Relatively low levels of cooling water will be discharged from project vessels and the MODU operating in the State proposal area (approximately 50 m3/day depending on vessel size). Under normal operating conditions, drilling and vessel activity (and associated marine discharges) will be limited to the deep waters near the location of the proposed development wells and subsea infrastructure. These cooling water discharges are expected to rapidly disperse and dilute (within tens of metres) with impacts expected to be a highly localised change in water quality. The reduction in water quality as a result of these discharges is not expected to have any impacts to the EVs of the State Proposal Area. Torosa FPSO Modelling of the FPSO cooling water discharge (Section 6.3.13.3 of the draft EIS/ERD predicted that the chlorine threshold for continuous discharges of 2 ppb (0.002 mg/L), which represents the predicted no effect concentration for chronic exposure at the 99% species protection level (Chariton and Stauber, 2008), would be achieved by the 3 nm State waters boundary based on the annualised 95^{th} percentile predictions for a conservative maximum discharge rate of 720,000 m^3/day. Temperature thresholds are expected to be reached within 120 m of the discharge location. As such the modelling indicates that sufficient dilutions to achieve 99% species protection will occur at the boundary of the State Proposal Area. Modelling of the FPSO cooling water discharge also indicates that the discharge plume may enter the State proposal area but at concentrations not exceeding the 99% species protection level (based on the 95^{th} percentile). The maximum extent of this incursion is approximately 2 km and remains 2.4 km away from Scott Reef shallow water benthic communities and habitat (<75 m bathymetry).

Discharge	Cooling water discharge
	Given the above, a detectable change in water quality may occur within the State Proposal Area as a result of the Torosa FPSO cooling water discharges in Commonwealth waters, however no impacts to biota are predicted. It should be noted that the modelling took a conservative approach and assumed that no processes other than dilution would reduce the source concentrations over time. The modelling assumed no natural degradation or decay of the chlorine would occur and further reduce the mixing zone. It also did not take account of all mixing processes due to wave action in the upper water column which will likely serve to increase the magnitude of dilution acting on the cooling water plume. This is likely to result in an underestimation of mixing and dilution and overestimation of cooling water concentrations in modelling predictions.
Mitigation and management	As described in Section 6.3.13 of the draft EIS/ERD, the following controls and adaptive management process have been adopted in relation to the discharge of cooling water from the FPSO. Note that as the FPSO cooling water discharges originate in Commonwealth waters, they will be managed under an accepted FPSO operations EP to be prepared under the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (OPGGS (E) Regulations). • Cooling water discharge from the FPSO facilities will be conducted below the water surface to increase dispersion and mixing. • Hypochlorite will be used to control fouling in sea water systems in line with best practice, due to its solubility in water and rapid biodegradability. • The FPSO facilities' cooling water systems have been designed to be segregated from process hydrocarbon streams to prevent potential contamination of the cooling water. • For Torosa FPSO cooling water discharges, the defined threshold value (i.e. 99% species protection; 3°C above ambient) will be met at the edge of the mixing zone and the State waters 3 nm boundary, 95% of the time based on dispersion modelling results. • During steady state operations, FPSO cooling water modelling and infield verification will be completed to verify the modelling predictions. Note infield verification using a range of monitoring techniques will be completed during steady state operations to verify the model predictions and confirm that the mixing zone, including at the 3 nm State waters boundary is met. In the event that the mixing zone is larger than anticipated, posing a significant increase in impact than that described in the draft EIS/ERD then corrective actions will be implemented onboard the FPSOs to reduce the impact. Corrective actions include additional engineering to produce a change in discharge characteristics.

Assessment of residual risk to EQO			
EV	**EQO**	**Assessment**	**Residual risk to EQO exists?**
Ecosystem health	Maintain ecosystem integrity	Detectable changes in water quality (below threshold levels) may be detected within the State Proposal Area as a result of the Torosa FPSO cooling water discharge in Commonwealth waters. No impact to EVs is predicted as the discharge will be diluted to below 99% species protection (95th percentile) prior to it	**Yes** (as a result of Torosa FPSO cooling water discharge in Commonwealth waters)

Discharge	Cooling water discharge		
		reaching the boundary of the State Proposal Area. No impacts to ecosystem integrity from discharges within the State Proposal Area (vessels and MODU) are predicted due to the extremely small volumes and short discharge durations.	
Fishing and aquaculture	Fishing – seafood is of a quality safe for eating	Highly localised and temporary change to water quality below threshold levels are not predicted to impact to seafood quality predicted.	No
Recreation and aesthetics	Primary contact recreation – water quality is safe for activities in the water	Highly localised and temporary change to water quality below threshold levels are not predicted to impact recreational use.	No
	Secondary contact recreation – water quality is safe for activities in the water	Highly localised and temporary change to water quality below threshold levels are not predicted to impact recreational use.	No
	Aesthetic values of the marine environment is protected	Highly localised and temporary change to water quality below threshold levels are not predicted to impact aesthetic value of marine environment.	No
Cultural and spiritual	Cultural and spiritual values of the marine environment are protected	As per (EPA, 2016), in the absence of any specific environmental quality requirements for protection of 'Cultural and Spiritual' values, it is assumed that if water quality is managed to protect ecosystem integrity, primary contact recreation, seafood quality safe for eating, and aesthetic values, then this may go some way towards maintaining cultural values. Incursion of cooling water discharge (below threshold levels) not predicted to impact this EQO.	No

3.3.6 Drilling or completions discharges

Table 3-7 outlines the assessment of the impact of the drilling or completions discharges with respect to achieving the EQOs.

Table 3-7 Assessment of drilling or completions discharges in relation to achieving EQO

Discharge	Drilling or completions discharges
Description	Development drilling activities within the State proposal area involve the drilling and completion of up to an estimated 20 wells. Drilling of production wells will generate drill cuttings, require cementing of the casing; and require the use of a range of fluids,

Discharge	Drilling or completions discharges
	that may be discharged to the marine environment, typically at the seabed and at or near the sea surface depending on the hole section and if riser in place. During the life of the proposed Browse Project, well components will require maintenance, repair or replacement. This will require well intervention activities which generally occur within the wellbore and may include but not limited to well logging activities (slickline, wireline, coil tubing), well testing and flowback; and well workovers. In addition, well abandonment activities can result in discharges to the marine environment including but not limited to installation and pressure testing of the blow out preventer (BOP), cutting/perforation of casing or production tubing; and installation of permanent reservoir and surface barrier (cementing). The discharges relevant to drilling and completion activities include the following which are described in Section 6.3.15 of the draft EIS/ERD and 8.2.4.8 of the State ERD: • drill cuttings • drilling fluids – water-based fluids (WBF) and non-water based fluids (NWBF) • cement • subsea control fluids • completion fluids • reservoir fluids • well annular fluids.
Draft EIS/ERD reference	• Draft EIS/ERD Section 6.3.15 • State ERD Section 8.2.4.8 • State ERD Section 8.3.4.9
Project stage(s)	Construction
Receptors	The following receptors within the State Proposal Area have been identified as potentially being impacted by this planned discharge**:** • water quality • sediment quality • biota.
Potential impacts	Drill cuttings and fluids discharge Modelling of the proposed seabed discharge of drill cuttings was presented in Section 6.3.15 of the draft EIS/ERD. The modelling indicated that the seabed discharge of drill cuttings from top-hole well sections may result in sediment plumes in the lower water column above seabed and associated deposition of sediment to the surrounding seabed. Such plumes are predicted to be confined to the bottom layers of the water column with no contact with deeper water or shallow water coral habitats at Scott Reef (<75 m bathymetry). There is some evidence of localised intrusions of cooler water around the western and eastern entrances to the channel between North and South Scott Reef during spring tides but no evidence of persistent upwelling or downwelling currents around Scott Reef (Green et al., 2019b) and therefore, no transport mechanisms to mobilise drill cuttings from deep waters to the shallower waters of the reef system. As such, given the location of the drill centres in deep water (>350 m), which experience strong surface and subsurface currents, drill cuttings and fluid discharge disposal at seabed would be expected to dilute rapidly. Therefore, any reduction in water quality due to elevated TSS is expected to occur in a localised area around the drill centre and will be temporary in nature.

Discharge	Drilling or completions discharges
	In relation to the proposed discharge of bottom-hole drilling discharges at drill centres within the State Proposal Area when the riser is in place (i.e. conduit back to the MODU), previous modelling indicated that the surface release of drilling discharges generated at the previously proposed TRE and TRD drill centre locations would potentially result in incursions of sediment plumes and associated increased sedimentation to portions of North and South Scott Reef including within the lagoons. This has been further investigated in **Appendix A** (Management Approach for Torosa wells in State Proposal Area), which details the discrete surface discharges (e.g. drill cuttings with residual fluids and WBF mud pit bulk discharges) to assess individual risk to the Scott Reef shallow water benthic communities and habitats (<75 m bathymetry), where a maximum LEP protection has been proposed. Additional management controls are proposed for the management of Torosa wells drilling discharges in the State Proposal Area to demonstrate that the maximum LEP for Scott Reef shallow water benthic communities and habitats (<75 m bathymetry) can be achieved. For TRA, TRD, and TRF wells on the eastern side of Scott Reef, within the State Proposal Area, drilling discharges at the surface/near surface when drilling with riser, are only being considered for bottom hole cuttings (with residual film of fluids) from the shakers (or equivalents) for WBF, and from the cuttings dryers (or equivalents) for NWBF, due to their inherently lower adhered WBF/NWBF content and the rapid settling velocity of the larger particle size of the cuttings (primary discharge source) and associated dispersion characteristics, and as such there is no anticipated credible risk to Scott Reef shallow water benthic communities and habitats (<75 m bathymetry). Noting that the WBF mud pit bulk discharges, which have larger volumes and finer particle distribution and hence wider dispersion, are proposed to be managed and either discharged at depth (>200 m), at the seabed, or retained for offshore disposal in Commonwealth waters in accordance with a sea dumping permit. Further details are provided in **Appendix A** (Management Approach for Torosa wells in State Proposal Area) **Change in water quality** The modelling (Section 6.3.15.3 of the draft EIS/ERD) indicates that both seabed and surface drilling discharges would result in impacts to water quality as a result of elevations in TSS and the introduction of low toxicity contaminants. This reduction in water quality will be temporary (i.e. limited to the duration of the activity, restricted to deep water (for Torosa drill centres in the State Proposal Area) and subject to rapid dispersion and dilution by prevailing currents, due to the open oceanic waters of the State Proposal Area. A description of the potential effect of drilling cuttings and fluids discharge in the State Proposal Area on water quality is provided in Section 8.2.4.8 of the State ERD which concluded that given the predicted rapid dispersion of suspended sediments within the open ocean environment of the State Proposal Area, the short period of intermittent discharge and the generally low concentration of total suspended solids (TSS) within the plume, any change in water quality associated with drill cutting discharge are expected to be temporary with a slight effect and with no long-term reduction in the environmental values of the State Proposal Area. **Cement discharge** Once each of the top hole sections are drilled, casing will be inserted into the wellbore and secured in place by pumping cement into the annular space. This may involve a discharge of excess cement at the seabed (~80 m^3/well). Overspill of cement will permanently alter physical sediment properties immediately adjacent to the well (within <50 m). The potential disturbance area is 0.008 km^2 per well; giving a total potential irreversible disturbance footprint of 0.16 km^2 within the State Proposal Area. This will result in the permanent loss of the benthic communities and habitats in the disturbance area and is reflected in the assessment against the EQOs below.

Discharge	Drilling or completions discharges
	Sediment deposition Following the discharge of drill cuttings and fluids, the coarser fractions (sand and gravel-sized particles), will rapidly settle to the seabed. Where cuttings are discharged to the seabed, a cuttings pile of deposited sediment particles will develop around and in close proximity to the well site. The nature and size of the pile will depend on a number of factors including particle size of the cuttings and tidal and current forces at the seabed. Discharge of cuttings at the surface will result in rapid dispersion and settlement of cuttings through the water column to the seabed with fines forming a sediment plume that will disperse and settle on the seabed less rapidly. Final deposition of cuttings will be dependent on the particle size distribution of cuttings, bathymetry, as well as the prevailing wind, tidal influence and current velocity and directions. Potential impacts are expected to be confined to sessile benthic biota such as sediment burrowing infauna and epifauna where present in or on the seabed offset up to several hundred metres from the immediate proximity to the well site and top hole cuttings pile. Ecological impacts to such biota are conservatively predicted when sediment deposition is equal to or greater than 6.5 mm in thickness (IOGP, 2016). Modelling (Section 6.3.15.3 of the draft EIS/ERD) indicated that such deposition would potentially occur out from the well location to approximately 200 m (following the direction of the prevailing current). This deposition may result in the reversible loss in the order of 0.13 km^2 of deepwater benthic habitat per well based on an assumption of an expected spread radius of 150 m from each well (in addition to the irreversible loss of 50 m associated with cement – described above). Recovery of affected benthic infauna, epifauna and demersal communities is expected to occur, given the short duration of sediment deposition and the widely represented benthic and demersal community composition. This effect on the EVs of the State Proposal Area is reflected in the assessment against the EQOs below.
Mitigation and management	The following controls have been adopted as per Section 6.3.15.7 of the draft EIS/ERD in relation to this discharge: • The number of wells will be optimised to meet hydrocarbon recovery objectives and operational requirements and thereby reduce unnecessary use of drilling fluids and generation of drill cuttings. • For technical, operational and environmental reasons NWBFs will be selected in accordance with Woodside's chemical selection and assessment processes. • Risers will be used to ensure that NWBF and associated cuttings are recirculated to the MODU, where cuttings will be treated prior to discharge. • There will be no planned discharge of unused NWBF at sea during drilling and completion operations. • Drill cuttings will be tested to confirm that the average oil on cuttings for the entire well (but limited to sections using NWBF) will not exceed 6.9% by wet weight. • Drilling or completions discharges (in particular, bottom hole discharges) at drill centre locations in the State Proposal Area (i.e. TRA, TRD and TRF) will be managed in such a manner to avoid impacts to Scott Reef shallow water benthic communities and habitats (<75 m bathymetry) (see Management approach - Torosa wells in the State Proposal Area). As previously described, the management approach for drill centre locations in the State Proposal Area (i.e. TRA, TRD and TRF) described in Section 6.3.15.3 of the draft EIS/ERD has been further reviewed and developed, in consideration of the discrete drilling discharges, and has resulted in the inclusion of additional proposed

Discharge	Drilling or completions discharges		
	management controls to demonstrate that the maximum LEP can be achieved for Scott Reef shallow water benthic communities and habitats (<75 m bathymetry). Refer to **Appendix A** (Management Approach for Torosa wells in State Proposal Area) for details.		
Assessment of residual risk to EQO			
EV	**EQO**	**Assessment**	**Residual risk to EQO exists?**
Ecosystem health	Maintain ecosystem integrity	Activity is predicted to result in sediment deposition above ecological thresholds (6.5 mm in thickness, (IOGP, 2016)) for a radius in the order of 200 m from each well, and the discharge of cement for a radius of approximately 50 m from each well. In addition, modelling indicates TSS levels will be temporarily increased above natural variability as a result of drilling discharges. No impacts to ecosystem integrity are predicted outside of these areas is predicted.	**Yes**
Fishing and aquaculture	Fishing – seafood is of a quality safe for eating	Localised and temporary change to water quality not predicted to impact seafood quality.	No
Recreation and aesthetics	Primary contact recreation – water quality is safe for activities in the water	Localised and temporary change to water quality below threshold levels are not predicted to impact recreational use.	No
	Secondary contact recreation – water quality is safe for activities in the water	Localised and temporary change to water quality below threshold levels are not predicted to impact recreational use.	No
	Aesthetic values of the marine environment are protected	Localised and temporary change to water quality below threshold levels are not predicted to impact aesthetic value of marine environment	No
Cultural and spiritual	Cultural and spiritual values of the marine environment are protected	As per (EPA, 2016), in the absence of any specific environmental quality requirements for protection of ‘Cultural and Spiritual’ values, it is assumed that if water quality is managed to protect ecosystem integrity, primary contact recreation, seafood quality safe for eating, and aesthetic values, then this may go some way towards maintaining cultural values. Sediment and cement deposition on seabed in	No

Discharge	Drilling or completions discharges		
		deepwater not predicted to impact this EQO.	

3.3.7 Subsea control fluids

Table 3-8 outlines the assessment of the discharge of subsea control fluids with respect to achieving the EQOs.

Table 3-8 Assessment of the discharge of subsea control fluids in relation to achieving EQO

Discharge	Subsea control fluids
Description	Subsea control fluids will be used to control subsea valves remotely and are present on subsea equipment utilised during construction and installation (e.g. ROVs and BOPs) and on the operational subsea infrastructure. The subsea hydraulic control system will have high pressure (HP) and low pressure (LP) circuits. The HP system will operate the downhole safety valve and the LP system will operate all other subsea valves. An open loop subsea control system will be adopted for the HP control systems, whereby the control fluid is pressurised on the FPSO facilities by the hydraulic accumulators and delivered to subsea valves via umbilicals. For the LP control system, a hybrid solution will be used. The open loop HP hydraulic system will discharge a small amount (0.1 L) at the Christmas tree when testing or operating the downhole safety valve. The release will be at the wellhead subsea control module, typically at 350 m water depth or greater. The hybrid LP hydraulic system will utilise a contingency injection line in the umbilical in order to achieve a closed loop configuration. This hybrid system has no planned discharges and will only release hydraulic fluid if the system leaks or the contingency injection line is required due to failure of the primary injection line. During drilling activities, control fluids will be discharged during function and pressure testing of the BOP control system. The maximum volume of control fluid that will be released to the marine environment per manifold is 1,900 L per year of water-based fluid containing ~3% active ingredient (40–68 L of control fluid additive).
Draft EIS/ERD reference	• Draft EIS/ERD Section 6.3.16 • State ERD Section 8.2.4.9
Project stage(s)	Construction and operations.
Receptors	The following receptors within the State Proposal Area have been identified as potentially being impacted by this planned discharge**:** • sediment quality • water quality • biota.
Potential impacts	Control fluids are sourced from proprietary suppliers and are composed of low toxicity, water-based fluids. The specific control fluid has not yet been selected; however, such fluids are typically water based with additives such as Monoethylene Glycol (MEG) (usually about 40% of the total volume), lubricants, corrosion inhibitors, biocides and surfactants. Given the small volumes and solubility of the proposed water-based discharges, it is anticipated that the fluids would be rapidly diluted in the prevailing currents adjacent to the discharge location on the seabed. Hence, the intermittent discharge of small volumes of subsea control fluid may result in a minor, localised and temporary change in water quality that will be temporary (limited to the duration of the activity), restricted to deep water (>350 m); and subject to rapid dispersion and dilution by prevailing

Discharge	Subsea control fluids		
	currents due to the open oceanic waters of the State Proposal Area. Due to the expected rapid dispersion and dilution by prevailing currents, and the fact that discharged subsea fluid is not predicted to accumulate in sediments, no lasting change to sediment quality is predicted. Therefore, the discharge of subsea control fluids is not predicted to impact the EVs of the State Proposal Area.		
Mitigation and management	The following controls have been adopted in relation to this discharge: • Chemicals that may be operationally released or discharged to the marine environment will be subject to Woodside's chemical selection and assessment process and approved prior to use. • For the subsea LP control system, a hybrid solution in closed loop configuration will be used which returns fluids to the FPSOs and minimises discharges. The system will revert to an open loop system if the return lines to the FPSOs are no longer available to support the LP hydraulic system.		
Assessment of residual risk to EQO			
EV	**EQO**	**Assessment**	**Residual risk to EQO exists?**
Ecosystem health	Maintain ecosystem integrity	Localised and temporary change to water quality not predicted to impact ecosystem integrity.	No
Fishing and aquaculture	Fishing – seafood is of a quality safe for eating	Localised and temporary change to water quality not predicted to impact seafood quality.	No
Recreation and aesthetics	Primary contact recreation – water quality is safe for activities in the water	Localised and temporary change to water quality in >350 m deep water not predicted to impact recreational use.	No
	Secondary contact recreation – water quality is safe for activities in the water	Localised and temporary change to water quality in >350 m deep water not predicted to impact recreational use.	No
	Aesthetic values of the marine environment are protected	Localised and temporary change to water quality in >350 m deep water not predicted to impact aesthetic value of the marine environment.	No
Cultural and spiritual	Cultural and spiritual values of the marine environment are protected	As per (EPA, 2016), in the absence of any specific environmental quality requirements for protection of 'Cultural and Spiritual' values, it is assumed that if water quality is managed to protect ecosystem integrity, primary contact recreation, seafood quality safe for eating, and aesthetic values, then this may go some way towards maintaining cultural values. Sediment and cement deposition on seabed in deepwater not predicted to impact this EQO.	No

3.3.8 Hydrotest fluid discharge

Table 3-9 outlines the assessment of the discharge of hydrotest fluid with respect to achieving the EQOs.

Table 3-9 Assessment of the discharge of hydrotest fluid in relation to achieving EQO

Discharge	Hydrotest fluid discharge
Description	Hydrotest fluids are used for two distinct purposes; testing of the integrity of the pipeline and flowlines and for preservation of the pipelines and flowlines prior to the introduction of reservoir fluids. Hydrotest fluids may consist of a combination of seawater, biocides, corrosion inhibitors, oxygen scavenger, MEG and fluorescent dye. The period of time the hydrotest fluid is left within the infrastructure as a preservation fluid will depend on the type of fluid selected and the Browse Project schedule for construction and installation activities. If treated water is selected as the hydrotest fluid, it may only be suitable to be left in-situ for a period of approximately 12 to 24 months, after which it is typically discharged at sea and the flowline refilled, if required. If MEG is selected, it is likely that it could be left in-situ for longer, therefore reducing the frequency of discharge to sea. Discharge of hydrotest fluids into the State Proposal Area is associated with the subsea umbilicals, risers and flowlines (SURF) infrastructure and MODU. BTL discharge (in Commonwealth waters) may extend into the State Proposal Area depending on the chosen discharge locations as described below.
Draft EIS/ERD reference	• Draft EIS/ERD Section 6.3.17 • State ERD Section 8.2.4.10
Project stage(s)	Construction and operations
Receptors	The following receptors within the State Proposal Area have been identified as potentially being impacted by this planned discharge**:** • sediment quality • water quality • biota.
Potential impacts	Hydrotest fluid toxicity Due to the proposed chemical additives with the hydrotest fluid (i.e. biocides, corrosion inhibitors, oxygen scavenger, fluorescent dyes and MEG), the discharges have the potential to impact sensitive receptors within the discharge area of influence, primarily through toxicological effects ranging from the inhibition of key biological processes (e.g. reproduction) to mortality. In considering the potential impacts to receptors it should be noted that the activity is planned during commissioning, with no ongoing discharge of hydrotest fluids during the normal operations. For the purpose of the BTL hydrotest impact assessment, the hydrotest chemical treatment is assumed to be Hydrosure 0-3670R as a conservative analogue for other chemical treatments. Hydrosure 0-3670R is a proprietary chemical mixture designed for the treatment of water (neutralising bacteria and dissolved oxygen). To identify the potential toxicity of the hydrotest fluids following discharge to the marine environment, Chevron Australia Pty Ltd (2015) conducted whole effluent toxicity (WET) testing on Hydrosure 0-3670R (Champion Chemicals Pty Ltd), diluted in seawater. WET testing was undertaken on five locally relevant species from four different taxonomic groups based on ANZECC & ARMCANZ (2000). Since Hydrosure 0-3670R is a mixture containing both the biocide and oxygen scavenger for chemical treatment, only one assay in each test species was necessary to evaluate the toxicity of the product. The results from this study established a 99% species protection value of 0.06 mg/L, which

Discharge	Hydrotest fluid discharge
	was applied in the modelling over a 48-hr rolling median (Chevron Australia Pty Ltd, 2015). In addition, MEG, which may be used in the hydrotest fluid, is commonly used as a hydrate inhibitor within oil and gas developments. The chemical itself is clear and colourless, with a low volatility and miscible with water; however, no hydrolysis of the compound is expected in surface waters (WHO, 2000). MEG is listed as ‘E’ category fluids under the Offshore Chemical Notification Scheme (OCNS) and are listed on the Oslo Paris Commission (OSPAR) PLONOR (‘pose little or no risk to the environment’) list. In addition, the compound has little or no capacity to bind to particulates and will be mobile in soil (WHO, 2000). Rapid degradation has been reported in surface waters, with a generally low toxicity to aquatic organisms. Direct toxicity testing of neat MEG, on eight, mainly tropical species, representing seven taxonomic groups, established the lowest no observable effect concentration (NOEC) for sea urchin fertilisation of 130 mg/L (Jacobs, 2019). *Commonwealth waters discharges (BTL)* As noted in Section 6.3.17 of the draft EIS/ERD, Woodside will continue to pursue dry commissioning of the BTL and inter-field spur line. If deemed technically feasible and acceptable, this is the preferred method for preparing the BTL and inter-field spur line for the introduction of export product. Acceptance of dry commissioning of the BTL and associated inter-field spur line is subject to stakeholder endorsement (most notably relevant regulator(s) and the Classification Society) that the as-installed BTL and associated inter-field spur line complies with relevant engineering standards to provide alternative means to verify its safety and integrity, replacing the traditional hydrostatic system test and associated flood, clean, gauge and dewater. Therefore, final stakeholder endorsement of the dry commissioning approach will only occur after the BTL and associated inter-field spur line has been installed. If dry commissioning of the BTL and inter-field spur line is not deemed technically feasible and acceptable, three discharge options are being assessed for the discharge of hydrotest fluid during dewatering of the BTL and inter-field spur line. Note the actual hydrotest dewatering scenario may be combination of Scenarios 1 to 3 described, with potential postponement in discrete discharges where required. The chosen scenario will however remain within the bounds of impact and risk assessment completed in the draft EIS/ERD. These include the following, which all originate in Commonwealth waters: • Base case - scenario 1 (NRC Pipeline End Terminal, PLET): 736,000 m^3 hydrotest fluid (BTL and inter-field spur line) is discharged at the NRC PLET location, followed by 110,000 m^3 hydrotest fluid (2TL) at least 6 months later. • Alternative scenario 2 (Torosa PLET): 846,000 m^3 hydrotest fluid (BTL, inter-field spur line and NWS Project’s 2TL) is discharged at the Torosa PLET. • Alternative scenario 3a / 3b (Brecknock/ Calliance PLET and Torosa PLET): BTL and NWS Project’s 2TL hydrotest fluid (790,000 m^3) is discharged at the Calliance/ Brecknock PLET, while the hydrotest fluid from the inter-field spur line (56,000 m^3) is discharged at the Torosa PLET. Modelling of Scenario 2 and 3b (as presented in Section 6.3.17 of the draft EIS/ERD), indicated that the hydrotest discharge plume would likely extend into the State Proposal Area resulting in a temporary and localised decline in water and sediment quality as a result of the presence of chemical additives in discharged hydrotest fluids. The modelling also indicates that sufficient dilutions to achieve 99% species protection may not be achieved by the time the plume reaches the State Proposal Area boundary, meaning potential impacts to deepwater benthic biota may occur. Based on the modelling, the hydrotest discharge above threshold levels is predicted to extend into the State Proposal Area for a distance of approximately 800 m for both Scenario 2 and Scenario 3b. The hydrotest plume is predicted to extend into the State

Discharge	Hydrotest fluid discharge
	Proposal Area a total distance of approximately 1.5 km for Scenario 2 and 1.8 km for Scenario 3b. No contact with Scott Reef shallow water benthic communities and habitats (<75 m bathymetry) is predicted due to the depth of the discharge (461 m), with the plume staying in deep water, following the contours at the base of the reef and the prevailing bed currents. The modelling predicts the plume will reach no closer than approximately 3.8 km and approximately 3.3 km from the Scott Reef shallow water benthic communities and habitats (<75 m bathymetry) for Scenario 2 and Scenario 3b respectively. It should be noted that there is no evidence of persistent upwelling or downwelling currents at Scott Reef, but seawater temperature monitoring has recorded some evidence of localised intrusions of cooler water around the western and eastern entrances to the channel between North and South Scott Reef during spring tides (Brinkman et al., 2010; Green et al., 2019). Such cool water intrusions are primarily semi-diurnal in timing, driven by the strong semi- diurnal periodicity in the prevailing internal wave and tide regime in the channel, combined with horizontal shear due to the strong tidal currents that can entrain water from below the sill depth of the channel up into the lagoon. Logger data suggests that the cool water entering the lagoon originates within the thermocline from depths shallower than 160 m, with no evidence of deeper waters entering the lagoon system (Brinkman et al., 2010). Hence, no influence on the hydrotest discharges at depth (>460 m). *State waters SURF* For the SURF infrastructure, the flowline and riser hydrotest fluid will most likely be returned to the FPSO facility and then discharged to sea in Commonwealth waters. However, discharge may occur in deep water at the manifolds or riser base flowline end terminals (FLETS) for rigid flowlines. For flowlines where the manifold is in the State Proposal Area, discharge will occur at the FPSO location (either from the FPSO or from the riser base FLETS) in order to maximise distance of the discharge from Scott Reef. However, for flowlines which are terminated at both ends within the State Proposal Area (for TRF manifolds only), discharge of flowline hydrotest fluid in the State Proposal Area may be unavoidable. Volumes are estimated to be up to up to approximately 250 m^3 for TRF flowline. A subsea flowline hydrotest discharge is likely to take less than a day to complete. These discharges will occur for each piece of infrastructure during pre-commissioning. The size of the mixing zone associated with a hydrotest discharge from flowlines is dependent on the discharge characteristics (e.g. rate, volume, density etc.) and prevailing hydrodynamics. Woodside has previously performed hydrotest modelling for a range of discharge rates (4.8 m^3/min, 3.7 m^3/min, 1.85 m^3/min and 1.5 m^3/min), in water depths ranging from 130 m to 830 m on the North West Shelf, which is considered appropriate to support this plan. The far-field dispersion modelling indicated that based on an in-pipe chemical concentration of 600 ppm, the plume would achieve 600 dilutions to dilute to below 1 ppm (based on LC50 over 96 hours) in proximity to the discharge location, ranging at a distance from 50 m (130 m water depth; 1.5 m^3/min; summer; 95^{th} percentile) to 300 m (844 m water depth; 4.8 m^3/min; summer; 95^{th} percentile) downstream of the discharge point. For the SURF dewatering discharges, the plume is expected to travel in proximity to the seabed which means the temporary change in water quality will be restricted to deep waters. The discharge would be subject to rapid dispersion and dilution by prevailing currents, due to the open oceanic waters of the Project Area. In addition, the low toxicity hydrotest fluids will degrade and decay once released. As such no lasting effect on water quality is predicted. *MODU* The temporary production system on the MODU will be hydrotested for well unloading activities. This will be conducted using hydrotest fluids, whereby the temporary

Discharge	Hydrotest fluid discharge		
	production system on the MODU flowlines will be pressurised with fluids and the pressure will be monitored to detect leaks, prior to discharge of the hydrotest fluids. Discharges of small volumes of hydrotest fluid would be subject to rapid dispersion and dilution by prevailing currents with no lasting impact on water quality predicted.		
Mitigation and management	The following controls have been adopted in relation to this discharge: • The subsea infrastructure installation schedule will be optimised to minimise the requirement for discharge and refill of hydrotest fluid. • Chemicals that may be operationally released or discharged to the marine environment will be subject to Woodside's chemical selection and assessment process and approved prior to use. • For flowlines connected to those production manifolds that are located within 3nm of Scott Reef, the discharge of flowline hydrotest fluid will occur from the end of the flowline furthest from Scott Reef, where technically feasible. • Future engineering will consider the viability of alternatives to flowline hydrotest fluid discharge in the State Proposal Area, which will be described in a future EP.		
Assessment of residual risk to EQO			
EV	**EQO**	**Assessment**	**Residual risk to EQO exists?**
Ecosystem health	Maintain ecosystem integrity	Detectable levels of contaminants (above threshold levels) may occur within the State Proposal Area as a result of the BTL hydrotest discharge (depending on chosen discharge location). Detectable levels of contaminants (above threshold levels) may occur within the State Proposal Area as a result of the SURF infrastructure hydrotest discharge.	**Yes**
Fishing and aquaculture	Fishing – seafood is of a quality safe for eating	Localised and temporary change to water quality in >350 m deep water not predicted to impact seafood quality	No
Recreation and aesthetics	Primary contact recreation – water quality is safe for activities in the water	Localised and temporary change to water quality in >350 m deep water not predicted to impact recreational use	No
	Secondary contact recreation – water quality is safe for activities in the water	Localised and temporary change to water quality in >350 m deep water not predicted to impact recreational use	No
	Aesthetic values of the marine environment are protected	Localised and temporary change to water quality in >350 m deep water not predicted to impact aesthetic value of the marine environment	No
Cultural and spiritual	Cultural and spiritual values of the marine	As per (EPA, 2016), in the absence of any specific environmental quality requirements for protection of 'Cultural and Spiritual' values, it	No

Discharge	Hydrotest fluid discharge		
	environment are protected	is assumed that if water quality is managed to protect ecosystem integrity, primary contact recreation, seafood quality safe for eating, and aesthetic values, then this may go some way towards maintaining cultural values. Sediment and cement deposition on seabed in deepwater not predicted to impact this EQO.	

3.3.9 Summary

Table 3-10 presents a summary of the discharges the are considered to have the potential to pose a residual risk to EQOs.

Table 3-10 Summary of the discharges the are considered to have the potential to pose a residual risk to EQOs

Activity	EV	EQO	Assessment
Drilling or completions discharges	Ecosystem health	Maintain ecosystem integrity	Activity is predicted to result in sediment deposition above ecological thresholds (6.5 mm in thickness (IOGP, 2016) for a radius in the order of 200 m from each well, and the discharge of cement for a radius of approximately 50 m from each well. In addition, modelling indicates TSS levels will be temporarily increased above natural variability as a result of drilling discharges.
Hydrotest fluid discharge	Ecosystem health	Maintain ecosystem integrity	Detectable levels of contaminants (above threshold levels) may occur within the State Proposal Area as a result of the BTL hydrotest discharge (depending on chosen discharge location). Detectable levels of contaminants (above threshold levels) may occur within the State Proposal Area as a result of the SURF infrastructure hydrotest discharge.
Torosa FPSO cooling water discharge in Commonwealth waters	Ecosystem health	Maintain ecosystem integrity	Detectable levels of contaminants (below threshold levels) may be detected within the State Proposal Area as a result of the Torosa FPSO cooling water discharge in Commonwealth waters. No impact to biota is predicted as the discharge will be diluted to below achieve 99% species protection prior to it reaching the boundary of the State Proposal Area.

3.4 Management framework

3.4.1 Environment Quality Plan

This EQMP was developed to manage those aspects of the proposed Browse Project activities that have the potential to affect the relevant EV (ecosystem health) or that may vary from the associated EQO of maintaining ecosystem integrity. A key component of this is the development of an EQP which is defined by the EPA as "a plan that identifies the environmental values that apply to an area and spatially maps the zones where the environmental quality objectives (including levels of ecological protection) should be achieved" (EPA, 2016).

The objective of this EQP is to maintain a healthy and diverse ecosystem and there are potentially four (low, moderate, high or maximum) LEP that may be applied, each corresponding to a different target environmental quality condition. This method is seen as a practicable and auditable way of setting an objective for maintenance of ecosystem integrity while allowing for some discharge of waste to the marine environment in certain areas and under strictly controlled conditions.

The definitions of allowable change beyond natural variation under each LEP are outlined in **Table 3-11**. The limits of acceptable change for each environmental element with regard to the four LEP are detailed in **Table 3-12**.

Table 3-11 Definition of allowable changes to natural background under Levels of Ecological Protection (LEP) (EPA 2016)

LEP	Definition
Low	Allows large changes in abundance and biomass of marine life, biodiversity, and rates of ecosystem processes, but only within a confined area.
Moderate	Applied to relatively small areas within inner ports and adjacent to heavy industrial premises where pollution from current and/or historical activities may have compromised a high LEP.
High	Allows for small measurable changes in the quality of water, sediment, and biota, but not to a level that changes ecosystem processes, biodiversity, or abundance and biomass of marine life beyond the limits of natural variation.
Maximum	Activities to be managed so that there were no changes beyond natural variation in ecosystem processes, biodiversity, abundance, and biomass of marine life or in the quality of water, sediment, and biota.

Table 3-12 Limits of acceptable change to State Proposal Area marine environmental quality (EPA 2016)

Key elements	Limits of acceptable change	Maximum LEP	High LEP	Moderate LEP	Low LEP
Ecosystem processes (e.g. primary production, nutrients cycles, food chains)	Ecosystem processes are maintained within the limits of natural variation (no detectable change)	✓	✓		
	Small changes in rates, but not types of ecosystem processes			✓	
	Large changes in rates, but not types of ecosystem processes				✓
Biodiversity (e.g. variety and types	Biodiversity as measured on both local and regional scales remains	✓	✓	✓	

Key elements	Limits of acceptable change	Maximum LEP	High LEP	Moderate LEP	Low LEP
of naturally occurring marine life)	at natural levels (no detectable change)				
	Biodiversity measured on a regional scale remains at natural levels although possible change in variety of biota at a local scale				✓
Abundance and biomass of marine life (e.g. number or density of individual animals, the total weight of plants)	Abundances and biomasses of marine life vary within natural limits (no detectable change)	✓	✓		
	Small changes in abundances and/or biomasses of marine life			✓	
	Large changes in abundances and/or biomasses of marine life				✓
The quality of water, biota and sediment (e.g. types and levels of contaminants such as heavy metals, dissolved oxygen content, water clarity)	Levels of contaminants and other measures of quality remain within limits of natural variation (no detectable changes)	✓			
	Small detectable changes beyond limits of natural variation but no resultant effect on biota		✓		
	Moderate changes beyond limits of natural variation but not to exceed specified criteria			✓	
	Substantial changes beyond limits of natural variation				✓

The LEPs for the State Proposal Area have been identified based on the assessment of the activities presented in the **Section 3.3**. When determining the proposed LEP, consideration has been given to potential impacts to marine environmental quality during construction and operations. This includes the planned staged development of the proposed Browse Project, where construction and commissioning activities such as drilling and completions of future drill centres may occur simultaneously with operations.

Due to the complex nature of the operations and need for clarity in the varying levels of protection that will apply to different times and activities, three maps defining spatial extent of each relevant LEP for certain activities have been prepared. Drilling activities may result in permanent change to the seabed within the immediate vicinity of each wells, but operation of these wells presents no further risk to the sea bed. Therefore, the LEPA proposed for the operations phase only applies to water quality. This allows for impacts due to construction to be monitored while allowing much lower limits of acceptable change for the long term operation of equipment. The proposed LEP are described in **Table 3-13**.

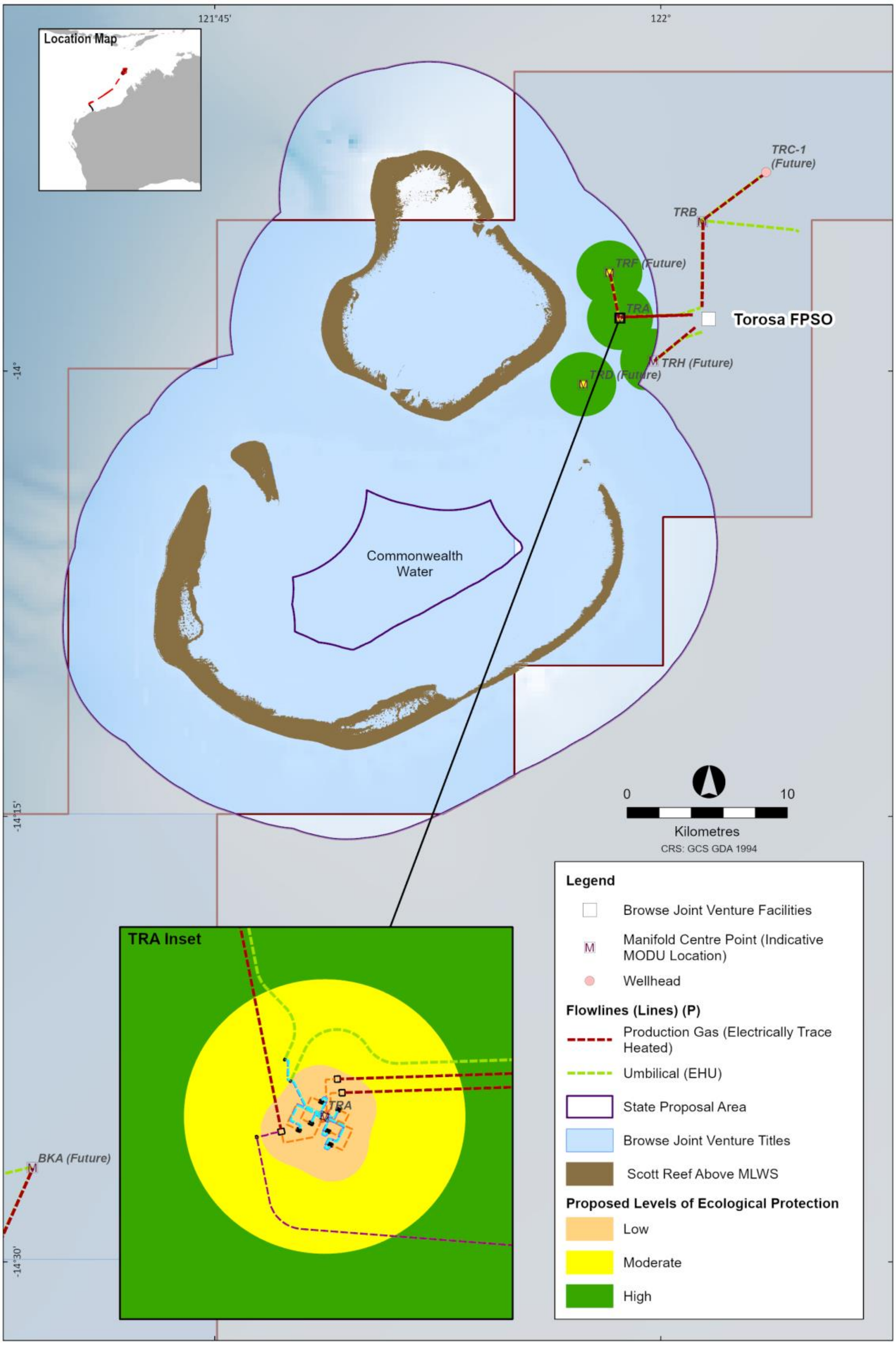

Figure 3-2 – LEP 1. Applicable to construction (i.e. drilling & hydrotest) activities, defining the levels of environmental protection applicable to **sediments** (i.e. benthic habitats).

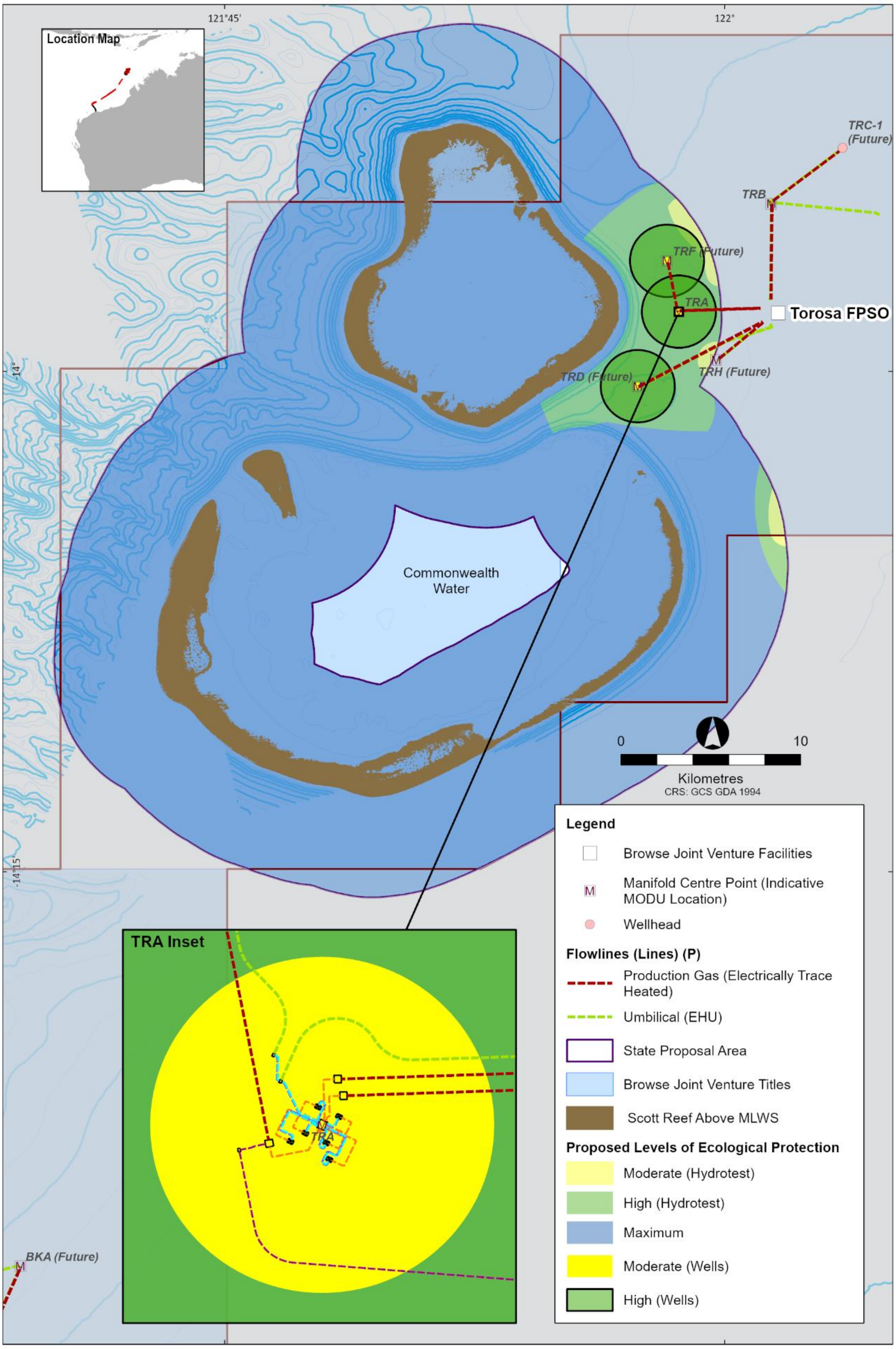

Figure 3-3 – LEP 2. Applicable to construction (i.e. drilling & hydrotest) activities, defining the levels of environmental protection applicable to the surrounding **water column**.

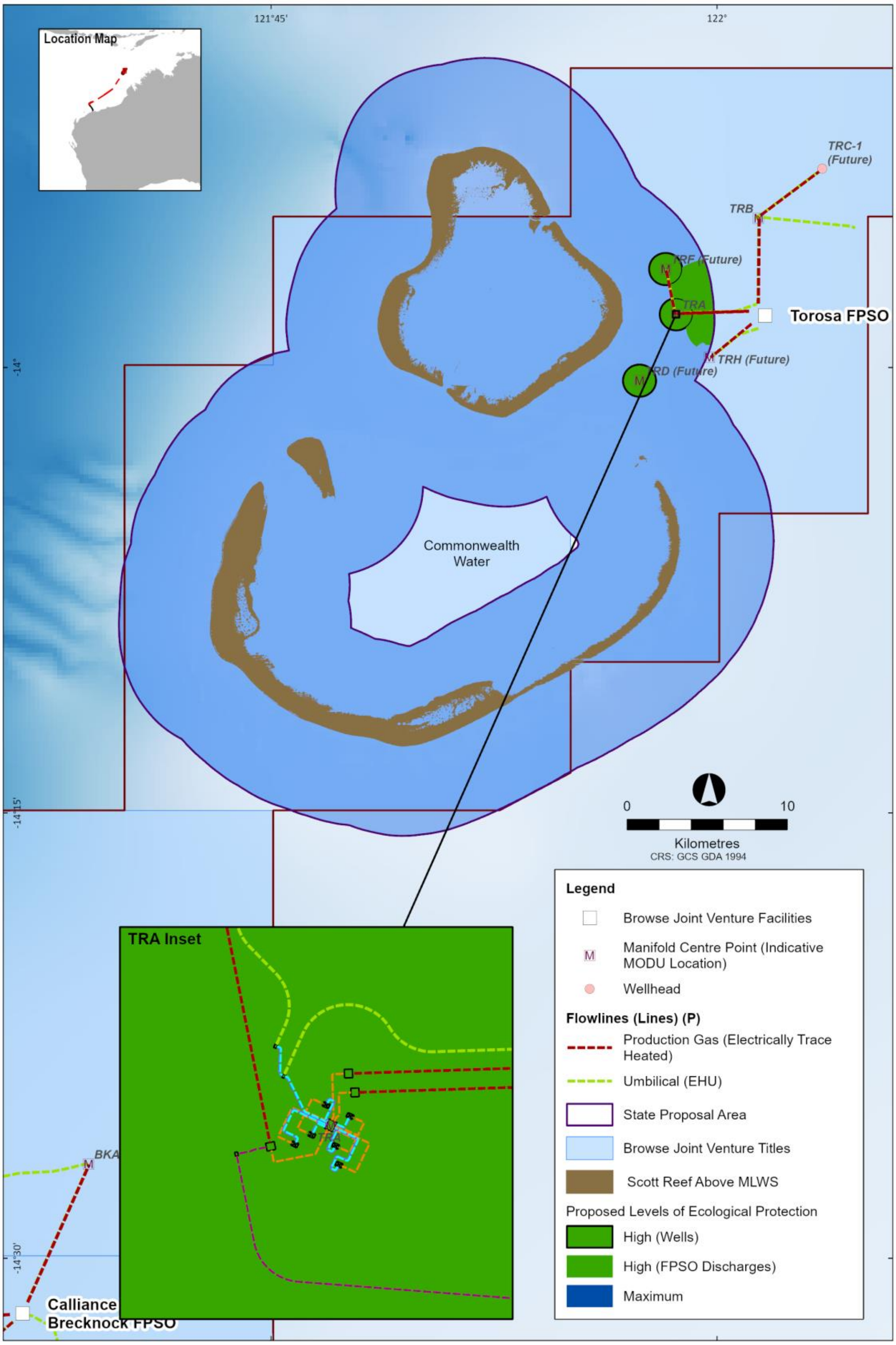

Figure 3-4. **LEP 3.** Applicable to operations, when no construction activities are occurring, defining the levels of environmental protection applicable to both **water column** and **sediments**.

Table 3-13 Proposed Limits of Ecological Protection (LEP) for the State Proposal Area

Activity	Predicted extent and magnitude of impact	Predicted limit of ecological change	Applicable LEP achieved
Construction activities			
Drilling and completions discharges [LEP 1]	Activity is predicted to result in sediment deposition above ecological thresholds (6.5 mm in thickness, (IOGP, 2016)) for a radius in the order of 200 m from each well, and the discharge of cement for a radius of approximately 50 m from each well. This may lead to the alteration of the physio-chemical composition of sediments, the burial and potential smothering of sessile benthic biota, and potential contamination and toxicity effects to benthic biota from drilling fluids.	**Ecosystem processes (e.g. primary production, nutrients cycles, food chains)** Given the localised area potentially affected by the drilling or completions discharges in the context of deepwater habitats that are well represented both in the State Proposal Area and regionally, ecosystem processes are expected to be maintained within natural variation (i.e. no detectable change). **Biodiversity (e.g. variety and types of naturally occurring marine life)** Given the localised area potentially affected by the drilling or completion discharges in the context of deepwater habitats that are well represented both in the State Proposal Area and regionally, biodiversity as measured on both local and regional scales remains at natural levels (no detectable change). **Abundance and biomass of marine life (e.g. number or density of individual animals, the total weight of plants)** The localised smothering of biota associated with deepwater habitats within the State Proposal Area resulting from discharge of drill cuttings and cement is expected to lead to small changes in the abundance and/or biomasses of marine life within approximately 200 m radius of each drill centre, depending on individual well locations.	***Drilling cuttings and cement discharge – low LEP (sediment and biota)*** Based on predicted changes to the abundance and biomass of marine life and the quality of sediment, a **low** LEP is proposed within a 50 m radius of each well where cement may be deposited within which benthic organisms (particularly burrowing organisms) may be unable to colonise. It should be noted that given the exact location of each well within the well centre is currently unknown, the exact locations of these low LEPs are also unknown and are indicatively depicted on Figure 3-2**.** Variation would be within 10s of metres of that shown on this map and not resolvable at the shown resolution. ***Drilling cuttings discharge – moderate LEP (sediment and biota)*** A **moderate** LEP is proposed from 50 m from each well, extending to a 200 m radius from each well. Cuttings deposition between 1mm and 6.5mm may occur in this area, leading to changes in localised species abundance and total biomass. Contaminants may exceed sediment toxicant default guideline values for

Activity	Predicted extent and magnitude of impact	Predicted limit of ecological change	Applicable LEP achieved
		The quality of biota and sediment (e.g. types and levels of contaminants such as heavy metals, dissolved oxygen content, water clarity) The deposition of drill cuttings (with residual fluids) may result in changes to natural composition of sediments within approximately 2,000 m radius of each drill centre, depending on individual well locations. The generation of localised and temporary elevated turbidity may result in a small detectable change in sediment quality beyond limits of natural variation but no resultant effect on biota is predicted.	sediment quality, but not exceeding high values. The estimated extent of deposition impacts within the low LEPs is 0.16 km^2. 0.16 km^2 is a 50 m radius around each well. A maximum temporary impact due to cuttings deposition of 2.4km^2 may occur in the moderate LEP, assuming each well is 100m apart, which is an over-estimate as wells are planned to be spaced less than 50m apart. ***Drilling discharges – high LEP (sediment and biota)*** Based on the modelling results presented in Section 6.3.15 of the draft EIS/ERD, sedimentation rates will be temporarily increased above natural variability to a distance not exceeding 2,000m from each well, with no expected impact on biota. Sedimentation rates of between 1mm and 0.01mm may occur in this zone, with no exceedances of sediment toxicant default guideline values predicted. No change to sediment quality beyond this zone.

Activity	Predicted extent and magnitude of impact	Predicted limit of ecological change	Applicable LEP achieved
Drilling and completions discharges [LEP 2]	Modelling indicates TSS levels will be temporarily increased above natural variability as a result of drilling discharges. TSS is typically less than 10 mg/L within less than 100 m of the discharge point. Concentrations may be above 10 mg/L for short periods for a distance of up to 1,000 m from the well	**Ecosystem processes (e.g. primary production, nutrients cycles, food chains)** Given any impacts to water quality will be localised and temporary, ecosystem processes are expected to be maintained within natural variation (i.e. no detectable change). **Biodiversity (e.g. variety and types of naturally occurring marine life)** Given any impacts to water quality will be localised and temporary, biodiversity as measured on both local and regional scales remains at natural levels (no detectable change). **Abundance and biomass of marine life (e.g. number or density of individual animals, the total weight of plants)** Given any impacts to water quality will be localised and temporary, abundances and biomasses of marine life is not expected to be vary outside of natural limits (no detectable change). **The quality of water, biota and sediment (e.g. types and levels of contaminants such as heavy metals, dissolved oxygen content, water clarity)** The generation of localised and temporary elevated turbidity may result in a small detectable change in water quality beyond limits of natural variation but no resultant effect on biota is predicted.	***Drilling cuttings discharge – Moderate LEP (water quality)*** A **moderate** LEP is proposed from each well for a radius of 200 m from each well as instantaneous but temporarily high concentrations (>2,000mg/L) of suspended sediments may occur, particularly from pit dumps. Note the restrictions on surface sediment discharges in Appendix A which restrict pit dumps at surface to eliminate risk to Scott Reef habitats. TSS up to 10mg/L in this area. ***Drilling discharges – high LEP (water quality)*** A **high** LEP is proposed based on a TSS threshold of less than 10 mg/L, which Nelson *et al*. (2016) identified as the no effect or sub lethal minimal effect concentration for TSS. The **high** LEP will apply from a radius of 200 m from each well to 2,000 m radius from the well centre.

Activity	Predicted extent and magnitude of impact	Predicted limit of ecological change	Applicable LEP achieved
Hydrotest discharge – flowlines and MODU [LEP 2]	Discharge of hydrotest fluid from the flowlines and the temporary production system in the MODU located in the State proposal area may result in a temporary and localised decline in water and sediment quality as a result of the presence of chemical additives in discharged hydrotest fluids. Representative modelling indicates that such discharge would dilute to achieve 90% species protection levels within 300 m.	**Ecosystem processes (e.g. primary production, nutrients cycles, food chains)** Given any impacts to water quality will be localised and temporary, ecosystem processes are expected to be maintained within natural variation (i.e. no detectable change).	Based on predicted changes to the quality of water, biota and sediment, a **moderate** LEP is proposed. This hydrotest discharge would occur within (and be incorporated within) the areas proposed as a **moderate** LEP around the drill centres and subsea infrastructure described above for the drilling or completions discharges.
		Biodiversity (e.g. variety and types of naturally occurring marine life) Given any impacts to water quality will be localised and temporary, biodiversity as measured on both local and regional scales remains at natural levels (no detectable change).	
		Abundance and biomass of marine life (e.g. number or density of individual animals, the total weight of plants) Given any impacts to water quality will be localised and temporary, abundances and biomasses of marine life is not expected to be vary outside of natural limits (no detectable change).	
		The quality of water, biota and sediment (e.g. types and levels of contaminants such as heavy metals, dissolved oxygen content, water clarity) The discharge of hydrotest fluid may result in moderate changes in water quality beyond limits of natural variation but not to exceed specified criteria.	
	Discharge of hydrotest fluid from the BTL in Commonwealth waters may	**Ecosystem processes (e.g. primary production, nutrients cycles, food chains)**	Based on predicted changes to the abundance and biomass of marine life and

Activity	Predicted extent and magnitude of impact	Predicted limit of ecological change	Applicable LEP achieved
Hydrotest discharge – BTL [LEP 2]	result in a temporary decline in water and sediment quality as a result of the presence of chemical additives in the discharge. Modelling of such a release at the Torosa PLET (not preferred option) which represents the worst-case option in proximity to the State Proposal Area indicates the discharge plume may enter the State Proposal Area. The modelling also indicates that sufficient dilutions to achieve 99% species protection may not be achieved by the time the plume reaches the boundary of the State Proposal Area.	Given any impacts to water and sediment quality will be localised and temporary, ecosystem processes are expected to be maintained within natural variation (i.e. no detectable change). **Biodiversity (e.g. variety and types of naturally occurring marine life)** Given any impacts to water and sediment quality will be localised and temporary, biodiversity as measured on both local and regional scales remains at natural levels (no detectable change). **Abundance and biomass of marine life (e.g. number or density of individual animals, the total weight of plants)** As the plume may not be diluted to a level that achieves 99% species protection at the 3nm State waters boundary, small changes in the abundance and/or biomass of marine life may occur. Once the plume is diluted to a 99% species protection level, no change to the abundance and biomasses of marine life is predicted. **The quality of water, biota and sediment (e.g. types and levels of contaminants such as heavy metals, dissolved oxygen content, water clarity)** As the plume may not be diluted to a level that achieves 99% species protection at the 3nm State waters boundary, changes in water quality at a moderate level and beyond the limits of natural variation may occur. Once the plume is diluted to a 99% species protection level, small detectable changes beyond limits of natural	the quality of water, biota and sediment, a **moderate** LEP is proposed in the area where modelling indicates that there are insufficient dilutions to achieve the defined thresholds based on 99% species protection level. Based on the modelling, this area of **moderate** LEP extends into the State Proposal Area for a distance of approximately 800 m for both Scenario 2 and Scenario 3b (refer to **Section 3.3.8**). A **high** LEP is proposed for the area where modelling indicates sufficient dilutions will have occurred to achieve 99% species protection levels, however insufficient dilutions to reach background levels. Based on the modelling, this area of **high** LEP extends into the State Proposal Area for a distance of 1.5 km for Scenario 2 and 1.8 km for Scenario 3b. This has been extended to the Scott Reef boundary for simplicity.

Activity	Predicted extent and magnitude of impact	Predicted limit of ecological change	Applicable LEP achieved
		variation may occur but with no resultant effect on biota.	
All other areas	A **maximum LEP** (no detectable change beyond natural variation) is proposed for all other areas within the State Proposal Area. This includes all Scott Reef shallow water benthic communities and habitats (<75 m bathymetry).		
Operations			
Subsea infrastructure (i.e. wells) [LEP 3]	The predicted irreversible loss (approximately 50 m radius of each well) of benthic habitat resulting from the discharge of cement that will occur during construction of the wells will remain throughout the operations phase. Note any reversible loss has not been considered in the operations phase LEP. It is noted that the subsea control fluid discharged as part of the operations of the wells is expected to be rapidly dispersed and diluted by prevailing currents and is expected to be undetectable outside of the proposed low LEP established for the construction phase.	**Ecosystem processes (e.g. primary production, nutrients cycles, food chains)** Given the small, localised area potentially affected in the context of deepwater habitats that are well represented both in the State proposal area and regionally, ecosystem processes are expected to be maintained within natural variation (i.e. no detectable change).	Based on predicted changes to the abundance and biomass of marine life a 500m **High** LEP is proposed around the well centres. It should be noted that only a small portion of the proposed **High** LEP area around the wells centres will be impacted. This LEP does not consider the benthic habitats, which are subject to the limits of acceptable change relevant to drilling/construction activities. Operations discharges are not predicted to impact sediments/benthic habitats.
		Biodiversity (e.g. variety and types of naturally occurring marine life) Given the small, localised area potentially affected in the context of deepwater habitats that are well represented both in the State Proposal Area and regionally, biodiversity as measured on both local and regional scales remains at natural levels (i.e. no detectable change).	
		Abundance and biomass of marine life (e.g. number or density of individual animals, the total weight of plants) No change as a result of discharge of operational fluids.	
		The quality of water, biota and sediment (e.g. types and levels of contaminants such as heavy metals, dissolved oxygen content, water clarity)	

Activity	Predicted extent and magnitude of impact	Predicted limit of ecological change	Applicable LEP achieved
		No detectable change to water quality during operations is predicted as cement discharge will only occur during construction.	
FPSO cooling water [LEP 3]	Discharge of cooling water from the Torosa FPSO (in Commonwealth waters) may result in a temporary and localised decline in water quality as a result of the presence of chemical additives in discharged cooling waters. Modelling of the FPSO cooling water discharge (**Section 6.3.13.3** of the draft EIS/ERD) indicates that the discharge plume may enter the State Proposal Area but at concentrations not exceeding the 99% species protection level (95Th percentile). The maximum extent of this incursion is approximately 2 km.	**Ecosystem processes (e.g. primary production, nutrients cycles, food chains)** Given any impacts to water quality will be localised and temporary, ecosystem processes are expected to be maintained within natural variation (i.e. no detectable change). **Biodiversity (e.g. variety and types of naturally occurring marine life)** Given any impacts to water quality will be localised and temporary, biodiversity as measured on both local and regional scales remains at natural levels (i.e. no detectable change). **Abundance and biomass of marine life (e.g. number or density of individual animals, the total weight of plants)** Given any impacts to water quality will be localised and temporary (with 99% species protection levels achieved) no change to the abundance and biomasses of marine life is predicted. **The quality of water, biota and sediment (e.g. types and levels of contaminants such as heavy metals, dissolved oxygen content, water clarity)** Given any impacts to water quality will be localised and temporary (with 99% species	A **high** LEP is proposed for the area where modelling indicates the cooling water plume discharged from the Torosa FPSO in the Commonwealth waters may enter into the State Proposal Area (at sufficient dilutions to achieve 99% species protection levels).

Activity	Predicted extent and magnitude of impact	Predicted limit of ecological change	Applicable LEP achieved
		protection levels achieved), small detectable changes beyond limits of natural variation may occur but with no resultant effect on biota.	
All other areas	A **maximum LEP** (no detectable change beyond natural variation) is proposed for all other areas within the State Proposal Area. This includes all Scott Reef shallow water benthic communities and habitats (<75 m bathymetry).		

3.4.2 Environmental Quality Criteria

EQC represent scientifically based limits of acceptable change to a measurable environmental quality indicator that is important for the protection of the associated environmental value (EPA, 2016).

The EQC provide the benchmarks against which environmental quality is measured. The EQC define the limits of acceptable change to the measured environmental quality indicators. The key to successful marine environmental performance under the EQMF is to maintain environmental quality within the bounds of the EQC. If the EQC are met, then it is assumed that the EQOs are met and EVs are protected

There are two levels of EQC:

- EQGs: These are relatively simple and easy-to-measure triggers that, if met, indicate a high degree of certainty that the associated EQO was achieved. If the EQG is not met, there is uncertainty as to whether the associated EQO was achieved and a more detailed assessment against the EQS is required.
- EQSs: These are numerical values or narrative statements that, if not met, indicate a significant risk that the associated EQO has not been achieved and a management response is required. The management response focuses on identifying the cause (or source) of the exceedance and identifying the cause of the exceedance and initiating a response to rectify.

As per EPA guidance (EPA, 2016) in the absence of any specific environmental quality requirements for protection of 'Cultural and Spiritual' values, it is assumed that if water quality is managed to protect ecosystem integrity, primary contact recreation, seafood quality safe for eating, and aesthetic values, then this may go some way towards maintaining cultural values. As such no EQCs are identified specifically for protecting cultural and spiritual values.

EQC and associated management provisions are outlined in **Table 3-14**.

3.4.3 Management provisions

For each environmental indicator monitored, the relevant EQC serve as a benchmark against which the monitoring data can be compared to determine whether the EQO has been achieved. If an EQG is exceeded, assessment against the EQS will commence. If an EQS is exceeded, a management response is required to ensure the EQO continues to be achieved. These responses are specific to maintaining the relevant EQO that is at risk of not being met. The response after triggering EQG/EQS typically requires reporting to the relevant agency (WA Department of Water and Environmental Regulation (DWER)). Responses include further investigations to determine the extent and source of the environmental impact and/or applying management options to reduce the impact. Outcomes-based management provisions for the proposed Browse Project are outlined in **Table 3-14**. Note that all monitoring data associated with the monitoring described in **Table 3-14** will be provided along with the Annual Report to the Compliance Branch at DWER.

Table 3-14 Outcomes-based management provisions for the Browse Project

Environmental Quality Objective	Monitoring Target	Monitoring	Environmental Quality Guidelines	Management Response / Reporting	Environmental Quality Standards	Management Response / Reporting
Construction Activities						
Drilling or completions discharges						
Maintenance of ecosystem integrity	Sediment quality	Sediment quality sampling conducted at locations based on a gradient design, radiating out from the well. Monitoring will be undertaken at completion of the first batch of drilling at each well centre as well as on completion of the last well at each well centre.	**EQG 1** The bioavailable fraction of the metal or metalloid concentrations measured the low LEP / moderate LEP and moderate LEP / high LEP boundaries will not exceed the recommended toxicant default guideline values for sediment quality (DGVs; ANZG, 2018) and as specified in **Section 3.5.1.2**. **EQG 2** Hydrocarbon concentrations measured at the low LEP / moderate LEP and moderate LEP / high LEP boundaries will not exceed the guideline values (DGVs) for sediment quality (ANZG, 2018) and as specified in **Section 3.5.1.2**. *For this EQG to be triggered, concentrations must be above background levels measured prior to the activity or a suitable reference location and be attributable to the Browse Project activities*	Report any exceedance to DWER in the Annual Environment Report. An investigation against EQS 1 and EQS 10 will then be conducted.	**EQS 1** Whole sediment toxicity tests (at least 3 tests) from sediment at the low LEP / moderate LEP boundary should not result in a statistically significant effect (P < 0.05) on lethal acute endpoints, or of greater than 50% on sublethal chronic endpoints for any species, compared to a matched reference sediment. **EQS 10** Whole sediment toxicity tests (at least 3 tests) from sediment at the low LEP/moderate LEP boundary should not result in a statistically significant effect (P < 0.05) on lethal acute endpoints, or of greater than 50% on sublethal chronic endpoints for any species, compared to a matched reference sediment.	Any exceedance of the EQS will be reported to DWER within five working days of confirmation that the exceedance has occurred. The significance of the exceedance and any required investigation/action will be determined following communication with DWER.
Maintenance of ecosystem integrity	Epibenthos cover	Epibenthos surveys involving video transects radiating out from target wells. Surveys will be undertaken at completion of the first batch of drilling at each well centre as well as on completion of the last well at each well centre.	**EQG 3** No net detectable change in epibenthos diversity or composition beyond the moderate LEP boundary, attributable to the Browse Project activities.	Report any exceedance to DWER in the Annual Environment Report. An investigation against EQS 2 and EQS 3 will then be conducted.	**EQS 2** At the low LEP / moderate LEP boundary, no change to epibenthos species diversity and composition attributable to the Browse Project. **EQS 3** At the moderate LEP / high LEP boundary, no detectable change in natural variation (including abundance, diversity and composition) of epibenthos cover attributable to the Browse Project activities.	Any exceedance of the EQS will be reported to DWER within five working days of confirmation that the exceedance has occurred. The significance of the exceedance and any required investigation/action will be determined following communication with DWER.

Environmental Quality Objective	Monitoring Target	Monitoring	Environmental Quality Guidelines	Management Response / Reporting	Environmental Quality Standards	Management Response / Reporting
Maintenance of ecosystem integrity	Water quality	Particle size distribution of surface discharges monitored within the first 24 hours of a relevant discharge occurring and at least weekly thereafter (if discharges are occurring). In-situ water quality monitoring will be undertaken at completion of the first batch of drilling at each well centre as well as on completion of the last well at each well centre.	**EQG 4** Particle size distribution of the drilling cuttings and fluids returned to the MODU via the riser, where the cuttings are separated from the fluids by Solids Control Equipment (SCE) and fluids discharged at surface within State Waters show that 99% of particles are greater than 63 µm in size. **EQG 14** In-situ water quality monitoring in the direction of the cuttings discharge plume shows the TSS is <10 mg/l above background at the moderate LEP / high LEP boundary and no detectable change from natural variation of total suspended solids is detected at the high LEP / maximum LEP boundary.	Report any exceedance to DWER in the Annual Environment Report. An investigation against EQS 4 will then be conducted.	**EQS 4** Water quality monitoring in the direction of the cuttings discharge plume shows no detectable change from natural variation of total suspended solids or contaminants in waters at Scott Reef (considered as the area above the 75 m bathymetric contour and within the 3 nm State waters boundary).	Any exceedance of the EQS will be reported to DWER within five working days of confirmation that the exceedance has occurred. The significance of the exceedance and any required investigation/action will be determined following communication with DWER. Response measures will include the reduction or cessation of the surface discharge of drill cuttings and fluids at times and locations where resultant plumes are likely to reach Scott Reef.
BTL hydrotest discharge						
Maintenance of ecosystem integrity	Water quality	Water quality monitoring conducted at the boundaries of the State waters / moderate LEP, State waters / High LEP, moderate LEP / high LEP and high LEP / moderate LEP during hydrotest discharge and in the hydrotest discharge plume.	**EQG 5** For BTL hydrotest discharge, concentration at the State waters boundary / moderate LEP for hydrotest discharge components indicate sufficient dilution to achieve 95% species protection levels has been achieved. **EQG 6** For BTL hydrotest discharge, concentration at the moderate/high LEP for hydrotest discharge components indicate sufficient dilution to achieve 99% species protection levels has been achieved.	Report any exceedance to DWER in the Annual Environment Report. An investigation against EQS 5 and EQS 6 will then be conducted.	**EQS 5** At the State waters / moderate LEP boundary, no change to epibenthos species diversity or composition attributable to the Browse Project. **EQS 6** At the moderate LEP / high LEP boundary, no detectable change in natural variation (including abundance, diversity and composition) of epibenthos cover attributable to the Browse Project.	Any exceedance of the EQS will be reported to DWER within five working days of confirmation that the exceedance has occurred. The significance of the exceedance and any required investigation/action will be determined following communication with DWER. Given the low likelihood of even EQG exceedance, EQS exceedance will trigger Woodside to develop an internal learning bulletin to prevent future occurrences.
SURF hydrotest discharge						
Maintenance of ecosystem integrity	Water quality	Water quality monitoring associated with the SURF hydrotest discharge is not proposed. The moderate LEP associated with the SURF hydrotest discharge is encompassed by the low LEP associated with the drilling and completions discharges. Further, SURF hydrotest	**EQG 7** For SURF discharges, modelling indicates the concentration of chemicals in the discharge would achieve 90% species protection levels at the low LEP / moderate LEP boundary.	Modify activity (e.g. reduced flow rates) until modelling shows EQG likely to be met. An investigation against EQS 7 and EQS 11 will then be conducted.	**EQS 7** At the moderate LEP / high LEP boundary, no detectable change in natural variation (including abundance, diversity and composition) of epibenthos cover attributable to the Browse Project.	Any exceedance of the EQS will be reported to DWER within five working days of confirmation that the exceedance has occurred. The significance of the exceedance and any required investigation will be determined following communication with DWER.

Environmental Quality Objective	Monitoring Target	Monitoring	Environmental Quality Guidelines	Management Response / Reporting	Environmental Quality Standards	Management Response / Reporting
		discharge will take less than a day to complete. It is not considered that water sampling in >400 m water due to discharge of a known toxicity is warranted from a scientific, safety or logistics/cost perspective given the area to be monitored will already be designated either a low or moderate LEP due to the drilling and completions discharges.			**EQS 11** At the low LEP / moderate LEP boundary, no change to epibenthos species diversity and composition attributable to the Browse Project.	
Operations – Water Column						
FPSO cooling water						
Maintenance of ecosystem integrity	Water quality	During steady state FPSO operations, cooling water modelling and infield verification will be completed to verify the modelling predictions. This study aims to verify the modelling predictions and in particular the dilutions achieved, which determines the point at which the defined thresholds levels are reached. In field water sampling will be carried out to establish a baseline and annually during the first three years of steady safe FPSO operations. After this time, periodic (every five years) and for cause (e.g. due to EQG 8 exceedance) water quality monitoring at a gradient away from the FPSO facility in the receiving environment will be undertaken to measure compliance with EQC 9 and EQC 10. This monitoring aims to determine no changes in the receiving environment water outside of the defined mixing zone as a result of the FPSO cooling water discharges.	**EQG 8** For FPSO cooling water discharges, residual chlorine will be monitored at the end of pipe so that the defined threshold value (i.e. 99% species protection) will be met at the edge of the mixing zone and the State waters 3 nm boundary, 95% of the time based on dispersion modelling results. **EQG 9** For cooling water, within the high LEP, water quality in the relation to the contaminants of concern meets the ANZG (2018) marine low reliability trigger value of 3 ug/L **EQG 10** For cooling water, within the maximum LEP, no detectable change from background concentrations in water quality in the relation to the contaminants of concern (i.e. temperature and residual chlorine).	Report any exceedance to DWER in the Annual Environment Report. An investigation against EQS 8 will then be conducted.	**EQS 8** Whole effluent toxicity (WET) testing of water quality samples taken in the high LEP show that no toxicity is detected (no significant difference from controls).	Any exceedance of the EQS will be reported to DWER within five working days of confirmation that the exceedance has occurred. The significance of the exceedance and any required investigation/action will be determined following communication with DWER. In the event the cooling water discharge results in an exceedance of the EQS an adaptive management strategy will be implemented which will be included in the EP governing the Torosa FPSO. Actions may include reducing discharge rates, changing discharge location, decreasing chemical dosing or changing the chemical dosing regime. The primary management response will be a review and adjustment of the chlorine dosage rate and regime so that residual chlorine is minimised. Residual chlorine levels will be monitored and routinely maintained at <0.2 parts per million (ppm) at the point of discharge. The frequency of monitoring of end of pipe chlorine concentrations and toxicity will be increased until such time that it can be shown that the risk of exceedances of the EQGs and EQS is removed.

Environmental Quality Objective	Monitoring Target	Monitoring	Environmental Quality Guidelines	Management Response / Reporting	Environmental Quality Standards	Management Response / Reporting
FPSO Produced water						
Maintenance of ecosystem integrity	Water quality	In the first year of operations, a PW modelling verification field program will be completed to verify model predictions. The study will aim to verify the modelling predictions and in particular the dilutions achieved, which determines the point at which the defined thresholds levels are reached. In situ water sampling (to verify EQG 12) will be undertaken to establish baseline and then annually during the first three years of steady state FPSO operations and every five years thereafter. This monitoring aims to determine no changes in the receiving environment water outside of the defined mixing zone are occurring as a result of the FPSO produced discharges.	**EQG 11** Chemical characterisation analysis of the produced water at end of pipe undertaken annually. Results demonstrate the ANZG (2018) 99% species protection guideline values will be achieved for each contaminant at the State Waters boundary, based on modelled dilution rates. **EQG12** At the entry to the State Waters boundary, water quality samples indicate no detectable change in water quality from background concentrations in the relation to the contaminants of concern. **EQG 13** WET Testing of the produced water at end of pipe undertaken annually. Results demonstrate the 99% species protection guideline values will be achieved at the State Waters boundary, based on modelled dilution rates.	Report the exceedance to DWER in the Annual Environment Report. An investigation against EQS 9 will then be conducted.	**EQS 9** Whole effluent toxicity (WET testing of water quality samples taken at the entry to State Waters (in the direction of the PW plume occurrence during the sampling period), shows that no toxicity above background is detected.	Any exceedance of the EQS will be reported to DWER within five working days of determining that an exceedance has occurred. The significance of the exceedance and any required investigation/action will be determined following communication with DWER. In the event the PW discharge results in an exceedance of the EQS, an adaptive management strategy will be implemented which will be included in the Environment Plan governing the Torosa FPSO. This adaptive management strategy will include actions such as reducing the discharge rate, which increases dilutions in the nearfield or reduces an individual chemical concentration through additional treatment or commingling prior to discharge or the addition of new/additional treatment stages or equipment.

3.5 Monitoring

3.5.1 Drilling and completions discharges - Deepwater sediment quality

3.5.1.1 Environmental Quality Criteria

The EQGs and EQSs for sediment quality in relation to drilling and completions discharges area shown in **Table 3-15**. Only contaminants of concern as relevant to drilling discharges are subject to the EQC.

Table 3-15 Environmental Quality Criteria (EQC) for contaminants in sediment (drilling and completions discharges)

Environmental Quality Guideline (EQG)	Environmental Quality Standard (EQS)
EQG 1 The bioavailable fraction of the metal or metalloid concentrations measured at the low LEP / moderate LEP and moderate LEP / high LEP boundaries will not exceed the recommended toxicant default guideline values for sediment quality (DGVs; ANZG, 2018) and as specified in **Section 3.5.1.2**. **EQG 2** Hydrocarbon concentrations measured at the low LEP / moderate LEP and moderate LEP / high LEP boundaries will not exceed the guideline values (DGVs) for sediment quality (ANZG, 2018) and as specified in **Section 3.5.1.2**. *For this EQG to be triggered, concentrations must be above naturally occurring background levels measured prior to the activity or a suitable reference location and be attributable to the Browse Project activities.*	**EQS 1** Whole sediment toxicity tests (at least 3 tests) from sediment at the low LEP / moderate LEP boundary should not result in a statistically significant effect (P < 0.05) on lethal acute endpoints, or of greater than 50% on sublethal chronic endpoints for any species, compared to a matched reference sediment. **EQS 10** Whole sediment toxicity tests (at least 3 tests) from sediment at the moderate LEP / high LEP boundary should not result in a statistically significant effect (P < 0.05) on sublethal chronic or lethal acute endpoints for any species, compared to a matched reference sediment.

3.5.1.2 Assessment against Environmental Quality Guidelines 1 and 2

The following assessment procedure will be followed:

- Sediment toxicant concentrations at sites at the low LEP / moderate LEP and moderate LEP / high LEP boundaries will be compared directly to the default guideline values (GVs) listed in ANZG (2018) (presented in **Table 3-16**). The concentrations of organics and metals will be normalised to 1% total organic carbon (TOC) before comparison with the guidelines, with the exception of Total Petroleum Hydrocarbons (TPH). For TOC contents of <0.2% or >10%, multiplication factors of 5 and 0.1 will be used for normalisation, respectively.
- EQG 1 - Results of the bioavailable fraction of the metal or metalloid concentration at sites at the low LEP / moderate LEP and moderate LEP / high LEP boundaries will be compared to the ANZG (2018) DGVs as specified in **Table 3-16**.
- EQG 2 - Results of the sediment hydrocarbon concentrations at sites at the low LEP / moderate LEP and moderate LEP / high LEP boundaries will be compared to the ANZG (2018) DGVs as specified in **Table 3-16**.
- For results that exceed the DGVs specified in ANZG (2018) , an assessment against background levels measured prior to the activity or a suitable reference location will be undertaken prior to triggering assessment against the EQS.

Table 3-16 Recommended toxicant default guidelines values (GV) for sediment quality (ANZG 2018)

Toxicant	Units	Default Guideline Value	GV - High
Metal and Metalloids			
Aluminium	mg/kg dry weight	N/A	N/A
Antimony	mg/kg dry weight	2.0	25
Arsenic	mg/kg dry weight	20	70
Barium	mg/kg dry weight	N/A	N/A
Cadmium	mg/kg dry weight	1.5	10.0
Chromium	mg/kg dry weight	80	370
Copper	mg/kg dry weight	65	270
Iron	mg/kg dry weight	N/A	N/A
Lead	mg/kg dry weight	50	220
Manganese	mg/kg dry weight	N/A	N/A
Mercury	mg/kg dry weight	0.15	1.0
Molybdenum	mg/kg dry weight	N/A	N/A
Nickel	mg/kg dry weight	21	52
Silver	mg/kg dry weight	1.0	4.0
Vanadium	mg/kg dry weight	N/A	N/A
Zinc	mg/kg dry weight	200	410
Organics			
TPH (C6 to C36)	mg/kg dry weight	280	550
PAH (total)*	µg/kg dry weight	10,000	50,000

*Normalised to 1% total organic carbon

3.5.1.2.1 Sampling protocol

Remote operated vehicles (ROV) fitted with sampling devices, or suitable alternative/s (with demonstrated limited fines loss) will be used to sample sediments, and provide a visual indication (post drilling) of the prevailing direction of deposited drill cuttings. In accordance with the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZG, 2018), quality control samples (e.g. splits, duplicates and/or triplicates) will be taken at a subset of sampling locations to account for variability.

Sediment quality sampling will be conducted at locations corresponding to EQG requirements (e.g. LEP boundaries).

The statistical design on the monitoring program will follow a Before After Control Impact (BACI) approach. A priori statistical power analysis will be conducted to determine the required number of samples to detect a difference or change with a specified level of statistical confidence and power. Confidence and power relate to probabilities of committing Type I (false positive) and Type II errors (false negative) when performing hypothesis tests. These parameters will be set to 0.05 (95%

confidence, or 5% chance of obtaining a false positive result) and 0.8 (20% chance of obtaining a false negative). Sufficient samples will be taken to ensure a sufficient 'effect size' can be determined.

The sampling design will be based on the following:

- Sampling to occur at the specified LEP boundaries and supplement by sampling along gradient (as described in Holdway and Heggie, 2000) radiating out from the drilling disturbance centre to 2 km.
- Increased sampling effort will occur in the direction of the prevailing current. Where technically feasible within the constraints of existing subsea infrastructure, sampling will commence at the low LEP / moderate LEP boundary (located 50m from the well) and will then be undertaken at the following distances from the well: 100 m, at the moderate LEP / high LEP boundary (200m), 300 m, 500 m, high LEP / maximum LEP 1km and 2km. Sampling will also occur at parallel locations down current of the well within the moderate LEP, where required to increase the statistical power.
- No monitoring will be undertaken within a 50 m radius of the drilling disturbance as a low LEP is proposed in this area (due to sediment deposition and cement discharge). Sediment sampling is typically not feasible where cement discharge has occurred, as equipment can not penetrate the cement layer.
- Consideration of the local hydrodynamics where deposition is likely the greatest. The monitoring locations will be based on those wells located closest to the moderate LEP / high LEP boundary in the direction of the prevailing current. For the TRA, TRD and TRF wells, which are typically affected by the north-west/south-east tidal currents, wells will likely be located on a transect NW and SE of the well.
- Sediment quality and ecological (epifauna) sampling locations will be co-located where possible to maximise comparisons and multiple lines of evidence assessments.

Samples will be collected, stored and handled using appropriate techniques consistent with guidance provided in *AS 5667.1:1998 Part 1: Guidance on the design of sampling programs, sampling techniques and the preservation and handling of samples* (Standards Australia, 1998) and the *Australian and New Zealand Guidelines for Fresh and Marine* Water Quality (ANZG, 2018).

All analyses will be undertaken by National Association of Testing Authorities (NATA) accredited laboratories and to a limit of detection that is below the ANZG 2018 guidelines.

3.5.1.2.2 Timing

Monitoring will be undertaken as soon as practicable but no more than 3 months after completion of the first batch of wells at each well centre. Multiple wells may be drilled at one time and it is not practicable to sampling while drilling of a subsequent well is ongoing. There may be periods of multiple years of drilling at a site, therefore sampling will also occur within three months of completion of the last well at each well centre. The maximum number of wells at each well centre is specified as a key element of the Browse development.

Monitoring will also be undertaken at an appropriate time pre-drilling, prior to impact occurring, but not sooner than 3 years before to ensure an appropriate baseline is developed against which to compare subsequent test results.

3.5.1.3 Assessment against Environmental Quality Standards 1 and 10

If EQG 1 or EQG 2 is exceeded (see **Table 3-15**), an investigation against EQS 1 and EQS 10 will be conducted at the same location at which exceedances were identified, within one month of the

EQG exceedance being identified as having occurred. The following assessment procedure will be followed:

- EQS 1 - Whole sediment toxicity tests (at least 3 tests) from sediment at the low LEP / moderate LEP boundary should not result in a statistically significant effect ($P < 0.05$) on lethal acute endpoints, or of greater than 50% on sublethal chronic endpoints for any species, compared to a matched reference sediment.
- EQS 10 - Whole sediment toxicity tests (at least 3 tests) from sediment at the moderate LEP / high LEP boundary should not result in a statistically significant effect ($P < 0.05$) on sublethal chronic or lethal acute endpoints for any species, compared to a matched reference sediment.

3.5.1.3.1 Sampling protocol

Sediment sample collection will be conducted using the same methodology as per EQG 1 and EQG 2 including at the locations at which exceedances were observed.

3.5.1.3.2 Timing

Monitoring of EQS 1 and EQS 10 will occur within one month of the EQG exceedance being determined to have occurred.

3.5.2 Drilling and completions discharges - Epibenthos cover

3.5.2.1 Environmental Quality Criteria

The EQG and EQS for epibenthos in relation to drilling and completions discharges are shown in **Table 3-17.**

Table 3-17 Environmental Quality Criteria for epibenthos cover (drilling and completions discharges)

Environmental Quality Guideline (EQG)	Environmental Quality Standard (EQS)
EQG 3 No net detectable change in epibenthos diversity or composition beyond the moderate LEP boundary, attributable to the Browse Project activities.	**EQS 2** At the low LEP / moderate LEP boundary, no change to epibenthos species diversity and composition attributable to the Browse Project. **EQS 3** At the moderate LEP / high LEP boundary, no detectable change in natural variation (including abundance, diversity and composition) of epibenthos cover attributable to the Browse Project activities.

3.5.2.2 Assessment against Environmental Quality Guideline 3 and Environmental Quality Standards 2 and 3

To assess against the EQG and EQS, density/abundance, diversity and composition will be assessed along 50 m transects based on both still and video images. Then the composition and diversity of epibenthic communities prior to and after drilling will be compared to assess potential for change as a result of drilling discharges. Assessment timing and location of the EQG and EQS are aligned, as due to the complexity and cost in obtaining this data, sufficient transects and data will be obtained for assessment of both the EQS and EQG simultaneously.

3.5.2.2.1 Sampling protocol

Ecological surveys of epibenthos cover are proposed to be conducted using high-definition cameras (video and/or stills) with adequate lighting mounted to either a ROV, Autonomous Underwater Vehicle (AUV), or suitable alternative/s methods. The camera system will have ultra-short baseline (USBL) positioning system to rectify the actual position on the seabed. In the post drilling survey, the selected method will be used to verify the prevailing direction of deposited drill cuttings and complete the survey transects.

Video surveys will be conducted at similar locations to sediment quality (for EQG 1 and EQG 2) along the prevailing current axis. Surveys will be conducted prior to drilling at the same locations as the post drilling monitoring sites, and also at control sites. Post drilling surveys will only be undertaken where the EQG are exceeded and at control sites. At each location, five transects of 30 - 50 m lengths will be videoed. Control sites will also be surveyed before and after the drilling program. Control sites will be separate sites located in similar habitats to determine epibenthos in areas unimpacted by drill cuttings.

Sampling design will include consideration of the local hydrodynamics where deposition is likely the greatest. The monitoring locations will be based on those wells located closest to the moderate LEP / high LEP boundary in the direction of the prevailing current. For the TRA, TRD and TRF wells, which are typically affected by the north-west/south-east tidal currents, wells will likely be located on a transect NW and SE of the well.

3.5.2.2.1 Timing

Monitoring of benthic (epibenthos) cover at a gradient away from the well will be undertaken at each well centre within the State Proposal Area, to verify that the EQC (as provided in **Table 3-17**) within the moderate LEP has been achieved. Monitoring will be undertaken within three months of completion of the first batch of drilling at each well centre as well as on completion of the last well at each well centre.

Monitoring will be undertaken at an appropriate time pre-drilling and as soon as practicable post-drilling (within 3 months where practicable).

3.5.3 Drilling and completions discharges – Water Quality

3.5.3.1 Environmental Quality Criteria

The EQG and EQSs for cutting discharge and water quality are shown in **Table 3-18.**

Table 3-18 Environmental Quality Criteria for water quality (drilling and completions discharges)

Environmental Quality Guideline (EQG)	Environmental Quality Standard (EQS)
EQG 4 Particle size distribution of the drilling cuttings and fluids returned to the MODU via the riser, where the cuttings are separated from the fluids by Solids Control Equipment (SCE) and fluids discharged at surface within State Waters show that 99% of particles are greater than 63 µm in size. **EQG 14** Water quality monitoring in the direction of the cuttings discharge plume shows the TSS is <10 mg/l above background at the moderate LEP / high LEP boundary and no detectable change from natural	**EQS 4** Water quality monitoring in the direction of the cuttings discharge plume shows no detectable change from natural variation in concentrations of total suspended solids or contaminants in waters at Scott Reef (considered as the area above the 75 m bathymetric contour and within the 3 nm State waters boundary).

Environmental Quality Guideline (EQG)	Environmental Quality Standard (EQS)
variation of total suspended solids at the high LEP / maximum LEP boundary.	

3.5.3.2 Assessment against Environmental Quality Guideline 4

Monitoring of the EQG (Particle Size Distribution (PSD) size of the cutting and fluid to be discharged) will occur on board the MODU at sufficient frequency to provide confidence the EQG is being achieved. This will be compared against the criteria of 99% of particles are greater than 63 μm in size.

3.5.3.2.1 Timing

Particle size analysis will occur within the first 24 of a new activity at each well site where discharges are planned and weekly thereafter when surface discharges occurring.

3.5.3.2.2 Sampling protocol

- Samples for PSD analysis will be collected from locations where samples will be representative of that being/to be discharged.

- Size class analysis will be conducted on board the MODU using standard particle size analysis techniques that meet relevant Australian or International certification.

3.5.3.3 Assessment against Environmental Quality Guideline 14

Water quality (total suspended solids) will be assessed against baseline levels and suitable reference locations to confirm suspended solid levels do not exceed 10 mg/L in the high LEP and do not vary from natural background levels in the maximum LEP.

3.5.3.3.1 Timing

Water quality monitoring will be undertaken at a representative well once per drill centre (TRA, TRD, TRF drill centres) per MODU during a relevant discharge event occuring. If wells at the same drill centre are drilled with a different rig additional monitoring will occur.

3.5.3.3.2 Sampling protocol

The statistical design on the monitoring program will follow a BACI approach. A priori statistical power analysis will be conducted to determine the required number of samples to detect a difference or change with a specified level of statistical confidence and power. Confidence and power relate to probabilities of committing Type I (false positive) and Type II errors (false negative) when performing hypothesis tests. These parameters will be set to 0.05 (95% confidence, or 5% chance of obtaining a false positive result) and 0.8 (20% chance of obtaining a false negative). Sufficient samples will be taken to ensure a sufficient ‘effect size’ can be determined.

The sampling design will be based on the following:

- Turbidity (NTU) will be used as a measure of TSS to allow real time measurements to be taken in the field to facilitate adaptive management.
- Water quality will be measured throughout the water column.
- A gradient design (as described in Holdway and Heggie, 2000).
- Sampling will occur direction of the prevailing current. Water sampling will occur at 50m distances from the discharge point and at each LEP boundary. Sampling will also occur at parallel locations down current of the well within the high LEP where required to increase the statistical power.

Monitoring will also occur at suitable reference sites account for natural variation in total suspended solids concentrations.

3.5.3.4 Assessment against Environmental Quality Standard 4

Water quality (total suspended solids) will be assessed against baseline levels and suitable reference locations to confirm suspended solid levels do not vary from natural background levels or exceed specified levels of change within each LEP zone.

3.5.3.4.1 Timing

Water quality monitoring will be undertaken within once month of an exceedance of EQG 14 being identified.

Water quality monitoring will be reactively undertaken if exceedance of the EQG occurs, noting Woodside has committed to not discharging particles of the size indicated in EQG 4 and immediately modifying discharge activities therefore a reactive EQS monitoring campaign would not be practical.

3.5.3.4.2 Sampling protocol

The statistical design on the monitoring program will follow a BACI approach. A priori statistical power analysis will be conducted to determine the required number of samples to detect a difference or change with a specified level of statistical confidence and power. Confidence and power relate to probabilities of committing Type I (false positive) and Type II errors (false negative) when performing hypothesis tests. These parameters will be set to 0.05 (95% confidence, or 5% chance of obtaining a false positive result) and 0.8 (20% chance of obtaining a false negative). Sufficient samples will be taken to ensure a sufficient 'effect size' can be determined.

The sampling design will be based on the following:

- Turbidity (NTU) will be used as a measure of TSS to allow real time measurements to be taken in the field to facilitate adaptive management.
- A gradient design (as described in Holdway and Heggie, 2000).
- Include sampling in the prevailing current from the point of discharge.
- Increased sampling effort will occur in the direction of the prevailing current. Distances will be targeted to include the low LEP / moderate LEP boundary, 250 m, 500 m, 750 m, 1 km, 2 km and at the moderate LEP / high LEP boundary. Sampling will also occur at parallel locations down current of the well within the Moderate LEP where required to increase the statistical power. Monitoring should also occur at suitable reference sites, before and after the wells are drilled.
- Consideration of the local hydrodynamics where dispersion is likely the greatest.

3.5.4 BTL hydrotest discharges - Water Quality

3.5.4.1 Environmental Quality Criteria

The EQG for water quality in relation to the BTL hydrotest discharge is shown in **Table 3-19**.

Table 3-19 Environmental Quality Criteria for water quality (hydrotest discharge)

Environmental Quality Guideline (EQG)	Environmental Quality Standard (EQS)
EQG 5 For BTL hydrotest discharge, concentration at the State waters boundary / moderate LEP for hydrotest discharge components indicate sufficient dilution to	**EQS 5**

Environmental Quality Guideline (EQG)	Environmental Quality Standard (EQS)
achieve 95% species protection levels has been achieved. **EQG 6** For BTL hydrotest discharge, concentration at the moderate/high LEP for hydrotest discharge components indicate sufficient dilution to achieve 99% species protection levels has been achieved.	At the State waters / moderate LEP boundary, no change to epibenthos species diversity or composition attributable to the Browse Project. **EQS 6** At the moderate LEP / high LEP boundary, no detectable change in natural variation (including abundance, diversity and composition of epibenthos cover attributable to the Browse Project activities.

3.5.4.2 Assessment against Environmental Quality Guideline 5 and 6

Water samples taken in accordance with the sampling protocol will be analysed for the concentration of hydrotest discharge chemicals in the receiving environment. Results will be compared to toxicity data for the hydrotest fluids, to ensure that either 95% (within the Moderate LEP) or 99% species protection levels (within the High LEP) are achieved. The distance of the LEP boundaries from the discharge point, water depth and predicted dilutions at LEP boundaries means that it highly unlikely to be able to detect hydrotest fluids in-situ at LEP boundaries so samples will be supplemented by water samples collected in-situ closer to the discharge point where the plume is expected to be visible. These water sampling results (measuring for the concentration of hydrotest fluids) will be compared with discharge modelling results to determine EQG conformance even if there is no detection at sampled LEP boundaries.

If there is uncertainty as to the toxicity of the final hydrotest discharge, WET testing will be performed on the final water makeup. Results will be known prior to the discharge occurring. WET testing protocols will adhere to those outlined in **Section 3.5.6.4.2**.

3.5.4.2.1 Timing

Water quality monitoring (sampling) close to the plume will be undertaken within five days of hydrotest discharge activities from the BTL commencing.

3.5.4.2.2 Sampling protocol

Due to the density of the hydrotest discharge it is expected to disperse close to the seabed, therefore a fluorescent dye tracer will be incorporated with the hydrotest discharge to enable detection of the plume for sampling. Water samples will be collected via ROV with suitable water collection devices fitted (within the visible plume) or via vessel using a grab/niskin bottle sampler for samples at LEP boundaries. Triplicate samplings will be taken at LEP boundaries and at samples, at least 5 locations will be collected within the visible plume, at increasing distances from the plume discharge point.

Water quality samples will be collected, stored and handled using appropriate techniques consistent with guidance provided in AS 5667.1:1998 Part 1: Guidance on the design of sampling programs, sampling techniques and the preservation and handling of samples (Standards Australia, 1998) and the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG, 2018).

All analyses will be undertaken by NATA-accredited laboratories.

3.5.4.3 Assessment against Environmental Quality Standards 5 and 6

To assess against the EQS, density/abundance, diversity and composition will be assessed along 50 m transects based on both still and video images. The composition and diversity of epibenthic communities prior to and after BTL hydrotest discharge will then be compared to assess potential for change.

3.5.4.3.1 Timing

Monitoring of epibenthos will be undertaken at a representative location near the discharge point before hydrotest discharges occur to establish a baseline of epibenthos cover. As modelling predicts that the hydrotest fluids may enter State waters at two different locations (depending on the current direction), the sampling will assess the ecological boundaries at both these locations. A repeat survey will be undertaken within and outside of the moderate LEP if the EQGs are exceeded.

3.5.4.3.2 Sampling protocol

Ecological surveys of epibenthos cover are proposed to be conducted using high definition cameras (video and/or stills) with adequate lighting mounted to either a ROV, AUV, or suitable alternative/s methods. The camera system will have an USBL positioning system to rectify the actual position on the seabed. In the post discharge survey, the selected method will be used to verify the prevailing direction of deposited drill cuttings and complete the survey transects. Video surveys will be conducted at similar locations to sediment quality sampling, along the prevailing current axis. At each location, five transects of 30 - 50 m lengths will be videoed. Control sites will also be surveyed in similar habitats.

Transect will be taken at the State waters / moderate LEP boundary, State waters / high LEP boundary, moderate LEP / high LEP boundary and high LEP / maximum LEP boundary in the direction of the prevailing current.

3.5.5 SURF hydrotest discharges – Epibenthos Cover

3.5.5.1 Environmental Quality Criteria

The EQCs for epibenthos cover in relation to SURF hydrotest discharge area shown in **Table 3-20**.

Table 3-20 Environmental Quality Criteria for epibenthos cover (SURF hydrotest discharge)

Environmental Quality Guideline (EQG)	Environmental Quality Standard (EQS)
EQG 7 For SURF discharges, modelling indicates the concentration of chemicals in the discharge would achieve 90% species protection levels at the low LEP / moderate LEP boundary.	**EQS 7** At the moderate LEP / high LEP boundary, no detectable change in natural variation (including abundance, diversity and composition) of epibenthos cover attributable to the Browse Project activities. **EQS 11** At the low LEP / moderate LEP boundary, no change to epibenthos species diversity and composition attributable to the Browse Project.

3.5.5.2 Assessment against Environmental Quality Guideline 7

To assess against the EQC, representative modelling of the proposed discharge will be undertaken to confirm that the discharge will achieve 90% species protection levels at the low LEP / moderate LEP boundary. This will be done prior to the discharge occurring and the chemical dosing regime to ensure the EQG is achieved.

3.5.5.3 Assessment against Environmental Quality Standard 7 and 11

To assess against the EQS, density/abundance, diversity and composition will be assessed along 50 m transects based on both still and video images. Then the composition and diversity of epibenthic communities at control sites will be compared to LEP boundary sites, to assess potential for change.

3.5.5.3.1 Timing

Monitoring to the requirement of EQS 7 and EQS 11 will be undertaken within 30 days of any EQG exceedance.

3.5.5.3.2 Sampling protocol

Ecological surveys of epibenthos cover are proposed to be conducted using high definition cameras (video and/or stills) with adequate lighting mounted to either a ROV, AUV, or suitable alternative/s methods. The camera system will have ultra-short baseline (USBL) positioning system to rectify the actual position on the seabed. In the post discharge (if triggered) survey, the selected method will be used to verify the prevailing direction of the current and complete the survey transects. Video surveys will be conducted along the prevailing current axis. At each location, five transects of 30 - 50 m lengths will be videoed. Data will be compared to that of relevant control sites.

3.5.6 FPSO cooling water discharges (originating in Commonwealth waters)

3.5.6.1 Environmental Quality Criteria

The EQG for water quality in relation to the FPSO cooling water discharge is shown in **Table 3-21.**

Table 3-21 Environmental Quality Criteria for water quality (Cooling water)

Environmental Quality Guideline (EQG)	Environmental Quality Standard (EQS)
EQG 8 For FPSO cooling water discharges, residual chlorine will be monitored at the end of pipe so that the defined threshold value (i.e. 99% species protection) will be met at the edge of the mixing zone and the State waters boundary, 95% of the time based on dispersion modelling results. **EQG 9** For cooling water, within the high LEP, water quality in relation to the contaminants of concern meets the ANZG (2018) marine low reliability trigger value of 3 ug/L. **EQG 10** For cooling water, within the maximum LEP, there will be no detectable change from background concentrations in water quality in relation to the parameters of concern (i.e. temperature and residual chlorine).	**EQS 8** Whole effluent toxicity (WET) testing of water quality samples taken in the high LEP show that no toxicity is detected (no significant difference from controls).

3.5.6.2 Assessment against Environmental Quality Guideline 8

Residual chlorine will be continually monitored through instrumentation installed on the FPSO. The equipment will be installed and maintained in accordance with manufacturer specifications and Woodside maintenance requirements. Modelling has been based on the FPSO discharge design parameter which is to ensure free chlorine discharge is less than 0.2ppm which is currently predicted to achieve relevant levels of environmental protection. Discharge modelling will be updated prior to operations commencing once final discharge parameters are known to ensure the planned discharge will conform to the specified outcomes.

3.5.6.3 Assessment against Environmental Quality Guideline 9 and 10

Samples are to be collected at the specified points will be analysed for the parameters of concern (i.e. potential contaminants discharged as part of the cooling water and change in temperature).

In field sample results will be compared to the ANZG (2018) 99% species protection levels (High LEP) and background levels (maximum LEP).

Results from the end of pipe sampling will be compared against the ANZG (2018) 99% species protection guideline values (3ug/L for chlorine) at the edge of the mixing zone, taking modelled dilutions into account.

The study would aim to verify the modelling predictions and in particular the dilutions achieved, which determines the point at which the defined thresholds levels are reached.

3.5.6.3.1 Timing

Within one year of steady state FPSO operations, cooling water modelling and infield verification will be completed to verify the modelling predictions underpinning EQG 8.

In field water sampling will be carried out to establish a baseline and annually for the first three years of steady safe FPSO operations to verify compliance with EQC 9 and EQC 10.

After this time, periodic (every five years) and for cause (e.g. due to EQG 8 exceedance) water quality monitoring at a gradient away from the FPSO facility in the receiving environment will be undertaken to measure compliance with EQC 9 and EQC 10.

Monitoring will entail water quality monitoring along a gradient from the Torosa FPSO and will include water quality monitoring at the boundary of the State proposal area (which is also the boundary of the high LEP associated with the FPSO cooling water discharge) and the boundary of the high LEP (where high LEP changes to the maximum LEP).

3.5.6.3.2 Sampling protocol

The cooling water will be discharged at a depth of approximately 12 m. Therefore water samples will be collected via equipment with suitable water collection devices fitted to sample through the water column. The statistical design on the monitoring program will follow a BACI approach. A priori statistical power analysis will be conducted to determine the required number of samples to detect a difference or change with a specified level of statistical confidence and power. Confidence and power relate to probabilities of committing Type I (false positive) and Type II errors (false negative) when performing hypothesis tests. These parameters will be set to 0.05 (95% confidence, or 5% chance of obtaining a false positive result) and 0.8 (20% chance of obtaining a false negative). Sufficient samples will be taken to ensure a sufficient 'effect size' can be determined.

The sampling design will be based on the following:

- A gradient design (as described in Holdway and Heggie, 2000).
- Sampling for parameters associated with cooling water discharge (e.g. residual chlorine and elevated temperature).
- Increased sampling effort will occur in the direction of the prevailing current (distances to include 250 m, 500 m, 750 m, 1 km and 2 km). Sampling will also occur at the boundary of the State Proposal Area, within the high LEP and at the boundary of the high / maximum LEP in the direction of the prevailing current.

- Depth of samples to be collected will consider modelled predictions of plume dispersion and prevailing currents at the time of sampling. Samples to be taken throughout the water column. Use of dye to be considered if necessary to aid detection of plume during sampling.

Water quality samples will be collected, stored and handled using appropriate techniques consistent with guidance provided in AS 5667.1:1998 Part 1: Guidance on the design of sampling programs, sampling techniques and the preservation and handling of samples (Standards Australia, 1998) and the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG, 2018).

All analyses will be undertaken by NATA-accredited laboratories unless localised (field or FPSO) sampling is required to achieve holding times. Quality assurance against NATA accredited laboratory results or alternate QA demonstrated to be conducted for any sampling event where it is necessary to conduct analysis in the field.

3.5.6.4 Assessment Against Environmental Quality Standard 8

Should the EQG for the high LEP or maximum LEP be exceeded, EQS 8 will be monitored, namely whole effluent toxicity (WET) testing of water quality samples taken in the high LEP will be compared to local controls.

3.5.6.4.1 Timing

Assessment of EQS will occur within one month of the EQG exceedance being detected.

3.5.6.4.2 Sampling Protocol

To determine whole effluent toxicity, a minimum of eight mainly chronic toxicity tests are to be carried out with each water sample. The toxicity tests typically include a range of tropical and temperate Australian marine species, selected based on their ecological relevance, known sensitivity to contaminants, availability of robust test protocols and known reproducibility and sensitivity as test species for assessing impacts from discharges in marine environments. Current test suite for Woodside operated offshore assets include:

- Bacterial 5- and 15-min luminescence (*Vibrio fischeri*) (Microtox® acute, temperate)
- Microalgal 72-h growth rate inhibition using the tropical isolate of *Nitzschia closterium* (chronic, tropical)
- Copepod 48-h survival test using *Acartia sinjiensis* test (acute, tropical)
- Copepod 7-d early life stage development test with *Gladioferens imparipes* (chronic, temperate)
- Sea urchin 72-h larval development with *Echinometra mathaei* (chronic, tropical/subtropical)
- Sea urchin 1-h fertilisation test with *Heliocidaris tuberculata* (chronic, temperate)
- Oyster 48-h larval development test with *Saccostrea echinata* (chronic, tropical)
- Fish 96-h larval imbalance using *Lates calcarifer* (acute, tropical).

Other tests can be exchanged over time if tests are not available, or become obsolete, however, preference would be for tests that mimic the receiving environment as closely as possible (i.e. for most facilities this would be tropical, marine water tests) and for at least eight mainly chronic tests (Warne et al. 2015).

Upon completion of WET testing, the results of these tests will be combined into safe dilution estimates for the protection of either 95% or 99% of species as relevant. These safe dilution estimates can be used as the predicted no-effect concentration (PNEC) in assessing environmental risk associated with each discharge. A statistical program (e.g. the Burrlioz (version 2.0, CSIRO), SSD Tools Shiny App or similar) is used to plot species sensitivity distributions and to derive species protection (e.g. PC99 or PC 95) concentrations (and safe dilutions). Acute toxicity results are converted to an equivalent chronic value by dividing the acute EC50 by 10 (the adjustment factor that was a substitute for the acute-to-chronic ratio). These data are then combined with chronic IC10 or EC10 values and plotted in a cumulative frequency plot. The Burr Type III curve is used to fit the species sensitivity distribution (SSD). PC values are converted to the equivalent safe dilutions by dividing 100 by the PCx value.

3.5.7 Produced Water (originating in Commonwealth waters)

There is no discharge of Produced Water from FPSOs within State Waters and in all modelled circumstances PW is predicted to be diluted sufficiently to achieve 99% species protection values at the State Waters boundary. For the majority of seasonal conditions, PW travels parallel to the State Waters boundary.

The following EQC are established only for State Waters but rely on monitoring within Commonwealth Waters to validate that environment objectives are being achieved.

3.5.7.1 Environmental Quality Criteria

The EQG for water quality in relation to the Produced Water discharge is shown in **Table 3-22.**

Table 3-22 Environmental Quality Criteria for water quality (Produced Water)

Environmental Quality Guideline (EQG)	Environmental Quality Standard (EQS)
EQG 11 Chemical characterisation analysis of the produced water at end of pipe undertaken annually. Results demonstrate the ANZG (2018) 99% species protection guideline values will be achieved for each contaminant at the State Waters boundary, based on modelled dilution rates. **EQG 12** At the entry to the State Waters boundary, water quality samples indicate no detectable change in water quality from background concentrations in the relation to the contaminants of concern. **EQG 13** WET Testing of the produced water at end of pipe undertaken annually. Results demonstrate the 99% species protection guideline values will be achieved at the State Waters boundary, based on modelled dilution rates.	**EQS 9** Whole effluent toxicity (WET) testing of water quality samples taken at the entry to State Waters (in the direction of the PW plume occurrence during the sampling period), shows that no toxicity above background is detected.

3.5.7.2 Assessment against Environmental Quality Guideline 11, 12 and 13

Assessment of EQG 11 and EQS 13 will involve collecting representative samples of PW at the discharge point and analysing either for chemical contaminants or conducting WET testing on the discharge. Assessment of EQG 12 will involve collecting water samples at the specified location and analysing this water for the presence of contaminants of concern.

3.5.7.2.1 Timing

- Chemical characterisation analysis of the produced water at end of pipe undertaken annually.

- In situ water sampling (to verify EQG 12) will be undertaken to establish baseline and annually for the first three years of steady state FPSO operations and every five years thereafter.
- Toxicity testing of the physical and chemical composition of the undiluted FPSO PW stream will be undertaken annually.
- Water quality monitoring will occur in accordance with the sampling protocol below. This monitoring aims to determine no changes in the receiving environment water quality outside of the defined mixing zone, as a result of the FPSO PW discharges.

3.5.7.2.2 Sampling protocol

The statistical design on the monitoring program will follow a BACI approach. A priori statistical power analysis will be conducted to determine the required number of samples to detect a difference or change with a specified level of statistical confidence and power. Confidence and power relate to probabilities of committing Type I (false positive) and Type II errors (false negative) when performing hypothesis tests. These parameters will be set to 0.05 (95% confidence, or 5% chance of obtaining a false positive result) and 0.8 (20% chance of obtaining a false negative). Sufficient samples will be taken to ensure a sufficient 'effect size' can be determined.

The in-situ water quality sampling design will be based on the following:

- A gradient design (as described in Holdway and Heggie, 2000).
- Include in-field sampling for containment of concern, informed through chemical characterisation of the PW stream. WET testing will be performed on collected sea water in relation to EQG 13 using the sampling protocol outlined in **Section 3.5.6.4.2**.
- Include sampling in the prevailing current from the point of discharge.
- Increased sampling effort will occur in the direction of the prevailing current (distances to likely include 250 m, 500 m, 750 m, 1 km and 2 km). Sampling will also occur at the boundary of the State Proposal Area in the direction of the prevailing current.
- Include appropriate statistical design, which shall be considered in context of field survey duration and sample holding times
- It should be noted, in no circumstances is PW predicted to be present at the State Waters boundary, so it may be necessary to select a location for the collection of in-situ water samples based on prevailing currents and distance to the FPSO.

Water quality samples will be collected, stored and handled using appropriate techniques consistent with guidance provided in AS 5667.1:1998 Part 1: Guidance on the design of sampling programs, sampling techniques and the preservation and handling of samples (Standards Australia, 1998) and the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG, 2018).

All analyses will be undertaken by NATA-accredited laboratories

3.5.7.3 Assessment against Environmental Quality Standard 9

In the event that EQG 11 or EQG 12 is exceeded an investigation against EQS 9 will be conducted at the same location as the exceedance.

3.5.7.3.1 Timing

Water samples required for EQS 9will be conducted within one month of the exceedance of EQG 11 or EQG 12 being identified.

3.5.7.3.2 Sampling protocol

WET testing protocols will adhere to those outlined in **Section 3.5.6.4.2**.

4. ADAPTIVE MANAGEMENT AND REVIEW OF THE EQMP

Recognising that the nature of the drilling discharges; cooling water and hydrotest discharges; the receiving environment; and the science underpinning environmental impact assessment; is not static, adaptive management also allows monitoring programs to feed back into the management processes so that environmental management continues to be fit-for-purpose. The EQMF that underpins this EQMP is inherently an adaptive management framework.

In line with the concept of adaptive management, the management actions presented in this EQMP shall be monitored, reviewed, evaluated and updated as required, with consideration of:

- persistent exceedances, systematic changes to the discharge/environmental conditions and/or changes to the science underpinning the monitoring and management of marine discharges
- material updates to the scientific literature supporting the GVs or management framework underpinning this EQMP
- a comparison of monitoring data that shows unexpected results which vary significantly from previous and baseline results or predictions.

Relevant updates identified through this process will be included in a revised EQMP.

In addition, this EQMP may be reviewed against:

- relevant changes in State or Commonwealth legislation or policy
- new or revised operating licence(s) issued under Part V of the *Environmental Protection Act 1986* (WA) (where relevant)
- revisions to EPs under the Commonwealth and State EP petroleum activities regulations
- if a new process or activity is proposed to be introduced that has the potential to alter the discharges from the Proposal (and that is not in accordance with this EQMP).

Technical review and evaluation of the management actions outlined in this EQMP will be conducted every five years (if not initiated prior to that time) to ensure the management actions are adequately addressing the key risks and meeting EPA objectives. If, as a result of any review, any significant changes are required to be made to this EQMP, a revised EQMP will be provided to the regulator for approval.

When the five-yearly review cycle is triggered, or if a significant change to either the facility, activity, or risk is identified, a revised EQMP will be submitted to the regulator. When approved, the revised plan will be made publicly available.

5. STAKEHOLDER CONSULTATION

Given the detailed information provided in the draft EIS/ERD, including the presentation of draft LEPs, it is considered that consultation on the contents of this EQMP has been undertaken via the draft EIS/ERD public comment period and regulator engagements. It should be noted that this EQMP is a draft and is expected to be matured and finalised beyond the State Proposal assessment process. Further stakeholder engagement may be undertaken during this process.

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7. TERMS

Acronym	Meaning
BACI	Before After Control Impact
BIO	Biological Important Areas
BOP	Blow Out Preventer
BJV	Browse Joint Venture
BTL	Browse Trunkline
draft EIS/ERD	draft Environmental Impact Statement / Environmental Referral Document
DWER	Department of Water and Environment Regulation
EP	Environmental Plan
EP Act	*Environmental Protection Act 1986* (WA)
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth)
EPA	Environmental Protection Authority
EQCs	Environmental Quality Criteria
EQGs	Environmental Quality Guidelines
EQMF	Environmental Quality Management Framework
EQMP	Environmental Quality Management Plan
EQOs	Environmental Quality Objectives
EQP	Environmental Quality Plan
EQSs	Environmental Quality Standards
EVs	Environmental Values
FLETS	Flowline End Terminals
FPSO	Floating Production Storage and Offloading
GV	Guideline Value
HP	High Pressure
IMMR	Inspection, Maintenance, Monitoring and Repair
KEF	Key Ecological Features
LEP	Levels of Ecological Protection
LP	Low Pressure
MEG	Monoethylene Glycol
MLWS	Mean Low Water Springs
MMscfd	Million Standard Cubic Feet per Day
MODU	Mobile Offshore Drilling Unit

Acronym	Meaning
NATA	National Association of Testing Authorities
NOEC	No Observable Effect Concentration
NORMS	Naturally Occurring Radioactive Materials
NWBFs	Non-water Based Fluids
NWQMS	National Water Quality Management Strategy
NRC	North Rankin Complex
NWBF	Non-water Based Fluids
NWS	North West Shelf
NWSJV	North West Shelf Joint Venture
OCNS	Offshore Chemical Notification Scheme
OPGGS (E) Regulations	Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009
PNEC	Predicted No-effect Concentration
PLET	Pipeline End Terminal
PLONAR	pose little or no risk to the environment
PW	Produced Water
ROV	Remote Operated Vehicle
SURF	subsea umbilicals, risers and flowlines
SCE	Solids control equipment
TOC	Total organic carbon
TPH	Total Petroleum Hydrocarbons
TSS	Total Suspended Solids
USBL	Ultra-short Baseline
WBFs	Water based fluids
WET	Whole Effluent Toxicity

Appendix A - Management Approach for Torosa wells in State Proposal Area

Proposed Browse Project

January 2023
Rev 4

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1. INTRODUCTION

1.1 Purpose and objective

The draft EIS/ERD provides a description of the proposed Browse Project drilling and completions program (in **Section 3.7.2**), and a detailed description of the assessment of the potential impacts and risks associated with the drilling discharges, including the high level management approach for Torosa wells in the State Proposal Area (in Section 6.3.15 of the draft EIS/ERD and Section 8.2.4.8 of the State ERD).

The purpose of this addendum is to review and provide further details on the proposed management approach for drilling discharges from Torosa wells in the State Proposal Area (see **Table 1-1**) in order to demonstrate that the maximum[1] level of ecological protection (LEP) can be achieved at Scott Reef shallow water benthic communities and habitats (<75 m bathymetry), as defined in Section 3.4.1 and Figure 3.2 of the Browse Project Environmental Quality Management Plan (EQMP).

The specific objective of the management approach is to manage drilling discharges (in particular, bottom-hole section discharges) at drill centres in the State Proposal Area (i.e. TRA, TRD and TRF)[2] using industry proven techniques to meet the maximum LEP at Scott Reef shallow water benthic communities and habitats (<75 m bathymetry).

Table 1-1: Coordinates and water depths of drill centres in the State Proposal Area[2]

Field	Drill centre	Coordinates	Approx. water depth (m)	Distance to Scott Reef 75 m bathymetric contour	Jurisdiction
Torosa	TRA	389 521 E, 8 455 338 N	423 m	2.7 km	State
Torosa	TRD	387 315 E, 8 451 207 N	389 m	2.3 km	State
Torosa	TRF	388 865 E, 8 458 144 N	446 m	2.7 km	State

1.2 Background

1.2.1 Drilling and completions overview

The proposed Browse Project requires the drilling of up to 54 production wells (with up to 24 wells within the State Proposal Area). It is anticipated the drilling and completion activities will be completed in multiple phases. The first phase is planned to include drilling and completion of three wells at the TRA drill centre within the State Proposal Area to achieve Phase 1 RFSU, with subsequent phases of drilling and completion of additional wells undertaken over the life of the Proposal to optimise reservoir recovery.

It is anticipated that a MODU will be used to drill and complete the wells. The MODU may be either conventionally moored or dynamically positioned (DP). The MODU utilised during development drilling and completion will be fitted with typical solids control equipment (SCE) which may include, but will not be limited to, shale shakers, cuttings dryers and centrifuges to maximise separation of the drilling fluid from the cuttings and drill solids.

The drilling process will typically start with the drilling of the largest size hole and a smaller diameter conductor will be cemented inside this hole. Next, a smaller diameter hole section will be drilled, and a surface and intermediate casing will be run in and cemented (with some discharge to the seabed).

[1] Activities to be managed so that there were no changes beyond natural variation in ecosystem processes, biodiversity, abundance, and biomass of marine life or in the quality of water, sediment, and biota.

[2] TRE drill centre described in draft EIS/ERD no longer proposed

Casings provide structural support for the hole walls, isolate geological formations and allow pressure management that may be experienced during drilling. Additional casing/liner sizes may be required to manage drilling risk. Drilling will then be paused far above the hydrocarbon reservoir.

A blow-out preventer (BOP) and riser system will then be installed. With the BOP in place, a hole will then be drilled into the top of the reservoir and a liner cemented over this hole section. The final hole section will then be drilled through the reservoir as required based on reservoir targets. A schematic of this process is provided in **Figure 1-1**.

During this process, drilling fluids will be used to lubricate the drill string, resist any pressure from the well stream and return cuttings to the surface. They will be formulated according to the well design, the expected reservoir geological conditions and the surrounding formations.

Drilling fluids are comprised of a base fluid, weighting agents and chemical additives used to give the fluid the exact properties required to minimise environmental impact and make the drilling as efficient and safe as possible. In general, the top-hole sections of the well will be drilled using water based fluids (WBFs) such as seawater with bentonite and then bentonite and guar gum sweeps. The bottom-hole sections will be drilled with either WBF or non-water based fluids (NWBF). The selection of fluid types will not be finalised until the detailed design phase when well design is confirmed.

Once the well has been drilled it will be completed, which is the process for making the well ready for production. Completions activities may be conducted using a light well intervention vessel (LWIV), MODU or a combination of the two. This process will involve the installation of the lower completions (including well casings, liners), the installation of the christmas tree and the installation of the upper completions (including the production tubing). During this installation process the well will remain isolated, with two independent and verifiable barriers. Typically, the BOP is removed in this sequence and replaced with an alternative barrier. The subsea christmas tree may be installed by a construction vessel on wire.

The well will then be flowed to the MODU or a suitable vessel. This first production is known as unloading and typically lasts approximately 1-2 days per well. Once stable flow is achieved, the produced fluids will be sent to tanks for separation. The produced gas and condensate will be flared, while produced water, making up a small proportion of the drill cuttings and fluids discharge stream, will be treated prior to discharge overboard.

Once unloading activities are completed, the wells will then be isolated until they are connected up to the FPSO facilities. The option to unload wells directly to the FPSOs (once connected) may also be considered in future. It should be noted that the precise sequence of the drilling, completions and unloading activity is dependent on the type of christmas tree installed.

There are a number of drilling and completions unplanned contingencies that may be required if operational or technical issues occur. These contingencies do not represent significant additional risks or impacts but may generate additional volumes of discharges such as drilling cuttings and fluids. These contingencies may include well workover, side-tracks, well suspension and well intervention.

A full description of the drilling and completions activity, including all associated potential discharges (i.e. primary and minor discharges) are provided in **Section 3.7.2** and in Section 6.3.15 of the draft EIS/ERD and Section 8.2.4.8 of the State ERD. This addendum focuses on the primary discharges defined as drill cuttings and fluids generated during drilling only.

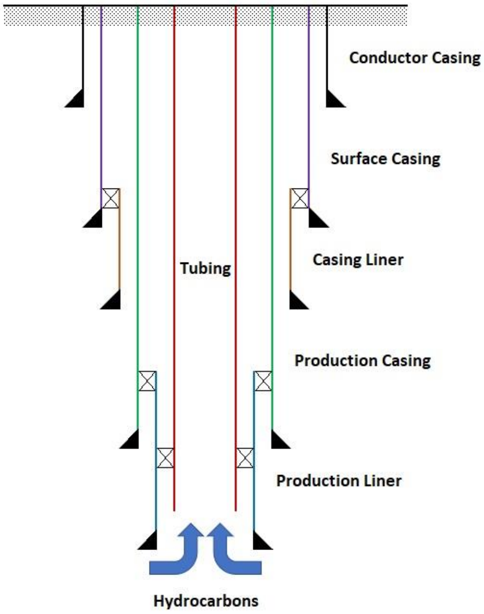

Figure 1-1: A schematic representation of a well (Domec and Thibodeaux, 2019)

1.2.2 Drill cuttings and fluids overview

Drilling of production wells will generate drill cuttings, require cementing of the casing, and require the use of a range of fluids, that may be discharged to the marine environment, typically at the seabed and at or near the sea surface depending on the hole section. The primary discharges used as the basis of the impact and risk assessment for the proposed Browse Project are as follows:

- Drill cuttings: drilling generates drill cuttings due to the breakup of solid material from within the borehole. The resultant drill cuttings are basically rock particles of various shapes, with sizes typically ranging from very fine to very coarse.
- Drilling fluids: serve many purposes including maintaining borehole stability and hydrostatic pressure, reducing friction and cleaning/ cooling of the drill bit, in addition to acting as a medium to carry cuttings from the well bore and return them to the surface at seabed or on the MODU. There are two main types of drilling fluids as follows:
    - Water based fluids (WBF) consists mainly of fresh water or seawater with the addition of chemical and mineral additives to aid in its function. Drilling additives typically used may include chlorides (e.g. sodium, potassium), bentonite (clay), cellulose polymers, guar gum, barite or calcium carbonate. These additives are either completely inert in the marine environment, naturally occurring benign materials, or readily biodegradable organic polymers with a very fast rate of biodegradation in the marine environment. Bentonite and guar gum are listed as ‘E’ category fluids under the OCNS and is included on the Oslo Paris (OSPAR) Commission PLONOR (chemicals that ‘pose little or no risk to the environment’) list (OSPAR Commission, 2019).
    - Non-water based fluids (NWBF) refers to drill fluids that are hydrocarbon rather than water based fluid. NWBF may contain a range of synthetic hydrocarbons, such as paraffins and olefins; however, such additives are designed to be low in toxicity and biodegradable, as well as not being readily bioavailable or likely to bioaccumulate, particularly in deeper water areas. It is noted that microbial biodegradation can result in oxygen reduction within sediments, however Nedwed et al (2006) found that depth is an important factor for residual concentrations of NWBF once they reach the seabed, suggesting that loss of base fluid during settling acted to significantly reduce chemical effects from discharges. It is also noted

that NWBF cuttings tend to clump and settle to the seabed rapidly adding to the cuttings pile in proximity to the well site.

Drill cuttings and unrecoverable WBFs are discharged at the seabed at each well site for the top-hole sections, which are drilled riser-less (i.e. no closed loop with the MODU). This results in a localised area of sediment deposition (known as a cuttings pile) around and in proximity to the well site influenced by prevailing seabed currents.

Once the top-hole sections are complete, installation of the riser and BOP provides a conduit back to the MODU, forming a closed circulating system. The bottom hole sections will be drilled with a marine riser in place that enables cuttings and drilling fluids to be circulated back to the MODU, where the cuttings are separated from the drilling fluids by the solids control equipment (SCE) and typically re-used in the closed loop system between the well bore and the MODU. The cuttings (with adhered residual fluids) are, in typical circumstances, discharged below the water line, with their fate and dispersion determined by cuttings particle size and the density of the unrecoverable fluids. In contrast the fluids are recirculated into the fluid system where there are a number of mud pits (tanks) on the MODU that provide a capacity to mix, maintain and store fluids required for drilling activities. The mud pits form part of the drilling fluid circulating system and may be discharged during the drilling of the well where particular criteria is met.

A schematic of a typical drilling process and associated discharges for reference is illustrated in **Figure 1-2**. Note this schematic represents an exploration activity rather than a production well sequence which is very similar, with the exception of the “after drilling” illustration which would include the christmas tree and flowlines.

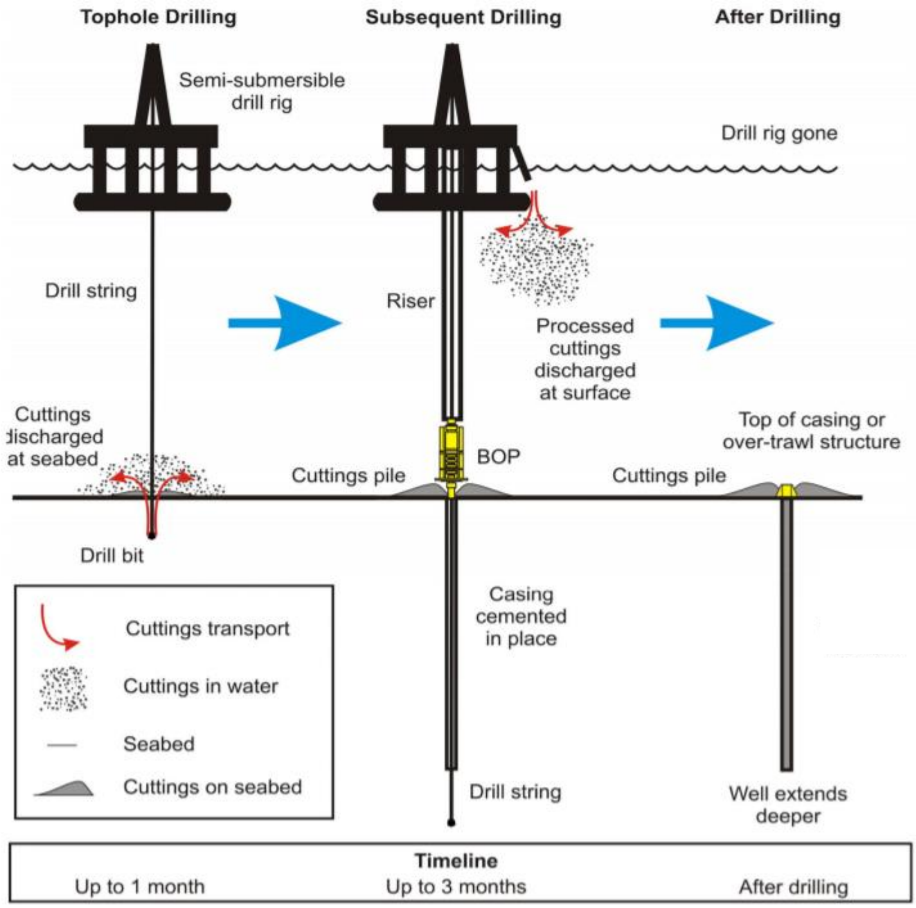

Figure 1-2 Primary drilling discharges during exploration drilling activity in deepwater (Cordes et al., 2016) representing a typical approach to drilling discharges

A summary of the drill cuttings and fluid volumes for a typical Browse well are presented in **Appendix A**, with further Project details provided in Section 3.7.2 of the draft EIS/ERD.

1.2.3 Drilling discharges process description

There are four primary types of drill cuttings and fluids discharges associated with drilling a production well. **Table 1-2** presents an overview of the types and their typical discharge/disposal management with the process (when drilling with a riser) also illustrated in **Figure 1-3** and **Figure 1-4** for WBF and NWBF respectively, for further context.

Table 1-2 Drill cuttings and fluids process description for typical Browse well

Aspects	Process description
Top hole cuttings (with unrecoverable WBF) *When drilling riserless*	• Drill cuttings and unrecoverable WBF are discharged at the seabed at each well site for the top-hole sections drilled riser-less (no closed loop with the MODU).
Bottom hole cuttings (with residual WBF/NWBF) *When drilling with riser and BOP in place (during routine operations)*	• Sections that are drilled with a marine riser in place that enables cuttings and drilling fluids to be circulated back to the MODU, where the cuttings are separated from the drilling fluids by the solids control equipment (SCE). • The SCE comprises equipment such as shale shakers, cuttings dryer(s) and centrifuges. **Drilling with WBF (Figure 1-3):** • The SCE uses shale shakers to remove coarse cuttings from the drilling fluid. Shakers are the primary solids control equipment comprising screens of selected mesh size that separate WBF and cuttings returning from the well into cuttings (discharged to the ocean with a residual film of WBF) and recovered WBF (which returns to the mud pits on the MODU). • From the shakers, cuttings with residual WBF are typically discharged via a chute below the waterline, while the fluids are recirculated into the fluid system (i.e. mud pits - see below) (**Figure 1-3**, discharge 1). • WBF in the mud pits may be circulated through de-weighting centrifuges[3], which are used to remove fine solids (i.e. 4.5 to 6 µm). Solids is a separate source of drilling discharge generated from the centrifuge process which removes fine cuttings (fine rock particles) or fine weighting agents from the drill fluids (fine weighting agents are added or removed to control a fluid's specific gravity) (**Figure 1-3**, discharge 3). • The volume of drilling fluid retained on cuttings is determined by the SCE (up to SCE technical limit; output varies based on input). Typically, treated WBF cuttings may retain 5 to 25% of the drilling fluid after passage through SCE (Neff, 2005). **Drilling with NWBF (Figure 1-4):** • The SCE uses shale shakers to remove coarse cuttings from the drilling fluid. When using NWBF, there is no direct discharge from the shakers (except for a short time in some emergency situations). • From the shakers, the cuttings with retained NWBF are diverted through a cuttings dryer[4]/s and associated SCE, to reduce the average oil on cuttings (OOC) to 6.9% wt/wt or less on wet cuttings, prior to discharge (**Figure 1-4**, discharge 1).

[3] De-weighting centrifuges are connected to the mud pit system on a MODU and used (when required) to remove fine solids from the WBF/NWBF to reduce the specific gravity of the fluid.

[4] Cuttings dryers are used to further reduce the volume of residual NWBF adhered to cuttings prior to discharge.

Aspects	Process description
	• Outputs from a dryer are separated into cleaned cuttings (which are typically discharged below the waterline with a residual film of NWBF) and recovered NWBF (which returns to the mud pits on the MODU via a dryer centrifuge). • The recovered NWBF fluids from the cuttings separated in the dryer may also be directed to dryer centrifuges[5] (**Figure 1-4**, discharge 2) and/or de-weighting centrifuges (Figure 1-4, discharge 3), which are used to remove fine solids (i.e. 4.5 to 6 µm). Solids is a separate source of drilling discharge generated from the centrifuge process which removes fine cuttings (fine rock particles) or fine weighting agents from the drill fluids (fine weighting agents are added or removed to control a fluid's specific gravity). • After passing through SCE the cuttings with residual NWBF from the dryers and/or centrifuges that meet the OOC requirements are usually discharged below the water line and the fluid is recirculated into the fluid system. • The volume of drilling fluid retained on cuttings is determined by the SCE (up to SCE technical limit; output varies based on input). Typically, treated cuttings when drilling with NWBF may retain 5 to 15% of the drilling fluid (Neff et al., 2000).
WBF discharges (pit dumps/bulk discharges) *Occurs at end of each well section or when switching between fluid types (riserless or with riser)*	• There are typically a number of mud pits (tanks) on the MODU that provide a capacity to mix, maintain and store fluids required for drilling activities. The mud pits form part of the drilling fluid circulating system. • If WBF cannot be re-used due to bacterial deterioration or does not meet required drilling fluid properties, it may be discharged to the marine environment using seawater flushing (**Figure 1-3**, discharge 2). WBF may not be able to be reused between drilling sections due to the drilling sequence, technical requirements of the fluid (i.e. no tolerance for deterioration of fluid during storage) and maintenance of productivity/ injectivity. • Unused or spent WBFs may be disposed of from the MODU as a bulk discharge (defined as a discrete discharge of large quantities) at the end of each well section (**Figure 1-3**, discharge 2). • Additional products such as barite and bentonite may be discharged in bulk/single discharge at the end of the activity if they cannot be reused or taken back to shore. Discharge may be in the form of dry bulk or as a slurry; however, discharges will not be contaminated with hydrocarbons.
NWBF discharges (pit dumps/bulk discharges) *No discharge of unused NWBF at sea during drilling and completion operations*	• The NWBF that cannot be re-used (i.e. do not meet required drilling fluid properties or are mixed in excess of required volumes) are recovered from the mud pits and returned to the shore base for onshore processing for recycling and/or disposal. • The mud pits and associated equipment/ infrastructure are cleaned when NWBF is no longer required, with wash water discharged with mud pit washings, or returned to shore for disposal if discharge criteria cannot be achieved. • The mud pits, any supply vessel storage tanks carrying WBF or NWBF, and associated equipment/ infrastructure are cleaned out during and at the end of drilling and completions operations. • Mud pit wash residue is operationally discharged from the MODU with less than 1% oil contamination by volume. Where the mud pit residue exceeds 1% by volume, the residue will be retained and disposed onshore.

[5] A dryer centrifuge is connected to the recovered NWBF output of a cuttings dryer to remove undesirable fine solids from the fluid before it returns to the mud pits, and to reduce the volume of residual NWBF adhered to the fines prior to discharge

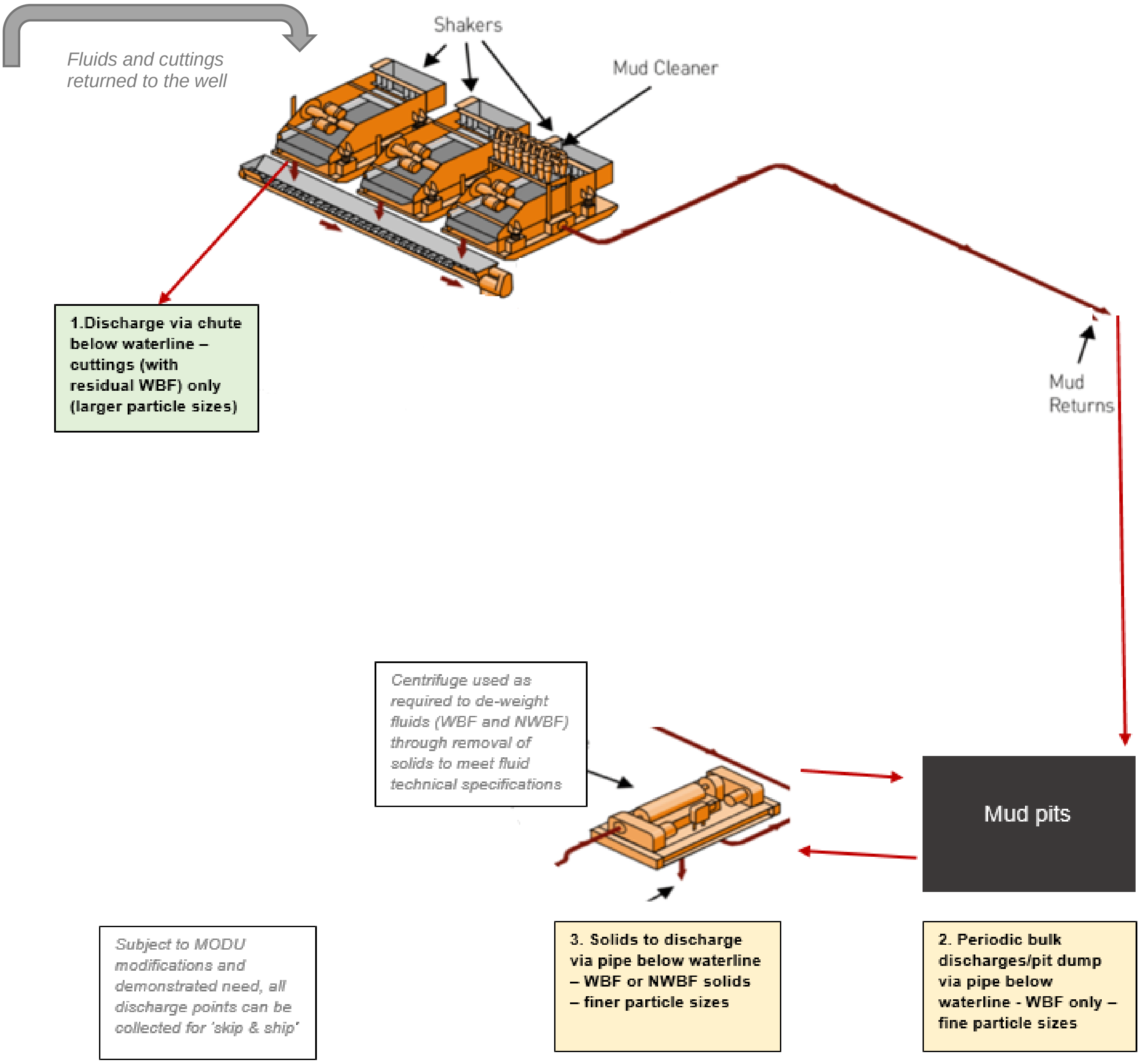

Figure 1-3: Example riser drilling discharges process diagram for WBF (adapted from IOGP (2016). Note green box discharge applies to all proposed Browse Project wells, while yellow box discharges are proposed to be managed for Torosa wells in the State Proposal Area.

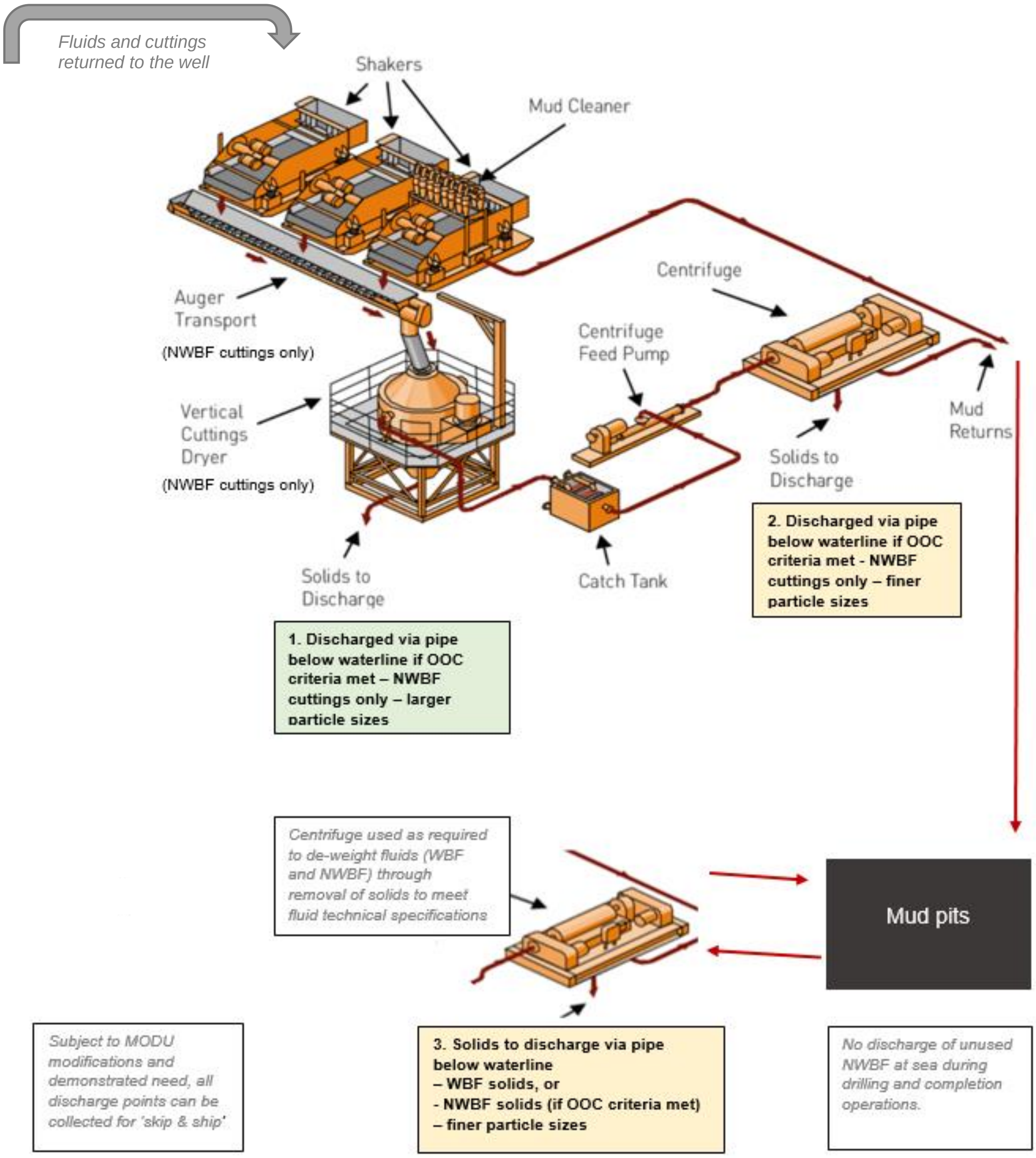

Figure 1-4: Example riser drilling discharges process diagram for NWBF (adapted from IOGP (2016). Note green box discharge applies to all proposed Browse Project wells while yellow box discharges are proposed to be managed for Torosa wells in the State Proposal Area.

1.2.4 Drill cuttings and fluids dispersion characteristics

The dispersion and fate of drilling discharges is dependent on a number of factors including the discharge rate, the discharge depth and associated water depth, the particle size distribution and density of the fluids and cuttings, the amount of fluid retained on the cuttings, and receiving environment hydrodynamics, including current speed and direction at different depths in the water column at the discharge site. The cuttings particle size and the density of the fluids are key parameters as they determine the settling velocity of the particle once it is passively dispersing in the marine environment.

Drill cuttings (and unrecoverable fluids) discharged at seabed (riserless drilling)

General description of base case for a typical Browse production well

For a typical Browse well, the total indicative volume of drill cuttings and associated fluids to be discharged to the seabed is predicted to be ~240 to 625 m^3 of cuttings with ~1,404 to 1,789 m^3 of adhered fluids (incl. ~56 to 106 m^3 of solids), depending on well sections drilled riserless (excluding mud pit discharge) (**Appendix A**).

Drill cuttings and unrecoverable fluids are discharged at the seabed at each well site for the top-hole sections drilled riser-less (i.e. no closed loop with the MODU). This results in a localised area of sediment deposition (known as a cuttings pile) in proximity to the well site. The larger cuttings particles will settle out of suspension and deposit in close proximity to the well site (tens of metres) with potential for localised spreading downstream. In contrast, the finer particles will remain in suspension and be transported away from the well site, rapidly diluting and eventually depositing over a slightly extended area (potentially up to several hundreds of metres) downstream of the well site. The spread of cuttings and associated unrecoverable WBF is expected to be around 50 to 200 m downstream from the discharge location based on a review of seven studies summarised by International Association of Oil and Gas Producers (IOGP, 2016).

Relevance to Torosa wells in the State Proposal Area

As described in Section 6.3.15 of the draft EIS/ERD, the seabed discharge of drill cuttings from top-hole well sections may result in sediment plumes in the lower water column above seabed and associated deposition of sediment to the surrounding seabed. Such plumes are predicted to be confined to the bottom layers of the water column with no contact with deeper water or shallow water coral habitats at Scott Reef (<75 m bathymetry). There is some evidence of localised intrusions of cooler water around the western and eastern entrances to the channel between North and South Scott Reef during spring tides but no evidence of persistent upwelling or downwelling currents around Scott Reef (Green et al., 2019b) and therefore, no transport mechanisms to mobilise drill cuttings from deep waters to the shallower waters of the reef system. As such, given the location of the drill centres in deep water (>350 m; **Table 1-1**), which experience strong surface and subsurface currents, drill cuttings and fluid discharge disposal at seabed would be expected to dilute rapidly. Therefore, any reduction in water quality due to elevated TSS is expected to occur in a localised area around the drill centre and will be temporary in nature.

Drill cuttings (and residual WBF/NWBF) discharged near surface (riser return to MODU)

General description of base case for a typical Browse production well

The bottom hole sections will be drilled with a marine riser in place that enables cuttings and drilling fluids to be circulated back to the MODU, where the cuttings are separated from the drilling fluids by the solids control equipment (SCE). The cuttings (with adhered residual fluids) under typical circumstances are usually discharged below the water line, with their fate and dispersion determined by cuttings particle size and the density of the residual fluids. For a typical Browse well, total indicative volumes of drill cuttings is predicted to be ~225 to 610 m^3 with adhered fluids of ~225 to

610 m^3 (incl. ~55 to 105 m^3 of solids in the fluids with the remainder being primarily brine for WBF). The values exclude mud pit discharges and includes an indicative range that is dependent on well sections drilled with a riser vs. riserless (**Appendix A**).

Drill cuttings with small amounts of residual WBF/NWBF dilute and disperse at different rates depending on particle size and density, with finer fractions more dependent on particle diameter (i.e. surface area) than density. For cuttings returned to the MODU, the particle size distribution of cuttings from the shale shakers[6] (WBF) or cuttings dryers[7] (NWBF), prior to discharge, typically consists of large particle sizes that are considered non-cohesive[8], with a minor proportion of finer particles and a density substantially denser than seawater (Jones et al., in prep). For example, particle size distribution for drilling cuttings from a northwest shelf development well showed 99.1% of cuttings were larger than 62 µm and 96.5% larger than 1 mm in **Table 1-3** (Jones et al., in prep). For the coarser particles the Stokes settling velocity for 1 mm sized sand is approximately 10 cm per second (Jones et al., in prep) and would settle to the seabed under very low flow conditions in approximately an hour based on 400 m water depth and sink below the 75 m water depth within less than 15 min.

Bottom-hole drill cuttings are typically discharged to the marine environment at a low velocity (i.e. nil to minimal dynamic plume) due to the near continuous discharge of a low volume of cuttings during the drilling of each well section. For a typical Browse well section (e.g. 16" well section) this is in the order of 0.8 m^3/hr of cuttings (with 0.1 m^3/hr of residual solids in fluids) (**Appendix A**). This discharge forms a plume in the water column, which often separates into an upper and a lower plume that dilutes rapidly as it drifts away from the discharge point driven by the prevailing currents.

The upper plume typically contains dissolved and fine particulate cuttings fractions. The dissolved components of the plume, including the salts and water soluble drilling fluid organic additives, dilute rapidly in the receiving environment. While the fine particulate fractions such as barite (grain size 6 to 75 µm; density 4.2 g/cm^3) and clay (grain size < 2 µm; density 2.4 g/cm^3), which typically form a minor component of the overall discharge, settle slowly and disperse over a wide area (IOGP, 2016). In contrast, the lower plume typically contains larger, denser cuttings particles including flocculated clay/barite particles and particle aggregates, which would settle rapidly and accumulate on the seabed nearer to the discharge point (IOGP, 2016). Note, most of the organic additives in WBF and the NWBF adsorb tightly to inorganic particles in the cuttings and disperse and settle with them through the water column.

After separation on the MODU, drill cuttings and residual fluids released below the waterline, in deeper waters, are generally deposited over an area extending up to approximately 500 m from the discharge site, with deposition patchy in nature and sharply decreasing with distance from the discharge point (Balcom et al., 2012). These discharges overlap and slightly extend the top hole cuttings pile, with the deeper the discharge point the smaller the associated deposition footprint.

Relevance to Torosa wells in the State Proposal Area

When assessing bottom hole drill cuttings with residual fluids alone (i.e. excluding mud pit discharges), there is no anticipated interaction of elevated total suspended solids (TSS) with Scott Reef shallow water benthic communities and habitats (<75 m bathymetry) , due to their discharge characteristics (e.g. volumes and rates), their inherently lower adhered WBF/NWBF content, typically large particle size and associated dispersion characteristics, in addition to the location of the Torosa drill centres in the State Proposal Area (in the order of 2 km from the 75 m bathymetric contour).

[6] Shakers are the primary solids control equipment that separate WBF and cuttings returning from the well into cuttings (discharged to the ocean with a residual film of WBF) and recovered WBF (which returns to the mud pits on the MODU).

[7] When using NWBF, there is no direct discharge from the shakers (except for a short time in some emergency situations). Instead, after cuttings have passed over the shakers, they are diverted to cuttings dryer/s. Cuttings dryers are used to further reduce the volume of residual NWBF adhered to cuttings prior to discharge. Outputs from a dryer are separated into cleaned cuttings (which are typically discharged to the ocean with a residual film of NWBF) and recovered NWBF (which returns to the mud pits on the MODU via a dryer centrifuge).

[8] Non-cohesive sediments are generally considered to have a mean particle size of >64 µm (sands) (Wolanski, 2007) .

Management outcome relevant to Torosa wells in the state Proposal Area

Based on no anticipated interaction with shallow waters of Scott Reef (<75 m bathymetry), drill cuttings (with residual WBF/NWBF) are planned to be discharged near surface for TRD, TRA and TRF wells. It is proposed however that fine solids[9] separated by dryer centrifuges[10] and de-weighting centrifuges[11] (or equivalents) will be managed. Refer to **Section 2** for further details.

Note, management of drill cuttings (and residual fluids) generated when drilling with a riser in place will also be further addressed and subject to appropriate performance outcomes in EPs required under petroleum legislation (refer to **Section 4**).

WBF discharges (pit dumps/bulk discharges) discharged near surface (from MODU)

General description of base case for a typical Browse production well

The dispersion and fate of WBF from mud pit discharges differs to drill cuttings given the considerable shift in particle size distribution to the finer fractions (for example 99.1% <7.8 µm; **Table 1-3**) and the significantly higher rate and volume of fluid discharge. For a typical Browse well, a total indicative volume of ~3,744 m^3 of mud pit fluids (incl. ~619 m^3 of solids) may be discharged at discrete times during the drilling campaign at a rate of ~200 m^3/hr (**Appendix A**). Particle size distribution measurements of drilling fluids in samples from the mud pits just prior to discharge consists of predominantly silts to clays, which are considered cohesive in nature.[12]

The dispersion of the discharge will depend, initially, on the geometry and hydrodynamics of the discharge itself, where the induced momentum and buoyancy effects dominate over background processes. The pit discharges occur at velocity over a short period (tens of minutes, depending on the amount discharged, typically at a rate of ~200 m^3/hr), and therefore the plume will initially be dominated by its own momentum. As the plume descends, the discharges mix with the ambient waters, the momentum and buoyancy signatures are lost, and the ambient processes become dominant. Once downward momentum is lost, the fate of the plume will depend upon discharge buoyancy as the dominating factor, which is expected to remain negatively buoyant (i.e. denser than the receiving environment). Noting that the Stokes sinking velocity for such fine particle fractions is considered to be very slow (Jones et al., in prep), and under low flow conditions the particles may take days to weeks to settle to the seabed under gravitational forces.

Relevance to Torosa wells in the State Proposal Area

Given the PSD, density, discharge characteristics, water depth and prevailing hydrodynamics at discharge location, it is anticipated that near surface discharge of unused/spent WBM fluids from the mud pits may disperse kilometres at low TSS concentrations from the discharge location and there may be a very minor risk that these could potentially reach Scott Reef shallow water benthic communities and habitats (<75 m bathymetry) within the maximum LEP zone. Note any suspended solids that could reach Scott Reef are not anticipated to pose a risk to Scott Reef shallow water benthic communities and habitats (<75 m bathymetry), due to the number of dilutions expected to occur over the intervening distances and hence the resultant TSS concentrations.

Management outcome relevant to Torosa wells in the state Proposal Area

Based on very minor risk of a low concentration of WBM fluids from mud pits reaching the shallow waters of Scott Reef (<75 bathymetry) (abet below biological/ ecological risk levels) – for TRD, TRA and TRF wells, WBF bulk discharges will be managed and occur either at depth (> 200 m), at the

[9] Solids in this context refers to fine rock particles (cuttings) that are removed from the well with fluids via SCE when returned to the MODU, and/or fine solid material intentionally added to or removed from a drill fluid to control its specific gravity
[10] A dryer centrifuge is connected to the recovered NWBF output of a cuttings dryer to remove undesirable fine solids from the fluid before it returns to the mud pits, and to reduce the volume of residual NWBF adhered to the fines prior to discharge.
[11] De-weighting centrifuges are connected to the mud pit system on a MODU and used (when required) to remove fine solids from the WBF/NWBF to reduce the specific gravity of the fluid.
[12] Muds are usually defined as having a mean particles size of <4 µm and are considered to be completely cohesive whereas silts are considered to be weakly cohesive (Wolanski, 2007).

seabed or retained for offshore disposal in Commonwealth waters under a sea dumping permit. Refer to **Section 2** for further details.

Table 1-3: - Drilling cuttings and drilling fluid particle size analysis. Mean particle size distribution (± 95% confidence intervals) and density of cuttings samples collected from the shale shakers at ~300 m intervals down the LPA1 well sampled between 340 to 2,176 m below sea level, and for the drilling fluids in samples from the mud pits just prior to discharge. PSD distribution was simplified to 5 and 9 sediment classes for the cuttings and discharge modelling. Extract from a North West Shelf well (Jones et al., in prep)

			Drill Cuttings			Drilling fluids				
Distribution	phi	µm	Sediment Class	mean	95% CI	Sediment Class	gel-mud	KCl mud	mean	95 CI
fine pebbles	-2	>4000	1	0.6	0.5		0.9	0.0	0.5	0.5
very fine pebbles	-1	>2000		62.4	12.2		0.0	0.0	0.0	0.0
very coarse sand	0	>1000	2	33.4	11.2		0.0	0.0	0.0	0.0
coarse sand	1	>500	3	1.8	0.4	1	0.0	1.2	0.6	0.6
medium sand	2	>250		0.6	0.2	2	0.0	1.4	0.7	0.7
fine sand	3	>125	4	0.2	0.1	3	0.0	8.1	4.1	4.1
very fine sand	4	>62.5		0.1	0.1	4	0.0	15.9	8.0	8.0
coarse silt	5	>31.3		0.1	0.1	5	0.0	18.4	9.2	9.2
medium silt	6	>15.6	5	0.2	0.2	6	0.0	15.5	7.8	7.8
fine silt	7	>7.81		0.2	0.2	7	3.1	13.4	8.3	5.2
very fine silt	8	>3.91		0.3	0.3	8	61.7	9.2	35.5	26.3
clay	9	>1.95		0.0	0.0	9	34.3	16.9	25.6	8.7
		phi		-0.78	0.16		6.39	4.91	5.65	0.74
		x̄ µm		1775	179		12	33	23	11
Wet bulk density (g/cm^3)				1.74	0.05		1.30	1.30	1.30	0.00
Grain density (g/cm^3)				2.30	0.03		-	-	-	-
TSS (g/L)				45	8		245	257	251	6

2. MANAGEMENT APPROACH

2.1 Proposed management approach

The management approach for drill centre locations in the State Proposal Area (i.e. TRA, TRD and TRF) described in Section 6.3.15.3 of the draft EIS/ERD has been further reviewed and developed, in consideration of the discrete drilling discharges, and has resulted in the inclusion of additional proposed management controls to demonstrate that the maximum LEP can be achieved for Scott Reef shallow water benthic communities and habitats (<75 m bathymetry). Demonstration that the new controls demonstrably minimise the risk to Scott Reef shallow water benthic communities and habitats (<75 m bathymetry) designated the maximum LEP, is provided in **Section 1.2**. Given the robustness of the additional controls, infield adaptive monitoring is not considered required.

The additional proposed management controls are provided in **Table 2-1**, with the revised approach illustrated in **Figure 2-1**, which shows an escalation in management relative to the potential risk to Scott Reef shallow water benthic communities and habitats (<75 m bathymetry). This includes management controls to eliminate the risk for particular discrete discharges, including discharge at depth and the collection and transportation of specific discharges to a location outside of State waters (in Commonwealth waters) for disposal (e.g. skip and ship) in accordance with a sea dumping permit, which are further described in **Section 2.2**. Note, in developing the details of the management approach an external SME has been engaged to provide advice.

Table 2-1 Summary of adopted drilling discharges management controls for Torosa wells in the State Proposal Area to demonstrably minimise risk to Scott Reef shallow water benthic communities and habitats (<75 m bathymetry)

Aspects	Draft EIS/ERD adopted controls (relevant to discharges)	Additional proposed controls to achieve maximum LEP for Scott Reef shallow water benthic communities and habitats (<75 m bathymetry)
Top hole cuttings (with unrecoverable WBF) *When drilling riserless*	• Use and discharge of all chemicals will be performed in line with Woodside's chemical selection and assessment process and approved prior to use. • NWBF will not be used for top-hole section drilling (riserless).	• No additional control (all cuttings and associated fluids discharged at seabed) – no predicted impact or potential risk to Scott Reef shallow water benthic communities and habitats (<75 m bathymetry).
Bottom hole cuttings (with residual WBF) *When drilling with riser and BOP in place (during routine operations)*	• Use and discharge of all chemicals will be performed in line with Woodside's chemical selection and assessment process and approved prior to use. • Risers will be used to ensure that WBF and associated cuttings are recirculated to the MODU,	• At TRD, TRA and TRF wells, only bottom hole cuttings (with residual film of WBF) from the shakers[13] (or equivalents) will be discharged at surface due to rapid settling velocity of the larger particle size of the cuttings (primary discharge source) and the inherently lower adhered WBF content (after treatment). • At TRD, TRA and TRF wells, fine solids[14] separated from WBF by de-weighting centrifuges[15] (or equivalent) will be discharged

[13] Shakers are the primary solids control equipment that separate WBF and cuttings returning from the well into cuttings (discharged to the ocean with a residual film of WBF) and recovered WBF (which returns to the mud pits on the MODU).
[14] Solids in this context refers to fine rock particles (cuttings) that are removed from the well with fluids via SCE when returned to the MODU, and/or fine solid material intentionally added to or removed from a drill fluid to control its specific gravity.
[15] De-weighting centrifuges are connected to the mud pit system on a MODU and used (when required) to remove fine solids from the WBF to reduce the specific gravity of the fluid.

Aspects	Draft EIS/ERD adopted controls (relevant to discharges)	Additional proposed controls to achieve maximum LEP for Scott Reef shallow water benthic communities and habitats (<75 m bathymetry)
	where cuttings will be treated prior to discharge. • The proposed Browse Project will use WBF as the preferred option.	at depth (>200 m), at the seabed, or retained for offshore disposal in Commonwealth waters in accordance with a sea dumping permit.
Bottom hole cuttings (with residual NWBF) *When drilling with riser and BOP in place (during routine operations)*	• Use and discharge of all chemicals will be performed in line with Woodside's chemical selection and assessment process and approved prior to use. • Risers will be used to ensure that NWBF and associated cuttings are recirculated to the MODU, where cuttings will be treated prior to discharge. • Drill cuttings will be tested to confirm that the average oil on cuttings for the entire well (sections using NWBF) will not exceed 6.9% by wet weight.	• At TRD, TRA and TRF wells, only bottom hole cuttings (with residual film NWBF) from the cuttings dryers[16] (or equivalents) will be discharged at surface due to rapid settling velocity of the larger particle size of the cuttings (primary discharge source) and the inherently lower adhered NWBF content (after treatment). • At TRD, TRA and TRF wells, fine solids[17] separated from NWBF by dryer centrifuges[18] and de-weighting centrifuges[19] (or equivalents) will be discharged at depth (>200 m), at the seabed, or retained for offshore disposal in Commonwealth waters in accordance with a sea dumping permit.
WBF discharges (pit dumps/bulk discharges) *Typically occurs at end of each well section or when switching between fluid types (riserless or with riser)*	• Use and discharge of all chemicals will be performed in line with Woodside's chemical selection and assessment process and approved prior to use.	• For TRD, TRA and TRF wells, WBF bulk discharges will occur either at depth (> 200 m), at the seabed or retained for offshore disposal in Commonwealth waters under a sea dumping permit.
NWBF discharges (pit dumps/bulk discharges) *No discharge of unused NWBF at sea during drilling and completion operations*	• There will be no discharge of unused NWBF at sea during drilling and completion operations. • Mud pit wash residue is operationally discharged from the MODU with less than 1% oil contamination	• No additional controls required, as discharge already managed.

[16] When using NWBF, there is no direct discharge from the shakers (except for a short time in some emergency situations). Instead, after cuttings have passed over the shakers, they are diverted to cuttings dryer/s. Cuttings dryers are used to further reduce the volume of residual NWBF adhered to cuttings prior to discharge. Outputs from a dryer are separated into cleaned cuttings (which are typically discharged to the ocean with a residual film of NWBF) and recovered NWBF (which returns to the mud pits on the MODU via a dryer centrifuge).

[17] Solids in this context refers to fine rock particles (cuttings) that are removed from the well with fluids via SCE when returned to the MODU, and/or fine solid material intentionally added to or removed from a drill fluid to control its specific gravity

[18] A dryer centrifuge is connected to the recovered NWBF output of a cuttings dryer to remove undesirable fine solids from the fluid before it returns to the mud pits, and to reduce the volume of residual NWBF adhered to the fines prior to discharge.

[19] De-weighting centrifuges are connected to the mud pit system on a MODU and used (when required) to remove fine solids from the NWBF to reduce the specific gravity of the fluid.

Aspects	Draft EIS/ERD adopted controls (relevant to discharges)	Additional proposed controls to achieve maximum LEP for Scott Reef shallow water benthic communities and habitats (<75 m bathymetry)
	by volume. Where the mud pit residue exceeds 1% by volume, the residue will be retained and disposed onshore.	

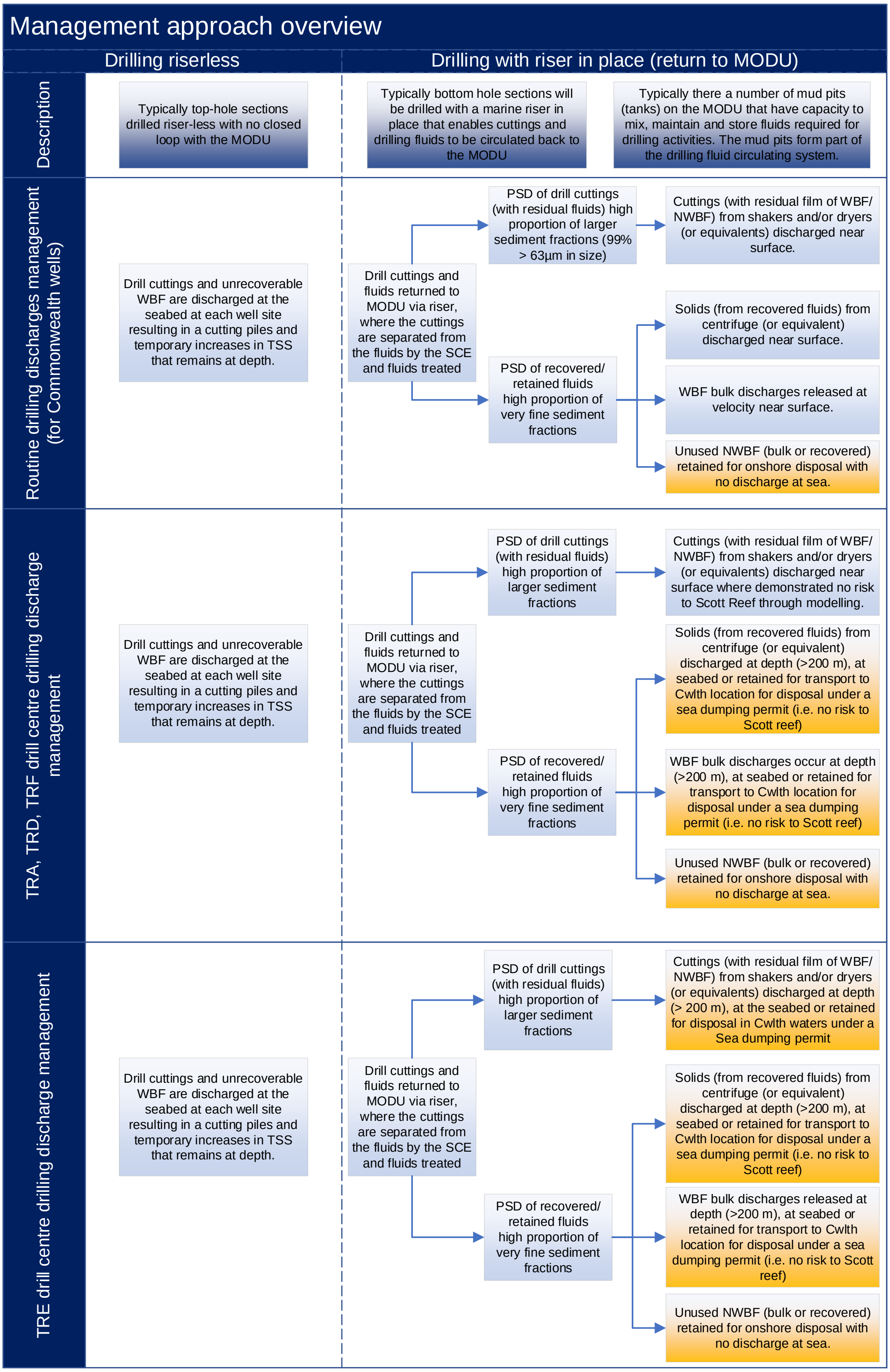

Figure 2-1: Process diagram with increasing levels of proposed management in context of potential risk to Scott Reef shallow water benthic communities and habitats (<75 m bathymetry)

2.2 Management options and assessment

2.2.1 Discharge of drill cuttings and fluids at depth (>200 m)

At Scott Reef, the local water flow within the reef system is largely influenced by the macro tidal environment and its interaction with the topography of the reef structure. The spring tidal range is approximately 4.5 m with a semi-diurnal tidal cycle (Seafarer Tides, 2011). Depending on the cycle of the tide, the reef flat may be exposed or immersed and it is this cycle of exposure and inundation that has a major influence on the surface currents and thermodynamics of the reef (AIMS, 2006; Green et al., 2019a) . Oceanic currents and the seasonal monsoonal weather conditions impact the layering of the water column so that the surface mixed layer deepens during periods of persistent wind and thins during calm periods (Brinkman et al., 2010).

The Scott Reef system is largely subject to the seasonal and inter-annual variability in temperature and salinity structure exhibited by the regional oceanic waters, with greater variability within the South Scott Reef lagoon caused by local processes such as enhanced vertical mixing due to internal waves, modified horizontal advection, residence times and local evaporation (Brinkman et al., 2010). Circulation is controlled by a south-eastward tidal propagation, with tidal currents flooding from the north-west and receding in a south easterly direction. Tidal driven flood currents within the channel between North and South Scott Reef propagate towards the east with enhanced velocities. The circulation around and inside Scott Reef is determined by dynamic influences (winds and tides) as well as thermodynamic processes (Green et al., 2019a).

There is no evidence of persistent upwelling or downwelling currents at Scott Reef, but seawater temperature monitoring has recorded some evidence of localised intrusions of cooler water around the western and eastern entrances to the channel between North and South Scott Reef during spring tides (Green et al., 2019a). Such cool water intrusions are primarily semi-diurnal in timing, driven by the strong semidiurnal periodicity in the prevailing internal wave and tide regime in the channel, combined with horizontal shear due to the strong tidal currents that can entrain water from below the sill depth of the channel up into the lagoon. Logger data suggests that the cool water entering the lagoon originates within the thermocline from depths shallower than 160 m, with no evidence of deeper waters entering the lagoon system (Brinkman et al., 2010).

The discharge of drill cuttings and fluids in deeper water (>200 m or at the seabed) may result in sediment plumes and associated deposition of sediment to the surrounding seabed, however in consideration of prevailing hydrodynamics and modelling outcomes, this is predicted to be confined to the deeper layers of the water column with no contact with deeper water or shallow water coral habitats at Scott Reef.

As outlined, while there is some evidence of localised intrusions of cooler water around the western and eastern entrances to the channel between North and South Scott Reef during spring tides, there is no evidence of persistent upwelling or downwelling currents around Scott Reef (Green et al., 2019b) and therefore, no transport mechanisms to mobilise drill cuttings and fluids from deep waters to the shallower waters of the reef system. As such, given the location of the drill centres in deep water (>350 m), which experience strong surface and subsurface currents, drill cuttings and fluid discharge disposal at depth or the seabed would be expected to settle rapidly.

As such this option has been carried forward as a key mitigative management control for bottom-hole (drilling with riser) discharge parameters that may pose a risk to the Scott reef shallow water benthic communities and habitat (<75 m bathymetry).

2.2.2 Transportation to offshore disposal site in Commonwealth waters

One of the key mitigative options for the management of drilling discharges from Torosa wells in the State Proposal Area involves the collection and transportation of specific discharges to a location outside of State waters (in Commonwealth waters) for disposal (e.g. skip and ship). This option involves modifications to the MODU which may differ depending on the discharge type and rig selection to allow the storage, potential treatment (e.g. slurrification) and transfer/disposal of the discharge. For drilling fluids, these may be recovered from the mud pits, transferred to storage tanks on the MODU or pumped into storage tanks on a barge/vessel for subsequent disposal.

For drill cuttings, this activity may consist of the collection of the cuttings from the MODU into specially designed skips, via a steerable chute. The filled skips are then offloaded via a crane onto a dedicated collection vessel (e.g. barge) or to a standard platform supply vessel (PSV) for disposal.

Alternatively, cuttings may be slurrified on the MODU and cuttings and/or fluids pumped to the barge/vessel for subsequent disposal. This process typically involves:

1. Cuttings processed over rig shakers
2. Cuttings then travel to grinding pumps where they are broken down into a pumpable slurry
3. Slurrified cuttings then stored on MODU until a critical volume is achieved
4. Critical volume then pumped to vessel via a transfer pump
5. Vessel then moves off location to ‘disposal site’ and discharges slurrified cuttings.

Cuttings and drill fluids returned to the MODU may also be processed through centrifugal slurry pumps fitted with tungsten carbide impellors designed to break down the cuttings particle size and form a slurry by the addition of water and a viscosifier. The slurry may then go over a classification shaker to screen out larger particles that needed further processing through the slurry pumps. Once the criteria is met, the classified slurry then may pass to the slurry holding tank, ready for transfer to the mud pits for temporary storage prior to being transferred to the vessel for discharge.

The disposal of such discharges within Commonwealth waters will be subject to assessment and approval of a sea dumping permit through the *Environment Protection (Sea Dumping) Act* 1981, with potential disposal locations within the Browse Development Area identified in **Figure 2-2**. These locations have been nominated as feasible sites as they are located within the Browse Development Area where the existing environment has been described, impacts and risks assessed, and consideration has been given to the avoidance of Key Ecological Features and proposed infrastructure location.

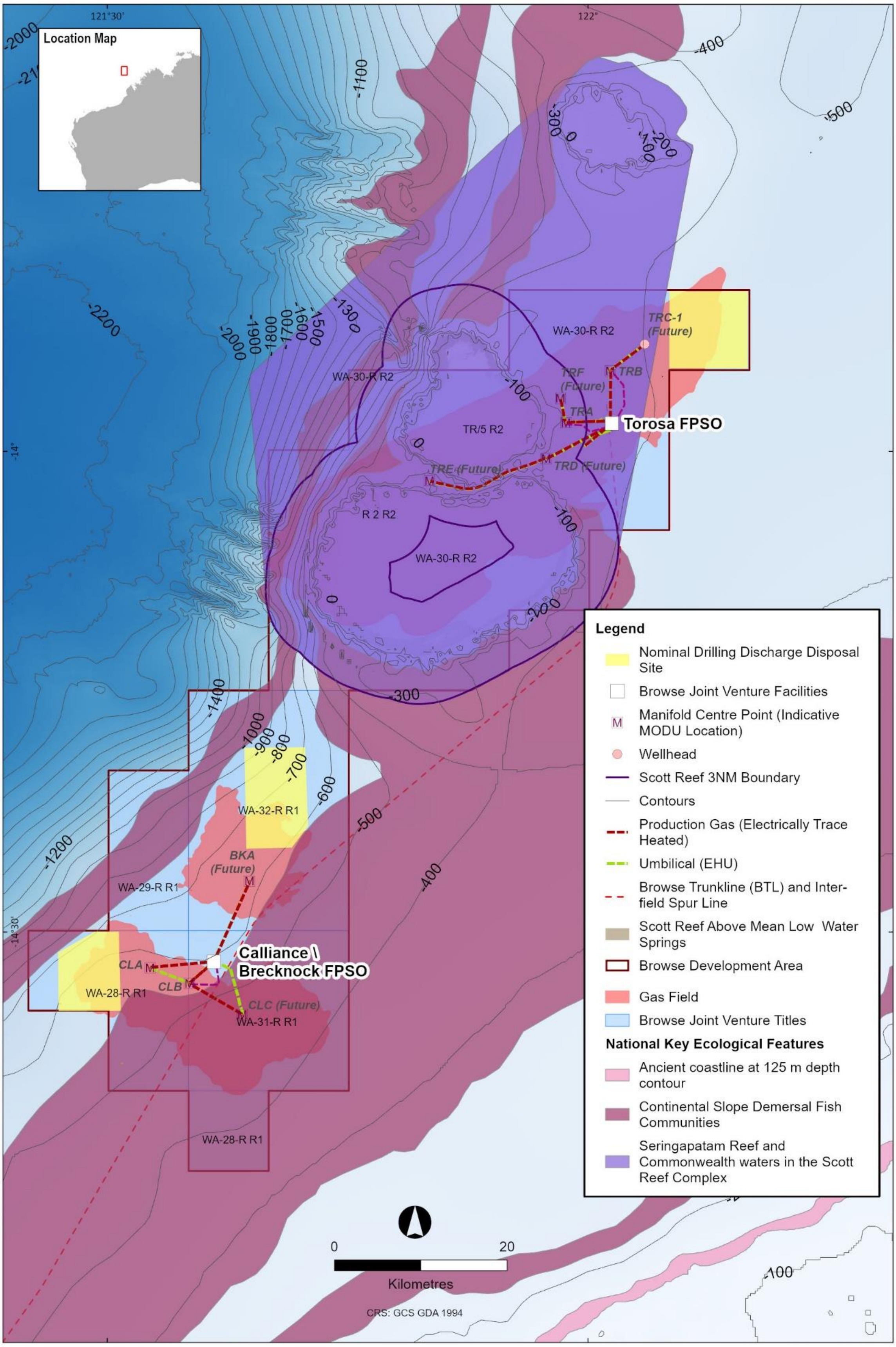

Figure 2-2: Nominal disposal location for retained drilling discharges

3. MONITORING APPROACH

3.1 Hydrodynamic model validation (pre-drilling)

3.1.1 Background

Detailed site-specific information on current direction and flow speeds as well as water column stratification and Ekman layering is essential for modelling. As a part of previous concepts, detailed metocean and ecosystem processes studies have been completed in the Scott Reef region, which has been used as the basis for model validation. Since the completion of modelling, additional metocean studies, including current and wave data in the region have also been collected.

3.1.2 Purpose

A further hydrodynamic model validation study is proposed, which consists of the following:

1. Undertake a desktop assessment to understand the full extent of metocean data available in the Scott Reef region and assess adequacy for robust model calibration and validation with respect to fine-scale hydrodynamics in proximity to the Torosa drill centre locations in the State Proposal Area.
2. Where it is deemed that there is insufficient data in consultation with the modelling consultant, conduct a metocean study to collect site specific information in the vicinity of the Torosa drill centres in the State Proposal Area.
3. Undertake further calibration and validation of the fine scale hydrodynamics model/s that drive the dispersion of discharges within the model domain, based on available metocean data.

3.1.3 Methods

Desktop metocean assessment

The Scott Reef region has been studied by Woodside, its contractors and academics institutions for decades. This review will collate and review all data collected on behalf of Woodside and any other publicly available information, which has sufficient resolution for the purpose of fine-scale hydrodynamic model calibration and validation.

Metocean study

Where a site specific metocean study is deemed necessary, water column current profiles and waves measurements are proposed to be recorded at observational sites through the deployment of Acoustic Waves and Currents (AWAC) and Acoustic Doppler Current Profilers (ADCP) with wave capability. The current profilers are proposed to be mounted at selected sites and acoustically sampled current velocities vertically up through the water column. Observational sites for moored instrumentation will be chosen to provide good spatial coverage of the water column surrounding Scott Reef, in context of existing data, with a focus on the areas in proximity to the proposed drill centre locations within the State Proposal Area.

Hydrodynamic model validation

Further, calibration and validation of the 3-dimensional hydrodynamic model for Scott Reef and the surrounding area is proposed to be completed as the basis for drilling discharges modelling for inclusion in EPs required under petroleum legislation. This will likely involve calibration and validation of the model for a two week period (in order to capture the spring-neap cycle) in each of the four seasons (where relevant) with in-situ measurements, using in field measurements in and around the region surrounding Scott Reef at sites applicable to the Torosa drill centres in the State Proposal Area.

3.2 Drilling discharges volume validation (during drilling)

3.2.1 Background

A key modelling input is the volume of cuttings and fluids to be discharged to the marine environment. Infield quantification of the mud/solids discharges is completed routinely and is important information that can be collected from early phase wells to inform future phase modelling. Noting in the absence of suitable data, conservative (worst-case) scenarios become the default typically overstating the impact/risk.

3.2.2 Purpose

For early Phase 1 drilling activities, detailed records of the discharge characteristics that are routinely tracked will be reviewed. The purpose of this is twofold:

- Validation of the modelling inputs to demonstrate that the modelling was appropriately conservative and that the impact/risk was adequately defined, and where not corrective actions would be implemented.
- Provide better information (i.e. input data to the models) for future phase drilling activities that will allow more realistic discharge scenarios to be modelled and hence a more balanced understanding of risk.

3.2.3 Methods

The following records will be reviewed whether remotely or on the MODU:

- cuttings discharge volumes and mass and discharge rates
- fluids lost on cuttings and below the mudline
- total fluids/solids lost per well and well section
- daily fluids/solids loss budget showing what proportion are lost to the formation, below the mudline, via mud pit dumps and via the centrifuges.

3.3 Drilling discharges deepwater sediment and water quality monitoring (Post drilling)

Monitoring of deepwater sediment quality and epibenthos cover at a gradient away from the well will be undertaken for a representative well for TRA, TRD and TRF drill centres within the State Proposal Area, to verify that the environmental quality criteria (as provided in **Table 3-1**) at the moderate LEP boundary have been achieved. Monitoring will be undertaken at an appropriate time pre-drilling and as soon as practicable post-drilling in water depths deeper than 350m (actual depth will be dependent on which drill centre is chosen to assess).

Water quality monitoring will be undertaken at Scott Reef (defined as the area above the 75 m bathymetric contour and within the 3 nm State waters boundary) during drilling of a single representative well for TRA, TRD, TRF drill centres, to verify that the environmental quality criteria (as provided in **Table 3-1**) at Scott Reef has been achieved.

Details of the drilling discharges sediment and water quality monitoring program is provided in Section 3.5.1 and Section 3.5.3 of the proposed Browse Project EQMP.

Table 3-1: EQGs and EQSs for the drilling discharges in the State Proposal Area

Potential Impact	Source of Impact	EQGs	EQSs
Drilling or completions discharges			
Contamination of sediments	Drilling cuttings and fluids discharges	**EQG 1** The bioavailable fraction of the metal or metalloid concentrations measured at the low LEP / moderate LEP and moderate LEP / high LEP boundaries will not exceed the recommended toxicant default guideline values for sediment quality (DGVs; ANZG, 2018) and as specified in Section 3.5.1.2 of the EQMP. **EQG 2** Hydrocarbon concentrations measured at the low LEP / moderate LEP and moderate LEP / high LEP boundaries, will not exceed the guideline values (DGVs) for sediment quality (ANZG, 2018) and as specified in Section 3.5.1.2 of the EQMP. *For this EQG to be triggered, concentrations must be above background levels measured prior to the activity or a suitable reference location and be attributable to the Browse Project activities*	**EQS 1** Whole sediment toxicity tests (at least 3 tests) from sediment at the low LEP / moderate LEP boundary should not result in a statistically significant effect (P < 0.05) on lethal acute endpoints, or of greater than 50% on sublethal chronic endpoints for any species, compared to a matched reference sediment. **EQS 10** Whole sediment toxicity tests (at least 3 tests) from sediment at the low LEP/moderate LEP boundary should not result in a statistically significant effect (P < 0.05) on lethal acute endpoints, or of greater than 50% on sublethal chronic endpoints for any species, compared to a matched reference sediment.
Sediment deposition causing burial or smothering of marine fauna	Drill cuttings discharged at the seabed	**EQG 3** No net detectable change in epibenthos diversity or composition outside 200	**EQS 2** At the low LEP / moderate LEP boundary, no change to epibenthos

Potential Impact	Source of Impact	EQGs	EQSs
		m radius from the well within the defined moderate LEP boundary attributable to the Browse Project activities.	species diversity and composition attributable to the Browse Project. **EQS 3** At the moderate LEP / high LEP boundary, no detectable change in natural variation (including abundance, diversity and composition) of epibenthos cover attributable to the Browse Project activities.
Water quality	Drilling or completions discharged at surface	**EQG 4** Particle size distribution of the drilling cuttings and fluids returned to the MODU via the riser, where the cuttings are separated from the fluids by Solids Control Equipment (SCE) and fluids discharged at surface within State Waters show that 99% of particles are greater than 63 µm in size. **EQG 14** Water quality monitoring in the direction of the cuttings discharge plume shows the TSS is <10 mg/l above background at the moderate LEP / high LEP boundary and no detectable change from natural variation of total suspended solids at the high LEP / maximum LEP boundary.	**EQS 4** Water quality monitoring in the direction of the turbid plume shows no detectable change from natural variation of total suspended solids or contaminants in waters at Scott Reef (considered as the area above the 75 m bathymetric contour and within the 3 nm State waters boundary).

4. CONCLUSION

Table 2-1 provides a summary of draft EIS/ERD and additional management controls relevant to drilling discharges from Torosa wells within the State Proposal Area that have been proposed to demonstrate that the maximum LEP can be achieved for Scott Reef shallow water benthic communities and habitats (<75 m bathymetry).

For TRA, TRD, and TRF wells on the eastern side of Scott Reef, within the State Proposal Area, drilling discharges at the surface/near surface when drilling with riser, are only being considered for bottom hole cuttings (with residual film of fluids) from the shakers (or equivalents) for WBF, and from the cuttings dryers (or equivalents) for NWBF, due to their inherently lower adhered WBF/NWBF content, and the rapid settling velocity of the larger particle size of the cuttings (primary discharge source) and associated dispersion characteristics, and as such there is no anticipated credible risk to Scott Reef shallow water benthic communities and habitats (<75 m bathymetry). Noting that the WBF mud pit bulk discharges, which have a finer particle distribution and associated wider dispersion, are proposed to be managed and either discharged at depth (>200 m), at the seabed, or retained for offshore disposal in Commonwealth waters in accordance with a sea dumping permit.

To support this approach, site specific modelling for the worst-case well at each Torosa drill centre within the State Proposal Area is being proposed for inclusion and assessment within the associated EP following detailed engineering and design. This modelling will be supported by additional hydrodynamic model validation as described in **Section 3.1** and may include a range of sensitivity testing. This process flow is illustrated in **Figure 4-1**.

Note the impact and risk assessment for Torosa wells within the State Proposal Area will be further described in future EPs submitted and accepted under the Petroleum (Submerged Lands) Act 1982, which provides the regulatory framework for the exploration and production of petroleum resources adjacent to the WA coast. The Petroleum (Submerged Lands) (Environment) Regulations 2012 are based on the Commonwealth OPGGS (E) Regulations and have the objective of ensuring petroleum or geothermal energy activities are carried out in a manner consistent with the principles of ecologically sustainable development. The Regulations require an EP be in force for any petroleum activity undertaken in WA State waters.

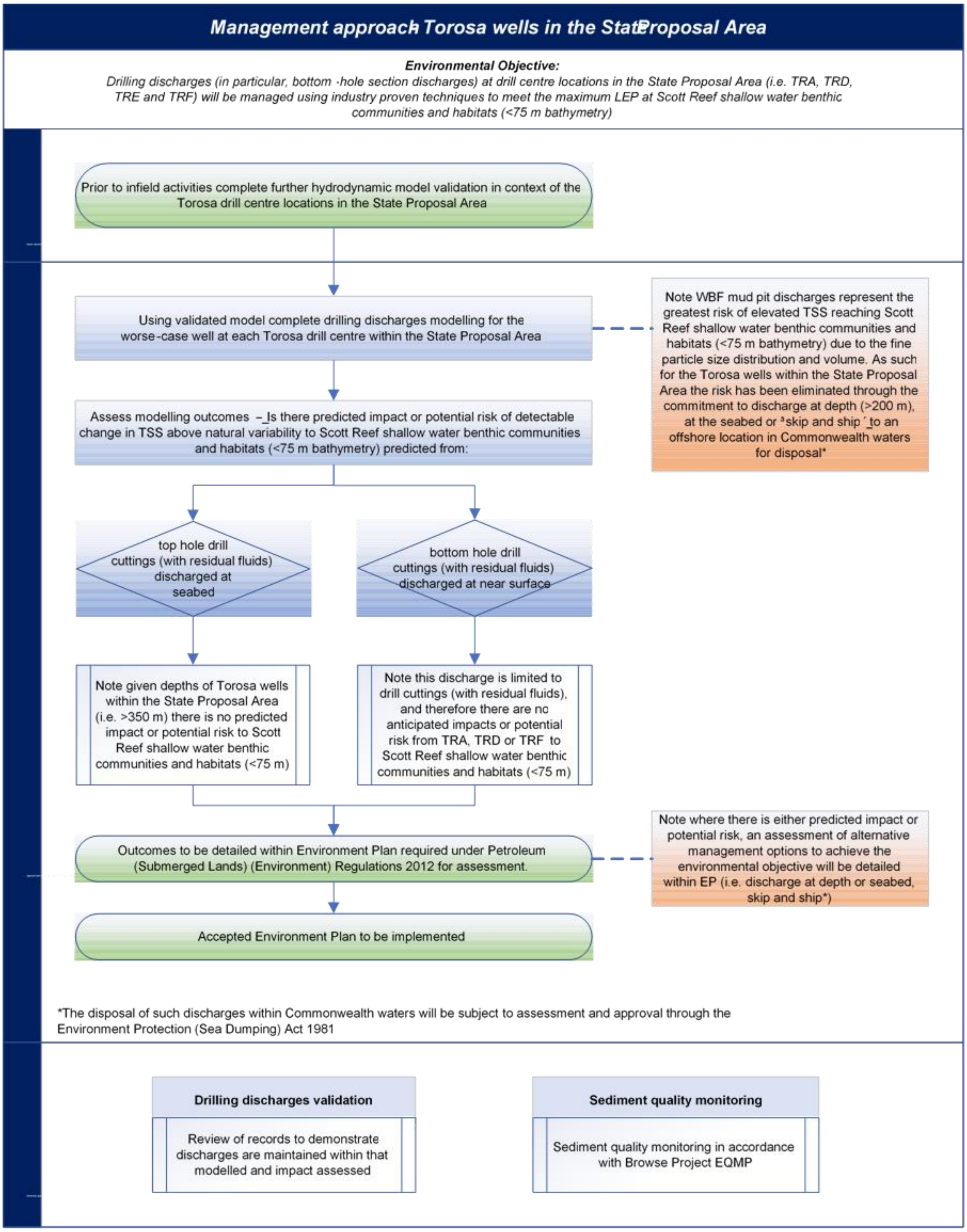

Figure 4-1: Approvals approach to demonstrate acceptable discharge of cuttings (with residual fluids) at surface/near surface at TRA, TRD and TRF drill centres.

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APPENDIX A: INDICATIVE CUTTINGS VOLUME AND FLUID TYPE FOR A TYPICAL BROWSE WELL

Table 5-1: Indicative cuttings volume and fluid type for a typical Browse well

Indicative well section diameter	**Indicative drill length (m)**	**Indicative cuttings volume (m^3)**	**Indicative fluids volume (m^3)**	**Fluids adhered to cuttings** (Indicative estimates for context purposes only)			**Mud pit discharges** (Indicative estimates for context purposes only)			**Indicative fluid type**	**Indicative discharge location***
				Fluids volume (m^3)	Solids in fluids volume (m^3)	Discharge duration (days)**	Fluids volume (m^3)	Solids in fluids volume (m^3)	Discharge duration (days)		
42”	100	89	427	342	14	~0.25	85	3	0.02	Seawater with bentonite sweeps	Drilled riserless – seabed discharge
26”	440	151	1327	1062	42	2	265	11	0.06	Seawater with bentonite sweeps	Drilled riserless – seabed discharge
16”	2970	385	1892	385	50	~20	1507	196	0.31	WBF	Drilled riserless – seabed discharge or drilled with riser – near surface discharge
$12^{1/4}$	2799	213	1478	213	53	~15	1265	316	0.26	WBF, **OR**	Drilled with riser – near surface discharge
			702	120	30	~15	Not applicable – no discharge of NWBF, backloaded for onshore storage/disposal.			NWBF	
$9^{7/8}$	243	12	633	12	2	5	621	93	0.13	WBF, **OR**	Drilled with riser – near surface discharge
			545	7	2	5	Not applicable – no discharge of NWBF, backloaded for onshore storage/disposal.			NWBF	
Total per well	**6,552 m**	**850 m^3**	**5,757 m^3**								

*This is based on a typical Browse well, noting near-surface drilling discharges from Torosa wells in the State Proposal Area are proposed to be managed as detailed in **Section 2**.

**Note cuttings and residual fluids are generally only discharged when drilling new hole section of the well (including circulating hole clean).