Operational and Scientific Monitoring Plan

Environmental Monitoring in the Event of an Oil Spill to Marine or Coastal Waters

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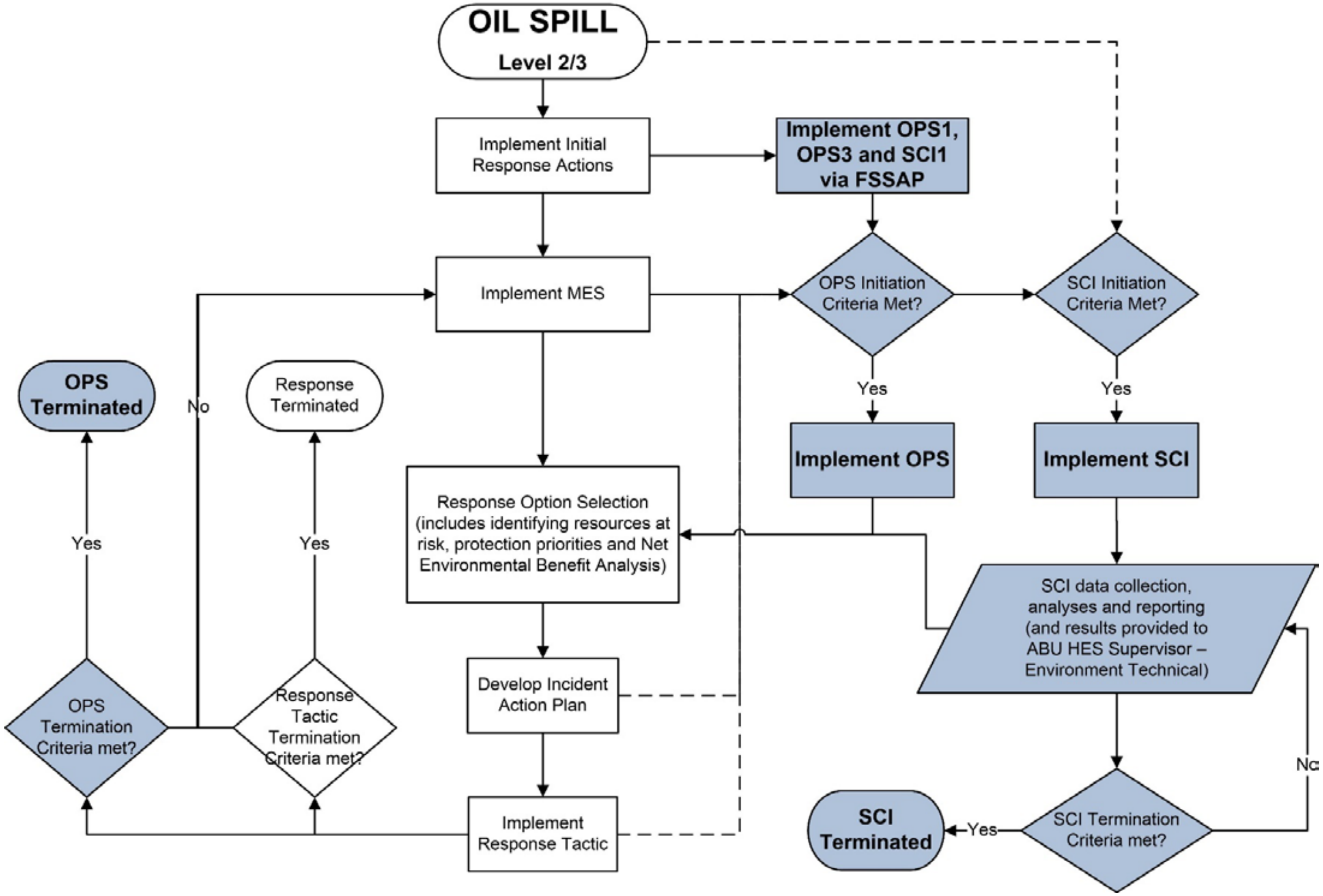
QUICK REFERENCE GUIDE

Operational and Scientific Monitoring within the Oil Spill Response Planning Process



Note: Shaded cells refer to steps related to this Plan. For details relating to other steps, refer to the relevant OPEP.

Overview of Monitoring Components

Code	Operational Component	Aim of Monitoring
OPS1	Oil Characterisation	Identify physical/chemical properties of the oil via laboratory analysis to assist response option(s) selection
OPS2	Chemical Dispersant Efficacy	Rapid information on the efficacy of dispersants as a response option
OPS3	Oil in Water	Collect data on the effects of the spill and response options (including dispersants) on water quality
OPS4	Oil in Sediment	Collect data on the exposure of sediments to oil and any effect of response activities on sediment quality
OPS5	Rapid (Oiled) Shoreline	Assess the state of shoreline habitats, presence and extent of oil, assess impacts of response activities
OPS6	Rapid Seabird and Shorebird	Rapidly quantify the presence and state of seabirds and shorebirds, their use (e.g. breeding, nesting, foraging) of areas predicted or already impacted, assess the impacts of response activities
OPS7	Rapid Marine Megafauna	Rapidly quantify the presence, state, and type of marine megafauna and their use (e.g. migrating, foraging) of areas predicted or already impacted
OPS8	Fish Tainting	Collect data on the effects of the spill and response options on pelagic and benthic fish species
Code	**Scientific Component**	**Aim of Monitoring**
SCI1	Water Quality	Assess water quality for oil and/or dispersant content against environmental benchmarks or natural variation
SCI2	Sediment Quality	Assess sediment quality for oil and/or dispersant content against environmental benchmarks or natural variation
SCI3	Coastal and Intertidal Habitat	Assess impacts to coastal and intertidal habitats and associated biological communities
SCI4	Seabird and Shorebirds	Identify and quantify the post-impact status and recovery of seabirds and shorebirds
SCI5	Marine Megafauna	Identify and quantify the post-impact status and recovery of marine reptiles, pinnipeds and other marine megafauna
SCI6	Benthic Habitat	Assess impacts to subtidal benthic habitat and biological communities
SCI7	Fisheries, Aquaculture, Fish	Monitor lethal and sublethal effects on fish and aquaculture species, and changes in fish population and abundance
SCI8	Heritage	Monitor changes in shipwrecks

Initiation Criteria and Implementation Times

Criteria	What is Initiated	Implement When	By Who	Comments
Level 2 or above spill to marine waters	This Plan, and OPS1,3 and SCI1 & SCI3 via the FSSAP	72hrs of the EMT declaring a Level 2/3 spill	OSMP Team, or field crew. Refer to FSSAP	The First-strike Sampling and Analysis Plan (FSSAP) is a template for rapid implementation of OPS1, 3 and 4.
Dispersant application is selected and is applied	OPS2 – Dispersant Efficacy Testing	Refer to relevant OPEP. Implement when dispersant is applied	Oil spill responder	
Oil predicted to reach coastal areas or shorelines	OPS4 is initiated for sediments	5 days from first prediction of coastal/shoreline exposure	OSMP Team, or field crew. Refer to FSSAP	Refer to First-strike Sampling and Analysis Plan for template
	OPS5 is initiated for rapid shoreline assessment	Refer to applicable OPEP / EP	Oil spill responder – shoreline specialist	
	OPS6 is initiated if those shores support seabirds/shorebird populations or their habitats	48 hrs from predicted/confirmed exposure to birds or shoreline habitats	Initially: Oil spill responder – shoreline specialist Later: OSMP Team	
Predicted exposure of oil to offshore sediments	OPS4 is initiated	5 days from first prediction of exposure to offshore sediments	OSMP Team	Refer to First-strike Sampling and Analysis Plan for template
Predicted exposure to sensitive marine megafauna habitat or migration pathways or fisheries	OPS7 for megafauna	48 hrs from first prediction of exposure to sensitive marine megafauna habitat	Initially: Aerial surveillance specialist Later: OSMP Team	
	OPS8 for fish tainting	5 days from first prediction of exposure of oil to known fisheries	OSMP Team	
OPEP response options implemented	Refer to Table on following page for activation of OPS components due to response options	Refer to each OPS component.	Refer to each OPS component.	Some response options and support functions trigger OPS components, e.g.: dispersant application, shoreline protection, shoreline clean-up, oiled wildlife, and waste management

Operational Monitoring Components Used to Monitor and Inform Response Options and Activities

Monitoring, Evaluation, and Surveillance
(Oil Pollution Emergency Plan (OPEP))

Response Option	Operational Monitoring Component							
	OPS1	OPS2	OPS3	OPS4	OPS5	OPS6	OPS7	OPS8
Source Control – Well Capping	X		X	X				
Source Control – Diverter/Shut-off Valves	X		X					
Natural Recovery and Assisted Natural Dispersion	X		X					X
Dispersant Application	X	X	X	X				X
Containment and Recovery	X							
Shoreline Protection	X		X	X	X			
Shoreline Clean-up	X		X	X	X			
Oiled Wildlife (Support Function)	X					X	X	
Waste Management (Support Function)	X		X	X	X	X	X	X

OPS1: Oil Characterisation
OPS2: Chemical Dispersant Efficacy Assessment
OPS3: Oil in Water Assessment
OPS4: Oil in Sediment Assessment
OPS5: Rapid (Oiled) Shoreline Assessment
OPS6: Rapid Seabird and Shorebird Assessment
OPS7: Rapid Marine Megafauna Assessment
OPS8: Fish Tainting Assessment

Note: This table displays the response options and the corresponding operational monitoring component that will be used to monitor and inform that option during the response. For example, the 'shoreline clean-up' response option is monitored through OPS1, OPS3, OPS4, and OPS5.

Contents

Tables

Figures

1 Introduction

1.1 Purpose

This Operational and Scientific Monitoring Plan (OSMP) (this Plan) describes the types of environmental monitoring that may be implemented in the event of an emergency condition[1] resulting in a Level 2 or above oil spill to marine or coastal waters where Chevron Australia Pty Ltd (CAPL) is the Nominated Titleholder (Commonwealth) or Operator (State). This Plan and associated documents is the principal tool for determining the extent, severity, and persistence of environmental impacts from an oil spill.

This Plan was also developed to meet monitoring requirements under these Commonwealth and State regulations:

- Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations
- Petroleum and Geothermal Energy Resources (Environment) Regulations
- Petroleum Pipelines (Environment) Regulations
- Petroleum (Submerged Lands) (Environment) Regulations.

Broadly, this Plan comprises two types of monitoring: operational and scientific. Operational monitoring collects information about the oil spill and associated response options to aid planning and decision making for executing spill response or clean-up operations. Operational monitoring typically finishes when the spill response is terminated, usually because response objectives were met and/or scientific monitoring was initiated.

Scientific monitoring focuses on the short-and long-term environmental impact assessment. It may occur in parallel to operational monitoring and can continue for some time after the oil spill event. Scientific monitoring determines the potential ongoing environmental impact attributable to the spill or the associated response activities, and informs the requirements for remediation.

Both types of monitoring comprise several components. Each component represents a particular assessment or study, and has tailored initiation and termination triggers to determine if, and when, that monitoring component will be implemented. Despite the individual initiation/termination criteria, components are inextricably linked, both across and within the two types of monitoring.

Aside from the initiation and termination criteria, the information in this Plan (and supporting documents, refer to Section 1.2) is not prescriptive; it provides a flexible framework for environmental monitoring that can be adapted based on the characteristics of a specific oil spill event. The Plan lists possible types of sampling and analyses that may be undertaken, allowing for the detailed final design (including selection of sample sites, monitoring priorities, methods, analytes etc.) to be confirmed once an event has occurred so that the monitoring implemented is appropriate to the nature and scale of the event.

[1] Emergency conditions are defined in each activity-specific Environmental Plan (EP) and relevant Oil Pollution Emergency Plan (OPEP).

1.2 Scope

This Plan focuses on operational and scientific monitoring of a Level 2 or above[2] oil spill event only, where CAPL is the Nominated Titleholder or Operator. Oil spill risks, prevention, and response activities are described in the activity-specific Environment Plan (EP) and Oil Pollution Emergency Plan (OPEP). Monitoring, Evaluation, and Surveillance (MES) activities of an oil spill are excluded from operational monitoring in this Plan; these are included in the relevant[3] OPEP.

This Plan is part of the overall oil spill preparedness and response framework in place at CAPL, which is described in the Australian Business Unit (ABU) Oil Spill Response Manual (Ref. 1). The relationship between the various emergency management and oil spill documentation is outlined in Figure 1-1. An emergency condition would result in the activation of the Emergency Management Team (EMT), and the relevant OPEP and this Plan would be enacted (Figure 1-1).

In the event of an oil spill, activity-specific plans (which may include Oil Spill Tactical Response Guides and Incident Management Guides) will be enacted by the On-site Response Team (ORT) who will control the source of the spill and initiate any immediate actions required to ensure personnel safety and reduce the volume of oil released to the environment.

For spill events where CAPL is not the Control Agency, the scientific monitoring components are activated as per the initiation triggers listed in Section 5; the Control Agency is responsible for implementing operational monitoring.

[2]Although Level 1 oil spills may have environmental impacts that require investigation (at an appropriate scale), Level 1 spills are typically small in size and of short duration; the spill response may be complete before the OSMP could be implemented.

[3] CAPL is currently transitioning to a consolidated OPEP that will eventually address multiple activity-specific EPs and replace activity-specific OPEPs. This document will use the term ‘relevant OPEP’ until such time as all activity-specific EPs are addressed by the consolidated OPEP. Emergency Management Teams should check with the ABU Oil Spill Coordinator or the OSMP Monitoring Coordinator to understand which OPEP is applicable at the time.

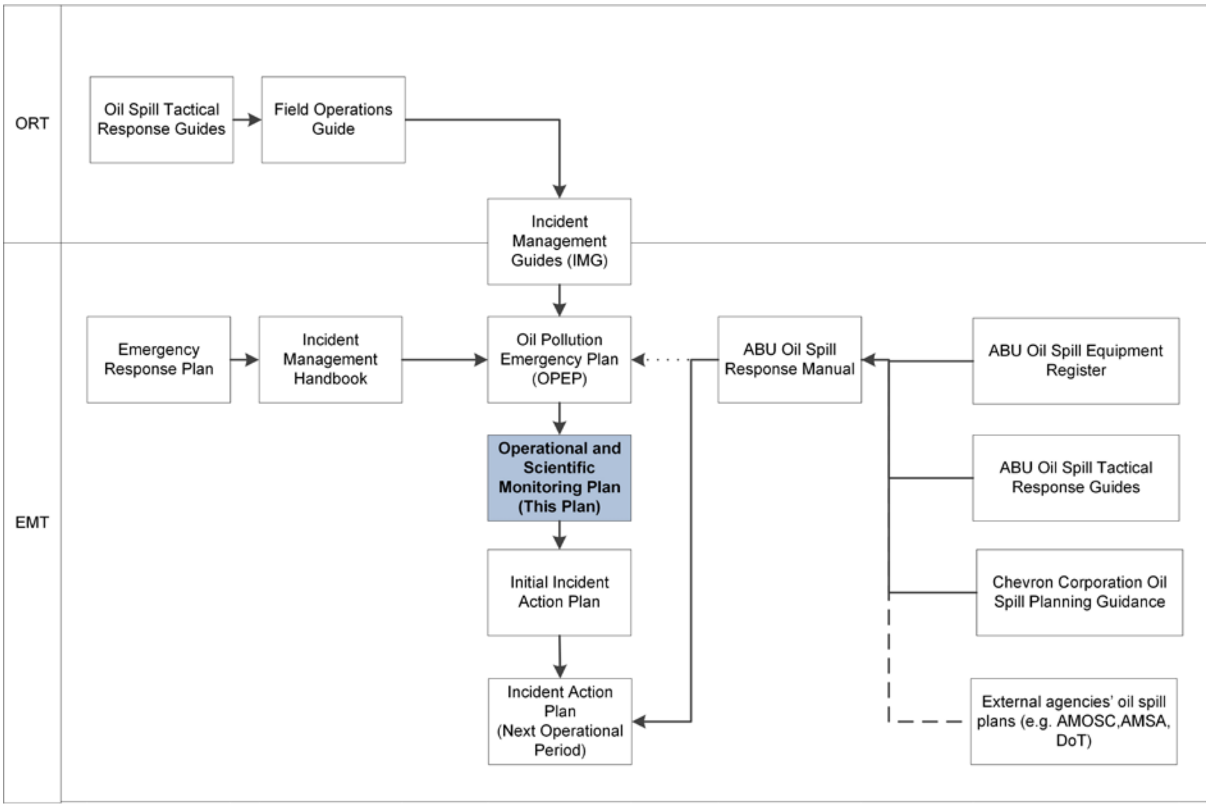


Figure 1-1: Relationship of Emergency Management and Oil Spill Documentation within CAPL

Note: Shaded cells refer to documents related to this Plan.

This Plan is supported by a number of other documents, tools and processes, as indicated in Figure 1-2.

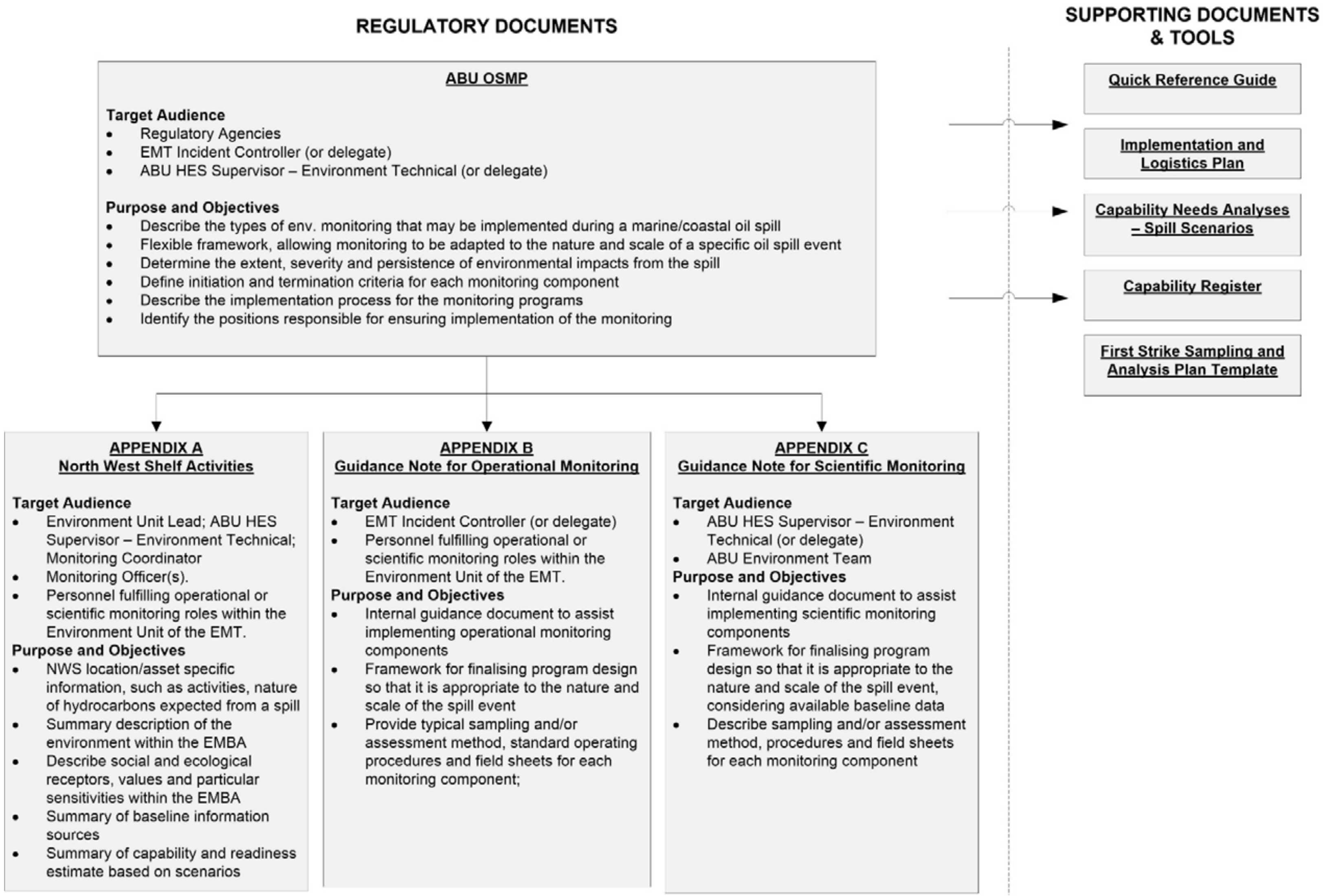


Figure 1-2: ABU OSMP Document Hierarchy and Supporting Tools

1.3 Objectives

The objectives of this document are to:

- describe the components of the operational and scientific monitoring that may be implemented in the event of an oil spill to marine or coastal waters
- define initiation and termination criteria for each monitoring component
- outline the environmental monitoring framework and process for designing and implementing the monitoring components
- identify the positions responsible for ensuring implementation of the monitoring
- outline the process for identifying, developing, and maintaining scalable capability to implement this Plan in a timely manner that is appropriate to the nature and scale of the event
- summarise the Environment that May be Affected (EMBA) by oil spills resulting from CAPL’s activities on the North West Shelf; including sensitive environmental receptors within those areas
- outline estimates of capability and readiness required to implement this Plan in those areas
- provide guidance on designing monitoring programs and standard operating procedures for typical monitoring methods.

1.4 Target Audience

This document is intended for use by:

- EMT Incident Commander
- ABU Health Environment Safety (HES) Supervisor – Environment Technical
- Monitoring Coordinator
- Operational and Scientific Monitoring Officer(s).

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2 Implementation Strategy

The OSMP (this Plan) is one of the key processes under the Emergency Management (Ref. 2) element of the Operational Excellence Management System (OEMS). The OEMS is a comprehensive management framework that supports Chevron Corporation's commitment to protect the safety and health of people and the environment. The OEMS framework ensures a systematic approach to environmental management, with the environmental aspects of each project addressed from project conception, throughout project planning, and as an integral component of implementation.

This Section outlines:

- Activation of this Plan, initiation of individual components, and implementation of those components
- positions, roles and responsibilities for personnel involved in implementing operational and scientific monitoring, specifically the key positions responsible for meeting the commitments outlined in this Plan
- the systems and processes to ensure that the Plan is fit for purpose and CAPL is ready to implement it
- the mechanism for consulting with stakeholders while implementing the Plan
- the schedule for reviewing this Plan to maintain currency of information and pursue continual improvement.

Specific information related to implementing this Plan on the North West Shelf geographic area is provided in the Appendix A.

2.1 Activation, Initiation, and Implementation

This Plan is activated when the EMT declares a Level 2 (or above) spill to marine or coastal waters[4], where CAPL is the Nominated Titleholder or Operator. For this Plan, activation means the requirements of the Plan are now applicable.

Individual monitoring components are initiated and terminated according to prescriptive initiation and termination criteria, respectively. For the Plan, initiation means starting preparation for implementation.

Upon initiation, some monitoring components have specific timeframes for implementation. For this Plan, the implementation time refers to being ready, at the point of staging or departure, to mobilise for monitoring. For example, for vessel-based monitoring components it could mean being field-ready with equipment, personnel and other resources at the nominated staging area or vessel departure point.

2.2 Roles and Responsibilities

The roles and responsibilities outlined in Table 2-1 apply to monitoring during the incident response while the EMT is active; a subset of these positions may be maintained beyond the response phase. For positions not specific to this Plan, the roles and responsibilities listed in Table 2-1 are in addition to those identified in other Emergency Management documents.

The EMT Incident Commander (or delegate) is ultimately accountable for managing the response operation, which includes this Plan. The OSMP

[4] Marine or coastal waters includes waters within Australian Marine Parks

Monitoring Coordinator is the key coordination role for implementing OPS and SCI components in accordance with this Plan and reporting to the Environment Unit Lead. However, the ABU HES Supervisor – Environment Technical (an everyday non-EMT position) has a key role in advising implementation of scientific monitoring components during the response phase, liaising directly with the EMT Incident Commander or indirectly via the OSMP Monitoring Coordinator. Beyond the response phase the ABU HES Supervisor – Environment Technical assumes responsibility for ongoing scientific monitoring.

Several OSMP-specific roles (see shaded cells in Figure 2-1) are designated through this Plan. Depending on the scale of the event, individual people may perform multiple roles; similarly, multiple people may share the same role.

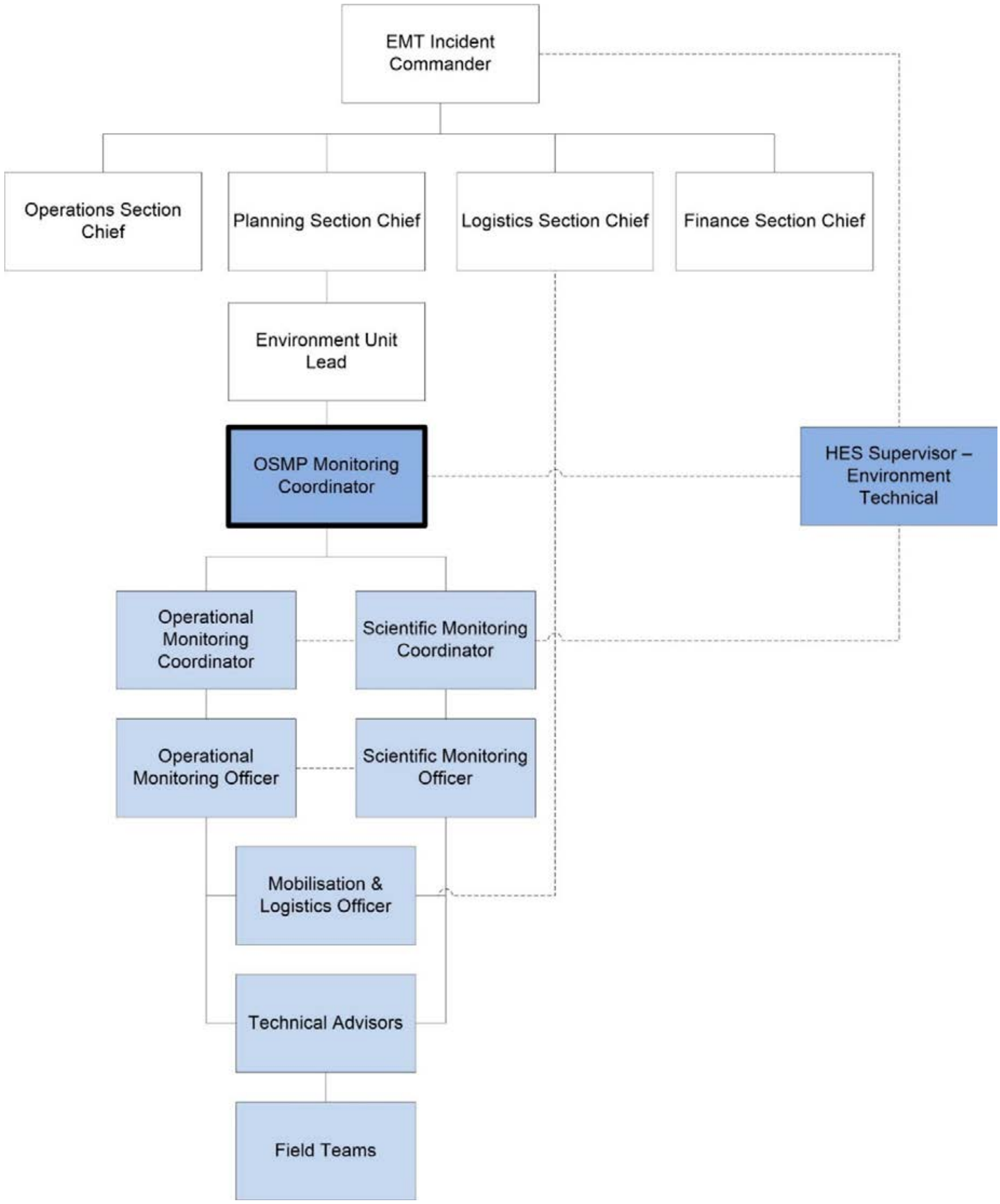

Figure 2-1: Organisational Structure Associated with Implementing Operational and Scientific Monitoring

Note: Shaded cells refer to roles specific to this Plan.

Table 2-1: Roles and Responsibilities

Role	Responsibility Summary
EMT Incident Commander (or delegate)	Ultimately accountable for implementing this Plan. Specific responsibilities: • ensure that the ABU HES Supervisor – Environment Technical (or delegate) and the Environment Unit Lead is sufficiently resourced to oversee and guide implementation of this Plan
Environment Unit Lead	The Environment Unit Lead has a broad range of duties in an emergency response. For this Plan, the Environment Unit Lead is the key position for relaying information between the EMT and the Monitoring Coordinator. Specific responsibilities: • ensure OSMP-specific roles (Figure 2-1) are established • integrate operational and scientific monitoring with the emergency response
OSMP Monitoring Coordinator	Responsible for coordinating the implementation of OPS and SCI components in accordance with this Plan, specifically: • identify the monitoring components that may be triggered based on the information collected during MES, OPS and via implementation of response options • ensure that monitoring components are implemented according to their specific initiation criteria, within nominated response times, and aligned with descriptions provided in Sections 4 and 5 and the relevant guidance notes (Appendix B and Appendix C) • contact point with the EMT via the Environment Unit Lead • facilitate activation of external support, if necessary.
ABU HES Supervisor – Environment Technical (or delegate)	• Oversee implementation of scientific monitoring components • Focal point for liaising with relevant stakeholders on monitoring design, monitoring priorities, and results (as required).
Scientific Monitoring Coordinator and Operational Monitoring Coordinator	The Operational and Scientific Monitoring Coordinators are the key program management roles for each type of monitoring. Responsibilities include: • provide overarching technical advice • advise on environmental impact from implementing monitoring and response options • approve final sampling and analysis plans for monitoring components
Operational Monitoring Officer and Scientific Monitoring Officer	The Operational and Scientific Monitoring Officers are the technical leads for each monitoring type. Responsibilities include: • ensure sampling and analysis plans align with monitoring objectives • understand the data metrics collected in the event of a spill • advise the Monitoring Coordinator on data collection, logistical support required, and monitoring priorities if constraints (e.g. safety, time, logistics) are encountered • oversee data analyses and interpretation • manage data, including spatial data • present data in an appropriate and informative format to allow for timely decisions.
Technical Advisors	Technical Advisors are assigned to individual monitoring components as required. Key responsibilities include: • advise on sampling design, methods and analysis. Assist in developing sampling and analysis plans • ensure quality assurance/quality control (QA/QC) of data, and its interpretation • prepare reports.

Role	Responsibility Summary
Mobilisation and Logistics Officer	Responsible for: • ensuring all field teams are mobilised to site as soon as practicable and in accordance with CAPL processes. • liaises with the EMT Logistics Section Chief (or delegate) during the response when planning mobilisation of monitoring field teams. • Identify and help facilitate procurement of any necessary resources.
Field Teams	A Field Team includes one Field Team Lead, who is the key contact point to the Technical Advisor or Monitoring Officer during a field deployment. The responsibilities of all Field Team members include: • understand the details of monitoring methods • ensure that they are supplied with adequate equipment and field data collection sheets to undertake the monitoring component • ensure awareness and understanding of QA/QC procedures • help with report preparation if required.
Other roles	Other support roles may include: • scribe(s) to document decisions • Document / data manager • External consultant coordinator • Laboratory services coordinator

2.3 Capability and Readiness

Development and maintenance of capability and readiness to implement the OSMP is categorised into three key resource groups:

- personnel
- logistics
- equipment, infrastructure, and support services.

Implementation of system-level measures such as internal reviews, readiness assessments (exercises and drills), and schedules ensure that resources within these interconnected groups are fit for purpose, capable, and ready for deployment to meet the required outcomes of the OSMP. CAPL's compliance assurance process manages compliance by verifying conformance against OSMP commitments (Section 2.4.1).

2.3.1 Personnel

Those capable of implementing this OSMP come from internal (CAPL and corporate global structure) and external (contractor) personnel.

Suggested minimum capability requirements (qualification, training, awareness, and experience) for individuals to fulfil OSMP-specific roles, from HES – Supervisor Environment Technical through to Field Team member, are identified in the ABU OSMP Capability Register (Ref. 3). The estimated number of personnel needed to fulfil roles for any given event depends on the event's circumstances. These estimates are determined internally and guided via internal workshops or exercises for responding to a range of credible scenarios, with a credible worst-case scenario defining the upper limit of the estimate. These scenarios cover the geographic range of CAPL's petroleum activities; refer to Appendix A for scenarios related to North West Shelf activities.

The expected capability of individual personnel to perform OSMP roles is assessed by comparing their skills against the requirements. Personnel are graded into one of three competency levels for each role according to these guidelines:

- SME (Subject Matter Expert level): knowledgeable and qualified. Examples of knowledge include peer reviewed publications, expert panel positions, and extensive experience (15+ years). Examples of qualification include relevant degrees: PhD or MS or BSc Hons with extensive experience. Such a person should be able to direct research and have in-depth knowledge of principles and practices of the role.
- P (Practitioner level): knowledgeable in the specific area. Examples of knowledge include experience (5+ years), and/or publications. Such a person should have a relevant degree (BSc or above) and experience, and be able to implement research and understand the principles of the role.
- A (Awareness level): a level of competency. Examples of competency include some level of practical experience to implement the role. Such a person should have relevant qualifications and/or experience, and be able to assist in implementing the role, but may not thoroughly understand principles or practices.

For specific key OSMP roles, people may be strategically pre-nominated based on their suitability to specific positions; with redundancy in personnel able to fill the key role. When this Plan is enacted, individual personnel will be assigned to key OSMP roles using this process:

- Identify roles that must be filled according to Figure 2-1 and the specific OPS and SCI Plans that have, or are likely to be, initiated. Note: EMT Incident Commander and Environmental Unit Leader roles are filled under Emergency Management.
- Confirm that individuals within CAPL who have been pre-nominated on the ABU OSMP Capability Register (Ref. 3) are still suitable for their roles and are available.
- Assign identified individuals to roles and communicate these assignments to the EMT.

Internal personnel capability is documented every six months in the ABU OSMP Capability Register. External contractors self-assess their capability against the requirements and provide a Statement of Personnel Capability and Readiness every six months.

2.3.1.1 Internal

Internal capability within CAPL includes those based in Western Australia (Perth, Onslow, and Barrow Island). If required, Chevron Corporation’s international offices (e.g. San Ramon [California]; Houston) have personnel skilled in oil spill monitoring if the scale and duration of the response is beyond local personnel.

Internal personnel are assigned to these OSMP-specific roles:

- HES Supervisor – Environmental Technical
- Monitoring Coordinator
- Operational Monitoring Officer/Scientific Monitoring Officer

- Mobilisation and Logistics Officer

Internal staff may perform Field Team roles and responsibilities, particularly first-response OPS monitoring; however, it is expected that Field Team personnel would be sourced externally.

2.3.1.2 External

External personnel, primarily for the roles of Field Team or Technical Advisors, are likely to be filled by contractors to CAPL and/or service providers. Current external capability relevant to specific OPS and SCI Plans and available to CAPL is summarised in Table 2-2.

Further scalability of external personnel is achievable through corporate-level contracts with service providers. For example, Chevron Corporation maintains a contract with Cardno for general environmental services, including responding to emergency situations.

Table 2-2: Capability and Arrangements for External Contractors

Contractor Type	Capability	Activation
Environmental Contractors	All operational and scientific monitoring components	Master contracts exist between CAPL and several specialist environmental consultancies, allowing them to undertake the types of monitoring required under this Plan. Additionally, environmental consultants contracted to Chevron corporation are also available.
Environmental Research Agencies	All operational and scientific monitoring components	Master contracts exist between CAPL, the Cooperative Research Council (CRC), the WA Energy Research Alliance (WA ERA) and Murdoch University, which allow several research agencies and universities to undertake the types of monitoring required under this Plan.
AMOSC	Aerial surveillance and dispersant efficacy testing - field (OPS2), rapid shoreline assessment (OPS5)	CAPL is an AMOSC member company and is represented on the AMOSC board. Activation is via 24hr, 7 days a week emergency hotline.
OSRL	Aerial surveillance and dispersant efficacy testing (OPS2)	CAPL is a member of OSRL. Activation is via 24hr, 7 days a week emergency hotline.
ChemCentre WA	Dispersant efficacy testing – laboratory (OPS2)	CAPL has a direct contract with ChemCentre.

2.3.1.3 Development of Personnel Capability

As described in Section 2.3.1, the ABU OSMP Capability Register (Ref. 3) defines the upper estimate of personnel requirements to implement this Plan for a credible worst-case scenario.

CAPL has a process to develop and record personnel capability (training, awareness, and experience) towards meeting the requirements. This process includes:

- an ABU OSMP Training Plan (included as part of the ABU OSMP Capability Register (Ref. 3)), which is used to identify and schedule capability development activities

- recording the completion of capability development, either through the Learning Management System (for computer-based learning components), or manually via the ABU OSMP Capability Register (Ref. 3)
- collating additional competency data within the ABU OSMP Capability Register (Ref. 3). Data collated include, but are not limited to, qualifications (tertiary education), years of experience, training (e.g. oil spill training, oiled wildlife response, offshore survival), and emergency exercise involvement.

The ABU Environmental Team Lead (or delegate) is responsible for ensuring that the above process and associated procedure(s) are implemented correctly, via six-monthly verification of the ABU OSMP Capability Register (Ref. 3) and six-monthly verification of external contractors' Statements of Personnel Capability and Readiness.

2.3.2 Logistics

Capability and readiness to implement this Plan depends on a functioning logistics system. Although the Mobilisation and Logistics Officer nominated through this Plan is responsible for ensuring that field teams (CAPL personnel and/or contractors) are mobilised to site as soon as practicable, the capability and readiness to execute the required work is held within, and delegated to, the CAPL Supply Chain Management Team via the EMT.

The ABU OSMP Capability Register – Resource Requirements Analysis (Ref. 4) defines the minimum logistics capability required to implement this Plan within the required time frames. The requirements for any given event depends on the event's circumstances, but the upper estimate of logistics support is determined internally, guided via internal workshops or exercises simulating a response to credible worst-case scenarios. These scenarios cover the geographic range of CAPL's petroleum activities; refer to Appendix A for scenarios related to North West Shelf activities.

Resources and logistics required to resource this Plan are just a subset of those required to resource a spill response. ABU Supply Chain Management, along with a large pool of contractors, is equipped with personnel to service ABU's complex and diverse asset portfolio (including two large LNG plants, an onshore oilfield, and offshore platform and offshore wells). During a spill, logistics resources would be re-directed to the response.

2.3.2.1 Access

For areas not under CAPL's operational control, access will be planned in conjunction with relevant State and Commonwealth statutory agencies (e.g. Western Australian [WA] Department of Transport [DoT]), other operators (e.g. Quadrant Energy for Varanus Island, Vermillion Oil and Gas Australia for the Montebello Islands), WA Department of Biodiversity, Conservation and Attractions (or equivalents) for marine parks, and relevant agencies for access to restricted heritage protection areas.

2.3.3 Equipment, Infrastructure, and Support Services

The ABU OSMP Capability Register – Resource Requirements Analysis (Ref. 4) estimates the equipment and infrastructure required to implement this Plan within the required time frames. The requirements for any given event depend on event's circumstances; the upper estimate of logistics support was determined internally, guided via internal workshops or exercises simulating a response to credible worst-case scenarios. These scenarios cover the geographic range of CAPL's petroleum activities; refer to Appendix A for scenarios related to North West Shelf activities. Critical equipment is identified and stores/inventories maintained according to need.

The capability and readiness to procure equipment, infrastructure, and support services is held within, and delegated to, the CAPL Supply Chain Management Team. Internal capability and/or external contractual arrangements for many of the support services are already in place; examples are presented in Table 2-3.

Table 2-3: Capability and Arrangements for Equipment, Infrastructure, and Support Services

Support Service	Capability	Activation
Analytical Laboratories	All laboratory analyses	Master contracts exist between CAPL and selected analytical laboratories, allowing them to undertake the types of analysis required under this Plan. Laboratories associated with university or research institutions can also be accessed via the CRC and WA ERA arrangements.
Vessels	Vessels of a range of size classes, specifications and capabilities, from small landing craft and tender vessels up to Platform Support Vessels	Master contracts exist between CAPL and selected vessel providers, with ability to provide all types of survey vessel that may be required under this Plan. Vessel providers are managed by internal CAPL marine logistics experts.
Aircraft	Helicopters and fixed-wing aircraft in a range of size classes and capabilities	Master contracts exist between CAPL and aircraft providers (e.g. Bond helicopters and Cobham aviation). Aircraft providers are managed by internal CAPL aviation experts.
Transport networks	Road and air freight networks	External contractors provide warehousing, line-haul and marine freight services to ABU supply bases and assets, with the ability to scale up services as required.
Travel services	Domestic travel and related services for personnel and small equipment	CAPL has a contract with a corporate travel services business that provides 24-hour support for all personnel travel. Contact with the provider is through CAPL administrators.
Communications	Establishment of communications systems and networks	CAPL telecoms maintain internal capability to procure and deploy communications networks.
Quarantine	Quarantine advice, inspection, detection, response and monitoring	A comprehensive quarantine management system was developed for all freight and personnel movements to/from Barrow Island. This process is administered via the CAPL Supply Chain Management team and, to varying degrees, can be applied to any freight/personnel movements, regardless of the destination. The quarantine management system is managed by internal CAPL experts, with inspection services undertaken by contractors.

2.4 Testing and Verifying Capability

System-level measures (e.g. internal audits, exercises, workshops) test and verify capability and readiness; exercising the OSMP is included in the ABU multi-year exercise schedule. Outcomes from these measures is used for continual improvement.

2.4.1 Compliance Assurance

Compliance Assurance (Ref. 5) is an element of the CAPL OEMS. This process manages compliance by verifying conformance with Operational Excellence requirements in applicable company policy, government laws, and regulations. This process has two key supporting procedures, as detailed below.

2.4.1.1 Compliance Assurance Audit Program

This procedure (Ref. 6) establishes internal audit programs to verify the effectiveness of controls and the extent to which requirements are met by CAPL. Audits may focus on in-field activities or administrative processes depending on the activities being undertaken around the time of audit. A record of audits and the audit outcomes is maintained, and actions arising from internal audits are tracked until closure, in accordance with Section 2.4.1.2.

2.4.1.2 Compliance Assurance Management of Instances of Potential Non-compliance

This procedure (Ref. 7) addresses instances where the requirements may not have been fully met. If findings are identified during internal audits, corrective actions are identified, assigned, and recorded in Essential Suite, which is a Chevron-wide database that sends notifications and follow-up emails to the responsible person for timely closure of audit actions.

2.5 Providing Information and Consulting with Stakeholders

External notification and reporting to regulators, Hazard Management Authorities, and key stakeholders is outlined in the relevant OPEP. The EMT coordinates ongoing communications with stakeholders, via embedding a Policy, Government and Public Affairs (PGPA) representative in the EMT to provide ongoing advice to, and coordination of, stakeholders (e.g. DoT, DBCA, Australian Maritime Safety Authority [AMSA]) or via regular verbal or written communications. The PGPA Officer also coordinates generic communications (e.g. key messaging) with relevant non-regulatory stakeholders through the ABU Communications Response Team.

The ABU HES Supervisor – Environment Technical (or delegate) is the focal point for communication and consultation of a technical scientific nature. This position consults with relevant government stakeholders on monitoring design and priorities, specifically with respect to state marine parks. Claims or objections raised by government stakeholders will be responded to, including communication of changes made to monitoring programs as a result of consultations. Similarly, this role is also responsible for communicating results of monitoring programs. The form, frequency, and content of communications will be appropriate to the nature and scale of the incident.

2.6 Reviewing this Plan

CAPL is committed to conducting activities in an environmentally responsible manner and aims to implement best practice environmental management as part of a program of continuous improvement. This commitment to continuous improvement means that CAPL will review this Plan every five years or more often as required (e.g. in response to new information). Internal processes linked to implementation of this Plan may be reviewed more frequently.

Reviews will address matters such as the overall design and effectiveness of the Plan, progress in environmental performance, changes in environmental risks, changes in business conditions, opportunities for improvement identified from inspections, audits, exercises, and any relevant emerging environmental issues.

3 Environmental Monitoring Framework

3.1 Overview

This Plan provides a flexible framework for implementing operational and scientific monitoring, thus allowing adaption to the nature and scale of a specific oil spill event. This Plan lists possible types of sampling and analyses that may be undertaken, allowing for the detailed final design (including selection of sample sites, monitoring priorities, methods, analytes etc.) to be confirmed once an event has occurred. This Plan is linked to the MES component of a spill response, as described in the relevant OPEP and the ABU Oil Spill Response Manual (Ref. 1).

The Plan comprises two types of monitoring:

- Operational – to collect information about the oil spill and associated response options to aid planning and decision making in executing spill response or clean-up operations
- Scientific – to determine the short- and long-term environmental impact of the oil spill and associated responses, and inform the requirements for remediation.

Both types of monitoring comprise several components. Each component represents a discrete assessment or study, with tailored initiation and termination triggers to determine if, and when, that monitoring component will be implemented. In some cases the criteria are fixed; others are linked to the relevant OPEP. Despite the individual initiation/termination criteria, the components are inextricably linked, both across and within the two types of monitoring.

Typically, operational monitoring is initiated by the spill event itself, through MES information collected during the response, or by implementation of a response option. Operational monitoring usually finishes when the spill response is terminated, usually because response objectives were met and/or scientific monitoring was initiated.

Specific components of scientific monitoring are triggered by the spill itself, while others are triggered by data generated by MES and operational monitoring. Scientific monitoring may occur in parallel to operational monitoring and can continue for some time after the oil spill event. Either type of monitoring may occur in areas impacted by the spill, areas not yet impacted by the spill (to gather pre-impact data), and areas not likely to be impacted by the spill (to act as reference or control data).

Figure 3-1 summarises how operational and scientific monitoring relates to oil spill response. The Quick Reference Guide at the front of the document summarises the initiation criteria, termination criteria, and time frames for implementation, while Sections 4 and 5, and Appendix B and Appendix C provide further details for each monitoring component.

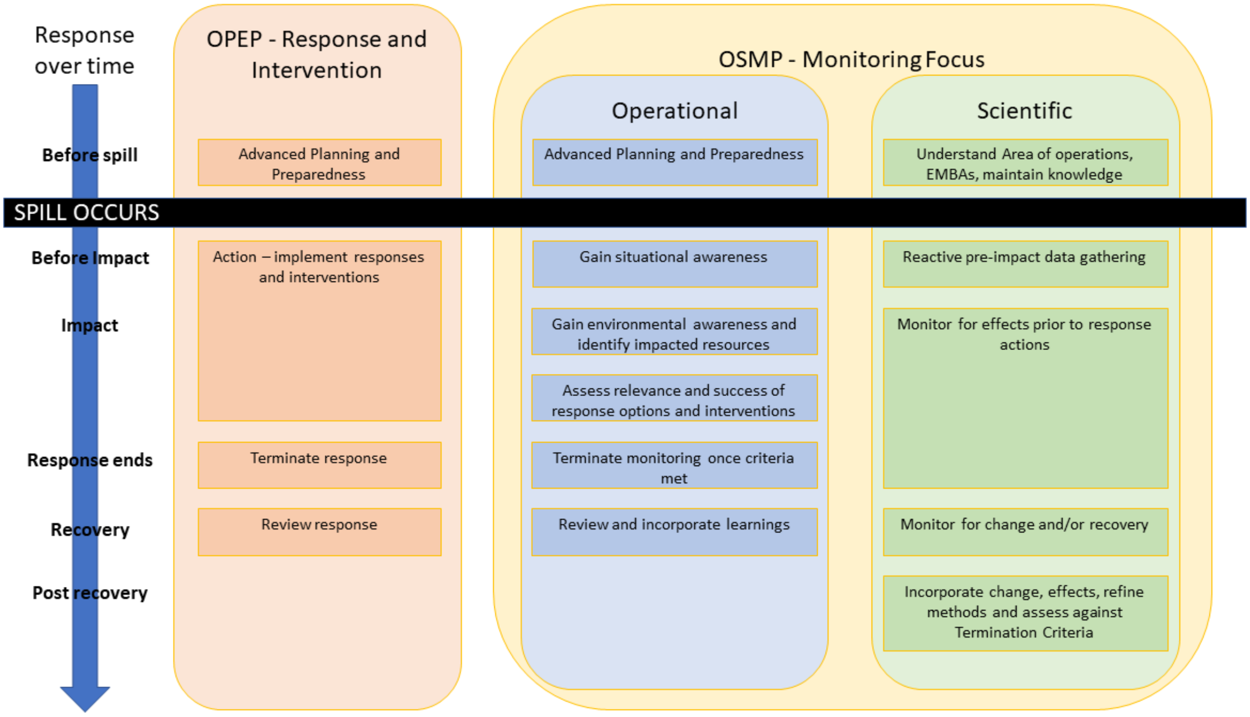

Figure 3-1: Oil Spill Response and Role of Operational and Scientific Monitoring

3.2 Design and Implementation

In the event of a spill to marine or coastal waters, advance planning and pre-mobilisation activities commence in anticipation of initiating monitoring components; these activities include consultation with stakeholders on monitoring design and priorities, as appropriate to the nature and scale of the spill (see Section 2.5).

Once a component of operational or scientific monitoring is triggered, a series of steps, beginning with preparing the final program design, is implemented (Figure 3-2). Each spill event is unique, and therefore the receptors at risk, selection of sites, and implemented monitoring programs will vary between each event.

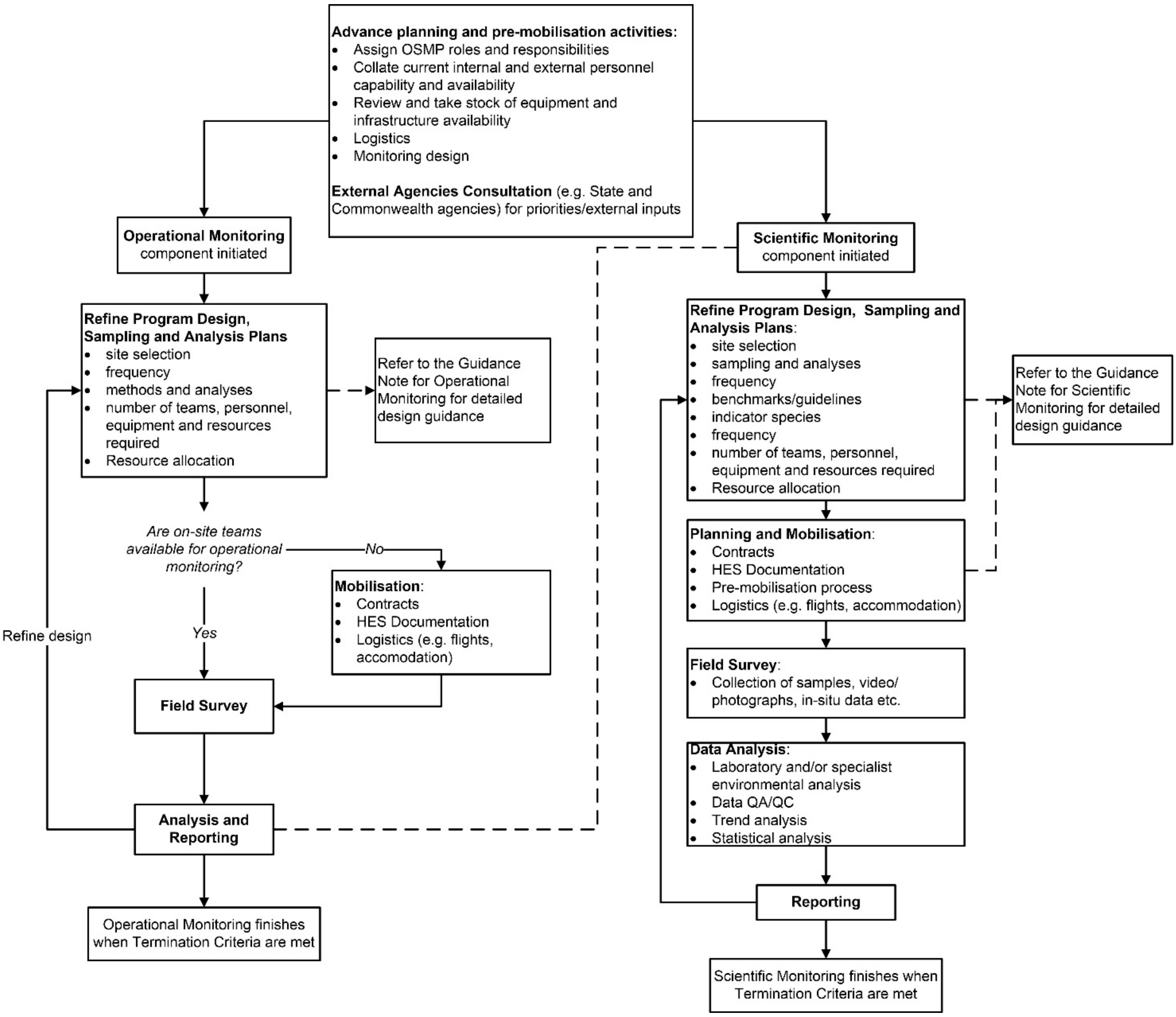

Figure 3-2: Implementation Process for Operational and Scientific Monitoring

Monitoring design is different for the two types of monitoring; however, the methods to obtain the data may be common between monitoring types. Operational monitoring focuses on informing planning and decision making in executing spill response; therefore, the objectives of this monitoring are closely linked to the MES tactics and response options used. Scientific monitoring focuses on determining the short- and long-term impacts; therefore, the main objective of this monitoring is to establish cause and to quantify effects.

Regardless of the monitoring type, common elements of designing a monitoring program include:

- clarify how the monitoring information will be used
- set the objectives of the study – what does the program seek to measure (e.g. descriptive; measurement of change; determination of cause and effect)
- define the parameters to include in monitoring
- define the spatial boundaries of the study

- identify monitoring priorities
- determine the most effective allocation of available resources.

3.2.1 Operational Monitoring

The Guidance Note and Standard Operating Procedures for Operational Monitoring (Appendix B) provides fine-level detail aimed at environmental personnel who implement operational monitoring components, including:

- implementation considerations
- a framework for finalising program design so that it is appropriate to the nature and scale of the event
- resources required to implement the monitoring
- descriptions of standard operating procedures to undertake the sampling required, including field sheets and checklists.

Where practicable, operational monitoring standard operating procedures are aligned with existing processes, including:

- DoT oiled shoreline assessment
- Special Monitoring of Applied Resource Technologies (SMART) protocol (Ref. 8) and the American Petroleum Institute (API) Subsea Dispersant Monitoring method (Ref. 9) for dispersants
- AMSA sampling guides (Ref. 10).

3.2.2 Scientific Monitoring

The Guidance Note and Standard Operating Procedures for Scientific Monitoring (Appendix C) is aimed at environmental personnel implementing scientific monitoring components. The guidance note includes:

- implementation considerations
- a framework for finalising program design so that it is appropriate to the nature and scale of the event
- resources required to implement the monitoring
- descriptions and guidance on various experimental monitoring approaches that can be applied to monitor various receptors (e.g. Before-After-Control-Impact, impact vs control, gradient of impacts, lines of evidence, control charts), taking into consideration existing baseline data and current monitoring techniques
- guidance on effects size and power to detect change
- descriptions of standard operating procedures to undertake the sampling required, including field sheets and checklists.

Selection of the survey design(s) will depend on these criteria:

- the scale and pattern of potential effects of the spill
- availability of baseline data and/or ability and time frame to rapidly obtain pre-spill data
- availability of OPS data

- availability of appropriate reference sites
- statistical approach proposed to analyse the data
- the range of possible chronic and acute effects on the parameters of concern, based on the characteristics of the spill
- monitoring frequency required to ensure short-and long-term impacts are detected
- legislative requirements
- available resources and equipment to conduct the work in terms of personnel, logistics, and access

To ensure the application of robust designs and sampling approaches that have the highest likelihood of detecting an environmental impact while allowing suitable flexibility, these guiding principles have been adopted:

- align with existing baseline sampling design and methods wherever possible to maximise data comparability
- allow for appropriate spatial and temporal replication to account for natural dynamics in the system
- use exposure gradients where appropriate
- use indicator taxa where appropriate
- use benchmarks where appropriate (see further information below)
- assess statistical power (if relevant).

If benchmarks[5] are relevant in the scientific studies, they will be selected taking into consideration trigger values that have already been established (e.g. Ref. 11, Ref. 12, Ref. 13, Ref. 14) or if appropriate, follow the process as outlined in Ref. 11 to develop a relevant benchmark value. If several levels of protection are available (e.g. Ref. 11), the 95% species protection level will be adopted, except in areas where a higher (99%) protection level is appropriate (e.g. marine parks, undisturbed ecosystems) or, conversely, a lower (80% or 90%) protection level is appropriate (e.g. highly disturbed ecosystems, defined low ecological protection areas).

3.3 Identifying Monitoring Priorities

Priorities for monitoring will be specific to the nature and scale of the event and will change throughout the duration of the monitoring effort. Factors to be considered when setting monitoring priorities include:

- presence of sensitive ecological and social receptors within the EMBA and protection prioritisation of those receptors
- predicted time until sensitive receptors are exposed to hydrocarbons
- availability of baseline data and/or ability and time frame to rapidly obtain pre-spill data
- availability of appropriate reference sites

[5] Benchmarks are used to describe concentrations above which there is the possibility of risk to the environmental receptor.

- statistical approach proposed to analyse the data
- available resources and equipment to conduct the work in terms of personnel, logistics, and access

3.3.1 Sensitive Receptors

CAPL has a process for identifying and ranking ecological and social receptors that are sensitive to oil spills, including: shoreline types; marine habitats; marine, coastal and terrestrial species. This process is described in the ABU Oil Spill Protection Prioritisation Process (Ref. 15), and is generally aligned with the Western Australian (WA) Department of Transport (DoT) Protection Prioritisation Process (Ref. 16).

CAPL's Protection Prioritisation Process for the North West Shelf consists of seven broad steps. In summary, the steps are:

1. Determine the Environment that May Be Affected (EMBA) by an oil spill using modelling
2. Identify ecological and socio-economic receptors present in the EMBA by gathering available geospatial data and information from industry, government bodies and monitoring/research projects
3. Use literature and research data to determine the sensitivity of the various receptors to the effects of oil
4. Rank each receptor according to its sensitivity to oil and display the rankings geospatially
5. Review deterministic oil modelling runs used for response planning assessment.
6. Overlay the results on PP geospatial data
7. List the highest value PPs

Steps 1 to 4 are done during the planning stage, while steps 5 to 7 are undertaken following an oil spill.

The ecological and socioeconomic values and sensitivities known to occur with the EMBA of each activity are defined in the activity-specific EPs. A Description of the Environment, which includes a summary of the values and sensitivities relevant to CAPL's North West Shelf Activities, is provided in Appendix A.

These values and sensitivities identified within the EMBA are used to assist CAPL in identifying the appropriate response strategies to implement through the application of a Net Environmental Benefit Analysis (NEBA). NEBA is way to compare the net environmental benefits associated with multiple management alternatives. Used both prior to a spill occurring (Strategic NEBA) and after a spill (Operational NEBA), NEBA is the process of considering advantages and disadvantages of different spill response options (including no response) to arrive at a spill response decision that results in the lowest overall environmental and social impacts. Operational Monitoring data will contribute to on-going Operational NEBAs by providing information relevant to understanding the feasibility and effectiveness of the response options being carried out.

3.3.1.1 Ecological

The alignment of sensitive environmental receptors, relevant to CAPL's North West Shelf Activities, and the operational and scientific monitoring components is provided in Appendix A.

3.3.1.2 Socioeconomic

The Commonwealth and State regulations (outlined in Section 1.1) define the 'environment' to mean ecosystems and their constituent parts, natural and physical resources, qualities and characteristics of areas, the heritage value of places, and the socioeconomic and cultural features of those matters.

For this Plan, a direct cause-effect pathway needs to be identified to allow for the successful monitoring of any potential significant impact. Direct monitoring of shipwrecks is addressed by SCI8; however, CAPL considers that the ecological impacts of an oil spill are suitable as a substitute measure of any potential significant impact on the remainder of socioeconomic and heritage features, including heritage features protected by the EPBC Act. CAPL has identified seven categories of socioeconomic and heritage features; the justification for the inclusion/exclusion of additional monitoring for these features is provided in Appendix A.

If the monitoring of ecological receptors indicates that a potential significant impact to socioeconomic and/or heritage features may occur, then CAPL will liaise with suitably qualified archaeologists, including relevant CAPL Aboriginal engagement representatives, to document accurate records, including map references, photographs, and descriptions of the material from in situ evaluations. Similarly, CAPL will liaise with relevant statutory bodies (i.e. government heritage and tourism agencies, Aboriginal affairs agency, fisheries and maritime agencies) to incorporate aspects of monitoring into operational and scientific monitoring programs, or if impacts have occurred, to determine an appropriate management action (e.g. in regards to temporary closures) and termination criteria. Refer to Section 2.5 for further details.

3.4 Resource Allocation

Responding to the spill itself often involves scaling of resources to effectively manage the spill. This is also the case with operational and scientific monitoring. Whilst a predicted worst-case scenario is planned for, each spill will be unique in terms of trajectory, required logistics (e.g. access, communications) and presence of sensitive receptors.

In the initial hours and days after a spill has been reported, the Environment Unit Lead (EUL) ensures the relevant operational monitoring components are commenced within the timeframes specified in the relevant OPEP and/or OSMP. The EUL works with the Operations Section Chief and OSMP Monitoring Coordinator to determine the most appropriate location and distribution of the available monitoring teams using the common operating picture (COP) and operational net environmental benefit analysis (NEBA) results.

The location and distribution of the monitoring teams in the initial stages of the spill will be influenced by the ecosystem components most at risk of impact from the spill. For example, if the spill is a considerable distance offshore and COP data indicates no shoreline contact is expected for a number of days, then the EUL may determine that the most appropriate resourcing strategy would be to direct the monitoring teams to focus on OPS1: oil characterisation and OPS3: oil in water assessment close to the spill source. However, once dispersant is applied, it may be necessary to divert some resources to conduct OPS2: chemical dispersant efficacy assessment, OPS3: oil in sediment assessment and SCI6: Benthic Habitat Impact Study, as the oil becomes more entrained into the water column.

The ABU OSMP Capability Register (Ref. 3) documents the skills and competency of personnel who may be called upon for monitoring activities. Many personnel are capable of performing a number of different roles, so that the OSMP structure is flexible enough to suit the nature and scale of the incident. The flexibility of monitoring teams is important to ensure resources can be directed towards the most relevant monitoring component.

Once the location and distribution of monitoring teams has been agreed, it is stated in the monitoring section of the EMTs Incident Action Plan (IAP). The Operational and Scientific Monitoring Coordinators appoint Technical Advisors for each monitoring component and work with them to finalise sampling and analysis plans. Data generated during the current operational period should be communicated directly back to the EMT via the EUL. This information is important to ensure the EMT make informed decisions around the allocation of resources for response activities and monitoring activities for the next operating period.

If the spill response is ongoing, additional resources to conduct operational and scientific monitoring will be scaled in. It is also possible that some OPS components will be replaced by SCI components, depending upon whether termination and initiation triggers have been met.

4 Operational Monitoring

4.1 Overview

Operational monitoring provides information for use in EMT response planning and decision making by measuring the impacts and effectiveness of response options. As such, operational monitoring needs to be able to provide data within a time frame relevant to the Incident Action Plan cycle. Operational monitoring can also provide information that can initiate components of the scientific monitoring program, where applicable (see Section 5).

The components of the operational monitoring program are:

- OPS1: Oil Characterisation
- OPS2: Chemical Dispersant Efficacy Assessment
- OPS3: Oil in Water Assessment
- OPS4: Oil in Sediment Assessment
- OPS5: Rapid (Oiled) Shoreline Assessment
- OPS6: Rapid Seabird and Shorebird Assessment
- OPS7: Rapid Marine Megafauna Assessment
- OPS8: Fish Tainting Assessment.

Appendix B contains the full suite of operational monitoring components listed above. Each plan provides fine detail aimed at personnel who implement operational monitoring components, including:

- Monitoring rationale;
- A framework for finalising program design so that it is appropriate to the nature and scale of the event;
- Resources required to implement the monitoring; and
- Descriptions of standard operating procedures to undertake the sampling required, including checklists.

Where practicable, the standard operating procedures are aligned with existing standards and processes, including:

- Department of Transport (Western Australia) oiled shoreline assessment (Ref. 17)
- Special Monitoring of Applied Resource Technologies (SMART) protocol for dispersants (Ref. 18).
- CSIRO Oil Spill Monitoring Handbook (Ref. 19)
- AMSA sampling guides (Ref. 20)
- ANZECC Guidelines (Ref. 11)
- Revised ANZECC/ARMCANZ Sediment Quality Guidelines (Ref. 21).

OPS components may be implemented concurrently with each other, and/or in conjunction with response activities such as Monitoring, Evaluation and Surveillance (MES) tactics described in the relevant OPEP. Examples of such synergies include:

- Complete aspects of OPS6 and OPS7 during aerial observation (MES)
- Complete OPS1, OPS2, OPS3, OPS4, OPS6 and OPS7 during vessel observation (MES)
- Deploy a tracking buoy, complete shoreline assessment and visual observations (MES) whilst implementing OPS1, OPS3, OPS4 and OPS5

Depending on the size and nature of the spill, OPS components may need to be implemented multiple times, or continuously, during the spill response; the frequency will be based on the data needs of the EMT.

Further to the initiation criteria specified for each operational monitoring component, Table 4-1 identifies operational monitoring components that may be triggered for the different response options and support functions.

Table 4-1: Operational Monitoring Components Used to Monitor and Inform Response Options and Activities

Response Option	Operational Monitoring Component							
	OPS1	OPS2	OPS3	OPS4	OPS5	OPS6	OPS7	OPS8
Source Control – Well Capping	X		X	X				
Source Control – Diverter/Shut-off Valves	X		X					
Natural Recovery and Assisted Natural Dispersion	X		X					X
Dispersant Application	X	X	X					X
Containment and Recovery	X							
Shoreline Protection	X		X	X	X			
Shoreline Clean-up	X		X	X	X			
Oiled Wildlife (Support Function)	X					X	X	
Waste Management (Support Function)	X		X	X	X	X	X	X
OPS1: Oil Characterisation	*OPS5: Rapid (Oiled) Shoreline Assessment*							
OPS2: Chemical Dispersant Efficacy Assessment	*OPS6: Rapid Seabird & Shorebird Assessment*							
OPS3: Oil in Water Assessment	*OPS7: Rapid Marine Megafauna Assessment*							
OPS4: Oil in Sediment Assessment	*OPS8: Fish Tainting Assessment*							

Note: This table displays the response options and the corresponding operational monitoring component that will be used to monitor and inform that option during the response. For example, the 'shoreline clean-up' response option is monitored through OPS1, OPS3, OPS4, and OPS5

4.2 OPS1: Oil Characterisation

Overview	OPS1 provides the EMT with the chemical properties of the released oil.
Initiation Criteria	Activation of this Plan
Implementation Time	• Preparation to deploy field personnel and equipment will commence upon initiation • Implementation will be achieved within 72 hours of initiation
Aim	Provide quantitative information on the chemical properties of the oil to assist the EMT in selecting the most effective response option(s).
Monitoring Approach	**Sampling**: • Collect spilt oil sample **Analysis**: • Chemical characterisation • Toxicological (if required) analysis **Reporting and/or data**: • To be provided to the EMT Incident Commander (or delegate) once available.
Termination Criteria	• The EMT Incident Commander (or delegate) has advised that agreement has been reached with the Jurisdictional Authority relevant to the spill to terminate the response; or • OPS1 is no longer contributing to or influencing spill response decision making, and • All data required by the EMT Incident Commander (or delegate) are received.

4.3 OPS2: Chemical Dispersant Efficacy Assessment

Overview	OPS2 provides the EMT with information on the efficacy of the chemical dispersant applied to the spilt oil.
Initiation Criteria	The EMT has decided to apply dispersant as a response option.
Implementation Time	Within 24 hours of initiation
Aim	To provide rapid information on the efficacy of dispersant as a response option.
Monitoring Approach	**Sampling**: • Surface chemical dispersant: SMART Protocol • Subsurface chemical dispersant: API method **Analysis**: • On-site and/or laboratory analysis of hydrocarbon and dispersant presence and state (e.g. concentration, oil droplet size) **Reporting and/or data**: • To be provided to the EMT Incident Commander (or delegate) once available.
Termination Criteria	• The EMT Incident Commander (or delegate) determines that continuing OPS2 monitoring will not result in a change to the scale or location of active response options; or • The EMT Incident Commander (or delegate) has advised that agreement has been reached with the Jurisdictional Authority relevant to the spill to terminate the response; or • The Monitoring Coordinator (or delegate) determines that continuing OPS2 monitoring is likely to increase overall environmental impact.

4.4 OPS3: Oil in Water Assessment

Overview	OPS3 provides the EMT with ongoing information on the water quality, particularly the oil content, within the response areas.
Initiation Criteria	Activation of this Plan
Implementation Time	• Preparation to deploy field personnel and equipment will commence upon initiation • Implementation will be achieved within 72 hours of initiation
Aim	The key component of this monitoring program is collecting data on the effects of the spill and response options on water quality.
Monitoring Approach	**Sampling**: • In situ water quality monitoring • Surface and subsurface sampling (if required). **Analysis**: • Data analysis to look for oil signatures from in situ data • Chemical characterisation of samples • Compare hydrocarbon characteristics to results of released oil from OPS1 • Assess bioavailability of oil **Reporting and/or data**: • To be provided to the EMT Incident Commander (or delegate) once available.
Termination Criteria	• The EMT Incident Commander (or delegate) determines that continuing OPS3 monitoring will not result in a change to the scale or location of active response options; or • The EMT Incident Commander (or delegate) has advised that agreement has been reached with the Jurisdictional Authority relevant to the spill to terminate the response; or • The Monitoring Coordinator (or delegate) determines that continuing OPS3 monitoring is likely to increase overall environmental impact; and – OPS3 monitoring has provided sufficient data to assess initiation of scientific monitoring components.

4.5 OPS4: Oil in Sediment Assessment

Overview	OPS4 provides the EMT with ongoing information on the sediment quality, particularly the oil content, within the response areas.
Initiation Criteria	Modelling and/or analysis of data from MES predicts an exposure of oil to marine and/or coastal sediment.
Implementation Time	• Preparation to deploy field personnel and equipment will commence upon initiation • Implementation will be achieved within 5 days of initiation
Aim	The key component of this monitoring program is collecting data on the exposure of sediments to oil and any effect of response activities on sediment quality.
Monitoring Approach	**Sampling**: • Collect push cores and/or grab samples • Surface and subsurface sampling (if required) **Analysis**: • Chemical characterisation of samples • Compare hydrocarbon characteristics to results of released oil from OPS1 • Assess bioavailability of oil **Reporting and/or data**: • To be provided to the EMT Incident Commander (or delegate) once available.
Termination Criteria	• The EMT Incident Commander (or delegate) determines that continuing OPS4 monitoring will not result in a change to the scale or location of active response options; or • The EMT Incident Commander (or delegate) has advised that agreement has been reached with the Jurisdictional Authority relevant to the spill to terminate the response; or • The Monitoring Coordinator (or delegate) determines that continuing OPS4 monitoring is likely to increase overall environmental impact; and – OPS4 monitoring has provided sufficient data to assess initiation of scientific monitoring components.

4.6 OPS5: Rapid (Oiled) Shoreline Assessment

Overview	OPS5 provides the EMT with ongoing information on: • the state (e.g. habitat type, extent of oiling) of shorelines within the predicted trajectory of the oil spill or that have been exposed • any observed impacts to shorelines and associated habitats from response activities • the effectiveness of clean-up activities. The geographic scope of OPS5 is the region above lowest astronomical tide (LAT) to the supratidal zone.
Initiation Criteria	Modelling and/or analysis of data from MES predicts an exposure of oil to shoreline habitat
Implementation Time	Within the response times for oiled shoreline assessment, as described in the relevant OPEP.
Aim	To assess the state of shoreline habitats, to identify the presence and extent of oil, and to assess impacts of response activities through shoreline assessments.
Monitoring Approach	**Sampling**: • Oiled Shoreline Assessment **Analysis**: • Not applicable **Reporting and/or data**: • To be provided to the EMT Incident Commander (or delegate) once available.
Termination Criteria	• The EMT Incident Commander (or delegate) determines that continuing OPS5 monitoring will not result in a change to the scale or location of active response options; or • The EMT Incident Commander (or delegate) has advised that agreement has been reached with the Jurisdictional Authority relevant to the spill to terminate the response; or • The Monitoring Coordinator (or delegate) determines that continuing OPS5 monitoring is likely to increase overall environmental impact; and – OPS5 monitoring has provided sufficient data to assess initiation of scientific monitoring components.

4.7 OPS6: Rapid Seabird and Shorebird Assessment

Overview	OPS6 provides the EMT with initial and ongoing information as to the presence and condition of seabirds and shorebirds within the predicted trajectory of the oil spill.
Initiation Criteria	Modelling and/or analysis of data from MES predicts/confirms an exposure of oil to seabirds, shorebirds or shorelines known to support seabird and shorebird populations and/or habitat.
Implementation Time	• Preparation to deploy field personnel and equipment will commence upon initiation • Implementation will be achieved within 48 hours of initiation. Initially, OPS6 monitoring may be implemented during MES activities.
Aim	To provide rapid quantification of the presence and state of seabirds and shorebirds, their use (e.g. breeding, nesting, foraging) of areas predicted to be impacted or have been impacted by the oil spill, and to assess the impacts of response activities on seabirds and shorebirds.
Monitoring Approach	**Sampling**: • Rapid surveillance surveys (ground, aerial, and/or vessel) **Analysis**: • Not applicable **Reporting and/or data**: • To be provided to the EMT Incident Commander (or delegate) once available.
Termination Criteria	• The EMT Incident Commander (or delegate) determines that continuing OPS6 monitoring will not result in a change to the scale or location of active response options; or • The EMT Incident Commander (or delegate) has advised that agreement has been reached with the Jurisdictional Authority relevant to the spill to terminate the response; or • The Monitoring Coordinator (or delegate) determines that continuing OPS6 monitoring is likely to increase overall environmental impact; and – OPS6 monitoring has provided sufficient data to assess initiation of scientific monitoring components.

4.8 OPS7: Rapid Marine Megafauna Assessment

Overview	OPS7 provides the EMT with initial and ongoing information as to the presence of marine megafauna within the predicted trajectory of the oil spill.
Initiation Criteria	Modelling and/or analysis of data from MES predicts an exposure of oil to known sensitive marine megafauna habitat.
Implementation Time	• Preparation to deploy field personnel and equipment will commence upon initiation • Implementation will be achieved within 48 hours of initiation. Initially, OPS7 monitoring may be implemented during MES activities.
Aim	To rapidly quantify the presence, state, and type of marine megafauna and their use (e.g. migrating, foraging) of areas predicted to be impacted or that have been impacted by the oil spill.
Monitoring Approach	**Sampling**: • Rapid surveillance surveys (aerial and/or vessel) **Analysis**: • Not applicable **Reporting and/or data**: • To be provided to the EMT Incident Commander (or delegate) once available.
Termination Criteria	OPS7 should be implemented until these termination triggers are met: • The EMT Incident Commander (or delegate) considers that continuing OPS7 monitoring will not result in a change to the scale or location of active response options; or • The EMT Incident Commander (or delegate) has advised that agreement has been reached with the Jurisdictional Authority relevant to the spill to terminate the response; or • The Monitoring Coordinator (or delegate) considers that continuing OPS7 monitoring is likely to increase overall environmental impact; and – OPS3 monitoring has provided sufficient data to assess initiation of scientific monitoring components.

4.9 OPS8: Fish Tainting Assessment

Overview	Monitoring undertaken to better manage fisheries, public, or media concerns relating to potential effects of the spill or response activities.
Initiation Criteria	Modelling and/or analysis of data from MES predicts an exposure of oil to known fisheries.
Implementation Time	• Preparation to deploy field personnel and equipment will commence upon initiation • Implementation will be achieved within 5 days of initiation.
Aim	The key component of this monitoring program is collecting data on the effects of the spill and response options on pelagic and benthic fish species.
Monitoring Approach	**Sampling**: • Collect samples of target fish species • Benthic and pelagic species **Analysis**: • Determine if oil tainting is present • Determine if dispersed/entrained oil has tainted fish (only applicable if dispersant used as a response option) **Reporting and/or data**: • To be provided to the EMT Incident Commander (or delegate) once available.
Termination Criteria	• The EMT Incident Commander (or delegate) considers that continuing OPS8 monitoring will not result in a change to the scale or location of active response options; or • The EMT Incident Commander (or delegate) has advised that agreement has been reached with the Jurisdictional Authority relevant to the spill to terminate the response; or • The Monitoring Coordinator (or delegate) considers that continuing OPS8 monitoring is likely to increase overall environmental impact; and – OPS8 monitoring has provided sufficient data to assess initiation of scientific monitoring components.

5 Scientific Monitoring

5.1 Overview

Scientific monitoring focuses on short-and long-term environmental impact assessments. The scientific monitoring implemented will be appropriate to the scale, location, and duration of the oil spill and only the relevant components (determined by the receptors exposed) will be implemented. CAPL will engage experts (internal or external) specific to each study scope as required.

The components of the scientific monitoring program are:

- SCI1: Water Quality Impact Study
- SCI2: Sediment Quality Impact Study
- SCI3: Coastal and Intertidal Habitat Impact Study
- SCI4: Seabird and Shorebird Impact Study
- SCI5: Marine Megafauna Impact Study:
  - SCI5a: Marine Reptiles
  - SCI5b: Pinnipeds
  - SCI5b: Other Marine Megafauna.
- SCI6: Benthic Habitat Impact Study
- SCI7: Fish Effects Impact Study:
  - SCI7a: Fishery and Aquaculture Impact Study
  - SCI7b: Fish Impact Study.
- SCI8: Heritage (including Shipwrecks)

Appendix C contains the full suite of scientific monitoring plans listed above. Each plan provides fine detail aimed at environmental personnel who will implement the scientific monitoring components, including:

- A framework for finalising program design so that it is appropriate to the nature and scale of the event;
- Resources required to implement the monitoring;
- Descriptions and guidance on various experimental monitoring approaches that can be applied to monitor various receptors taking into consideration existing baseline data and current monitoring techniques; and
- Descriptions of standard operating procedures to undertake the sampling required, including checklists.

These components are presented separately below; however, in practice they may be carried out simultaneously, and monitoring may commence while response activities are still occurring.

5.2 SCI1: Water Quality Impact Study

Overview	The behaviour of the oil once released will vary depending on several factors, including sea temperature and weather conditions. Sampling of the oil in the water will provide quantitative data on the fate, weathering, and distribution of the oil. The geographic scope of SCI1 is the region offshore from the LAT.
Initiation Criteria	Activation of this Plan.
Implementation Time	Implementation will be achieved within 7 days of initiation
Aim	To assess water quality for oil and/or dispersant content against environmental benchmarks or natural variation.
Monitoring Approach	**Sampling**: • Conduct pre-impact surveys where possible • In situ water samples • Collect surface and subsurface samples **Analysis**: • Chemical analysis (hydrocarbon, dispersants [if used in the response] etc.) • Samples analysed by a National Association of Testing Authorities (NATA) accredited (where possible) laboratory **Reporting and/or data**: • To be provided to the OSMP Monitoring Coordinator and/or ABU HES Supervisor – Environment Technical (or delegate).
Termination Criteria	• There is no demonstrable impact on water quality from hydrocarbons/dispersants; or • Hydrocarbon and dispersed hydrocarbon concentrations in water are below relevant benchmarks or guideline values, or have returned to within the expected natural dynamics of baseline state and/or reference sites; or • Agreement has been reached with the relevant stakeholders and Jurisdictional Authorities to cease monitoring. Note: SCI1 may still be required by other SCI studies even after the termination criteria are reached.

5.3 SCI2: Sediment Quality Impact Study

Overview	Sampling of the oil in sediments will provide quantitative data on the fate, weathering, and distribution of the oil in sediments. The geographic scope of SCI2 is the region offshore from the LAT. The main concerns are the persistence of poly-aromatic hydrocarbons and total petroleum hydrocarbons.
Initiation Criteria	Operational monitoring (OPS4) has confirmed hydrocarbon concentrations are above: • relevant benchmarks or guideline values at the termination of the response option, or • baseline values at the termination of the response option.
Implementation Time	Implementation will be achieved within 7 days of initiation.
Aim	To assess sediment quality for oil and/or dispersant content against environmental benchmarks or natural variation.
Monitoring Approach	**Sampling**: • Conduct pre-impact surveys where possible • Collect push cores and/or grab samples • Surface and subsurface sampling (if required) **Analysis**: • Chemical analysis (hydrocarbon, dispersants [if used in the response] etc.) • Samples analysed by NATA-accredited (where possible) laboratory **Reporting and/or data**: • To be provided to the OSMP Monitoring Coordinator and/or ABU HES Supervisor – Environment Technical (or delegate).
Termination Criteria	• All hydrocarbon concentrations in sediments are below relevant benchmarks or guideline values or below baseline or reference site values, whichever is greater; or • No ongoing impacts to biological receptors can be linked to sediment quality, or • Agreement has been reached with the relevant stakeholders and Jurisdictional Authorities to cease monitoring Note: SCI2 may still be required by other SCIs even after the termination criteria are reached.

5.4 SCI3: Coastal and Intertidal Habitat Impact Study

Overview	SCI3 determines the extent, severity, and persistence of impacts on coastal and intertidal habitats and associated biological communities arising from a hydrocarbon spill and subsequence response activities.
Initiation Criteria	Operational monitoring (OPS3, OPS4), MES, or scientific monitoring (SCI1, SCI2) has predicted or confirmed exposure of coastal or intertidal habitats or communities to hydrocarbons.
Implementation Time	Implementation will be achieved within 7 days of initiation.
Aim	To assess impacts to coastal and intertidal habitats and associated biological communities as a consequence of an oil spill and associated response.
Monitoring Approach	**Sampling**: • Conduct pre-impact surveys where possible • State of habitats and associated biological communities (transects, quadrats) • Aerial imagery **Analysis**: • Percent cover, community composition, health/condition **Reporting and/or data**: • To be provided to the OSMP Monitoring Coordinator and/or ABU HES Supervisor – Environment Technical (or delegate).
Termination Criteria	• There has been no demonstrable impact to coastal and intertidal habitats and associated biological communities (confirmation that habitats and species were not exposed to hydrocarbons); or • Measures of coastal and intertidal habitats and associated biological communities have returned to within the expected natural dynamics of baseline state and/or reference sites, at areas that were impacted by hydrocarbons spills, or • The extent of damage and rate of recovery of key coastal and intertidal parameters has been quantified and agreement has been reached with the relevant stakeholders and Jurisdictional Authorities to cease monitoring.

1.1 SCI4: Seabird and Shorebird Impact Study

Overview	This scientific monitoring study is intended to determine the extent, severity, and persistence of impacts on seabirds and shorebirds from an oil spill.
Initiation Criteria	Operational monitoring (OPS6) has: • predicted or confirmed shoreline contact of hydrocarbons at important bird habitat location or known bird colonies, and/or • recorded dead, oiled, or injured bird species during the response phase.
Implementation Time	Implementation will be achieved within 7 days of initiation.
Aim	To identify and quantify the post-impact status and recovery of seabirds and shorebirds.
Monitoring Approach	**Sampling**: • Surveillance surveys (ground and/or aerial) • Fauna (e.g. tissue sampling, dead fauna collection) **Analysis**: • Community composition, abundance, health/condition • Necropsy and chemical analysis **Reporting and/or data**: • To be provided to the OSMP Monitoring Coordinator and/or ABU HES Supervisor – Environment Technical (or delegate).
Termination Criteria	• There has been no demonstrable impact on seabirds and/or shorebirds; or • Measured parameters of seabird and/or shorebird communities have returned to within the expected natural dynamics of baseline state or reference sites, within seabird or shorebird communities that have been impacted by hydrocarbon spills, or • The extent of damage and rate of recovery of key seabird and/or shorebird parameters has been quantified and agreement has been reached with the relevant stakeholders and Jurisdictional Authorities to cease monitoring.

5.5 SCI5: Marine Megafauna Impact Study

5.5.1 SCI5a: Marine Reptiles

Overview	This scientific monitoring study is intended to determine the extent, severity, and persistence of impacts on marine reptiles (turtles and sea snakes) from an oil spill. Monitoring will primarily focus on marine turtles, given sea snakes have a highly dispersed distribution that results in limited opportunities for monitoring.
Initiation Criteria	Operational monitoring (OPS7 or MES) has: • predicted or confirmed shoreline or habitat contact of hydrocarbons at important habitat locations for turtles (foraging and rookery) and sea snakes, or • recorded dead, oiled, or injured turtles or sea snakes during the response phase.
Implementation Time	Implementation will be achieved within 7 days of initiation.
Aim	To identify and quantify the post-impact status and recovery of marine reptiles.
Monitoring Approach	**Sampling**: • Surveillance surveys (aerial or vessel, i.e. field), including nesting sites • Fauna (e.g. tissue sampling, dead fauna collection) **Analysis**: • Presence of oil • Health/condition • Observed behaviour, abundance (counts), species identification • Nest characteristics • Necropsy and chemical analysis. **Reporting and/or data**: • To be provided to the OSMP Monitoring Coordinator and/or ABU HES Supervisor – Environment Technical (or delegate).
Termination Criteria	• There has been no demonstrable impact on turtles or sea snakes; or • Measured parameters of turtles (and sea snake communities if determined appropriate) have returned to within the expected natural dynamics of baseline state or reference sites, within turtle and sea snake communities that have been impacted by hydrocarbon spills; or • The extent of damage and rate of recovery of key parameters has been quantified and agreement has been reached with the relevant stakeholders and Jurisdictional Authorities to cease monitoring.

5.5.2 SCI5b: Pinnipeds

Overview	This scientific monitoring study is intended to determine the extent, severity, and persistence of impacts on pinniped populations (Australian Sea Lion *Neophoca cinerea*, New Zealand Fur Seal *Arctocephalus forsteri*, and the Australian Fur Seal *A. pusillus*, and other pinnipeds present) from an oil spill. Monitoring will focus on onshore populations (e.g. breeding colonies and haul-out sites). This is based on the priority of the life cycle stage (e.g. breeding), and that population estimates are generally based on onshore counts.
Initiation Criteria	Operational monitoring (OPS7 or MES) has: • predicted or confirmed contact of hydrocarbons at important habitat locations for pinnipeds (foraging, breeding colonies, and haul-out sites), or • recorded dead, oiled or injured pinnipeds during the response phase.
Implementation Time	Implementation will be achieved within 7 days of initiation.
Aim	To identify and quantify the post-impact status and recovery of pinnipeds.
Monitoring Approach	**Sampling**: • Surveillance surveys (vessel and/or aerial) • Fauna (e.g. tissue sampling, dead fauna collection) **Analysis**: • Health/condition • Observed behaviour, counts of abundance, population structure • Necropsy and chemical analysis **Reporting and/or data**: • To be provided to the OSMP Monitoring Coordinator and/or ABU HES Supervisor – Environment Technical (or delegate).
Termination Criteria	• There has been no demonstrable impact on pinnipeds; or • Measured parameters of pinniped populations have returned to within the expected natural dynamics of baseline state or reference sites, within pinnipeds that have been impacted by hydrocarbon spills; or • The extent of damage and rate of recovery of key parameters has been quantified and agreement has been reached with the relevant stakeholders and Jurisdictional Authorities to cease monitoring.

5.5.3 SCI5c: Other Marine Megafauna

Overview	This scientific monitoring study is intended to determine the extent, severity, and persistence of impacts on marine megafauna from an oil spill. Note: The understanding of abundance and distribution of many marine mammals (e.g. cetaceans and dugongs) and large cartilaginous fish (e.g. Whale Sharks) is often poor, making it difficult to assess potential impacts from oil spill incidents. The low density and mobility of these animals also makes it difficult to assess and quantify effects.
Initiation Criteria	SCI5c is triggered when operational monitoring (OPS7 or MES) has: • predicted or confirmed contact of hydrocarbons at important habitat locations for marine megafauna, or • recorded dead, oiled or injured megafauna during the response phase.
Implementation Time	Implementation will be achieved within 7 days of initiation.
Aim	To identify and quantify the post-impact status and recovery of marine megafauna.
Monitoring Approach	**Sampling**: • Surveillance surveys (vessel and/or aerial) • Fauna (e.g. tissue sampling, dead fauna collection) **Analysis**: • Presence of oil • Health/condition • Observed behaviour, abundance, community composition, population structure, track census counts • Necropsy and chemical analysis **Reporting and/or data**: • To be provided to the OSMP Monitoring Coordinator and/or ABU HES Supervisor – Environment Technical (or delegate).
Termination Criteria	• There has been no demonstrable impact on marine megafauna; or • Measured parameters of marine megafauna have returned to within the expected natural dynamics of baseline state or reference sites, within marine megafauna that have been impacted by hydrocarbon spills; • The extent of damage and rate of recovery of key parameters has been quantified and agreement has been reached with the relevant stakeholders and Jurisdictional Authorities to cease monitoring.

5.6 SCI6: Benthic Habitat Impact Study

Overview	This scientific monitoring program is designed to: • determine the extent, severity, and likely persistence of impacts to subtidal benthic habitats and associated biological communities arising from a hydrocarbon spill and subsequent response activities • collect information to determine short-and long-term (including direct and indirect) impacts of hydrocarbons (and implementation of response strategies) on benthic habitats and associated biological communities, post-spill and post-response recovery, remediation efforts, and areas where monitoring may need to continue for an extended time following termination of the response
Initiation Criteria	Operational monitoring (OPS3, OPS4), MES, or scientific monitoring (SCI1, SCI2) has predicted or confirmed exposure of subtidal benthic habitat or communities to hydrocarbons.
Implementation Time	Implementation will be achieved within 7 days of initiation.
Aim	To assess the impact on subtidal benthic habitat and biological communities as a consequence of an oil spill and associated response.
Monitoring Approach	**Sampling**: • Benthic habitat survey (e.g. photographed/video transects) • Fauna and flora (e.g. tissue sampling) **Analysis**: • Percent cover, community composition, health/condition, benthic grabs **Reporting and/or data**: • To be provided to the OSMP Monitoring Coordinator and/or ABU HES Supervisor – Environment Technical (or delegate).
Termination Criteria	• There has been no demonstrable impact to benthic habitat and communities (confirmation that benthic habitats were not exposed to hydrocarbons); or • Measures of benthic habitat and communities have returned to within the expected natural dynamics of baseline state or reference sites, at benthic areas that were impacted by hydrocarbon spills; or • The extent of damage and rate of recovery of key benthic habitat parameters has been quantified and agreement has been reached with the relevant stakeholders and Jurisdictional Authorities to cease monitoring.

5.7 SCI7: Fisheries and Fish Impact Study

5.7.1 SCI7a: Fisheries and Aquaculture Impact Study

Overview	This scientific monitoring study focuses on the direct effects of an oil spill on fish and aquaculture resources. Monitoring for the impact of the oil spill on fish health will be carried out using fish tissue sampling and analysis to ascertain direct contamination.
Initiation Criteria	Operational monitoring (OPS3, OPS4, OPS8), MES, or scientific monitoring (SCI1) has predicted or confirmed exposure to hydrocarbons of fishing areas, habitat for commercial fisheries, or active aquaculture leases.
Implementation Time	Implementation will be achieved within 7 days of initiation.
Aim	To monitor lethal and sublethal effects of oil spills on fish and aquaculture species.
Monitoring Approach	**Sampling**: • Fish physiological indicators and biochemical markers, fish tissue sample, including muscle, biopsy and gut contents, blood, bile, gonads, and dead fish counts **Analysis**: • Chemical analysis (e.g. hydrocarbon, dispersants [if used in the response] etc.), tainting **Reporting and/or data**: • To be provided to the OSMP Monitoring Coordinator and/or ABU HES Supervisor – Environment Technical (or delegate).
Termination Criteria	• There has been no demonstrable impacts on fish and aquaculture; or • Measured parameters of fish and aquaculture have returned to within the expected natural dynamics of baseline state or reference sites, within marine fisheries and aquaculture locations that have been impacted by hydrocarbon spills; or • The extent of damage and rate of recovery of key fisheries and aquaculture parameters has been quantified and agreement has been reached with the relevant stakeholders and Jurisdictional Authorities to cease monitoring.

5.7.2 SCI7b: Fish Impact Study

Overview	This scientific monitoring study focuses on the effects of an oil spill on fish population and abundance if a hydrocarbon spill impacts an area considered ecologically important for fish and fisheries resources.
Initiation Criteria	Operational monitoring (OPS3), MES, or scientific monitoring (SCI1) has predicted or confirmed exposure to fish areas or fish habitat to hydrocarbons.
Implementation Time	Implementation will be achieved within 7 days of initiation.
Aim	To monitor changes in fish population and abundance as a result of an oil spill and associated response.
Monitoring Approach	**Sampling**: • Population surveys (e.g. baited underwater video surveys, remotely operated vehicles [ROVs], towed camera) **Analysis**: • Community composition, abundance **Reporting and/or data**: • To be provided to the OSMP Monitoring Coordinator and/or ABU HES Supervisor – Environment Technical (or delegate).
Termination Criteria	• There has been no demonstrable impact on fish and fish population structure, or • Measured parameters of fish and fish habitat have returned to within the expected natural dynamics of baseline state or reference sites, within locations that have been impacted by hydrocarbon spills; or • The extent of damage and rate of recovery of key seabird and/or shorebird parameters has been quantified and agreement has been reached with the relevant stakeholders and Jurisdictional Authorities to cease monitoring.

5.8 SCI8: Heritage (including Shipwrecks)

Overview	This scientific monitoring study focuses on the effects of an oil spill on shipwrecks in areas considered to have heritage.
Initiation Criteria	MES, operational or scientific monitoring has predicted or confirmed exposure of shipwrecks to hydrocarbon or associated response activities.
Implementation Time	Implementation will be achieved within 7 days of initiation.
Aim	To monitor changes in shipwrecks as a result of an oil spill and associated response activities (e.g. anchoring and ROV disturbance).
Monitoring Approach	**Sampling**: • Surveys (e.g. ROV) **Analysis**: • Heritage attributes **Reporting and/or data**: • To be provided to the OSMP Monitoring Coordinator and/or ABU HES Supervisor – Environment Technical (or delegate).
Termination Criteria	SCI8 will be terminated when: • There has been no demonstrable impact on shipwrecks, or • Measured parameters of shipwrecks have been documented and no further change as a result of hydrocarbons or response activities is anticipated.

6 Acronyms and Abbreviations

Table 6-1 defines the acronyms and abbreviations used in this document.

Table 6-1: Acronyms and Abbreviations

Acronym / Abbreviation	Definition
ABU	Australian Business Unit
AMOSC	Australian Marine Oil Spill Centre
AMSA	Australian Maritime Safety Authority
API	American Petroleum Institute
BSc Hons	Bachelor of Science, with Honours
CAPL	Chevron Australia Pty Ltd
CRC	Cooperative Research Council
DoT	Western Australian Department of Transport
EMBA	Environment that May be Affected
Emergency Condition	As defined in each activity-specific EP and relevant OPEP
EMT	Emergency Management Team
EP	Environment Plan
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
HES	Health, Environment, and Safety
ICS	Incident Command System
IMG	Incident Management Guide
Implementation	Being ready, at the point of staging or departure, to mobilise for monitoring
Initiation/Termination	‘Or’ means only one of the possible options, ‘and’ means both need to occur before initiation/termination
LAT	Lowest Astronomical Tide
MES	Monitoring, Evaluation, and Surveillance
MS	Master of Science
NATA	National Association of Testing Authorities, Australia
NEBA	Net Environmental Benefit Analysis
OEMS	Operational Excellence Management System
OPEP	Oil Pollution Emergency Plan
OPS	Operational monitoring
OPS1	Oil Characterisation
OPS2	Chemical Dispersant Efficacy Assessment
OPS3	Oil in Water Assessment
OPS4	Oil in Sediment Assessment
OPS5	Rapid (Oiled) Shoreline Habitat Assessment
OPS6	Rapid Seabird and Shorebird Habitat Assessment
OPS7	Rapid Marine Megafauna Assessment

Acronym / Abbreviation	Definition
OPS8	Fish Tainting Assessment
ORT	On-site Response Team
OSMP	Operational and Scientific Monitoring Plan
PGPA	Policy, Government and Public Affairs
PhD	Doctor of Philosophy
QA/QC	Quality Assurance/Quality Control
ROV	Remotely Operated Vehicle
SCI	Scientific monitoring
SCI1	Water Quality Impact Study
SCI2	Sediment Quality Impact Study
SCI3	Coastal and Intertidal Habitat Impact Study
SCI4	Seabird and Shorebird Habitat Impact Study
SCI5	Marine Megafauna Impact Study
SCI6	Benthic Habitat Impact Study
SCI7	Fish Effects Impact Study
SCI8	Heritage (including shipwrecks)
Significant Impact	Defined as a moderate or higher consequence rating as per the Chevron Integrated Risk Prioritization Matrix. This aligns with ‘moderate to significant environmental damage’ as described in the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009; and to ‘moderate, or more serious than moderate environmental impact’ as described in the Western Australian Petroleum and Geothermal Energy Resources (Environment) Regulations 2012, Petroleum Pipelines (Environment) Regulations 2012, and the Petroleum (Submerged Lands) (Environment) Regulations 2012; as applicable.
SMART	Special Monitoring of Applied Resources Technologies
WA	Western Australia
WA ERA	WA Energy Research Alliance

7 References

The following documentation is either directly referenced in this document or is a recommended source of background information.

Table 7-1: References

Ref. No.	Description	Document ID
1.	ABU Oil Spill Response Manual (Chevron Australia, 2014)	OE-11.01.101
2.	Emergency Management Process – ABU Standardised OE Process (Chevron Australia, 2012)	OE-11.01.01
3.	ABU OSMP Capability Register (Chevron Australia)	ABU181001264
4.	ABU OSMP Capability Register – Resource Requirements Analysis (Chevron Australia)	
5.	ABU OE Compliance Assurance Process – ABU Standardised OE Process (Chevron Australia, 2014)	OE-12.01.01
6.	Compliance Assurance Audit Program – ABU Standardised OE Procedure (Chevron Australia, 2015)	OE-12.01.19
7.	Compliance Assurance Management of Instances of Potential Noncompliance – ABU Standardised OE Procedure	OE-12.01.18
8.	Special Monitoring of Applied Resource Technologies (SMART) protocol	
9.	Industry Recommended Subsea Dispersant Monitoring Plan, API Technical Report 1152 (American Petroleum Institute, 2013)	
10.	Oil Spill Monitoring Handbook (Commonwealth Scientific and Industrial Research Organisation, 2016)	
11.	Australian and New Zealand Guidelines for Fresh and Marine Water Quality (Australian and New Zealand Environment and Conservation Council/Agriculture and Resource Management Council of Australia and New Zealand, 2000).	
12.	Aquatic Life Benchmarks (United States Environmental Protection Authority, 2012). Available from: http://www.epa.gov/bpspill/water-benchmarks.html	
13.	National Assessment Guidelines for Dredging (Department of the Environment, Water, Heritage and the Arts, 2009).	
14.	Australia New Zealand Food Standards Code.	
15.	Chevron Australia. 2018. ABU Oil Spill Protection Prioritisation. Revision 1.0 Chevron Australia, Perth, Western Australia.	ABU180500232
16.	DoT 2017. DOT307215 Provision of Western Australian Marine Oil Pollution Risk Assessment – Protection Priorities. Protection Priority Assessment for Zone 2: Pilbara – Final Report. Report for the WA Department of Transport, Perth.	
17.	Department of Transport – Shoreline Assessment Form. Available at www.transport.wa.gov.au/	
18.	USCG *et al.* (2006). *Special Monitoring of Applied Response Technologies* (SMART). U.S. Coast Guard (USCG), National Oceanic and Atmospheric Administration (NOAA), U.S. Environmental Protection Agency (U.S. EPA), Centers for Disease Control and Prevention (CDC), Minerals Management Service (MMS).	

Ref. No.	Description	Document ID
19.	Hook, S., Batley, G., Holloway, M., Irving, P., and Ross, A. (2016). Oil Spill Monitoring Handbook. CSIRO, Clayton South. Authority (AMSA) and the Marine Safety Authority of New Zealand (MSA). Published by AMSA, Canberra.	
20.	AMSA (2003) Oil Spill Monitoring Handbook. Prepared by Wardrop Consulting and the Cawthron Institute for the Australian Maritime Safety Authority (AMSA) and the Marine Safety Authority of New Zealand (MSA). Published by AMSA, Canberra	
21.	Simpson SL, Batley GB and Chariton AA (2013). Revision of the ANZECC/ARMCANZ Sediment Quality Guidelines. CSIRO Land and Water Science Report 08/07. CSIRO Land and Water	

Appendix A North West Shelf Activities

Operational and Scientific Monitoring Plan

North West Shelf Activities

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Operational and Scientific Monitoring Plan
North West Shelf Activities

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Approvals

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Contents

Tables

Figures

1 General Introduction

1.1 Purpose

The Australian Business Unit (ABU) OSMP (Figure 1-1; Ref. 3) sits above this OSMP NWS Activities document and is an overarching document that covers all CAPL assets in State and Commonwealth waters. The ABU OSMP includes information, relevant to all assets, on implementing the OSMP (including capability and readiness), the environmental monitoring framework (including operational and scientific monitoring) and monitoring components (initiation criteria, termination criteria, and implementation timeframes).

This Operational and Scientific Monitoring Plan North West Shelf Activities (OSMP NWS; this document) provides location- and asset-specific information related to Chevron Australia Pty Ltd (CAPL) activities on the North West Shelf of Western Australia (WA) that would be used if an unplanned hydrocarbon discharge from a CAPL asset occurred in the region. The document covers upstream and downstream marine assets of the Gorgon Gas Development, Wheatstone Project, and Barrow Island Joint Venture – including platforms, pipelines, and processing and export facilities.

This document summarises or refers to information in other CAPL documents such as Environment Plans (EPs), Oil Pollution Emergency Plans (OPEPs), and CAPL's Description of the Environment document (Ref. 2). The aim of the asset-specific information is not to repeat such information but to direct the reader to the relevant sections in those documents and therefore expedite the response process.

1.2 Scope

This document is a component of the OSMP framework described in the ABU OSMP (Ref. 3), where the overall scope is presented. It guides CAPL personnel in responding to a hydrocarbon spill in the NWS. Service providers are expected to read and understand this document before providing hydrocarbon spill standby services to CAPL.

1.3 Objectives

The overarching objective of this document is to direct responders to existing information and baseline data that may assist monitoring during an oil spill; more specifically, this document's objectives are to:

- briefly describe the environment that may be affected (EMBA) by a hydrocarbon spill, with reference to relevant EPs, the Description of the Environment document (Ref. 2), and other relevant documents (Section 3).
- collate baseline information sources (Section 4.3).
- provide a summary of estimates of capability and readiness for the NWS region including scenarios, scalability, sustainability, and response times (Section 5).

1.4 Target Audience

This document is intended for use by:

- Emergency Management Team (EMT) Incident Commander
- Environment Unit Lead

- ABU Health Environment Safety (HES) Supervisor – Environment Technical
- OSMP Monitoring Coordinator
- Operational and Scientific Monitoring Officer(s)
- personnel fulfilling operational or scientific monitoring roles within the Environment Unit of the EMT.

Note: Although this document gives guidance for operational monitoring, it is assumed that the teams implementing the monitoring outlined in this document have a basic understanding of operational monitoring, and are familiar with environmental sampling methods, equipment, and procedures.

1.5 Related Documentation

This document is specific to NWS activities and is a component of the OSMP framework described in the ABU OSMP (Figure 1-1).

Table 1-1 summarises and provides links to CAPL documents that are relevant to NWS activities. Refer to Section 4.3 for information and documents relating to the baseline state of environment.

CAPL uses GeoHouse to reference environmental aspects relative to oil spill modelling outputs. GeoHouse is mapping software that can store literature with georeferenced tags that allow users to identify where studies have been undertaken. This expedites access to key literature that is needed during the early phases of implementation of operational (OPS) and scientific (SCI) monitoring.

Table 1-1: Chevron Australia Key Documents Relevant to NWS Activities

Document Title	Summary of Interface with this Appendix
EP and OPEP Register (Ref. 6; ABU180500351)	The EP and OPEP Register lists all current ABU EPs and OPEPs that have been accepted and are in force. This Appendix, along with the ABU OSMP and other supporting documents describe the environmental monitoring that may be implemented in the event of an emergency condition described in the activity specific EPs listed within this register. Operational monitoring outcomes support OPEP implementation and termination by collecting information about the oil spill and associated response options to aid planning and decision making for executing spill response or clean-up operations.
Description of the Environment (Ref. 2)	This document describes the environment within CAPLs planning area (the outer area in which CAPL’s activities may interact with the environment).
ABU Protection Prioritisation Process (Ref. 4)	This process outlines and ranks the receptors (i.e. values or resources) at risk and helps CAPL understand which receptors should take priority in terms of protection from a spill.

Operational Specific Documents Supporting the OSMP

ABU OSMP

Target Audience
- Regulatory Agencies
- EMT Incident Controller (or delegate)
- ABU HES Supervisor – Environment Technical (or delegate)

Purpose and Objectives
- Describe the types of env. monitoring that may be implemented during a marine/coastal oil spill
- Flexible framework, allowing monitoring to be adapted to the nature and scale of a specific oil spill event
- Determine the extent, severity and persistence of environmental impacts from the spill
- Define initiation and termination criteria for each monitoring component
- Describe the implementation process for the monitoring programs
- Identify the positions responsible for ensuring implementation of the monitoring

APPENDIX A
North West Shelf Activities

Target Audience
- Environment Unit Lead; ABU HES Supervisor – Environment Technical; Monitoring Coordinator
- Monitoring Officer(s).
- Personnel fulfilling operational or scientific monitoring roles within the Environment Unit of the EMT.

Purpose and Objectives
- NWS location/asset specific information, such as activities, nature of hydrocarbons expected from a spill
- Summary description of the environment within the EMBA
- Describe social and ecological receptors, values and particular sensitivities within the EMBA
- Summary of baseline information sources
- Summary of capability and readiness estimate based on scenarios

APPENDIX B
Guidance Note for Operational Monitoring

Target Audience
- EMT Incident Controller (or delegate)
- Personnel fulfilling operational or scientific monitoring roles within the Environment Unit of the EMT.

Purpose and Objectives
- Internal guidance document to assist implementing operational monitoring components
- Framework for finalising program design so that it is appropriate to the nature and scale of the spill event
- Provide typical sampling and/or assessment method, standard operating procedures and field sheets for each monitoring component;

APPENDIX C
Guidance Note for Scientific Monitoring

Target Audience
- ABU HES Supervisor – Environment Technical (or delegate)
- ABU Environment Team

Purpose and Objectives
- Internal guidance document to assist implementing scientific monitoring components
- Framework for finalising program design so that it is appropriate to the nature and scale of the spill event, considering available baseline data
- Describe sampling and/or assessment method, procedures and field sheets for each monitoring component

ABU OSMP Quick Reference Guide

Initiation summary; checklists for the first 48hrs; OSMP framework and hotlinks to important documents

Implementation and Logistics Plan

Detailed steps required to implement the various monitoring components, and links, contact details and information related to logistics. Includes:
- Step by step 'playbooks' for each component
- Logistics arrangements for mobilising vessels, personnel, equipment and other resources, both internal and 3rd party

ABU Capability Needs Analyses – LOWC scenario and HFO scenario

A tool used to determine the resourcing requirements for operational and scientific monitoring under particular (pre-nominated) spill scenarios, for up to 4 phases of the response. Includes:
-number of teams required per component, number of personnel per team, and the skill/role makeup of those teams
- equipment and resources required per team
- summation of resourcing per phase
- sources and suppliers of those resources
- gap analysis of what equipment might be available in the short-term and what items are long-lead or unlikely to be available
- explanatory document on using the tool

ABU OSMP Capability Register

A register of personnel and equipment (CAPL, Chevron corporate and 3rd party) that is likely to be available in the event of a spill. Includes:
- personal information contact details
- qualifications and training relevant to OSMP
- self assessment of capability to fill OSMP roles (SME, Practitioner or Assistant)
- pre-nomination of internal people into specific OSMP roles

First Strike Sampling and Analysis Plan Template

Provide a well developed framework, methods and QAQC procedures for rapid implementation of first-strike sampling required under OPS 1, OPS3 and OPS4, within 48 hours of a spill. Includes:
- outline of the sampling program design, number, type and location of sampling required
- sampling equipment required
- methods for sampling, preservation, transportation and storage,
- QA/QC procedures

Figure 1-1: OSMP Document Structure

2 Region-specific Introduction

2.1 Description of the Assets

Assets and activities on the NWS, which are under the operational control of CAPL and outlined in Table 2-1. Further information on the individual assets or activities can be found in the activity specific EPs (Table 1-1; Ref . 6).

Table 2-1: Summary of Operating Assets, Infrastructure and Spill Scenarios covered in related EP and/or OPEPs

Asset	Infrastructure Location	Spill Scenarios in Related EP and/or OPEP
Wheatstone	Producing and infill wells, all located within Commonwealth Waters; Commonwealth and State Waters components of the trunkline; Marine Terminal area at Ashburton North	Spill scenarios include: • the release of marine diesel oil (MDO), intermediate fuel oil (IFO), or Heavy Fuel Oil (HFO) at all asset locations, including CAPL's operations within the Port of Ashburton and in adjacent waters including the Port of Onslow • the loss of condensate and produced fluids from the hydrocarbon system, including wells and trunkline
Gorgon	Producing wells, future production wells, and a future exploration well in Commonwealth Waters; Commonwealth and State Waters component of the feed gas pipeline; liquefied natural gas (LNG) jetty on Barrow Island; Gorgon domestic gas (DomGas) pipeline including pipeline and subsea installation and pre-commissioning	Spill scenarios include: • an MDO spill arising from a vessel collision or failure of the mobile offshore drilling units (MODUs) in Commonwealth Waters • the release of MDO or HFO from vessels operating within the Port of Barrow Island or adjacent State Waters • a Gorgon or Jansz condensate leak arising from a major defect in the production pipeline (in scope for both State and Commonwealth Waters) • a Gorgon or Jansz condensate release arising from a loss of well control (LOWC) during well intervention, abandonment, or infill drilling (Commonwealth Waters only)
Barrow Island Joint Venture (BWIJV)	Exploration and production operations on Barrow Island and surrounding areas; tanker loading line for Barrow Island crude offtake	Spill scenarios include: • failure of the tanker loading line

2.2 Hydrocarbon Properties

Credible spill scenarios relevant to CAPLs activities are outlined in the activity specific EPs. Depending on the activity, the hydrocarbon released to the environment may be one of several hydrocarbon types. The composition and physical properties of the hydrocarbons will evolve over time through weathering processes that change its composition and properties, such as the viscosity, density, water content and pour point. The rate of change of the hydrocarbon properties will affect the likely time-window of monitoring opportunities for OSMP components and the associated logistical requirements of these programs. As such it is important that OSMP teams are aware of the characteristics of the hydrocarbon types they will encounter.

Hydrocarbons represented in the worst credible spill scenarios within activity specific EPs can be grouped into oil types as defined by the International Tanker Owners Pollution Federation Ltd (ITOPF) classification system:

- Group 1 – Including Iago, Wheatstone, and Jansz condensate; Wheatstone trunkline fluids; and Wheatstone flowline fluids
- Group 2 – Including MDO, Gorgon condensate, Barrow Island crude and Gorgon/Jansz mixed trunkline fluids
- Group 3/4 – Including HFO and IFO (depending on blend).

Chevron ABU: Oil Properties and Dispersion Application Applicability (Ref. 5) outlines the basic hydrocarbon characteristics of the hydrocarbons that may be spilt to the environment. A summary of this information is presented in Table 2-2.

Table 2-2: Oil Types that may be Spilt to the Environment from CAPL NWS Activities

Product and Asset	Oil Type and ITOPF Group	API
Jansz Condensate (Gorgon Project)	Condensate – Group 1 AMSA Classification: Group I, light, non-persistent oil	51.4
Gorgon Condensate (Gorgon Gas Development)	Light Crude Oil – Group 2 AMSA Classification: Group II, persistent, light crude oil	35.3
Gorgon/Jansz Condensate Blend (Gorgon Gas Development)	Condensate Blend – Group 1 AMSA Classification: Group I, light, non-persistent oil	45.3
Wheatstone Condensate (Wheatstone Project)	Condensate Blend – Group 1 AMSA Classification: Group I, light, non-persistent oil	55.4
Iago Condensate (Wheatstone Project)	Condensate Blend – Group 1 AMSA Classification: Group I, very light, non-persistent oil	49.1
Wheatstone Trunkline (Processed trunkline fluids from Wheatstone, Iago and JDP wells.)	Condensate Blend – Group 1 AMSA Classification: Group I, light, non-persistent oil	52.3
Barrow Island Crude (WA Oil)	Light Crude Oil – Group 2 AMSA Classification: Group II, persistent, light crude oil	35.9
MDO (General vessel use)	Diesel – Group 2 AMSA Classification: Group III Medium, persistent oil	35.9
HFO/IFO (General cargo vessel use)	IFO – HFO – Group 3 / Group 4 AMSA Classification: Group III and IV heavy, persistent oils	15.1

3 Description of the Environment

Within each individual EP, the environment that may be affected (EMBA) by planned operations is described. The EMBA for a particular activity or asset is determined by modelling the potential worst-case spills from the petroleum activities; the EMBA represents a combination of multiple model outputs based on many plausible spill scenarios. Importantly, the EMBA does not represent the area that would be affected during a single spill event. A single spill would affect only a small proportion of the EMBA.

The Description of the Environment (Ref. 2) defines an Planning Area for CAPLs activities and assets (and associated spill scenarios) on the NWS, as described in Section 2.1. The Planning Area was derived using impact thresholds from conservative stochastic spill modelling undertaken for the range of emergency conditions described within the relevant activity specific EPs and is based on low level hydrocarbon presence, representative of a socio-economic impact.

Comprehensive descriptions of the NWS environment, values and sensitivities are presented in the Description of the Environment (Ref. 2). Further descriptive information for the EMBA specific to certain ABU activities is detailed in the activity specific EPs.

4 Monitoring Ecological and Social Receptors in the EMBA

Descriptions of the NWS environment, values and sensitivities are presented in the Description of the Environment (Ref. 2) and activity specific EPs. The process for identifying and ranking ecological and social receptors that are present within the EMBA and sensitive to oil spills is described in the ABU Oil Spill Protection Prioritisation Process[1] (Ref. 4). The process involves these steps:

1. Identify ecological and socio-economic receptors present in the EMBA by gathering available geospatial data and information from industry, government bodies and monitoring/research projects
2. Use the latest available literature and research data to determine the sensitivity of the various receptors to the effects of oil
3. Rank each receptor according to its sensitivity to oil and display the rankings geospatially

The ranking of ecological and socio-economic receptors allows the emergency management team to make timely and defensible decisions around response and monitoring priorities. A key mechanism for this is through the completion of strategic and operational Net Environmental Benefit Analysis (NEBA), which are completed both pre-spill (strategic) and at regular intervals during the response operation (operational). Further, the ranking values will be considered when designing and implementing operational and scientific monitoring and prioritising resources.

4.1.1 Ecological Receptors

The alignment of sensitive ecological receptors to OPS and SCI monitoring plans is detailed in Table 4-1 and in Section 3.3.1.1. of the ABU OSMP (Ref. 3).

Table 4-1: Sensitive Ecological Receptors within the NWS EMBA and Corresponding Monitoring Components

Receptor	Summary Description
Marine Fauna	
Turtles	Presence of oiled turtles and any impact on potential nesting areas from the oil spill or associated spill response activities can be monitored via: • OPS5: Rapid (Oiled) Shoreline Assessment • OPS7: Rapid Marine Megafauna Assessment • SCI3: Coastal and Intertidal Habitat Impact Study • SCI5: Marine Megafauna Impact Study
Seabirds and shorebirds	Presence of oiled seabirds and shorebirds and any potential impact to coastal habitat from the oil spill or associated spill response activities can be monitored via: • OPS5: Rapid (Oiled) Shoreline Assessment • OPS6 Rapid Seabird and Shorebird Assessment • SCI3: Coastal and Intertidal Habitat Impact Study • SCI4: Seabird and Shorebird Impact Study

[1] The EMBA represented in the ABU Oil Spill Protection Prioritisation Process relates to an uncontrolled loss of condensate from the Wheatstone or Gorgon production platforms. These scenarios have the greatest geographical coverage of any spill scenarios.

Receptor	Summary Description
Cetaceans, pinnipeds, and large cartilaginous fish	Presence of oiled marine megafauna including whales, dolphins, Dugong, pinnipeds, Whale Sharks, sharks, manta rays, sawfish, and other marine megafauna can be monitored via: • OPS7: Rapid Marine Megafauna Assessment • SCI5: Marine Megafauna Impact Study
Fish	Monitoring of any potential impact on fish populations and fisheries, including aquaculture can be monitored via: • OPS8: Fish Tainting • SCI7: Fish Effects Impact Study
Sea snakes	Monitoring of any potential impact on sea snake populations is considered infeasible due to difficulties in finding and tracking a suitable population to enable scientific rigour. Opportunistic observations can be made through appropriate monitoring scopes, including: • OPS7: Rapid Marine Megafauna Assessment • SCI5: Marine Megafauna Impact Study • SCI6: Benthic Habitat Impact Study
Shoreline Habitats	
Mangroves, intertidal mudflats and sandflats, intertidal shoals and sandbars, sandy beaches, intertidal rock pavement, and rocky shores	Extent of oil presence, persistence, associated change in percent (live) cover of these habitats, and impacts from spill response activities can be monitored via: • OPS5: Rapid (Oiled) Shoreline Assessment • SCI3: Coastal and Intertidal Habitat Impact Study
Marine Habitats	
Pelagic	Monitoring of any potential impact on micro flora and fauna (e.g. plankton) inhabiting the pelagic zone can be inferred by water and sediment quality studies: • OPS3: Oil in Water Assessment • OPS4: Oil in Sediment Assessment • SCI1: Water Quality Impact Study • SCI2: Sediment Quality Impact Study
Benthic habitats	Extent of oil presence, persistence, associated change in percent (live) cover of these benthic habitats such as coral reefs, seagrass, macroalgal communities, filter-feeding communities, and soft sediment communities can be monitored via: • OPS3: Oil in Water Assessment • OPS4: Oil in Sediment Assessment • SCI1: Water Quality Impact Study • SCI2: Sediment Quality Impact Study • SCI6: Benthic Habitat Impact Study

4.1.2 Socioeconomic Receptors

The alignment of sensitive socioeconomic and heritage receptors to OPS and SCI monitoring plans is detailed in Table 4-2.

Table 4-2: Socioeconomic and Heritage Features and Corresponding Monitoring Components

Category	Justification
Infrastructure	Potential impacts of an oil spill and associated response activities on water, sediment, or benthic habitat within areas of infrastructure are considered in: • OPS3: Oil in Water Assessment • OPS4: Oil in Sediment Assessment • SCI1: Water Quality Impact Study • SCI2: Sediment Quality Impact Study • SCI6: Benthic Habitat Impact Study
Commercial shipping	Oil spills are not considered to have a long-term significant impact on the use of existing commercial shipping channels and regional ports
Commercial fishing	Potential impacts of an oil spill and associated response activities on fish are considered in: • OPS8: Fish Tainting Assessment • SCI1: Water Quality Impact Study • SCI7 Fish Effects Impact Study
Recreational fishing	Potential impacts of an oil spill and associated response activities on fish are considered in: • OPS8: Fish Tainting Assessment • SCI1: Water Quality Impact Study • SCI7 Fish Effects Impact Study
Aquaculture	Potential impacts of an oil spill and associated response activities on aquaculture are considered in: • OPS3: Oil in Water Assessment • SCI1: Water Quality Impact Study • SCI7 Fish Effects Impact Study
Tourism and recreation	Potential impacts of an oil spill and associated response activities on water, sediment, benthic habitat, or marine fauna within tourism and recreation areas are considered in: • OPS3: Oil in Water Assessment • OPS5: Rapid (Oiled) Shoreline Assessment • OPS8: Fish Tainting Assessment • SCI1: Water Quality Impact Study • SCI2: Sediment Quality Impact Study • SCI3: Coastal and Intertidal Habitat Impact Study • SCI4: Seabird and Shorebird Impact Study • SCI5: Marine Megafauna Impact Study • SCI6: Benthic Habitat Impact Study • SCI7: Fish Effects Impact Study
Heritage (including shipwrecks)	Potential impacts of an oil spill and associated response activities on water, sediment, or benthic habitat within heritage areas are considered in: • OPS3: Oil in Water Assessment • OPS4: Oil in Sediment Assessment • SCI1: Water Quality Impact Study • SCI2: Sediment Quality Impact Study • SCI6: Benthic Habitat Impact Study • SCI8: Heritage (including Shipwrecks)

4.2 Stakeholder Consultation

The process for consultation with key stakeholders is presented in the ABU OSMP (Ref. 3). Table 4-3 shows a matrix of key values and sensitivities, and the core stakeholders that may need to be consulted. The stakeholder list not exhaustive; consult the stakeholder management plan within the relevant EP for a full list of stakeholders consulted when preparing that EP.

Table 4-3: EP Values and Sensitivities and Associated Core Stakeholders for Consultation

Particular EP Values and Sensitivities	Core Stakeholders										
	DAWE	AFMA	AMSA	NOPSEMA	DBCA	DoT	DPIRD	WAFIC	DWER	Port Authorities	Local Gov’t
National Heritage Areas	X			X	X				X		X
World Heritage Areas	X		X	X	X				X		X
Ramsar Wetlands	X			X	X				X		X
Australian Marine Parks	X	X	X	X	X				X		
State Marine Areas/Reserves	X			X	X	X	X	X	X		X
Commonwealth Marine Areas – KEFs identified through Marine Bioregional Plans	X	X	X	X							
Commonwealth and State Fisheries and Aquaculture			X					X	X		
Recreation and Tourism			X		x	X		X		X	X

Note:

DAWE = Department of Agriculture, Water and the Environment

AFMA = Australian Fisheries Management Authority

AMSA = Australian Maritime Safety Authority

NOPSEMA = National Offshore Petroleum Safety and Environmental Management Authority

DBCA = Department of Biodiversity, Conservation and Attractions

DoT = WA Department of Transport

DPIRD = Department of Primary Industries and Regional Development

WAFIC = Western Australian Fisheries Industry Council

DWER = Department of Water and Environment Regulation

4.3 State of the Environment (Baseline) – Information Sources

Baseline monitoring provides information on the condition of ecological receptors prior to, or spatially independent (e.g. if used in control chart analyses) of, a spill event and is used for comparison with the post-impact scientific monitoring where required. This is particularly important for scientific monitoring where the ability to detect changes between pre-impact and post-impact conditions is necessary.

CAPL has completed several studies around project and asset sites that would provide suitable quantitative data for comparison with post-spill conditions. Additionally, CAPL also completes ongoing monitoring programs that would also inform baseline state; these studies and the type of data available are summarised in Section 4.3.1.

CAPL also has access to information from industry partners through direct or collaborative agreements (Section 4.3.1.2). Public information sources (Section 4.3.3) complement CAPL and industry partner data.

Some operational and scientific monitoring components are suited to pre-impact baseline monitoring. If an oil spill to marine or coastal waters occurs, reactive pre-impact monitoring will, where practicable, be implemented to gather additional data on the current state of the environment. Where timing, logistics, and safety considerations allow for the implementation of reactive baseline monitoring, methods will follow the relevant operational or scientific monitoring components.

Baseline information on the ecological receptors of the NWS will be reviewed and updated annually. The process for obtaining and maintaining baseline data is outlined below:

1. Assess existing CAPL studies (much of the baseline information will come from the comprehensive Description of the Environment (Ref. 2), which provide a baseline description of the physical, ecological, cultural, and socioeconomic marine environment of north-west WA relevant to CAPL's petroleum activities and potential oil spill scenarios.
2. Systematically assess scientific and grey literature searched through Web of Science, Web of Knowledge, Google Scholar, and any other relevant sources.
3. Assess industry–government environmental metadata (I-GEM), or other industry portals, to understand design and collection methods (which would strongly influence data collection and project design post-spill).
4. Document in logical sequence the existing baseline data gathered from steps 1 to 3 above. Collect, manage, and cite research sources to create a database of abstracts/summary, keywords, and links to literature locations that can be easily searched and rapidly produce a reference list.
5. Identify gaps in the knowledge and consider what further information is required (i.e. undertake a data gap analysis).
6. Undertake a risk assessment of the gaps.
7. Identify how data would be collected to fill gaps (if required).

4.3.1 Data Collected by Chevron Australia

Baseline environmental data resources held by, or on behalf of CAPL are described in the following sections and summarised in Table 4-4.

4.3.1.1 Data Stored Internally

CAPL stores environmental data across a range of accessible platforms and repositories, the mixture of which changes over time depending on the age, type, originator, and IS facilities/platforms available at the time.

Table 4-4 provides an indication of the data storage location at the time of writing this revision.

Table 4-4: Available Baseline Data Relevant to Monitoring the Effects of Oil Spills in the Marine Environment

<table>
<tr><th>Data Source</th><th>Collection Time and Location</th><th>Summary of Data</th><th>Relevant SCI Component</th><th>External Report Reference</th><th>Data Location</th><th>Metadata Record Description</th></tr>
<tr><td colspan="7">Gorgon Gas Development</td></tr>
<tr><td>• Coastal and Marine Baseline State and Environmental Impact Report
• Materials Offloading Facility (MOF), Liquefied Natural Gas (LNG) Jetty, Dredge Spoil Disposal Ground</td><td>2008–2011
• East coast of Barrow Island</td><td rowspan="3">• Benthic habitat mapping (broadscale mapping, finer detail at selected coral monitoring sites)
• Coral (composition, % cover, size class frequency, growth and survival, recruitment)
• Non-coral benthic macroinvertebrates (composition, abundance)
• Macroalgae (composition, % cover, biomass)
• Seagrass (composition, % cover, biomass)
• Mangroves (composition, canopy density, pneumatophore density, leaf pathology, qualitative health)
• Fish – intertidal and subtidal (composition,</td><td rowspan="3">SCI1
SCI2
SCI3
SCI6
SCI7</td><td>**CAPL website**
Report # **G1-NT-REPX0001838**
Appendices # **G1-NT-REPX0001838**</td><td>• Environmental Data Management System (EDMS)
• Environment raw data archiving project register
• Network drive (O drive)
• Document Management System (DMS)</td><td rowspan="3">I-GEM – Chevron – Coral (Gorgon Marine Baseline Program) 2008–2010
I-GEM – Chevron – Benthic Macro-invertebrates (Gorgon Marine Baseline Program) 2008–2010
I-GEM – Chevron – Macroalgae (Gorgon Marine Baseline Program) 2008–2010
I-GEM – Chevron – Seagrass (Gorgon Marine Baseline Program) 2008–2010
I-GEM – Chevron – Mangrove (Gorgon Marine Baseline Program) 2008–2010
I-GEM – Chevron – Demersal Fish (Gorgon Marine Baseline Program) 2008–2010
I-GEM – Chevron – Demersal Fish (Gorgon Post-</td></tr>
<tr><td>• Coastal and Marine Baseline State and Environmental Impact Report
• Offshore Feed Gas Pipeline System and Marine Component of the Shore Crossing</td><td>2008–2011
• West coast of Barrow Island</td><td>**CAPL website**
Report # **G1-NT-REPX0002749**</td><td>• Environmental Data Management System (EDMS)
• Environment raw data archiving project register
• Network drive (O drive)
• DMS</td></tr>
<tr><td>• Coastal and Marine Baseline State and Environmental Impact Report
• Domestic Gas Pipeline</td><td>2008–2011
• DomGas Pipeline Route, DomGas Mainland Shore Crossing</td><td>**CAPL website**
Report # **G1-NT-REPX0002750**</td><td>• Environmental Data Management System (EDMS)
• Environment raw data archiving project register
• Network drive (O drive)
• DMS</td></tr>
</table>

Data Source	Collection Time and Location	Summary of Data	Relevant SCI Component	External Report Reference	Data Location	Metadata Record Description
		abundance, fork length) • Sediments (particle size distribution, total organic/inorganic carbon) • Water quality (light, turbidity, profiles [salinity, temperature, depth, dissolved oxygen, pH, turbidity])				Development Surveys) 2011–2014 I-GEM – Chevron – Water Quality (Gorgon) 2009 I-GEM – Chevron – Sediment Quality (Gorgon) 2009–2010
• Post-Development Coastal and Marine State and Environmental Impact Survey Reports • MOF, LNG Jetty, Dredge Spoil Disposal Ground, Year 1: 2011–2012 • MOF, LNG Jetty, Dredge Spoil Disposal Ground, Year 2: 2012–2013 • MOF, LNG Jetty, Dredge Spoil Disposal Ground, Year 3: 2013–2014	2011–2014 East coast of Barrow Island	• Coral (composition, % cover, size class frequency, growth and survival, recruitment) • Non-coral benthic macroinvertebrates (composition, abundance) • Macroalgae (composition, % cover, biomass) • Seagrass (composition, % cover, biomass) • Mangroves (composition, canopy density, pneumatophore density, leaf pathology, qualitative health)	SCI2 SCI3 SCI6 SCI7	**CAPL website** Year 2, Report #G1-NT-REPX0005152	• Environmental Data Management System (EDMS) • Environment raw data archiving project register • Network drive (O drive) • DMS	I-GEM – Chevron – Coral (Gorgon Post-Development Surveys) 2011–2014 I-GEM – Chevron – Benthic Macro-invertebrates (Gorgon Post-Development Surveys) 2011–2014 I-GEM – Chevron – Macroalgae (Gorgon Post-Development Surveys) 2011–2014 I-GEM – Chevron – Seagrass (Gorgon Post-Development Surveys) 2011–2014 I-GEM – Chevron – Mangrove (Gorgon Post-Development Surveys) 2011–2014

Data Source	Collection Time and Location	Summary of Data	Relevant SCI Component	External Report Reference	Data Location	Metadata Record Description
		• Fish – intertidal and subtidal (composition, abundance, fork length) • Sediments (particle size distribution)				
• Post-Development Coastal and Marine State and Environmental Impact Survey Reports • Offshore Feed Gas Pipeline System and Marine Component of the Shore Crossing , Year 1: 2013 • Offshore Feed Gas Pipeline System and Marine Component of the Shore Crossing , Year 2: 2014	2013–2015 West coast of Barrow Island	• Non-coral benthic macroinvertebrates (composition, abundance) • Macroalgae (composition, % cover, biomass) • Seagrass (composition, % cover, biomass) • Fish – intertidal and subtidal (composition, abundance, fork length)	SCI3 SCI6 SCI7	**CAPL website** Year 2, Report # **G1-NT-REPX0007241**	• Environmental Data Management System (EDMS) • Environment raw data archiving project register • Network drive (O drive) • DMS	
• Baseline Marine and Coastal Sediment Sampling and Analysis (unpublished)	• East coast of Barrow Island • West coast of Barrow Island • DomGas Pipeline Route, DomGas	2009–2011 • Sediments (particle size distribution, total inorganic/organic carbon, moisture content, nitrogen [NH_3, NO_X, Total Kjeldahl Nitrogen (TKN)], phosphorus, metals/ metalloids,	SCI2 SCI3		• Network drive (O drive)	

Data Source	Collection Time and Location	Summary of Data	Relevant SCI Component	External Report Reference	Data Location	Metadata Record Description
	Mainland Shore Crossing	organotins, PAHs, TPHs, BTEX, organochlorine/ organophosphate pesticides, oil/grease)				
• Baseline Study of the Composition and Quality of Nearshore Waters	East coast of Barrow Island	2008 • Water quality (profiles [salinity, temperature, depth, dissolved oxygen, pH, turbidity], nutrients [NH_3, NO_X, orthophosphate], total organic carbon, metals, carbonates, Total Dissolved Solids [TDS], turbidity)	SCI1		• Network drive (O drive)	
• Marine Environmental Quality Management Plan	East coast of Barrow Island	• 2016–ongoing • Water quality (metals) • Sediment quality (metals and hydrocarbons) • Biota quality (metals)	SC1 SC12 SCI7		• Network drive (O drive) • SharePoint 3PC site	
• Baseline Hydrocarbon Content of Bivalves on Barrow Island (unpublished)	East coast of Barrow Island	• 2014 • PAH, TPH, BTEX, and metals	SCI3 SCI7		• Network drive (O drive). Report# G1-VE-H-CE00-H23C8325700019	I-GEM – Chevron – Oysters (Gorgon) 2014

Data Source	Collection Time and Location	Summary of Data	Relevant SCI Component	External Report Reference	Data Location	Metadata Record Description
• Monitoring programs required under the Long-term Marine Turtle Management Plan	• East coast of Barrow Island • Mainland coast (Mundabullangana)	• 2005–ongoing (annual survey) • Flatback Turtles (nest success, track counts and satellite tracking, hatchling survival and dispersal)	SCI5	**CAPL website** Gorgon Gas Development and Jansz Feed Gas Pipeline: Five-year Environmental Performance Report (August 2010–August 2015) Report # **G1-NT-REPX0007517**	• Environmental Data Management System (EDMS) • Environment raw data archiving project register • Network drive (O drive) • SharePoint 3PC site • DMS	I-GEM – Chevron – Marine Turtle Nesting (Gorgon) 2005–2014
• Terrestrial and Subterranean Baseline State and Environmental Impact Report	• East coast of Barrow Island • West coast of Barrow Island • DomGas Mainland Shore Crossing	• 2003–2006 • Avifauna (assemblage, total counts) • Physical landforms (coastal foredunes, cliffs, and gorges)	SCI4	**CAPL website** Terrestrial and Subterranean Baseline State Environmental Impact Report. Report # G1-TE-H-0000-REPX027	• Environmental Data Management System (EDMS) • Environment raw data archiving project register • Network drive (O drive) • DMS	
• Barrow Island Seabird Monitoring Program (as required under Terrestrial and Subterranean Environmental	• East coast of Barrow Island • West coast of Barrow Island	• 2008–ongoing (annual survey) • Abundance, nest density, presence/absence of egg or chick/fledgling	SCI4	**CAPL website** Gorgon Gas Development and Jansz Feed Gas	• Environmental Data Management System (EDMS) • Environment raw data archiving project register • Network drive (O drive) • SharePoint 3PC site	I-GEM – Chevron – Seabirds (Gorgon) 2008–2014

Data Source	Collection Time and Location	Summary of Data	Relevant SCI Component	External Report Reference	Data Location	Metadata Record Description
Monitoring Program)	• Middle Island, Boodie Island, Parakeelya Island, Double Island North, Double Island South	in burrows, predation and mortality records		Pipeline: Five-year Environmental Performance Report (August 2010–August 2015) Report # **G1-NT-REPX0007517**	• DMS	
• Introduced Marine Pest Monitoring for the Gorgon Gas Development	East coast of Barrow Island	• 2010–ongoing • Intertidal species composition • Subtidal species composition	SCI3		• Environmental Data Management System (EDMS) • Environment raw data archiving project register • Network drive (O drive) • SharePoint 3PC site • DMS	
• Coastal Monitoring	East coast of Barrow Island	• 2008–ongoing • Coastal landforms, stability, and habitat	SCI2 SCI3 SCI4 SCI5		• Network drive (O drive) • SharePoint 3PC site • DMS	
Wheatstone Project						
Wheatstone Baseline State of the Marine Environment Report	• Onslow area • Thevenard Island area	• 2012–2013	SCI1 SCI2 SCI6		• Network drive (O drive) • SharePoint 3PC site • DMS Report	I-GEM – Chevron – Coral (Wheatstone Baseline State of the Marine Environment) 2009–2013 I-GEM – Chevron – Macroalgae (Wheatstone Baseline

Data Source	Collection Time and Location	Summary of Data	Relevant SCI Component	External Report Reference	Data Location	Metadata Record Description
						State of the Marine Environment) 2012 I-GEM – Chevron – Seagrass (Wheatstone Baseline State of the Marine Environment) 2012 I-GEM – Chevron – Filter Feeders (Wheatstone Baseline State of the Marine Environment) 2012
Wheatstone Marine Fauna Monitoring Program	• Onslow Area • Thevenard Island Area • Montebello Island Area	• 2009–2010 • Whales (acoustic loggers)	SCI5		• Network drive (O drive) • DMS	
Wheatstone Marine Fauna Monitoring Program	• Exmouth Gulf to Barrow Island	• 2009–2010 • Whales (aerial observations) • Other marine fauna also recorded	SCI5		• Network drive (O drive) • DMS	
Wheatstone Marine Fauna Monitoring Program	• Onslow Area	• 2012–2014 • Dugong (aerial observations) • Other marine fauna also recorded	SCI5		• Network drive (O drive) • DMS	I-GEM – Chevron – Dugong (Wheatstone) 2012–2014
Wheatstone Marine Fauna Monitoring Program	• Onslow Area	• 2010–2011	SCI7		• Network drive (O drive) • DMS	

Data Source	Collection Time and Location	Summary of Data	Relevant SCI Component	External Report Reference	Data Location	Metadata Record Description
		• Fish (community composition, abundance)				
Deepwater Benthic Habitats	• Onslow Area	• 2008–2009 • Benthic habitat (composition)	SCI6		• Network drive (O drive) • DMS	
Wheatstone Baseline Benthic Habitat Monitoring	• Onslow Area	• 2009–2013 • Benthic habitat (composition, percent cover)	SCI6		• Network drive (O drive) • DMS	
Wheatstone Mangrove Monitoring Program	• Onslow Area	• 2009–ongoing • Mangroves (composition, canopy density, qualitative health) • Algal mat coverage	SCI3		• Network drive (O drive) • SharePoint 3PC site • DMS	
Wheatstone Coastal Habitat Survey	• Onslow Area	• 2008–2009 • Intertidal habitat, coastal type • Physical shoreline features	SCI3			
Wheatstone Turtle Impact Monitoring Program	• Onslow Area	2013–ongoing • Flatback Turtles (nest success, track counts, hatchling survival and dispersal)	SCI5	**CAPL website** EIS/ERMP APPENDIX O11 – TECHNICAL APPENDIX MARINE TURTLES	• Network drive (O drive) • SharePoint 3PC site • DMS	I-GEM – Chevron – Turtles (Wheatstone) 2012–2014

Data Source	Collection Time and Location	Summary of Data	Relevant SCI Component	External Report Reference	Data Location	Metadata Record Description
Baseline Hydrocarbon Content of Bivalves and Sediments (unpublished)	• Onslow Area • Offshore Islands • Thevenard Island Area	2013 PAH, TPH, BTEX, and Metals	SCI2 SCI3		• Network drive (O drive) • DMS	
Thevenard Island (TVI) Marine Environmental Monitoring Program	• Thevenard Island Area	• 1991–ongoing • Coral (composition, abundance) • Sediment (hydrocarbons, metals) • Bivalve (hydrocarbons, metals)	SCI2 SCI3 SCI6		• Network drive (O drive) • DMS	
TVI Marine Environmental Monitoring Program	• Thevenard Island Area	• 2009–2010 • Benthic Habitat	SCI6		• Network drive (O drive) • DMS	
Sea Serpent Project	Various	• Deep-sea benthic surveys • Deep-sea marine fauna surveys • Sediment sampling	SCI2 SCI5 SCI6 SCI7		• Network drive (O drive) • DMS	
Deep-sea sediment sampling	2013 HERA-1 and Delphin-1	• Sediment sampling (hydrocarbons)	SCI2		• Network drive (O drive) • DMS	

4.3.1.2 Data Stored Externally

Additional baseline datasets are available to CAPL, but are held by external consultants and described in reports held by CAPL. These data can be accessed when required from the consultants.

4.3.2 Industry Agreements (including I-GEM)

Vermillion Oil and Gas (Australia) Pty Ltd have confirmed that, in the event of an oil spill, they would release data collected at the Montebello Islands on sediment and water quality, mangrove condition, marine turtle nesting activity, and bird presence (roosting; nesting and foraging) for CAPL's use in environmental assessment.

I-GEM is an industry and government collaboration to collate and present spatial metadata on marine environmental baseline and monitoring studies collected in the last decade. The objective of this program is to ensure industry and government have the same marine studies knowledge.

The intention of I-GEM is to capture spatially referenced metadata on marine environmental studies from the Abrolhos Islands to the Timor Sea and from the nearshore waters of the coast to the edge of Australia's continental shelf. This metadata database will allow organisations to understand what environmental baseline studies exist and where, and identify the custodian. The database provides a valuable shared resource to support impact assessment in the unlikely event of a major oil spill in the region.

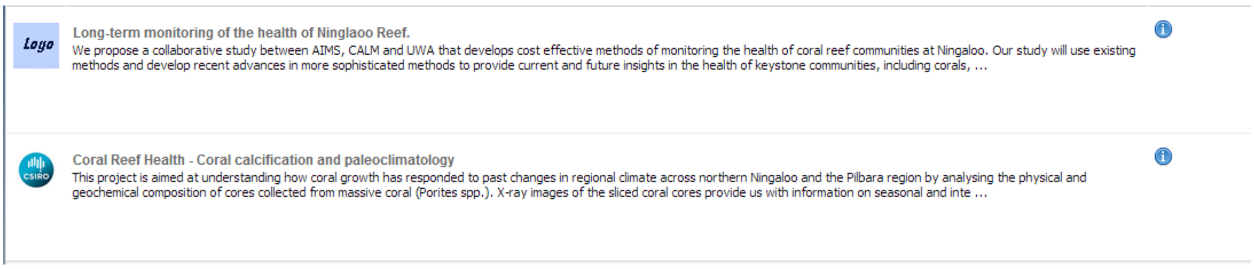
I-GEM metadata are publicly accessible from the AODN metadata catalogue, with accessibility to the WAODN metadata catalogue. It is not necessary to apply for a user name and password to search publicly available metadata records and public data; however, a user name and password is required to create metadata records or download and view restricted data.

Login details for CAPL are included in Environment Unit Lead guidance documents and a user guide is available via this link.

An example of an I-GEM metadata search is provided below.

Search: *coral health Ningaloo*

Results as viewed online:



Extract of titles relevant to example search:

- Long-term monitoring of the health of Ningaloo Reef
- CSIRO Coral Reef Health – Coral calcification and paleoclimatology

- WAMSI Node 3.2.2c – Spatial variation in algal-herbivore interactions on the Ningaloo Reef, Western Australia: Regional differences in the piscine drivers of macroalgal herbivory in a coral-reef marine park (Honours thesis)
- WAMSI Node 3.2.2c – Spatial variation in algal-herbivore interactions on the Ningaloo Reef, Western Australia: Regional differences in the piscine drivers of macroalgal herbivory in a coral-reef marine park (Honours thesis)
- CSIRO Pilbara Marine Conservation Partnership (PMCP) – Environmental Drivers: Coastal Reef Monitoring (Ningaloo) 2014–2015
- Methods for monitoring the health of benthic communities, Ningaloo Reef, Western Australia (WAMSI Node 3 Project 3.1.2)
- AIMS Long-Term Monitoring of Ningaloo Marine Park: Status of Drupella and shallow water benthic reef communities
- Data on the long-term monitoring of Ningaloo Marine Park
- CSIRO Coral Reef Health Broadscale Reef Fish Survey – Reef Fish Short Transect Survey 2013-2015
- CSIRO Coral Reef Health Broadscale Reef Fish Survey – Reef Target Fish Survey 2013-2015
- CSIRO Coral Reef Health Broadscale Survey – Reef Benthic Survey 2013–2015
- CSIRO Coral Reef Health Sediment Survey 2013–2015
- CSIRO Pilbara Marine Conservation Partnership (PMCP) – Stable isotope ratios of selected flora and fauna from Ningaloo and the Pilbara 2014–2016
- CSIRO Coral Reef Broadscale Invertebrate Survey – 2013–2015
- CSIRO Macroalgae and seagrass biomass and diversity across the Pilbara Region in November 2013 and May 2014
- CSIRO Pilbara Marine Conservation Partnership (PMCP) – Fish and Sharks – Raw Stereo-BRUV Imagery – 2015_08_Ningaloo.deep.sanctuaries_stereoBRUVs

Example of metadata record linked to each title:

Link: http://catalogue.aodn.org.au:80/geonetwork?uuid=506cd950-371b-4c99-a43e-584557972348

Abstract: This project is aimed at understanding how coral growth has responded to past changes in regional climate across northern Ningaloo and the Pilbara region by analysing the physical and geochemical composition of cores collected from massive coral (*Porites* spp.). X-ray images of the sliced coral cores provide us with information on seasonal and inter-annual changes in the density and rate of vertical extension from which we can calculate annual rates of coral growth, or more precisely, calcification. Coral cores from massive *Porites* spp. were collected from sites across northern Ningaloo (Tantabiddi and Coral Bay in July 2013) and the western Pilbara (Onslow to the Dampier peninsula in April 2014).

4.3.3 Public Information Sources

A bibliography of research and data relevant to CAPL's Resources at Risk project was created in 2014. This document listed published and unpublished material relevant to the marine and intertidal environments within the EMBA in the event of a worst-case scenario hydrocarbon release associated with the Wheatstone or Gorgon Gas Developments. The output was a comprehensive bibliography of the physical, ecological, and biological components of the marine and intertidal environments within the EMBA. An overview of this output is stored as a list in DMS at this link http://webtop-sg.dm.chevron.net/webtop/drl/objectId/09024afe83127eae/chronicleId/09024afe83127e9f/versionLabel/CURRENT or on SharePoint at this link Resources at Risk

Chevron holds a Zotero user licence to enable access to the details of the bibliography. The relevant text file to be opened with Zotero is stored in DMS at this link http://webtop-sg.dm.chevron.net/webtop/drl/objectId/09024afe8312927d/chronicleId/09024afe8312927d/versionLabel/CURRENT.

5 Capability and Readiness Estimate

5.1 Process for Determining Required Capability

The ABU OSMP (Ref. 3) outlines the high-level process for determining capability requirements and maintaining an appropriate level of capability, internally and externally. This Section summarises the process for estimating the personnel, logistics, and equipment required to implement operational and scientific monitoring for two representative modelled spill scenarios on the NWS:

- Offshore loss of well control event
- Heavy Fuel Oil spill (1040 m^3 over three days) at the Wheatstone Product Loading Facility (Ashburton North)

The requirements for one field team to implement each individual monitoring component were determined via internal workshops that considered:

- number of personnel per team
- team composition (e.g. field leader, subject matter experts [SMEs], field workers)
- sampling equipment per team (generic equipment [e.g. laptop] and that specific to the monitoring component [e.g. water column profiler])
- work platform (e.g. 4WD vehicle, fixed-wing aircraft, inshore vessel, offshore vessel).

For each scenario, the number of teams required to implement the monitoring components was determined for up to four phases of the event:

- Phase 1: Initial (0–30 days)
- Phase 2: 30 days to end of release and dispersion; ~240 days
- Phase 3: Initial Recovery (3 years)
- Phase 4: Ongoing (time defined for each receptor).

The number of teams accounted for the following factors:

- co-mobilisation of common scopes (i.e. the ability of one team to implement multiple monitoring components)
- shift hours (12-hour or 24-hour operations) and rotation of field teams (e.g. 14 days on/off).

Up to four equipment suppliers were identified for each equipment type, with their name, number of items available, lead time for equipment to be ready to mobilise from the location, location, and contact number.

5.2 Existing Capability Compared to Estimate

CAPL's capability to implement the ABU OSMP (Ref. 3) for an incident on the NWS draws on internal (CAPL and corporate structure) and external (contractor) resources. Capability is maintained in a central register; internal personnel capability is updated quarterly, while external capability is updated every 6 months.

The combined internal and external capability is compared to Phase 1 estimated requirements to ensure sufficient resources are available to support the initial response, while allowing time for scaling up for prolonged events.

6 Acronyms and Abbreviations

Table 6-1 defines the acronyms and abbreviations used in this document.

Table 6-1: Acronyms and Abbreviations

Acronym/ Abbreviation	Meaning
~	Approximately
°C	Degrees Celsius
4WD	Four-wheel drive (vehicle)
ABU	Australian Business Unit
AFMA	Australian Fisheries Management Authority
AMSA	Australian Maritime Safety Authority
ANZECC	Australian and New Zealand Environment and Conservation Council
AODN	Australian Ocean Data Network
APPEA	Australian Petroleum Production and Exploration Association
ArcGIS	An integrated collection of GIS software products developed by ESRI that provides a standards-based platform for spatial analysis, data management, and mapping
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
Avifauna	Birds of a particular region
BIA	Biologically Important Area
Biogenic	Produced or brought about by living organisms
Bombora	Raised, dome-shaped, limestone feature, >1 m high, often formed by coral of the genus Porites.
Bonn Convention	Convention on the Conservation of Migratory Species of Wild Animals 1979
BTEX	Benzene, toluene, ethylbenzene, and xylene compounds
CAMBA	China–Australia Migratory Bird Agreement
CAPL	Chevron Australia Pty Ltd
Cetacean	Various aquatic (mainly marine) mammals of the order Cetacea, (including whales, dolphins and porpoises) characterised by a nearly hairless body, front limbs modified into broad flippers and a flat notched tail
Commonwealth Waters	Waters stretching from three to 200 nautical miles from the Australian coast.
CSIRO	Commonwealth Scientific and industrial Research Organisation
DAWE	Commonwealth Department of Agriculture, Water and the Environment
DBCA	Western Australian Department of Biodiversity, Conservation and Attractions
Demersal	Living on the seabed or just above it
DMP	Former Western Australian Department of Mines and Petroleum (2009–2017); now Department of Mines, Industry Regulation and Safety
DMS	Document Management System
DomGas	Domestic Gas
DoT	Western Australian Department of Transport
DPIRD	Western Australian Department of Primary Industries and Regional Development

Acronym/ Abbreviation	Meaning
DWER	Western Australian Department of Water and Environment Regulation
EDMS	Environmental Data Management System
EMBA	Environment that May be Affected
EMT	Emergency Management Team
EP	Environment Plan
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
Finfish	A term used to distinguish fish with fins and gills, from shellfish, crayfish, jellyfish, etc.
Foraminifera	Microscopic, single-celled organisms with shells
FSSMP	First Strike Sampling and Analysis Plan
GIS	Geographic Information System
HES	Health, Environment, and Safety
HMAS	His Majesty's Australian Ship (during World War II)
HSK	Ship of the German Navy (during World War II)
IAA	Impact Assessment Area
I-GEM	Industry–Government Environmental Metadata
IMCRA	Integrated Marine and Coastal Regionalisation of Australia
IPIECA	International Petroleum Industry Environmental Conservation Association
IS	Information Systems
IUCN	International Union for Conservation of Nature
JAMBA	Japan–Australia Migratory Bird Agreement
KEF	Key Ecological Feature
km	Kilometre
km^2	Square kilometre
LNG	Liquefied Natural Gas
m	Metre
m/s	Metres per second
m^3	Cubic metre
MEQMP	Marine Environmental Quality Management Plan
MNES	Matters of National Environmental Significance, as defined in Part 3, Division 1 of the EPBC Act
MOF	Materials Offloading Facility
N/A	Not applicable
Nekton	The aggregate of actively swimming organisms at the sea's surface
NH_3	Ammonia
NOPSEMA	National Offshore Petroleum Safety and Environmental Management Authority
NO_x	Oxides of nitrogen (NO and NO_2)
NWMR	North-West Marine Region
NWS	North West Shelf

Acronym/ Abbreviation	Meaning
NWSJEMS	North West Shelf Joint Environmental Management Study
OPEP	Oil Pollution Emergency Plan
OPS	Operational monitoring
OSMP	Operational and Scientific Monitoring Plan
PAH	Polycyclic Aromatic Hydrocarbon
Pelagic	Living in the open sea rather than in coastal or inland waters
pH	Acidity or basicity of a solution
Photic Zone	The depth of the water in a lake or ocean that is exposed to sufficient sunlight for photosynthesis to occur. The depth of the photic zone can be greatly affected by turbidity.
PSU	Practical Salinity Units, equivalent to parts per thousand
QA/QC	Quality Assurance / Quality Control
Ramsar Wetland	A wetland of international importance, recognised globally under the Ramsar Convention. The Ramsar Convention is an international treaty for the conservation and sustainable use of wetlands; it recognises the fundamental ecological functions of wetlands and their economic, cultural, scientific, and recreational value.
ROKAMBA	Republic of Korea–Australia Migratory Bird Agreement
SCI	Scientific monitoring
SME	Subject Matter Expert
SQL	Structured Query Language (Microsoft)
State Waters	The marine environment within three nautical miles of the mainland of Western Australia or its islands
TDS	Total Dissolved Solids
TKN	Total Kjeldahl Nitrogen
TPH	Total petroleum hydrocarbon
Trophic	Pertaining to food or nutrition
TVI	Thevenard Island
WA	Western Australia
WAFIC	Western Australian Fisheries Industry Council
WAMSI	Western Australian Marine Science Institution
WAODN	Western Australian Ocean Data Network

7 References

The following documentation is either directly referenced in this document or is a recommended source of background information.

Table 7-1: References

Ref. No.	Description	Document ID
1.	Chevron Australia. 2018. *Description of the Environment*. Chevron Australia, Perth, Western Australia.	ABU140700357
2.	Chevron Australia. 2017. *Operational and Scientific Monitoring Plan: Environmental Monitoring in the Event of an Oil Spill to Marine Coastal Waters*. Rev. 6.0. Chevron Australia, Perth, Western Australia	ABU130700448
3.	Chevron Australia. 2018. *ABU Oil Spill Protection Prioritisation*. Revision 1.0 Chevron Australia, Perth, Western Australia.	ABU180500232
4.	Chevron Australia. 2018. *Chevron ABU – Oil Properties and Dispersion Application Applicability*	ABU180501458
5.	Chevron Australia. 2020. *ABU Operations: Environment Plan Changes Tracking Register*	ABU180500351

Appendix B Guidance Note and Standard Operating Procedures – Operational Monitoring

Operational and Scientific Monitoring Plan

Guidance Note for Operational Monitoring

Document ID:	ABU150300650
Revision ID:	4.0
Revision Date:	25 May 2020
Next Revision Due	25 May 2025
Information Sensitivity:	Company Confidential

Contents

Tables

Figures

1 Introduction

1.1 Purpose

The Operational and Scientific Monitoring Plan (OSMP): Operational Monitoring Guidance Note (this Guidance Note) describes the implementation for operational monitoring if an emergency condition results in an oil spill to marine or coastal waters where Chevron Australia Pty. Ltd. (CAPL) is the Nominated Titleholder (Commonwealth) or Operator (State).

This Guidance Note focuses on operational monitoring only, as set out in the OSMP (ABU130700448; Ref. 1).

The OSMP splits operational monitoring into individual components (Figure 1-1); each represents a particular assessment or study, with tailored initiation and termination triggers to determine if and when that monitoring component will be implemented.

Note: This Guidance Note is for operational monitoring purposes, not scientific monitoring. Therefore, some of the design and methodology cannot be prescriptive and must focus on rapid data collection for response decision-making rather than long-term studies to determine impact.

1.2 Scope

This Guidance Note focuses on the implementation of operational monitoring components only. Monitoring, Evaluation and Surveillance (MES) tactics for an oil spill are excluded as they are covered in the activity-specific Oil Pollution Emergency Plans (OPEPs). Similarly, the response option selection process (including Net Environmental Benefit Analysis [NEBA]) that may use the data collected under operational monitoring programs (OPS) is part of the OPEP processes and is not discussed in this Guidance Note.

This Guidance Note is part of the overall oil spill preparedness and response framework in place at Chevron Australia, which is described in the Australian Business Unit (ABU) Oil Spill Response Manual (Ref. 2), and outlined in Figure 1-2.

The geographic scope of the implementation of the OSMP, including this document, is described in Section 2.3.1 and shown in Figure 2-2.

Field sheets and checklists that supplement this Guidance Note are contained in the Appendices.

1.3 Objectives

The objectives of this Guidance Note are to:

- provide a framework for finalising program design for operational monitoring so that it is appropriate to the nature and scale of the event
- describe standard operating procedures (SOPs) for required sampling, including providing standard field sheets and checklists.

1.4 Target Audience

Personnel fulfilling operational monitoring roles within the Environment Unit (Figure 2-1) of the Emergency Management Team (EMT) will use this Guidance Note.

Note: Although this document gives guidance for operational monitoring, it is assumed that the teams implementing the monitoring outlined in this document have a baseline understanding of operational monitoring, and are familiar with environmental sampling methods, equipment, and procedures.

1.5 Limitations

Monitoring is to be implemented in a way that meets the objectives of the OSMP (Ref. 1), while retaining operational flexibility such that abnormal conditions, access to resources (including access to vessels and aircraft), and/or events beyond CAPL's control can be accommodated. The potential survey areas occur in a remote region with limited logistical capability, and can experience extreme weather events. The need for flexibility in monitoring design, effort, and rapid deployment (possibly using a vessel of opportunity) may dictate the nature and extent of the monitoring. There may be times where it is not possible to implement or complete one or more OMPs as described in this document. If this occurs, CAPL will take measures and/or reprioritise its monitoring programs to ensure the objectives of this document are met.

This document provides a framework for finalising program design so that it is appropriate to the nature and scale of the event. This document provides more details for OPS that must be implemented immediately by CAPL. External environmental specialists, engaged to support other OPS, will provide additional guidance where required. Although this document is intended to provide guidance on most monitoring situations, additional monitoring may be required by the EMT.

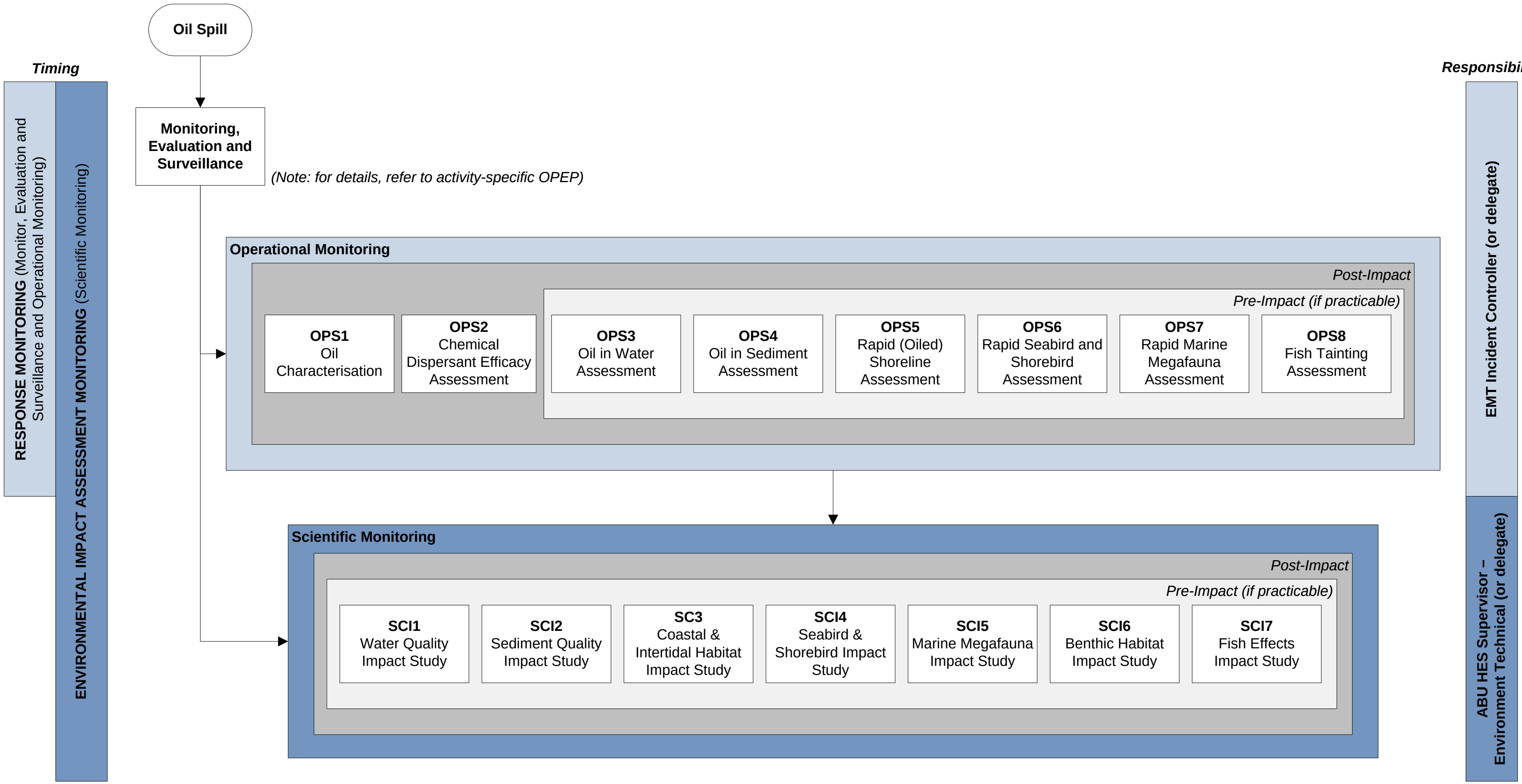


Figure 1-1: Monitoring in the Event of an Oil Spill to Marine or Coastal Waters

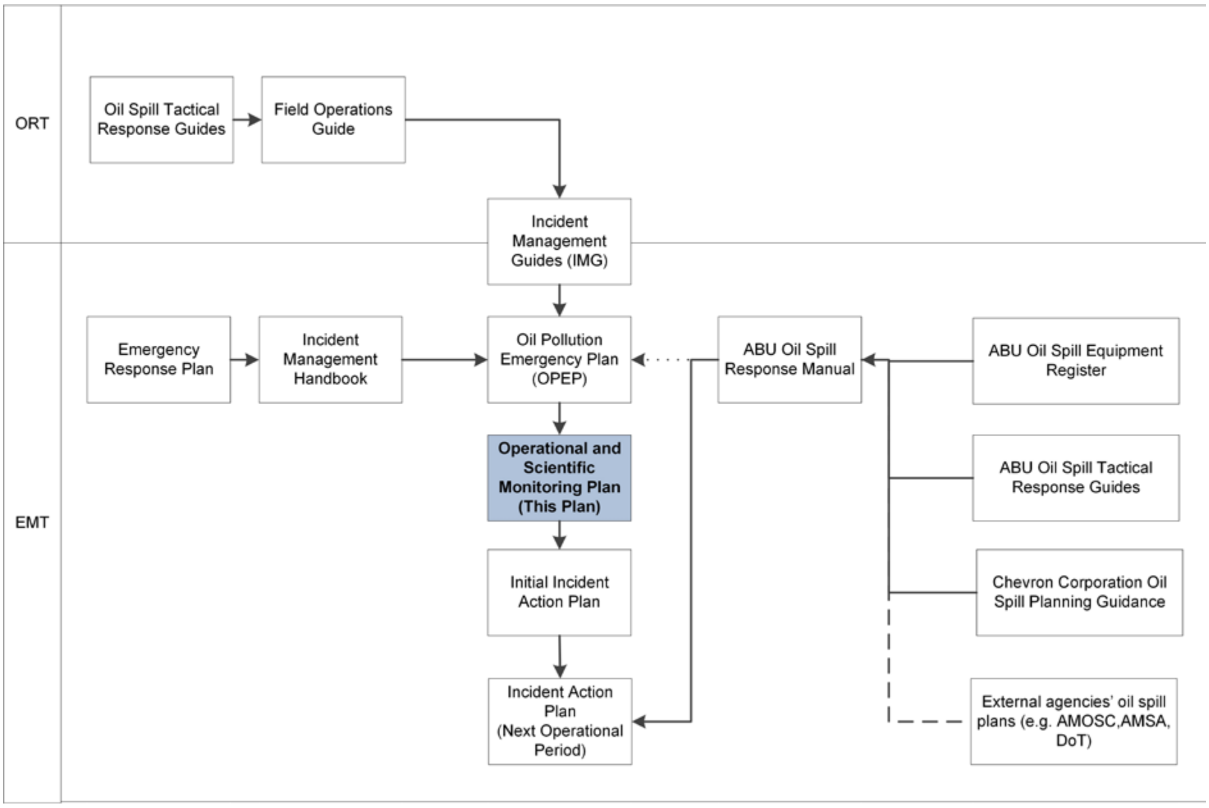


Figure 1-2: Relationship of Emergency Management and Oil Spill Documentation within CAPL

Note: Shaded cells refer to documents related to this Guidance Note.

1.6 Continual Improvement

CAPL is committed to conducting activities in an environmentally responsible manner and aims to implement best practice environmental management as part of a program of continuous improvement. This commitment to continuous improvement means that CAPL will review this Plan every five years, or more often as required (e.g. in response to new information).

Reviews will address matters such as the overall design and effectiveness of the Plan, progress in environmental performance, changes in environmental risks, changes in business conditions, and any relevant emerging environmental issues.

1.7 Acronyms and Abbreviations

Section 12 defines the acronyms and abbreviations used in this Guidance Note.

2 Implementation Strategy

Operational and Scientific Monitoring is a key element in effectively responding to oil spill incidents and CAPL's process for this activity is described in the ABU OSMP (Ref. 1). This Guidance Note is one of the key supporting procedure documents that support the OSMP.

2.1 Roles and Responsibilities

The roles and responsibilities outlined in Figure 2-1 apply to all phases of the monitoring process. The EMT Incident Commander (or delegate) will be responsible for ensuring the implementation of the operational monitoring components. Several specific monitoring roles (see shaded cells in Figure 2-1) will also be required.

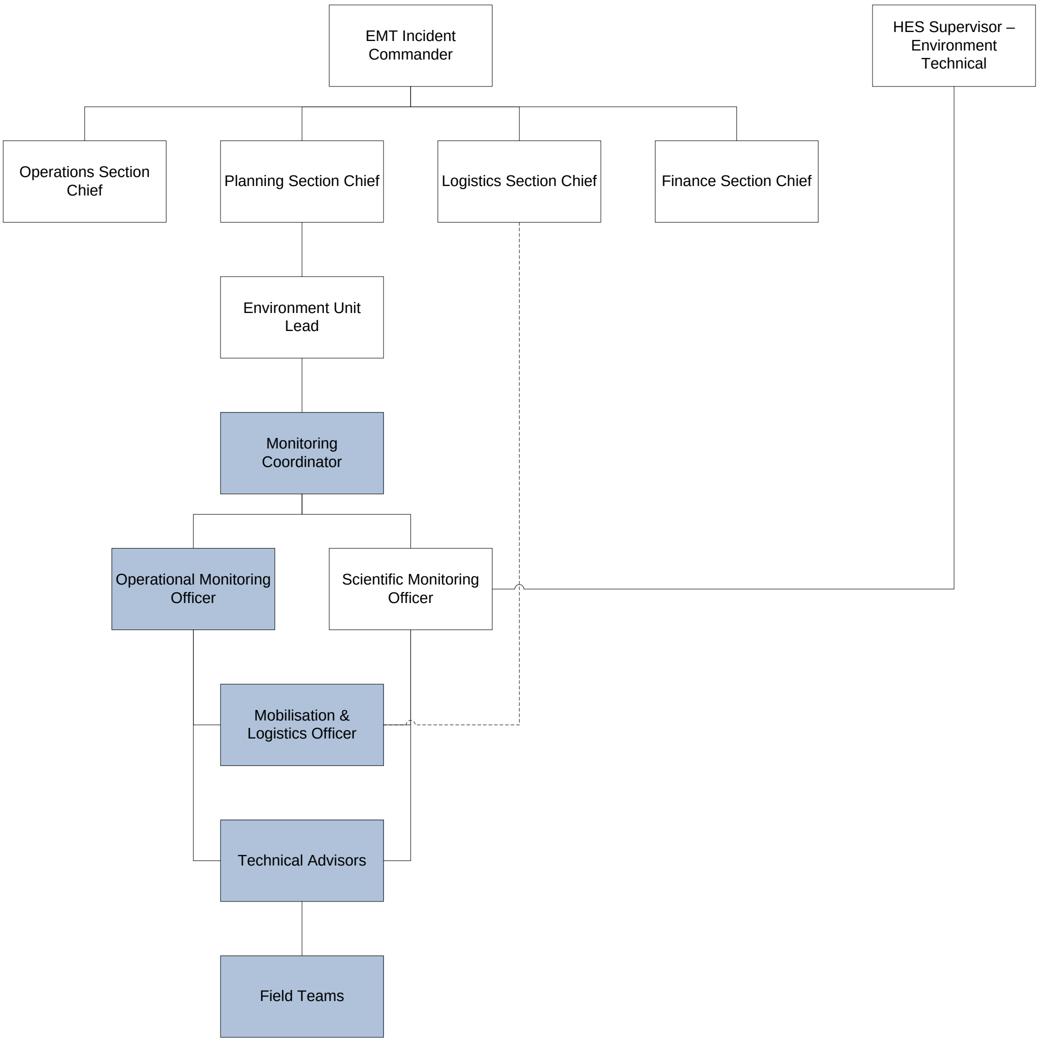


Figure 2-1: Roles Associated with Operational Monitoring

Note: Shaded cells refer to roles associated with this Guidance Note.

Table 2-1: Operational Monitoring Roles, Responsibilities, and Rationale for using this document

Role	Responsibilities	Reason for using this document
EMT Incident Commander (or delegate)	Ultimately responsible for ensuring that operational monitoring is implemented in accordance with the OSMP (Ref. 1).	Is aware of this document but does not directly implement each OPS
Environment Unit Lead (EUL)	Key position for relaying information between the EMT and the Monitoring Coordinator.	Refers the Monitoring Coordinator to this document for use by the monitoring team
Monitoring Coordinator	Key program management role for the monitoring scopes. Responsibilities include: • contact point with the EMT (through EUL) • providing overarching technical advice • financial tracking and management (in consultation with Finance Section in EMT) • logistics tracking (in consultation with Logistics Section in EMT) • engaging with required third-party contractors including consultants and laboratories • supporting the EUL in ensuring that: – relevant OPS components are implemented in line with the descriptions in the OSMP (Ref. 1) – necessary monitoring roles are defined as appropriate to the nature and scale of the event • ensuring operational monitoring components are implemented within the times defined in Section 2.2.	• Communicating monitoring activities to the EMT • Acquiring personnel to fulfil roles and ensure responsibilities are met
Operational Monitoring Officer	Operational Monitoring Officers are the technical leads for each of the monitoring types. Responsibilities include: • understanding the data metrics that would be collected in the event of a spill • advising the Monitoring Coordinator on data collection, logistical support required, and monitoring priorities if constraints (e.g. safety, time or logistics) are encountered • facilitating activation of contractors if necessary • overseeing data analyses and interpretation • managing data including spatial data • presenting data in an appropriate and informative format to allow for timely decisions.	• Design of OPS programs • Ensuring SOPs are appropriate for the spill scenario • Directing contractors on tasks required • Ensuring appropriate laboratory analyses are conducted and reported back to the EUL

Role	Responsibilities	Reason for using this document
Mobilisation and Logistics Officer	The Mobilisation and Logistics Officer is responsible for ensuring that field teams (CAPL personnel and/or contractors) are mobilised to site as soon as practicable and in accordance with CAPL processes. This position also liaises with the EMT Logistics Section Chief (or delegate) during the response when planning mobilisation of operational and/or scientific monitoring field teams. If required, this position is also responsible for facilitating procurement of any necessary vessels or sampling equipment.	• Understanding resources required (resource lists for each OPS) • Understanding requirements to mobilise people and equipment for monitoring tasks
Technical Advisors	Technical Advisors will be assigned to monitoring scope(s) as required. Technical Advisors will have a thorough understanding of the receptors they are assigned. Key responsibilities include: • overseeing and advising on the collection of data • advising the Operational and Scientific Monitoring Officers on data collection methods • ensuring sampling and analysis plans (where required) are completed before mobilisation • ensuring quality assurance/quality control (QA/QC) and interpreting data • preparing reports.	• Design of OPS • Verifying SOPs • Ensuring QA/QC in data collection and reporting
Field Teams	A Field Team will include a Field Team Lead, who will be the key contact point to the Technical Advisor during the survey . All Field Team members are responsible for: • understanding the details of monitoring methods • having adequate field data collection sheets and survey-specific equipment readily available • ensuring awareness and understanding of QA/QC procedures • assisting with report preparation if required • implementing relevant health, environment, and safety (HES) protocols.	• SOPs for each OSMP • Resource lists

2.2 Timing Commitments

Implementation times were committed to and are provided in the OSMP (Ref. 1).Implementation times for the Operational Monitoring Components are directly linked to the initiation criteria which are found in Section 4 of the OSMP. Implementation times must be adhered to.

2.3 Mobilisation Times

2.3.1 Operational Areas

The operational areas of CAPL are shown in Figure 2-2; these areas also represent the geographic scope of the implementation of the OSMP (Ref. 1), including this document. Indicative mobilisation times for these areas is provided in Appendix A.

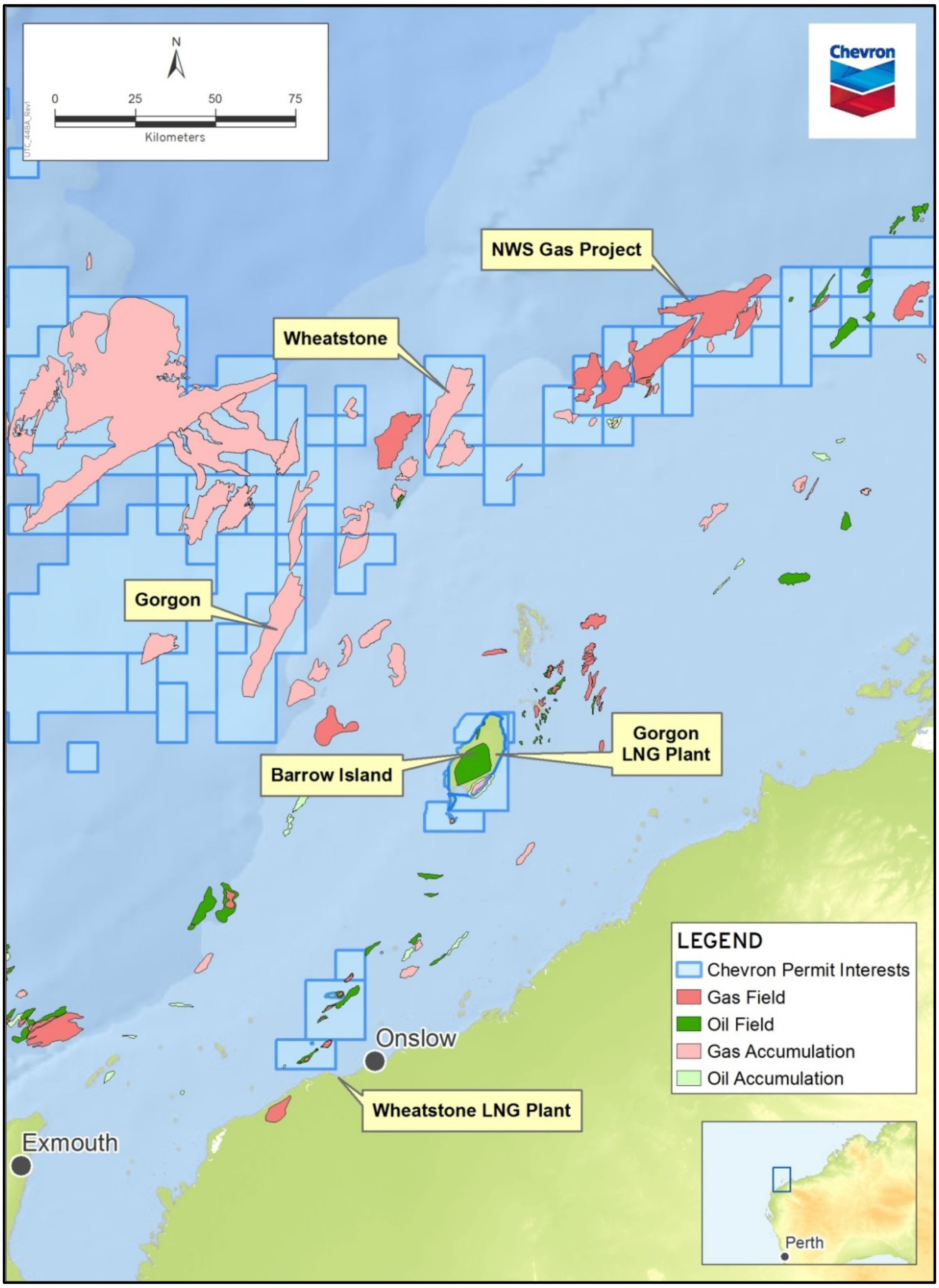


Figure 2-2: CAPL Operational Areas

2.3.2 Non-operational Areas

For areas not under CAPL operational control, access will be planned in conjunction with relevant statutory agencies (e.g. Western Australian [WA] Department of Transport [DoT]), other operators (e.g. Quadrant Energy for Varanus Island, Vermillion Oil and Gas Australia for the Montebello Islands), and WA Department of Parks and Wildlife (Parks and Wildlife) for locations managed by the Marine Parks and Reserves Authority (MPRA).

2.3.3 Permits

Individual operational monitoring plans have specific requirements for field sampling, with some plans requiring collection of biota. A sampling permit is required where biological samples are collected from the water column or seabed, or where an exemption is required to use a specific type of sampling gear. For operational monitoring, this applies to OPS8: Fish Tainting Assessment, under which live and dead fish specimens will be collected. Several different permits or exemptions will be required from different government departments, depending on where the sampling will be undertaken (based on the nature and scale of the hydrocarbon spill). Table 2-2 outlines the permits required and issuing authority. outlines the likely permits required for each monitoring component. Note: This does not include any entry or research permit requirements from the WA Department of Aboriginal Affairs (http://www.daa.wa.gov.au/en/Entry-Permits/EP_Y_PermitForm/).

Table 2-2: Permits Potentially Required to Support Operational Monitoring Plans

Government Approval / Permit Issuing Authority	Permit Reference	Permit Required For	Legislative Requirement
Parks and Wildlife	Application for a licence to take (i.e. capture, collect, disturb, study) fauna for scientific purposes in State Waters out to three nautical miles	Conducting scientific research (including filming and photography) in a State Marine Protected Area (MPA) in State Waters out to three nautical miles	*Wildlife Conservation Act 1950* (WA) and Regulations – Regulation 17
WA Department of Fisheries (DoF)	Application for exemption	Collecting virtually all marine biota (flora and fauna), whether alive or dead, anywhere in marine waters out to 200 nautical miles. Excludes aquatic mammals, aquatic reptiles, aquatic birds, amphibians, or (except in relation to Part 3 and Division 1 of Part 11) pearl oysters. Exemption for any non-standard equipment	Section 7 and Regulation 6 of the *Fish Resources Management Act 1994* (WA) and associated Regulations

2.4 Safety and Health

Safety and health is paramount in any oil spill response. CAPL has a strong safety culture that is part of daily operations. All the usual safety practices that CAPL personnel follow in their regular activities still apply during a spill response. In addition, special safety measures will be implemented to protect personnel from the risks associated with oil spill response activities.

The potential risks and hazards associated with operational monitoring are listed in Table 2-3. This information may be used to develop a Job Safety Analysis (JSA) before undertaking operational monitoring activities. Note: Each survey will have unique hazards associated with its monitoring activities. The hazards listed in Table 2-3 are not exhaustive.

Table 2-3: Potential Hazards Associated with Operational Monitoring Activities

Hazards	Impacts	Mitigation Measures
General		
Chemical Exposure to dispersant chemicals	• Eye irritant • Inhalation and ingestion hazard	• Exclude non-essential personnel from spray areas • Appropriate clothing and personal protective equipment (PPE) for essential personnel • Conduct vessel spraying from upwind • Buffer zones (0.5 nm for vessel application, 1 nm for aerial)
Sound Noise (85–90 dB(A))	• Hearing damage from prolonged exposure to loud machinery	• Hearing protection • Limit exposure
Motion Manual handling (including during use of monitoring equipment)	• Back strains or injuries	• Manual handling training • Weights clearly marked on labels • Lift-assist equipment and procedures
Gravity Slips, trips, and falls	• Injuries (cuts, bruises, fractures)	• Highlight risks during safety briefings • Appropriate footwear • Non-slip surfaces
Chemical Exposure to toxic components of oil (i.e. volatile organic compounds [VOCs]), H_2S)	• Health impacts: nausea, vomiting, fatalities in extreme cases • Explosive risk	• Air monitoring • Site entry • Respiratory protection and PPE
Biological Exposure to Irukandji (jellyfish) or other dangerous marine fauna	• Health impacts: severe pain, nausea, vomiting, fatalities in extreme cases	• Follow Marine Stinger Protective Clothing Best Practice Guidelines (Ref. 23) • Appropriate clothing and PPE
Motion Acute motion sickness	• Dehydration, inability to undertake assigned duties	• Premedication as needed
Aerial Operations		
Motion Injury from aircraft on airfield taxiing or starting engines	• Impact injuries • Possible fatalities	• Flight crew safety instructions and pre-flight briefings • Designated walking corridors on airfield
Gravity Emergency ditching of aircraft	• Injuries • Possible fatalities	• HUET and/or BOSIET training for all aerial observers • PPE: aviation lifejackets, survival suits, etc.
Motion Collision with other aircraft	• Impact injuries • Possible fatalities	• Communications plan • Flight crew briefing regarding simultaneous operations (SIMOPS)

Hazards	Impacts	Mitigation Measures
Vessel Operations		
Motion Unsecured loads on deck	• Potential crush injuries • Possible fatalities	• Properly secure all equipment to deck
Gravity/motion Person overboard	• Hypothermia • Drowning	• Use personal flotation devices (PFDs) on deck • Rails and restraints
Motion Vessel collision or grounding	• Hypothermia • Drowning • Impact injuries	• Vessel crew training • Navigational safety equipment
Motion Person struck by vessel/propeller during transfer (vessel to vessel or vessel to shore)	• Hypothermia • Drowning • Impact injuries	• Transfer procedures • Follow Vessel Master's instructions • Awareness of sea state and conditions
Temperature Fire on board vessel	• Burns or injuries • Possible fatalities	• Alarm systems • Firefighting equipment on board • Emergency fire procedures
Temperature Exposure to elements (hot/cold)	• Fatigue or confusion • Loss of consciousness • Heatstroke • Hypothermia • Possible fatalities	• Regular work breaks to cool down or warm up • Appropriate clothing and PPE • Hydration • Sun protection/shades
Mechanical Propeller entanglement during deployment of survey equipment	• Loss of navigation, stranding, grounding	• Vessel engines stopped or in neutral during deployment • On-board communications
Shore Operations		
Biological Contact with Irukandji or other dangerous marine fauna (stonefish, octopus, sharks, echinoderms)	• Health impacts: severe pain, nausea, vomiting, fatalities in extreme cases	• Follow Marine Stinger Protective Clothing Best Practice Guidelines (Ref. 23) • Appropriate clothing and PPE • Over-ankle hard-soled reef boots
Gravity Slips, trips, and falls, uneven ground, oiled surfaces, low visibility while wading	• Injuries (cuts, bruises, fractures)	• Appropriate clothing and PPE • Use PFDs if working near deep water (e.g. cliffs) • Over-ankle hard-soled reef boots
Temperature Exposed shorelines away from amenities Physical exertion	• Fatigue or confusion • Loss of consciousness • Hypothermia	• Regular work breaks • Appropriate clothing and PPE • Hydration • Sun protection/shades
Motion Person caught in rip, tide, or mudflats	• Hypothermia • Drowning • Heatstroke	• Awareness of sea state and conditions • Use PFDs

2.4.1 Personal Protective Equipment (PPE)

The work described in this document must be performed in compliance with minimum PPE requirements as defined in the ABU – Personalised Protective Equipment (PPE) Standard (OE-03.06.112; Ref. 24). For guidelines on PPE for working in the marine environment, refer to the Marine Stinger Protective Clothing Best Practice Guidelines (Ref. 23). For operational monitoring activities, conduct a risk assessment to determine the PPE required and consider items listed below as safeguards:

- wide-brimmed hat (safety hard hat when operating a crane on marine vessels)
- safety sunglasses
- PFD jackets (when working on a marine vessel)
- stinger suit (0.5 mm thickness or greater, worn under overalls or high-visibility clothing)
- over-ankle reef booties (not dive booties; should have grip on the sole)
- protective gloves suitable for entering water during intertidal work. Consider long lycra gloves, latex gloves, dishwashing gloves or a combination (without causing cross-contamination of samples)
- consider duct-taping PPE to wrists and ankles when contacting sea water.

2.4.2 Washdown for Marine Stinger Safety

Following exposure to marine stingers, particularly Irukandjis (i.e. exposure to salt water), clothing and equipment is to be washed down before disrobing. Vinegar washdown provides the greatest measure of protection. Fresh water may be used; however, particular care must be taken to not expose skin to potentially contaminated surfaces until these surfaces have been treated with fresh water for at least ten minutes. See Marine Stinger Protective Clothing Best Practice Guidelines (Ref. 23) for the Vinegar Washdown procedure.

3 Operational Monitoring

Operational monitoring is undertaken to:

- collect information about the oil spill and enhance situational awareness
- aid planning and decision-making in executing spill response or clean-up operations
- assess the impact on sensitive resources
- assess the effectiveness of response options.

Operational monitoring typically finishes when the spill response is terminated, usually because response objectives have been met and/or scientific monitoring has been initiated.

The primary objective of operational monitoring is to provide information that can be used in planning or carrying out a current spill response operation. The characteristics of operational monitoring are:

- results are generally required quickly
- lower requirement for statistical strength (e.g. smaller requirement for replicates at sampling locations and fewer locations)
- lower requirement for identifying control sites or demonstrating baseline conditions
- includes monitoring required before response activities will be approved by regulatory agencies (e.g. use of chemical agents, such as dispersants, or bioremediation agents)
- includes monitoring to help predict environmental effects or define the sensitivity of resources to guide spill response activities.

3.1 Designing the Monitoring Program

The text in this Section is from the Australian Maritime Safety Authority's (AMSA) Oil Spill Monitoring Handbook (Ref. 4); refer to that Handbook for more information. Appendix C contains an extract of the Oil Spill Monitoring Handbook that describes program design.

3.1.1 Setting the Objectives of the Study

Setting objectives is the first step in defining what a monitoring program needs to deliver. In its simplest form it is a statement of what the monitoring program seeks to measure (e.g. descriptive; measurement of change; determination of cause and effect), and defines the parameters to include in monitoring. When setting objectives it is important to understand how monitoring information will be used in the decision-making process. Some key aspects to consider when setting objectives are:

- What specific question(s) needs to be answered?
- Have knowledge gaps been identified and addressed?
- Have the limitations of not having information been evaluated?
- Will the information gathered address major stakeholders' needs?
- How will the information be managed and communicated?

- Do specific objectives:
  - Clearly and concisely communicate the purpose of monitoring?
  - Specify what the monitoring will achieve?
  - Indicate when the monitoring is complete?

3.1.2 Responsibility for Setting Objectives

For OPSs, primary objectives will generally be determined by the CAPL EMT Incident Commander or other nominated person within the EMT. Responsibility for designing or developing a monitoring program is assigned to the EUL who manages the monitoring team. The monitoring team(s) will collect the information needed to meet the set objectives.

3.1.3 Determining the Scale of the Program

It is important that the monitoring program reflects the scale and potential effects of the spill, and addresses key environmental issues relevant to the spill. The appropriate scale for a program will be determined largely by the specific objectives of the program. If variability is high, the time and resources required to reliably detect an impact may require a large monitoring effort. The need for such effort must then consider whether the objective of the study is of sufficient importance to justify the monitoring needed, i.e. the time and resources required may be considered 'unreasonable' unless the objective of the study is of high importance.

3.1.4 Setting the Spatial Boundaries of the Study

The spatial boundaries of a monitoring study will depend primarily on the actual or potential area affected by the spill. Spatial boundaries should be sufficient to meet monitoring objectives; usually set by determining impacted areas and the level of effects, linking effects to the spill source, and supporting decisions on clean-up options.

The boundaries should also be sufficient to cover representative areas of each:

- type of substrate
- ecological community
- shoreline energy level
- degree of oiling
- clean-up method used
- reference area.

Compromise and constant review of priorities may be necessary as OPSs are usually designed and executed during an emergency situation where time and resources are likely to be limited.

3.2 Data Management

Sampling data, and assessments of that data, need to be conveyed to the appropriate response team personnel and decision makers in a suitable time frame and in a simple and usable form. This requires developing mechanisms for ensuring that information is presented appropriately and on time. Field data collected can be obtained in various forms:

- results from field sampling and observations
- forms
- photographs
- videos
- maps
- notebooks and logs
- portable global positioning system (GPS)/geographic information system (GIS) units
- verbal transmission
- Chain of Custody forms
- laboratory reports
- samples (biological, sediment, or oil).

Photographic and video evidence ranging from coastlines to detailed quadrats are a useful operational monitoring tool. Photo documentation has the advantage that skilled interpretation of data can be done later, remotely, and be centralised; such documentation is a fast and relatively inexpensive data collection process.

Whatever the format, it is essential that data are quickly and effectively stored and transmitted, and that the accuracy of the collected data, and of any consequent analysis, is optimised.

All data should be backed up as soon as possible. This applies to data as it is acquired in the field, as it is transmitted, and when it is compiled and stored. Reliance on a single copy of data, whether on paper or digitally recorded, should be avoided. Note: Data collected as part of any OPS will be used as part of the legal record of the incident and subsequent response effort. Therefore, data management should be comprehensive, well organised, and appropriately analysed.

Appendix D is an extract from the AMSA Oil Spill Monitoring Handbook (Ref. 4) that provides a guide to data management.

3.3 Laboratory Analysis

Hydrocarbon analysis will be undertaken by an appropriate laboratory, with (where possible) National Association of Testing Authorities (NATA) accreditation for the analytes of interest or a robust QA/QC program. It is the responsibility of the Operational Monitoring Officer to ensure correct laboratory requests, deliveries, and reports are obtained.

3.4 Laboratories

CAPL has contracts in place with these laboratories:

Australian Laboratory Services (ALS)

26 Rigali Way
Wangara WA 6065 Australia

Chevron Client Services Manager
Direct phone: +61 8 9406 1301

Chemistry Centre of WA (ChemCentre)

Resources and Chemistry Precinct
Corner of Manning Road and Townsing Drive
Bentley WA 6102 Australia

Reception: Level 2, South Wing, Building 500

Deliveries: Ground Floor, use Conlon Street entrance

Chevron Account Manager
Direct phone: +61 8 9422 9966

Before engaging ChemCentre or ALS, these tasks must be undertaken:

1. A quote must be prepared by the laboratory once there is agreement of service requirements. Supporting information that can be provided to the laboratory when requesting a quote is available in Template Request for Chevron Lab Services (ABU140601604; Ref. 25; see also Appendix F).
2. The Monitoring Coordinator must submit a Purchase Requisition to get a Service Request in the Chevron Ariba System.
3. A Service Request number must be supplied to the field team collecting the sample for use in Chain of Custody Form.
4. The Chain of Custody Form (Appendix F) should stipulate that the report is sent to the Monitoring Coordinator and EUL.

Services can be directly engaged by CAPL personnel or by selected Environmental Contractors (with support from a CAPL contact to arrange the Service Request). Additional information regarding the correct communication process between CAPL, contracted laboratories, and any environmental contractors engaged to undertake monitoring is outlined in the ABU Contracts for the Provision of Laboratory Services – Contractor Information document (ABU140601602; Ref. 26).

The standard turnaround times for return of the analytical report is five to ten days from receipt of samples at the laboratory. However, reduced turnaround times can be requested with appropriate notice, although a surcharge applies, as outlined in Table 3-1. Note: Shorter turnaround times may not be available for some analytes due to holding time requirements for particular analysis.

Table 3-1: Surcharge Rates for Expedited Turnaround Times for CAPL Contracted Laboratories

Turnaround Time Surcharge	ALS	ChemCentre
Same day	100% sample cost	Not available
1 day	40% sample cost	100% sample cost

Turnaround Time Surcharge	ALS	ChemCentre
2 day	25% sample cost	50% sample cost
3 day	none	none

3.5 Monitoring Capability

CAPL has contracts in place with environmental consultancies to provide services for operational monitoring. As contracts change from time to time, the initial determination of the suitable contract should be sought from the HES Supervisor – Environment.

The level of services provided by these consultants in relation to OPS1–OPS8 are:

- skills and expertise available within the organisation to execute the plan
- resources available, including the number of personnel with skills within the organisation for field deployment and office/laboratory support
- access to the required equipment for quick activation
- ability to mobilise teams on short notice.

4 OPS1: Oil Characterisation

4.1 Rationale

OPS1 provides quantitative information on the chemical properties of the oil, which helps the EMT select the most effective response option(s). It requires samples of the oil to be collected and analysed.

Operational monitoring for the nature and behaviour of oil during a response is essential to:

- allow ongoing assessment of the effectiveness of, and any negative side-effects of, specific treatments that are applied, such as chemical dispersion or shoreline cleaning techniques
- provide in-field information on the oil properties, behaviour, and weathering of the spilt oil to assist in spill response operations.

Oil characterisation helps quantify the physical and chemical properties of the oil, which determine how the oil will behave in, and interact with, its receiving environment. This information helps the EMT select the most suitable response options.

Depending on the nature of the spill, ongoing oil characterisation sampling may be required throughout the spill. For this Guidance Note, standard processes will focus on the first-response sampling. Further oil spill characterisation sampling may be required (e.g. vertical water column profiling), which will be supported by external environmental consultants.

This monitoring component will be co-mobilised with OPS3: Oil in Water Assessment in most instances and will be the first operational monitoring component implemented when the OSMP is initiated.

4.2 Initiation and Termination Criteria

The initiation and termination criteria for this OPS are provided in Section 4 of the OSMP. Implementation times for this OPS are directly linked to the initiation criteria and are found in the same section of the OSMP.

4.3 Monitoring Design

This monitoring activity requires a sample of the spilt oil to be collected, and in-field observations made. The appropriate design of this activity will vary between situations depending on:

- Size of the spill
- Knowledge of the source of the spill
- Location and access to the spill
- Weathering rate of the oil
- Potential environmental and economic consequences of the spill
- Requirements to test specific response methods that may affect oil or be sensitive to the oil properties (e.g. Testing chemical dispersants)
- Requirements to inform the public or other stakeholders
- The availability of human resources, suitable vessels, and other logistics

- Capacity for transporting samples from the site (e.g. By helicopter or vessel)
- Safety considerations.

A defined, incident-specific sampling and analysis plan should be in place before conducting fieldwork. A First Strike Sampling and Analysis Plan Template (ABU180500476; Ref. 36) has been developed to provide guidance and instructions for implementing first-strike sampling and analysis, under the requirements of this operational monitoring component and within the initiation times listed in the OSMP. This plan provides a template to be completed by those implementing the OSMP. Once relevant details on the spill become available from the Emergency Management Team (EMT) the template can be completed and will become a sampling and analysis plan that can be issued to the sampling team for use.

The Operational Monitoring Officer along with Technical Advisors (as required) will be required to finalise this template.

When finalising the template, the following points should be considered:

- Move sampling locations, as required. Because the primary objective of this monitoring program is to assess changes in the properties of the oil over time, move sampling locations with the slick and/or plume based on the MES activities of aerial surveillance, visual observations, and oil satellite tracking buoys.
- Plan the number of locations and samples to be collected, taking into account level of effort, potential logistical limitations, weather conditions, etc. that may compromise sample integrity.
- Contact the laboratories that will receive the oil samples for analysis to ensure they have the capacity to receive and analyse samples from the study. Follow relevant guidelines from the laboratory and consult with them about necessary modifications.
- Adjust the sampling strategy, as required. The sampling strategy should have flexibility to be adjusted based on conditions in the field.
- When sampling in remote areas with limited shipping capabilities, plan to make sure that the integrity of samples is not compromised by ensuring that the processing laboratory receives the samples within their recommended holding time. It may take several days for shipments from remote areas to reach a laboratory facility. This last stage is the most important and requires due diligence until the samples are safely delivered. (Ref. 20).
- Collect floating oil using an oleophilic sampling device that selectively collects oil, or carefully skim with a narrow-neck flask to minimise mixing with the water immediately below the slick, which may contain soluble hydrocarbons or other components that would contaminate the floating oil sample.
- Take multiple samples, as required. The sample taken should be representative of the oil. If the slick varies in appearance, or if more than one oil may be present, then multiple samples need to be taken.
- Consider the size of the slick, source of spill (number of potential oils present), and distribution (number of locations) of slick.
- Determine the type of containers and the amount of the sample needed (see Appendix E). The total volume of sample and the containers required should be determined before field activities commence. It is better to divide a single

sample than to take multiple samples from a slick, particularly if more than one oil could be involved or the oil is highly variable.

- Decide the platform to sample from (response/other vessel, shoreline).
- Consider the potential for contamination from response vessels (e.g. bilge outlets, exhausts), logistics, weather, and other safety considerations (staff training and experience) (Ref. 4).
- Measure the physical parameters of the water in the vicinity of the oil slick; this will provide important information on the behaviour of the oil in water. See OPS3 for measuring the physical water parameters.
- Sampling at depth may be required for subsurface oil slicks. This can be achieved using a Niskin bottle or similar device that allows remote opening and closing. Alternatively, samples can be pumped from defined depths using a hose suspended vertically.
- Collect at least three replicates (three complete samples) to allow assessment of local variability in oil properties and to allow for QA/QC.
- Prepare and transport discrete samples within holding times (there is potential to increase time frames if solvent extracts are prepared) to a suitable NATA-accredited laboratory for analysis.

Visual indicators of the floating oil properties should also be taken and recorded on Form 4 (in Appendix F), and should include:

- The colour and optical effects generated by surface films—indicating the local concentration of oil that is present—judged using the standardised Bonn Agreement Oil Appearance Code
- The general flow properties at ambient temperatures indicated by the tendency to spread and flow freely (pour point > ambient sea temperature) or to clump and solidify (pour point < ambient sea temperature)
- The formation of water-in-oil emulsions (referred to as mousse) revealed by a characteristic change in colour (typically to a brown/orange colour), sometimes with a foamy appearance
- The formation of solid sheets or balls indicating that the more volatile components have evaporated from the slick, leaving a waxy residue
- Evidence of submergence indicating that the oil film is at a similar or greater density to the ambient sea water.

4.4 Resources

This monitoring component requires specific technical and general equipment to adequately collect water samples and physicochemical profiles for chemical screening. All equipment required is listed in the First Strike Sampling and Analysis Plan Template (ABU180500476; Ref. 36).

Where possible, equipment should be wet-tested in an uncontaminated area before mobilising to site.

4.5 Standard Operating Procedure – Field Sampling

Sampling techniques will vary depending on the type and location of the oil to be collected. Some considerations are consistent across all techniques:

- All sampling and storage equipment should be stainless steel, Teflon, glass or other non-plastic material.
- Avoid plastics as plasticisers may mimic the anolytes in analysis and give false results.
- Use clean equipment at each sample site to avoid cross-contamination. If equipment requires cleaning, wash with a detergent and triple rinse with distilled water.
- Unless prescribed differently by the laboratory for specific analyses, each oil sample should contain 10 mL to 200 mL of oil, and jars are not be filled more than ¾ full to allow room for liquids to expand with temperature changes. Sorbent films or light, volatile oil samples should fill the jar to reduce evaporative loss (see Ref. 5)

Step	Standard Operating Procedure – Field Sampling for Oil Characterisation	Completed
1	Confirm all required resources are available and ready to use.	☐
2	Familiarise team members with sampling design and allocate tasks required to be completed, such as sample collection, data recording, photography.	☐
3	Conduct safety assessment of task and JSA	☐
4	Commence data entry into the Oil Sampling Form (Form 4 in Appendix F)	☐
5	Using the sample jar or other sampling device, take samples from the thickest part of the slick or film. This is usually the ‘leading edge’ of the slick.	☐
6	If sampling from a vessel, use a grab pole or similar to take a sample from the bow, or at least to the forward, of the vessel and avoid contamination from vessel engines.	☐
7	Collect three replicate samples from each site (i.e. Site 1; samples A, B, and C), record the location with a GPS and mark the collection site on the sampling form (Section 4.7)	☐
8	For films/sheens, use a piece of sorbent material to soak up the oil film. This can be passed through the film several times. Place a piece of unoiled sorbent in a sample jar as the control and label accordingly (this is additional to the three replicates). For thin slicks and sheens, collect water samples (at least 1 L) and samples using oleophilic materials. Depending on the thickness of the slick, it may be more appropriate to use sorbents and Teflon swabs to sample the slick. Both materials will repel water and adsorb hydrocarbons when moved through the water. The material should then be placed in the sample jars with an unused piece of the material in a separate jar to be sent as a control to analysis. Chemically treated sorbent pads should not be used to sample slicks (Ref. 5).	☐

Step	Standard Operating Procedure – Field Sampling for Oil Characterisation	Completed
	 **Figure 4-1: Example of a Sheen** *Source: Ref. 5*	
9	Shoreline sampling of stranded oil is relatively simple; however, it is important to try to limit the amount of non-oiled material in a sample. Do not fill sample jars more than ¾ full. Methods include directly scooping oiled sand into the jar using the jar itself or by scraping oil off sediment and debris using a wooden scraper or metal ruler. Use a clean scraping tool for each sample to avoid cross-contamination. Place oiled debris such as small stones and some vegetation directly into the jars. Sampling field team members are not to handle dead or live oiled animals. Immediately contact the EUL to arrange for oiled wildlife responders to address the issue. (Ref. 5)	☐
10	Place samples into laboratory-provided jars/bottles and seal. Fill the sample to approximately ¾ full if the oil is heavy or weathered. Expansion of the sample should not be a problem if samples are chilled properly. Sorbent films or light, volatile oil samples should fill the jar to reduce evaporative loss.	☐
11	Label jars/bottles immediately with: • sample number or code • sample description (oil, debris, thick slick, film etc.) • time and date (24-hour clock and DD/MM/YYYY) • location (GPS coordinates; place names e.g. Sandy Island – western side) • full name of person taking sample • full name of witness (if sample is for legal purposes)	☐
12	Record the above information on a sample log (Form 4 in Appendix F). Reference any photographs taken or other observations on the log. Take photographs throughout the sampling process of: • the sampling area • the sampling site • the sampling jar before the sample is collected • the sampling process • the sample jar with contents and being sealed • the sealed and secured sampling jars in the case • the completed paperwork • the sealed and secured case on completion of the sampling. If samples have been given to a Vessel Master, a photograph should be taken of the samples in the Master's possession. Keep a log of what photographs were taken to assist with compiling the documentation at a later time. (Ref. 5)	☐

Step	Standard Operating Procedure – Field Sampling for Oil Characterisation	Completed
13	Place samples in a small esky with frozen ice pack. Transfer to refrigerator if possible for storage at 4 °C.	☐
14	Complete Chain of Custody forms (Appendix F)	☐
15	Send samples to the laboratory as soon as possible (within 24 to 48 hours if possible). Preservation techniques and sample holding times are listed in Appendix E.	☐

4.6 Reporting

- All data collected is to be analysed within the Planning Unit to achieve the OPS1 objectives.
- All data collected is to be collated for the Planning Officer for integration into the Incident Action Plan (IAP).
- All data collected is to be made available to the Monitoring Coordinator for initiation of the Scientific Monitoring (if applicable).

4.7 Forms and Tools

Refer to Appendix F for the forms required to undertake OPS1:

- Form 1 – Chain of Custody Form
- Form 2 – Freight Consignment Form
- Form 3 – OPS1: Oil Characterisation – Oil Sampling Form.

5 OPS2: Chemical Dispersant Efficacy Assessment

5.1 Rationale

OPS2 provides the EMT with information on the efficacy of the chemical dispersant applied to the spilt oil. Note: This OPS is only for the full-scale efficacy assessment of dispersant and does not cover any laboratory or shipboard (e.g. ‘shake jar test’) field-testing. CAPL personnel would be likely to conduct Tier 1 Special Monitoring of Applied Response Technologies (SMART) Monitoring Protocol in the first instance. Tier 2 and 3 monitoring will be conducted by external agencies, and will be implemented based on the size and nature of the spill, the effectiveness of Tier 1 monitoring, and the need for more accurate analysis of dispersant efficacy

5.2 Initiation and Termination Criteria

The initiation and termination criteria for this OPS are provided in Section 4 of the OSMP. Implementation times for this OPS are directly linked to the initiation criteria and are found in the same section of the OSMP.

5.3 Design

5.3.1 Surface Dispersant Application

The SMART protocol is a field tool for monitoring the effectiveness of dispersants. The SMART protocol suggests three tiers of monitoring (Note: the SMART tiers are NOT related to the tiered concept of oil spill response) (Ref. 6) and are described in Table 5-1.

Table 5-1: SMART Protocol for Dispersant Efficacy

Tier	Description
Tier I	This monitoring is usually performed after the ‘shake jar test’. If the shake jar test is effective, then a ‘test spray’ is done before full-scale deployment of dispersant spraying. Tier 1 involves visual monitoring (refer to the Visual Observation Dispersant Monitoring Handbook [Ref. 6]), which gives rapid results until additional resources and equipment are deployed to conduct Tier II and III monitoring.
Tier II	Combines visual monitoring with on-water teams conducting real-time water column monitoring (using the fluorometer) at a single depth and collecting water samples for later analysis.
Tier III	Expands on the Tier 2 water monitoring to meet the information needs of the incident. This may include monitoring at multiple depths (using the fluorometer) and also taking water quality measurements or more extensive water samples.

(Source: Ref. 6)

Note: CAPL personnel would only be required to undertake Tier 1 Monitoring, which includes visual observations only. Tiers 2 and 3 Monitoring will be undertaken by trained and experienced third parties because specialised equipment is required.

The SMART tiers may merge during a response. For example, personnel may monitor at multiple depths without taking samples if no laboratories are available to analyse samples.

The Tier 1 SMART Monitoring Protocol involves visual observation from an aerial or vessel platform (whichever is available) to determine whether applying dispersant to the spill appears effective. Table 5-2 lists some of the advantages and disadvantages for each platform.

Table 5-2: Suitable Platforms for Tier 1 Visual Monitoring: Advantages and Disadvantages

Platform	Advantages	Disadvantages
Fixed installation or vessel	• Assets are relatively readily available	• Using a vessel or installation to survey from provides a very limited field of view
Fixed-wing aircraft	• Faster transit times than a helicopter • Longer endurance than a helicopter • Less expensive than a helicopter • More seats available than on a helicopter (per unit cost) • More readily available	• Depending on position in aircraft, view could be obstructed
Helicopter	• More manoeuvrable than fixed-wing aircraft • Fly slower and able to loiter, unlike fixed-wing aircraft • Ability to land 'off airport' • Unobstructed visibility	• Short endurance

(Source: Ref. 6)

5.3.2 Subsea Dispersant Monitoring

Subsea dispersant injection is an effective and efficient response option; however, some of the oil may still rise to the surface and therefore the SMART Monitoring Protocol will continue to be used in conjunction with subsea dispersant monitoring methods.

Subsea dispersant application and monitoring will be undertaken by third-party support agencies with expertise in this response method. Development of the subsea dispersants monitoring plan will be undertaken in consultation with Chevron Corporation Worldwide Emergency Response Resources. The subsea dispersants monitoring program must align with the Industry Recommended Subsea Dispersant Monitoring Plan (Ref. 7).

Subsea dispersant monitoring will include these monitoring 'phases':

- Phase 1: Assessment of subsea dispersant effectiveness and reduction in surface VOCs
- Phase 2: Characterisation of dispersed oil concentrations in the water column
- Phase 3: Assessment of potential for ecological effects.

Phases 2 and 3 will follow the methods outlined in the Industry Recommended Subsea Dispersant Monitoring Plan (Ref. 7). Phase 3 will rely on data obtained in OPS1 and OPS3. The ecological effects will be assessed by comparing water quality data obtained in these operational monitoring components (including, but not limited to, total petroleum hydrocarbons [TPH] and dissolved oxygen [DO]) to toxicity benchmarks, which, when combined with the distribution of sensitive of receptors and forecast oil movement, will be used to determine the extent of any adverse environmental effects of using subsea dispersants versus leaving oil to disperse naturally. This information will be fed into an operational NEBA assessment used for decision-making regarding the continuation or termination of subsea dispersant use.

Initially, the hydrocarbon plus dispersant ecotoxicity benchmark will be based on:

- Lethal concentration for 50% of the test species (LC50) = 10 ppm TPH
- No Observed Effect Concentration (NOEC) = 1 ppm TPH.

Threshold data sourced from the United States Environmental Protection Agency (Ref. 27).

The benchmarks are based on best-available literature and may be updated if new information becomes available. Note: These benchmarks will only inform the area/receptors likely to be impacted under different response scenarios (and inform NEBA) and will not trigger a termination of subsea dispersant injection.

During an uncontrolled release, toxicity testing of hydrocarbons and/or hydrocarbons plus dispersants will be used to validate assumptions made when determining literature-based toxicity benchmarks, or to refine these benchmarks where appropriate.

Measurements of DO will be assessed against an ecotoxicity benchmark of:

- 4.6 mg/L, which corresponds to a 90% species protection
- median lethal oxygen concentrations for 50% of species (LC50) = 2mg/L.

Data sourced from Vaquer-Sunyer and Duarte (Ref. 28).

Note: DO concentrations naturally vary with depth and may occur below 4.6 mg/L, typically in mid-water (mesopelagic zone) environments (e.g. at depths ~300–500 m [Ref. 29]). Therefore, in an Operational NEBA assessment, DO concentrations measured at a potential impact zone would need to be considered against natural DO concentrations (e.g. using controls or available literature) when determining adverse environmental effects.

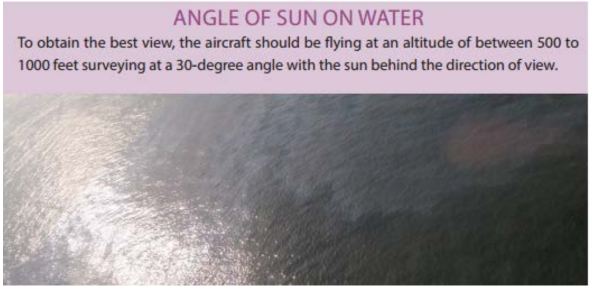
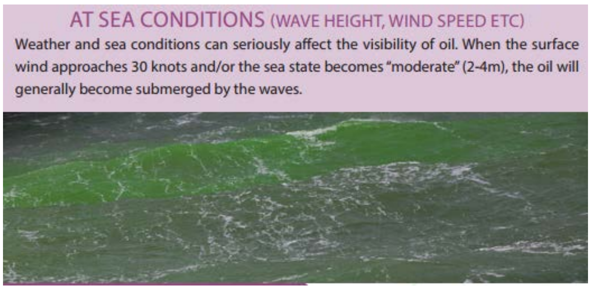
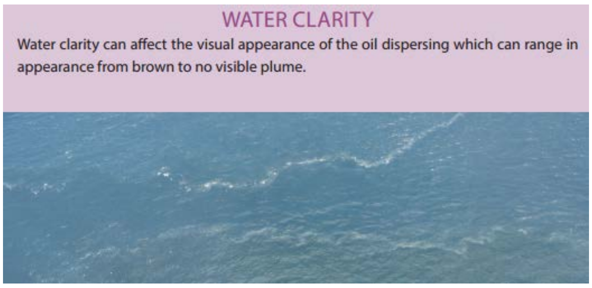
5.4 Resources

5.4.1 Tier 1 Surface Dispersant Efficacy Monitoring

Item (per team)	Check
Sampling platform (vessels must be in survey for commercial use)	☐
Specialist sampling team (2 to 3 people) – if using CAPL personnel, one or more Oil Spill Offshore Specialists should be included in this team	☐
Digital camera and/or video recorder	☐
Handheld GPS	☐
Compass (may be useful to orientate when in flight)	☐
Spare batteries	☐
A method of communication with the crew (vessel/aircraft, including spray vessels/aircraft)	☐
Stopwatch	☐
High-visibility jacket/vest may be required on the airfield (once in flight, remove to minimise glare; it is also advisable to wear clothes that are dark or neutral in colour)	☐
Form 5 (Surface Dispersant Monitoring Form) and Form 6 (Visual Dispersant Monitoring Form) in Appendix F	☐

(Source: Ref. 6)

5.5 Standard Operating Procedures – Tier 1 Surface Dispersant Efficacy Monitoring

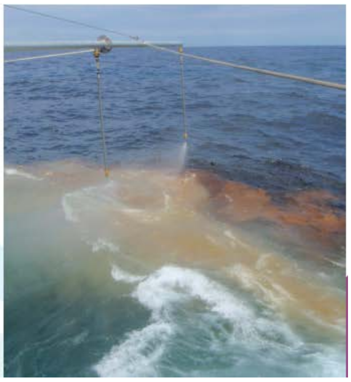
No.	SOP – Field Sampling for Oil in Subtidal Water Assessment
Pre-work	
1.	Receive tasking information. This information may be provided verbally or on a form, and include the purpose of the mission (e.g. to determine through visual observation whether dispersant application appears to be effective or not). Although this seems like a relatively straightforward task, several factors or natural phenomena may confuse the pictures at monitoring sites such as: • Angle of the sun on water  • Weather  • Sea state  • Water clarity  • Dispersant dosage rates • Time between application and monitoring
2.	Conduct a pre-mission briefing to provide operational details, such as: • location of the area of operation

<table>
<tr><th>No.</th><th>SOP – Field Sampling for Oil in Subtidal Water Assessment</th></tr>
<tr><td></td><td>

objective of the flight
roles and responsibilities of each of the survey crew
radio frequencies used in the area and on the response
call signs of other aircraft that are operating in the vicinity
locations of any temporary or permanent exclusion zones
health and safety points of note for the vessel or aircraft being used

</td></tr>
<tr><td colspan="2">NOTE: Wherever possible, and as soon as it can be made available, fluorometry and/or particle analysis should be used in support of the Tier 1 observation. This equipment can help quantify the effectiveness of the spray operation by determining whether the ratio or amount of suspended oil particles in the water column has increased significantly following dispersant application. Expert external personnel will undertake this monitoring as per the Tier II and III SMART Monitoring Protocol.</td></tr>
<tr><td colspan="2">Conduct Visual Dispersant Effectiveness Monitoring</td></tr>
<tr><td>3.</td><td>
Record all observations on the Visual Dispersant Observers Log Form (Form 6 of Appendix F)
Indications of effective dispersant operations
Visual indicators that show the dispersant is effective:

yellow/coffee/grey colour plume present in the water (the exact colour will vary with original colour of the oil)
oil spill surface area reduced
oil rapidly disappearing from the surface
oil in some areas being dispersed to leave only sheen on the surface.

OIL APPEARANCE POST DISPERSANT APPLICATION
Described as '3' on the Visual Dispersant Observers Log Form.
NOTE: Colour changes may not been seen immediately; allow time (e.g. 10 to 40 minutes) for dispersion to occur, particularly for more viscous oils.
  
Indications of ineffective dispersant operations
A milky white plume will be present if:

too much dispersant is applied (overdosing)
there is poor targeting of the spill area
if the spilt oil is heavy or emulsified, the dispersant may not penetrate the oil running off into the unoiled water
dispersant is washed off the black oil as a white, watery solution leaving oil on the surface
quantity of oil on the sea surface is not altered by dispersant

OIL APPEARANCE POST DISPERSANT APPLICATION
Described as '1' on the Visual Dispersant Observers Log Form.
</td></tr>
</table>

No.	SOP – Field Sampling for Oil in Subtidal Water Assessment

Applying too little dispersant (underdosing) will make the spray run ineffective and there will be no visible effect on the oil other than possibly temporary herding.

Underdosing is recognisable through:

- some surface activity (oil appearance altered)
- droplets of oil seen rapidly rising back to the sea surface, but overall quantity appears to be similar to that before dispersant spraying.

OIL APPEARANCE POST DISPERSANT APPLICATION

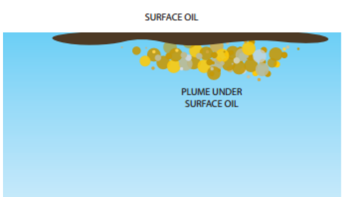
Described as '2' on the Visual Dispersant Observers Log Form.

Oil will remain on the sea surface in its normal state. Careful observations must be made as the effect from a bow wave and herding of the dispersant may be misleading and give false impressions (negative or positive) of effective application.

False Negatives: Where it is wrongly concluded that little or no dispersion is occurring.

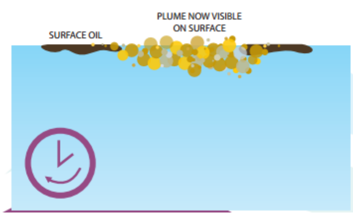
DISPERSED PLUME UNDER REMAINING SLICK

The dispersed oil plume may be hidden by the remaining surface oil giving the impression that the dispersant application has no effect. This is unlikely to persist for any prolonged period.



DISPERSED PLUME REQUIRES TIME TO FULLY DEVELOP

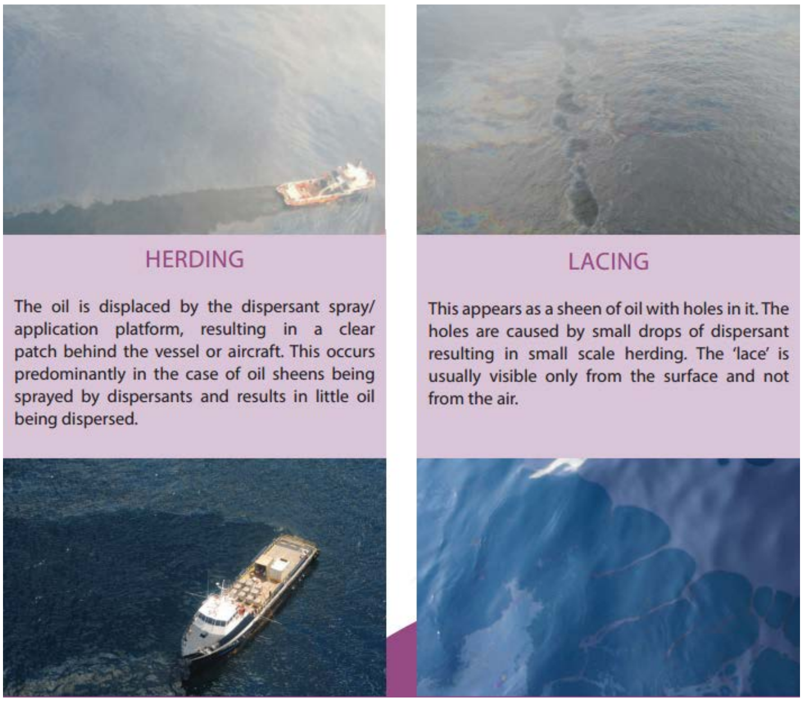
It may be several hours after the application of dispersant before it begins to be visibly effective. If emulsification occurs a visible plume may not be present, although the emulsion may be seen to "break" (turn from a thick chocolate mousse consistency to visually darker and less viscous substance).



POOR VISIBILITY CONDITIONS

The dispersed plume is not highly visible and can be obscured by haze or fog.

No.	SOP – Field Sampling for Oil in Subtidal Water Assessment
	False Positives: Where it is wrongly concluded that dispersion is occurring. OIL APPEARANCE POST DISPERSANT APPLICATION Described as '4' on the Visual Dispersant Observers Log Form.



(Source: Ref. 6)

Key points

- Ideally aerial support is needed to help locate areas near the spill that will be targeted for chemical dispersant and areas that are clear of surface oil.
- Ensure that the oil thickness, oil condition etc. are recorded by the Aerial Surveillance Specialists as per the Bonn Agreement Oil Appearance Code.
- The dispersant may take 10 to 40 minutes to affect the oil and may continue working for up to an hour afterwards.
- Communication with the dispersant application platform is essential to ensure that the monitoring vessel is positioned in the correct location.
- Record data using:
- GPS with waypoints (to mark positions of dispersant application)
- photographs (ideally georeferenced) for all stages of monitoring
- Visual Dispersant Monitoring Observer Log (Form 6 of Appendix F)

(Source: Ref. 6)

5.6 Reporting

Report (to incident command):

- unit/individual log

- location of the dispersant application (use a GPS to record the latitude and longitude)
- degree of weathering and thickness of the oil before dispersant application
- weather and sea state (dispersants require a degree of turbulence to promote mixing with the oil, although this can be created using the wake of a vessel)
- method of dispersant application
- time when dispersant was applied and time when any notable chemical dispersion was observed
- anything that has been or may be impacted by the oil or dispersant application such as marine mammals, fish coral reefs, etc.

5.7 Forms and Tools

Refer to Appendix F for the forms required to undertake OPS2:

- Form 5: Surface Dispersant Monitoring Summary Form – Tier 1 SMART Monitoring
- Form 6: Visual Dispersant Monitoring Observer Log.

6 OPS3: Oil in Water Assessment

6.1 Rationale

OPS3 provides the EMT with ongoing information on the water quality, in particular the distribution of oil in the water column, within the response areas. This information will help verify MES predictions and data.

6.2 Initiation and Termination Criteria

The initiation and termination criteria for this OPS are provided in Section 4 of the OSMP. Implementation times for this OPS are directly linked to the initiation criteria and are found in the same section of the OSMP.

6.3 Monitoring Design

In the event of a hydrocarbon spill, pre-emptive monitoring will, where practicable, be implemented to gather additional environmental data on the current condition of ecological receptors within the potentially affected area. The selection of sites and the extent and intensity of reactive monitoring will be confirmed before field sampling starts, as per the OSMP (Ref. 1). Ongoing sampling during operational monitoring will also use these sample collection methods.

A defined, incident-specific sampling and analysis plan should be in place before conducting fieldwork. A First Strike Sampling and Analysis Plan Template (ABU180500476; Ref. 36) has been developed to provide guidance and instructions for implementing first-strike sampling and analysis, under the requirements of this operational monitoring component and within the initiation times listed in the OSMP. This plan provides a template to be completed by those implementing the OSMP. Once relevant details on the spill become available from the Emergency Management Team (EMT) the template can be completed and will become a sampling and analysis plan that can be issued to the sampling team for use.

The Operational Monitoring Officer along with Technical Advisors (as required) will be required to finalise this template.

When finalising the template, the following points should be considered:

- Sampling at intertidal locations must coincide with tidal states that allow sampling to be undertaken on foot, in water less than waist deep.
- Sampling in offshore environments will occur from an appropriate vessel using diverless operations; this is determined by the Operational Monitoring Officer in the design of the monitoring program.
- For intertidal monitoring, sediment (OPS4) and water quality samples (OPS3) should be taken concurrently.
- Water quality monitoring will involve taking water samples for laboratory analysis, and recording in situ physical water quality parameters using a water quality probe. The physical water quality parameters will also feed into OPS1 to allow determination of oil behaviour in ambient water conditions. A defined sampling strategy must be in place before conducting fieldwork. The objective of water quality monitoring will be determined based on the nature of the spill and may include sampling reference sites, delineating the extent of hydrocarbons in water, determining the maximum concentration of

hydrocarbons in water, or determining the change in hydrocarbon concentrations over time.

- The terminology used to define general to specific sampling geographies is:
  - Location = a place that represents the area; it may include a visible hydrocarbon plume, or a bay or beach that generally comprises similar physical characteristics.
  - Site = a specific point within a location where samples are collected or observations are made.
- At least three sites should be sampled within each location.
- At least one triplicate sample (three complete samples at one site – e.g. Site 1 A, B, and C) should be taken at each location.
- Plan the number of areas and samples to be collected at each area, taking into account level of effort, potential logistical limitations, weather conditions, and other issues that may compromise sample integrity.
- The number of sampling locations and number of sites per location needed will be determined based on the sampling objectives.
- For water samples, sampling 'areas' can be defined as:
  - waterbodies with defined boundaries (such as lagoons, bays, or river mouths)
  - distances downcurrent from the release site (such as 0–5 km, 5–10 km)
  - waterbodies expected to have similar oil exposure based on observations or models (particularly plume models).
- Depending on the water depth, water samples may need to be collected at different depths. Generally, near-surface samples should be prioritised if the sampling effort is limited by logistics or other factors. In shallower water (<5 m), samples should be collected at just one near-surface depth. (Note: Do not exceed the depth rating of the instrumentation).
- Contact the laboratories that will be receiving field samples for analysis and confirm they have the capacity to receive and analyse samples from the study. Follow relevant guidelines from the laboratory and consult with them about necessary modifications.
- The sample volume required, along with the container type and required analysis, is listed in Appendix E
- Shoreline visualisation tools (e.g. GIS maps, satellite images, Oil Spill Response Atlas [OSRA; Ref. 30]) should be used to develop a sampling strategy and estimate distances, number of sampling sites, intertidal zone width, etc. before going into the field. The sampling strategy should have flexibility to be adjusted based on conditions in the field.
- Consult appropriate OPS guidelines (such as OPS4: Oil in Sediment or OPS1: Oil Characterisation) for the concurrent collection of other environmental media and biota when water sampling. If observed during water sampling, tar balls, sheens, or other oil residues can be collected opportunistically for chemical analysis and fingerprinting.
- The number of sampling locations and sites should be determined based on the nature of the spill. As a minimum, three sampling sites per location should

be used. In addition, at least one triplicate sample (three complete samples) should be taken at a minimum of one site per location.

(Source: Ref. 20)

Table 6-1 summarises the monitoring to be undertaken for each location. Water quality physical parameters only need to be recorded once per location, while hydrocarbon analysis should be undertaken at each site within a location. For a complete list of analysis, including sample volume, containers, and holding times, refer to Appendix E.

Table 6-1: Summary of Oil in Water Assessment Monitoring to be Undertaken in the Event of an Offshore Hydrocarbon Spill

Monitoring Component	Parameter	Location	Survey Method
Water Quality	Physical parameters: • salinity • temperature • DO • pH • total dissolved solids (TDS)	Subtidal	Probe
	Hydrocarbons: • Total recoverable hydrocarbons (TRH) • suites of VOCs and semi-volatile organic compounds (SVOCs)—SVOCs include polycyclic aromatic hydrocarbons (PAHs), phenols, phthalates, and chlorinated hydrocarbons • benzene, toluene, ethyl benzene and, xylenes (BTEX)	Subtidal and offshore	Niskin bottles
		Intertidal	Manual bucket or grab pole

6.4 Resources

This monitoring component requires specific technical and general equipment to adequately collect water samples and physicochemical profiles for chemical screening. All equipment required is listed in the First Strike Sampling and Analysis Plan Template (ABU180500476; Ref. 36).

Where possible, equipment should be wet-tested in an uncontaminated area before mobilising to site.

6.5 Standard Operating Procedures – Field Sampling for Oil in Water Assessment

No.	SOP – Field Sampling for Oil in Subtidal Water Assessment
Pre-work	
1.	Ensure the required sampling containers are available for use on site, with sufficient spares for ad hoc sampling
2.	Use GPS to navigate the team as close to the proposed site as possible
3.	Take an 'actual' GPS location to mark the sampled location
Survey physicochemical parameters	
4.	Prepare the water quality probe (e.g. YSI 6600 v2) for use, including battery check and calibration
5.	Holding the display, lower the probe into the water

No.	SOP – Field Sampling for Oil in Subtidal Water Assessment
6.	Position the probe end near the bottom (0.5 m above sediment) for the first reading
7.	Wait for the reading on the display to stop changing rapidly (1 minute) and record a reading for each of these parameters: salinity, temperature, DO, pH, and turbidity
8.	Raise the probe to 0.5 m below the surface level for another reading
9.	Wait for display to equalise (1 minute) and record a reading for each of these parameters: salinity, temperature, pH, and turbidity
10.	Sample at only one site per location unless the water seems highly variable
11.	At each subsequent location, triple-rinse all equipment submersed in water with site water before sampling
Collect water samples for laboratory analysis	
12.	Place vessel in neutral to avoid contaminating samples with hydrocarbons from the vessel's exhaust
13.	Fill out the label on the laboratory bottle (use permanent marker) with this information: • sample number (each sample container must have discrete number) • sample type (e.g. water) • date • analyses to be conducted (e.g. TPH) • location of sampling • depth of sample • time of collection • collector's name
14.	For sampling at depth, thread a Niskin bottle onto a hydrographic line following the instruction manual for the device
15.	Ensure that stoppers on both ends of the bottle are held open and that the release mechanism works before deploying overboard. Ensure the weight used to trigger the stoppers to close on the bottle is manually held on board around the tether
16.	Using measurements on the line to guide the depth of the bottle, lower the bottle using the tether until the bottle is at the desired depth
17.	When the bottle is at the correct depth, straighten the line and then drop the weight straight down the line to trigger the stoppers of the bottle to close
18.	Retrieve the bottle using the line and neatly coiling the tether as it comes on board
19.	Once the bottle is on board, rinse the glass laboratory bottle to ensure all surfaces are washed. Empty bottle. Rinse three times.
20.	Once rinsed, fill the laboratory bottle with sample water
21.	Complete the sample collection data sheet/Chain of Custody forms (see Appendix F)
22.	Place sample in a small esky with frozen ice bricks to maintain a temperature of 4 °C
23.	At one site per location, collect at least one triplicate (three complete samples)
24.	Sample at least three sites per location
25.	Collect at least one triplicate (three complete samples) from one site at each location (i.e. Site 1; samples A, B, and C)
26.	Once finished at the site, store the equipment safely and move to next site
27.	At each subsequent site, triple-rinse all equipment submersed in water with site water before sampling
28.	Send samples to the laboratory as soon as possible. Maximum holding times for analysis are listed in Appendix E

No.	SOP – Field Sampling for Oil in Intertidal Water Assessment
Pre-work	
1.	Ensure the required sampling containers are available for use on site, with sufficient spares for ad hoc sampling
2.	Use GPS to navigate the team as close to the proposed site as possible
3.	Take an 'actual' GPS location to mark the sampled location (see GPS manual for instructions on calibrating the GPS device and recording a location)
Collect water samples for laboratory analysis	
4.	Fill out the label on the laboratory bottle (use permanent marker) with this information: • sample number (each sample container must have discrete number) • sample type (e.g. water) • date • analyses to be conducted (e.g. TPH) • location of sampling • time of collection • collector's name
5.	Using a decontaminated bucket, wade in and carefully collect water from a depth of about 0.5 m (within the zone between low and high tides), then transfer the bucket to the beach
6.	Rinse the glass laboratory bottle/s to ensure all surfaces are washed. Empty bottle. Rinse three times.
7.	Once rinsed, fill the laboratory bottle with sample water and ensure there is no debris stopping the thread from sealing tightly
8.	Complete the sample collection data sheet / Chain of Custody forms (see Appendix F)
9.	Place sample in a small esky with frozen ice bricks to maintain a temperature of 4 °C
10.	Collect at least one triplicate (three complete samples) from one site at each location (i.e. Site 1; samples A, B, and C).
11.	Once finished at the site, store equipment safely and move to next site
12.	At each subsequent site, triple-rinse all equipment submersed in water with site water before sampling
13.	Sample at least three sites at each location.
14.	Send samples to the laboratory as soon as possible. Maximum holding times for analysis are listed in Appendix E

6.6 Reporting

- Record and report the results to the Monitoring Coordinator for integration into IAP development.
- Record results and handover to the Monitoring Coordinator for initiation of the SMPs (if applicable).

6.7 Forms and Tools

Refer to Appendix F for the forms required to undertake OPS3:

- Form 1 – Chain of Custody Form
- Form 2 – Freight Consignment Form

- Form 6 – OPS3: Oil in Water Assessment – Oil Sampling Form.

7 OPS4: Oil in Sediment Assessment

7.1 Rationale

OPS4 provides the EMT with ongoing information on the sediment quality, in particular the oil content, within the response areas. This monitoring is undertaken to better design shoreline clean-up methods, determine adverse effects from clean-up (e.g. shoreline washing/mechanical clean-up on shorelines), formulate priorities, and/or measure the effectiveness of clean-up activities.

Key considerations for oil in sediment assessment:

- oil may enter intertidal/subtidal sediment
- oiled sediment may release oil over time
- sediment often contains sensitivities of high value (biological, human uses, cultural, commercial)
- sediment is susceptible to oil impacts
- sediment may be directly impacted by response actions (e.g. shoreline washing operations including sediment reworking, high- and/or low-pressure washing).

CAPL personnel are likely to conduct surface and intertidal sediment sampling; however, offshore sediment monitoring will be performed by external agencies. This Section provides guidance for internal and external monitoring teams.

7.2 Initiation and Termination Criteria

The initiation and termination criteria for this OPS are provided in Section 4 of the OSMP. Implementation times for this OPS are directly linked to the initiation criteria and are found in the same section of the OSMP.

7.3 Monitoring Design

In the event of a hydrocarbon spill, pre-emptive monitoring will, where practicable, be implemented to gather additional environmental data on the current condition of ecological receptors within the potentially affected area. The selection of sites and the extent and intensity of reactive monitoring will be influenced by the nature and scale of the spill and will be confirmed before field sampling starts, as per the OSMP (Ref. 1).

A defined, incident-specific sampling and analysis plan should be in place before conducting fieldwork. A First Strike Sampling and Analysis Plan Template (ABU180500476; Ref. 36) has been developed to provide guidance and instructions for implementing first-strike sampling and analysis, under the requirements of this operational monitoring component and within the initiation times listed in the OSMP. This plan provides a template to be completed by those implementing the OSMP. Once relevant details on the spill become available from the Emergency Management Team (EMT) the template can be completed and will become a sampling and analysis plan that can be issued to the sampling team for use.

The Operational Monitoring Officer along with Technical Advisors (as required) will be required to finalise this template.

When finalising the template, consider these points:

- Sampling at intertidal locations must coincide with tidal states that allow sampling to be undertaken on foot, in water less than waist deep.
- Sampling in offshore environments will occur from an appropriate vessel using diverless operations.
- Sediment (OPS4) and water quality (OPS3) samples should be taken concurrently.
- The analytical parameters for sediment, along with the sample volume, container types, and holding times are listed in Appendix E.
- The terminology used to define general to specific sampling geographies is:
  - Location = a place that represents the area; it may include a visible hydrocarbon plume, or a bay or beach that generally comprises similar physical characteristics
  - Site = a specific point within a location where samples are collected or observations are made.
- At least three sites should be sampled within each location.
- At least one triplicate sample (three complete samples at one site – e.g. Site 1 A, B, and C) should be taken at each location.

Determining the survey method depends on the purpose of the survey. The AMSA Oil Spill Monitoring Handbook (Ref. 4) is used to provide guidance on the selection of survey methods. Figure 7-1 shows the decision tree for four onshore sediment sampling methods and Figure 7-2 is a copy of Methods S.8.1 to S.8.4, as outlined in the AMSA Oil Spill Monitoring Handbook (Ref. 4). Figure 7-3 lists subsurface sediment sampling guidelines from the Handbook (Ref. 4).

These guidelines can be used by the Operational Monitoring Officer when designing an appropriate operational monitoring program for subsurface and intertidal sediment sampling.

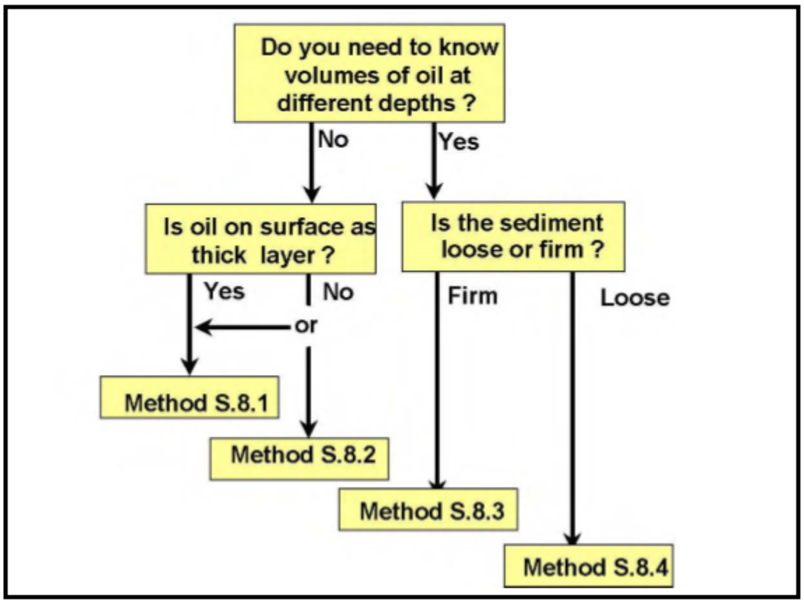


Figure 7-1: Selection of Sediment Sampling Methods

(Source: Ref. 4)

GUIDELINE FOR OBTAINING SEDIMENT SAMPLES — S.8

Rationale

Monitoring the extent and distribution of oil on shorelines is needed for planning shoreline response strategies, methods and cleanup. This procedure sets out the method for obtaining sediment samples.

Methodology

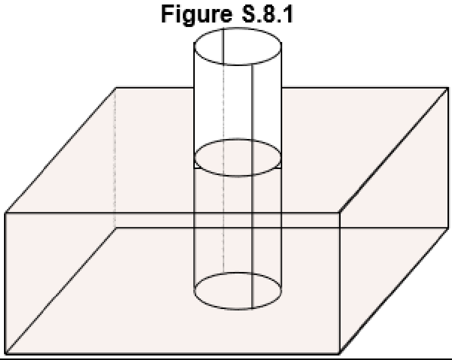
S.8.1 Push Core Sampling A

This method of sampling involves pushing a clean plastic tube down into the substrate and extracting a column, or "core" of sediment. It is suitable for most sediment conditions, but particularly when:

- *Oil is present on the surface as a thin layer (coat, stain, film).*
- *Oil penetrated to a fairly shallow depth (e.g. < 10 cm).*
- *Accurate measures of the amount of oil at various depths are not needed*

1	Push plastic tube into sediment. Generally the depth of sampling should not be more than two thirds of the length of the tube.
2	Seal the top of the tube and extract. A gentle gyration may be applied to facilitate this but avoid bending the tube.
3	If the sediment is wet or loose, or does not stick to the inside of the tube when extracted, it may be necessary to dig down beside the tube and block the bottom opening before removing the tube from the sediment. Alternately sealing the top of the tube with a bung can facilitate extraction of the core.
4	The core of sediment should be transferred immediately to a clean glass container.

Figure S.8.1



Equipment

The sampling tube can be constructed from a piece of PVC tubing. This should be split along its length so that it can be pulled apart and the core easily removed. The tube diameter should be about 5 cm (2"), giving a surface area of about 20 cm^2 and a core volume of 200 cm^3 for a 10 cm deep sample. Tubes should be cut to at least 30 cm lengths.

S.8.2 Push Core Sampling B

This method is essentially the same as Method 1, but is used when it is necessary to differentiate between surface oil and subsurface oil. This may be needed if attempting to determine, for example:

- *The amount of oil that could be removed by tidal action (i.e. surface oil) in low energy shores and oil likely to persist (i.e. subsurface oil).*
- *The rate of degradation of the oil. In this case the presence of relatively large amounts of surface oil could mask any observation of changes in subsurface oil (or visa versa).*

1	Scrape surface oil from a given area prior to pushing in the sampling tube.
2	Transfer this "surface sample" to a clean storage jar and record the area cleaned (square centimetres) and approximate depth of sediment removed (if possible).
3	Proceed as per S.8.1.

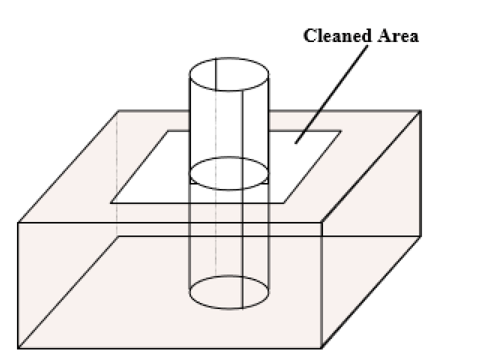


Figure S.8.2

Equipment

	A clean wooden or stainless steel scraper will be required.

S.8.3 Sediment Block Extraction

This method of sampling is used when an accurate measure of the amount of oil at various depths is needed. It is useful only for firm, and preferably dry, sediments. The method can be modified for wet consolidated sediments but some hydrocarbons will be lost with water draining from the samples.

1	If fluid oil is present on the surface it should be removed by scraping the oil from a measured area of sediment. This area should be slightly more than a 30 cm x 30 cm square.
2	With a flat spade, make a "U" shaped cut into the mud. The depth should be no more than 30cm (spade blade depth).
3	Place the spade in the bottom cut (base of the "U" shape) and lever up the block of sediment. Note a wedge may need to be cut below the base of the "U" and a pivot object used to facilitate the leverage.
4	The open edge of the "U" should break free. This is the uncontaminated edge of the core. Because this side has not been cut, no oil has been pushed along it from the surface, i.e. it is uncontaminated.

5	Samples from various depths can be taken by slicing into the back from this open edge. Care should be taken not to sample close to the three cut (contaminated) sides
6	Note: If water percolates down the core, the core can be laid on its side so that water, and associated oil, drains along the core gradient not down the gradient.
7	Place sediment samples into labelled clean jars.

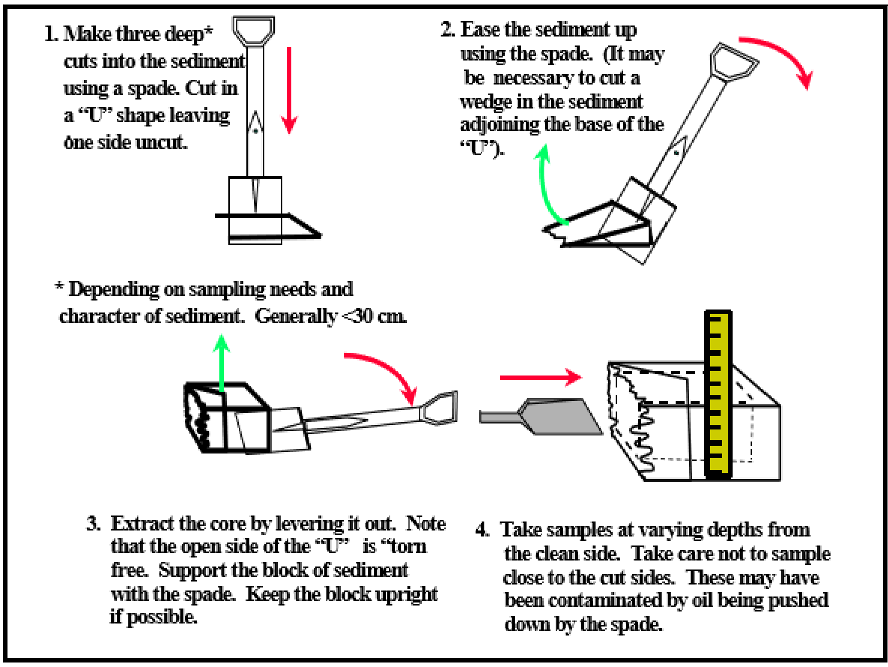


Figure S.8.3

S.8.4 Loose Sediment Extraction	
This method can be used in loose sediments such as gravel, pebbles or wet muds, where, if Method 2 is used, the core of sediment would likely collapse. It can also be used when or where the sediment particle size is too large for Method S7.1, S7.2 or S7.3.	
1	A metal perimeter is pushed into the sediment (surface oil can be left or removed as per earlier methods).
2	Sediment is then removed from inside the perimeter. This can be done as a composite sample, or layer by layer, depending on whether data from different depths are required.
3	The perimeter prevents the sides of the excavated pit from collapsing and contaminating lower sediment layers with upper sediments, and also limits the seepage of oily water or liquid oil from the upper layers of sediment.
4	The size of the perimeter should be large enough to allow an adequate working area, but not require the removal of too much sediment. A 30 cm x 30 cm square should Suffice.

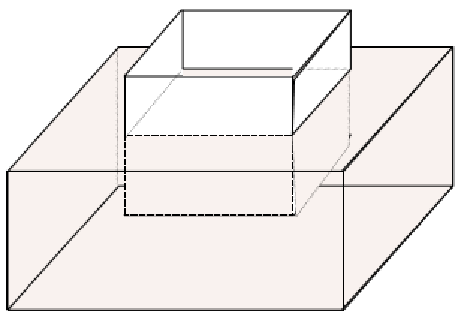


Figure S.8.4

Figure 7-2: Onshore Sediment Sampling Guidelines from the AMSA Oil Spill Monitoring Handbook

(Source: Ref. 4)

GUIDELINE FOR SAMPLING OF SEABED SEDIMENTS	M.9

Rationale

Oil can become incorporated into offshore sediments through natural processes or due to shoreline cleanup methods. If this accumulates to a significant extent then alternative cleanup strategies may be required. This monitoring method is usually only required in shallow waters. Grab Samplers or Drop Corers can be used. The former are suitable for the wider set of sediments and sea conditions. Sample handling is also easier. Sample volume should be consistent between sites and surveys to allow cross comparison.

Methodology

1	Determine the number of samples required. Consider:		
	1.1	Area of possible contamination.	
	1.2	Currents.	
2	Decide platform to sample from (response/other vessel, shoreline). Vessels should:		
	2.1	Be suited to expected weather and other safety considerations (staff training and experience).	
	2.2	Be stable and suitable for expected water depths and sea states.	
	2.3	Provide adequate deck space (vessel should be > 5m).	
	2.4	Have shelter (e.g closed cabin).	
	2.5	Be equipped with communications, GPS and life preservation equipment.	
	2.6	Comply with state boating regulations re safety equipment.	
3	Obtain sampling kits or supplies:		
	3.1	Sample jars (250 ml or other larger size if biological samples are to be taken). Pre cleaned, teflon or aluminium cap or alfoil barrier.	As Required
	3.2	Tape (for sealing jars). 2cm wide.	2
	3.3	Plastic sheeting	>1/sample
	3.4	Sampling equipment (grab or corer: see 5) Note: if biological samples are to be taken samples should be at least 10 cm depth and have a minimum surface area of at least 125 square centimetres	
	3.5	Disposable gloves	
	3.6	Sample identification labels.	
	3.7	Sorbent padding for storage cooler.	
	3.8	Sample Log Sheets.	
	3.9	Sample storage coolers with pre-frozen freezer blocks.	
	3.10	Chain of Custody Forms.	
	3.11	Waterproof plastic envelopes (for forms).	
	3.12	Decontamination equipment (Guideline G.2).	
4	Samplers should be deployed in clean water, not through surface oil. A perimeter may be used to keep the surface clean (see Guideline 7).		

<table>
<tr><td colspan="5">M.9 Methodology Continued</td></tr>
<tr><td rowspan="12">5</td><td colspan="4">Obtain samples:</td></tr>
<tr><td rowspan="11">5.1</td><td colspan="3">Grab Sampler: Spring loaded (see Figure M.9.1):</td></tr>
<tr><td>5.1.1</td><td colspan="2">Lower the grab at a slow, constant speed (about 0.3m/second) to avoid prematurely triggering the grab.</td></tr>
<tr><td>5.1.2</td><td colspan="2">Once the seafloor is hit and the grab is triggered, recover the grab slowly.</td></tr>
<tr><td>5.1.3</td><td>If sediments are muddy, the grab may be cleaned in surface waters prior to bringing it on deck (Note: This should <u>not</u> be done if surface waters that may be oily).</td><td rowspan="5">
Figure M.9.1 Example of Spring-loaded Grab Sampler
(Photo: Cawthron Inst.)</td></tr>
<tr><td>5.1.4</td><td>The Grab Sampler should be opened over a sheet of plastic (but <u>not</u> emptied onto it).</td></tr>
<tr><td>5.1.5</td><td>Debris such as seagrass or algae should be separated from the sediment. The presence of this should be logged.</td></tr>
<tr><td>5.1.6</td><td>Note: This seagrass and algal material may be required for analysis, e.g. for the presence of entrained oil.</td></tr>
<tr><td>5.1.7</td><td>Sediment samples should be removed from the centre of the grab sample (i.e. away from the sides) using clean spatulas or scoop, and placed in clean jars.</td></tr>
<tr><td>5.1.8</td><td colspan="2">Label jars with location, water depth, time and date, description.</td></tr>
<tr><td>5.1.9</td><td colspan="2">Place unused sediment in bin.</td></tr>
<tr><td>5.9.10</td><td colspan="2">Wash Grab Sampler in the sea, then distilled water. (see Guideline G.2).</td></tr>
</table>

M.9 Methodology Continued				
5	5.2	Drop Core Sampler:		
		5.2.1	Lower Corer, avoiding twisting of lines. Allow Corer to "free fall" the last 5-6m or so to the seafloor.	
		5.2.2	Recover Corer at a very slow, regular rate (<0.3 m/second).	
		5.2.3	Make sure that the Corer does not strike the side of the vessel.	
		5.2.4	Always hold the Corer in a vertical position and seal the ends (with. supplied caps) as soon	
			as possible Note: The top cap should be clearly marked "TOP" and attached to the correct end of the Corer.	**Figure M.9.1 Deployment of Spring-loaded Grab Sampler** (Photo: Sakhalin Energy Investment Company)
		5.2.5	Attach waterproof labels (Tags are easier). Labels should note location, water depth, time and date, description including length of sediment core (samples may settle during transportation).	
		5.2.6	Store cores upright.	
6	A Sample Log should be maintained (see Guideline G.1).			

Figure 7-3: Subsurface Sediment Sampling Guidelines from the AMSA Oil Spill Monitoring Handbook

(Source: Ref. 4)

7.4 Resources

This monitoring component requires specific technical and general equipment to adequately collect sediment samples for chemical screening. All equipment required is listed in the First Strike Sampling and Analysis Plan Template (Ref. 36). Where possible, equipment should be wet-tested in an uncontaminated area before mobilising to site.

7.5 Standard Operating Procedures – Field Sampling for Oil in Sediment Assessment

No.	SOP – Field Sampling for Oil in Intertidal Sediment Assessment
Pre-work	
1.	Ensure that sufficient sample containers for the analysis being undertaken (as listed in Appendix E), including spare sample containers for ad hoc sampling, are available
2.	Use detergent to wash all equipment that will be used to collect samples and rinse completely with distilled water before use. Equipment to be cleaned includes spatulas, mixing bowls, grabs, etc.
3.	Navigate to site
4.	Use GPS to navigate the team as close to the proposed site as possible
5.	Take an 'actual' GPS location to mark the sampled location (see GPS manual for instructions on calibrating the GPS device and recording a location)

No.	SOP – Field Sampling for Oil in Intertidal Sediment Assessment
Collect sediment samples **(This SOP may be amended [using guidelines from Figure 7-2 and Figure 7-3] by the Operational Monitoring Officer depending on the site to be sampled and the nature and scale of the spill)**	
6.	Fill out the label on the laboratory bottle (use a permanent marker) with this information: • sample number (each sample container must have discrete number) • sample type (e.g. sediment) • date and time of collection • analyses to be conducted (e.g. TPH) • location of samplingcollector's name
7.	Place a quadrat on the ground on the sampling site so that all samples are taken within an area of 1 m^2
8.	Prepare the corer by unclipping the top cap of the cylinder
9.	Push the corer into the sediment until the corer is slightly buried, then replace the cap of the cylinder; remove the core from the ground in a vertical motion
10.	Empty the contents of the corer into a Pyrex bowl using Teflon-coated spoons
11.	Repeat the sediment sample collection five times within the quadrat using the corer to retrieve sediments and place into the Pyrex bowl
12.	Homogenise the sediments from the five cores using Teflon-coated spoons until the colour and texture is uniform; however, limit mixing to avoid oxygenation
13.	Fill the labelled jar completely with soil/sediment, then replace the cap making sure the cap cover is tightly sealed
14.	Complete the sample collection data sheet / Chain of Custody forms (Appendix F)
15.	Place the sample in a small esky with ice bricks to maintain a temperature of 4 °C
16.	Return excess sediment to the sea immediately after completing the process
17	Use a field sheet to record activities (see Form 8 in Appendix F)
18.	Once finished at the site, store the equipment safely and move to next site
19.	In each location, sample a minimum of three sites, including one triplicate
20.	At each subsequent site, triple-rinse all equipment submersed in water with distilled water before sampling
21.	Send samples to the laboratory as soon as practicable and within the applicable holding times (see Appendix E for holding times)

7.6 Reporting

- Provide results to the EUL for analysis and integration into IAP development.
- Collate results for use by the Monitoring Coordinator for initiation of the SMPs (if applicable) and overall response impact tracking by the Planning Section Chief.

7.7 Forms and Tools

Refer to Appendix F for the forms required to undertake OPS4.

- Form 1 – Chain of Custody Form
- Form 3 – Freight Consignment Form
- Form 7 – OPS4: Oil in Sediment Assessment Form.

8 OPS5: Rapid (Oiled) Shoreline Assessment

8.1 Rationale

OPS5 provides the EMT with ongoing information as to the state (e.g. habitat type, extent of oiling) of shorelines within the predicted trajectory of the oil spill or that have been exposed to the spill. The geographic scope of OPS5 is the region above lowest astronomical tide (LAT) to the supratidal zone. CAPL personnel trained in oiled shoreline assessment will likely undertake OPS5.

The priority for rapidly gathering oiled shoreline data is to enable the operational response. However, consideration should be given to the scientific data requirements, to inform subsequent scientific monitoring plans.

8.2 Initiation and Termination Criteria

The initiation and termination criteria for this OPS are provided in Section 4 of the OSMP. Implementation times for this OPS are directly linked to the initiation criteria and are found in the same section of the OSMP.

8.3 Design

The design of OPS5 requires judgements to be made about scope, methods, data inputs, and outputs that are specific to the incident response. These judgements must balance the operational needs of the response with the logistical and time constraints of gathering and processing information, and the level of certainty needed. Usually there is a need for information to be collected and processed rapidly to suit response needs, with a lower level of sampling and accuracy needed than for scientific purposes.

OPS5 involves two proposed methods for field surveys:

- Reconnaissance surveys: designed as an initial phase (or further as required) to characterise the distribution, extent, and condition of shoreline habitats before exposure
- Continual monitoring surveys: monitors hydrocarbon spill extent at the shoreline to assess the potential impact, extent of actual impact, and the effectiveness of clean-up.

Reconnaissance surveys, combined with physical monitoring, will monitor shoreline biological communities, concentrating on key habitats or species that are indicators of biological community health. The level of detail required for operational monitoring only needs to be sufficient to describe the distribution and extent of habitats, rather than rigorous and comprehensive data on the condition of biological communities. Appropriate community biological indicators for the shoreline habitats at risk for each individual spill will need to be determined during pre-survey planning (see Section 8.3.1). The OPS5 monitoring design will need to consider:

- Monitoring usually needs to cover a large area and results are required quickly, thus the methods need to be efficient, cost-effective, and relayed back to the EMT as quickly as possible to assist in decision-making.
- The number of sampling sites and replication within sampling sites needs to be sufficient to characterise habitats and validate existing data, but the level of data is not required to provide robust data with statistical power for hypothesis testing.

- The focus is on collecting relevant information for spill response decisions on shoreline habitats at risk and identifying response activities to be approved by relevant regulatory agencies (see the relevant OPEP), rather than identifying reference sites or demonstrating baseline conditions.
- Monitoring needs to help predict environmental effects or define resource sensitivity to guide spill response activities.
- Monitoring should define the resource and logistical constraints to sampling.
- Wherever possible, the monitoring methods used will complement information required for subsequent scientific monitoring.

The reconnaissance survey may use various remote sensing (including aerial surveys) and ground survey methods, which can be used independently or collectively. It aims to gather information on the condition and distribution of shoreline habitats so as to inform the assessment of the potential impact and the development of effective spill responses. The reconnaissance survey may also provide preliminary information, data, and guidance for the subsequent scientific monitoring program.

Reconnaissance surveys will be conducted to:

- characterise pre-impact/post-spill distribution, extent, and condition of habitats within the predicted spill area
- validate that the effects of oil from the spill have reached the shoreline; or
- confirm that the spatial area predicted to be impacted in MES trajectory modelling is relevant.

Detailed statistical analysis of the physical, biological, and chemical data is not required. The locations of all sampling sites will be recorded by GPS and linked to electronic and hardcopy monitoring proforma. The georeferenced data from reconnaissance surveys will be used to update ocean current maps of the study area to further identify the current distribution, extent, and condition of shoreline habitats to help predict environmental effects or to define the sensitivity of resources to guide spill response actions.

Remote sensing includes aerial surveillance and a wide range of airborne and satellite technologies (e.g. infrared thermal imaging, side-looking airborne radar, satellite images). Aerial surveillance is a reliable and rapid method for characterising the distribution and extent of habitats within the spill area, and validating oiled shorelines and habitats at risk from the spill. Photos, videos, maps, and verbal feedback all provide basic information that can be used to define information needs and response priorities. Helicopters can be useful in combining aerial surveillance with ground surveys.

Ground surveys allow more detailed observations of shoreline conditions including the physical structure, ecological character, and human use of shorelines. This monitoring approach can provide comprehensive detail on the resources and activities likely to be affected by a spill, the potential extent of oiling and level of impact, likely recovery, and logistical considerations for different response methods. Rapid shoreline survey methods will be determined by the EMT to ensure the priorities relating to the spill response activities are the primary objective of the ground survey.

Physical monitoring will determine how oil will behave over time, the likelihood that the shoreline can be damaged by oil and clean-up activities, and how the shoreline can most effectively be cleaned. The physical character of the shoreline segment will be described in terms of:

- extent of shoreline habitat and segment boundaries
- substrate type and size
- length and width of shoreline
- form: geomorphological type, processes, dimensions, profile, or gradient
- energy: winds, waves (Table 8-1)
- degree of anthropogenic influence
- photographic evidence and observation of access restrictions.

Table 8-1: General Indicators of Shoreline Energy

Energy	Low						High
Substrate	Mud	Sand	Grit	Pebble	Cobble	Boulder	Bedrock
Form	Swamp	Flats		Beach	Reef	Cliff	
Gradient/Slope	Flat	Gentle Slope		Steep Slope	Vertical		

Oiled Wildlife and Dead Fauna

Dead fauna provide essential information for an impact assessment and wider ecological interest. Marine invertebrates, including bivalves, crabs, sea urchins, and starfish that are washed up dead or moribund and discovered ad hoc during surveys should be recorded in terms of the numbers and species, with photographs and at least some representative specimens taken for later analysis. As far as practicable, individual samples will be labelled (including location and date found). If possible, collected individuals will be received and logged on arrival at a central location then deep frozen. Dead specimens will kept for later reference, evidence, or scientific research and natural history collections.

Continual monitoring relies on rapid and frequently repeated surveys to regularly update the EMT on the level of oiling on shorelines during the operational phase and provides information to determine the effectiveness of response operations. Survey The frequency will vary depending on the characteristics of the spill, habitats/species affected, weather and sea state, and rate of clean-up, and is likely to be iterative.

8.3.1 Pre-survey Planning

A rapid review of the hydrocarbon spill response resource tools will be conducted on shoreline habitats that are impacted or at risk of being impacted as determined by MES. Shoreline habitats will be assessed with regards to their sensitivity to impacts from the Tier 3 hydrocarbon spill and accessibility for clean-up operations. Pre-survey planning includes:

- identifying the shoreline segments
- determining the survey requirements.

8.3.1.1 Identifying Shoreline Segments

The area predicted to be impacted will be divided into discrete management areas by the EMT to plan and implement proposed sampling designs, defined as ‘segments’. Shoreline segment identification will be undertaken once the spatial scale of the spill and the area required for survey has been identified. Shoreline segments will be defined using these considerations:

- likelihood of hydrocarbon contact on shorelines, as determined in OPS1
- homogeneity of habitats, physical features, and sediment type to assign location identifiers
- length of segment considering the resolution required to detail the distribution of hydrocarbon; as a guide, segments should be between 0.2 km and 2 km long
- practical aspects that can be used by the EMT for deployment of response (i.e. access and staging locations).

The OSRA (Ref. 30) may be useful for reviewing the distribution of sensitive habitats, species, and protected areas. These information sources will be reviewed to help select impact shoreline segments (in high-risk areas where sensitive receptors are found or are of protection or conservation priority) and reference shoreline segments (where potential impacts can be compared against natural conditions). If delineating appropriate segments is difficult because of insufficient information on habitat type and extent, then the information collected during the reconnaissance survey(s) may be used to refine the segments.

8.3.1.2 Determining Survey Requirements

The scale of the spill and the likelihood/consequence of impact with sensitive habitats/species will determine the level of effort required for OPS5. Survey method planning should consider these questions to specify if the proposed survey is ‘reasonable’ and ‘appropriate’ in scope, design, and subsequent cost:

- Will the results be sufficient to guide response action (wherever possible), help quantify the specific impacts, and assess the effectiveness of response actions?
- Is the scope of the program, and speed of obtaining results, the minimum necessary to fulfil the stated objectives?

For the operational phase assessment of most shoreline habitats, broad-scale transects (at the segment level) with recording of observations is recommended, combined with digital photograph quadrats captured at fixed intervals along the transect. The photographs will be reviewed as part of a pilot study for the scientific monitoring program SCI3: Coastal and Intertidal Habitat Impact Study, if required. For more densely populated habitats (e.g. mangroves), selective sampling may be more appropriate. The number of replicate sites needed to provide a representation of the area at risk depends on the scale of the individual spill conditions.

8.4 Resources

Item	Check
Oil Spill Assessment team (3 to 4 people per team, including one trained Oil Spill Assessment Specialist)	☐
Transect tape measure	☐
Flags or stake (to mark location of buried oil)	☐
Trowel and/or shovel	☐
Plastic sediment corer	☐
Dumpy level and staff	☐
Tide table(s)	☐
Clipboards (large enough to fix A4 assessment sheets)	☐
Assessment sheets printed on waterproof paper	☐
DoT Field Guide	☐
Species ID sheet	☐
Several pencils	☐
Radio	☐
First aid equipment	☐
GPS (it is essential to note the system the GPS uses [e.g. WGS 84])	☐
Camera (with polarised filter if available)	☐
Aircraft for reconnaissance (if available)	☐
Vessel/vehicle (depending on location)	☐

8.5 Standard Operating Procedures – Field Surveys

No.	SOP – Field Sampling for Aerial Surveys
Pre-work	
1.	Select and commission aircraft. Aircraft should have downward visibility (helicopter/ fixed-wing aircraft with over-fuselage wing), GPS, slow speed, and be suitable for low altitudes (preferably a helicopter)
2.	Assemble equipment
3.	Obtain information on the predicted shoreline impact area
4.	Time the flight to correspond with the low tide (if possible)
5.	Discuss and confirm the flight pan with the pilot
Aerial survey	
6.	Undertake a high-altitude (up to 500 m) rapid flyover of the shoreline to gain an overall perspective of the extent of oiling. Use this to determine: • length of shoreline to be surveyed during the flight • frequency timing of photographs
7.	Conduct a low-altitude, slow-speed survey of the target shoreline
8.	Record data:

No.	SOP – Field Sampling for Aerial Surveys
	• Take video of still photos at a downward angle of 30° to 45°. Note: Unlike aerial surveillance over water it is not always possible to avoid photographing into the sun. A polarising filter may be used to reduce glare, but use of this filter should be recorded on the photographer log • Mark oil distribution on map (shoreline assessment form). Estimate and mark: – tidal position (upper, mid, or lower intertidal) – band width – percentage cover – shoreline substrate • Mark photo locations and direction on the coastal map using an arrow (direction) and number (sequence) • Backup then clear camera memory after each survey
9.	Note: Separate surveys should overlap shoreline lengths by a few hundred metres or should include an obvious feature (e.g. building, headland, rock outcrop) at the start of the next survey
10.	At the end of each survey: • review and copy photos • label and catalogue photos

No.	SOP – Field Sampling for Ground Surveys
Pre-work	
1.	Identify shoreline segments
2.	Conduct JSA
3.	Develop survey objective in conjunction with the EMT and collect resources to undertake the survey
Ground survey	
4.	Complete shoreline assessment form (see AMSA Oil Spill Monitoring Handbook, Guideline S.5 Figure 8-1 and S.2 Figure 8-2 [Ref. 4])
5.	Record presence/absence of any oiled wildlife
6.	Conduct shoreline geomorphology assessment, including beach profiling if required (see AMSA Handbook, Guideline S.3 Figure 8-3 [Ref. 4])
7.	Collate assessment forms and any other supporting information (such as logbooks of notes), then submit to supervisor for data management

GUIDELINE FOR ASSESSMENT OF OILED SHORELINES: SURFACE OIL — S.5

Rationale

Monitoring the extent and distribution of oil on shorelines is needed for planning shoreline response strategies, methods and cleanup. This procedure sets out the method for describing oil on shoreline Segments (Guideline S.1). The general distribution of oil over large lengths of shoreline is monitored by using modified aerial surveillance procedures (Guideline S.3).

Methodology

1	Divide shoreline into Sectors and Segments (see Guideline S.1)			
2	Record the following shoreline descriptors:			
	2.1	Length	In metres	
	2.2	Width	In metres, from high tide to low tide.	
	2.3	Gradient	In degrees; approximate or as per Guideline S.3	
	2.4	Energy	High, medium or low as suggested by form	
	2.5	Substrate	Mud, sand, pebble etc. as per Guideline S.2	
	2.6	Form (or type)	Cliff, platform cobble beach etc.	
3	For each Segment, draw a sketch map showing the approximate location of the oil.			
4	Record the following parameters for the oily band:			
	4.1	Length	In km for Sectors or total, in m, for Segments. The distance the oily band extends along the shoreline.	
	4.2	Width	In metres. Average width of the oily band within a Segment or Sector. Measured across a beach from high to low elevations.	
	4.3	% Cover	Visual estimate of the percentage of the band (or average of bands). As per Figure below;	

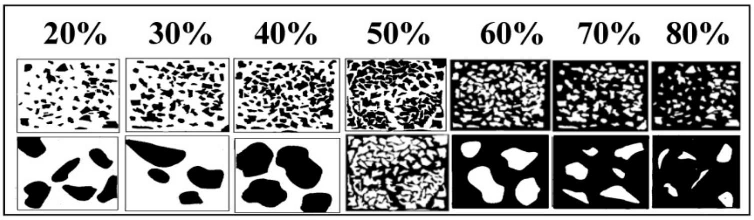


Figure S.5.1

	4.4	Oil Thick-ness	Po	Pooled oil. Can be estimated or measured in mm or cm.
			Cv	Cover. In mm, this is measurable (> 1mm thick)
			Ct	Coat. Can be scratched off rock with fingernail. Ct will mask the colour and texture of underlying substrate.
			St	Stain. Cannot be scratched off rock. Texture of substrate is visible through the oil
			Fi/ Sh	Film (Fi) or Sheen (Sh). Transparent. The colour and texture of substrate is visible through the oil
5	If necessary, or requested, classify surface oiling as per Tables overpage.			

S.5 Methodology Continued

Surface Oil Coverage

	Width of Oiled Band			
% Oil Cover	>6m	3-6m	0.5-3m	<0.5m
51-100	**High**	**High**	**Medium**	**Low**
11-50	**Medium**	**Medium**	**Low**	**Very Low**
1-10	**Low**	**Low**	**Very Low**	**Very Low**
<1	**Very Low**	**Very Low**	**Very Low**	**Very Low**

Surface Oil Classification

	Surface Oil Coverage			
Ave. Thickness	High	Medium	Low	Very Low
Pooled/Thick	**Heavy**	**Heavy**	**Light**	**Light**
Cover (>1mm)	**Heavy**	**Heavy**	**Moderate**	**Light**
Coat	**Moderate**	**Moderate**	**Light**	**Very Light**
Stain/Film	**Light**	**Light**	**Very Light**	**Very Light**

Figure S.5.2

(Source Wardrop 2000 as adapted from Owens & Sergy, 1994)

Note: Use Band Width (W) and % Coverage (%) to determine the surface oil cover, and then use oil Thickness (T) to classify the degree of oiling; the Surface Oil Classification.

Figure 8-1: Surface Oil Monitoring Guidelines from the AMSA Oil Spill Monitoring Handbook

(Source: Ref. 4)

Oil Spill Monitoring Handbook

GUIDELINE FOR CHARACTERISING SHORELINE SUBSTRATE	S.2

Rationale

Substrate type (particle size) determines the size of the spaces between particles and this in turn influences the depth to which oil will penetrate, and the ease with which wave action will remove the oil. These considerations are important in determining the need for, and type of, shoreline cleanup.

Methodology

Type	Abbr.	Descriptive Terms	Explanation
Bedrock or Rock	**R**	• Porous/non-porous • Broken/not broken (crevices/no crevices).	Porosity and crevices increase the likely persistence of the oil.
Boulder	**B**	• As above.	>256mm diameter: Larger than a head.
Cobble	**C**	• Porous (e.g. coral, pumice)/non-porous.	64 – 256mm: Fist or brick to head-sized
Pebble	**P**	• Or use "shingle" if flattened.	4 – 64mm: Pen diameter to fist sized.
Granules/ Gravel	**G**	• Rounded/flat. • Compacted/loose.	2 – 4mm diameter.
Sand	**S**	• Fine to coarse.	0.06 – 2mm diameter.
Mud/Silt/ Clay	**M**	• Note organic matter (debris/ fauna/ flora). • Consolidated/loose. • Dry (e.g. mud cliffs).	<0.06mm diameter. Field Test: Mix with water: If it "clouds up" it is silt/mud. If it sinks/clears it is sand.
Earth/ Soil	**E**	• Generally only applicable to cliffs and seawalls.	
Ice	**I**	• Likely only in the Antarctic territories.	
Shellgrit	**Sh**	• Wet/dry.	Usually with sand (Sh/S).
Coral(1)	**Co**	• Rubble/Boulder/ Cobble (e.g. Co-C).	Use to describe dead coral areas, e.g. coral cobble.
Concrete(2)	**Cc**	• Rubble; rip-rap.(2)	Artificial substrates/forms should be described and marked on segment maps.
Wood	**W**	• Debris/logs; pilings.	Debris can overlay other substrates.
Metal	**Mt**	• Pilings, sheeting.	Usually artificial structures.

1. *If corals are live, the shoreline should be described as coral noting its biological character and substrate type.*
2. *The abbreviation "A" can be used to designate artificial structures when they are not otherwise easily described, e.g. A-B would describe artificial boulder shoreline (i.e. rip-rap).*

	Page 1 of 1	S.2

50

Figure 8-2: Shoreline Assessment Guidelines from the AMSA Oil Spill Monitoring Handbook

(Source: Ref. 4)

GUIDELINE FOR DETERMINING BEACH PROFILE (GRADIENT) — S.3

Rationale

Physical cleanup methods can alter the elevation or profile of sand, pebble or cobble beaches. This may lead to erosion of beach or back beach areas. Shoreline profile may need to be monitored during cleanup, particularly if heavy machinery is used.

Methodology

S.3A Use of Marker Stakes

This is the simplest method and is suitable for low energy shores where manual rather than mechanical cleanup is used. It detects changes in sediment distribution but does not allow an accurate profile of the beach to be determined.

1	Hammer wooden or steel stakes into the beach at a number of locations and at various tidal elevations.
2	Measure the distance between the top of each stake and the sediment surface (H in Figure S.3.1).

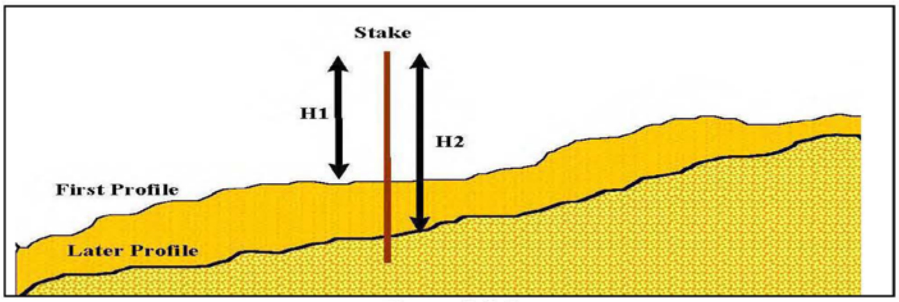


Figure S.3.1

S.3B Pole and Horizon Method 1

This method is suitable for all "soft" sediment shoreline types, i.e. those that allow a stake to be pushed or hammered into the surface.

1	Fix stakes (the "back stakes") along the beach above the high tide mark (i.e. in the Supratidal Zone).
2	A linear transect is established across the beach (from supratidal zone to lower intertidal zone). The orientation of this is identified using a compass bearing from each "back stake" position.
3	To measure beach profile, a second stake (the "front" stake) is placed 2-4 m along the transect, and a tape or pole is used to align the top of the back stake to the horizon, and the eye of an observer on the back stake. Alternatively a spirit level can be used to ensure that the pole is horizontal.
4	The back stake is used to measure changes in sediment height; i.e. changes in the distance between the tape level and the top of the stake (H in Figure S.3.2).
5	This procedure can be repeated at regular intervals along the transect.

Oil Spill Monitoring Handbook

S.3B Pole and Horizon Method 1 Continued

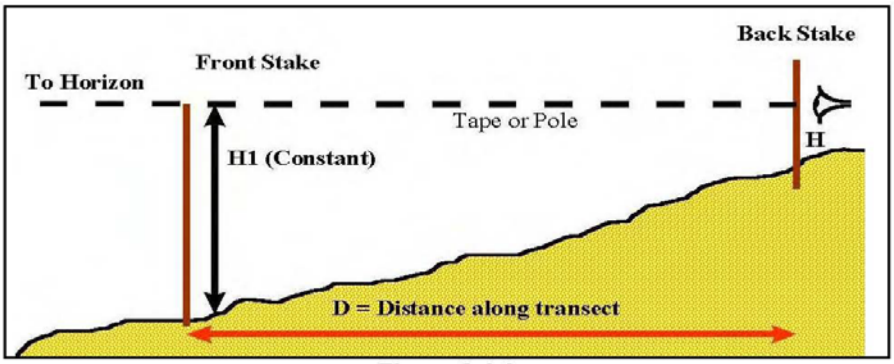


Figure S.3.2

S.3C Pole and Horizon Method 2	
This is similar to Method 2.3B except that it does not require the front stake to be pushed into the surface.	
1	Fix stakes (the "back stakes") along the beach above the high tide mark.
2	A linear transect is established across the beach (from supratidal zone to lower intertidal zone). The orientation of this is identified using a compass bearing from each "back stake" position.
3	To measure beach profile, a second stake (the "front" stake) is placed 2-4 m along the transect, and a tape or pole is used to align the top of the back stake to the horizon, and the eye of an observer on the back stake. Alternatively a spirit level can be used to ensure that the pole is horizontal.
4	The height between the sediment and the tape/pole at the front stake is measured (H1). The drop from the back stake to the front stake is H1-H0 (H0 is the height of the back stake, see Figure S.3.3)
5	This procedure is repeated at various intervals along the transect. Note if the "front stake" is left in place, measurements down-beach can be referenced from this point. This is an advantage if a pole (2-4 metres) is used to align stakes.

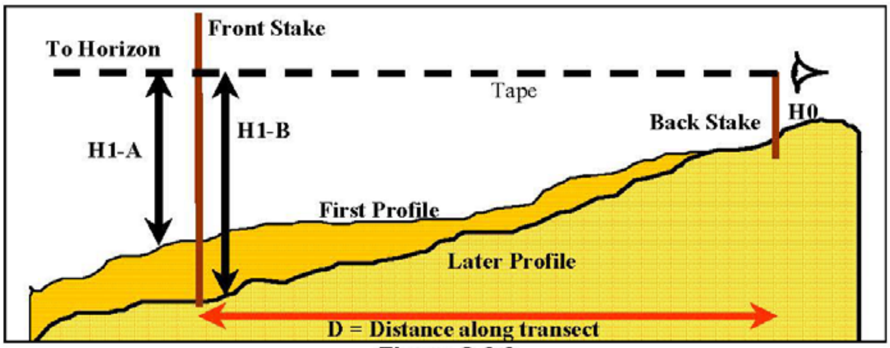


Figure S.3.3

	Page 2 of 3	**S.3**

52

Figure 8-3: Guidelines for Determining Beach Profiles from the AMSA Oil Spill Monitoring Handbook Guideline

(Source: Ref. 4)

8.6 Reporting

- All data on shoreline habitats and spill impacts are to be sent to the EMT each day.

- Results are to be provided to the EUL for analysis and integration into the IAP development.
- Results are to be collated for use by the Monitoring Coordinator to initiate scientific monitoring programs (SCIs) (if applicable) and overall response impact tracking by the Planning Chief.
- All raw data collected should be disseminated into geospatial format for subsequent use in the Emergency Response GeoHouse tool and/or OSRA WMA.
- A final report will be prepared at the completion of the spill response activities, which will include all data collected and its interpretation.

8.7 Forms and Tools

Refer to Appendix F for the forms required to undertake OPS5:

- Form 9 – OPS5: Rapid (Oiled) Shoreline Assessment Form.

9 OPS6: Rapid Seabird and Shorebird Assessment

9.1 Rationale

OPS6 provides the EMT with initial and ongoing information as to the presence and condition of seabirds and shorebirds within the predicted trajectory of the oil spill. CAPL personnel trained in oiled shoreline assessment will likely undertake the shorebird component of OPS6, at the same time as OPS5 (Rapid Shoreline Assessment).

The objectives of OPS6 are to:

- identify shorebird and seabird populations and habitats at risk from the spill
- undertake a rapid assessment of known shorebird and seabird populations to help determine appropriate management and response actions during the oil spill event so as to manage the potential impacts to, and inform long-term scientific monitoring of, shorebirds and seabirds
- identify appropriate response strategies to minimise threats to shorebirds and seabirds, based on spill characteristics, modelling outcomes, habitats, and quantified shorebirds and seabirds at risk.

9.2 Initiation and Termination Criteria

The initiation and termination criteria for this OPS are provided in Section 4 of the OSMP. Implementation times for this OPS are directly linked to the initiation criteria and are found in the same section of the OSMP.

9.3 Design

Occasionally, the study area may be small enough to comprehensively search the entire area within a reasonable time. However, selective searches may be required if the study area is too large to search it completely within a reasonable time. In such cases, rapid shoreline assessments will use key baseline data on the distinct habitat types and common alongshore distributions of ecologically significant species known to inhabit the area to concentrate the search effort within favoured habitat and known distributions. Priority will be given to areas of known occurrence or favoured habitats of breeding seabirds and shorebirds. However, other areas or habitats will not be completely excluded from survey designs in case relevant information is identified outside areas of known occurrence or favoured habitats.

The operational field study will cover rapid assessments of known breeding colonies for seabirds and important foraging areas for shorebirds to provide single measures of diversity and abundance of birds. The rapid assessments provide important information that will be communicated by the Field Teams to the EMT to mitigate, as far as practicable, impacts from hydrocarbon on the identified locations and bird species. The information from these rapid assessments will inform:

- the shoreline protection efforts
- the oiled wildlife response team
- the scientific monitoring program for seabirds and shorebirds (SCI4 – Shorebird and Seabird Impact Study).

These methods detail how this seabird and migratory shorebird assessment will be implemented for hydrocarbon spills for the Project, as adapted from the Survey Guidelines for Australia's Threatened Birds (Ref. 31):

- aerial and/or vessel-based surveys to verify the presence and abundance of seabirds at identified significant breeding colonies of seabirds within the known and predicted trajectory of the hydrocarbon spill
- aerial, vessel, and/or ground surveys to verify the presence and abundance of shorebirds at identified important foraging areas within the known and predicted trajectory of the hydrocarbon spill
- records of observed oiled or dead seabirds and shorebirds.

The timing and frequency of implementation of the survey activities will be confirmed by the EMT, or delegate. Priority will be given to aerial shoreline assessments because they can capture the most data within the shortest time. Vessel-based and/or aerial surveys may also be used to detect and count pelagic seabirds offshore; however, these surveys will have a lower priority due to their low efficiency in detecting birds.

On-ground shoreline assessments may also be conducted opportunistically with OPS5 – Shoreline Habitat Rapid Assessment. Before implementing the on-ground survey activities, the EMT (or delegate) must ensure that field personnel have the appropriate qualifications (e.g. Fauna Handling), or work under the guidance of those with appropriate qualifications, to capture and respond to oiled birds in the field.

Operational activities and surveys on shorelines may disrupt the breeding cycles of birds if not conducted with adequate care. However, the option to disrupt and shift the colony will be considered during operational planning as a potential strategy to minimise threats of hydrocarbon impacts on migratory shorebirds and seabirds.

9.4 Resources

The specific skills required to complete this OPS are:

- shorebird and seabird observers with appropriate experience in:
  - shorebird and seabird identification
  - familiarity with shorebird and seabird behaviour
  - familiarity with shorebird and seabird associated habitats
- oiled wildlife responders with appropriate experience in:
  - oiled wildlife response
  - fauna handling
  - fauna euthanasia.

Item	Check
Assessment team (3 to 4 people), including one trained Fauna Handler and/or one trained Oiled Wildlife Responder	☐
Knowledge of the area, access points, potential feeding and roosting sites – primarily derived from local topographic maps, published information, local relevant government departments, local councils, regional bird watching groups, local knowledge, exploration	☐

Item	Check
Field guides to help identify shorebirds	☐
Notepad and pen	☐
Handheld GPS	☐
Binoculars, ideally 8x30 to 10x50 i(smaller or larger binoculars are inappropriate for bird watching)	☐
Spotting scope (small tripod-mounted telescope), ideally with x20 to x60 magnification	☐
Logbook/observation sheets	☐
Measurement tools	☐
Gloves	☐
Refrigerator or eskies with ice	☐
Sample bags	☐
Camera	☐
Aircraft for reconnaissance	☐
Vessel/vehicle (depending on location)	☐

9.5 Standard Operating Procedure – Shorebird and Seabird Rapid Assessment Surveys

No.	SOP – Shorebird and Seabird Rapid Assessment Surveys	
Vessel-based survey techniques *		**Aerial survey techniques**
Pre-work		
1.	Use MES to establish the boundaries of the study area. Once priority areas for monitoring are determined, gather background information on the study area (including habitat type and ecologically significant birds known to occur there).	
	Calibrate distance estimation for each observer	Calibrate transect estimation for each observer
2.	Establish transects to be surveyed	Establish transects to be surveyed
3.	Establish strip width for transects (e.g. 50 m each side of the vessel and 100 m ahead). NOTE: For pelagic surveys, scan the entire area around the vessel out to a maximum distance that still permits accurate identification.	Establish strip width for transects (e.g. 200 m each side of the aircraft)
During survey		
4.	Vessel speed: 10 knots (range 5–15 knots)	Aircraft speed: 185 km/h^{-1} or as slow as safely possible; to be determined by the pilot Altitude: below 100 m. Selected to maximise ease of detecting and identifying birds detection and minimise the risk of colliding with ground structure of airborne birds (Ref. 8)
5.	Record latitude and longitude continuously (e.g. 30-second intervals) using handheld data logger	Record latitude and longitude continuously (e.g. 30-second intervals) using handheld data logger
6.	Bird observations:	Bird observations:

No.	SOP – Shorebird and Seabird Rapid Assessment Surveys	
	Vessel-based survey techniques *	**Aerial survey techniques**
	• record observations of each individual bird or group of birds in real time to a dedicated handheld logger • conduct complete counts of dense flocks • count all birds observed and record their identity to the lowest taxonomic group possible, preferably species	• record observations of each individual bird or group of birds in real time to a dedicated handheld logger • conduct complete counts of dense flocks • count all birds observed and record their identity to the lowest taxonomic group possible, preferably species
7.	Obtain photographs and/or video to help identify and count species	Obtain photographs and/or video to help identify and count species
8.	Record other variables, as far as practicable, including location, vessel speed and direction, whether transect is in oil-affected water, and weather conditions: • temperature • precipitation • wind strength and direction • visibility (including glare)	Record other variables, as far as practicable, including location, whether transect is in oil-affected water, and weather conditions: • temperature • precipitation • wind strength and direction • visibility (including glare)
9.	Confine observations to daylight hours, and suspend in heavy rain, heavy winds, fog, or rough seas	Confine observations to daylight hours, and suspend in heavy rain, heavy winds, fog, or rough seas
10.	Record the presence of other vessels within the survey area, as these vessels may affect the behaviour of the birds	Record the presence of vessels or other aircraft within the survey area, as they may affect the behaviour of the birds
11.	Count individuals following the vessel only once	

** Note: Access to a dedicated vessel for seabird surveys may not be possible in the event of a spill. However, data on seabirds may be gathered opportunistically on board a response vessel working in the spill area.*

9.5.1 Shoreline Surveys

Shoreline surveys are effective for detecting the presence and abundance of many breeding shorebird and seabird species. The rapid surveys undertaken for this program will examine shoreline plots of predetermined sizes based on information obtained from MES. The rapid surveys will include known seabird breeding colonies and shorebird foraging sites to confirm the presence of bird aggregations, and will be undertaken at islands identified and prioritised to be at risk of impact from the hydrocarbon spill, as far as practicable. Note: The ability to detect birds that are present varies with the time of day, season, and between years. For example, the areas of coastal habitat occupied by many shorebird species may vary over the course of the day in relation to tidal cycles (Ref. 8; Ref. 9; Ref. 10). Further, many birds present are migratory and may use only part of their range at any particular time of the year (Ref. 11; Ref. 12; Ref. 13; Ref. 14). Changes in abundance and highly irregular movement patterns may also occur in relation to variable environmental conditions such as cyclonic events (Ref. 15, Ref. 16). For tidal areas, these guidelines will apply, as far as practicable:

- Spatial coverage should be conducted of the entire habitat thought to be used by the same population of shorebirds, and the entire area of contiguous habitat where shorebirds may occur. This may include multiple discrete roosts and feeding areas.

- Surveys for roosting shorebirds should be conducted as close to high tide as practicable and no more than two hours either side of high tide (unless local knowledge indicates a more suitable time).
- Surveys for foraging shorebirds should be conducted as close to low tide as practicable and no more than two hours either side of low tide (unless local knowledge indicates a more suitable time).
- Surveys should not be undertaken during periods of high rainfall or strong winds.
- Surveys should not be undertaken when activities that disturb the birds, such as shoreline clean-up, are taking place.
- For large sites or for sites where large numbers of birds are expected, it is recommended that at least two people undertake the counts and agree on the number of birds and the number of species present.

Counting shorebirds may be done by directly counting individuals of each species present or by estimating if numbers are large. It is recommended to estimate the total number of birds first. If the birds being counted take flight, this ensures knowledge of the total number, and possibly some idea of the proportions of each species, has been obtained. Estimating proportions of species is a secondary priority.

9.5.2 Aerial Shoreline Surveys

Aerial surveys allow rapid coverage of large areas of land and/or water and can cover areas that are difficult to access on the ground. Aerial shoreline surveys provide information on taxon presence and their quantity, and also reveal the location of particular habitat types or nest sites for follow-up ground surveys. Aerial shoreline surveys are performed for shorebirds and seabirds using either helicopters or fixed-wing aircraft. Aerial surveys usually involve flying along systematically or randomly-placed straight-line routes (similar to ground-based transect surveys) along shorelines where birds or bird colonies may occur. The best coverage and accuracy is achieved with two observers recording from each side of the aircraft (Ref. 17). About 600–1000 km of transects can be flown in a six-hour period (Ref. 10). The survey guidelines presented in Section 9.5.1 will apply, as far as practicable. Further details on procedures for conducting aerial surveys can be found in Braithwaite *et al.* (Ref. 18) and Resources Inventory Committee (Ref. 10).

9.5.3 Vessel-based Shoreline Surveys

Vessel-based shoreline surveys for shorebirds and seabirds usually involve systematically or randomly-placed line transects along shorelines where birds or bird colonies may occur. The best coverage and accuracy is achieved with two observers recording from each side of the vessel (Ref. 17). The survey guidelines presented in Section 9.5.1 will apply, as far as practicable.

9.5.4 Pelagic Surveys

Both vessel-based and aerial surveys may be used to detect and count pelagic seabirds offshore. Vessel-based surveys have the advantage of providing more time to identify the taxa and record other details such as age, sex, and behaviour. This improves the chances of recording rare, inconspicuous, and diving taxa.

9.5.5 Vessel-based Surveys

Vessel-based surveys include observations and recordings of birds at sea from a moving vessel. Vessel-based surveys may be conducted opportunistically and therefore observers may not be able to specify the vessel's course. The survey guidelines presented in Section 9.5.1 will apply, as far as practicable. Pelagic surveys and colony censuses may be useful because the study area supports several species that breed elsewhere and visit Australian waters outside their breeding season; they do not come to land and so would not be detected by colony surveys.

9.5.6 Aerial Pelagic Surveys

Aerial surveys of seabirds are typically performed using either helicopters or fixed-wing aircraft. Aerial surveys involve flying along systematically or randomly-placed, straight-line routes (similar to ground-based transect surveys) at sea where birds may occur. The best coverage and accuracy is achieved with two observers recording from each side of the aircraft (Ref. 17). About 600–1000 km of transects can be flown in a six-hour period (Ref. 10). The survey guidelines presented in Section 9.5.1 will apply, as far as practicable. Further details for conducting aerial surveys can be found in Braithwaite *et al.* (Ref. 18) and Resources Inventory Committee (Ref. 10).

9.5.7 Recording Oiled and Dead Seabirds and Shorebirds

This rapid survey includes collecting, recording, and scientifically examining a representative sample of live oiled and dead seabirds and migratory shorebirds. The sample size will depend on the resources available to undertake the assessment. As far as practicable, the initial assessment of live oiled and dead seabirds and shorebirds collected by oiled wildlife response personnel will collect information on:

- date and location of finding
- identification to species
- details of rings or other markers (e.g. satellite transmitters)
- oiling status of the bird (% oiled)
- external ageing and sexing
- external biometrics (to determine age and breeding population of origin) including:
  - bill length
  - bill shape
  - body mass
  - wing length
  - tarsus length
- internal examination to determine sex and age.

Live oiled and dead seabirds and shorebirds collected by Emergency Response personnel (e.g. shoreline clean-up teams or vessel crews engaged in response) who do not have the appropriate level of experience to conduct the initial assessment, will capture and store the individual birds as soon as possible and mark each bird with information on:

- date and location of finding
- degree of oiling (% oiled)
- species (if known).

The dead seabirds and shorebirds will be stored in appropriate facilities (preferably freezing facilities). Identified live, oiled birds found onshore and at sea will be captured, as far as practicable, using equipment such as nooses, hoop nets, and throw nets and then transported to the staging facility. The number and status of oiled seabirds and shorebirds may also be collected during other operational surveys (e.g. OPS5 – Shoreline Rapid Assessment). Methods for collecting and/or capturing oiled shorebirds are provided in Appendix B of the western Australian Oiled Wildlife Response Plan (Ref. 22).

9.6 Reporting

- All data on shorebird and seabird presence/absence and spill impacts will be sent to the EMT each day.
- A final report will be prepared at the completion of the monitoring plan (as determined by the termination triggers) and will include all the data collected and its interpretation.

9.7 Forms and Tools

Refer to Appendix F for the forms required to undertake OPS6:

- Form 10 – OPS6: Rapid Seabird and Shorebird Assessment.

10 OPS7: Rapid Marine Megafauna Assessment

10.1 Rationale

OPS7 provides the EMT with initial and ongoing information as to the presence of marine megafauna (including marine turtles, sea snakes, pinnipeds, cetaceans, sharks, and rays) within the predicted trajectory of the oil spill.

The objectives of OPS7 are to:

- assess, and if possible confirm, the presence of marine megafauna in the environment that may be affected to predict the potential exposure to oil
- assess, and if possible confirm, where marine megafauna are in relation to the spill incident and the predicted spill trajectory to assess the level of risk
- observe, and where possible quantify, actual exposure of receptors to oil or exposure to the incident response measures
- record mortality of marine megafauna in the environment that may be affected.

10.2 Initiation and Termination Criteria

The initiation and termination criteria for this OPS are provided in Section 4 of the OSMP. Implementation times for this OPS are directly linked to the initiation criteria and are found in the same section of the OSMP.

10.3 Design

OPS7 records and collates observations of marine mammals, reptiles, and large cartilaginous fish within the study area using reconnaissance aerial and/or vessel-based surveys. Rapid and systematic identification (using standardised survey protocols) is required . Given the low precision of data/knowledge on the distribution and abundances of most marine mammals, reptiles, and large cartilaginous fish, and the time available in the event of a spill, quantification of abundance is unlikely. However, qualitative assessment of animal numbers present and any observable impacts to individuals is possible. Methods are principally designed to collect information on presence/absence, mortality, and, if possible, the status of those individuals encountered (e.g. behaviour, oiling etc.).

Flexibility is required when implementing OPS7 so that methods/procedures best suited for collating information to inform the response strategy can be selected. The design outlines several potential approaches, with the decision made at the time of the spill on which aspects will be implemented.

10.3.1 Pre-survey Planning

It is anticipated that the surveys conducted as part of OPS7 will supplement already established distribution information. Data on relevant species, their seasonality, and potential breeding stage will be tabled to determine the scope of surveillance surveys and to establish priorities for data collection.

Information from MES will be overlaid with resource maps for the relevant species, including location of critical habitats. This information will be used to identify the priority species and any specific survey locations that will be considered when determining the geographic area for reconnaissance and scientific monitoring studies (if required). Given the impracticalities of monitoring all potential receptors under the marine mammal, reptile, and large cartilaginous fish groupings, indicator species will be used to provide a method to track the potential impact. Depending on location of the spill and its predicted extent, several potential indicator species for assessing risk to marine megafauna during the operational response have been identified.

The selection of indicators species was based on:

- currently available information/data on abundance/distribution/migration patterns within the region
- ability to observe/detect and correctly identify the species
- likelihood of exposure to hydrocarbons
- sensitivity to hydrocarbon spills
- regulatory protection status (i.e. Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* [EPBC Act] listed species).

Based on these considerations, indicator species recommended for operational monitoring are outlined in Table 10-1.

Table 10-1: Potential Indicator Species for Surveillance Surveys

Baleen Whales	Toothed Whales or Dolphins	Other Marine Mammals	Large Cartilaginous Fish	Reptiles
• Blue Whale • Humpback Whale	• Bottlenose Dolphin • Indo-Pacific Humpback Dolphin • Spinner Dolphin • Australian Snubfin Dolphin	• Dugong • New Zealand Fur Seal	• Whale Shark	• Green Turtle • Flatback Turtle

10.3.2 Monitoring Design

The scale of likely impact will determine the scale of both spatial and temporal monitoring. Any sampling design must be adaptable to different scales, as constrained by available resources, and be adaptable on the day to changes in the predicted zone of impact of an oil spill incident. The priority of resources, receptors, and sites are likely to be different under different spill or weather conditions, the seasonal presence of species, and/or the life stage of the species present. A judgement will need to be made at the time of the spill about the relative value of different sites and resources that are the focus of operational monitoring.

10.3.3 Field Survey Assessment

The study will include rapid surveillance surveys to determine what marine mammals and large cartilaginous fish are present in the predicted spill trajectory pathway and the wider environment that may be affected by the spill. The size of the wider environment that may be affected will be determined based on several factors including: season, life stages of species likely to be observed, geographic range, species residency, and timing in relation to migration. A qualitative visual assessment over and extending beyond the area of the hydrocarbon spill (but within the area of impact) to identify the presence and/or behaviour/activity of the selected marine wildlife is recommended. The standard survey platforms used for assessing marine wildlife at sea and along coastlines are aerial (manned) or marine vessels. Aircraft can survey large and inaccessible areas in a short space of time and reduce the risk of double counting that can potentially occur from vessel-based surveys. Aerial surveillance works well for large marine mammals (principally whales) and where waters have good light penetration and visibility. However, aerial survey methods do not provide robust counts for inshore dolphin populations where shallow waters are turbid. Visual assessments using aerial surveillance may under-report substantially, and species identification can be problematic. In situations where the study area includes shallow coastal waters, vessel-based surveys are more suitable (taking into account safety considerations). The environmental conditions at the time of survey will influence what survey platform is most appropriate. For operational monitoring, aerial surveys are preferred, with vessel-based surveys completed opportunistically.

10.3.4 Vessel-based Surveys

Vessel-based surveys for presence of marine mammals and large cartilaginous fish will occur opportunistically and will depend on vessel access. Observational data will be gathered on species and location of any marine mammals and large cartilaginous fish close to the surface slicks, as well as any unusual behaviour or ill health.

As far as practicable, the observer(s) will be positioned at the highest accessible point (termed ‘primary platform’) with an angle board mounted on the deck railing (preferably towards the stern) to measure radial angle to the sighting. Increasing observer height increases the resolution with which observers can measure the downward angle to sightings, lessening the change of response movement and increasing the ability to see animals.

Double-platform data collection will be implemented, when possible. Data will be collected using digital audio recordings and/or standardised observation logbook records. For each sighting, data collated should include:

- location
- species
- group size
- group composition (adults and calves)
- angle to sighting (declination)
- behaviour (directional/non-directional swimming, feeding, resting)
- cue (underwater, body at surface, splash, blow)
- swimming direction
- reaction to the survey craft.

10.3.5 Aerial Survey

Aerial surveillance for marine mammals and large cartilaginous fish will, as far as practicable, be undertaken daily in conjunction with MES aerial surveys. The survey will detect presence of visible animals without confidence of estimates of abundance. Visual and photographic/video data should be collected and information on sea state and flight path recorded, as outlined below. Where possible, double-platform line-transect and cue counting will be implemented to limit bias. Data will be collected using digital audio recordings and/or standardised observation logbook records. For each sighting, data collated should include:

- location (GPS)
- species
- group size
- group composition (adults and calves)
- behaviour (directional/non-directional swimming, feeding, resting)
- cue (underwater, body at surface, splash, blow)
- swimming direction
- reaction to the survey craft.

10.3.6 Shoreline Survey (Marine Turtles)

Track data for marine turtles will be collected using aerial photographic surveillance; however, in poor weather conditions it may be necessary to conduct ground-based track census surveys. Aerial overnight track counts are constrained by tides and sun elevation—overnight tides clear the beach of new tracks below the high-tide line, while tracks cannot be seen past ~10:00 am due to the sun's elevation making them impossible to see clearly. The tracks and other evidence left on the beach after a marine turtle has emerged (crawls) can be used to identify the species. The aerial survey results will be verified by ground surveys, which will also confirm the level of oil contamination at key nesting beaches (which is not always possible from the air). Shoreline surveillance will be conducted in conjunction with OPS5 – Rapid Shoreline Assessment.

10.3.7 Live Stranding and Carcass Recording (Marine Mammals)

Strandings of marine megafauna create an important opportunity for gathering information on the species' biology, pathology, toxicology, population genetics, and natural and human-induced population mortality.

If a fauna stranding is recorded, at least 10 carcasses will be sampled for tissue analysis (providing the criteria for necropsy are met). If fewer than 10 carcasses are recorded, all carcasses that meet the necropsy criteria will be sampled.

In Western Australia, Wildcare (08 9474 9055; part of DBCA) is the lead stranding organisation. Standardised protocols are available for carcass handling and necropsy procedures; these will be adopted:

- Standardised protocols for the collection of biological samples from stranded cetaceans (Ref. 32)
- Marine Mammals Ashore: A Field Guide for Strandings (Ref. 33)
- Eros *et al.* outlines details on salvage and necropsy procedures for dugong (Ref. 34).

Trained professionals will be involved in handling any strandings encountered. Where carcasses are observed, physical details (species, length, sex, condition, etc.) will be recorded and photographs taken. Basic biological information and tissue samples for laboratory analysis (where appropriate) also need to be collected.

A necropsy should be undertaken by a pathologist to determine cause of death. Careful and consistent documentation of marine mammal strandings is needed and clinical pathology is required to determine whether the cause of death can be attributed to the oil spill event. The state of decomposition of any carcasses will be evaluated to determine the viability of the samples for specific analysis, with analysis unlikely on severely decomposed carcasses. Tissue samples are required for hydrocarbon analysis and, where possible, these must be assessed against background reference points for the interpretation to be meaningful.

Immediate necropsy, or appropriate freezer storage of carcasses, is required for the physiological and pathological state to be correlated to any concentration of petroleum products found in tissue samples. For any marine megafauna tissue collected, a basic set of analytical tests will be undertaken as part of the scientific monitoring conducted as part of SCI5.

10.3.8 Oiled, Injured, Diseased, and Dead Fauna Recording

Oiled, injured, diseased, and dead reptiles will be handled by trained personnel. All records will be entered into an Oiled Wildlife Database and include details on species, size, sex, condition, damage, etc. with photographic records made of the body. All dead and oiled/injured animals will be collected—live animals for clean-up and tissue sampling; dead animals for tissue sampling and freezer storage.

Any sea snakes collected will be sent to the WA Museum for identification. Live sea snake observations will be photographed for identification.

10.4 Resources

CAPL has access to a number of environmental professionals based on Barrow Island, at Onslow, and in Perth. The specific skills required to complete this OPS are:

- experience in marine spill response operations
- marine mammal knowledge and field skills to correctly identify marine mammals (Marine Mammal Observer [MMO] certification [essential]; experience in marine mammal surveys from aerial surveys [desirable])
- veterinary and pathology expertise on call for diagnosis of cause of death with experience in record keeping (chain of command procedures) and advising on diagnosis of death

To prevent injury to animals and the people handling them, it is preferable that only experienced people handle wildlife. Any on-site training should include written descriptions of handling and cleaning techniques, and demonstrated compliance with these. Each person should also be provided with a written brief that covers safety, legal requirements, and the importance of recording all data.

Item	Check
Survey platform: Access to rotary or fixed-wing aircraft (recommended AMSA Dornier 318 or CASA 212-400 fixed-wing aircraft; i.e. high-wing aircraft with downward visual capability) or marine vessels	☐
Trained MMO on aircraft	☐
Handheld video camera with date stamp and GPS capability	☐
Digital camera (with GPS) and telephoto lens	☐
GPS device	☐

Item	Check
Binoculars, preferably 8x30 to 10x50	☐
Clinometers	☐
Nautical charts	☐
Logbook/observation sheets	☐
Species field identification guide(s)	☐
Audio recorder	☐

Aircraft are available on Barrow Island and Karratha through Bristow's. The activation time (under ideal metocean conditions) for the helicopter on Barrow Island is two hours (three hours from Karratha or Exmouth). Vessel providers are available from regional port/harbour facilities in Exmouth, Onslow, Dampier, and Port Hedland.

10.5 Standard Operating Procedure – Field Sampling

No.	SOP – Standard Marine Megafauna Survey Methods	
	Vessel-based survey techniques	**Aerial survey techniques**
Pre-work		
1.	Calibrate distance estimation for each observer	Calibrate transect estimation for each observer
2.	Establish transects to be surveyed	Establish transects to be surveyed
3.	Establish strip width for transects (e.g. 400 m each side of the vessel and 100 m ahead). NOTE: For pelagic surveys, scan the entire area around the vessel out to a maximum distance that still permits accurate identification	Establish strip width for transects each side of the aircraft: • 400 m for whales and dugong • 750 m for Whale Sharks
During survey		
4.	Vessel speed: 10 knots (range 5–15 knots)	Aircraft speed: approximately 90–100 knots or as slow as safely possible; to be determined by the pilot Altitude: approximately 500 ft Beaufort state: <3
5.	Record latitude and longitude continuously (e.g. 30-second intervals) using handheld data logger	Record latitude and longitude continuously (e.g. 30-second intervals) using handheld data logger
6.	Marine mammal observations: • record observations of each individual or group in real time to a dedicated handheld data logger • count all observed individuals, record their identity (preferably species), and determine their age class (if possible)	Marine mammal observations: • record observations of each individual or group in real time to a dedicated handheld data logger • count all observed individuals, record their identity (preferably species), and determine their age class (if possible)
7.	Obtain photographs and/or video to help identify and count species	Obtain photographs and/or video to help identify and count species
8.	Record other variables including, as far as practicable, location, vessel speed and direction, whether transect is in oil-affected water, and weather conditions:	Record other variables including, as far as practicable, location, whether transect is in oil-affected water, and weather conditions: • temperature

No.	SOP – Standard Marine Megafauna Survey Methods	
	Vessel-based survey techniques	**Aerial survey techniques**
	• temperature • precipitation • wind strength and direction • visibility (including glare)	• precipitation • wind strength and direction • visibility (including glare)
9.	Confine observations to daylight hours, and suspend in heavy rain, heavy winds, fog, or rough seas	Confine observations to daylight hours, and suspend in heavy rain, heavy winds, fog, or rough seas

10.6 Reporting

- All data will be sent to the EMT each day.
- A final report will be prepared at the completion of the spill response activities and will include all the data collected and its interpretation.

10.7 Forms and Tools

Refer to Appendix F for the forms required to undertake OPS7:

- Form 11 – OPS7: Aerial Survey Log Form
- Form 12 – OPS7: Marine Vessel Survey Log Form.

11 OPS8: Fish Tainting Assessment

11.1 Rationale

OPS8 relates to monitoring undertaken to better manage concerns expressed by fisheries, the public, or the media about the potential effects of the spill or response activities.

Fish tainting assessment (OPS8) will be performed by external agencies possessing this specialised skill set. This Section provides general guidance and expectations for external monitoring teams.

11.2 Initiation and Termination Criteria

The initiation and termination criteria for this OPS are provided in Section 4 of the OSMP. Implementation times for this OPS are directly linked to the initiation criteria and are found in the same section of the OSMP.

11.3 Design

The key component of OPS8 is collecting data on the effects of the spill and response strategies on pelagic and benthic fish species. The assessment will include:

- an adequate and reasonable sample size for both pelagic and benthic species (where applicable to response strategies) for rapid response sampling
- those areas of known importance for commercial fisheries
- requirements to inform recreational and commercial fisheries
- availability of human resources, suitable vessels, and other logistics
- capacity for transporting samples from the site (e.g. by helicopter or vessel)
- safety considerations.

As per wildlife impact monitoring during the Montara oil spill (Ref. 19), samples can be collected from commercial fishers who have landed fish in areas known to have been impacted by oil (refer to MES results to determine). If no commercial fishers have landed catch for areas within the zone of (potential/actual) impact, other operational monitoring vessels and teams can be used for this task. However, if the response depends on the results of this program for decision-making for the next operational period/IAP, then a vessel and team dedicated to the task will be engaged as they become available.

Implementation of OPS8 will focus on rapidly determining fish taint, given the specifics of the spill and the zone of actual impact, thus allowing for appropriate response strategies to continue. The results of OPS8 could also reduce the time that commercial and recreational fisheries are impacted.

Whole fish samples for chemical analysis and examination of fish health will be obtained through field sampling, with the analysis being undertaken at specialist fish health laboratories.

Study design guidance:

- Plastics can contaminate samples, therefore sampling methods and storage containers should avoid plastics.

- As well as reporting on tissue levels of hydrocarbons, other diagnostic chemical characteristics relevant to the spilt hydrocarbons (such as various ratios) will be screened to confirm the contaminant's source.
- If fish kill is observed, whole, dead fish must be collected and preserved (frozen) for necropsy. If a large number dead fish are evident, the total number will be estimated, with a reduced number (~20 fish per species) of representative specimens retained for necropsy. The standard procedure for reporting fish kills to the WA DoF will be adhered to (Ref. 35).

11.4 Resources

OPS8 depends on field sampling, thus all vessel-related requirements and logistical considerations are relevant. Chemical analysis of tissue samples will require an extensive list of equipment for extracting tissue samples and examining fish health; a complete list should be developed in consultation with appropriate experts in this field and the ecotoxicologist (biopsy collection and handling), but may include:

- disposable nitrile gloves
- glass vials with PTFE lids
- aluminium foil
- ziplock bags.

11.5 Standard Operating Procedure – Field Sampling

No.	SOP – Field Sampling for Fish Tainting
1.	Contact the Fish Health Laboratories for advice on the preferred options for sampling and shipping. Phone: 08 9368 3286 or 08 9368 3357 Email: jo.bannister@agric.wa.gov.au; phillier@agric.wa.gov.au The three main options are: • Live sick specimens placed in plastic bags filled one-third with water and two-thirds with air (or oxygen if possible), to be delivered within 12 hours. (Use this option, where possible.) • Frozen whole fish and/or very fresh dead or recently killed fish placed in separate, clean, amber glass vials with PTFE lids or wrapped in aluminium foil stored in a ziplock bag, kept at -20 °C, to be delivered within 24 hours. • Small dead fish, with their abdomen slit open, should be placed in 10% formalin (or in methylated spirits in an emergency). If possible, chilled or frozen specimens (as above) should also be supplied. Supply: • a one-litre sample of water from where the fish were collected • an accurate history of the fish, their environment, and any water quality data.
2.	Send samples for diagnosis to: **Fish Health Laboratories** c/o Animal Health Laboratory Department of Agriculture and Food 3 Baron-Hay Court SOUTH PERTH WA 6151

11.6 Reporting

- Record and report results to the EUL for integration into IAP development.
- Record and report results to the EUL for referral to the Public Information Section for dissemination to recreational and commercial fisheries.

- Record results and handover to the Monitoring Coordinator for initiation of the SCIs (if applicable).

11.7 Forms and Tools

Refer to Appendix F for the forms required to undertake OPS8:

- Form 1 – Chain of Custody Form
- Form 2 – Freight Consignment Form
- Form 12 – Fish Tainting Assessment Form.

12 Acronyms and Abbreviations

Table 12-1 defines the acronyms and abbreviations used in this document.

Table 12-1: Acronyms and Abbreviations

Acronym/Abbreviation	Definition
°C	Degrees Celsius
µg/L	Micrograms per litre
4WD	Four-wheel Drive Vehicle
ABU	Australian Business Unit
ALS	Australian Laboratory Services
AMOSC	Australian Marine Oil Spill Centre
AMSA	Australian Maritime Safety Authority
BOSIET	Basic Offshore Safety Induction and Emergency Training
BTEX	Benzene, toluene, ethylbenzene, and xylene
C_6, C_{40}, etc.	Hydrocarbon chain length
cm	Centimetre
cm^3	Cubic centimetre
dB(A)	A-weighted decibels
DO	Dissolved Oxygen
DoF	Western Australia Department of Fisheries
DoT	Western Australian Department of Transport
Emergency condition	Emergency conditions are defined in each activity-specific Environment Plan and Oil Pollution Emergency Plan
EMT	Emergency Management Team
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
EUL	Environment Unit Lead
FID	Flame Ionization Detector
g	Gram
GC	Gas Chromatography
GCMS	Gas Chromatography Mass Spectrometry
GIS	Geographic Information System
GPS	Global Positioning System
H_2S	Hydrogen sulfide
HES	Health, Environment, and Safety
HUET	Helicopter underwater Escape Training
IAP	Incident Action Plan
IMG	Incident Management Guide
JSA	Job Safety Analysis
kg	Kilogram

Acronym/Abbreviation	Definition
km	Kilometre
kn	Knot
L	Litre
LAT	Lowest Astronomical Tide
LC50	Lethal concentration for 50% of the test species
LNG	Liquefied Natural Gas
m	Metre
MES	Monitoring, Evaluation, and Surveillance
mg	Milligram
mL	Millilitre
mm	Millimetre
MMO	Marine Mammal Observer
MPA	Marine Protected Area
MPRA	Marine Parks and Reserves Authority
NATA	National Association of Testing Authorities
NEBA	Net Environmental Benefit Analysis
nm	Nautical mile
NMI	National Measurement Institute
NOEC	No Observed Effect Concentration
NWS	North West Shelf
Oleophilic	Oil attracting
OPEP	Oil Pollution Emergency Plan
OPS	Operational Monitoring Program
ORT	On-site Response Team
OSMP	Operational and Scientific Monitoring Plan
OSRA	Oil Spill Response Atlas
PAH	Polycyclic Aromatic Hydrocarbons
Parks and Wildlife	Western Australian Department of Parks and Wildlife
PFD	Personal Flotation Device
pH	The acidity or basicity of a solution
Photo documentation	Photographic and video evidence, ranging from aerial imagery to detailed still images
PPE	Personal Protective Equipment
QA/QC	Quality Assurance/Quality Control
Quadrat	A rectangle or square measuring area used to sample living things in a given site; can vary in size.
Reference Site	Specific area of the environment not at risk of being affected by the Project or existing developments, that can be used to determine the natural state, including natural variability, of environmental attributes such as coral health or water quality.

Acronym/Abbreviation	Definition
SCI	Scientific Monitoring Program
SIMOPS	Simultaneous Operations
SMART	Special Monitoring of Applied Response Technologies
SOP	Standard Operating Procedure
State Waters	The marine environment within three nautical miles of the coast of Barrow Island or the mainland of Western Australia.
SVOC	Semi-volatile Organic Compound
TDS	Total Dissolved Solids
TOC	Total Organic Carbon
TPH	Total Petroleum Hydrocarbons
Transect	The path along which a researcher moves, counts, and records observations.
TRH	Total Recoverable Hydrocarbons
USEPA	United States Environmental Protection Agency
VOC	Volatile Organic Compounds; organic chemical compounds that have high enough vapour pressures under normal conditions to vaporise and enter the atmosphere.
WA	Western Australia

13 References

The following documentation is either directly referenced in this document or is a recommended source of background information.

Table 13-1: References

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Appendix A Indicative Transit Times for Mobilisation to Operational Areas

From	To	Distance in nm (sea)	Distance in nm (air)	Required via					
				Vessel (hours)				Helicopter	Truck
				8 kn	11 kn	17 kn	25 kn	140 kn	60 km/h
58	47	7.3	5.3	3.4	2.3	20	-		
67	51	8.4	6.1	3.9	2.7	22	-		
75	73	9.4	6.8	4.4	3.0	31	-		
114	95	14.3	10.4	6.7	4.6	41	-		
-	110	-	-	-	-	47	-		
57	57	7.1	5.2	3.4	2.3	24	-		
187	168	23.4	17.0	11.0	7.5	72	9.3 hours		
-	173	-	-	-	-	74	-		
116	107	14.5	10.5	6.8	4.6	46	-		
113	108	14.1	10.3	6.6	4.5	46	9 hours		
87	87	10.9	7.9	5.1	3.5	37	-		
13	13	1.6	1.2	0.8	0.5	6	-		
65	57	8.1	5.9	3.8	2.6	24	6.7 hours		
-	65	-	-	-	-	28	-		
108	108	13.5	9.8	6.4	4.3	46	-		
57	57	7.1	5.2	3.4	2.3	24	-		
-	70	-	-	-	-	30	-		

1. *Allow ~3 hours to travel from the east to the west coast of Barrow Island via vessel*
2. *Total time = Activation time + travelling time, depending on the availability of the logistics*
3. *Vessel time is based on site information and knowledge and Geohouse*
4. *Estimated activation times are: Barrow Island – 2 hours; Thevenard Island – 1 hour; Onslow – 2 hours; Dampier – 1 hour; Exmouth – 2 hours*

Appendix B Environmental Permit Application Forms

Department of Fisheries Western Australia
3rd Floor, The Atrium
168-170 St George's Terrace
PERTH 6000

Telephone (08) 9482 7333
Facsimile (08) 9482 7390

Office Use Only

Date Received	
Application Fee Paid	
Receipt No.	

Fish Resources Management Act 1994

APPLICATION FOR EXEMPTION

Section 7 & Regulation 6

This application is made to the Minister for Fisheries at the Department of Fisheries.

The applicant named in Part A, in accordance with Section 7 and Regulation 6 of the *Fish Resources Management Act 1994* and *Regulations,* hereby applies in respect of the purpose set out in Part B and in respect of the proposed activities set out in Part C for the grant of an Exemption from the provisions set out in Part D.

PART A

1. **Applicant:** ....

Address: ....

.... Post Code: ....

Telephone No: (........) .... Facsimile No.: (......)..

PART B

2.1 **Purpose for which Exemption is sought:** ....

....

....

....

....

2.2 **Identify the relevant paragraph of section 7(2) :**

....

....

PART C

3. **Proposed Activities**

....

....

....

....

15/11/11

PART D

4. **Provision of Legislation from which Exemption is sought**

....

....

....

PART E

5. **Declaration**
I/We declare that the statements made in this Application are true and correct.

6. **Execution of Application**
Please sign and date in the appropriate section below.

6.1 ***Individuals***

....	....	....
(signature)	(print name)	(date)
....	....	....
(signature)	(print name)	(date)
....	....	....
(signature)	(print name)	(date)
....	....	....
(signature)	(print name)	(date)

6.2 ***Corporation***

The Common Seal of the authorisation holder is hereunto affixed in accordance with the corporation's Constitution:

Affix
Seal
Here

Director :	....	....
(signature)	(print name)	(date)
Director/Secretary:	....	....
(signature)	(print name)	(date)

Declaration where sole director/secretary (if applicable):

I .... declare that I am the sole director and sole company secretary of
(print name)

....	....	....
(print company name)	(signature)	(date)

Attorney

Attorney under Power:	....	....
(signature)	(print name)	(date)

Fish Resources Management Act 1994

APPLICATION FOR EXEMPTION

Section 7 & Regulation 6

This form is to be used to **apply** for an exemption from a provision or provisions of the Act or any subsidiary legislation made under the Act.

Applications for an exemption may be made to the Minister for Fisheries..

The address at which this application is to be **lodged** is the address of the Department of Fisheries Western Australia (please refer to the head of the Application).

Section 7 of the *Fish Resources Management Act 1994* states:

7. (1) The Minister may, by instrument in writing, exempt a specified person or specified class of persons from all or any of the provisions of this Act.

(2) The Minister may only grant an exemption under subsection (1) for one or more of these purposes -

(a) research;

(b) environmental protection;

(c) public safety;

(d) public health;

(e) commercial purposes;

(f) community education about and compliance with this Act ;

(g) enforcement of this Act.

An exemption is subject to any conditions specified by the the Minister for Fisheries, or a person to whom the Minister for Fisheries has delegated, under section 12 of the Act, the power to grant exemptions. A condition may be varied or cancelled by the Minister for Fisheries (or the Minister's delegate) by notice in writing.

A person who contravenes a provision of a condition of an exemption will be liable to a penalty of $10,000 ($20,000 if a body corporate).

A person who acts beyond the authority conferred by an exemption will be liable to a penalty for breach of the Act.

Application Fee
The Prescribed Application Fee must accompany this application

Note: Application Fees are set out in *Fish Resources Management Regulations 1995*, Schedule 1, Part 2. Fees may be subject to change.

Instructions for completing this Application

Please use block letters when completing this Application.

Address the application to the "Minister for Fisheries".

PART A

1. **Applicant** - state the full name, business address of the applicant. Enter the daytime telephone number at ☎.

PART B

2. **Purpose for which Exemption is sought** - give details of the reason(s) for wanting to carry on the Proposed Activities (to be set out in Part C). Give details as to why the purpose for which the Exemption is sought is one of the purposes set out in section 7(2) of the Act, and identify the relevant paragraph of section 7(2).

PART C

3. **Proposed Activities for which Exemption is sought** - give full details of the proposed activities, including (as appropriate) by reference to quantity of fish, place or area, dates and times, persons to be involved and gear (including boats) to be used. Attach copies of relevant documents where appropriate

PART D

4. **Provision(s) of Legislation from which Exemption is sought** - specify the provisions of the Act, Regulations or other subsidiary legislation which prohibit the proposed activities (or any part of them); [e.g. Section 46 and Regulation 10 (where the take of a totally protected fish is proposed)].

PART E

5. **Declaration** - there are penalties under the *Fish Resources Management Act 1994* for making false or misleading statements.

6. **Execution of Documents -**

   6.1 **Signatures** - if the exemption is to be recorded as being held by more than one person, then all persons to be named on the exemption must sign and date this Application.

   6.2 **Body Corporate** - if the exemption is to be held by a body corporate, the Application must be signed and sealed in accordance with the sealing clause of the Corporation's Article of the Association and dated.

   6.3 **Attorney** - if the Applicant has appointed an Attorney, the Attorney signing may be requested to produce the relevant Power of Attorney instrument for viewing and a copy for recording.

NOTE: Applicants should be aware that the details disclosed in this Application will be recorded on the Public Register and be available for public search.

Appendix C Operational Monitoring Program Design

Extract from AMSA's Oil Spill Monitoring Handbook (Ref. 4)

GUIDELINE FOR DESIGNING A MONITORING PROGRAMME — D.1

Methodology

1. Set the objectives of the study

- 1.1 What specific question(s) needs to be answered?
- 1.2. Have knowledge gaps been identified and addressed?
- 1.3. Have limitations of not having information been evaluated?
- 1.4. Will the information gathered address all needs?
- 1.5. How will the information be managed and communicated?
- 1.6. Do specific objectives:
  - (a) Clearly and concisely state the purpose of monitoring?
  - (b) Specify what the monitoring will achieve?
  - (c) Indicate when the monitoring is complete?

2 Set the spatial boundaries of the study

3 Determine the scale of the programme

4 Estimate the level of variability (location/time)

5 Decide the level of accuracy required

6 Select suitable parameters for measurement

- 6.1 Are parameters able to detect changes/ trends?
- 6.2 Are measurements reliable, reproducible and cost-effective?
- 6.3 Are parameters appropriate for the time/scale of the study?
- 6.4 Are appropriate field techniques available?

Continued overpage

7 Determine method for obtaining data

7.1 Can data collection be undertaken safely?

7.2 Can data be obtained by field measurements?

7.3 Does the design account for spatial and temporal variability?

7.4 Will the study provide information in a relevant timeframe?

7.5 Will samples need to be collected?

7.6 Will sampling devices collect representative samples?

7.7 Will sampling devices contaminate or affect the sample?

7.8 Will samples contaminate or affect the sampling devices?

7.9 What size sample containers are required?

7.10 Will samples need to be preserved before analysis?

7.11 Are procedures in place to track samples and field data?

7.12 Can potential sampling error be minimised?

7.13 Can potential sampling error be assessed?

7.14 Can data be analysed and accessed in a timely manner?

8 Determine sample numbers and schedule

8.1 Are replicates needed?

8.2 How frequently is sampling required?

9 Determine the likely duration of the study?

10 Obtain materials, plan deployment (logistics)

11 Determine data management requirements

Appendix D Guideline for Data Management

Oil Spill Monitoring Handbook

GUIDELINE FOR DATA MANAGEMENT	Q.1

Rationale

Data management is needed for all monitoring programmes but will depend on the scale, complexity and purpose of each programme. This Guideline provides a basic checklist for the development of a Data Management Plan.

Methodology

1	Data management pre-planning:	
	1.1	Develop standard forms for all field data.
	1.2	Establish a standard methodology for assigning location names, sample numbers and descriptors.
	1.3	Prepare and provide pre-printed photo or sample log forms, labels and/ or chain of custody forms.
	1.4	Establish data storage system (hard copy/computer database/GIS).
	1.5	Obtain and supply maps and other recording equipment as required.
	1.6	Establish sample handling/management procedures (Guideline G.1).
	1.7	Assign responsibilities for data management, overall and in the field.
2	Field data recording and handling:	
	2.1	Ensure that data is documented on standard format forms, log books, film, tape or disk.
	2.2	Assign the task of data recording task to one person per team. If more than one person or one team is involved in these tasks, then training and field calibration of measurements should be undertaken.
	2.3	Ensure that all data recorded in the field is recorded in a data log (data type, location, time, custodian and location of storage).
3	Initial data validation, compilation and storage:	
	3.1	Assign responsibility and procedure for checking data for errors and ensuring that corrective action is taken.
	3.2	All data (and all formats) should be backed-up as soon as possible.
	3.3	Ensure that all data and samples are properly stored.
4	Assessment and compilation of data (data reduction):	
	4.1	Assign responsibility for checking requests for analysis, calculations etc.
	4.2	Establish responsibility and procedures for assessment, verification and storage of data.
	4.3	Ensure that laboratory or third party responsibility and procedures for the internal review of all analysis, calculations etc. has been established.

	Page 1 of 2	Q.1

Oil Spill Monitoring Handbook

Q.1	**Methodology Continued**			
5	Data validation.			
	5.1	Ensure that data is assessed for accuracy, e.g:		
		5.1.1	Analysis requested against data supplied.	
		5.1.2	Blanks, duplicates and other QA/QC samples for errors.	
		5.1.3	Detection limits, holding times.	
		5.1.4	Calculations.	
	5.2	Ensure that, if needed, data is corrected. Note: If data is corrected by management, or other third party, then changes should be recorded and initialed.		
6	Data reporting and display.			
	6.1	The format and content of final reports will vary according to the purpose of the monitoring programme. Generally it should include:		
		6.1.1	All results (raw data).	
		6.1.2	Interpretation (if required).	
		6.1.3	A discussion of any data gaps, QA/QC issues.	
	6.2	Data display and dissemination methods may include:		
		6.2.1	Status Boards.	
		6.2.2	Hard copy maps	
		6.2.3	Digital maps and data (GIS/OSRA or other)	
		6.2.4	Restricted or public bulletins. These may be	
			a	Paper copy
			b	Digital; either distributed via e-mail or displayed on the internet.

	Page 2 of 2	**Q.1**

Appendix E Oil Characterisation – Analytical Parameters

Analytical parameter	Suggested lab analytical method or field method	Type of spill material sample, including analysis units			Volume of sample/ Bottle requirements	Preservation and Holding time	Comment
		Oily/slick materials (limited water), separate phase oily product present or Oily potential source material	Water with sheen or water from underneath slick/spill	Oily sediment			
Total petroleum hydrocarbons (TPH) **C4-C12**	USEPA3510/8015 GC/FID. Includes EPA Method 3546/ ASTM D-5765 for sediments.	mg/L or µg/L	mg/L or µg/L	mg/kg as a dry weight	**Oily Sample:** 2 x 250 mL glass jar or 100 mL amber bottle (no or limited water content) **Water Sample:** Each analysis needs a 100 mL amber bottle i.e. 10 x 100 mL (or 1 x 1 L amber glass bottle). **Sediment Sample**: 4 x 250 mL glass jar NOTE: Should the oily sample or the sediment sample contain little oily material, larger quantities should be collected (more equivalent to the water sample quantities).	All containers use Teflon lined plastic screw caps/lids. All containers must be completely full with no airspace. All containers kept at or below 4 °C following collection until the time it arrives at laboratory. Holding time for analysis or extraction by lab is 7 days following sample collection. This means that following collection the sample must be received by the laboratory within allowable time for the sample to be analysed or extracted to	
Total recoverable hydrocarbons (TRH) **C6-C40**	USEPA3510/8015 GC/FID. Includes EPA Method 3546/ ASTM D-5765 for sediments.	mg/L or µg/L	mg/L or µg/L	mg/kg as a dry weight			
TRH C6-C40 with silica gel clean-up	USEPA3510/8015 GC/FID. Includes EPA Method 3546/ ASTM D-5765 for sediments.	mg/L or µg/L	mg/L or µg/L	mg/kg as a dry weight			
TRH Speciation Aliphatic/Aromatic fractions	CWG 1998	mg/L or µg/L	mg/L or µg/L	mg/kg as a dry weight			
Hydrocarbon product identification – GC-FID chromatograms	USEPA3510/8015 GC/FID, chromatogram review (non-NATA). Includes EPA Method 3546/ ASTM D-5765 for sediments.						Written statement by chemist, plus provision of chromatogram

Analytical parameter	Suggested lab analytical method or field method	Type of spill material sample, including analysis units			Volume of sample/ Bottle requirements	Preservation and Holding time	Comment
		Oily/slick materials (limited water), separate phase oily product present or Oily potential source material	Water with sheen or water from underneath slick/spill	Oily sediment			
Full VOC Target Scan, with Select Ion Mode (SIM) reporting. Includes use of ultra-trace analysis where available and Scan for Unknowns. Includes: • **Monocyclic Aromatic Hydrocarbon speciation (MAH)** • **Naphthalene** • **Oxygenated Compounds**	USEPA 5030/8260 P&T/GC/MS or HS/GC/MS	mg/L or µg/L	mg/L or µg/L	mg/kg as a dry weight		make the 7 day holding time (i.e. less than 7 days).	**MAH:** Benzene, toluene, ethyl benzene and, xylenes (BTEX), styrene, isopropylbenzene, n-propylbenzene, 1,3,5-trimethylbenzene, sec-butylbenzene, 1,3,4-trimethylbenzene, tert-butylbenzene, p-isopropyltoluene, n-butylbenzene **Naphthalene** **Oxygenated Compounds:** 2-propanone (acetone), vinyl acetate, 2-butanone (MEK), 4-methyl-2-pentanone (MIBK), 2-hexanone (MBK)
Fuel oxygenates	USEPA 5030/8260 P&T/GC/MS or HS/GC/MS	mg/L or µg/L	mg/L or µg/L	mg/kg as a dry weight			Tert-amyl ethyl ether (TAEE), Tert-amyl methyl ether (TAME), tert-butyl alcohol (TBA), diisopropyl ether (DIPE), ethyl tert-butyl ether (ETBE), methyl tert-butyl ether (MTBE)
Solvents	HS-GCMS	mg/L or µg/L	mg/L or µg/L	mg/kg as a dry weight			Butyl acetate, ethyl acetate, 1-heptane, cyclopentene, cyclohexene, pentane, hexane, heptane, octane, nonane, decane
Full **SVOC Target Scan, with SIM reporting. Includes use of ultra-trace analysis where available and Scan for Unknowns. Includes:** • **Phenols** • **PAHs** • **Phthalate esters** • **Nitrosamines** • **Nitroaromatics and ketones**	USEPA 3510/8270 GC/MS	mg/L or µg/L	mg/L or µg/L	mg/kg as a dry weight			**Phenols:** phenol, 2-chlorophenol, 2-methylphenol, 3 & 4-methylphenol, 2-nitrophenol, 4-nitrophenol,2,4-dimethylphenol, .4-dinitrophenol, 2,4-dichlorophenol, 2,6-dichlorophenol, 4-chloro-3-methylphenol, 2,4,6-trichlorophenol, 2,4,5-trichlorophenol, pentachlorophenol, hexachlorophene, m, o and p-cresol, 2-methyl-4.6-dinitrophenol, dinoseb, 2-cyclohexyl-4.6-dinitrophenol, 2,3,4,6-tetrachlorophenol **PAH:** naphthalene, 2-methylnaphthalene, 2-chloronaphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, anthracene, fluoranthene, pyrene, N-2-fluorenylacetamide, benz(a)anthracene, chrysene, benzo(b)&(k)fluoranthene, 7,12-dimethylbenz(a)anthracene, benzo(a)pyrene, 3-methylcholanthrene, indeno(1,2,3-cd)pyrene, dibenz(a,h)anthracene, benzo(g,h,i)perylene, benzo(e)pyrene, coronene, perylene

Analytical parameter	Suggested lab analytical method or field method	Type of spill material sample, including analysis units			Volume of sample/ Bottle requirements	Preservation and Holding time	Comment
		Oily/slick materials (limited water), separate phase oily product present or Oily potential source material	Water with sheen or water from underneath slick/spill	Oily sediment			
• **Anilines and benzidenes**							**Phthalate esters:** Dimethyl phthalate, Diethyl phthalate, Di-n-butyl phthalate, Butyl benzyl phthalate, Bis(2-ethylhexyl) phthalate, Di-n-octyl phthalate **Nitrosamines:** N-Nitrosomethylethylamine, N-Nitrosodiethylamine, N-Nitrosopyrrolidine, N-Nitrosomorpholine, N-Nitrosodi-n-propylamine, N-Nitrosopiperidine **Nitroaromatics and ketones:** 2-Picoline, Acetophenone, Nitrobenzene, Isophorone, 2,6-Dinitrotoluene, 2,4-Dinitrotoluene, 1-Naphthylamine, 4-Nitroquinoline-N-oxide, 5-Nitro-o-toluidine, Azobenzene, 1,3,5-Trinitrobenzene, Phenacetin, 4-Aminobiphenyl, Pentachloronitrobenzene, Pronamide, Dimethylaminoazobenzene, Chlorobenzilate **Anilines and benzidenes:** aniline, 4-chloroaniline, 2-nitroaniline, 3-nitroaniline, dibenzofuran, 4-nitroaniline, carbazole, 3,3-dichlorobenzidine
Paraffins, Isoparaffins, Aromatics, Napthenes, and Olefins (PIANO)	USEPA 8260 M	mg/L or µg/L					All volatile organic paraffins, isoparaffins, aromatics, naphthenes, olefins. Can be performed by ALS Newcastle.
Asphaltene Content	MA-1221/D3279	as a % of the whole oil					Can be done through labs subcontracting to Intertek Geotech (Petroleum Geochemistry Division).
Metals content (vanadium, Zinc, nickel, cadmium, lead, mercury)	USEPA 6020 ICP/MS (nickel, vanadium, cadmium, lead), ASTM 3112 Hd-B CV/FIMS (mercury)	mg/L or µg/L			**Oily Sample:** Additional 2 x 250 mL glass jar (no or limited water content)		
Sulfur content by XRF	ASTM D4294	%					
Density or Specific Gravity (at 15 °C)	ASTM D1298/D5002/D4052	mg/L					
Viscosity (at 20 °C and 30 °C)	ASTM D445	centistokes (cSt)					
Pour Point	ASTM D97	°C					

Analytical parameter	Suggested lab analytical method or field method	Type of spill material sample, including analysis units			Volume of sample/ Bottle requirements	Preservation and Holding time	Comment
		Oily/slick materials (limited water), separate phase oily product present or Oily potential source material	Water with sheen or water from underneath slick/spill	Oily sediment			
Water Content	ASTM 2709	% of sample					
Particle Size Distribution (PSD)	AS1289.3.6.1 – 2009			g/cm³	**Sediment Sample:** Additional 2 x 250 mL glass jar		Method by sieving – can be done on wet and dry sediments.
Total Organic Carbon (TOC)	ASTM D7573 – 09			%			Method by high temperature catalytic combustion and IR detection.
Water quality physical parameters: • **temperature** • **dissolved oxygen (DO)** • **salinity/EC** • **pH** • **redox potential (Eh)** • **turbidity** • **colour**	Suitable calibrated field probe or sample sent to laboratory.				**Water Sample to Laboratory**: 250 mL plastic bottle	If sent to lab then it is likely that the holding time for many of these analyses will be exceeded • 6 hours for DO, pH, Eh • 2 days for salinity/EC, turbidity and colour All containers use Teflon-lined plastic screw caps/lids. All containers must be completely full with no airspace. All containers kept at or below 4 °C following collection until the time it arrives at laboratory.	

Appendix F Forms

Form number	Description	Document ID
1.	Chain of Custody forms	
2.	Freight consignment form	
3.	OPS1: Oil Sampling Form	
4.	OPS2: Surface Dispersant Monitoring Summary Form – Tier 1 SMART Monitoring	
5.	OPS2: Visual Dispersant Monitoring Observer Log	
6.	OPS3: Oil in Water Assessment – Oil Sampling Form	
7.	OPS4: Oil in Sediment Assessment Form	
8.	OPS5: Rapid (Oiled) Shoreline Assessment Form	
9.	OPS6: Rapid Seabird and Shorebird Assessment	
10.	OPS7: Aerial Survey Log Form	
11.	OPS7: Marine Vessel Survey Log Form	
12.	OPS8: Fish Tainting Assessment Form	

Form 1 – Chain of Custody

Chevron

Chain of Custody Form
Environmental Sample Submission Sheet

1.0 General Information			
Samples sent to: (contract laboratory)			
Attention:			
Chevron Charge Caption:		or Service Order No.:	

2.0 Sample Information			
Samples From:		Sampled by:	
Sample Type:		Date Sampled:	

	Description of sample	Analysis required
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

☐ **Additional samples overleaf** ☐ **Preserved at 4°C**

3.0 Tracking

☐ **Copy 1** To Contract Lab with Sample
- Lab to acknowledge receipt of samples by signing below, and faxing a copy to EH&S representative.
- Lab to mail this **original** copy to EH&S representative with completed results.

☐ **Copy 2** Contract Lab to attach a copy to the invoice for this work.

☐ **MEJ number must be included prior to analysis of samples.**

Acknowledge receipt signature:		Date:	

Document ID: OE-11.01.34
Revision ID: 3.0. Revision Date: 16 November 2011.
Information Sensitivity: Company Confidential
Printed 21 December 2015.
Page 1 of 3

Chevron	Chain of Custody Form Environmental Sample Submission Sheet	

4.0 Reporting

☐ Chevron PO Box S1580, GPO Perth WA 6001	☐ Chevron phone number: (08) 9216 4000
☐ Fax: (08) 9216 4444	
☐ Environmental Advisor:	☐ HES rep. phone number:

5.0 Additional Samples

	Description of sample	Analysis required
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		

6.0 Additional Information

Chevron	Chain of Custody Form Environmental Sample Submission Sheet	

7.0 Chain of Custody

Samples Relinquished by:				
Name (Print)	Organisation	Date	Time	Signature
Samples Relinquished by:				
Name (Print)	Organisation	Date	Time	Signature
Samples Relinquished by:				
Name (Print)	Organisation	Date	Time	Signature
Samples Relinquished by:				
Name (Print)	Organisation	Date	Time	Signature
Samples Relinquished by:				
Name (Print)	Organisation	Date	Time	Signature
Samples Relinquished by:				
Name (Print)	Organisation	Date	Time	Signature

CHAIN OF CUSTODY

ChemCentre, Building 500 Resources and Chemistry Precinct,
Post: PO Box 1250, Bentley Delivery Centre WA 6983
PH: (08) 9422 9800 **FAX**: (08) 9422 9801 **Email**: ssd@chemcentre.wa.gov.au

ChemCentre EXPERT SOLUTIONS

GOVERNMENT OF WESTERN AUSTRALIA

Off Conlon Street, BENTLEY WA 6102

PAGE No: _____ **of** _____

COURIER NAME: .... CON NOTE No:	**NOTES**	ANALYSIS REQUIRED
CLIENT (Billing):		
ADDRESS:		
CLIENT P/O No:		
SAMPLED BY:		
RESULTS TO:		

ChemCentre Job No:

Please indicate if QC results are required:
☐ Method QC
☐ Batch QC
☐ Special LOD (use comments section)
*Method QC data refers to results from a lab blank and a lab verification standard.
*Batch QC data refers to results obtained from duplicate and spiked samples supplied by client and incurs extra charges.

LAB ID	SAMPLE ID / DESCRIPTION	Sample Type	Depth	DATE COLLECTED	TIME COLLECTED							*Comments/ Sampling Details*
				/ /	:							
				/ /	:							
				/ /	:							
				/ /	:							
				/ /	:							
				/ /	:							
				/ /	:							
				/ /	:							
				/ /	:							
				/ /	:							
				/ /	:							

RELINQUISHED BY: DATE/TIME:	Ph No: Email:	Contract:	RECEIVED BY: DATE/TIME:
☐ Normal Turnaround	**☐ Urgent Turnaround (will attract a surcharge)**.	LAB COMMENTS:	

Form 2 – Freight Consignment Form

CVX Advanced Shipping Notification (ASN)

Order Ref No:	
Date:	

Company Name:	
Address:	
Phone No:	
A/H Contact:	
Submitted By:	
Email:	
Phone No:	
A/H Contact:	

Date Revised:	
Revision No:	
ROS Date:	

AFE/Cost Code/CVX PO:	
Project/Facility/Well Details:	

Expected Delivery/ Collection Date:	ED: CD:	Time:	
Collection Address: *(If pickup Required)*	N/A		
Contact Name:			
Email:			
Phone No:			
A/H Contact:			

Final Destination:	
Consignee:	
Delivery Address:	

Special Handling Instructions Where Applicable		YES	N/A
Lift Plan:		☐	☐
COG:		☐	☐
Oversize:		☐	☐
Fork tyne pockets in container:		☐	☐
Lifting assembly included:		☐	☐
Explosives no forklift handling:		☐	☐

Comments:

Check List confirming (with attachments where deemed necessary by business)	YES	N/A
Is all material Quarantine compliant?	☐	☐
Are Dangerous Goods present?	☐	☐
Are DG's Chemalert approved?	☐	☐
Are current (<5yrs) Australian MSDS's attached?	☐	☐
AS1604 H3 Timber treatment certs?	☐	☐
Additional Certs (Heat, Hydrostatic,	☐	☐
Are lifting points certified?	☐	☐
QA/QC release	☐	☐
Chain of custody form	☐	☐
Customs clearance for imported pkgs	☐	☐
Timber treatment certificate for imported pkgs	☐	☐
Country of Origin declaration for imported pkgs	☐	☐
Export compliance certificate for goods ex USA	☐	☐

ASN TEMPLATE INSTRUCTIONS

Advanced Shipping Notification:

- This template is designed to upload material details into Chevron iLogistics system
- All the mandatory details as specified in below table **MUST** be populated in **Advanced Shipping Notification** work sheet before submission
- Material details should only be entered at item level or package level.
- The maximum number of characters against a field are represented in the column header. Ex: **Material Description can have max 30 characters. Above the limit characters will be truncated**

FIELD TITLE	REQUIRED	DESCRIPTION
Sl No.	Not Applicable	
Order Type	Mandatory	CVX Type of order the materials being delivered against. By default this should be **external Ref** type, unless delivering against a PO number
Order Ref No. (15)	Mandatory	Reference number against which the materials are delivered. Each shipment must have its own unique number. This can be any number but **MUST** be prefixed by the first 3 letters of your company name (e.g. MONxxxxxxx)
Order Item Ref. No.(15)	Optional	Unique line item number in the Order
Invoice No.(15)	Optional	
Work Order No.(15)	Optional	
Material Description(30)	Mandatory	Description/Label of the material(s)
L(500)	Optional	Long description of material(s)
Material No.(10)	Optional	
Material type(30)	Optional	Type of material. Choose from existing list
Quantity (10)	Mandatory	Numbers of quantity
Est. Quantity-Units (10)	Mandatory	Units of Quantity. Please refer to Units table for unit code descriptions
Weight (10)	Mandatory	Weight of materials in numeric
Est. Weight-Units (10)	Mandatory	Units of weight
ROS Date(DD/MM/YYYY)	Mandatory	Required on Site Date
Remarks(500)	Optional	Remarks
Length (m) (10)	Mandatory	Length in meters
Width (m) (10)	Mandatory	Width in meters
Height (m) (10)	Mandatory	Height in meters
Delivery Type	Optional	Partial, Full or Over
HAZMAT(Yes/No)	Mandatory	Hazardous Material specification
Value of Material(10)	Not Applicable	
Currency	Not Applicable	
Custom Status	Not Applicable	
Rental(Yes/No)	Optional	Specify if the material is a rental equipment

Unit Code	Description
BD	Bundle
BE	Bale
BG	Bag
BK	Bucket
BN	Bulk
BR	Barrel
BT	Bottles
BU	Bushel
BX	Box
CA	Case
CD	Cylinder
CL	Coil
CR	Carton
CT	Caret
CU	Cubes
DR	Drum
DZ	Dozen
EA	Each
JR	Jar
JT	Joints
KI	Kit
LO	Lot
PA	Pail
PC	Pieces
PD	Pad
PK	Pack
PL	Pallet
PR	Pair
RE	Reel
RL	Roll
RM	Ream
SK	Sack
SL	Sleeve
SP	Spool
ST	Set
TB	Tube
TC	Tank Car
TI	Tin
TK	Tank
UN	Units

Header:

- Enter the Order reference number into ASN ref No field, against wich the materials can be tracked
- Fill in the collection details if pick up is required
- Please select all the special handling instructions where applicable
- Please mark the ASN check list and attach necessary documents were deemed necessary to the email

Form 3 – Oil Sampling Form

Sample Sheet _____ of _____

Sampling Location Sketch

(State location and site references)

Sample Sheet _____ of _____

OIL SAMPLING FORM FOR OPS1					
Incident Name:			Ref No.		
Sampling Team					
Sample Number Unique number (as shown on sampling location sketch)					
Date (dd/mm/yyyy)					
Time 24 hrs					
Location/Reference Site reference and GPS coordinates					
Tide, current and weather					
Colour and optical effect (Bonn Agreement)					
Flow properties at ambient temp					
Water-in-oil emulsion (mousse)?					
Formation of solid sheets or balls?					
Evidence of submerged oil?					
Container Type	Glass jar				
	Bottle				
	Other				
Comments General observations, sampling method, variation on collection procedure etc.					
Photos Taken	Held By:				
Replicate A	Held By:				
Replicate B	Held By:				
Replicate C	Held By:				

(Based on DoT Oil Sampling Form)

Form 4 – OPS2: Surface Dispersant Monitoring Summary Form – Tier 1 SMART Monitoring

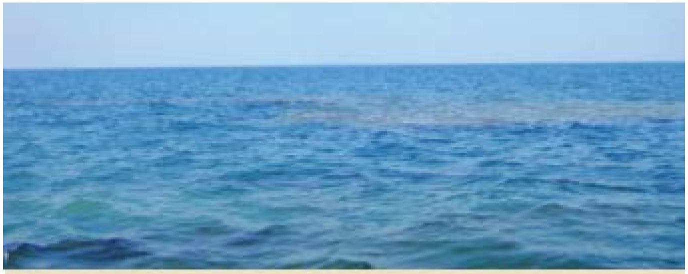
Surface Dispersant Monitoring Summary Form – Tier 1 SMART Monitoring	
Incident	
Incident name:	Ref No.:
Reporting Details	
Assessment team leader:	Position/Organisation:
Team members (Name/Organisation):	
Date completed:	Time completed (24 hrs):
Reporting to:	Position/Organisation:
Date received:	Time received (24 hrs):
Location Details	
Wind:	
Sea state:	
Water temp:	
Visibility/cloud cover:	
Dispersant used:	
Application method:	
Oil condition and type:	
Activity Log	

Comments should include:

1. *Where and when dispersant was applied*
2. *Perceived effectiveness:*
    a. *No obvious dispersion – Dispersant being washed off the black oil as white watery solution leaving oil on surface. Quantity of oil on sea surface not altered by dispersant.*
    b. *Slow or partial dispersion – Some surface activity (oil appearance altered). Spreading out of oil. Droplets of oil seen rapidly rising back to sea surface, but overall quantity appear to be similar to that before dispersant spraying.*
    c. *Rapid dispersion – Oil rapidly disappearing from surface. Light brown plume of dispersed oil visible in water under the oil and drifting away from it. Oil in some areas being dispersed to leave only sheen on water.*

    Ensure photos are taken to demonstrate the observations – include the photo number that you are referring to and if possible the direction the photo was taken in.
3. *Operations – was the dispersant applied appropriately in the correct dosage?*
4. *Sensitivities – note potential ecological impacts, the presence of marine mammals, coral reefs etc.*

Time	Actions/Events

Surface Dispersant Monitoring Summary Form – Tier 1 SMART Monitoring
Evidence collected e.g. photos
 Observation of oil prior to dispersant application
 Observation of oil post dispersant application
 Observation of oil post dispersant application
Recommendations: (e.g. the dispersant appears to be effective on fresh oil)

(Source Ref. 6)

Form 5 – Visual Dispersant Monitoring Observer Log

VISUAL DISPERSANT MONITORING OBSERVER LOG

Incident		Date		Observers	
Aircraft Type		Call Sign		Area Of Survey	
Survey Start Time		Survey End Time		Average Altitude	
Wind Speed (knots)		Wind Direction		Notes	
Cloud Base (feet)		Visability (nm)			
Time High Water		Time Low Water			
Current Speed (nm)		Current Direction			

SLICK	TIME UTG	OIL POSITION (CENTRE)		SLICK ORIENT Degrees	OIL SLICK LENGTH			OIL SLICK WIDTH			AREA km²	AREA COVERAGE %	OILED AREA km²
		LATITUDE NORTH	LATITUDE EAST/WEST		G/SPEED	TIME Seconds	DISTANCE km	G/SPEED	TIME Seconds	DISTANCE km			
A													
B													
C													
D													
E													

SLICK	OIL APPEARANCE Post Dispersant Application%				Log Photo Reference Number (and direction photo taken)	OIL APPEARANCE - Post Dispersant Application	
	1	2	3	4			
A						1	No obvious dispersion - Dispersant being washed off the black oil as white, watery solution leaving oil on surface. Quantity of oil on sea surface not altered by dispersant.
B						2	Slow or partial dispersion - Some surface activity (oil appearance altered). Spreading out of oil. Droplets of oil seen rapidly rising back to sea surface, but overall quantity appear to be similar to that before dispersant spraying.
C						3	Rapid dispersion - Oil rapidly disapearing from surface. Light brown plume of dispersed oil visible in water under the oil and drifting away from it. Oil in some areas being dispersed to leave only sheen on.
D						4	Other observations - Such as herding or lacing.

(Source Ref. 6)

Form 6 – OPS3: Oil in Water Assessment – Oil Sampling Form

Sample Sheet _____ of _____

OIL IN WATER SAMPLING FORM FOR OPS3					
Incident Name:			Ref No.		
Sampling Team					
Location Name					
Date (dd/mm/yyyy) / Time					
Tides, currents and weather					
Coordinates for physical water quality sample.					
Probe readings:		Bottom	Surface	Bottom	Surface
• Salinity					
• Temperature					
• Dissolved Oxygen					
• pH					
• Turbidity					
Site Number					
Site Coordinates					
Sample Depth					
Replicate/Triplicate Samples					
Container Type	Glass bottle				
	Glass Jar				
	Other				
Comments General observations, sampling method, variation on collection procedure etc., evidence of hydrocarbons (e.g. odour, sheen)					
Photos Taken	Held By:				
Replicate A	Held By:				
Replicate B	Held By:				
Replicate C (if required)	Held By:				

(Based on the DoT Oil Sampling Form)

Form 7 – OPS4: Oil in Sediment Assessment Form

Sample Sheet _____ of _____

Sampling location sketch

Sample Sheet _____ of _____

OIL IN SEDIMENT SAMPLING FORM FOR OPS4					
Incident Name			Ref No		
Location Name					
Personnel Sampling					
Date / Time					
Weather conditions Wind speed/direction, sea state, cloud cover, rainfall					
Site Coordinates					
Site Number					
Container Type	Glass jar				
	Other				
Comments General observations, sampling method, variation on collection procedure etc., sediment characteristics (colour, odour, grain size)					
Photos taken	Held By:				
Replicate A	Held By/Ref no.:				
Replicate B	Held By/Ref no.:				
Replicate C	Held By/Ref no.:				

(Source: DoT Oil Sampling Form)

Form 8 – OPS5: Rapid (Oiled) Shoreline Assessment Form

<table>
<tr><th colspan="7">Shoreline Assessment Form</th></tr>
<tr><th colspan="7">Incident</th></tr>
<tr><td colspan="4">Incident name:</td><td colspan="3">Ref No.:</td></tr>
<tr><th colspan="7">Reporting Details</th></tr>
<tr><td colspan="3">Assessment team leader:</td><td colspan="4">Position/Organisation:</td></tr>
<tr><td colspan="7">Team members (Name/Organisation):</td></tr>
<tr><td colspan="3">Date completed:</td><td colspan="4">Time completed (24 hrs):</td></tr>
<tr><td colspan="3">Reporting to:</td><td colspan="4">Position/Organisation:</td></tr>
<tr><td colspan="3">Date received:</td><td colspan="4">Time received (24 hrs):</td></tr>
<tr><th colspan="7">Location Details</th></tr>
<tr><td colspan="3">Sector:</td><td colspan="4">Segment:</td></tr>
<tr><td colspan="7">Name of beach or location:</td></tr>
<tr><td colspan="7">Description (e.g. slope):</td></tr>
<tr><td colspan="4">Topography/other map (No.):</td><td colspan="3">Map reference:</td></tr>
<tr><td>Access via:</td><td>☐ Foot</td><td>☐ Road</td><td>☐ 4WD</td><td colspan="2">☐ Boat</td><td>☐ Helicopter</td></tr>
<tr><td colspan="7">Hazards:</td></tr>
<tr><th colspan="7">Timing</th></tr>
<tr><td>First assessment:</td><td>☐ Yes</td><td>☐ No</td><td colspan="2">Last assessment:</td><td>☐ Yes</td><td>☐ No</td></tr>
<tr><td>Timing:</td><td>☐ Pre-Impact</td><td colspan="3">☐ Post-Impact Before Clean-up</td><td colspan="2">☐ Post-Impact After Clean-up</td></tr>
<tr><td>Time since:</td><td colspan="2">Impact (days/hrs):</td><td colspan="4">Last clean-up (days/hrs):</td></tr>
<tr><th colspan="7">Assessment</th></tr>
</table>

Parameter	LITZ	MITZ	UITZ	Supratidal
Shoreline Description				
Shoreline type*				
Substrate type				
Length of shoreline				
Width of shoreline				
Biological character				
Oil Distribution and Character				
Oil Band Length				
Oil band width				
% cover in oil band				
Surface oil thickness				
Oil appearance/character				

Shoreline Assessment Form				
Depth of buried oil (from surface)				
Buried oil bands (min-max m/cm)				
Description of buried oil				
Other				
Un-oiled debris				
Oiled debris				

Sketch Map (Include North point and a scale)

Notes:

Photo Numbers:

(Based on DoT Oiled Shoreline Assessment Form)

Form 9 – OPS6: Rapid Seabird and Shorebird Assessment

Site code:		
GPS coordinates:	Start:	End:
Personnel:		
Date:		
Time:		
Length:	(Approx. length of transect)	
Weather conditions:	e.g. wind speed/direction, sea state, cloud cover, rainfall	
General site description:	(include notes on exposure [wave energy etc.], drainage, gradient)	
Wildlife description:	(type/species present, abundance, behaviour)	
Oiled wildlife description:	(type/species present, abundance, behaviour)	

Photographs:	Looking along transect from start: ☐ Looking along transect from end: ☐ Note any additional photos taken at site (e.g. vegetation, fauna, access etc.):

Form 10 – OPS7: Aerial Survey Log Form

Site code:		
GPS coordinates:	Start:	End:
Personnel:		
Date:		
Time:		
Length:	(Approx. length of transect)	
Weather conditions:	e.g. wind speed/direction, sea state, cloud cover, rainfall	
General description:	(include notes on exposure [wave energy etc.], drainage, gradient)	
Wildlife observations:	(type/species present, abundance, behaviour)	
Video and Photographic record:	Looking along transect from start: ☐ Looking along transect from end: ☐	

Form 11 – OPS7: Marine Vessel Survey Log Form

BLUE PLANET MARINE

Gorgon LNG Project
Marine Fauna Observations

Chevron

Vessel:

Log to be maintained by the MFO

Week starting ____________

Date	Time (24 hour)	Latitude (dd.mm.mm) DEGREES & DECIMAL MINUTES	Longitude (dd.mm.mm) DEGREES & DECIMAL MINUTES	Your activity (ie transit, at anchor)	Distance in metres of fauna from vessel	Bearing of fauna from vessel	Species (if known * See note below)	Total number of animals	Mitigation activities if required (ie manoeuvred slowly away from whale)	Seastate (Beaufort)	Overall visibility (Very good, Average, Poor)

*If species unknown, use "turtle", "dolphin", "whale", "dugong" or "whale shark".

Page _____ *of* _____

Form 12 – OPS8: Fish Tainting Assessment Form

Site code:		
GPS coordinates:	Start:	End:
Personnel:		
Date:		
Time:		
Location description:		
Site condition of tainted fish:	e.g. wind speed/direction, sea state, cloud cover, rainfall	
General description of fish:		
Fish observations:	(type/species present, tainting observations/records)	
Other records:	Notes as necessary	

Appendix C Guidance Note and Standard Operating Procedures – Scientific Monitoring

Operational and Scientific Monitoring Plan

Guidance Note for Scientific Monitoring

Document ID:	**ABU151200658**
Revision ID:	**4.0**
Revision Date:	**25 May 2020**
Next Revision Due	**25 May 2025**
Information Sensitivity:	**Company Confidential**

Contents

Tables

Figures

1 Introduction

1.1 Purpose

This Operational and Scientific Monitoring Plan (OSMP): Scientific Monitoring Guidance Note (this Guidance Note) describes the implementation of scientific monitoring if an emergency event results in an oil spill to marine or coastal waters where Chevron Australia Pty. Ltd. (CAPL) is the Nominated Titleholder (Commonwealth) or Operator (State).

This Guidance Note focuses on scientific monitoring only, as set out in the Operational and Scientific Monitoring Plan (ABU130700448; Ref. 1).

The OSMP (Ref. 1) splits scientific monitoring into individual components (Figure 1-1). Each component represents a particular assessment or study, with initiation and termination triggers to determine if and when that monitoring component will be implemented.

Note: This Guidance Note is for scientific monitoring purposes, not operational monitoring.

1.2 Scope

This Guidance Note focuses on the implementation of scientific monitoring components only. Monitoring, Evaluation and Surveillance (MES) tactics for an oil spill are excluded as they are covered in the activity-specific Oil Pollution Emergency Plans (OPEPs). Similarly, the response option selection process (including Net Environmental Benefit Analysis [NEBA]) that may use the data collected under operational monitoring programs is part of the OPEP processes and not discussed in this Guidance Note.

This Guidance Note is part of the overall oil spill preparedness and response framework in place at CAPL, which is described in the Australian Business Unit (ABU) Oil Spill Response Manual (Ref. 2), and outlined in Figure 1-2.

Field sheets and checklists that supplement this Guidance Note are contained in the Appendices.

1.3 Objectives

The objectives of this Guidance Note are to:

- provide a framework for finalising program design for scientific monitoring so that it is appropriate to the nature and scale of the event
- describe standard operating procedures for required sampling, including providing standard field sheets and checklists
- describe potential sampling and analysis design for each component, taking into consideration existing baseline data and current monitoring techniques.

1.4 Target Audience

This Guidance Note is for environmental personnel implementing scientific monitoring scopes, including those fulfilling scientific monitoring roles within the Environment Unit (Figure 1-3) of the Emergency Management Team (EMT).

1.5 Limitations

Monitoring is to be implemented in a way that meets the objectives of the OSMP (Ref. 1), while retaining operational flexibility such that abnormal conditions, access to resources (including access to vessels and aircraft and/or events beyond CAPL's control) can be accommodated. The potential survey areas occur in a remote region, with limited logistical capability and can experience extreme weather events. The need for flexibility in monitoring design, effort, and rapid deployment (possibly using a vessel of opportunity), may dictate the nature and extent of the monitoring. There may be times where it is not possible to implement or complete one or more scientific monitoring programs (SCIs) as described in this document. If this occurs, CAPL ensures the objectives of this document are bet my taking measures to alter designs and/or reprioritise its monitoring programs.

This Guidance Note provides a framework for finalising program design so that it is appropriate to the nature and scale of the emergency event. It provides details for SCIs that must be implemented by CAPL. External environmental specialists, engaged to support SCIs, will provide additional guidance where required. Although this document is intended to provide guidance on most monitoring situations, additional monitoring may be required as determined by the Health, Environment, and Safety (HES) Supervisor and/or the EMT.

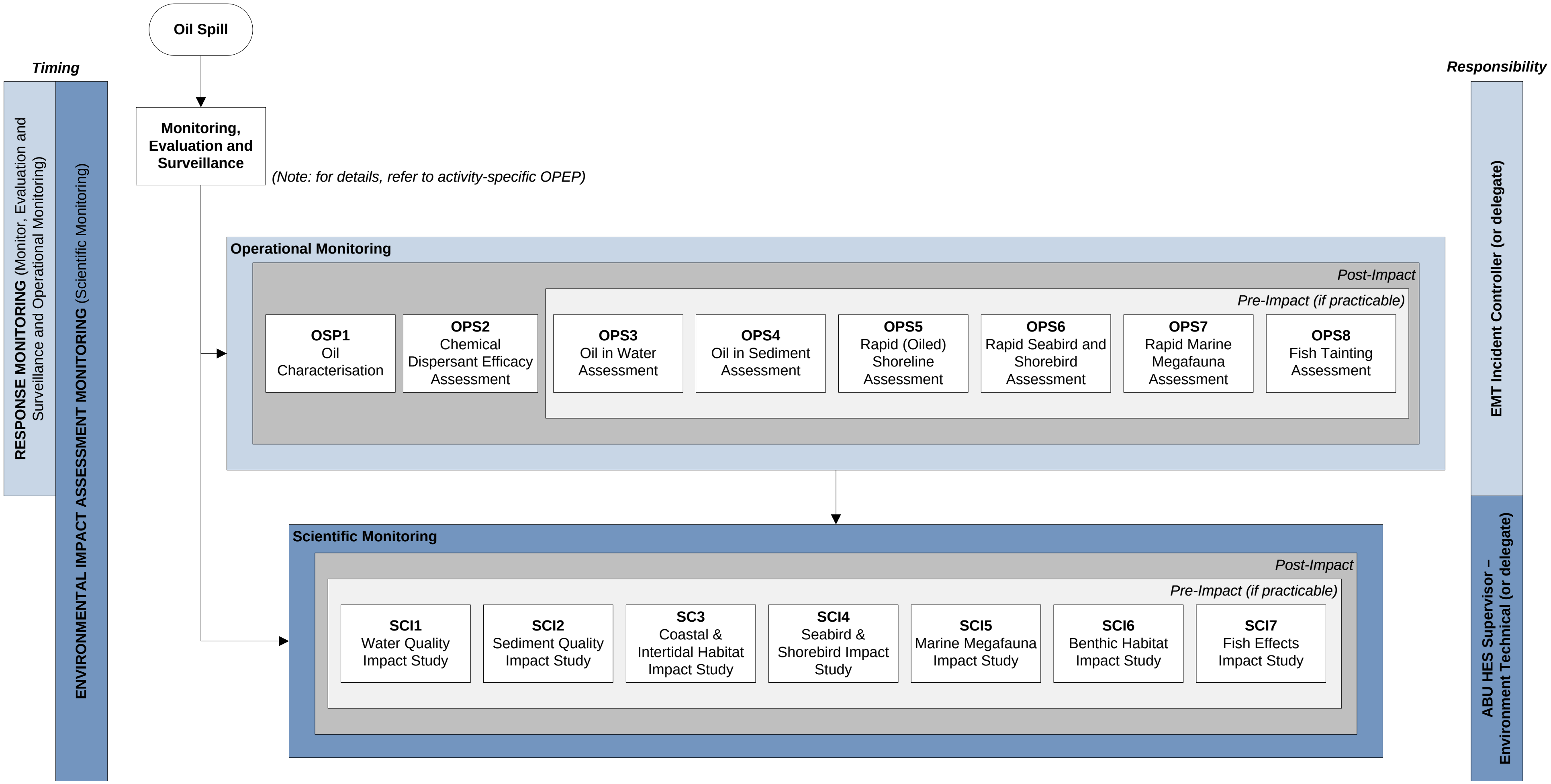


Figure 1-1: Monitoring in the Event of an Oil Spill to Marine or Coastal Waters

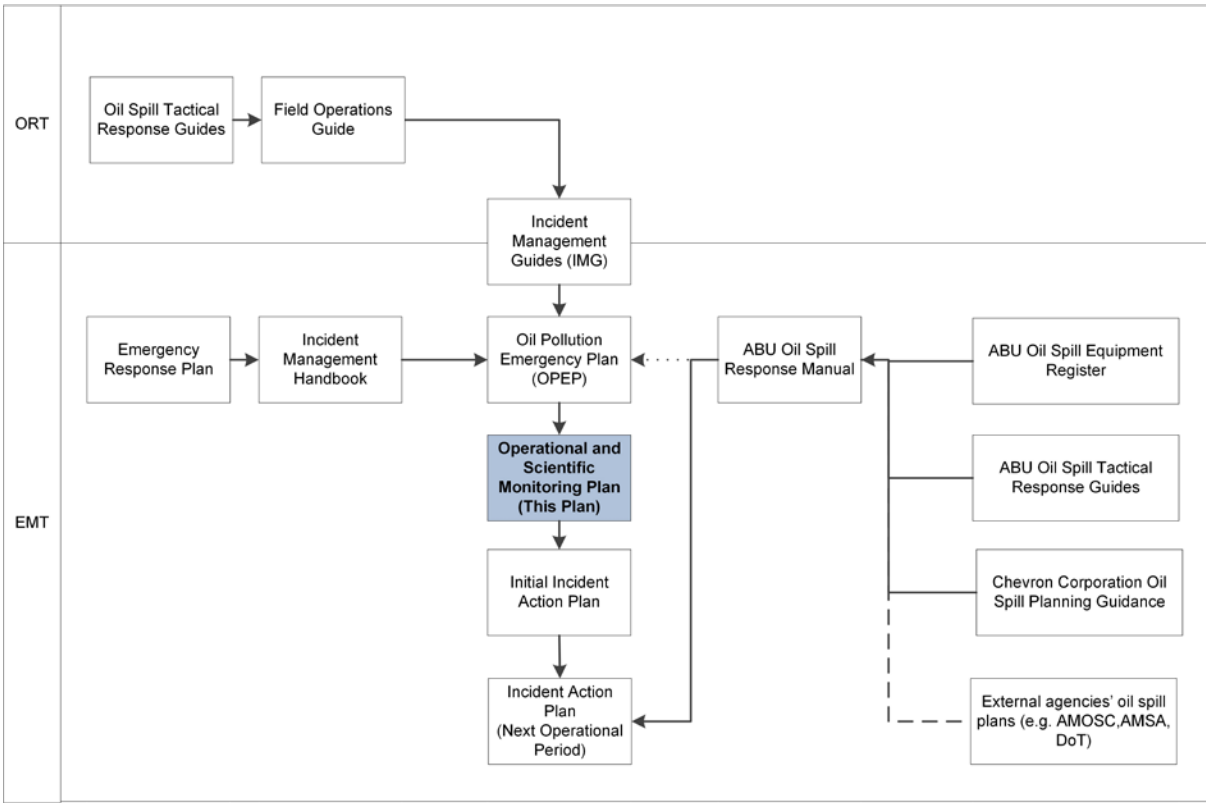


Figure 1-2: Relationship of Emergency Management and Oil Spill Documentation within CAPL

Note: Shaded cells refer to documents related to this Guidance Note.

1.6 Continual Improvement

CAPL is committed to conducting activities in an environmentally responsible manner and aims to implement best practice environmental management as part of a program of continuous improvement. This commitment to continuous improvement means that CAPL will review the OSMP (Ref. 1) every five years, or more often as required (e.g. in response to new information).

Reviews will address matters such as the overall design and effectiveness of the Plan, progress in environmental performance, changes in environmental risks, changes in business conditions and any relevant emerging environmental issues.

1.7 Acronyms and Abbreviations

Section 14.0 defines the acronyms and abbreviations used in this Guidance Note.

1.8 Roles and Responsibilities

The roles and responsibilities outlined in Figure 1-3 apply to all phases of the monitoring process. The HES Supervisor (or delegate) is responsible for ensuring the implementation of the scientific monitoring components; however, in the short term (during the event), the EMT will be closely consulted. Several specific monitoring roles (see shaded cells in Figure 1-3) will also be required.

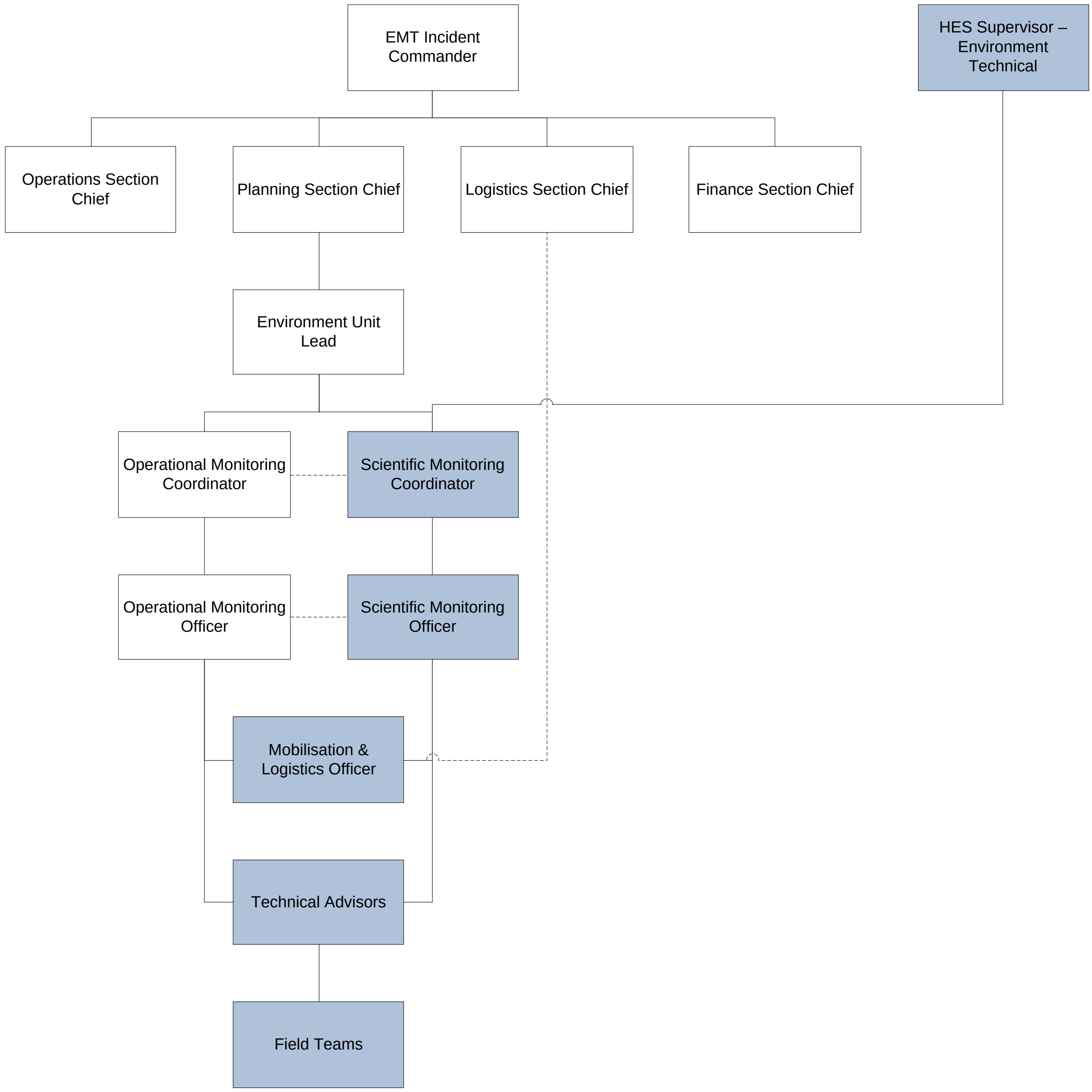


Figure 1-3: Roles Associated with Scientific Monitoring

Note: Shaded cells refer to roles related to this Guidance Note.

Table 1-1: Scientific Monitoring Roles, Responsibilities, and Rationale for using this Document

Role	Responsibilities	Reason for using this document
HES Supervisor – Environment Technical (or delegate)	Ultimately responsible for: • Ensuring that scientific monitoring is implemented in accordance with the OSMP (Ref. 1). • Setting the objectives for the scientific monitoring programs.	• Is aware of this document but does not directly implement each SCI • Refers the Scientific Monitoring Coordinator to this document for use
Environment Unit Lead	Key position for relaying information between the EMT and the Scientific Monitoring Coordinator.	• Ensures communication between Operational and Scientific Monitoring Coordinators for sharing of resources/data etc.
Scientific Monitoring Coordinator	Key program management role for the monitoring scopes. Responsibilities include: • Contact point with HES Supervisor and the EMT (through the Environment Unit Lead) • Ensuring relevant SCI components are implemented in line with the OSMP (Ref. 1) and this Guidance Note • Providing overarching technical advice • Financial tracking and management (in consultation with HES Supervisor – Environment Technical and EMT [through the Environment Unit Lead] as appropriate) • Logistics tracking (in consultation with Logistics Section in EMT as appropriate) • Engaging with required third-party contractors including consultants and laboratories.	• Communicating monitoring activities to the HES Supervisor – Environment Technical and Environment Unit Lead as appropriate • Ensuring initiation and termination criteria are met • Acquiring personnel to fulfil roles and ensuring responsibilities are met
*Scientific Monitoring Officer	Scientific Monitoring Officers are the technical leads for each monitoring type. Responsibilities include: • Understanding the data metrics that would be collected in the event of a spill • Advising the Scientific Monitoring Coordinator on data collection, logistical support required, and monitoring priorities if constraints (e.g. safety, time, or logistics) are encountered • Facilitating activation of contractors if necessary • Overseeing data analyses and interpretation • Managing data including spatial data • Presenting data in an appropriate and informative format to allow for timely decisions * The Scientific Monitoring Officer may undertake the responsibilities of Technical Advisor if appropriate (i.e. technical capability, availability).	• Design of SCIs • Ensuring Standard Operating Procedures (SOPs) are appropriate for the spill scenario • Directing contractors on tasks required • Ensuring appropriate laboratory analyses are conducted

Role	Responsibilities	Reason for using this document
Mobilisation and Logistics Officer	Responsibilities include: • Ensuring field teams (CAPL personnel and/or contractors) are mobilised to site as soon as practicable, in accordance with CAPL processes and the initiation criteria outlined in this Guidance Note • Liaising with the EMT Logistics Section Chief (or delegate) during the response when planning mobilisation of operational and/or scientific monitoring field teams • Facilitating procurement of any necessary vessels or sampling equipment, if required.	• Understanding resources required (resource lists for each SCI) • Understanding requirements to mobilise people and equipment for monitoring tasks
*Technical Advisors	Technical Advisors will be assigned to monitoring scopes as required. Technical Advisors will have a thorough understanding of the receptors they are assigned. Key responsibilities include: • Overseeing and providing advice on collecting data • Advising the Operational and Scientific Monitoring Officers on data collection methods • Ensuring sampling and analysis plans (where required) are completed before mobilisation • Undertaking quality assurance/quality control (QA/QC) and interpreting data • Preparing reports. * The Scientific Monitoring Officer may undertake the responsibilities of Technical Advisor if appropriate (i.e. technical capability, availability etc.).	• Designing SCIs • Verifying SOPs • Ensuring QA/QC in data collection and reporting
Field Teams	A Field Team will include one Field Team Lead, who is the key contact point to the Technical Advisor during the survey . All Field Team members are responsible for: • Understanding the details of monitoring methods • Having adequate field data collection sheets and survey-specific equipment readily available • Ensuring awareness and understanding of QA/QC procedures • Assisting with report preparation if required • Implementing relevant HES protocols.	• SOPs for each OSMP • Resource lists

1.9 Mobilisation Times

1.9.1 Operational Areas

The operational areas of CAPL are shown in Figure 1-4; these areas represent the geographic scope of the OSMP (Ref. 1). Indicative mobilisation times for these areas is provided in Appendix A.

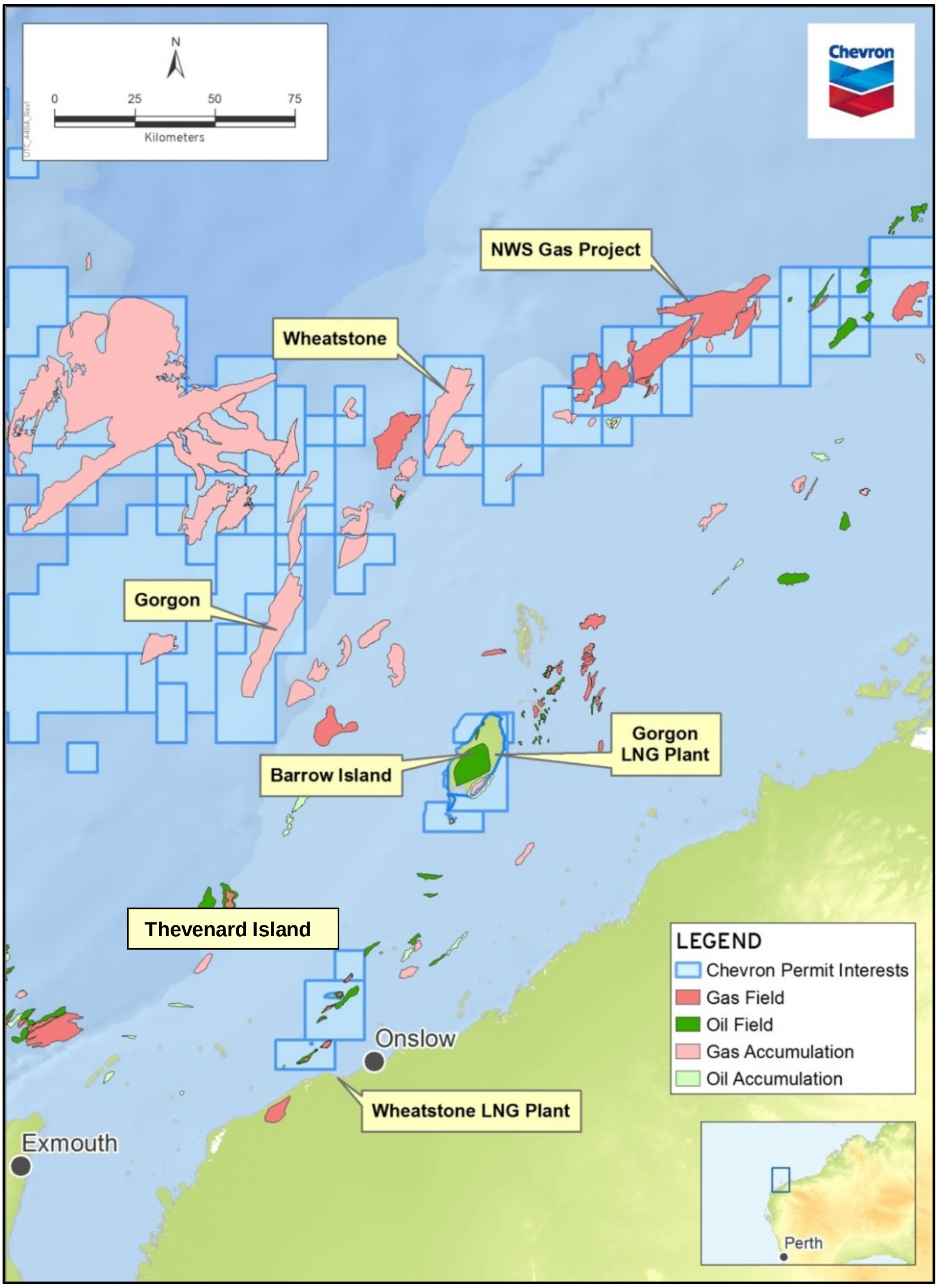


Figure 1-4: CAPL's Operational Areas

1.9.2 Non-operational Areas

For areas not under CAPL's operational control, access will be planned in conjunction with relevant statutory agencies (e.g. Western Australian [WA] Department of Transport [DoT]), other operators (e.g. Quadrant Energy for Varanus Island, Vermillion Oil and Gas Australia for the Montebello Islands), and the WA Department of Biodiversity, Conservation and Attractions (DBCA) for locations managed by the Marine Parks and Reserves Authority (MPRA).

1.9.3 Permits

Individual scientific monitoring plans have specific requirements for field sampling, with some plans requiring collection of biota. A sampling permit is required if biological samples are collected from the water column or seabed, or if an exemption requires using a specific type of sampling gear. Several permits or exemptions will be required from different government departments, depending upon where the sampling will be undertaken (based on the nature and scale of the hydrocarbon spill). Table 1-2 outlines the permits required and the issuing authority, and Table 1-3 outlines the likely permits required for each SCI. Note: This does not include any entry or research permit requirements from the WA Department of Aboriginal Affairs (http://www.daa.wa.gov.au/en/Entry-Permits/EP_Y_PermitForm/).

Table 1-2: Permits Potentially Required to Support Scientific Monitoring Plans

Government Approval / Permit Issuing Authority	Permit Reference	Permit Required for	Legislative Requirement
Commonwealth Department of the Agriculture, Water and the Environment (DAWE)	Application for a permit to access biological resources in Commonwealth Marine Protected Areas (MPAs) for non-commercial research	Conducting scientific research in a Commonwealth MPA, including filming and photography	
	The requirement to have a permit for access to biological resources or to kill, take, keep, or injure a listed threatened, migratory or marine species in a Commonwealth area is exempt for actions undertaken to manage or respond to a maritime environmental emergency (such as an oil spill), in accordance with the National Plan for Maritime Environmental Emergencies (Ref. 3)	Collecting any biological specimens from Listed species	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) – Part 13 Commonwealth EPBC Regulations 2000 – Part 8a http://www.environment.gov.au/epbc/notices/pubs/140306-section-303a-exemption.pdf.
Commonwealth Department of Conservation, Biodiversity and Attractions (DBCA)	Application for a licence to take (i.e. capture, collect, disturb, study) fauna for scientific purposes in State Waters out to three nautical miles (nm).	Conducting scientific research (including filming and photography) in a State MPA in State Waters out to three nm	*Biodiversity Conservation Act 2016*(WA) and Regulations – Regulation 25

Government Approval / Permit Issuing Authority	Permit Reference	Permit Required for	Legislative Requirement
WA Department of Fisheries (DoF)	Application for exemption	Collecting virtually all marine biota (flora and fauna), whether alive or dead, anywhere in marine waters out to 200 nm. Excludes aquatic mammals, aquatic reptiles, aquatic birds, amphibians, or (except in relation to Part 3 and Division 1 of Part 11) pearl oysters. Exemption for any non-standard equipment	Section 7 and Regulation 6 of the *Fish Resources Management Act 1994* (WA) and Regulations

Table 1-3: SCIs Requiring Engagement with Government Approval / Permit Issuing Authorities to Determine Permit Requirements for Response and Post-response Phase Monitoring (excluding permits required to access Indigenous lands)

Permit	SCI1	SCI2	SCI3	SCI4	SCI5	SCI6	SCI7
DAWE (formally DotEE – 8A and 13 permit)	Exemption for maritime environmental emergencies						
DAWE (formally DotEE – MPA permit)	X	X	X	X	X	X	X
DBCA (within 3 nm)			X	X	X	X	X
DoF permit			X			X	X

** Note: Infauna sampling will be conducted as part of SCI6 and not SCI2.*

1.10 Safety and Health

Safety and health are paramount in any oil spill response. CAPL has a strong safety culture that is part of daily operations. All the usual safety practices that CAPL personnel follow in their regular activities still apply during a spill response. In addition, special safety measures will be implemented to protect personnel from the risks associated with oil spill response activities.

The potential risks and hazards associated with scientific monitoring are listed in Table 1-4. Note: Each survey will have unique hazards associated with its monitoring activities. The hazards listed in Table 1-4 are not exhaustive.

This information may be used to develop a Job Safety Analysis before undertaking scientific monitoring activities.

Table 1-4: Potential Hazards Associated with Scientific Monitoring Activities

Hazards	Impacts	Mitigation Measures
General		
Chemical Exposure to dispersant chemicals	• Eye irritant • Inhalation and ingestion hazard	• Exclude non-essential personnel from spray areas

Hazards	Impacts	Mitigation Measures
		• Supply appropriate clothing and personal protective equipment (PPE) for essential personnel • Conduct vessel spraying from upwind • Establish buffer zones (0.5 nm for vessel application, 1 nm for aerial)
Sound Noise (85–90 dB(A))	• Hearing damage from prolonged exposure to loud machinery	• Supply hearing protection • Limit exposure
Motion Manual handling (including during use of monitoring equipment)	• Back strains or injuries	• Attend manual handling training • Clearly mark weights on labels • Use lift-assist equipment and procedures
Gravity Slips, trips, and falls	• Injuries (cuts, bruises, fractures)	• Highlight risks during safety briefings • Wear appropriate footwear • Provide non-slip surfaces
Chemical Exposure to toxic components of oil (i.e. VOCs, H_2S)	• Health impacts: nausea, vomiting, fatalities in extreme cases • Explosive risk	• Monitor air emissions • Restrict site entry • Supply respiratory protection and PPE
Biological Exposure to Irukandji (jellyfish) or other dangerous marine fauna	• Health impacts: Sever pain, nausea, vomiting, fatalities in extreme cases	• Follow Marine Stinger Protective Clothing Best Practice Guidelines (Ref. 4). • Wear appropriate clothing and PPE
Motion Acute motion sickness	• Dehydration • Inability to undertake assigned duties	• Use premedication as needed
Aerial Operations		
Motion Injury from aircraft on taxiing or starting engines	• Impact injuries • Possible fatalities	• Follow flight crew safety instructions and pre-flight briefings • Use designated walking corridors on airfield
Gravity Emergency ditching of aircraft	• Injuries • Possible fatalities	• Attend HUET and/or Basic Offshore Safety Induction and Emergency Training (BOSIET) training (all aerial observers) • Supply PPE: aviation lifejackets, survival suits, etc.
Motion Collision with other aircraft	• Impact injuries • Possible fatalities	• Follow the communications plan • Follow the flight crew briefing regarding simultaneous operations
Vessel Operations		
Motion Unsecured loads on deck	• Potential crush injuries • Possible fatalities	• Properly secure all equipment to deck
Gravity/motion Person overboard	• Hypothermia • Drowning	• Use personal flotation devices (PFDs) on deck

Hazards	Impacts	Mitigation Measures
		• Use rails and restraints
Motion Vessel collision or grounding	• Hypothermia • Drowning • Impact injuries	• Attend vessel crew training • Use navigational safety equipment
Motion Person struck by vessel/propeller during transfer (vessel to vessel or vessel to shore)	• Hypothermia • Drowning • Impact injuries	• Follow transfer procedures • Follow Vessel Master's instructions • Be aware of sea state and conditions
Temperature Fire on board vessel	• Burns or injuries • Possible fatalities	• Comply with alarm systems • Provide firefighting equipment on board • Follow emergency fire procedures
Temperature Exposure to elements (hot/cold)	• Fatigue or confusion • Loss of consciousness • Heatstroke • Hypothermia • Possible fatalities	• Take regular work breaks to cool down or warm up • Wear appropriate clothing and PPE • Hydrate • Wear sun protection/shades
Mechanical Propeller entanglement during deployment of survey equipment	• Loss of navigation, stranding, grounding	• Stop vessel engines or place them in neutral during deployment • Follow on-board communications
Shore Operations		
Biological Contact with Irukandji or other dangerous marine fauna (stonefish, octopus, sharks, echinoderms	• Health impacts: Sever pain, nausea, vomiting, fatalities in extreme cases	• Follow Marine Stinger Protective Clothing Best Practice Guidelines (Ref. 4) • Wear appropriate clothing and PPE • Wear over-ankle hard-soled reef boots
Gravity Slips, trips, and falls, uneven ground, oiled surfaces, low visibility while wading	• Injuries (cuts, bruises, fractures)	• Wear appropriate clothing and PPE • Use PFDs if working near deep water (e.g. cliffs) • Wear over-ankle hard-soled reef boots
Temperature Exposed shorelines away from amenities Physical exertion	• Fatigue or confusion • Loss of consciousness • Hypothermia	• Take regular work breaks • Wear appropriate clothing and PPE • Hydrate • Wear sun protection/shades
Motion Person caught in rip, tide, or mudflats	• Hypothermia • Drowning • Heatstroke	• Be aware of sea state and conditions • Use PFDs

1.10.1 Personal Protective Equipment

The work described in this Guidance Note must comply with the minimum PPE requirements, as defined in ABU – Personalised Protective Equipment (PPE) Standard (OE-03.06.112; Ref. 5). For guidelines on PPE for working in the marine environment, refer to the Marine Stinger Protective Clothing Best Practice

Guidelines (Ref. 4). For scientific monitoring activities, conduct a risk assessment to determine the PPE required and consider these items as safeguards:

- wide-brimmed hat (safety hard hat when operating a crane on marine vessels)
- safety sunglasses
- PFD jackets (when working on a marine vessel)
- stinger suit (0.5 mm thickness or greater), worn under overalls or high-visibility clothing
- over-ankle reef booties (not dive booties; should have grip-on sole)
- protective gloves suitable for entering water during intertidal work, e.g. long lycra gloves, latex gloves, dishwashing gloves, or a combination of these (without causing cross-contamination of samples)
- duct-tape PPE to wrists and ankles when in contact with sea water.

1.10.2 Washdown for Marine Stinger Safety

Following potential exposure to marine stingers, particularly Irukandjis and the sea water where they live, wash down clothing and equipment before disrobing. Vinegar washdown provides the greatest measure of protection (see Marine Stinger Protective Clothing Best Practice Guidelines (Ref. 4) for the vinegar washdown procedure). Fresh water may be used; however, particular care must be taken to not expose skin to potentially contaminated surfaces until they have been treated with fresh water for at least ten minutes.

2 Scientific Monitoring

2.1 Experimental Monitoring Design

It is important that monitoring design and statistical approach are developed concurrently and given adequate consideration to ensure that the data collected can be readily analysed, and where practicable given constraints, achieve appropriate power to detect an important level of impact and meet the Plan objectives. This Section provides guidance on appropriate survey design approaches that may be used within each SCI. Although this Section provides a generalised approach to survey design and statistical methods, each SCI further details which of these approaches applies under different situations to meet the specific Plan objectives, and the level of sampling required associated with the approach.

This Section outlines five general survey approaches likely to apply to each SCI Monitoring Plan:

- Before-After-Control-Impact (BACI)
- Impact versus Control (IvC)
- Gradient of Impacts
- Lines of Evidence
- Control Chart.

The survey design(s) chosen depends on these criteria:

- scale and pattern of potential effects of the spill
- availability of baseline data and/or ability to rapidly obtain baseline data
- time frame available to gather pre- and post-spill data
- availability of Operational Monitoring Program (OPS) data
- availability of appropriate reference sites
- statistical approach proposed for data analysis
- range of possible chronic and acute effects on the parameters of concern, based on the characteristics of the spill
- monitoring frequency required to ensure short-and long-term impacts are detected
- legislative requirements
- available resources and equipment to conduct the work in terms of personnel, logistics, and access

Note: Data collection depends on several constraints (as outlined above), including but not limited to, the type and location of hydrocarbon spill, and site locations and access given logistical and safety constraints. As such, the design that was conceived before implementation of each SCI may not be implemented exactly as intended in situ. For example, there may be inadequate number of control locations because of the size of the spill. Therefore, data collected as part of SCIs may need to be analysed using alternative designs (e.g. data from an expected BACI design may need to be analysed as a Gradient Approach).

2.1.1 BACI Approach

SCI applications:

- where the physical location of the parameter to be measured, or the predicted impacts to the parameter of concern occurs in discrete locations (e.g. segments of shoreline habitat, islands) that allow for unimpacted sites (control locations)
- where baseline data are available or able to be collected post-spill but pre-impact
- where reference data are also available pre- and post-impact
- where the objective is to determine whether a significant impact has occurred in a given location or set of locations (not where the objective is to map the impact, or examine gradients of effect).

The optimal approach for assessing and inferring whether an effect has caused an impact in a study is generally considered to be a BACI design (Ref. 6). This design involves taking measurements for parameters of interest at one or more potentially impacted sites and one or more control (reference) sites, both before and after an event occurs that could potentially cause an impact (Figure 2-1). The BACI Approach provides a robust and powerful method for detecting a significant change in the parameters of interest and for inferring the cause of that change (i.e. natural factors versus unplanned hydrocarbon spill). If the change that is observed from before to after the event at impact sites is statistically greater than the before-after change observed at control (reference) sites, then the inference is that an impact from the stressor (such as hydrocarbons) has occurred. This design is most applicable when strong evidence exists that the indicator is likely to be impacted by hydrocarbons (either directly or indirectly), and this potential impact can be examined in the context of natural variation by examining natural changes at comparable reference sites.

The simplest BACI design assumes no temporal trends occur in the measured parameters across sample dates in the period before or after the impact. Although the simplest BACI design involves taking measurements at two times (before and after) and two treatments (control and impact), modifications to this design can help improve the ability to detect and infer the cause of change, if data and/or time permit. These modifications include taking samples at multiple times before and after impact in a Multiple Before-After-Control-Impact approach (MBACI; Ref. 7; see also Beyond BACI) (Figure 2-2). This approach will help examine different temporal scales of impact (acute versus chronic impact) and responses (acute versus chronic effect), and help differentiate the potential effects of hydrocarbons from natural fluctuations in the measured parameter through time.

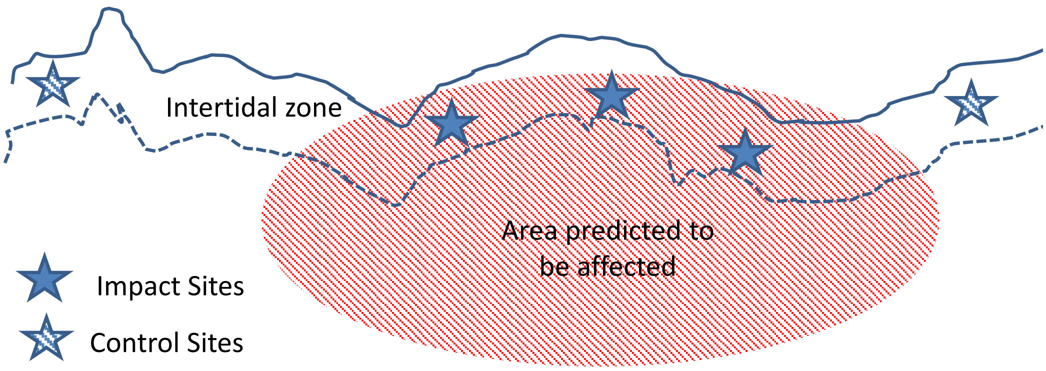
The constraints of the BACI or MBACI Approach are the availability of appropriate control (reference) areas and data collected before impact (baseline data). If an unplanned release affects a wide area, or if a unique or spatially discrete ecosystem or species is the focus of potential impacts, finding suitable controls that are comparable to impact locations may not be achievable. Likewise, the impact area may cover a region or receptor where baseline data do not exist and cannot be readily obtained post-spill, before the impact occurs. In each of these examples, it may be more appropriate to use a Gradient (see Section 2.1.3) or IvC approach (see Section 2.1.2).

If baseline data are available through monitoring programs for other Chevron projects or third-party organisations (e.g. Commonwealth Scientific and Industrial

Research Organisation [CSIRO], DBCA), then the methods used in those baseline data investigations should be repeated (if possible and practicable). Improved methods may be used that result in finer-scale data, the outputs of which can always be scaled back to compare to previously collected data. If suitable pre-existing baseline data are not available, and sufficient time is available, field sampling should be prioritised to allow post-spill/pre-impact baseline data to be collected for regions and sensitive receptors where impacts are likely to occur, to enable a subsequent BACI assessment.

Within each sampling location, sites should be replicated, and, with each site replicate, samples (e.g. transects or quadrats) should be taken into account for different spatial variation scales that may affect the outcome of the assessment. This is called a nested (or hierarchical) sampling design, where successively smaller spatial scales are nested within the scale above (similarly for temporal collections if practicable, noting the time scales of natural change within individual SCIs). Stratification of sites, or replicates within sites, may be required where obvious environmental gradients occur (e.g. within different areas of zonation within the intertidal zone).

Before Impact



After Impact

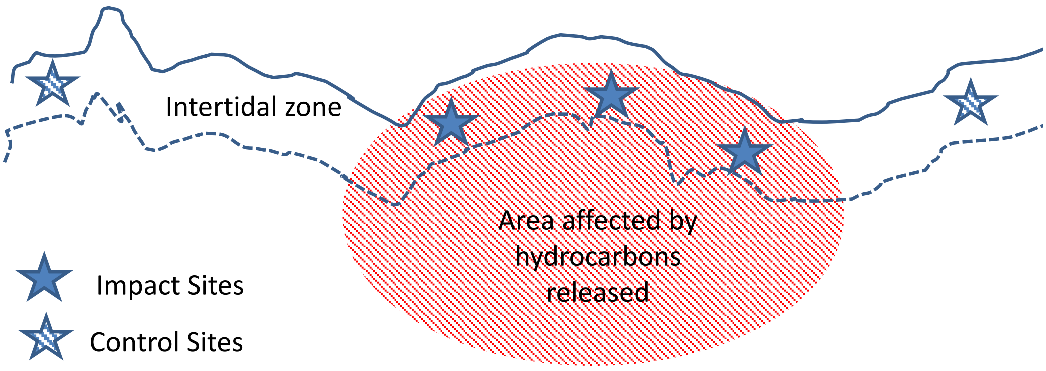


Figure 2-1: Generalised BACI Design

Note: The number of sites is for example only and is discussed in further detail in each SCI plan where this approach is likely to be used.

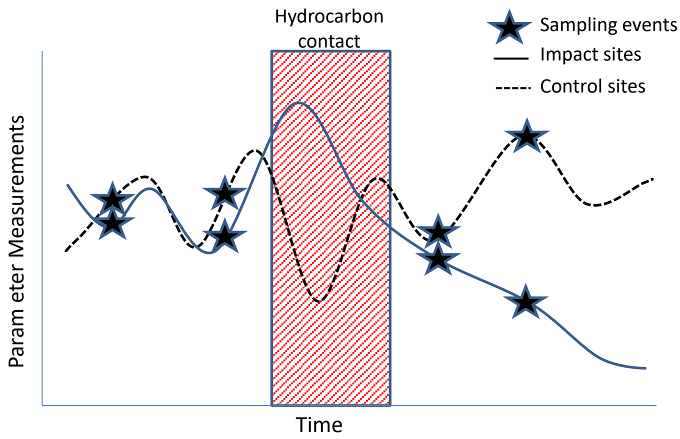


Figure 2-2: Generalised MBACI Design

Note: The number of sampling periods is for illustration only; designs would benefit from as many sampling periods as logistically feasible.

2.1.1.1 Statistical Approach

Multi-factorial analysis of variance (ANOVA)—including permutational multivariate analysis of variance (PERMANOVA) and similar non-parametric tests—that test for an interaction between treatment (impact versus reference [IvR]) and time (before versus after) can be used to test data. Components of variation may help partition a sum of squares into different sources, and describe the importance of factors within tests.

2.1.2 Impact versus Control Approach

SCI applications:

- where the physical location of the parameter to be measured, or the predicted impacts to the parameter of concern occurs in discrete locations (e.g. segments of shoreline habitat, islands) that allow for unimpacted sites (control locations)
- where baseline data are unavailable and where such data cannot be collected post-spill/pre-impact
- where suitable control (reference) locations are available
- where the objective is to determine whether a significant impact has occurred in a given location or set of locations (not where the objective is to map impacts, or examine the gradients of effect).

For some locations and sensitive receptors it is likely that baseline data does not exist, is not recent and applicable, or was collected using methods that are unrepeatable in the current study. If there is a lack of baseline information that can feed into a BACI design, a simpler IvC approach can be used to assess impacts. However, due to the unknown status of the parameter before impact, there is a higher likelihood of encountering Type I error (falsely concluding that an impact has occurred) with this approach. For example, if the status of the parameter to be measured was already naturally lower at impact sites than reference sites before the impact occurred, but this was not measured, a conclusion may be reached using the IvC approach that an impact has occurred when it may be natural variation. For this reason, sampling designs should always try to collect or use baseline data (i.e. aim for a BACI design), and if an IvC design is used, it is important to ensure that the reference sites are comparable to the impact sites in every way possible except for the presence or absence of the studied effect (hydrocarbon). This may include, but not be limited to: site physical aspect, substrate (where applicable), current regimes, and community composition.

Because of the higher likelihood of Type I error, it is also useful to collect additional data on relevant physical environmental parameters that are likely to be different at impact and reference sites and may affect the conclusion of the assessment (e.g. physical aspect, sediment type). This is similar to collecting data for Lines of Evidence Approach (Section 2.1.4). These parameters can be examined later for any potential co-variance with the observed changes in the parameter of interest, to understand whether hydrocarbons or natural variation affected the outcome. As with the BACI Approach, when using the IvC Approach it is important to understand the scale of natural variation that may affect the outcome of the assessment by replicating sites within sampling locations, and replicating samples within each site. In addition, stratification of sites, or replicates within sites, may be required where obvious environmental gradients occur (e.g. within different areas of zonation within the intertidal zone).

2.1.2.1 Statistical Approach

Multi-factorial ANOVA (to account for nested data), including PERMANOVA and similar non-parametric tests, test whether the level of variation among treatments (IvC) is greater than the level of variation within treatments. Components of variation may help partition variance into different sources and help infer whether the effect of hydrocarbons or spatial variation was responsible for any detected change.

2.1.3 Gradient Approach

SCI applications:

- where the objective is to quantify the spatial extent of environmental effects; or
- where the objective is to provide data (e.g. water quality, sediment quality) to infer or correlate with changes in other parameters (e.g. infauna abundance); or
- where the objective is to determine whether a significant impact has occurred in a given location or set of locations, but where baseline data are unavailable and suitable reference locations are unavailable.

The Gradient Approach relies on sampling at a set of sites at increasing distance from the source of hydrocarbon impact, or a set of sites that have had different levels of exposure to the hydrocarbon spill. This method is most commonly used in investigations of point source pollution where concentrations of pollutants typically decline with distance from the source, and the level of observed impact also declines. The overall objective of the Gradient Approach is to assess if there is a relationship between distance from source or level of exposure to an impact, and level of detected impact. Such a relationship would imply the presence of an impact, and provide data on the severity, nature, and physical extent of that impact. If thresholds of change are known for receptors (i.e. physiological response of flora/fauna above which mortality occurs), then the scale or severity of an impact may be gauged in the absence BACI or IvC designs. The Gradient Approach also provides a 'Line of Evidence' (Section 2.1.4) that the source of potential impact (hydrocarbons) was responsible for the observed effect, rather than natural variation. However, care should be taken to ensure awareness of any natural gradients in the parameter measured and ensure that these do not confound interpretations.

The Gradient Approach can also be used in some instances where a lack of suitable reference sites prohibits using a BACI or IvC Approach. Similar to the description above, sampling should be established along a gradient of predicted effect (based on input of data from OPS or modelling), with sites established at various distances from the source of impact or along a gradient of magnitudes of concentrations of hydrocarbons (if known from OPS or SCI data). The Gradient Approach can also be used in combination with a BACI or IvC Approach to help infer the cause of a detected impact, and describe thresholds of impacts at which a response appears to have occurred.

When designing a study using a Gradient Approach, it is important to include any prior knowledge of the likely direction of any gradient of effect (e.g. is there likely to be an initial gradient of effect mainly in one direction from the release, due to prevailing currents, or 360° from the source as hydrocarbons spread?), as well as the likely magnitude of change with distance (are all observed effects within hundreds of metres of the release or do they extend over greater distances?). Relevant OPS data, SCI data (e.g. water and sediment quality), and modelling should be considered in the design. Prior knowledge or prediction of the likely gradient of effect will greatly improve the efficiency of the sampling design by minimising the collection of data points that provide no additional information in the analysis (e.g. data points showing similar or no effects that do not help to characterise the gradient of effect), though noting these may aid in statistical power of gradient description.

Typically, the level of observed impact will decline exponentially from the source of a hydrocarbon release; therefore, sampling effort can be distributed along the gradient of effect in a way that best characterises the changes in the parameter measured (see Figure 2-3). Generally, sites would be sampled close together (e.g. every few hundred metres) near the source where changes in observed effect are greatest, and would be spaced further apart at the outer limits of the affected areas (e.g. kilometres or tens of kilometres apart) (Figure 2-3). However, the gradient of environmental effects may not always be this simple—the components of the spill and elapsed time since the spill may alter this gradient. For example, hydrocarbons on the surface are likely to accumulate on shorelines, where they may have their greatest environmental effects, rather than having an exponential gradient of environmental effects with distance from the release point. These factors should be considered in each SCI Plan.

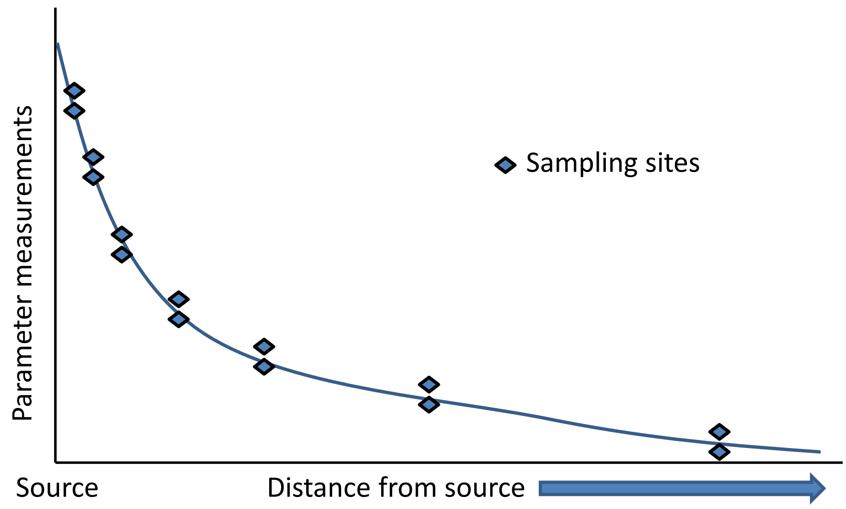


Figure 2-3: Decay in Level of Effect with Distance from Effect Source and Matching Gradient Approach Designed to Characterise the Extent of Environmental Effect

It is also useful (though not essential) to obtain replicate samples within each distance from the source to characterise natural variation and help separate this from potential effects of the release (as was the case for BACI and IvC Approaches). It is recommended that at least two sites are sampled at each distance along the gradient (if logistics and time permit) to provide an understanding of natural spatial variation. Sites should also be sampled at distances at which no environmental effect is predicted or observed, if possible, to characterise the full extent of the effects gradient (Figure 2-4 and Figure 2-5).

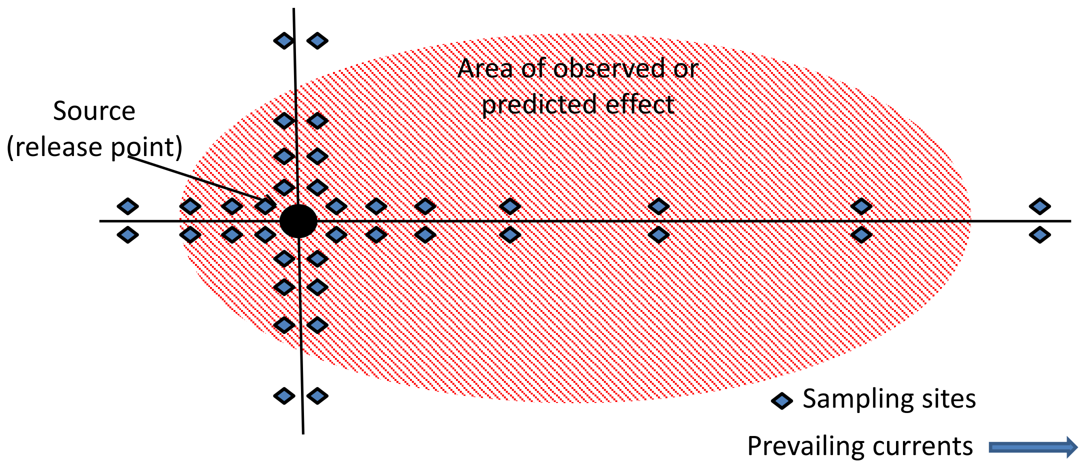


Figure 2-4: Generalised Gradient Approach where the Measured Parameter/Receptor Occurs at all Distances from the Source

Note: The number of sampling points is for illustration only.

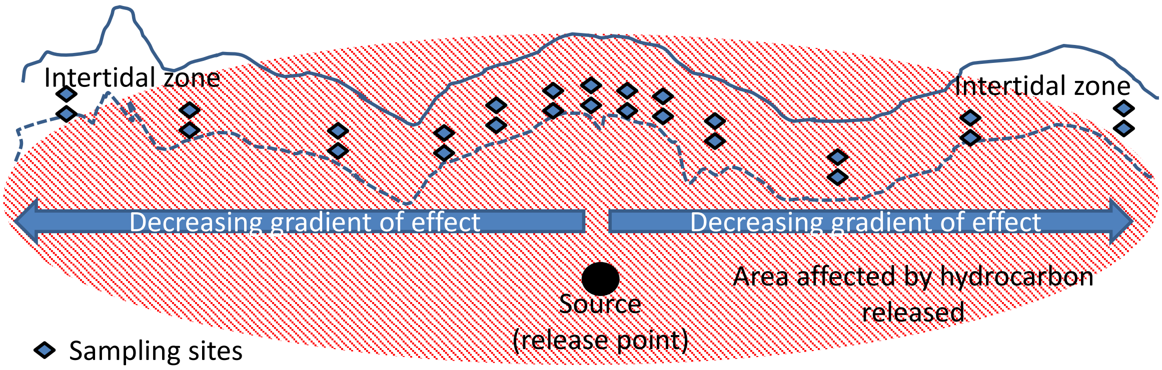


Figure 2-5: Generalised Gradient Approach for Shoreline Habitat where Lack of Baseline or Reference Sites Do Not Permit an BACI or IvR Approach

Note: The number of sampling points is for illustration only.

2.1.3.1 Statistical Approach

Correlation analysis between impact (measurements of hydrocarbon/stress; x-axis) and measurement parameter (biological and non-biological response; y-axis), and associated regression analyses, may include least-squares regression line and hypotheses testing to determine if the trend is significantly different from zero.

Descriptive approach (e.g. illustration) of changes in parameter measured with distance from source to define the spatial extent of impact.

2.1.4 Lines of Evidence Approach

SCI applications:

- can be combined with any of the above designs to provide inferential evidence of an effect
- are useful to support evidence of effect if there are limited (or only one) impact locations
- are useful to support evidence of effect if the effect radiates outward from source
- are useful to infer cause of change if limited or no baseline data exist
- are useful to infer cause of change if limited or no reference sites exist.

Although an optimal sampling design for impact assessment includes BACI or MBACI approaches (Section 2.1.1; Ref. 6; Ref. 7), unfortunately, sampling designs to assess impacts from an unplanned release of hydrocarbons are likely to be suboptimal. This may be due to limited or outdated baseline data, only one rather than multiple impact locations, and a lack of reference sites that are environmentally and ecologically comparable to the impact location(s). When a sampling design is suboptimal, the Lines of Evidence Approach can be used to help infer the cause of an observed change (i.e. attribute change to the hydrocarbon release or to other causes such as natural variation). Within the Lines of Evidence Approach, inference is developed based on carefully structured arguments. A weakness of this method is that the evidence may be largely circumstantial because it is based on correlations (Ref. 8), which does not necessarily imply causation. Each causal argument may be weak independently, but combined they may provide strong circumstantial evidence and support for a conclusion (Ref. 8).

This approach was originally developed in medicine (Ref. 9), but it has been used in more recent ecological studies (Ref. 10; Ref. 11; Ref. 12; Ref. 8; Ref. 13). Hill (Ref. 9) categorised different types of causal argument into nine criteria for studies into the effects of diseases on humans. Table 2-1 lists each causal criterion and how it relates to ecological impact assessment (adapted from Hill [Ref. 9]). With Lines of Evidence, there is a need to seek evidence not only to support the impact prediction, but evidence to rule out plausible alternative predictions, such as that the observed difference was due to natural processes (Ref. 12; Ref. 8).

Table 2-1: Hill's (Ref. 9) Causal Criteria and Description in the Context of Ecological Impact Assessment

Causal Criterion	Description
Strength of association	A large proportion of individuals are effected in the exposed area relative to reference areas
Consistency of association	The association was observed by other investigators at other times and places
Specificity of association	The effect is diagnostic of exposure
Temporality	Exposure must precede the effect in time
Biological gradient	The risk of effect is a function of magnitude of exposure
Biological plausibility	A plausible mechanism of action links cause and effect
Experimental evidence	A valid experiment provides strong evidence of causation
Coherence	Similar stressors cause similar effects
Analogy	The causal hypothesis does not conflict with existing knowledge of natural history and biology

In the Lines of Evidence Approach, a set of descriptions should be developed for all or some of the causal criteria listed in Table 2-1 before the survey is undertaken (see Ref. 8 for further criteria and examples). Data would then be collected that allows each Line of Evidence to be tested or objectively questioned. The final assessment of whether an impact is likely to have occurred will be based on the 'weight of evidence' from examining multiple Lines of Evidence. Example generalised Lines of Evidence descriptions are provided in Table 2-2. These would be modified and tailored to each SCI Plan and each parameter investigated.

Table 2-2: Causal Criteria and Example Lines of Evidence Descriptions that could be used to Assess whether a Change in a Measured Parameter was due to the Effects of a Hydrocarbon Release

Causal Criterion	Evidence Supportive of a Hydrocarbon Release Impact	Evidence Unsupportive of a Hydrocarbon Release Impact
Strength of association	Larger decline in individuals in areas affected by hydrocarbon than in reference areas	Similar declines in individuals in areas affected by hydrocarbon and reference areas
Consistency of association	Consistent finding of declines in a range of biota in areas affected by hydrocarbon	Inconsistent declines in biota in areas affected by hydrocarbon (e.g. declines in one species but not in other similar species)

Causal Criterion	Evidence Supportive of a Hydrocarbon Release Impact	Evidence Unsupportive of a Hydrocarbon Release Impact
Specificity of association	Number of individuals affected correlates with hydrocarbon concentrations	No correlation between number of individuals affected and hydrocarbon concentration
Temporality	Decline in individuals immediately preceded by contact with hydrocarbon	Decline in individuals occurred before or long after hydrocarbon contact
Biological gradient	Changes in individuals aligned with exposure to hydrocarbon spills or concentrations	Decline in individuals occurs with increasing distance from a hydrocarbon spill or hydrocarbon concentrations
Biological plausibility	Evidence from literature of sensitivity to detected hydrocarbon concentration for species where declines are observed	Evidence from literature suggests lack of sensitivity to detected hydrocarbon concentration for species where declines are observed
Experimental evidence	A valid experiment provides strong evidence of causation	Not applicable (N/A)
Coherence	Evidence of a decline in species abundance, habitat, and food source with increasing hydrocarbon exposure	Evidence of a decline in species abundance, but no other evidence of expected declines associated with exposure
Analogy	Apparent declines in hatchling numbers despite no apparent decline in numbers of adults	Apparent declines in hatchling numbers associated with decreased numbers of adults

2.1.5 Control Chart Approach

SCI applications:

- when long-term (multi-year) datasets exist for the measured parameter
- when a large amount of natural variation exists in the measured parameter
- when predicting the expected range of outcomes from an impact.

One of the causal criteria described in the Lines of Evidence Approach (Section 2.1.4) is ‘Strength of Association’ (Ref. 9), exemplified by a ‘Larger decline in individuals in areas affected by hydrocarbon than in reference areas’. The Control Chart Approach takes this causal criterion a step further and uses rules to establish whether a detected change in a parameter at impact sites is outside what would be expected to occur naturally. This technique requires tracking a parameter over time and determining whether an observed change is within the bounds of what has been observed to occur naturally at that impact site or at control sites.

A control chart has a central line for the mean, an upper control limit (e.g. 3 standard deviations [SD] above the mean), and a lower control limit (e.g. 3 SD below the mean), which are all determined from historical data (Figure 2-6). This can include data from an impact site compared to its own historical data, or data from an impact site compared to the historical data from impact and/or reference locations. By comparing measurements at a given point in time to these lines, broad inferences can be drawn about whether an observed change was consistent with previous observations (in control) or not (out of control). Any inconsistent data are investigated to determine the cause of the change.

In addition, if ongoing data collection is possible following a potential impact, the Control Chart Approach is also used to examine the direction of change and whether this is consistent or inconsistent with historical data. The number of data points above or below the centreline (mean) can be tracked and used to provide a weight of evidence of a directional change in a given parameter.

The Control Chart Approach is only useful if there is an adequate historical knowledge of natural variability in a given parameter. However, if this information exists (e.g. data from the Long-term Marine Turtle Monitoring Program [Ref. 14]), the Control Chart Approach can be a powerful tool for detecting impacts for systems that are naturally highly variable.

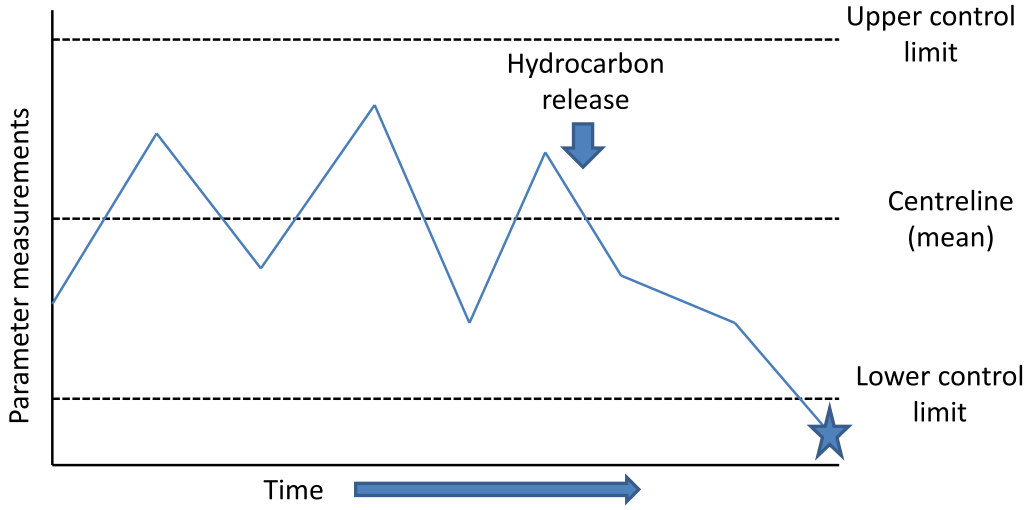


Figure 2-6: Example Control Chart showing Centreline (mean), Upper Control Limit (3 SD above mean), Lower Control Limit (3 SD below mean), and Measurements

Note: The star represents an 'out of control' measurement that needs to be investigated.

2.1.5.1 Statistical Approach

The statistical approach for Control Charts is:

- calculate the historical mean for the centreline
- calculate the upper and lower control limits from historical data, e.g. two or three SD above and below the mean (Ref. 15)
- calculate the mean (ongoing) for an impact site to compare against the control chart.

2.1.6 Effect Size and Power

Power is measured in terms of the probability of detecting an impact of a certain effect size, if an impact has actually occurred. Effect size is the magnitude of difference in a measured variable between impact and control samples, taking into account natural variation. It is important to know the power of a sampling design before commencing a study to ensure that there is a likelihood of detecting a biologically or ecologically important effect size. A study that has insufficient power can be a waste of time and effort, if statistical testing is to be used to infer impacts, as important impacts may not be detected statistically and the objectives of the study to determine significant differences (with an estimated power) may not be achieved.

The power of statistical designs and tests is largely driven by sample size, e.g. the number of sites sampled or the number of replicates within a site. Various statistical techniques are available to undertake power analysis in a study's design stage to calculate the level of replication required to detect a specified effect size. Power analysis used to determine the required level of replication depends on these inputs:

- the effect size (the desired magnitude of change to detect; this should be a biologically or ecologically important level of change)
- the population variance
- alpha (α) (the acceptable level of Type I error; the chance of falsely detecting a change that is not real; usually set at 0.05)

Generally a moderate level of power of 0.8 or higher is desired (Ref. 16) but may not always be achievable, depending on the effect size to be detected and the level of sampling that is logistically feasible. The effect size should relate to the study's objectives and should be a level of change that is biologically or ecologically meaningful, taking into account natural variability. For certain parameters, effect size may also need to consider a level of change that is meaningful to stakeholder values, such as fisheries or tourism. Natural change of varying magnitudes across temporal and spatial scales at impact and reference sites make detection of small effect sizes difficult. However, small changes due to impacts from an unplanned release are unlikely to be considered to be biologically or ecologically significant if dwarfed by large-magnitude natural variability. Therefore, the effect size chosen should take into account what is known of natural variability in the parameter to be measured, such as that observed in baseline studies or known from the literature. For example, it may be trivial to be able detect an effect size of 20% in the benthic cover of tropical seagrasses, which vary naturally from season to season by up to 100%. Detecting such an effect size may also be extremely difficult to achieve in such a highly dynamic community without a logistically unfeasible level of replication. However, detecting an effect size of 20% in a coral community, which is generally more stable over time, is important because changes of this magnitude may be outside the natural levels of change, and the coral community may take longer to recover from such a change because of its greater population stability.

Population variability can be estimated from data collected during previous studies (e.g. baseline). If these data are unavailable, natural variability may have to be estimated from published studies elsewhere that use the same parameters and similar sampling methods, or through pilot data collected during the OPS (if available), or through data collected during the initial SCI that will then need to feed back into revisions of the sampling design (i.e. increased or decreased replication based on initial findings).

Alpha—the probability of falsely detecting a change that is not real (Type I error)—is typically set at 0.05, although other values are acceptable. Although the level of Type I error (and alpha) should be kept as low as possible to avoid falsely detecting an impact, the lower the level of alpha (e.g. α=0.01), the lower the likelihood that that the null hypothesis will be rejected and hence, the lower the likelihood of a conclusion that an impact has occurred.

2.1.7 Setting the Spatial Boundaries of the Study

The spatial boundaries of a monitoring study depends primarily on the actual or potential area affected by the spill. Spatial boundaries should be sufficient to meet monitoring objectives, usually by determining impacted areas and the level of effects, linking effects to the spill source, and supporting decisions on clean-up strategies.

The boundaries should also be sufficient to cover representative areas of each:

- substrate type
- ecological community
- shoreline energy level
- degree of oiling
- clean-up method used
- reference area.

2.2 Data Management

Data need to be conveyed to appropriate response team personnel and decision makers in a suitable time frame and in a simple and usable form. This requires developing mechanisms for ensuring that data are presented appropriately and on time. The data can be collected in several ways:

- field data, including:
  - results from field sampling and observations
  - forms
  - photographs
  - video
  - maps
  - notebooks and logs
  - portable global positioning system (GPS)/geographic information system (GIS) units
  - verbal transmission
  - Chain of Custody (CoC) forms
  - laboratory reports
  - samples (biological, sediment, or oil).

Photographic and video evidence, covering coastlines to detailed quadrats, is a useful scientific monitoring tool, because collecting such evidence is fast and relatively inexpensive. Skilled interpretation of photos/videos can be done later.

Whatever the format, it is essential that data are quickly and effectively stored and transmitted, and that the accuracy of the collected data, and of any consequent analysis, is optimised.

All data should be backed up as soon as possible. This applies to data as it is acquired in the field, as it is transmitted, and when it is compiled and stored. Reliance on a single copy of data, whether on paper or digitally recorded, should be avoided. Note: Data collected as part of any scientific monitoring program will be used as part of the legal record of the incident and subsequent response effort. Therefore, data management should be comprehensive and well organised.

Appendix B is an extract from the Australian Maritime Safety Authority (AMSA) Oil Spill Monitoring Handbook (Ref. 17) that provides a guide to data management.

2.3 Laboratories

CAPL has contracts in place with these laboratories:

Australian Laboratory Services (ALS)

26 Rigali Way
Wangara WA 6065 Australia

Chevron Client Services Manager
Direct phone: +61 8 9406 1301

Chemistry Centre of WA (ChemCentre)

Resources and Chemistry Precinct
Corner of Manning Road and Townsing Drive
Bentley WA 6102 Australia

Reception: Level 2, South Wing, Building 500

Deliveries: Ground Floor, use Conlon Street entrance

Chevron Account Manager
Direct phone: +61 8 9422 9966

Before engaging ChemCentre or ALS, these tasks must be undertaken:

1. A quote must be prepared by the laboratory once there is agreement of service requirements. Supporting information that can be provided to the laboratory when requesting a quote is available in Template Request for Chevron Lab Services (ABU140601604; Ref. 18).
2. The Monitoring Coordinator must submit a Purchase Requisition to get a Service Request in the Chevron Ariba System.
3. A Service Request number must be supplied to the field team collecting the sample for use in a CoC Form (see Appendix C).
4. The CoC Form (see Appendix C) should stipulate that the report is sent to the Monitoring Coordinator and Environment Unit Lead.

Services can be directly engaged by CAPL personnel or by selected environmental contractors (with support from a CAPL contact to arrange the Service Request). Additional information regarding the correct communication process between CAPL, contracted laboratories, and any environmental contractors engaged to undertake monitoring is outlined in the ABU Contracts for the Provision of Laboratory Services – Contractor Information document (ABU140601602; Ref. 19).

The standard turnaround times for return of the analytical report is five to ten days from receipt of samples at the laboratory. However, reduced turnaround times can be requested with appropriate notice, although a surcharge applies. Note: Shorter turnaround times may not be available for some analytes due to holding time requirements for particular analysis.

2.4 Monitoring Capability

CAPL has contracts in place with environmental consultancies to provide services for scientific monitoring. As contracts change from time to time, the initial determination of the suitable contract should be sought from the HES Supervisor – Environment.

The level of services provided by CAPL's environmental consultants in relation to scientific monitoring are highlighted below:

- skills and expertise available to execute the plan
- resources available, including the number of people with skills for field deployment and office/laboratory support
- access to the required equipment for quick activation
- marine scientific expertise.

3 SCI1 – Water Quality Impact Study

3.1 Aims and Objectives

The aim of the Scientific Monitoring Program SCI1 – Water Quality Impact Study (SCI1) is to describe the influence of hydrocarbon exposure (level, duration, and type) on the water column. This information will inform other scientific monitoring programs (SCI2 – Sediment Quality Impact Study [Section 4.0], SCI3 – Coastal and Intertidal Habitat Impact Study [Section 5.0], SCI4 – Seabirds and Shorebirds Impact Study [Section 6.0], SCI5a – Marine Megafauna Impact Study: Marine Reptiles [Section 7.0], SCI5b – Marine Megafauna Impact Study: Pinnipeds [Section 8.0], SCI5c – Marine Megafauna Impact Study: Other Marine Megafauna [Section 9.0], SCI6 – Benthic Habitat Impact Study [Section 10.0], SCI7a – Fisheries and Aquaculture Impact Study [Section 11.0], and SCI7b – Fish Effects Impact Study[Section 12.0]).

The objectives of SCI1 are to:

- quantify the temporal and spatial distribution of hydrocarbon compounds and dispersants both on and in marine waters
- assess hydrocarbon/dispersant content of water samples against accepted environmental guidelines or benchmarks to predict potential areas of impact.

Comparing data collected under SCI1 with baseline data (where available) and operational monitoring data will allow for a comprehensive interpretation of spatial and temporal trends. Therefore, the data collected during the scope of SCI1 should be as comparable as possible (in sampling methods and analysis) to baseline data and operational monitoring data.

3.2 Initiation and Termination Criteria

The initiation and termination criteria for this scientific monitoring program are provided in Section 5 of the OSMP. Implementation times for this scientific monitoring program are directly linked to the initiation criteria and are found in the same section of the OSMP.

3.3 Data and Information Requirements

Table 3-1 lists the inputs relevant to planning for the implementation of SCI1, once the notification to commence is initiated.

Table 3-1: Data Requirements Summary for SCI1

Baseline Information	Operational Information
• Access to consolidated project-specific baseline data (Excel file) and baseline summary report/data for the relevant location • Additional baseline data may be available from I-GEMS, including any information on natural hydrocarbon seeps in the area	Outputs from MES and *OPS3* activities, including: • spill type • spill volume and duration • spatial extent and movement of the spill • details of dispersants used • consolidated database, including exceedances of benchmark levels.

SCI1 will likely inform other SCI studies, and as such outputs from it will be required by those plans.

3.4 Design

3.4.1 Monitoring Design

The monitoring approach needs to consider the data collected during MES and OPS3 activities. The geographic extent of the area to be monitored will be based on the hydrocarbon distribution and predicted movement of the hydrocarbon spill, as determined through the MES outcomes, and measured hydrocarbons within the water column, as determined through OPS3. These outputs will identify potential impact areas to be sampled, which will allow comparison of results to baseline values. Table 3-2 summarises the monitoring designs recommended for various outcomes. Section 2.1 describes these approaches in detail.

Table 3-2: Monitoring Design Approaches Recommended for Different Spill Outcomes

MES and *OPS3* Outcomes Indicate	Monitoring Design[1]	Replicate Sites Required[2]
Spill Extent		
Hydrocarbon plume concentrated around source, dissipating with distance	Gradient Approach	Minimum of **two** replicate sites at each distance from source
Hydrocarbon plume has dissipated away from source	Gradient Approach (with revised centre point of gradient based on OPS monitoring, modelling, and/or other data)	Minimum of **two** replicate sites at each distance from source
Nearshore spill or spill reaches shoreline	BACI, IvC, or Gradient Approach	Minimum of **three** replicate sites at each location (impact and reference) or minimum **two** replicate sites at each distance from the centre of the gradient
Spill interacts with area of biological importance (bay/shoal/island)	BACI or IvC	Minimum of **three** replicate sites at each location (impact and reference)
Spill Depth	**Sampling Effort**	
Surface spill	Surface spill involving light hydrocarbons: • water column profile to 50 m (or depth indicated by other information) • minimum two water sample depths (surface 0 to 0.5 m) and subsurface (~5 to 10 m) Surface spill involving heavy hydrocarbons: • water column profile to full water depth • in waters <50 m, a minimum of two water sample depths (as determined by fluorometer, or if inconclusive, a surface and near-bottom sample) • in waters >50 m, a minimum of three water sample depths (as determined by fluorometer, or if inconclusive, a surface, mid-water, and near-bottom sample)	
Subsurface spill	• Water column profile to full water depth • In waters <50 m, a minimum of two water sample depths (as determined by fluorometer, or if inconclusive, a surface and near-bottom sample) • In waters >50 m, a minimum of three water sample depths (as determined by fluorometer, or if inconclusive, a surface, mid-water, and near-bottom sample)	

1 Reference sites required for each monitoring approach are detailed in Section 1.

2 It is recommended that sample replication is conducted for 10% of samples.

3.4.2 Monitoring Sites

Sampling sites (impact and reference sites) will be selected once the outputs from MES and OPS3 are generated so that the depth and extent of the spill can be incorporated into the survey design. Location of monitoring sites will also consider the requirements of other SCIs.

The number of sites that can be monitored each day depends on the travel distance between sites, number of replicates required, depth of water, and weather conditions. For a spill in 300 m water depth or greater, requiring sampling of three depths and assuming 12 hours operations in good weather, it is expected that an average of four to five sites can be sampled each day. This is based on the potential to deploy the profiling equipment separately to the water sampling equipment, download the profiling data, take photographs, and write comprehensive field notes at each site.

3.4.3 Monitoring Parameters

Water column profiles will be collected for the full water depth at all sampling sites, for these parameters:

- temperature (°C)
- conductivity (mS/cm)
- pH
- dissolved oxygen (%)
- turbidity (Nephelometric Turbidity Units)
- Raw Fluorometry Units (RFU).

Water samples will be collected from all sampling sites, from multiple depths depending on the depth of the spill but from at least the surface (approximately 0 to 0.5 m), mid-water, and near-bottom (seabed >5 m). Selection of appropriate sampling equipment depends on water depth and the potential for contamination (equipment that passes through the water column in the open position may be contaminated if surface slicks are present). Samples will be collected using a stainless steel bomb sampler, Van Dorn sampler, or equivalent. Water samples will be analysed for these parameters:

- Total Recoverable Hydrocarbons (TRH)
- Polycyclic Aromatic Hydrocarbons (PAH; only analysed if TRH is detected)
- benzene, toluene, ethylbenzene, xylene (BTEX; only analysed if TRH is detected)
- dispersant compounds, depending on those used during spill response (2-Butoxyethanol, Ethylene Glycol Monobutyl Ether [EGMBE], Dipropylene Glycol n-Butyl Ether [DPnB], Propylene Glycol, Dioctyl sulfosuccinate [DOSS]).

All samples will be compared to the United States Environmental Protection Agency's (USEPA) Water Quality Benchmarks for Aquatic Life (Ref. 20)as detailed in Table 3-3. For samples where analytical data indicate the concentration levels exceed the individual benchmark, the sample will be reviewed to assess the likelihood that the exceedance resulted from the spill.

3.4.4 Monitoring Frequency and Duration

Following the initiation of SCI1, surveys will be undertaken at least once a year, although are likely to be at a greater frequency (e.g. every three months) in the first year, based on the biological indicators being monitored (unless the termination criteria are triggered within this time). Survey data will be reviewed annually and the frequency of any ongoing monitoring will be determined by the data collected to date, the spatial, temporal, and seasonal variability of the biological indicators being measured and may, for example, be seasonal, six-monthly, or annual until the termination criteria are reached.

Note: SCI1 may reach termination criteria but still be required by other SCIs.

During each survey, sampling may be conducted during day and/or night operations.

3.4.5 Sample Integrity

Sample holding times, storage containers, and preservation requirements are summarised in Table 3-3. Spare sample containers are required for redundancy.

Table 3-3: Test Parameters for SCI1

Test Parameter	ANZECC Guideline	USEPA Benchmark value (µg/L)*	Storage Container#	Preservation	Holding Time
TRH (C_6–C_{40})	7[1]		100 mL amber glass with Teflon cap liner, zero headspace	Chill to 4 °C	7 days
PAHs			100 mL amber glass with Teflon cap liner, zero headspace	Chill to 4 °C	7 days
Acenaphthene		116.1			
Acenaphthylene		640			
Anthracene		43.1			
Benz (a)anthracene		4.64			
Benzo(a)pyrene		1.99			
Benzo(b) fluoranthene		1.41			
Benzo(g,h,i) perylene		0.91			
Benzo(k) fluoranthene		1.34			
Chrysene		4.24			
Dibenz (a,h) anthracene		0.59			
Fluoranthene		14.8			
Fluorene		81.8			
Indeno (1,2,3-cd) pyrene		0.57			
Naphthalene		402			
Phenanthrene		39.8			
Pyrene		21.0			
BTEX			Pair of 40 mL glass vials	Chill to 4 °C	7 days
Benzene		13 500			

Test Parameter	ANZECC Guideline	USEPA Benchmark value (µg/L)*	Storage Container#	Preservation	Holding Time
Toluene		4070			
Ethylbenzene		2010			
Xylenes		1780			
Dispersant compounds			100 mL Amber glass with Teflon cap liner, zero headspace	Chill to 4 °C	7 days
2-Butoxyethanol		165			
EGMBE		50[2]			
DPnB		1000 (chronic)			
Propylene Glycol		500 000			
DOSS		40 (chronic)			

1 *ANZECC/ARMCANZ Water Quality Guidelines (Ref. 21) low reliability trigger value*

2 *Based on the ANZECC/ARMCANZ Water Quality Guidelines (Ref. 21) for freshwater*

Storage containers may vary depending on laboratory

* *Consideration is required of whether laboratory practical quantification limits can meet these guideline values*

3.4.6 Sample Analysis

Water samples will be analysed at National Association of Testing Authorities (NATA)-accredited laboratories. PAH and BTEX analysis will only be undertaken if TRH is detected.

Water sample analysis will be subjected to laboratory-specific QA/QC procedures and results will be included in laboratory results reports.

3.5 Data Management

Managing the generated data requires extensive data storage, analysis, backup, and archiving. Samples should be treated as legal evidence and secured against loss or tampering.

A guide for data management can be found in the AMSA Oil Spill Monitoring Handbook (see Appendix B; Ref. 17). In summary:

- All records will be kept in a field log. This log will be copied to an electronic spreadsheet each day.
- All electronic files including those downloaded from the profiler will be backed up onto external hard drives each day.
- Original hardcopies will be transferred to a project folder and kept in a secure location (e.g. wheelhouse or vessel survey laboratory).
- GPS positional information and photographs will be downloaded and backed up onto external hard drives each day.
- Hard drives will be transported by the demobilising survey team.
- Copies of datasheets and analysis should be archived.
- Data received from the laboratories (including backups) will be downloaded and stored on the contractor’s computer system. These data are usually received approximately two to three weeks after receipt of that batch of

samples. QA/QC'd data will be presented in spreadsheet format and then transferred to CAPL as required.

3.6 QA/QC Procedures

These QA/QC samples will be taken to determine whether contamination has occurred during the sampling procedure:

- Field blank: To estimate any contamination introduced to the sample during collection. This involves following the same sampling procedure used to collect field samples to fill containers with low analyte water (ultrapure water). A minimum of one field blank per analyte per day should be taken.
- Laboratory blank: To estimate any contamination introduced to the sample during the transport, storage, and analysis, the ultrapure water will be provided by the laboratory in the relevant sample jars and will remain unopened. The water will then be tested to determine any contamination from a laboratory or transport source. A minimum of one transport blank per analyte per survey should be taken.

In addition, these measures will also be taken to QA the sampling:

- Nitrile gloves must be worn at all times when handling water sampling equipment. Gloves need to be changed between each water sampling location or when contaminated.
- Sun cream/zinc and any other potential anthropogenic contaminants are to be avoided by those in contact with the water sampling equipment.
- No smoking is to occur when sampling is undertaken.
- Avoid possible contamination from the vessel by sampling in as far forward position as possible with the vessel moving slowly up-current and into the wind.
- The insides of the sample container lids are not come in contact with anything potentially contaminated (such as hands, vessel, or potentially contaminated surfaces), and if contamination occurs, use a substitute container.
- Take care to avoid sources of airborne contamination (e.g. diesel fumes).
- Take GPS waypoints of all sites sampled from the vessel.

3.7 Mobilisation Requirements

3.7.1 Survey Planning

This checklist outlines considerations as part of the survey planning phase.

Task	
☐	Determine the scale of the study area
☐	Select study area sites (including impact and reference sites, if applicable)
☐	Select sampling approach and techniques
☐	Determine sampling replication required
☐	Consider data management requirements (e.g. data format, metadata, storage protocols, delivery schedule, and communication methods)
☐	Develop site-specific health and safety plan

Task	
☐	Develop survey/sampling plan incorporating the latest operational data
☐	GIS team to prepare survey maps from the latest data
☐	Check material safety datasheets (MSDSs) and chemical handling procedures
☐	Undertake hazard identification workshops (HAZIDs) as required
☐	Develop site-specific health and safety plan, including Job Hazard Analyses (JHAs)

3.8 Logistics

These activities must be undertaken before mobilisation to the field.

Task	
☐	Arrange survey platform (vessel, vehicle) as required to survey or access monitoring sites
☐	Confirm availability and rating certificates for any required rigging gear required on vessel (e.g. winches, Hiab), confirm size and available space in fridge/freezers
☐	Consider port logistics (e.g. access pass, berth, crane, wharf gang, fuel)
☐	Assemble scientific survey team
☐	Book flights, accommodation, and car hire
☐	Confirm equipment list and availability of items; purchase consumables (as required)
☐	Confirm availability of NATA-accredited laboratories to receive samples and analyse within holding times. Confirm sample analysis requirements, including limits of detection, and arrange provision of sample containers, CoC forms, eskies, and ice bricks
☐	Arrange delivery and freight of any sampling equipment and laboratory sample jars
☐	Confirm information on sample holding times and the requirements for transporting samples from vessel to laboratories
☐	Develop field survey schedules, considering staff rotation and offloading of samples
☐	Communicate with all involved parties the plan to transport samples with a short holding time from the survey vessel to the laboratory
☐	Conduct a pre-mobilisation meeting with the survey team, confirm scope, schedule, HES requirements
☐	Print all survey documentation, including hardcopy field sheets, maps, and GPS locations

3.9 Equipment Preparation

These activities need to be undertaken before mobilisation to the field, to ensure equipment is working (for an equipment list, see Section 3.12).

Task	
☐	Confirm specialist equipment requirements and availability (Profiler, Van Dorn bottle, or other water sampling devices), and any appropriate duplication of field equipment
☐	Confirm water quality profilers and sensors (including fluorometry sensor) have been calibrated before shipping, have adequate batteries, spares, and specific profiling cables, and download software
☐	Check GPS units and digital cameras are working and that sufficient spare batteries and memory cards are available
☐	Check field laptops, ensuring they have batteries, power cable, login credentials, and are functional

Task	
☐	Check if a first aid kit or specialist PPE is required
☐	Confirm freight delivery to mobilisation port

All equipment should be checked before transport and before deployment so that the equipment can be operated safely and efficiently. Calibration and pre-deployment records should be kept on file.

The hydrocarbon sensor should be calibrated to an appropriate standard before mobilisation. Water samples will be sent to a NATA-accredited laboratory for TRH analysis and the laboratory measurements correlated with the sensor measurements. In this way post-calibration of the sensor to actual hydrocarbon readings can occur and profile data can be correctly adjusted.

3.10 Resources

The personnel required to undertake this monitoring program, their roles, and relevant qualifications are listed in Table 3-4.

Table 3-4: Field Roles and Responsibilities

Role	Responsibility	Recommended Qualifications
Technical Lead	• Develop sampling plan • Analyse statistics analysis and oversee data	• Higher degree in relevant subject • Water quality sampling experience
Water Quality Field Lead	• Manage deck operations • Liaise with vessel crew and master • Confirm that work is undertaken safely and conditions are safe • Manage sample contamination risk • Ensure sample integrity and data quality	• Minimum degree in relevant subject • Water quality profiling and sampling field experience • Tropical Basic Offshore Safety Induction and Emergency Training (TBOSIET) • Offshore medical
Water Quality Field Technician	• Deploy equipment • Collect samples • Handle, store, and label samples according to guidelines • Provide HES support	• Water quality profiling and sampling field experience • TBOSIET • Offshore medical

3.11 Equipment

This list is not exhaustive, but includes basic items that may be used for water quality sampling and requires redundancy for key items.

Item	
☐	Glass sampling jars (with Teflon-lined lids) for sample collection, as provided by the laboratory
☐	Sample labels for glass jars
☐	Disposable nitrile gloves
☐	Van Dorn sampler (e.g. Niskin bottle or equivalent)
☐	Dyneema or equivalent rope/cable for lowering equipment
☐	Water column profiler with appropriate sensors

Item	
☐	Stainless steel sampling buckets/containers
☐	Boom
☐	Absorbent pads
☐	Pouring jugs to fill bottles
☐	CoC documents
☐	Plastic ziplock bags to place glass jars into
☐	Insulated esky for transporting samples
☐	Ice bricks
☐	Bubble wrap
☐	Tamper-proof security seals
☐	Sampling log book or field notebook, pens, and waterproof markers
☐	Digital camera with integrated GPS stamp, if practicable
☐	Sampling case to hold all sampling equipment ready for transport to a spill location
☐	Fridge of appropriate size
☐	GPS unit
☐	Field laptop
☐	Hard drives for data backup
☐	Spare batteries, cable ties, tape, and other miscellaneous items

3.12 Standard Operating Procedures (SOPs)

Sampling techniques will vary depending on the type and location of the hydrocarbon to be collected. Consistent across all techniques are:

- The profiler may require a weighted base that will help the unit sink and also protect the sensors from contacting the sediments on the seabed.
- The type of sensor on the fluorometer is important—an ultra-violet fluorescent sensor will detect aromatics, whereas an infrared sensor will detect aliphatics.
- The sampler for water quality within the water column should allow remote opening and closing to ensure that the required sampling depth has been reached and there is no contamination as the sampler passes through an oiled area. This can be achieved using a bomb sampler, which is usually made of stainless steel but is limited to shallower depths. If a stainless steel sampler is not available, a Van Dorn sampler or similar device could be used. Choice of equipment with remote opening capabilities may be limited; therefore, the contamination potential when using equipment that is open as it passes through the water column (e.g. bomb and Van Dorn samplers) needs to be considered. Water can also be sampled from various depths using a hose and oil-free pump (depth limited).
- Water collected from each depth should be processed by transferring it into a stainless pouring jug or equivalent container easily decontaminated by

hydrocarbon components, so that the appropriate number of sample jars can be filled directly.

- Sampling equipment must be decontaminated and rinsed in ultrapure water before use and in between sites. Sampling containers that do not contain preservatives must also be rinsed before use.
- Decontamination techniques need to take into account the sensitive nature of probes on the profiler.
- Samples are to be stored in the appropriate sample containers, as provided by the laboratory.
- Nitrile rubber gloves must worn at all times when sampling and—at a minimum—be changed between sites or when contact with contaminated material is suspected.
- Because the sample containers are usually glass, they must be covered with a protective covering (e.g. bubble wrap) to prevent damage to the samples.
- Field duplicate samples will be taken at all sampling locations. Field blanks should be taken for every day of sampling.
- All samples will be labelled and recorded, and cross-checked with field sheets and CoC forms.
- Appropriate CoC must be maintained and samples must be secured.

3.12.1 Water Profiling

Step	
☐	In the absence of equipment that can give real-time fluorometry readings (such as a YSI) or if the area is outside the depth capability of instrument (i.e. 250 m), deploy the water column profiler before using the water sampling equipment so that the depths of peaks in fluorometry readings can be determined first. If a dual profiler/sampler is available, then these steps can be done at the same time.
☐	Check that all sampling has been accomplished from the previous drop and the equipment has been decontaminated.
☐	Check that the area where the profiler is to be lowered has no surface slick (which is not expected at this stage of monitoring). If it does, follow the steps below to remove hydrocarbons before deployment.
☐	Remove any protective casings on the profiler sensors before deployment.
☐	Set the profiler to logging mode before lowering it into the water column.
☐	Deploy the profiler over the side of the vessel via a Hiab or similar. The Water Quality Lead should run the deck operations, guiding the Hiab and winch operators and the Water Quality Assistant.
☐	Perform any relevant deployment checks on the profiler that are specific to that piece of equipment.
☐	Allow the profiler to sit at the surface water with sensors submerged so the sensors can equilibrate with environment.
☐	Lower the profiler into the water column at a rate of half a metre per second. Use the ship's echo sounder and markings on the lowering cable/rope to judge water depth and the position of the profiler.
☐	For surface spills involving light hydrocarbons: • Water column profile to 50 m (or depth indicated by other information) Surface spill involving heavy hydrocarbons: • Water column profile to full water depth

Step	
☐	When the water profiler reaches the desired bottom depth, retrieve the equipment and download the data. Keep the sensors moist and protected when the profiler is not in the water. Review data for peaks in fluorometry then collect water samples at those depths.

3.12.2 Water Sampling

Step	
☐	Check that all sampling has been accomplished from the previous drop.
☐	Check the site for a hydrocarbon slick before setting up sampling equipment. If using sampling equipment that only closes remotely (rather than opens and closes remotely), follow these steps to prevent decontamination across depths (when collecting subsurface samples). Deploy a boom from the vessel and use absorbent pads to remove surface hydrocarbons from within this area . Note the presence of a slick and actions taken in the field notes. Hydrocarbon absorption using this method may not completely remove the risk of contamination, but may reduce it.
☐	Drain the sampling equipment so that no water remains.
☐	Decontaminate sampling equipment by rinsing with Decon 90 or equivalent.
☐	Prepare most sampling equipment just before deployment to avoid on-deck contamination. This must be done by designated experienced personnel only. Misfires could occur if any errors are made when cocking the bottles (when Van Dorn sample bottles are used).
☐	Follow manufacturer instructions for how to safely and accurately set up the sampling equipment.
☐	Check that sampling equipment triggers are correctly set up before deployment.
☐	Deploy the water sampling equipment over the side of the vessel via a Hiab or winch. The Water Quality Lead should run the deck operations, guiding the Hiab and winch operators and the Water Quality Assistant.
☐	Lower the sampling equipment into the water column at a rate of half a metre per second. Use the ship's echo sounder and markings on the lowering cable/rope to judge water depth and the position of the water sampling system.
☐	Collect samples at the depths where peaks in fluorometry were observed, or, if this was inconclusive, at a minimum of two depths for waters <50 m deep (near surface and near bottom) or a minimum of three depths for water >50 m deep (near surface, mid-water, and near bottom). How samples are collected depends on the sampling equipment used.
☐	For surface spills involving light hydrocarbons: • minimum two water sample depths (surface 0–0.5 m) and subsurface (~5–10 m) For subsurface spills or a surface spill involving heavy hydrocarbons: • in waters <50 m, a minimum of two water sample depths (as determined by fluorometer, or if inconclusive a surface and near-bottom sample) • in waters >50 m, a minimum 3 water sample depths (as determined by fluorometer, or if inconclusive a surface, mid-water, and near-bottom sample).
☐	Retrieve the equipment once the subsurface samples have been collected, and extract the water samples. Lower a single water sampling bottle to 0–0.5 m and activate it as the near surface water sample collection.
☐	Once the sample is retrieved, empty the water into sampling containers before filling the laboratory sample jars. Filling sample containers directly from sampling equipment can be difficult and possibly lead to contamination. Decontaminate these containers (as for all sampling equipment) and cover them, if required, to prevent contamination.
☐	Place samples into laboratory provided jars/bottles and seal. Fill sample jars to zero headspace to prevent evaporative loss of volatiles.
☐	Label jars/bottles immediately with: • sample number or code

Step	
	• analysis required • depth • time and date (24-hour clock and DD/MM/YYYY).
☐	Place samples in a small esky with frozen ice bricks. Transfer to refrigerator when possible for storage at 4 °C.
☐	Complete laboratory-specific CoC forms.
☐	Send samples to the laboratory within 72 to 96 hours if possible. Maximum holding time including extraction is 7 days.
☐	At each site, complete a field log including details on: • time arrived at site • environmental conditions at the site • presence of a hydrocarbon slick • sample details for individual samples (as above) • sample description notes (oil, debris, thick slick, film etc.) • location of each sample (GPS coordinates, place names e.g. Sandy Island – western side) • full name of person taking sample • full name of witness (if sampling for legal purposes) • photograph numbers recorded at this site • time departed site.
☐	Take photographs throughout the sampling process of: • sampling area (including surface of water) • sampling site • sampling jar before the sample is collected • sampling process • sample jar with contents and being sealed • sealed and secured sampling jars in the case • completed paperwork • sealed and secured case on completion of the sampling. Keep a record of what photographs were taken (on field log) to assist with compiling the documentation at a later time.

3.13 Forms and Tools

Refer to Appendix C.

4 SCI2 – Sediment Quality Impact Study

4.1 Aims and Objectives

The aim of the Scientific Monitoring Program SCI2 – Sediment Quality Impact Study (SCI2) is to describe the influence of hydrocarbon exposure (level, duration, and type) on sediments.

The objectives of SCI2 are to:

- quantify the temporal and spatial distribution of hydrocarbons in marine sediment
- assess hydrocarbon content of sediment samples against accepted environmental guidelines or benchmarks.

Monitoring requires consistent repeat surveys to determine trends over time. SCI2 is best informed with comprehensive baseline data. The data collected as part of SCI2 should be as comparable as possible (in sampling methods, analysis, and interpretation of results) to baseline data and operational monitoring data.

4.2 Initiation and Termination Criteria

The initiation and termination criteria for this scientific monitoring program are provided in Section 5 of the OSMP. Implementation times for this scientific monitoring program are directly linked to the initiation criteria and are found in the same section of the OSMP.

4.3 Data and Information Requirements

Table 4-1 lists the inputs relevant to planning for the implementation of SCI2, once the notification to commence is initiated.

Table 4-1: Data Requirements Summary for SCI2

Baseline Information	Operational Information
• Access to consolidated project-specific baseline data and baseline summary report/data for the relevant location • Additional baseline data may be available from I-GEMS (WA only), or from other agencies, including any information on natural hydrocarbon seeps in the area	Outputs from MES and *OPS3* activities, including: • spill type • spill volume and duration • spatial extent and movement of the spill • details of dispersants used • consolidated data file (Excel file) including exceedances of benchmark levels.

SCI2 will likely inform other SCI studies, and as such outputs from it will be required by those studies.

4.4 Design

4.4.1 Monitoring Design

The monitoring approach needs to consider the data collected during MES and OPS4 activities. The geographic extent of the area to be monitored will be based on the hydrocarbon distribution and predicted movement of the hydrocarbon spill, as determined through the MES outcomes, and measured hydrocarbons in sediments, as determined through OPS4. These outputs will identify potential impact areas to be sampled, which will allow comparison of results to baseline values. Table 3-2 summarises the monitoring designs recommended for various outcomes. Section 2.1 describes these approaches in detail.

Table 4-2: Monitoring Design Approaches Recommended for Different Spill Outcomes

MES and *OPS4* Outcomes Indicate Spill Extent	Monitoring Design[1]	Replicate Sites Required[2]
Hydrocarbon plume concentrated around source, dissipating with distance	Gradient Approach	Minimum of **two** replicate sites at each distance from source
Hydrocarbon plume has dissipated away from source	Gradient Approach (with revised centre point of gradient based on OPS monitoring, modelling, and/or other data)	Minimum of **two** replicate sites at each distance from source
Nearshore spill or spill reaches shoreline	BACI, IvC or Gradient Approach	Minimum of **three** replicate sites at each location (impact and reference) or minimum **two** replicate sites at each distance from the centre of the gradient
Spill interacts with area of biological importance (bay/shoal/island)	BACI or IvC	Minimum of **three** replicate sites at each location (impact and reference)

1 *Reference sites required for each monitoring approach are detailed in Section 1.*

2 *It is recommended that sample replication is conducted for 10% of samples.*

4.4.2 Monitoring Sites

Sampling sites will be selected once the outputs from MES and OPS4 are generated so that the depth and extent of the spill can be incorporated into the survey design. The location of these sites will also be coordinated with the requirements of SCI1 – Water Quality Impact Study.

Sampling sites will be based on locations where hydrocarbons may have sunk through the water column and have contact with sediments. These include areas:

- around the well head, in the event of a loss of well control, as most hydrocarbon-contaminated deposits will be distributed close to the release site
- underlying hydrocarbons that have sunk through water column
- with high levels of suspended sediments (generally nearshore areas)
- such as shorelines and tidal flats where hydrocarbons can potentially become concentrated
- where other SCIs have been triggered

The number of sites that can be monitored each day depends on the travel distance between sites, number of replicates required, depth of water and weather conditions. As an example, for a spill in 300 m water depth or greater, assuming 12 hours operations in good weather, it is expected an average of 6 to 8 sites can be sampled each day. This is based on currently available grab sample methods and a winch speed of half a metre per second. This time also includes the requirement for comprehensive field notes and photos for each sample.

4.4.3 Monitoring Parameters

Sediment samples will be collected from all sampling sites using a stainless steel grab, box corer, or remotely operated vehicle (ROV) with corers (or equivalent) for subsequent laboratory analysis of these parameters:

- particle size distribution (PSD)
- TRH
- PAH; only analysed if TRH is detected
- BTEX; only analysed if TRH is detected
- total organic carbon (TOC).

All samples will be compared to the USEPA Sediment Quality Benchmarks for Aquatic Life (Ref. 22) or other relevant benchmarks or guidelines, as detailed in OPS4. For samples where analytical data indicate the concentration levels exceed the individual benchmark, the sample will be reviewed to assess the likelihood that the exceedance resulted from the spill.

4.4.4 Monitoring Frequency and Duration

Following the initiation of SCI2, surveys will be undertaken at least once a year, although are likely to be at a greater frequency (e.g. every three months) in the first year, based on the biological indicators being monitored (unless the termination criteria are triggered within this time). Survey data will be reviewed annually and the frequency of any ongoing monitoring will be determined by examining the data collected to date and the spatial, temporal, and seasonal variability of any associated biological indicators measured in other plans. Survey frequency may, for example, be seasonal, six-monthly, or annual until the termination criteria are reached.

Note: SCI2 may reach termination criteria but still be required by other SCIs.

4.4.5 Sample Integrity

Sample holding times, storage containers, and preservation requirements are summarised in Table 4-3. At each site, three sample jars and one sample bag (total volume/site 1400 mL minimum) will be required. Spare sample containers are required for redundancy.

Table 4-3: Test Parameters for SCI2

Test Parameter	ANZECC Guidelines (µg/g)	USEPA Aquatic Life Benchmark Value (µg/g)	Storage Container	Preservation	Holding Time
TRH (C_6–C_{40})	550[1]		250 mL wide-mouth glass with Teflon cap liner[2]	4 °C (fridge)	14 days (plus holding extracts for up to 40 days)
PSD		N/A	300–500 mL polyethylene bag	-20 °C (freezer)	6 months
TOC		N/A	150 mL wide-mouth glass jar[3]	-20 °C (freezer)	6 months

<table>
<tr><th>Test Parameter</th><th>ANZECC Guidelines (µg/g)</th><th>USEPA Aquatic Life Benchmark Value (µg/g)</th><th>Storage Container</th><th>Preservation</th><th>Holding Time</th></tr>
<tr><td colspan="3">PAHs</td><td rowspan="17">250 mL wide-mouth glass with Teflon cap liner[3]</td><td rowspan="17">-20 °C (freezer)</td><td rowspan="17">56 days (plus holding extracts for up to 40 days)</td></tr>
<tr><td>Acenaphthene</td><td></td><td>1 020 000</td></tr>
<tr><td>Acenaphthylene</td><td></td><td>800 000</td></tr>
<tr><td>Anthracene</td><td></td><td>1 235 000</td></tr>
<tr><td>Benz (a)anthracene</td><td></td><td>1 750 000</td></tr>
<tr><td>Benzo(a)pyrene</td><td></td><td>2 010 000</td></tr>
<tr><td>Benzo(b) fluoranthene</td><td></td><td>2 035 000</td></tr>
<tr><td>Benzo(g,h,i) perylene</td><td></td><td>2 270 000</td></tr>
<tr><td>Benzo(k) fluoranthene</td><td></td><td>2 040 000</td></tr>
<tr><td>Chrysene</td><td></td><td>1 755 000</td></tr>
<tr><td>Dibenz (a,h) anthracene</td><td></td><td>2 330 000</td></tr>
<tr><td>Fluoranthene</td><td></td><td>1 470 000</td></tr>
<tr><td>Fluorene</td><td></td><td>1 120 000</td></tr>
<tr><td>Indeno (1,2,3-cd) pyrene</td><td></td><td>2 310 000</td></tr>
<tr><td>Naphthalene</td><td></td><td>800 000</td></tr>
<tr><td>Phenanthrene</td><td></td><td>1 240 000</td></tr>
<tr><td>Pyrene</td><td></td><td>1 450 000</td></tr>
<tr><td colspan="3">BTEX</td><td rowspan="5">250 mL wide-mouth glass with Teflon cap liner (taken from TRH sample)[2]</td><td rowspan="5">4 °C (fridge)</td><td rowspan="5">14 days</td></tr>
<tr><td>Benzene</td><td></td><td>1 680 000</td></tr>
<tr><td>Toluene</td><td></td><td>2 060 000</td></tr>
<tr><td>Ethylbenzene</td><td></td><td>2 465 000</td></tr>
<tr><td>Xylenes</td><td></td><td>2 490 000</td></tr>
</table>

1 National Assessment Guidelines for Dredging (Ref. 23) ISQG Trigger Value
2 Minimise headspace in jars. Avoid exposure to light.
3 Room for expansion (during freezing) must be left at the top of the jar. Avoid exposure to light.

4.4.6 Sample Analysis

Sediment samples will be analysed at NATA-accredited laboratories. PAH and BTEX analysis will only be undertaken if TRH is recorded. PSD will be analysed using laser diffraction (for <500 µm fraction) and dry sieving (≥500 µm fraction).

4.5 Data Management

Managing the generated data requires extensive data storage, analysis, backup, and archiving. Samples should be treated as legal evidence and secured against loss or tampering.

A guide for data management can be found in the AMSA Oil Spill Monitoring Handbook (see Appendix B; Ref. 17). In summary:

- All records will be kept in a field log. This log will be copied to an electronic spreadsheet each day.
- All electronic files including those downloaded from the profiler will be backed up onto external hard drives each day.
- Original hardcopies will be transferred to a project folder and kept in a secure location (e.g. wheelhouse or vessel survey laboratory).
- GPS positional information and photographs will be downloaded and backed up onto external hard drives each day.
- Hard drives will be transported by the demobilising survey team.
- Copies of datasheets and analysis should be archived.

Data received from the laboratories (including backups) will be downloaded and stored on the contractor's computer system. These data are usually received approximately two to three weeks after receipt of that batch of samples. QA/QC'd data will be presented in spreadsheet format and then transferred to CAPL as required.

4.6 QA/QC Procedures

These QA/QC samples will be taken to determine whether contamination has occurred during the sampling procedure:

- Field blank: To estimate any contamination introduced to the sample during collection. This involves following the same sampling procedure used to collect field samples, but, instead, using a sample jar pre-filled with laboratory-certified clean sediment. A minimum of one field blank per analyte per day should be taken.
- Laboratory blank: To estimate any contamination introduced to the sample during transport, storage, and analysis, laboratory-certified clean sediment will be provided by the laboratory in the relevant sample jars and these jars are to remain unopened. The sediment will then be tested to determine any contamination from a laboratory or transport source. A minimum of one transport blank per analyte per survey should be taken.

In addition, these measures will also be taken to QA the sampling:

- Sampler will be cleaned with Decon 90 and ultrapure water between sampling sites.
- Sample processing equipment (utensils/bowls) will be cleaned between replicates.
- Contaminant samples will not be taken from within 5 to 10 mm of the sides of the sampler walls.
- Samples where water has dripped into the sample from the winch wire will be discarded.
- Samples in which the grab has not closed correctly will be sampled again.
- Nitrile gloves must be worn at all times when handling sediment sampling equipment. Gloves must be changed between each sediment sampling location or when contaminated.

- Sun cream/zinc and any other potential anthropogenic contaminants are to be avoided by those in contact with the sediment sampling equipment.
- No smoking is to occur while sampling is being undertaken.
- As far as possible, the insides of the sample container lids are not come in contact with anything potentially contaminated (such as hands, surfaces, or vessel).
- A review of the deck will be undertaken before vessel departure to identify any areas of potential contamination and to define a clean area where sample processing may be undertaken to reduce contamination risk.
- Take GPS waypoints of all sites sampled from the vessel.

4.7 Mobilisation Requirements

4.7.1 Survey Planning

This checklist outlines considerations as part of the survey planning phase.

Task	
□	Determine the scale of the study area
□	Select study area sites (including impact and reference sites if applicable)
□	Select sampling approach and techniques
□	Determine sampling replication required
□	Consider data management requirements (e.g. data format, metadata, storage protocols, delivery schedule, and communication methods)
□	Develop site-specific health and safety plan
□	Develop survey/sampling plan incorporating the latest operational data
□	GIS team to prepare survey maps from the latest data
□	Check MSDSs and chemical handling procedures
□	Undertake HAZIDs as required
□	Develop site-specific health and safety plan, including JHAs

4.8 Logistics

These activities must be considered before mobilisation to the field.

Task	
□	Arrange survey platform (vessel, vehicle) as required to survey or access monitoring sites
□	Confirm availability and rating certificates for any required rigging gear required on vessel (e.g. winches, Hiab), confirm size and available space in fridge/freezers
□	Consider port logistics (e.g. access pass, berth, crane, wharf gang, fuel)
□	Assemble scientific survey team
□	Book flights, accommodation, and car hire
□	Confirm equipment list and availability of items; purchase consumables (as required)

Task	
☐	Confirm availability of NATA-accredited laboratories to receive samples and analyse within holding times. Confirm sample analysis requirements, including limits of detection, and arrange provision of sample containers, CoC forms, eskies, and ice bricks
☐	Arrange delivery and freight of any sampling equipment and laboratory sample jars
☐	Confirm information on sample holding times and the requirements for transporting samples from the vessel to laboratories
☐	Develop field survey schedules, considering staff rotation and offloading of samples
☐	Communicate with all involved parties the plan to transport samples with a short holding time from the survey vessel to the laboratory
☐	Conduct pre-mobilisation meeting with the survey team, confirm scope, schedule, HES requirements
☐	Print all survey documentation, including hardcopy field sheets, maps, and GPS locations

4.9 Equipment Preparation

These activities need to be undertaken before mobilisation to the field, to ensure equipment is working (for an equipment list, see Section 3.12).

Task	
☐	Confirm specialist equipment requirements and availability (grab, corer, or ROV)
☐	Check GPS units and digital cameras are working and that sufficient spare batteries and memory cards are available
☐	Check field laptops, ensuring they have batteries, power cable, login credentials, and are functional
☐	Check if a first aid kit or specialist PPE is required
☐	Check if redundancy is required
☐	Book freight to mobilisation port

All equipment should be checked before transport and before deployment so that the equipment can be operated safely and efficiently.

4.10 Resources

The personnel required to undertake this monitoring program, their roles, and relevant qualifications are listed in Table 3-4.

Table 4-4: Field Roles and Responsibilities

Role	Responsibility	Qualifications
Sediment Quality Field Lead	• Develop sampling plan	• Minimum degree in relevant subject • Sediment quality sampling experience
Sediment Quality Field Technician	• Deploy equipment • Collect samples • Handle, store, and label samples according to guidelines • Provide HES support	• Sediment quality sampling field experience

4.11 Equipment

This list is not exhaustive, but includes basic items that may be used for sediment quality sampling and requires redundancy for key items.

Item	
☐	Glass sampling jars (with Teflon-lined lids) for sample collection, as provided by the laboratory
☐	Sample labels for glass jars
☐	Disposable nitrile gloves
☐	Stainless steel grab or box corer, or equivalent
☐	Glass mixing bowl
☐	Stainless steel spoons
☐	Boom
☐	Absorbent pads
☐	CoC documents
☐	Polyethylene/ziplock bags for PSD
☐	Polyethylene/ziplock bags to place glass jars into
☐	Insulated esky to place samples into
☐	Ice bricks
☐	Bubble wrap
☐	Tamper-proof security seals
☐	Sampling log book or field notebook
☐	Digital camera with integrated GPS stamp, if practicable
☐	Camera set up for sampling equipment
☐	Sampling case to hold all sampling equipment ready for transport to a spill location
☐	Field laptop
☐	Hard drives for data backup

4.12 Standard Operating Procedures (SOPs)

Sampling techniques will vary depending on the type and location of the hydrocarbon to be collected. Consistent across all techniques are:

- Sediment samples will be collected using a corer/grab, either from a vessel or using an ROV, on an ongoing basis (if hydrocarbons are detected during the initial survey and attributable to the spill) until the termination criteria are reached.
- The grab or corer for sampling marine sediments should close when the equipment encounters the seabed to ensure that the bottom has been reached. This can be achieved using a grab or box corer, which is made of stainless steel.

- Sampling equipment must be decontaminated and rinsed before use and in between sites. Sampling jars that do not contain preservatives must also be rinsed before use.
- When the core or grab is retrieved, the sample should be photographed with a site label, then homogenised in a glass bowl using a stainless steel spoon.
- Samples must be placed into laboratory-provided sampling containers.
- Samples must be stored in the laboratory-provided sampling containers.
- Nitrile rubber gloves must be worn at all times when sampling, and—at a minimum—be changed between sites or when contact with contaminated material is suspected.
- Samples must be put into refrigerated storage immediately and chilled to 4 °C before shipping to a NATA-accredited laboratory.
- Sample containers must be covered in protective covering (e.g. bubble wrap) to prevent damage to the samples.
- Samples should be analysed by the analytical laboratory within 14 days of collection.
- Field duplicate samples will be taken at all sampling locations. Field blanks should be taken for every day of sampling.
- All samples will be recorded and photographed for forensic/legal purposes.
- Appropriate CoC forms must be maintained and samples must be secured.

4.12.1 Sediment Sampling

Step	
☐	Check that all sampling has been accomplished from the previous drop.
☐	Check the site for a hydrocarbon slick before setting up sampling equipment. As most sediment sampling equipment passes through the water column in the open position and only closes when it contacts bottom sediments, there is potential for contamination from a surface slick. Deploy a boom from the vessel and use absorbent pads to remove surface hydrocarbons from within this area. Note the presence of a slick and actions taken in the field notes. Hydrocarbon absorption using this method may not completely remove the risk of contamination, but may reduce it.
☐	Check the equipment is empty so that no sediment remains.
☐	Decontaminate sampling equipment by rinsing with Decon 90 or equivalent.
☐	Prepare most sampling equipment just before deployment to avoid on-deck contamination. This must be done by designated experienced personnel only.
☐	Follow manufacturer instructions for how to safely and accurately set up the sampling equipment.
☐	Check that sampling equipment triggers are correctly set up before deployment.
☐	The sediment sampling equipment will likely be deployed over the side of the vessel via a Hiab or deck winch. The Sediment Quality Lead should run the deck operations, guiding the Hiab and winch operators and the Sediment Quality Assistant.
☐	Lower the equipment into the water column at a rate of approximately half a metre per second. Use the ship's echo sounder and markings on the rope or cable to judge water depth water and the position of the sediment sampling equipment.
☐	Take samples when the sampling equipment reaches the bottom. Preferably, sampling equipment will have an attached camera that can take plan view and downward-facing photos of the seabed.

<table>
<tr><th colspan="2">Step</th></tr>
<tr><td>☐</td><td>Retrieve the equipment and extract the sediment samples.</td></tr>
<tr><td>☐</td><td>Assess the sediment samples before removing them from the sediment sampler to check that sufficient volume was collected and there is no indication of potential contamination or loss of sediment that could affect the integrity of the sample. Take photos of the sample before removal, including a photo slate that shows:
date
sample reference (including information on location, site, and replicate number)
scale bar</td></tr>
<tr><td>☐</td><td>Collect subsamples from the surface 2–3 cm, put into the glass mixing bowl, then homogenise. Collect subsamples from the bowl for each analyte required.
TOC and PAH samples both require room for expansion as these samples will be frozen. Samples for TRH/BTEX should not have any headspace.</td></tr>
<tr><td>☐</td><td>Label jars/bottles immediately with:
sample number or code
analysis required
depth
time and date (24-hour clock and DD/MM/YYYY)</td></tr>
<tr><td>☐</td><td>Place samples in a small esky with frozen ice packs. Transfer to refrigerator/freezer (depending on sample type) when possible.</td></tr>
<tr><td>☐</td><td>Complete laboratory-specific CoC forms.</td></tr>
<tr><td>☐</td><td>Send samples to the laboratory within 10 days if possible. The maximum holding time including extraction is 14 days for TRH and BTEX.</td></tr>
<tr><td>☐</td><td>Complete a field log at each site, including details on:
time arrived at site
environmental conditions at the site
presence/absence of a hydrocarbon slick
sample details for individual samples (as above)
sample description notes (oil, debris, thick slick, film etc.)
location of each sample (GPS coordinates, place names e.g. Sandy Island – western side)
full name of person taking sample
full name of witness (if sampling for legal purposes)
photograph numbers recorded at this site
time departed site</td></tr>
<tr><td>☐</td><td>Take photographs throughout the sampling process of:
sampling area
sampling site
sampling jar before the sample is collected
sampling process
sample jar with contents and being sealed
sealed and secured sampling jars in the case
completed paperwork
sealed and secured case on completion of the sampling.
Keep a record of what photographs were taken (on field log) to assist with compiling the documentation at a later time.</td></tr>
</table>

4.13 Forms and Tools

Refer to Appendix C.

5 SCI3 – Coastal and Intertidal Habitat Impact Study

5.1 Aims and Objectives

The primary aim of SCI3 – Coastal and Intertidal Habitat Impact Study (SCI3) is to assess impacts to coastal and intertidal habitats and associated biological communities after a hydrocarbon spill. Sampling may need to be conducted on an ongoing basis throughout the spill, response activities, and for some time after termination of the response.

The intertidal zone is the focus of SCI3—it is the region that extends from the lowest astronomical tide (LAT) to the highest astronomical tide. Habitats seaward of LAT (e.g. the subtidal zone) are included in SCI6 – Benthic Habitat Impact Study.

The objective of SCI3 is to:

- determine the extent, severity, and persistence of impacts on intertidal habitats and associated biological communities arising from a hydrocarbon spill and subsequent response activities.

5.2 Initiation and Termination Criteria

The initiation and termination criteria for this scientific monitoring program are provided in Section 5 of the OSMP. Implementation times for this scientific monitoring program are directly linked to the initiation criteria and are found in the same section of the OSMP.

5.3 Data and Information Requirements

Table 5-1 lists the inputs relevant to planning for the implementation of SCI3, once the notification to commence is initiated.

Table 5-1: Data Requirements Summary for SCI3

Baseline Information	Operational Information	Scientific Monitoring
• Access to consolidated project-specific baseline data and baseline summary report/data/maps/models, where available, for the relevant study area • External datasets (e.g. DAWE, DoF etc.), information, including access to raw data and metadata statements outlining data collection methods • Oil Spill Response Atlas (OSRA) provided by AMSA	Outputs from OPS5 activities including: • intertidal habitat distribution, extent, and impact (i.e. maps, photographs, Excel datasheets) • intertidal assessment methods Outputs from MES activities including: • spill type • spill volume and duration • details of dispersants used, volumes, locations, and methods of application • observed and/or recorded spatial extent and movement of the spill • metocean data (e.g. currents, wind, sea state) • consolidated water quality and chemical characterisation data from Operational Scientific Monitoring, including locations of exceedances of benchmark levels, where available.	Information available at the commencement of SCI3 on survey design, or results from implemented scientific monitoring (primarily SCI1, SCI2, and SCI6)

5.4 Design

5.4.1 Monitoring Design

Intertidal habitats within the study area support various biological communities, which vary in their sensitivity to hydrocarbon spills. Some ecosystems have been reported to recover quickly from spills, with little or no noticeable harm, while others experience long-term harmful effects. To help inform scientific monitoring, it is essential that the pre-impact condition of the intertidal habitats of interest are known or can be reliably inferred. This can be achieved by assessing against pre-impact baseline data (if available) or inferring from reference sites that are considered comparable to impact locations.

Monitoring will concentrate on activities that help in understanding the impacts on the most sensitive areas. A combination of monitoring types will be used:

- Physical: To provide observations and measurements used to describe the physical environmental conditions during intertidal surveys.
- Remote sensing: To initially determine potentially impacted habitats, habitats at risk, and reference areas (outputs from OPS5 and MES scope may be suitable). Once images are ground-truthed, remote sensing can potentially be used as a proxy for biological monitoring of large-scale changes in some intertidal habitats.
- Biological: To determine the extent, severity, and persistence (including recovery) of impacts on intertidal habitats and associated biological communities.
- Chemical studies: To identify contamination and attribute cause and effect relationships to the impacts of a hydrocarbon spill.

The monitoring approach needs to consider the data collected during MES and OPS activities. The geographic extent of the area to be monitored will be based on the hydrocarbon distribution and predicted movement of the hydrocarbon spill, as determined through the MES outcomes, and measured hydrocarbons within the water column, sediments, and shoreline, as determined through OPS3, OPS4, and OPS5. These outputs will identify potential impact areas to be sampled, which will allow comparison of results to baseline values. Table 5-2 summarises the monitoring designs recommended for various outcomes. Section 2.1 describes these approaches in detail.

Table 5-2: Monitoring Design Approaches Recommended for Different Spill Outcomes

MES and *OPS3* Outcomes Indicate Spill Extent	Monitoring Design[1]	Replicate Sites Required[2]
Hydrocarbon plume concentrated around source, dissipating with distance	Gradient Approach	Minimum of **two** replicate sites at each distance from source
Hydrocarbon plume has dissipated away from source	Gradient Approach (with repositioned centre point, aligned with results from OPS monitoring or SCI1 or SCI2 and/or modelling), and/or Lines of Evidence Approach.	Minimum of **two** replicate sites at each distance from the centre point
Nearshore spill or spill reaches shoreline	BACI, IvC, Gradient Approach, and/or Lines of Evidence Approach	Minimum of **three** replicate sites at each impact and control locations (BACI and IvC); or minimum **two** replicate sites at

MES and *OPS3* Outcomes Indicate Spill Extent	Monitoring Design[1]	Replicate Sites Required[2]
		each distance from source (Gradient); and/or multiple replicates depending on Line of Evidence type
Spill interacts with area of biological importance (bay/shoal/island)	BACI, IvC, and/or Lines of Evidence Approach	Minimum of **three** replicate sites at each impact and control locations (BACI and IvC); and/or multiple replicates depending on Line of Evidence type

1 Reference sites required for each monitoring approach are detailed in Section 1.

2 It is recommended that sample replication is conducted for 10% of samples.

Key points on monitoring design:

- monitor, if possible, potential impact sites and control sites before any impact from a spill, then during and after the spill
- randomly or haphazardly select transect position for grabs, quadrats etc. within each site.

5.4.2 Monitoring Sites

Sampling sites will be defined once data and information from the sources outlined in Section 1.4 are reviewed. This review will help identify sensitive habitats, species, and protected areas.

Identify monitoring sites using these guidelines:

- likelihood of hydrocarbon impact on benthic habitats
- similarity and representation of habitats, physical features, and sediment type between impact and reference locations
- the degree of hydrocarbon exposure or potential exposure of the benthic habitats
- accessibility of habitat types.

When selecting monitoring sites, follow these guidelines:

- Select several impact and reference locations over a large spatial area.
- Select and prioritise impact sites within representative benthic habitats at greatest risk of impact within the environment that may be affected (EMBA), or those within areas of protection or conservation priority.
- When selecting reference sites, key physical factors (e.g. temperature, salinity, currents, aspect, habitat type, shore profile, substrate) should not differ significantly between sites.
- Reference sites may also include areas impacted by the spill and left to recover naturally.
- Determine location areas (typically 0.2–2 km^2) considering resolution needs. Replicate monitoring sites will be placed within benthic habitat locations.

- Dispersion of a large spill may be influenced by seasonal patterns; in this case, reference sites should be selected to allow for sufficient spatial separation from potential impact areas.

5.4.3 Monitoring Parameters

5.4.3.1 Physical Monitoring Parameters

Monitoring physical parameters complements biological monitoring where direct changes to the intertidal habitats are measured. Monitoring will be conducted at all biological monitoring sites, where practicable.

The physical character of the intertidal sites will be described by recording the parameters in Table 5-3.

Table 5-3: Physical Parameters and Methods

Parameter	Method
Surface and subsurface oil observations, mass of oil on intertidal	See AMSA [Ref. 17], Guidelines S.5, S.6, and S.9
Substrate type	See AMSA [Ref. 17], Guideline S.2
Form: geomorphological type, dimensions, profile, or gradient	See AMSA [Ref. 17], Guideline S.3
Energy: winds, waves	See AMSA [Ref. 17], Guideline S.1
Water quality	Refer to data collected from SCI1

5.4.3.2 Biological Monitoring Parameters

Cause-effect relationships based on existing literature will guide the selection of monitoring indicators that are likely to show a response in the target receptor for the intertidal habitat(s) surveyed. This risk-based approach initially focuses on response indicators that show early warning signs of effect (e.g. molluscs) in intertidal habitats. The proposed parameters, biological indicators, and monitoring methods are listed in Table 5-4.

Table 5-4: Proposed Biological Parameters and Survey Methods within Coastal and Intertidal Habitats

Habitat	Ecological Community	Taxa	Suggested Biological Survey Method	Community Parameters	Population Parameters	Individual Health and Condition Parameters
Rocky shoreline	Algae	Macroalgae	Stratified/haphazard sampling using quadrats/transects	• Percentage cover[1] • Diversity[1] • Distribution[1] • Dominant taxa[1]	• Density/distribution of sensitive taxa[1] • Above-ground biomass[1]	• Hydrocarbon cover • Leaf/blade/thallus condition[1] • Plant height[1] • Tainting[2]
	Epifauna	Molluscs[2], barnacles, chitons, crabs[2]	Stratified/haphazard sampling using quadrats/transects	• Density of organisms • Diversity • Distribution • Dominant taxa	• Density/distribution of sensitive taxa • Size structure1	• Hydrocarbon cover • Tainting[2]
Sandy beach	Infauna	Amphipods, polychaetes	Stratified/haphazard sampling using quadrats/transects	• Density of organisms[3] • Diversity[3] • Distribution[3] • Dominant taxa[3]	N/A	• Tainting[2]
Low (intertidal) tidal flats	Algae and plants	Macroalgae (e.g. *Sargassum*), seagrass	Stratified/haphazard sampling using quadrats/transects	• Percentage cover[1] • Diversity[1] • Distribution[1] • Dominant taxa[1] • Canopy height[1]	• Density/distribution of sensitive taxa[1] • Above-/below-ground biomass[1]	• Hydrocarbon cover • Thallus/leaf/blade condition[1] • Plant height[1] • Tainting[2]
	Epifauna	Hard corals, soft corals, filter feeders, molluscs[2], crabs[2]	Stratified/haphazard sampling using quadrats/transects	• Percentage cover/ density of organisms • Diversity • Dominant taxa	• Density/distribution of sensitive taxa • Size structure[1]	• Hydrocarbon cover • Health indicators (bleaching, disease) • Tainting[2]
	Algae and plants	Samphire shrubs[4]	Remote sensing	• Canopy cover[1] • Distribution and extent[1]	• Species density/ distribution[1]	N/A

Habitat	Ecological Community	Taxa	Suggested Biological Survey Method	Community Parameters	Population Parameters	Individual Health and Condition Parameters
High (intertidal) tidal flats		Samphire shrubs[4], microalgae[4]	Stratified/haphazard sampling using quadrats/transects	• Plant density[1] • Distribution[1]	• Species density/ distribution[1] • Increase in microalgal density[1]	• Plant height[1] • Hydrocarbon cover • Seedling height and density • Tainting (microalgae)[2]
	Epifauna	Molluscs[4], burrowing crabs[4]	Stratified/haphazard sampling using quadrats/transects	• Density of organisms • Diversity • Distribution • Dominant taxa	• Density/ distribution of sensitive taxa • Size structure[1]	• Hydrocarbon cover • Tainting[2]
Mangrove and depositional intertidals	Plants	Mangroves	Remote sensing	• Canopy cover[1] • Distribution and extent[1]	• Species density/ distribution1	N/A
			Stratified/haphazard sampling using quadrats/transects	• Density of trees[1] • Distribution[1]	• Species density/ distribution[1]	• Foliage density[1] • Health (withered yellowing leaves, dull colouring) • Canopy height • Girth • Dead vegetation • Pneumatophore density • Seedling height and density
	Epifauna	Molluscs[3], burrowing crabs[3]	Stratified/haphazard sampling using quadrats/transects	• Density of organisms • Diversity • Distribution • Dominant taxa	• Density/ distribution of sensitive taxa • Size structure[1]	• Hydrocarbon cover • Tainting[2]

1 *Some of these parameters can be expected to show large seasonal and interannual variability and this must be taken into account when designing the surveys (i.e. number of replicates required, frequency of surveys).*

2 *Can show strong variation in response to physical parameters such as height of tide, wind direction, position of the sun. Sampling times should be collected from similar heights on shore and similar tidal patterns.*

3 *Highly variable and adequate replication is required for sampling replicates and frequency. On sandy intertidal habitats, shows strong correlations with PSDs and depth. Some species show strong behavioural cycles such as response to temperatures and inactivity during moulting (e.g. crabs in mangroves).*

4 *Can show strong variation in response to physical parameters such as rainfall patterns and salinity.*

5.4.3.3 Chemical Monitoring Parameters

Chemical monitoring of water and sediment samples should be conducted at all biological monitoring sites, where practicable. Parameters to be tested and methods for water and sediments are described in detail in SCI1 and SCI2 respectively.

Tissue samples of benthic organisms may be examined for chemicals at both impact and control sites to determine the bioavailability and bioaccumulation of hydrocarbon contaminants. The requirement for tissue sampling will be determined based on the scale and magnitude of the impact. SCI7a – Fisheries and Aquaculture Impact Study details the parameters, methods, and sampling protocols to collect samples from molluscs and similar organisms. Selection of taxa depends on their relative abundance, and consequent ability to obtain suitable sample sizes over a range of sites and treatments (impacted, non-impacted). Potential indicator taxa to be tested for bioaccumulation of hydrocarbons include:

- bivalve molluscs (Ref. 24)
- gastropod molluscs (Ref. 25)
- macroalgae
- infauna, corals and filter feeders may provide suitable alternatives (Ref. 26).

5.4.4 Monitoring Frequency and Duration

Following the initiation of SCI3, surveys will be undertaken at least once a year, although are likely to be at a greater frequency (e.g. every three months) in the first year, based on the biological indicators being monitored (unless the termination criteria are triggered within this time). Survey data will be reviewed annually and the frequency of any ongoing monitoring will be determined by the data collected to date, the spatial, temporal, and seasonal variability of the biological indicators being measured, and may, for example, be seasonal, six-monthly, or annual until the termination criteria are reached.

5.4.5 Sample Integrity

5.4.5.1 Physical Monitoring Methods

Table 5-3 details the physical monitoring parameters and sampling methods to be used.

5.4.5.2 Remote Sensing Methods

Remote sensing can be used initially to determine potentially impacted habitats, habitats at risk, and reference areas (the outputs from OPS3, OPS4, OPS5, and MES scopes may also be suitable). Remote sensing may, if practicable, also be used to assess biological parameters for some habitat types within the study area to measure the condition of those habitats during scientific monitoring. For example, remote sensing is the quickest way to estimate the distribution and extent, and in some cases the condition, of upper intertidal habitats such as mangroves and samphire shrubs, and can also detect hydrocarbon spills.

A guideline for undertaking aerial surveillance of intertidal areas is provided in AMSA (Ref. 17), Guideline S.4. The remote sensing technique used (e.g. infrared thermal imaging, synthetic aperture radar, side-looking airborne radar, satellite images) will depend on the intended parameter to be collected (e.g. presence/absence, percentage cover), and evaluating the pixel size required (i.e. coarse, medium, fine) as well as cost. A guideline for implementing remote sensing monitoring equipment is provided in by the Remote Sensing Research Centre (Ref. 27).

However, to correctly calibrate remote sensing imagery, ground-truthing (i.e. validating the density of trees and distribution and extent of the habitat) of imagery and measurements will be required (as discussed in the subsections below). Remote sensing has been shown to be a successful tool for estimating canopy density and extent in mangrove and high tidal flat habitats (Ref. 28), and these parameters can be used to infer the condition of these habitats during scientific monitoring.

In Situ Monitoring Methods

Intertidal systems are highly complex and demonstrate natural spatial and temporal variation in physical and biological structure. The monitoring program must target the main ecological communities, biological indicators, and key species of intertidal habitats that are sensitive indicators, and which can act as proxies for assessing wider community health. Potential biological indicators, parameters, and methods are shown in Table 5-4.

Mangrove, Saltmarsh, and Epiflora

Ground surveys provide quantitative data on the health, density, and condition of mangrove and saltmarsh habitats, as well as data for calibrating remote sensing data, validating the density and distribution of trees, and determining the extent of the habitat. Systematic sampling of quadrats along transects for mangrove and saltmarsh environments will, as far as practicable, include measures of the parameters in Table 5-3.

Ground surveys will use 0.25 m^2 quadrats for measuring seedling density and height, and, depending on the density of trees, a minimum of 1 m^2 (often 5 m^2) quadrats for tree measurements. The quadrant sizes should be adjusted according to the density of the taxa being surveyed. Quadrats will, as far as practicable, be photo documented to allow for skilled interpretation at a later stage, and to allow precise, digitised estimates of the relevant parameter.

Transects/quadrats may also be used to determine the percentage cover, diversity, and distribution of macroalgae on low tidal flats and microalgae on high tidal flats. Any assessment of the potential impact of hydrocarbons on these organisms may be influenced by large natural variability in both populations and communities.

Monitoring of macroalgae and microalgae will be of limited value unless the intention is to demonstrate and confirm that hydrocarbons have been taken up into these organisms.

Epifauna

An initial guideline for monitoring the potential impact on invertebrate intertidal fauna is provided in AMSA (Ref. 17), Guideline S.10. The recommended methods for monitoring community structure and population density on rocky intertidal (and mangrove and mudflat) habitats for epifaunal macroinvertebrates are those described in MacFarlane and Burchett (Ref. 29). Surveys would typically lay multiple quadrats (0.25 m^2 quadrats are commonly used) along a transect line.

Transect locations may be stratified in different heights in the intertidal zone (i.e. high, mid, and low intertidal).

Information recorded by field scientists for each quadrat will vary with location and assessment goals; however, it may include:

- main species (macroinvertebrates and algae) present
- range of species richness (i.e. numbers of species)
- indicator species
- ranges of mean abundances in each subzone.

Quadrats should be photo documented to allow for further skilled interpretation at a later stage, and to allow precise, digitised estimates of percentage cover, density diversity, and abundance.

Infauna Sampling

Infauna is the assemblage of animals (often microscopic) that live buried or partially buried with the sediment matrix (e.g. worms, bivalves, crustaceans). A guideline for obtaining intertidal sediment samples is provided in AMSA (Ref. 17) Guideline S.8.A. The entire sample is sieved for benthic infaunal analyses, or, if chemical subsamples are required, care must be taken to ensure the subsamples are very small to avoid losing organisms. Once sieving is completed, the remaining organisms are washed, fixed using formalin or ethanol (consult the identifying laboratory), stored safely, and then sent to a laboratory. Because infaunal communities may be variable or patchy, it is standard practice to take replicate samples from any one site to provide an average of species richness and abundance, and a representative sample of the species present.

As infauna community structure is often strongly correlated with PSD, sediment samples should also be collected for PSD analysis.

If a decision is made to investigate infauna as part of SCI3, it will likely be based on assessments made during OPS5.

Dead Fauna

Any marine invertebrates, including bivalves, crabs, sea urchins, and starfish found washed up dead or moribund and discovered opportunistically during surveys should be recorded and, in some cases, collected. Dead fauna provide essential information for assessing impacts and wider ecological interest. Handling of large dead fauna and birds should be done in accordance with SCI4 – Seabirds and Shorebirds Impact Study. Numbers of individuals and species identification should be recorded, with photographs and at least some specimens taken for later analysis. Individual samples must be labelled with information that includes the location and date found.

5.4.5.3 Chemical Monitoring Methods

Chemical monitoring of water and sediment samples will be conducted at all biological monitoring sites, where practicable.

Water and Sediment Sampling

Water and sediment sampling are described in detail in SCI1 and SCI2 respectively. The general steps outlined in SCI1 and SCI2 will be followed for determining the overall sampling design and appropriate levels of replication.

Biota Tissue Sampling

Tissue samples of epibenthic organisms for chemical analysis and examination may be obtained through field sampling. Following collection, tissues samples should be extracted from shells, and holdfasts removed from algae. Material should be separated by taxa and approximately 50 g wet weight of flesh for each sample, transferred into sterile packs, then frozen until delivery to the analytical laboratory. SCI7a details the parameters, methods, and sampling protocols to collect biota specimens for analysis.

These protocols outline the sampling methodology used for SCI3:

- Sampling Surface Oil Slicks and Films (AMSA [Ref. 17] M.6)
- Sampling of Subsurface Water (AMSA [Ref. 17] M.7)
- Guideline for Handling Samples (AMSA [Ref. 17] G.1)
- sampling of invertebrate intertidal communities, based on MacFarlane and Burchett (Ref. 29)
- sampling of macro infauna intertidal communities, based on Junoy *et al*. (Ref. 30)
- Guidelines for Sediment Sampling (AMSA [Ref. 17] S.8)
- biomarker assessment of macroinvertebrate tissue, based on Brooks *et al*. (Ref. 31) for mussels
- Mangrove Tree Health Scoring System, as adapted from Eldridge *et al*. (Ref. 32).

See Section 5.13 for the SOPs associated with each of these sampling methods.

5.4.6 Sample Analysis

The data collected will be obtained in various ways:

- Samples: Water, sediment, or tissue samples that require preservation, transport, storage, and analysis. The procedures for sampling, storage, and analysis are provided in SCI1, SCI2, and SCI7.
- Field data: Including results from field sampling and observations.
- Photo documentation: Photographic and video evidence, ranging from aerial imagery to detailed still images.

Data should be recorded in a format for easy analysis and stored for comparison with data collected in later years. Data must be organised in a way that is easily accessible for future reference.

Many of the monitored parameters collected using quadrats will be measured and quantified from the still photos taken in the field. Percentage cover of common and conspicuous organisms (e.g. macroalgae, microalgae) will be quantified with the aid of image analysis software such as point-intercept software Coral Point Count with Excel extension (CPCe) (Ref. 33). For relatively small or discrete organisms (e.g. gastropods, bivalves) the density, diversity, and abundance of organisms will be recorded per quadrat or unit area.

5.5 Data Management

A guide for data management can be found in the AMSA Oil Spill Monitoring Handbook (see Appendix B; Ref. 17).

Monitoring activities may be undertaken over many months and are likely to result in data that may be obtained/generated from several sources in various formats:

- logs and forms
- photographs and video recordings
- annotated maps
- portable GPS/GIS units.

Managing the generated data requires extensive data storage, analysis, backup, and archiving. Samples should be treated as legal evidence and secured against loss or tampering. Copies of datasheets and analysis should be archived.

5.6 QA/QC Procedures

QA/QC procedures will be used to objectively remove any photographic images that are not suitable for analysis (e.g. images that are blurred, smudged, out of focus, under-/over-exposed, or otherwise of bad quality). For QA/QC of the point-intercept analysis, a random selection of images will be re-analysed by an experienced observer to double-check for inconsistencies or misclassifications.

Species lists of benthic infauna provided by taxonomy laboratories will be QA/QC checked using these methods:

- confirming current correct nomenclature and authorities using the World Register of Marine Species (WoRMS) Taxon Match Tool (http://www.marinespecies.org/aphia.php?p=match)
- rationalising data to remove pelagic taxa (e.g. ctenophores, chaetognaths) that are not part of the benthic community, so as to remove ‘ecological noise’ from the dataset
- excluding juvenile life stages from the data for analysis. Juvenile stages can provide a false assessment of level of impact and recovery because they can exhibit significant natural post-settlement mortality, which can mask or be attributed to anthropogenic impacts. Juveniles may be analysed separately to determine potential recruitment.

It is essential that appropriate procedures for metadata recording, data storage, and data backup are implemented to avoid loss of data and information, and prevent confusion or misinterpretation of valuable data collected during the course of the monitoring program.

5.7 Mobilisation Requirements

5.7.1 Survey Planning

This checklist outlines considerations as part of the survey planning phase.

Task	
◻	Determine the scale of the study area
◻	Select study area sites (including impact and reference sites if applicable)

Task	
☐	Select sampling approach and techniques
☐	Determine sampling replication required
☐	Consider data management requirements (e.g. data format, metadata, storage protocols, delivery schedule, and communication methods)
☐	Develop site-specific health and safety plan
☐	Develop survey/sampling plan incorporating the latest operational data
☐	GIS team to prepare survey maps from the latest data
☐	Check MSDSs and chemical handling procedures
☐	Undertake HAZIDs as required
☐	Develop site-specific health and safety plan, including JHAs

5.8 Logistics

These activities must be considered before mobilisation to the field.

Task	
☐	Arrange survey vehicles/platform (vessel, 4WD vehicle, aircraft), as required, to survey or access monitoring sites
☐	Plan site access points (i.e. tracks, carparks etc.)
☐	Book flights, accommodation, and car hire
☐	Confirm sample analysis requirements, and arrange provision of sample containers, CoC, eskies, and ice bricks. Confirm sample holding times
☐	Arrange freight of any sampling equipment and laboratory sample jars
☐	Develop field survey schedules, considering staff rotation
☐	Assemble scientific survey team
☐	Conduct pre-mobilisation meeting with the survey team, confirm scope, schedule, HES requirements

5.9 Equipment Preparation

These activities must be undertaken before mobilisation to the field, to ensure equipment is working(for an equipment list, see Section 5.12).

Task	
☐	Confirm specialist equipment requirements and availability (grab, corer, or ROV)
☐	Check GPS units and digital cameras are working and that sufficient spare batteries and memory cards are available
☐	Check field laptops, ensuring they have batteries, power cable, login credentials, and are functional
☐	Check if a first aid kit or specialist PPE is required
☐	Check if redundancy is required
☐	Book freight to mobilisation port

All equipment should be checked before transport and before deployment so that the equipment can be operated safely and efficiently.

5.10 Resources

Accurate identification of marine intertidal biological communities and species will require specialist taxonomists, and a team to sort and curate specimens. Specialist marine ecologists with knowledge of the region will determine indicator taxa, undertake peer review of reports, and conduct technical QA/QC of image analysis. The personnel required to undertake SCI3, their roles, and relevant qualifications are listed in Table 5-5.

Table 5-5: Field Roles and Responsibilities

Role	Responsibility	Recommended Qualifications
Field Lead/ Party Chief	• Manage survey plan • Capture survey positional data • Coordinate with aerial and ground survey teams • Manage fatigue and health and safety • Prepare daily field survey reports • Plan survey schedule	• Minimum degree in a relevant subject • Significant field experience
Marine Scientists / Field Technician (as required)	Scientific program delivery: • set up transects and quadrats • classify habitat • QA/QC still photos • manage data • collect sediment samples • sieve and preserve benthic infauna samples • conduct physical site observations • record survey and sampling data • backup digital data (including images) • maintain equipment and resolve technical issues	• Minimum degree in a relevant subject • Specialist coastal ecological knowledge of the region • As above if vessels are used

5.11 Equipment

It may be necessary to mobilise a vessel for transport or intertidal access depending on the remoteness of the study area and scale of the hydrocarbon spill.

The basic set of equipment required for SCI3 is listed below.

Items	
☐	Specialist equipment: • Multiparameter probe/conductivity temperature depth (CTD) probe • Thermometer • Benthic grab and sieve • Remote sensing platform
☐	Is redundancy required?
☐	Measuring equipment: • Transect tape measure • Tape measure for establishment of 5 × 5 m^2 quadrats • 1 m^2 quadrat • 0.5 m^2 quadrat

Items	
	• 0.25 m^2 quadrat • Metal ruler • Dressmakers tape • Tree-high pole
☐	Sediment sample collection: • Trowel • Plastic sediment corers • Shovel
☐	Beach profiling tools: • Dumpy level • Staff
☐	Paperwork: • Clipboards (large enough for A4 datasheets) • Datasheets (printed on waterproof paper) • Several pencils • Tide tables • Species identification sheet
☐	Cameras, including batteries and data cables
☐	Radios, 3G data, satellite phone/data for communication
☐	First aid equipment and PPE (e.g. reef boots, lycra leggings)
☐	Field laptops with relevant software (e.g. CPCe, photo editing, Collaborative and Annotation Tools for Analysis of Marine Imagery and Video [CATAMI; Ref. 60])
☐	Backup field data storage

5.12 Standard Operating Procedures (SOPs)

Sampling techniques will vary depending on the type and location of the hydrocarbon to be collected.

5.12.1 Stratified Haphazard Transects – Pre-mobilisation

Step	
☐	Generate a field map with the location and coordinates of all monitoring sites, including reference sites, to meet the monitoring objectives.
☐	Define monitoring parameters including habitat type, boundaries, number of sites, number of transects, length of transects, and number of quadrats per transect, to meet the monitoring objectives.
☐	Prepare and assemble all field equipment, including redundancies.
☐	Arrange access to vessel or other suitable monitoring platform.

5.12.2 Stratified Haphazard Transects – In Situ Monitoring

Step	
☐	Assess percentage cover of each habitat type at each site using photo quadrats, taken along transects.
☐	Randomly select the locations of transects at each site.

Step	
☐	Record and georeference the start location (latitude and longitude) of each transect, as well as the bearing and distance of each transect.
☐	Use a minimum of three replicate transects at each site.
☐	Randomly locate photo quadrats along each transect. Photo quadrats will cover an area of 1 m^2 (either 1 × 1 m^2 photo, or 4 × 0.25 m quadrats, depending on water conditions and available equipment).
☐	Plan for a minimum of five photo quadrats per transact. The length of each transect and the number of photo quadrats along each transect will depend on habitat characteristics and the survey objectives. Note: Standardise the length of transects and number of quadrats across sites.
☐	Take photos with a still camera, or as still images from video transect footage.
☐	Maintain a consistent method of capturing photographs among surveys, and where possible, across all survey sites (Note: Technology improvements may be incorporated into surveys). If practicable, use sufficient lighting to capture high-quality still plan (downward-facing) images (taken from a still camera or still images from video transect footage).
☐	If practicable, mark the quadrat boundary within each image as either a solid boundary (i.e. frame placed on the transect) or use underwater lasers to mark out a scale.
☐	Where possible, locate transects in similar depths within sites.
☐	After retrieval, QA/QC check and backup data on site.
☐	Analyse data using appropriate software to determine point-intercept estimates of multiple points to define benthic habitats.

5.12.3 Benthic Samples

Step	
☐	Use sediment grabs (e.g. Van Veen; refer to SCI2 for SOP) to collect five samples (minimum 250 mL jar) from each site.
☐	Check that samples are at least 10 cm deep, with a minimum surface area of at least 125 cm^2.
☐	From each sample, separate biological samples (plants, algae), place in jars that have been pre-cleaned with Teflon or aluminium cap / alfoil barrier.
☐	Complete and check jar labels and CoC forms. Store samples as directed by the laboratory.

5.13 Forms and Tools

Refer to Appendix C.

6 SCI4 – Seabirds and Shorebirds Impact Study

6.1 Aims and Objectives

The aim of the Scientific Monitoring Program SCI4 – Seabirds and Shorebirds Impact Study (SCI4) is to document and quantify shorebird and seabird presence and any resulting impacts and potential recovery from hydrocarbon exposure.

The objectives of SCI4 are to:

- identify and quantify, if time allows, the post-spill/pre-impact presence and status (e.g. foraging and/or nesting activity) of shorebirds and seabirds in the study area
- observe, and if possible quantify, actual exposure of shorebirds and seabirds to oil (i.e. post-impact) and to the response
- identify and quantify the post-impact status of shorebirds and seabirds (e.g. foraging and/or nesting activity) in the study area
- quantify recovery of shorebirds and seabirds from any harmful effects of hydrocarbons.

The scope of seabird and shorebird monitoring depends on the receptors identified within the EMBA of the hydrocarbon spill.

6.2 Initiation and Termination Criteria

The initiation and termination criteria for this scientific monitoring program are provided in Section 5 of the OSMP. Implementation times for this scientific monitoring program are directly linked to the initiation criteria and are found in the same section of the OSMP.

6.3 Data and Information Requirements

Table 6-1 lists the inputs relevant to planning for the implementation of SCI4, once the notification to commence is initiated.

Table 6-1: Data Requirements Summary for SCI1

Baseline Information	Operational Information
Any existing baseline data including population sizes and any known life-history parameters. Baseline data may be available from: • OSRA provided by AMSA • I-GEMS (WA only) • Species Profile and Threats (SPRAT) database (Ref. 34) • Bird Life Australia (birdlife.org and birdsinbackyards.net) • Birds Korea (birdskorea.org). Review methods undertaken during baseline studies to ensure that data collected during SCI3 can be directly compared to the existing baseline data.	Outputs from MES, OPS3, OPS 4, OPS5, OPS6, SCI1, and SCI2 activities, including: • identify and map sensitive resources and key receptors within the EMBA (OPS5 and OPS6) • knowledge of any proposed designs for other SCI activities • data streams from marine water quality monitoring (OPS3 and SCI1), including the location and concentrations of hydrocarbons in marine waters • data streams from sediment quality monitoring (OPS4 and SCI2), including the location and concentrations of hydrocarbons in sediments on nesting beaches.

6.4 Design

Flexibility is required when implementing the scientific monitoring program to allow for changes to the trajectory of the actual hydrocarbon spill, weather conditions, seasonal presence of shorebirds/seabirds, and/or the life stages present. To prioritise monitoring, this information will be necessary to establish which species may occur in the area, and to select appropriate survey methods and effort to be used:

- review maps that characterise activities of seabirds and shorebirds in the study area
- assess the regional habitat frequency and function:
  - are the habitats rare or common?
  - are the habitats likely to be critical to the species' persistence?
  - how likely is the species to use the site? (breeding, overwintering etc.). Adjust the survey design to determine these aspects, if necessary.
- identify ecologically significant birds known to occur in the study area and determine the likelihood of occurrence, habitat requirements, and timing.

Existing information on the study area and surrounding region and the best-available information on species composition and population sizes developed from OPS6, together with available ongoing seabird and shorebird studies, should be used to develop the sampling design of the seabird and shorebird monitoring program

6.4.1 Monitoring Design

The monitoring approach needs to consider the data collected during MES and OPS3, OPS4, OPS5, and OPS6 activities. The geographic extent of the area to be monitored will be based on the hydrocarbon distribution, as determined through the MES outcomes, and hydrocarbon contact, as determined through OPS5 and OPS6. These outputs will identify potential impact areas to be sampled, which will allow comparison of results to baseline values. Table 6-2 summarises the monitoring designs recommended for various outcomes. Section 2.1 describes these approaches in detail.

Table 6-2: Monitoring Design Approaches Recommended for Different Spill Outcomes

MES and *OPS3* Outcomes Indicate Spill Extent	Monitoring Design[1]	Replicate Sites Required[2]
Offshore hydrocarbon plume (pelagic surveys)	Gradient Approach	Will be determined when the program is finalised
Hydrocarbon spill reaches shoreline with known roosting habitat	BACI or IvC or Control Chart Approach, and/or Lines of Evidence Approach	Will be determined when the program is finalised
Hydrocarbon spill interacts with areas of biological importance, foraging areas	BACI or IvC or Control Chart Approach, and/or Lines of Evidence Approach	Will be determined when the program is finalised

1 Reference sites required for each monitoring approach are detailed in Section 1.

The scientific monitoring program may include shoreline and pelagic assessments. The program must allow for more detailed bird counts and inclusion of other parameters (e.g. nests or roosting sites) as compared to the program conducted under OPS6. The scientific monitoring program also requires repeating targeted searches of selected colonies and/or foraging grounds at frequent intervals. The procedure for moving from single measures of the diversity and abundance of populations to a monitoring program is described below:

- Select colonies, foraging grounds, and species for routine monitoring: Colonies and/or foraging grounds must support a variety of species and be reasonably accessible, allowing both aerial survey/photography and ground counts, and must include colonies and/or foraging grounds in vulnerable areas as well as reference colonies and/or foraging grounds not considered to be at risk from the hydrocarbon spill; species selected should be representative of the taxonomic and ecological variety of the region.
- Within selected colonies and/or foraging grounds, identify particular resources or habitat strata and representative study plots where birds will be counted in detail to assess changes in status. Permanently mark these plots in the field and on good-quality photographs, for future reference.

6.4.1.1 Shorebirds

Shorebird assessments will focus on monitoring species at important foraging sites. Specific shorebird monitoring techniques recommended by the former Commonwealth Department of Environment Water, Heritage, and the Arts [Ref. 35]) are outlined in Table 6-3.

Table 6-3: Recommended Survey Methods for Shorebirds

Environment	Recommended Techniques
On land	• Area searches of suitable habitat in and around the study area for nesting colonies and roosting sites. Searches for signs indicative of recent nesting activity (e.g. nests, egg shells, dead young). Spotlight searches may be suitable for some nocturnally active species • Observation from vantage points for birds arriving at or leaving nesting colonies • Aerial searches over suitable nesting and roosting habitat

Source: Ref. 35

6.4.1.2 Seabirds

Seabird assessments will focus on monitoring species at important breeding colonies. Table 6-4 outlines the proposed techniques for monitoring the diversity and abundance of seabird populations.

Table 6-4: Recommended Survey Methods for Seabirds

Environment	Recommended Techniques
At sea	• Shipboard transect surveys, observing in all directions from the ship • Aerial transect surveys for detecting in expansive areas • Observation from onshore vantage points using a telescope, particularly during strong onshore winds
On land	• Area searches of suitable habitat in and around the study area for nesting colonies and roosting sites. Searches for signs indicative of recent nesting activity (e.g. nests, egg shells, dead young). Spotlight searches may be suitable for some nocturnally active species • Observation from vantage points for birds arriving at or leaving nesting colonies • Aerial searches over suitable nesting and roosting habitat

Source: Ref. 35

6.4.2 Monitoring Sites

The scale of monitoring depends upon the size, location, and time of year of a spill. Sampling, and therefore monitoring sites, needs to be balanced against the logistical constraints of sample collection in remote locations, and the ability to provide meaningful information within a relevant time frame. Data from operational monitoring will be used to understand the spill trajectory and the potential exposure of nesting beaches to spilt hydrocarbons. This data will help identify monitoring locations, including impact sites (all colonies/nesting sites that may have been exposed to hydrocarbons) and reference sites.

The selection of monitoring sites will be based on these criteria:

- the type of hydrocarbon spilt, weathering characteristics, and extent of the spill
- for shorebirds, the number of important foraging areas affected by the spill
- for seabirds, the number of colonies affected by the spill.

Colonies and nesting sites for ground-based surveys should be accessible by a tender from a vessel or from land. Sites that are inaccessible by land or boat may not be monitored.

6.4.3 Monitoring Parameters

Shorebird and seabird scientific monitoring programs will focus on a subset of shorebird and seabird species—indicator species—considered to be ecologically significant to the study area. These indicator species have a high number of interactions with the region (nesting and/or foraging) or have life-history characteristics that make them particularly susceptible at a population level to impacts from a hydrocarbon release (Ref. 36). Routine data on all other shorebird and seabird species that are encountered should also be gathered.

Table 6-5 summarises the monitoring methods and associated parameters that will be used to assess the impact and recovery of seabird and shorebird populations in the event of a hydrocarbon spill.

Table 6-5: Monitoring Metrics for Seabird and Shorebird Populations

Environmental Focus	Methodology	Condition Metric
Seabird and shorebird abundance	• Aerial shoreline surveys • Vessel shoreline surveys • Ground shoreline surveys • Aerial pelagic surveys • Vessel pelagic surveys	• Species diversity • Abundance of indicator species based on numbers of adults • Abundance of non-breeding birds • Abundance of breeding pairs • Species distribution • Total counts of occupied sites or nests (including stages of the breeding cycle and attendance patterns of adults) • Qualitative abundance estimates (breeding presence) • Injury/mortality

6.4.4 Monitoring Frequency and Duration

Following the initiation of SCI4, surveys will be undertaken at least once a year, although are likely to be at a greater frequency (e.g. every three months) in the first year, based on the biological indicators being monitored (unless the termination criteria are triggered within this time). Survey data will be reviewed annually and the frequency of any ongoing monitoring will be determined by the data collected to date, the spatial, temporal, and seasonal variability of the biological indicators being measured, and may, for example, be seasonal, six-monthly, or annual until the termination criteria are reached

For robust estimates of shorebird populations, counts should be conducted at least once (preferably twice) during summer and winter and possibly repeated based on the initial results, so that natural variation can be accounted for and used to predict potential future trends. However, shorebird populations are known to vary between years and even within seasons when environmental conditions change. Estimates of seabird populations are best measured at a time of the year when their presence is most stable; e.g. breeding season.

For robust estimates of the breeding seabird population it is recommended to conduct the assessment towards the end of the incubation period. Any ongoing monitoring should to be undertaken at the same time of year (within the bounds of finding the most appropriate tidal series). Appropriate tide heights will be identified by CAPL when the study commences (e.g. the second high tide series in November may be considered appropriate based on other shorebird monitoring conducted in the north-west of Australia). Spring tides are favoured for shorebird surveys—birds are concentrated appropriately during high water, making the identification of important roost sites possible, and making the birds relatively easy to count.

6.4.5 Sample Integrity

Transect estimations for each observer will be calibrated before aerial and vessel surveys (see SOPs in Section 6.13).

6.4.6 Sample Analysis

These analyses will be used as part of this assessment:

- Observe and quantify actual hydrocarbon exposure of birds: Detail and compare records of oiled and dead birds during the spill and for a required duration after the spill.
- Identify and quantify the post-impact presence and activity/status of birds (e.g. foraging and/or nesting activity in the study area): Measure changes of selected bird populations at impact sites before and after impacts, compared to population changes recorded at reference sites.
- Quantify recovery: Monitor populations at impact and reference sites over time until they display similar dynamics.

6.5 Data Management

A guide for data management can be found in the AMSA Oil Spill Monitoring Handbook (see Appendix B; Ref. 17).

Monitoring activities may be undertaken over many months and are likely to result in data that may be obtained/generated from several sources in various formats:

- logs and forms
- photographs and video recordings

- annotated maps
- portable GPS/GIS units.

Managing the generated data requires extensive data storage, analysis, backup, and archiving. Samples should be treated as legal evidence and secured against loss or tampering. Copies of datasheets and analysis should be archived.

6.6 QA/QC Procedures

These field data procedures and protocols will be implemented:

- All personnel will have training, where relevant, on species identification and procedures for shorebird and seabird surveys.
- All images will be checked to confirm that they are not blurry, etc.
- Each day, the Field Lead will review video and datasheet recordings and the database/spreadsheet to confirm accuracy and consistency in recording of data.

6.7 Mobilisation Requirements

6.7.1 Survey Planning

This checklist outlines considerations as part of the survey planning phase.

Task	
☐	Determine the scale of the study area
☐	Select study area sites (including impact and reference sites if applicable)
☐	Select sampling approach and techniques
☐	Determine sampling replication required
☐	Consider data management requirements (e.g. data format, metadata, storage protocols, delivery schedule, and communication methods)
☐	Develop site-specific health and safety plan
☐	Develop survey/sampling plan incorporating the latest operational data
☐	GIS team to prepare survey maps from the latest data
☐	Check MSDSs and chemical handling procedures
☐	Undertake HAZIDs as required
☐	Develop site-specific health and safety plan, including JHAs

6.8 Logistics

These activities must be considered before mobilisation to the field.

Task	
☐	Arrange survey vehicles/platform (vessel, 4WD vehicle, aircraft), as required to survey or access monitoring sites
☐	Plan site access points (i.e. tracks, carparks etc.)
☐	Book flights, accommodation, and car hire

	Task
☐	Confirm sample analysis requirements and arrange provision of sample containers, CoC, eskies, and ice bricks. Confirm sample holding times
☐	Arrange freight of any sampling equipment and laboratory sample jars
☐	Develop field survey schedules, considering staff rotation
☐	Assemble the scientific survey team
☐	Conduct pre-mobilisation meeting with the survey team, confirm scope, schedule, HES requirements

6.9 Equipment Preparation

These activities must be undertaken before mobilisation to the field, to ensure equipment is working (for an equipment list, see Section 5.12).

	Task
☐	Confirm specialist equipment requirements and availability (grab, corer or ROV)
☐	Check GPS units and digital cameras are working and that sufficient spare batteries and memory cards are available
☐	Check field laptops, ensuring they have batteries, power cable, login credentials, and are functional
☐	Check if a first aid kit or specialist PPE is required
☐	Book freight to mobilisation port

All equipment should be checked before transport and before deployment so that the equipment can be operated safely and efficiently.

6.10 Resources

The personnel required to undertake SCI4, their roles, and relevant qualifications are listed in Table 6-6.

Table 6-6: Field Roles and Responsibilities

Role	Responsibility	Qualifications
Seabird/ Shorebird Field Lead	• Conduct shoreline and pelagic observations • Identify species • Prepare daily field reports	• Shorebird and seabird identification skills relevant to the species in the study area • Familiarity with shorebird and seabird behaviour • Familiarity with shorebird and seabird habitats
Field Assistant	• Record survey observations and GPS positions during observations on datasheets	• Familiarity with shorebird and seabird behaviour • Familiarity with shorebird and seabird habitats
Oiled Wildlife Responders	• Handle oiled wildlife	• Oiled wildlife response • Fauna handling • Fauna euthanasia

6.11 Equipment

The basic set of equipment required for SCI4 is listed below.

Item	
☐	Knowledge of the area, access points, potential feeding and roosting sites – primarily derived from local topographic maps, published information, local relevant government departments, local councils, regional bird watching groups, local knowledge, exploration
☐	Field guides to help identify shorebirds and seabirds
☐	Note pad and pen (or alternative recording means e.g. laptop)
☐	GPS and spare batteries
☐	Survey plan
☐	Field datasheets
☐	Required permits, where applicable
☐	Binoculars, ideally 8 × 30 to 10 × 50 in size (smaller or larger binoculars are inappropriate for bird watching)
☐	Spotting scope (small tripod-mounted telescope), ideally with x20 to x60 magnification
☐	Log book/observation sheets
☐	Camera, storage media, and batteries (with spares)
☐	Laptops, battery chargers
☐	Hard drives
☐	Phones, satellite or radio communications
☐	Measurement tools
☐	Gloves
☐	Refrigerator or eskies with ice
☐	Sample bags
☐	Aircraft for reconnaissance
☐	Vessel/vehicle (depending on location)

6.12 Standard Operating Procedures (SOPs)

6.12.1 Shoreline Surveys

Shoreline assessments are effective for detecting the presence and abundance of many breeding shorebird and seabird species. Shoreline assessments will be conducted using one or more of these methods:

- aerial surveys, including drone surveys (can rapidly cover large areas of land and/or water and can provide information on nesting sites for follow-up ground surveys)
- vessel surveys
- ground surveys (used to count birds, pairs, or nests).

6.12.2 Pelagic Surveys

Both vessel and aerial surveys may be used to detect and count pelagic seabirds offshore. Vessel surveys allow more time to identify the taxa and record other details such as age, sex, and behaviour, thus improving the chances of recording rare, inconspicuous, and diving taxa.

The SOPs for these survey techniques are detailed below.

<table>
<tr><th colspan="2">Vessel Survey SOP</th></tr>
<tr><th colspan="2">Pre-survey</th></tr>
<tr><td>☐</td><td>Calibrate distance estimation for each observer</td></tr>
<tr><td>☐</td><td>Establish transects or shoreline plots to be surveyed</td></tr>
<tr><td>☐</td><td>Record GPS location of all sampling unties and provide maps of study area</td></tr>
<tr><td>☐</td><td>Establish strip width for transects (e.g. 50 m each side of the vessel and 100 m ahead).
NOTE: For pelagic surveys, the entire area around the vessel will be scanned out to a maximum distance that still permits accurate identification</td></tr>
<tr><th colspan="2">During Survey</th></tr>
<tr><td>☐</td><td>Vessel speed: 10 knots (range 5–15 knots)</td></tr>
<tr><td>☐</td><td>Continuously record latitude and longitude (e.g. 30-second intervals) using a handheld data logger</td></tr>
<tr><td>☐</td><td>Two observers record from each side of the vessel</td></tr>
<tr><td>☐</td><td>Bird observations, where practicable:
• Record observations of each individual bird or group of birds in real time to a dedicated handheld data logger
• Conduct complete counts of dense flocks*
• Count all birds observed and record their identity to the lowest taxonomic group possible, preferably species
• Behaviour
• Impacts from hydrocarbons (oiling, injury, and mortality)</td></tr>
<tr><td>☐</td><td>Count actual numbers (direct counting) or estimate if numbers are large. If estimating:
• estimate total number of birds first; then
• estimate the proportion of species within the total number of birds estimate</td></tr>
<tr><td>☐</td><td>Take photographs to help identify and count species</td></tr>
<tr><td>☐</td><td>General observations:
• describe the habitat in detail (including condition of the habitat at the time of the survey)
• predator presence / evidence of predation.</td></tr>
<tr><td>☐</td><td>Record other variables including, as far as practicable:
• location
• vessel speed and direction
• weather conditions, including:
  – temperature
  – precipitation
  – wind strength and direction
  – visibility.</td></tr>
<tr><td>☐</td><td>Confine observations to daylight hours, and suspend observations in heavy rain, heavy winds, fog, or rough seas</td></tr>
<tr><td>☐</td><td>Record the presence of other vessels in the survey area, as they may affect the behaviour of the birds</td></tr>
<tr><td>☐</td><td>Count individuals following the vessel only once</td></tr>
</table>

* *Where practicable, compare direct counting and the assessment methods with those from other observers.*

** *Census techniques may vary according to the nesting behaviour of the species.*

Aerial Survey SOP (equivalent methods may be used for drone techniques)	
Pre-survey	
☐	Calibrate transect estimation for each observer
☐	Establish transects or shoreline plots to be surveyed
☐	Record GPS location of all sampling unties and provide maps of study area
☐	Establish strip width for transects (e.g. 200 m each side of the aircraft)
During Survey	
☐	Aircraft speed [1]: 185 km/h^{-1} or as slow as safely possible; to be determined by the pilot Altitude: below 100 m. Select aircraft speed and altitude to maximise ease of bird detection and identification and minimise the risk of collision with ground structures or airborne birds (Ref. 37) (~600 to 1000 transects can be flown in a six-hour period)
☐	Continuously record latitude and longitude (e.g. 30-second intervals) using handheld data logger
☐	Two observers record from each side of the aircraft
☐	Bird observations, where practicable: • Record observations of each individual bird or group of birds in real time to a dedicated handheld data logger • Conduct complete counts of dense flocks* • Count all birds observed and record their identity to the lowest taxonomic group possible, preferably species • Behaviour • Impacts from hydrocarbons (oiling, injury, and mortality)
☐	Count actual numbers (direct counting) or estimate if numbers are large. If estimating: • estimate total number of birds first; then • estimate the proportion of species within the total number of birds estimate
☐	Take photographs to help identify and count species
☐	General observations: • describe the habitat in detail (including condition of the habitat at the time of the survey) • predator presence / evidence of predation.

☐	Record other variables including, as far as practicable:
	• location
	• aircraft speed and direction
	• weather conditions, including:
	  – temperature
	  – precipitation
	  – wind strength and direction
	  – visibility.

☐	Confine observations to daylight hours, and suspend observations in heavy rain, heavy winds, fog, or rough seas

[1] Can use a helicopter, fixed-wing aircraft, or drone (with replacement of equivalent methods)

Aerial Survey SOP (equivalent methods may be used for drone techniques)	
☐	Record the presence of vessels or other aircraft in the survey area, as they may affect the behaviour of the birds

* *Where practicable, compare direct counting and the assessment methods with those from other observers.*

Ground Survey SOP	
Pre-survey	
☐	Determine colonies and/or transects/shoreline plots to be surveyed
☐	Sampling units should be positioned far enough apart that individual birds are unlikely to be detected from more than one sampling location, ensuring the samples are independent
☐	The number of sampling units within the study area (or strata) should be proportional to its size, a principle referred to as 'area-proportionate sampling'
☐	Record GPS location of all sampling unties and provide maps of study area
☐	Establish points or census method for colonies and/or strip width for transects
During Survey	
☐	Breeding sites: • describe the colony in as much detail as possible to allow precise relocation in future surveys • develop a map that describes the relevant features and limits of the environment • take photographic records that include location, direction of photograph, date, time, camera, and shooting distance.
☐	Obtain GPS positioning for: • extent of the colony • survey points within the colony • start and end points for transects.
☐	Bird observations, where practicable: • Record observations of each individual bird or group of birds in real time to a dedicated handheld data logger • Conduct complete counts of dense flocks* • Count all birds observed and record their identity to the lowest taxonomic group possible, preferably species • Behaviour (including nesting activity) • Impacts from hydrocarbons (oiling, injury, and mortality)
☐	Initially assess live oiled and dead seabirds and shorebirds collected by oiled wildlife response personnel, collecting information, as far as practicable, on: • date and location of finding • identification to species level • details of rings or other markers (e.g. satellite transmitters) • oiling status of the bird (% oiled) • external ageing and sexing • external biometrics (to determine age and breeding population of origin) including: – bill length – bill shape – body mass – wing length – tarsus length • internal examination to determine sex and age

Ground Survey SOP	
☐	Store dead seabirds and shorebirds in appropriate facilities (on ice in eskies and then preferably freezing facilities).
☐	Take photographs to help identify and count species
☐	Record other variables including, as far as practicable: • location • weather conditions, including: – temperature – precipitation – wind strength and direction – visibility.
☐	Confine observations to daylight hours, and suspend observations in heavy rain, heavy winds, fog, or rough seas
☐	Census techniques** for breeding sites: • count breeding pairs • count occupied sites or nests (including stages of the breeding cycle and attendance patterns of adults) • count non-breeding birds

* *Where practicable, compare direct counting and the assessment methods with those from other observers.*

** *Census techniques may vary according to the nesting behaviour of the species.*

6.13 Forms and Tools

Refer to Appendix C.

7 SCI5a – Marine Megafauna Impact Study: Marine Reptiles

7.1 Aims and Objectives

The aims of this Scientific Monitoring Program SCI5a – Marine Megafauna Impact Study: Marine Reptiles (SCI5a) are to identify and quantify the status and recovery of marine reptiles, including marine turtles and sea snakes, related to a hydrocarbon spill

The objectives of SCI5a are to:

- determine abundance (including life stage) of marine reptiles present in the EMBA
- where possible, identify mortality of marine turtles and sea snakes directly related to the oil spill or other secondary spill-related impacts (including vessel strike and/or use of dispersants)
- assess the impact of the oil spill on nesting turtles, nests, and hatchlings
- understand changes in nesting beach usage by marine turtles following the hydrocarbon spill.

The monitoring program will focus primarily on marine turtles. The highly dispersed distribution and ecology of sea snakes restricts the opportunity to monitor this group, although sea snakes will still be studied in a limited capacity.

7.2 Initiation and Termination Criteria

The initiation and termination criteria for this scientific monitoring program are provided in Section 5 of the OSMP. Implementation times for this scientific monitoring program are directly linked to the initiation criteria and are found in the same section of the OSMP.

7.3 Data and Information Requirements

Table 7-1 lists the inputs relevant to planning for the implementation of SCI5a, once the notification to commence is initiated.

Table 7-1: Data Requirements Summary for SCI5a

Baseline Information	Operational Information
• Existing baseline data (as documented in Chevron internal databases) for marine turtle nesting beaches, which were identified as being at risk from exposure of hydrocarbons, and marine turtle nesting beaches outside the predicted EMBA. Additional baseline data may be available from the following: – OSRA provided by AMSA – I-GEMS (WA only) • Review methods undertaken during baseline studies to ensure that data collected during SCI5a can be directly compared to the existing baseline data	Outputs from MES, OPS3, OPS 4, OPS5, OPS7, SCI1, and SCI2 activities including: • identify and map sensitive resources and key receptors within the EMBA (OPS5 and OPS7) • data streams from marine water quality monitoring (OPS3 and SCI1), including the location and concentrations of hydrocarbons in marine waters • data streams from sediment quality monitoring (OPS4 and SCI2), including the location and concentrations of hydrocarbons in sediments on nesting beaches

7.4 Design

7.4.1 Monitoring Design

Scientific monitoring for marine reptiles will be achieved by observing populations in potentially affected areas, and tissue sampling and analysis to examine direct contamination of turtles and sea snakes. The focus is on marine turtles because of the challenges of estimating sea snake population status. Monitoring of marine turtles will include, where applicable:

- assessing population size of the affected and unaffected marine turtle species (including both nesting and in-water populations)
- assessing exposure of marine turtles to hydrocarbon (e.g. oiled wildlife)
- assessing nesting site condition e.g. hydrocarbon contamination levels.

Note: There are limitations to this study. Scientific studies on marine reptiles are only likely to produce impact assessment outcomes if there is a known resident population, or reasonable confidence in the population numbers and use of an area. Often, insufficient data exists to compare the behaviour and condition of animals after a spill.

The monitoring approach needs to consider the data collected during MES and OPS3, OPS4, OPS5, and OPS7 activities. The geographic extent of the area to be monitored will be based on the hydrocarbon distribution, as determined through the MES outcomes, and hydrocarbon contact, as determined through OPS5 and OPS7. These outputs will identify potential impact areas to be sampled, which will allow comparison of results to baseline values. Table 7-2 summarises the monitoring designs recommended for various outcomes. Section 2.1 describes these approaches in detail.

Table 7-2: Monitoring Design Approaches Recommended for Different Spill Outcomes

MES and *OPS3* Outcomes Indicate Spill Extent	Monitoring Design[1]	Replicate Sites Required[2]
Offshore hydrocarbon plume (in-water surveys only)	Gradient Approach	Will be determined as part of Program finalisation
Hydrocarbon spill reaches shoreline with known nesting beaches	BACI or IvC or Control Chart Approach and/or Lines of Evidence Approach	Will be determined as part of Program finalisation
Hydrocarbon spill interacts with areas of biological importance, and/or internesting areas	BACI or IvC or Control Chart Approach and/or Lines of Evidence Approach	Will be determined as part of Program finalisation

1 Reference sites required for the monitoring approaches are detailed in Section 1.
2 Design implemented depends on available baseline data.

Key points on monitoring design:

- monitor, if possible, potential impact sites and control sites before any impact from the spill, then during and after the spill.

7.4.2 Monitoring Sites

The scale of monitoring depends on the size, location, and time of year of a spill. Sampling, and therefore the location of monitoring sites, needs to be balanced against the logistical constraints of sample collection in remote locations, and the ability to provide meaningful information within a relevant time frame. Data from

MES, OPS3, OPS4, OPS5, and OPS7 will be used to understand the spill trajectory and the potential exposure of nesting beaches to spilt hydrocarbons. This data will help identify impact beaches (known turtle nesting beaches where shoreline contact has been identified) and impact in-water survey locations, as well reference beaches and in-water reference locations.

7.4.2.1 Population Abundance/Status of Marine Turtles

7.4.2.2 Marine Turtle Nesting Populations

Beaches with nesting activity in the EMBA will be divided into primary beaches (those with high nesting density) and secondary beaches (restricted sandy nesting habitat [e.g. small physical size] or low to moderate nesting activity).

7.4.3 Monitoring Parameters

7.4.3.1 Physical Monitoring Parameters

Sampling to assess the status of the population of marine reptiles in the EMBA will address the selection and spatial/temporal variation of measured parameters (Table 7-3).

Table 7-3: Selection of Parameters for Assessment

Environmental Focus	Condition Metric	Methods	Parameter
Population abundance/status of marine reptiles	Annual marine turtle nesting abundance	Census and snapshot track counts (aerial or field surveys)	• number (#) of tracks • species identification
	Marine turtle nesting distribution on beaches	Census and snapshot track counts (aerial or field surveys)	• # and spatial distribution of tracks • species identification
	In-water abundance (sea snakes and marine turtles) and distribution	Aerial or vessel surveys	• # of individuals • species identification
Marine reptile exposure/mortality/ health	Chemical contamination	Necropsy/tissue sampling	• TRH levels • PAH levels • condition of individual turtles e.g. oiling, sores • # of oiled individuals (dead and alive) • # of dead marine reptiles
	Marine turtle reproductive success	Excavation of hatched nests to characterise clutch sizes, hatching success, emergence success, and record any deformities	• clutch size • hatching success • emergence success • records of hatchling conditions

Environmental Focus	Condition Metric	Methods	Parameter
Beach condition	Hydrocarbons in sediments	Results from SCI2	• TRH levels • PAH levels • USEPA priority pollutants • saturated hydrocarbons (C10 to C36) • BTEX • organochlorides • trace metals (mercury and arsenic)

Before finalising the survey plan, an assessment will be done to determine the likelihood of marine reptile presence/absence, species, and life cycle stage (e.g. nesting, mating) at the time of the hydrocarbon spill, based on the predicted EMBA and time of year.

7.4.3.2 Indicator Species

Indicator species may be selected for monitoring; selection will consider:

- currently available information/data on abundance/distribution/migration patterns within the region
- ability to observe/detect and correctly identify the species
- likelihood of exposure to hydrocarbons.

Additionally, prioritisation of indicator marine turtle species for monitoring should follow this order, as far as practicable:

1. breeding/nesting females
2. mating males
3. incubating nests
4. hatchlings
5. foraging residents.

7.4.4 Monitoring Frequency and Duration

Following the initiation of SCI5a, surveys will be undertaken at least once in the first year, although are likely to be at a greater frequency (e.g. every three months) in the first year, based on the biological indicators being monitored (unless the termination criteria are triggered within this time). Survey data will be reviewed annually; and the frequency of any ongoing monitoring will be determined by the data collected to date, the spatial, temporal, and seasonal variability of the biological indicators being measured, and may, for example, be seasonal, six-monthly, or annual until the termination criteria are reached.

7.4.4.1 Population Abundance/Status of Marine Reptiles

In respect to marine turtle nesting populations, monitoring will be timed to occur during the first peak nesting period (if known and feasible for mobilisation) after the hydrocarbon release. If the peak nesting period for a particular beach is not known, monitoring will be undertaken during the nesting periods for the relevant species, based on literature for the area. However, the frequency of the monitoring plan may be determined by the extent of the spill and the spatial, temporal, and seasonal variability of the biological indicators. Ideally, the survey will occur early in the morning when the light is low and before the first high tide.

If the hydrocarbon release occurs during the nesting season, the priority will be to mobilise teams to capture pre-hydrocarbon contact data for key marine turtle nesting beaches. For impacted areas, intra-season variation will be assessed via repeated sampling within a season. Conversely, inter-season variation identifies the duration of impact over time at the impact site(s) when compared to the selected regional pre-spill baseline and/or reference site(s). Primary beaches will be assessed over five consecutive days and surveys will be conducted weekly during the spill event, then every two weeks during clean-up. Secondary beaches will be assessed twice a week during the spill event then weekly during clean-up.

7.4.4.2 Marine Reptile Exposure, Health, and Mortality

Reproductive success surveys will occur concurrently with the surveys for population abundance and status (see Section 7.5.4.1). Tissue samples will be collected opportunistically.

7.4.5 Sample Integrity

Any uncertainties concerning species identification, nesting success, etc., will be mitigated in the field by communicating with the Field Lead/marine turtle expert.

7.4.5.1 Tissue Sampling

To maintain sample integrity, transport and storage requirements for tissue sampling must be adhered to. If there may be a delay in freezing these samples, they can be stored for a limited time in an esky with ice blocks until they can be frozen. All sample storage containers will contain a small temperature logger, which will remain with the samples until delivery to the final storage location or laboratory.

DNA samples can be stored in plain table salt for transport or a salt-buffered dimethyl sulfoxide (DMSO) solution. Stable isotope samples can be stored in plastic bags in a refrigerator or cooler.

Table 7-4 summarises the storage and transport needs for tissue samples.

Table 7-4: Tissue Sample Storage and Transport Requirements

	Sample	Preservation Method	Storage Requirements	Transport Requirements
Genetics	Skin or liver (if available)	70 to 100% ethanol, in internally labelled vials	Frozen	Frozen
Stable isotopes	Scute (1 to 2 cm^3)	70% ethanol	Frozen	Frozen
Toxicology	Tissue, swab, and stomach/intestine samples	• Samples stored in sterile aluminium foil and then bagged • Heavy metal testing samples stored in plastic or glass	Frozen (-20 °C)	Frozen (-20 °C)

7.4.6 Sample Analysis

Once data for biological and habitat parameters are collected, they can be conveyed to decision makers using control charts, if sufficient information from historic populations is known. These decision-aiding tools allow managers to visualise whether a management action (e.g. spill response) is having a predicted effect on the recovery of a parameter, and whether natural variation is driving the changes observed. Control charts may help managers diagnose when a parameter of interest (e.g. turtle track counts) shows deviation beyond those naturally expected by plotting through time some measure of a stochastic process with reference to its expected (baseline) value, where data are available.

7.4.6.1 Population Abundance

In-water Populations

These resources will be used for in-water population estimates:

- Introduction to Distance Sampling: Estimating Abundance of Biological Populations (Ref. 38)
- Florida's Wildlife Contingency Plan for Oil Spill Response – June 2012 Sea Turtle Guidelines for Oil Spill Response (Ref. 39)
- The Centre for Research into Ecological and Environmental Modelling at University of St Andrews, Scotland, has developed a statistical tool for analysing distance data. The program—DISTANCE 6.0—can be downloaded free of charge (http://www.ruwpa.st-and.ac.uk/distance/). An indication of the statistical power to detect change in monitoring criteria will be assessed following analysis of the baseline/reference data by the subject matter expert (SME) statistician/modeller

Nesting Populations

Track counts will be used as the abundance metric for the nesting female population.

7.4.6.2 Marine Reptile Exposure, Health, Mortality

Reproductive Success

Hatching and emergence success will be calculated for each nest. Formulas used to determine clutch size, hatching, and emergence successes (Ref. 40) are:

1. Clutch size = #S+ #UD + #UH + #UHT + #LE + #P
2. Hatching success = #S × 100/clutch size
3. Emergence success = #S-(#L+#D) × 100/clutch size

= numbers of:

S = shells

L = live hatchlings in nest

D = dead hatchlings in nest

UD = undeveloped eggs

UH = unhatched eggs

UHT = unhatched eggs with full-term embryos

E = emerged hatchlings

P = depredated eggs

Y = yolkless eggs

Necropsy

Necropsies (and subsequent pathological or toxicological tests) will help diagnose the likely cause of mortality of dead individuals collected. These standardised protocols for carcass handling and necropsy procedures will be adopted:

- A veterinarian's guide for sea turtle post mortem examination and histological investigation (Ref. 41)
- Sea turtle necropsy annual for biologists in remote refuges. (Ref. 42)

Tissue Sample Analysis

Samples collected from all stranded and live animals during the oil spill event will be stored pending decisions on sample analyses. The number and types of analyses to be carried out will be determined after consultation with the SME. Tissue sample analyses will, as far as practicable, include:

- PAH and the USEPA list of 16 priority pollutants, via normal phase silica chromatography and gas chromatography mass spectrometry (GCMS)
- saturated hydrocarbons in the C10 to C36 range via by flame ionisation gas chromatography (GC)
- volatile hydrocarbons via purge and trap into a GCMS (BTEX)
- organochlorides (dichlorodiphenyldichloroethylene ; dichlorodiphenyltrichloroethane)
- trace metals (mercury and arsenic) if assay indicates concentrations above detection limits
- DNA
- stable isotopes.

Turtle carcasses may also be sampled for humeri (flipper bones) and scleral ossicles (a ring of bones embedded in the sclera and surrounding the irises of the eye) to help determine the age of the animal.

As well as reporting on tissue levels of hydrocarbons, other diagnostic chemical characteristics that can be used to fingerprint the oil will be screened to confirm the oil source.

Chemical analysis of turtle tissue will consider methods outlined in Burns *et al*. (Ref. 43) and Gagnon and Rawson (Ref. 44; Ref. 45). All onshore chemical analysis will be completed at an accredited NATA laboratory (where relevant).

7.5 Data Management

A guide for data management can be found in the AMSA Oil Spill Monitoring Handbook (see Appendix B; Ref. 17).

Monitoring activities may be undertaken over many months and are likely to result in data that may be obtained/generated from several sources in various formats:

- logs and forms
- photographs and video recordings
- annotated maps
- portable GPS/GIS units.

Managing the generated data requires extensive data storage, analysis, backup, and archiving. Samples should be treated as legal evidence and secured against loss or tampering. Copies of datasheets and analysis should be archived.

7.6 QA/QC Procedures

7.6.1 Data

These field data procedures and protocols will be implemented:

- The Marine Turtle Field Lead will review the hardcopies and the database/spreadsheet daily, to ensure accuracy.

7.6.2 Samples

These procedures and protocols will be implemented for data capture:

- All personnel will have training, where relevant, on species identification and procedures for marine turtle surveys.
- All images will be checked to confirm that they are not blurry etc.

7.7 Mobilisation Requirements

7.7.1 Survey Planning

This checklist outlines considerations as part of the survey planning phase.

Task	
☐	Determine the scale and scope of the program based on relevant species, seasonality, numbers, and potential breeding stage
☐	Examine existing literature, baseline data, and existing monitoring programs to establish priorities for data collection
☐	Determine survey field requirements
☐	Select suitable indicator species
☐	Select monitoring sites (including impact and reference sites)
☐	Select sampling approach and technique
☐	Determine sampling replication required
☐	Develop site-specific health and safety plan
☐	Determine data management requirements
☐	Apply baseline data to the design of the survey approach to ensure protocols and standards for collecting data are aligned
☐	Update and confirm survey/sampling plan, including consideration of tides for access to monitoring sites

7.8 Logistics

These activities must be undertaken before mobilisation to the field.

Task	
☐	Assemble scientific survey team
☐	Undertake HAZIDs as required and consolidate/review field documentation including safety plans, emergency response plans, and daily field reports
☐	GIS team to prepare survey maps
☐	Confirm data formats and metadata requirements with data manager
☐	Purchase consumables
☐	Arrange survey platform (vessel, vehicle, aircraft) as required to survey or access monitoring sites
☐	Coordinate NATA-accredited laboratories to confirm availability, limits of detection, obtain sample analysis quotes, and arrange provision of appropriate sample containers, CoC forms, eskies, and ice blocks
☐	Confirm information on sample holding times and the requirements for collecting and transporting tissue samples to laboratories
☐	Book flights, accommodation, and car hire
☐	Conduct pre-mobilisation meeting with the survey team
☐	Develop field survey schedules, detailing staff rotation

7.9 Equipment Preparation

These activities must be undertaken before mobilisation to the field, to ensure equipment is working (for an equipment list, see Section 7.12).

Task	
☐	Confirm specialist equipment requirements and availability
☐	Check GPS units and digital cameras are working and that sufficient spare batteries and memory cards are available
☐	Check field laptops, ensuring they have batteries, power cable, login credentials, and are functional
☐	Check if a first aid kit or specialist PPE is required
☐	Book freight to mobilisation port

All equipment should be checked before transport and before deployment so that the equipment can be operated safely and efficiently.

7.10 Resources

The personnel required to undertake this monitoring program, their roles, and relevant qualifications are listed in Table 7-5.

Table 7-5: Field Roles and Responsibilities

Role	Responsibility	Qualifications
Marine Turtle Expert	• Lead turtle beach surveys including track counts and nest excavations • QA/QC database each day	• Experience in marine turtle surveys from aerial surveys (desirable), track counts, and necropsy (desirable)

Role	Responsibility	Qualifications
		• Able to identify species by tracks and hatchlings
Field Assistants	• Undertake ground/aerial/vessel surveys • Input data into database each day	• Experience in marine turtle surveys
Veterinary and Pathology Expert	• Conduct necropsy	• Relevant degree • Able to advise on cause of death • Experience in marine turtle necropsy (desirable)
SME/Peer Reviewer	• Review methods	• Experience in marine turtle population estimates • Marine turtle necropsy procedures • Sampling/monitoring design suitable for control charting

7.11 Equipment

The equipment required for the beach survey component of SCI5a is listed below.

Item	
☐	Survey platform: Access to rotary or fixed-wing craft or marine vessels
☐	Site access to remote beaches (vessel or chopper)
☐	Handheld video camera
☐	Digital camera (with GPS where possible)
☐	GPS
☐	Binoculars, ideally 8 × 30 to 10 × 50 in size
☐	Nautical charts
☐	Log book/observation sheets
☐	Species Field Identification Guide
☐	Access to an NATA-accredited laboratory for processing tissue samples
☐	Haul nets
☐	Ropes for restraining turtles
☐	Turtle stretcher big enough to take an adult turtle
☐	Containers for small juveniles and hatchlings
☐	Dip nets
☐	Disposable gloves; hand disinfectant; garbage bags
☐	Plastic aprons and rubber boots
☐	Measuring tape
☐	Disposal biopsy tool
☐	Disposable forceps

Item	
☐	Surgical scissors
☐	Clean tins and aluminium foil (for hydrocarbon samples)
☐	Sampling bottles and preservative (70–100% ethanol) • plastic bag • glass/plastic jar • vials
☐	Sharps disposal container
☐	Plain table salt
☐	Cooler for sample storage
☐	Temperature loggers
☐	Eskies
☐	Freezer capable of freezing to -20 °C

7.12 Standard Operating Procedures (SOPs)

7.12.1 Population Abundance/Status of Marine Turtles

Assessments of marine turtle populations and population status will be carried out via field studies, based on SOPs for surveying marine turtles from aerial, vessel, and track census surveys.

7.12.1.1 In-water populations

The standard survey platforms used for assessing marine reptiles at sea are aerial (manned or unmanned) or marine vessels. This will use distance sampling population estimator using aerial transect surveys in reference and impact sites.

7.12.1.2 Aerial Surveys

The standard protocols for recording effort and sighting data recommend line-transect distance sampling methods.

7.12.1.3 Vessel Surveys

Vessel surveys for the presence of marine reptiles (marine turtles and sea snakes) are likely to occur opportunistically, depending on the vessel type, and will provide a direct count of observed affected individuals. The survey guidelines listed in Table 7-6 will apply.

Table 7-6: Survey Techniques: Guidelines

Timing	Survey Techniques	
	Vessel	Aerial[1]
Pre-survey	N/A	Preference: aircraft-mounted cameras and techniques that can photograph transects flown
	Calibrate distance estimation for each observer	
	Establish transects to be surveyed	

<table>
<tr><th rowspan="2">Timing</th><th colspan="2">Survey Techniques</th></tr>
<tr><th>Vessel</th><th>Aerial[1]</th></tr>
<tr><td></td><td>Establish strip width for transects (e.g. 50 m each side of the vessel and 100 m ahead).
NOTE: For pelagic surveys, the entire area around the vessel will be scanned out to a maximum distance that still permits accurate identification</td><td>Establish strip width for transects (e.g. 200 m each side of the aircraft)</td></tr>
<tr><td rowspan="8">During survey</td><td>Vessel speed: 10 knots (range 5–15 knots)</td><td>Aircraft speed: 185 km/h^{-1} or as slow as safely possible; to be determined by the pilot
Altitude: below 100 m. Selected to maximise ease of marine turtle detection and identification, and minimise the risk of collision with ground structures or airborne birds (Ref. 37)</td></tr>
<tr><td colspan="2">Continuously record latitude and longitude (e.g. 30-second intervals) using handheld data logger</td></tr>
<tr><td colspan="2">Marine turtle (or sea snake) observations:
• Record observations of each individual turtle or group of turtles in real time to a dedicated handheld data logger
• Count all observed turtles and record their identity (preferably species), and determine their age class (if possible)</td></tr>
<tr><td colspan="2">Take photographs and/or video to help identify and count species</td></tr>
<tr><td colspan="2">Record other variables including, as far as practicable:
• location
• vessel/aircraft speed and direction
• weather conditions, including:
– temperature
– precipitation
– wind strength and direction
– visibility.</td></tr>
<tr><td colspan="2">Confine observations to daylight hours, and suspend observations in heavy rain, heavy winds, fog, or rough seas</td></tr>
<tr><td>Record any marine reptiles close to the surface slicks and document any unusual behaviour or ill health.</td><td>N/A</td></tr>
</table>

7.12.2 Nesting Populations

Dead and injured stranded turtles will be collected (where practicable) during the ground-based snapshot and census track surveys. Track surveys may be replaced with aerial photographic surveys following data analysis and consultation with SMEs. If aerial surveys of beaches are used, these must be conducted in early morning when the sun is low and tracks can be seen.

7.12.2.1 Snapshot Track Counts – Secondary Beaches

These counts are designed to rapidly assess beaches and include a single standalone beach inspection, which provides a limited indication of the number of turtles that have visited the beach. However, no temporal inference can be made as the number of tracks present depends on several factors, including weather conditions, tide state, and substrate type.

Step	
☐	Conduct snapshot track census in the early morning after a midnight high tide and before the nest high tide washes the overnight tracks away
☐	Walk the length of the beach and record all downward tracks, or use high-resolution drone imagery
☐	Assess track patterns to identify species, where possible
☐	Follow downward tracks back to the last gigging location to assess nesting success
☐	Use GPS to mark identified nest (inferred from visual observations) locations
☐	Record the number of clutches hatched (based on hatchling tracks)
☐	Record signs of human presence (e.g. vehicle tracks) or predators
☐	Complete a field log each day, recording the: • date of survey • location • habitat type • high and low tide times • weather • start and finish times • GPS position, latitude/longitude at start and finish

7.12.2.2 Census Track Surveys – Primary Beaches

Census track surveys collect data on nesting marine turtle abundance, spatial and temporal usage, and distribution between nesting beaches. Census track surveys record the number of new overnight nesting tracks on a beach across consecutive days. Primary indicator beaches will undergo regular ground-based census track monitoring, which may be supported by aerial photographic transect surveys.

Step	
Day 1	
☐	Day 1 – see SOP for Snapshot Track counts (Section 7.13.2.1
☐	Mark all tracks to ensure they are not counted the following day
Day 2	
☐	Walk the length of the beach and record all downward tracks, if no lines are marked
☐	Follow downward tracks back to last gigging location to assess nesting success
☐	Use GPS to mark identified nest (inferred from visual observations) locations
☐	Record number of clutches hatched overnight (based on hatchling tracks) – see Reproductive Success SOP (Section 7.13.3.1)
☐	Record signs of human presence (e.g. vehicle tracks) or predators
☐	Complete a field log each day, recording the: • date of survey • location • habitat type • high and low tide times • weather • start and finish times

Step	
	• GPS position, latitude/longitude at start and finish

7.12.3 Marine Reptile Exposure, Health, and Mortality

7.12.3.1 Reproductive Success

Step	
☐	Walk the entire beach and identify emerged nests, through hatchling tracks (the optimal time to follow hatchling tracks is early morning when there is low light)
☐	Use GPS to record nest locations
☐	Excavate nests using hands and/or digging implements
☐	Count and record nest contents including number of: • shells • live hatchlings • dead hatchlings • undeveloped eggs • unhatched eggs • emerged hatchlings
☐	Collect unhatched eggs (up to 10) and freeze for chemical analysis

7.12.3.2 Chemical Contamination

Step	
☐	Only trained personnel are to handle live or dead stranded turtles and sea snakes.
☐	Collect and freeze all stranded animals (as far as practicable)
☐	Undertake necropsy, as required
☐	Sample carcasses of oil-affected turtles/sea snakes
☐	Samples may include: • necropsy and biopsy samples (e.g. serum samples, gall bladder bile, liver, gonads) • 10 g of skin or muscle for DNA and stable isotope analysis • 100 g of muscle tissue per sample for chemical (hydrocarbon, trace metal, VOC etc.) and stable isotope analysis • gut (stomach/intestinal contents) for hydrocarbon analysis • fibropapillomatosis tumours and spirorchoidiasis (spirorchid trematodes), if present
☐	Place samples in a small esky with frozen ice bricks. Transfer to freezer when possible for storage.
☐	Complete laboratory-specific CoC forms
☐	Label, record, and cross-check all samples with field sheets and CoC forms
☐	Maintain appropriate CoC and secure samples

7.12.4 Beach Condition

See sediment SOPs in SCI2 (Section 4.13)

7.13 Forms and Tools

Refer to Appendix C.

8 SCI5b – Marine Megafauna Impact Study: Pinnipeds

8.1 Aims and Objectives

The aim of the Scientific Monitoring Program SCI5b – Marine Megafauna Impact Study: Pinnipeds (SCI5b) is to undertake a quantitative assessment to understand hydrocarbon impact and subsequent recovery of affected pinniped populations (Australian Sea Lion, *Neophoca cinerea*, New Zealand Fur Seal, *Arctocephalus forsteri* and the Australian Fur Seal, *A. pusillus*) where they exist within the hydrocarbon release EMBA.

The objectives of SCI5b are to:

- where possible, identify mortality of pinnipeds directly related to the hydrocarbon spill or other spill-related impacts (including boat strike and/or use of dispersants)
- assess the impact of the hydrocarbon spill on pinniped species populations as recorded for breeding colonies and haul-out sites of hydrocarbon exposure/contact
- evaluate the recovery of pinniped breeding colonies.

The monitoring focus is onshore populations (e.g. breeding colonies and haul-out sites), which is based on the priority of the life cycle stage (e.g. breeding) and that population estimates are generally based on direct counts onshore.

8.2 Initiation and Termination Criteria

The initiation and termination criteria for this scientific monitoring program are provided in Section 5 of the OSMP. Implementation times for this scientific monitoring program are directly linked to the initiation criteria and are found in the same section of the OSMP.

8.3 Data and Information Requirements

Table 8-1 lists the inputs relevant to planning for the implementation of SCI5b, once the notification to commence is initiated.

Table 8-1: Data Requirements Summary for SCI5b

Baseline Information	Operational Information
• Existing baseline data (as documented in Chevron internal databases) for pinniped nesting beaches, which were identified as being at risk from exposure of hydrocarbons, and pinniped nesting beaches outside the predicted EMBA. Additional baseline data may be available from the following: – OSRA provided by AMSA – I-GEMS (WA only) • Review methods undertaken during baseline studies to ensure that data collected during SCI5b can be directly compared to the existing baseline data	Outputs from MES, OPS3, OPS 4, OPS5, OPS7, SCI1, and SCI2 activities, including: • identify and map sensitive resources and key receptors within the EMBA (OPS5 and OPS7) • data streams from marine water quality monitoring (OPS3 and SCI1), including the location and concentrations of hydrocarbons in marine waters • data streams from sediment quality monitoring (OPS4 and SCI2), including the location and concentrations of hydrocarbons in sediments on beaches / other terrestrial habitats

8.4 Design

Scientific monitoring for pinnipeds will be achieved by using tissue sampling and analysis to examine direct contamination of pinnipeds, as well as assessing the population status of potentially affected pinniped species. Monitoring of pinnipeds will include, where applicable:

- assessing the population size of the affected pinnipeds
- assessing the exposure of pinnipeds to hydrocarbon.

The most accepted census technique for pinnipeds is to directly count newborn pups at breeding colonies, as this is the only age class guaranteed to be on land and available at one occasion. Additionally, pups generally remain ashore when disturbed during pupping season. Trends in pup numbers can be used as an indicator of the change in population over time. A census will also be undertaken to assess impacts at haul-out sites, with observations undertaken remotely from the haul-out site (e.g. aerial, vessel, lookout location) to avoid disturbing sea lions or seals, which are highly mobile and often leave the colony when disturbed.

8.4.1 Monitoring Design

The monitoring approach needs to consider the data collected during MES and OPS3, OPS4, OPS5, and OPS7 activities. The geographic extent of the area to be monitored will be based on the hydrocarbon distribution, as determined through the MES outcomes, and hydrocarbon contact, as determined through OPS5 and OPS7. These outputs will identify potential impact areas to be sampled, which will allow comparison of results to baseline values. Table 8-2 summarises the monitoring designs recommended for various outcomes. Section 2.1 describes these approaches in detail.

Table 8-2: Monitoring Design Approaches Recommended for Different Spill Outcomes

MES and *OPS3* Outcomes Indicate Spill Extent	Monitoring Design[1]	Replicate Sites Required
Hydrocarbon spill reaches shoreline areas known to be pinniped breeding or haul-out sites	BACI or IvC or Control Chart Approach and/or Lines of Evidence Approach	Will be determined before the survey; at least **three** replicate sites within impact and control areas.
Hydrocarbon spill interacts with nearshore areas close to breeding or haul-out sites	BACI or IvC or Control Chart Approach and/or Lines of Evidence Approach	

1 Reference sites required for the monitoring approaches are detailed in Section 1

8.4.2 Monitoring Sites

Sampling will address spatial and temporal variation of the key parameters. The scale of monitoring depends on the size, location, and time of year of a spill and the potential number of breeding colonies and haul-out sites affected. Sampling needs to be balanced against the logistical constraints of collecting samples in remote locations , and the ability to provide meaningful information within a relevant time frame. Data from operational monitoring will be used to understand the spill trajectory and the potential impact sites (pinniped terrestrial habitat that may have been exposed to hydrocarbons) and reference sites.

8.4.3 Monitoring Parameters

8.4.3.1 Physical Monitoring Parameters

Sampling to assess the status of the population of pinnipeds in the EMBA will address the spatial and temporal variation of measured parameters (Table 8-3).

Table 8-3: Selection of Parameters for Assessment

Environmental Focus	Key Parameter	Methods	Metric
Population abundance of pinnipeds	Abundance at breeding colonies (pup production)	Ground surveys for pup counts at breeding colonies	• # of pups (dead, alive, brown, moulted)
	Abundance at haul-out sites	Aerial or boat census	• # of pinnipeds
Marine reptile exposure/ mortality/ health	Chemical contamination	Necropsy/tissue sampling	• TPH levels • PAH levels • condition of individual pinnipeds (e.g. oiling, sores) • # of oiled individuals

Before finalising the survey plan, an assessment will be done to determine the likelihood of pinniped presence/absence, species and life cycle stage (e.g. breeding) at the time of the hydrocarbon release, based on the predicted EMBA and time of year.

8.4.4 Monitoring Frequency and Duration

Following the initiation of SCI5b, surveys will be undertaken at least once a year, although are likely to be at a greater frequency (e.g. every three months) in the first year, based on the biological indicators being monitored (unless the termination criteria are triggered within this time). Surveys should be undertaken during the breeding season and at each breeding colony location and haul-out site. Annual variations occur in pup production (e.g. annual variation can be as high as 25% in a stable population of the New Zealand Fur Seal, *Arctocephalus forsteri*) and therefore, ongoing surveys should occur annually. Survey data will be reviewed annually, and the frequency of any ongoing monitoring will be determined by the data collected to date, the spatial, temporal, and seasonal variability of the biological indicators being measured, and may, for example, be seasonal, six-monthly, or annual until the termination criteria are reached.

Tissue samples will be collected opportunistically during the census of breeding colonies.

8.4.5 Sample Integrity

Any uncertainties concerning species identification, nesting success, etc., will be mitigated in the field by communicating with the Field Lead/marine pinniped expert.

8.4.5.1 Tissue Sampling

To maintain sample integrity, transport and storage requirements must be adhered to. If there may be a delay in freezing these samples, they can be stored for a limited time in an esky with ice blocks until they can be frozen. All sample storage containers will contain a small temperature logger, which will remain with the samples until delivery to the final storage location or laboratory.

DNA samples can be stored in plain table salt for transport or a salt-buffered DMSO solution. Stable isotope samples can be stored in plastic bags in a refrigerator or cooler.

Table 8-4 summarises the storage and transport needs for these samples.

Table 8-4: Tissue Sample Storage and Transport Requirements

	Sample	Preservation Method	Storage Requirements	Transport Requirements
Genetics	Skin or liver (if available)	70 to 100% ethanol, in internally labelled vials	Frozen	Frozen
Stable isotopes	Tissue (other than fat)	70% ethanol	Frozen	Frozen
Toxicology	Tissue, swab, and stomach/intestine samples	• Samples stored in sterile aluminium foil and then bagged • Heavy metal testing samples stored in plastic or glass	Frozen (-20 °C)	Frozen (-20 °C)

8.4.6 Sample Analysis

8.4.6.1 Population Abundance

Breeding Colonies of New Zealand and Australian Fur Seals

Total pup production for each breeding colony will be the maximum sum of live and dead pups counted. Total population size will be estimated by multiplying the total pup production by a factor of

- 4.79 to 4.9 based on two age-structure population models for New Zealand Fur Seals (Ref. 46; Ref. 47).
- 4.5 based on survivorship model for Australia Fur Seals (Ref. 48).

Breeding Colonies of Australian Sea Lion

Small Colonies (<40 pups)

Pup numbers will be estimated for each survey from the number of marked pups and accumulated dead pups plus the number of live unmarked pups. The maximum of the estimates from each survey will be taken as the pup production estimate for the season.

Large Colonies (<40 pups)

Pup numbers will be calculated using the Cormack-Jolly-Seber (CJS) capture-mark-recapture (CMR) model implemented in a software package (e.g. MARK) to model year-specific survival, recapture probability of pups, population size, and new individuals entering a population.

Total population size will be estimated by multiplying the total pup production by a factor of 4.08, as derived by Goldsworthy and Page (Ref. 47).

Haul-out sites

Abundance will be the total number of seals or sea lions counted at each location.

8.4.6.2 Pinniped Exposure, Health, Mortality

Necropsy

Necropsies (and subsequent pathological or toxicological tests) will help diagnose the likely cause of mortality of dead individuals collected. The standardised protocol for carcass handling and necropsy procedures to be adopted is:

- Marine Mammal Necropsy: An introductory guide for stranding responders and field biologist (Ref. 49).

Lung tissue will be assessed visually to identify any hydrocarbon spots.

Tissue Sample Analysis

Samples collected from all stranded and live animals during the hydrocarbon spill event will be stored pending decisions on sample analyses. The number and types of analyses to be carried out will be determined after consultation with Scientific Monitoring Officers. Tissue sample analyses will, as far as practicable, include:

- swabs from visibly oiled pinnipeds for hydrocarbon confirmation and fingerprinting
- PAH (Cytochrome P450 may be used as a measure of hydrocarbon exposure) and TPH analysis
- stable isotopes analysis to help identify where stranded animals may have originated
- bacterial cultures for pathogen identification from fresh carcasses or live animals.

As well as reporting on tissue levels of hydrocarbons, other diagnostic chemical characteristics that can be used to fingerprint the hydrocarbon will be screened to confirm the hydrocarbon source.

All onshore chemical analysis will be completed at an accredited NATA laboratory (where relevant).

Other sampling for other analyses may include:

- stomachs for prey analysis
- tissue histopathology
- genetic analyses.

8.5 Data Management

A guide for data management can be found in the AMSA Oil Spill Monitoring Handbook (see Appendix B; Ref. 17).

Monitoring activities may be undertaken over many months and are likely to result in data that may be obtained/generated from several in various formats:

- logs and forms
- photographs and video recordings
- annotated maps
- portable GPS/GIS units.

Managing the generated data requires extensive data storage, analysis, backup, and archiving. Samples should be treated as legal evidence and secured against loss or tampering. Copies of datasheets and analysis should be archived.

8.6 QA/QC Procedures

8.6.1 Data

These field data procedures and protocols will be implemented:

- The Pinniped Field Lead will review the hardcopies and the database/spreadsheet each day, to ensure accuracy.
- Backup data files will be opened once created to verify the backup was completed.

8.6.2 Samples

These procedures and protocols will be implemented for data capture:

- All personnel will have training, where relevant, on species identification and procedures for pinniped surveys.
- All images will be checked to confirm that they are not blurry etc.

8.7 Mobilisation Requirements

8.7.1 Survey Planning

This checklist outlines considerations as part of the survey planning phase.

Task	
☐	Determine the scale and scope of the program based on relevant species, seasonality, numbers, and potential breeding stage
☐	Examine existing literature, baseline data, and existing monitoring programs to establish priorities for data collection
☐	Determine survey field requirements
☐	Select suitable indicator species
☐	Select monitoring sites (including impact and reference sites)
☐	Select sampling approach and technique
☐	Determine sampling replication required
☐	Develop site-specific health and safety plan
☐	Determine data management requirements
☐	Apply baseline data to the design of the survey approach to ensure protocols and standards for collecting data are aligned
☐	Update and confirm survey/sampling plan, including consideration of tides for access to monitoring sites

8.8 Logistics

These activities must be undertaken before mobilisation to the field.

	Task
☐	Assemble scientific survey team
☐	Undertake HAZIDs as required and consolidate/review field documentation including safety plans, emergency response plans, and daily field reports
☐	GIS team to prepare survey maps
☐	Confirm data formats and metadata requirements with data manager
☐	Purchase consumables
☐	Arrange survey platform (vessel, vehicle, aircraft) as required to survey or access monitoring sites
☐	Coordinate NATA-accredited laboratories to confirm availability, limits of detection, obtain sample analysis quotes, and arrange provision of appropriate sample containers, CoC form, eskies, and ice blocks
☐	Confirm information on sample holding times and the requirements for collecting and transporting tissue samples to laboratories
☐	Book flights, accommodation, and car hire
☐	Conduct pre-mobilisation meeting with the survey team
☐	Develop field survey schedules, detailing staff rotation

8.9 Equipment Preparation

These activities must be undertaken before mobilisation to the field, to ensure equipment is working (for an equipment list, see Section 5.12).

	Task
☐	Confirm specialist equipment requirements and availability
☐	Check GPS units and digital cameras are working and that sufficient spare batteries and memory cards are available
☐	Check field laptops, ensuring they have batteries, power cable, login credentials, and are functional
☐	Check if a first aid kit or specialist PPE is required
☐	Book freight to mobilisation port

All equipment should be checked before transport and before deployment so that the equipment can be operated safely and efficiently.

8.10 Resources

The personnel required to undertake this monitoring program, their roles, and relevant qualifications are listed in Table 8-5.

Table 8-5: Field Roles and Responsibilities

Role	Responsibility	Qualifications
Pinniped Field Lead	• Lead pup production counts • Lead and undertake counts of pinnipeds at haul-out sites • QA/QC database each day	• Experience in pinniped surveys • Experience in aerial surveys (if this method is used)
Field Assistants	• Undertake pup production counts • Assist in counts at haul-out sites	• Experience in pinniped surveys

Role	Responsibility	Qualifications
	• Input data into database each day	
Veterinary and Pathology Expert	• Conduct necropsy and take tissue samples	• Relevant degree • Able to advise on cause of death • Experience in pinniped necropsy (desirable)
SME/Peer Reviewer	• Review methods	• Experience in pinniped population estimates • Pinniped necropsy procedures

Access to breeding colonies or haul-out sites may require vessels and/or vehicles and therefore, additional team members (e.g. vessel master) and qualifications may be required (e.g. offshore medical, 4WD/off-road training).

8.11 Equipment

The equipment required for the beach survey component of SCI5b is listed below.

Item	
☐	Survey platform: Access to rotary or fixed-wing aircraft or marine vessels
☐	Site access to remote beaches (vessel or helicopter)
☐	Handheld video camera
☐	Digital camera (with GPS where possible)
☐	GPS
☐	Binoculars, ideally 8 × 30 to 10 × 50 in size
☐	Nautical charts
☐	Log book/observation sheets
☐	Species Field Identification Guide
☐	Access to an NATA-accredited laboratory for processing tissue samples
☐	Haul nets
☐	Ropes for restraining pinnipeds
☐	Stretcher big enough to take an adult pinniped
☐	Containers for small juveniles and hatchlings
☐	Dip nets
☐	Disposable gloves; hand disinfectant; garbage bags
☐	Plastic aprons and rubber boots
☐	Measuring tape
☐	Disposal biopsy tool
☐	Disposable forceps
☐	Surgical scissors
☐	Clean tins and aluminium foil (for hydrocarbon samples)

Item	
☐	Sampling bottles and preservative (70–100% ethanol): • plastic bag • glass/plastic jar • vials
☐	Sharps disposal container
☐	Plain table salt
☐	Cooler for sample storage
☐	Temperature loggers
☐	Eskies
☐	Freezer capable of freezing to -20 °C

8.12 Standard Operating Procedures (SOPs)

8.12.1 Population Abundance of Pinnipeds

Different methods will be implemented depending on whether it is a breeding colony or haul-out site, or whether it is a breeding site for the Australian Sea Lion or the New Zealand/Australia Fur Seal. During the surveys, any seals or sea lions with visible oiling will be recorded.

8.12.1.1 Breeding Colonies of New Zealand and Australian Fur Seals – 'Direct Count'

Step	
☐	Two observers will move together, as quietly as possible, along the shoreline
☐	Count and record all pups
☐	One observer will be responsible for maintaining the count
☐	The other will search carefully including under vegetation and in rock holes, reporting any sightings to the recorder
☐	Classify pups brown, moulted, unclassed
☐	Once the count of live pups is complete, go back through the colony and count dead pups
☐	Mark all dead pups to prevent recounting in subsequent surveys
☐	Complete a field log each day, recording the: • date of survey • location • habitat type • high and low tide times • weather • start and finish times • GPS position, latitude/longitude at start and finish • results from survey

8.12.1.2 Breeding Colonies of Australian Sea Lion

Because of the long breeding season of Australian Sea Lions (up to 7 months), by the end of the pupping season, some pups may have dispersed or moulted (and therefore, may go unrecognised). Therefore, one of these methods will be used:

- Cumulative Mark and Count method to estimate pup numbers for small colonies (<40 pups); or
- CJS CMR model to estimate pup numbers for large colonies (>40 pups) (Ref. 50; Ref. 51; Ref. 52)

Breeding Colony

Step	
☐	Two observers will move together, as quietly as possible, along the shoreline
☐	Catch and mark all pups (marks can include clipping a patch of hair on the back, bleach on the shoulder, or tags on the fore-flipper)
☐	One observer will be responsible for maintaining the count
☐	The other will search carefully including under vegetation and in rock holes, reporting any sightings to the recorder
☐	Classify pups as marked or unmarked
☐	Record the number of pups marked (that were previously unmarked)
☐	Once the count of live pups is undertaken, go back through the colony and count dead pups
☐	Mark all dead pups to prevent recounting in subsequent surveys
☐	Complete a field log each day, recording the: • date of survey • location • habitat type • high and low tide times • weather • start and finish times • GPS position, latitude/longitude at start and finish • results from survey

Haul-out sites – ‘direct count’

Step	
☐	Two observers will observe the haul-out site from aerial surveys, a vessel, or land-based (e.g. cliff lookout)
☐	Each observer will undertake an independent count; count all seals and/or sea lions and identify them to species level (if possible)
☐	If aerial surveys are undertaken simultaneously with the real-time counts, take oblique photographs to corroborate the counts
☐	Complete a field log each day, recording the: • date of survey • location • habitat type • high and low tide times • weather

Step	
	• start and finish times • GPS position, latitude/longitude at start and finish • results from survey

8.12.1.3 Pinniped Exposure, Health, and Mortality

Step	
☐	Only trained personnel can handle live or dead stranded pinnipeds
☐	Collect and freeze all stranded animals (as far as practicable)
☐	Undertake a necropsy, if required (see Section 8.5.6)
☐	Sample carcasses of oil-affected pinnipeds
☐	Samples may include: • swabs from externally visible oiled pinnipeds • tissue from the lung, liver, and kidney • stomach and intestinal contents • bile secretions
☐	Place samples in a small esky with frozen ice bricks. Transfer to freezer when possible for storage
☐	Complete laboratory-specific CoC forms
☐	Label, record, and cross check all samples with field sheets and CoC forms
☐	Maintain appropriate CoC and secure samples

8.13 Forms and Tools

Refer to Appendix C.

9 SCI5c – Marine Megafauna Impact Study: Other Marine Megafauna

9.1 Aims and Objectives

The aim of Scientific Monitoring Program SCI5c – Other Marine Megafauna (SCI5c) is to is to undertake a quantitative assessment to understand hydrocarbon impact and subsequent recovery of affected marine mammals (cetaceans and dugongs) and large cartilaginous fish (such as Whale Sharks, Great White Sharks, Manta Rays, and sawfish).

The objectives of SCI5b are:

- where possible, identify mortality of marine megafauna directly related to a hydrocarbon spill or other spill-related impacts (such as vessel strike, use of dispersants)
- assess the impact of a hydrocarbon spill on marine megafauna. If applicable, evaluate recovery of impacted species.

9.2 Initiation and Termination Criteria

The initiation and termination criteria for this scientific monitoring program are provided in Section 5 of the OSMP. Implementation times for this scientific monitoring program are directly linked to the initiation criteria and are found in the same section of the OSMP.

9.3 Data and Information Requirements

Table 9-1 lists the inputs relevant to planning for the implementation of SCI5c, once the notification to commence is initiated.

Table 9-1: Data Requirements Summary for SCI5c

Baseline Information	Operational Information
• Existing baseline data (as documented in Chevron internal databases2F2F2F2) for marine megafauna, which were identified as being at risk from exposure of hydrocarbons. Additional baseline data may be available from: – OSRA provided by AMSA – I-GEMS (WA only) • Review methods undertaken during baseline studies to ensure that data collected during SCI5c can be directly compared to the existing baseline data	Outputs from MES, OPS3, OPS5, OPS7, and SCI1 activities, including: • identify and map sensitive resources and key receptors within the EMBA • identify and map sensitive resources and key receptors within the EMBA (OPS 5 and OPS7) • data streams from marine water quality monitoring (OPS3 and SCI1), including the location and concentrations of hydrocarbons in marine waters

9.4 Design

Scientific monitoring for marine megafauna, including marine mammals (cetaceans and dugongs) and cartilaginous fish, will be achieved by determining the abundance of marine megafauna in the EMBA and using tissue sampling and analysis to examine direct contamination of marine megafauna.

[2] Access to data relevant to third-party providers may be required for baseline information (including CSIRO and state conservation agencies e.g. DBCA)

Monitoring will include, where applicable:

- assessing the presence/absence or abundance of marine megafauna
- assessing the exposure of marine megafauna to hydrocarbons.

There are several limitations in this study, including:

- Current information on the status of marine mammal populations (e.g. stock structure; abundance; movement patterns; age structure; reproductive rates; survival rates and health) is required and can be lacking in most regions. The monitoring of cetacean health is currently considered unfeasible and although visual signs such as changes in behaviour or skin lesions can be used as indicators of health, clearly identifiable links to a particular hydrocarbon incident are unlikely to be established. It is likely statistical tests will not be feasible and interpretation will be largely qualitative.
- A quantitative assessment of cartilaginous fish species is unlikely because of the small numbers encountered. Assessing changes to the presence of adult sawfish at sea is not plausible due to the low numbers and their benthic habitat association, making their detection difficult. However, the presence/absence of populations ascertained by monitoring numbers entering the creeks (using acoustic methods) may be an appropriate proxy to assess change.
- Cartilaginous fish species strandings are unlikely—they do not have a swim bladder so are more likely to sink to the seabed.

A degree of flexibility is required in implementing the scientific monitoring program—the limitations listed above, the focus of assessment in terms of species, and locations cannot be determined until the actual spill event occurs. The methods listed in the subsections below outline several potential approaches for collecting the necessary information, with the actual methods to be selected at the time of the spill.

9.4.1 Monitoring Design

The monitoring approach needs to consider the data collected during MES and OPS3, OPS4, OPS5, and OPS7 activities. The geographic extent of the area to be monitored will be based on the hydrocarbon distribution, as determined through the MES outcomes, and hydrocarbon contact, as determined through OPS5 and OPS7. These outputs will identify potential impact areas to be sampled, which will allow comparison of results to baseline values. Table 9-2 summarises the monitoring designs recommended for various outcomes. Section 2.1 describes these approaches in detail.

Table 9-2: Monitoring Design Approaches Recommended for Different Spill Outcomes

MES and *OPS3* Outcomes Indicate Spill Extent	Monitoring Design[1]	Replicate Sites Required[2]
Hydrocarbon spill interacts with areas of biological importance (feeding areas or migration routes)	BACI or IvC or Control Chart Approach and/or Lines of Evidence Approach	Minimum of three sites within each of impact and control areas (for BACI and IvC)

1 *Reference sites required for each monitoring approach are detailed in Section 1*

9.4.2 Monitoring Sites

9.4.2.1 Species Presence

Sampling will address the spatial and temporal variation of the key parameters. The scale of monitoring depends on the size, location, and time of year of a spill and the potential number of breeding colonies and haul-out sites affected. Sampling needs to be balanced against the logistical constraints of collecting samples in remote locations, and the ability to provide meaningful information within a relevant time frame. Data from operational monitoring will be used to understand the spill trajectory and the potential impact and reference sites.

If marine megafauna are to be assessed, two reference sites/regions (three if possible) should be selected to compare against the EMBA. The reference sites/regions must be matched with impact areas in relation to spatial dimension, habitat, and distance from mainland and/or island coastline habitats, and must be determined during the pre-survey planning period.

The scale of likely impact will determine the spatial and temporal scale of monitoring. Any sampling design must be adaptable to different scales, as constrained by available resources, and be appropriate to the EMBA of a hydrocarbon spill incident. The priority of resources and receptors and the sites themselves, are likely to be different under different spill or weather conditions, the seasonal presence of key species, or the life stage of the species present.

9.4.3 Monitoring Parameters

Sampling to assess the status of marine megafauna populations in the EMBA will address the spatial and temporal variation of measured parameters (Table 9-3).

Table 9-3: Selection of Parameters for Assessment

Environmental Focus	Condition Metric	Methods	Parameters
Species presence	Species present	Aerial/vessel survey	• record presence of species • species identification (where possible)
	Estimate of Abundance	Aerial/vessel survey/ passive acoustic monitoring (PAM)	• # of individuals • species identification
Mortality, health, and fitness	Chemical contamination	Laboratory analysis	• hydrocarbons • biomarkers • trace metals • DNA • stable isotopes
	Oil distribution on individuals	Aerial/vessel survey	• percentage of oiled individuals • distribution of oil on individuals

9.4.3.1 Indicator Species

Depending on location of the spill and its predicted extent, potential indicator species for assessing risks to marine mammals and cartilaginous fish during the operational response have been identified. The selection of indicator species for a particular event will be based on:

- currently available information/data on abundance/distribution/migration patterns within the region
- ability to observe/detect and correctly identify the species
- likelihood of exposure to hydrocarbons
- sensitivity to hydrocarbon spills
- regulatory protection status (i.e. EPBC Act listed species).

9.4.4 Monitoring Frequency and Duration

Monitoring will be conducted at least once in the first year, although is likely to be at a greater frequency (e.g. every three months) in the first year to identify the short-term direct impacts of the hydrocarbons, unless the termination criteria are triggered within this time. Survey data will be reviewed annually; and the frequency of any ongoing monitoring will be determined by the data collected to date, the spatial, temporal, and seasonal variability of the biological indicators being measured, and may, for example, be seasonal, six-monthly, or annual until the termination criteria are reached.

9.4.4.1 Aerial Surveys

Aerial surveys work well for large marine megafauna (principally whales, Whale Sharks, and Dugongs) and where waters have good light penetration and visibility. The standard protocols for recording effort and sighting data via aerial surveys recommends line-transect distance sampling methods. The survey guidelines listed in Table 9-3 will be applied, as far as practicable, by a trained observer. Visual and photographic/video data and information on sea state and flight path (as outlined in Table 9-3) should be collected. To limit bias, double-platform line-transect and cue counting will be implemented, where possible.

Data will be collected using digital audio recordings and/or standardised observation logbook records. For each sighting, data collected should include: location (GPS); species; group size; group composition (adults and calves); behaviour (directional swimming, non-directional swimming, feeding, resting); cue (underwater, body at surface, splash, blow); swimming direction; oiling on individuals; and reaction to the survey craft.

9.4.4.2 Vessel Surveys

Vessel surveys are suitable in shallow coastal waters where waters may be turbid and therefore, visibility for aerial surveys may be limited. Vessel surveys will be undertaken, if considered practicable, to gather observational data on any marine megafauna close to where the spill occurred or inshore waters (and appropriate reference sites). The survey guidelines listed in Table 9-3 will be applied, as far as practicable, by a trained observer.

Observers will, as far as practicable, be positioned at the highest accessible point (termed ‘primary platform’) with an angle board mounted on the deck railing (preferably towards the stern) to measure the radial angle to the sighting. Increasing observer height increases the resolution with which observers can measure the downward angle to sightings, lessening the change of response movement and increasing the ability to see animals. Double-platform data collection will be implemented, when possible.

Data will be collected using digital audio recordings and/or standardised observation logbook records. For each sighting, data collected should include:

location; species; group size; group composition (adults and calves); angle to sighting (declination), behaviour (directional swimming, non-directional swimming, feeding, resting); cue (underwater, body at surface, splash, blow); swimming direction; oiling on individuals; and reaction to the survey craft.

9.4.4.3 Passive Acoustic Monitoring (PAM)

PAM uses acoustic monitoring technologies and recognition software to detect and record marine mammal vocalisations, with data coupled with visual monitoring. This tool may be used to assess relative abundance estimates of large whales in the EMBA and suitable reference sites. Vocalisation signatures for whale species exist and data are freely available via the Integrated Marine Observing System website (Ref. 53) through the acoustic observatories. Each observatory comprises four autonomous sea noise loggers deployed on the sea floor to form a triangular array of about 5 km sides, with the fourth logger installed in the centre. The Centre for Marine Science and Technology at Curtin University and the Murdoch University Cetacean Research Unit have developed, or are developing, passive acoustic methodology for monitoring marine mammals.

9.4.5 Marine Megafauna Mortality, Health, and Fitness

Data will be collected via visual observations (see Sections 9.5.4.1 and 9.5.4.2) and through chemical contamination.

Marine mammal strandings create an important opportunity for gathering information on an animal's biology, pathology, toxicology, and population genetics, as well as data on natural and human-induced mortality of cetacean populations of the concerned species. If fauna stranding is recorded, a minimum of ten carcasses will be sampled for tissue analysis (providing the necropsy criteria are met). If fewer than ten carcasses are recorded, all carcasses that meet the necropsy criteria will be sampled.

Trained professionals will be involved in handling strandings. If carcasses are observed, physical details (species, length, sex, condition, etc.) will be documented and photographs taken. Basic biological information will need to be collected, and where appropriate, tissue samples for laboratory analysis. Careful and consistent documentation of marine mammal strandings is needed and clinical pathology is required to determine whether the cause of the mortality can be attributed to the hydrocarbon spill event.

The state of decomposition of any carcasses will be evaluated to determine the viability of the samples for specific analysis (analysis is unlikely for severely decomposed carcasses). Tissue samples are required for hydrocarbon analysis and for the interpretation to be meaningful these will need to be assessed against background reference points, where possible. Immediate necropsy, or appropriate freezer storage of carcasses, is required to correlate the physiological and pathological state to any concentration of petroleum products found in tissue samples.

9.4.6 Sample Integrity

Any uncertainties concerning species identification will be mitigated in the field by communicating with the Field Lead.

9.4.6.1 Tissue Sampling

To maintain sample integrity, transport and storage requirements must be adhered to. If there may be a delay in freezing these samples, they can be stored for a limited time in an esky with ice blocks until they can be frozen. All sample storage containers will contain a small temperature logger, which will remain with the samples until delivery to the final storage location or laboratory.

DNA samples can be stored in plain table salt for transport or a salt-buffered DMSO solution. Stable isotope samples can be stored in plastic bags in a refrigerator or cooler. Samples should be kept cool (<5 °C) if kept in bags but not frozen, and they should not be held for an extended period. Table 9-4 summarises the storage and transport needs for these samples.

Table 9-4: Tissue Sample Storage and Transport Requirements

	Sample	Preservation Method	Storage Requirements	Transport Requirements
Genetics	Skin or liver (if available)	70 to 100% ethanol, in internally labelled vials	Frozen	Frozen
Stable isotopes	Tissue (other than fat)	70% ethanol	Frozen	Frozen
Toxicology	Tissue, swab, and stomach/intestine samples	• Samples stored in sterile aluminium foil and then bagged • Heavy metal testing samples stored in plastic or glass	Frozen (-20 °C)	Frozen (-20 °C)

9.4.7 Sample Analysis

In addition to contrasting between impact and reference sites, the power of a sampling design to detect real changes in system state is determined by the level of replication. In this instance, replication is unlikely to achieve sufficient power; hence statistical tests will not be conducted to compare spatial and temporal variability. However, the Marine Mammal Health and Strandings Response Program (Ref. 54), which uses the Unusual Mortality Events (UME) method to assess strandings significance, may be used.

9.4.8 Species Presence

These resources will be used for distance sampling design and analyses (Line-Transect Surveys):

- Introduction to Distance Sampling: Estimating Abundance of Biological Populations (Ref. 38)
- Design of distance sampling surveys and Geographic Information Systems (Ref. 55).

An indication of the statistical power to detect change in strandings should be provided. Data will need to be stratified and categorised accordingly. The Marine Mammal Health and Strandings Response Program (Ref. 54) uses the UME method to assess strandings significance.

9.4.9 Marine Megafauna Exposure, Health, Mortality

9.4.9.1 Necropsy

Necropsies (and subsequent pathological or toxicological tests) help diagnose the likely cause of mortality of dead individuals collected. This standardised protocol for carcass handling and necropsy procedures will be adopted:

- Marine Mammal Necropsy: An introductory guide for stranding responders and field biologist (Ref. 49).

Lung tissue will be assessed visually to identify any hydrocarbon spots.

9.4.9.2 Tissue Sample Analysis

Samples collected from all stranded and live animals during the hydrocarbon spill event will be stored pending decisions on sample analyses. The number and types of analyses to be carried out will be determined after consultation with Scientific Monitoring Officers. Tissue samples analyses will, as far as practicable, include:

- swabs from visibly oiled marine megafauna for hydrocarbon confirmation and fingerprinting
- PAH (Cytochrome P450 may be used as a measure of hydrocarbon exposure) and TPH analysis
- stable isotopes analysis to help identify where stranded animals may have originated
- bacterial cultures for pathogen identification from fresh carcasses or live animals.

As well as reporting on tissue levels of hydrocarbons, other diagnostic chemical characteristics that can be used to fingerprint the hydrocarbon will be screened to confirm the hydrocarbon source. All onshore chemical analysis will be completed at an accredited NATA laboratory (where relevant).

Other sampling for other analyses may include:

- stomachs for prey analysis
- tissue histopathology
- genetic analyses
- teeth for determining the animal's age.

9.5 Data Management

A guide for data management can be found in the AMSA Oil Spill Monitoring Handbook (see Appendix B; Ref. 17).

Monitoring activities may be undertaken over many months and are likely to result in data that may be obtained/generated from several sources in various formats:

- logs and forms
- photographs and video recordings
- annotated maps
- portable GPS/GIS units.

Managing the generated data requires extensive data storage, analysis, backup, and archiving. Samples should be treated as legal evidence and secured against loss or tampering. Copies of datasheets and analysis should be archived.

9.6 QA/QC Procedures

9.6.1 Data Collection

These field data procedures and protocols will be implemented:

- The Field Lead will review the hardcopies and the database/spreadsheet each day, to ensure accuracy.
- Backup data files will be opened once created to verify the backup was completed.

9.6.2 Samples

These procedures and protocols will be implemented for data capture:

- All personnel will have training, where relevant, on species identification and procedures for marine megafauna surveys.
- All images will be checked to confirm that they are not blurry etc.
- All samples that will be transported for laboratory analysis will be accompanied by a CoC form that provides details of the samples being sent and that will be used to verify that all samples collected were received at their intended location. The CoC form documents all aspects of sample storage and transport from collection to the final storage location or laboratory.

9.7 Mobilisation Requirements

9.7.1 Survey Planning

This checklist outlines considerations as part of the survey planning phase.

Task	
☐	Determine the scale of the study area
☐	Select study area sites (including impact and reference sites if applicable)
☐	Select sampling approach and techniques
☐	Determine sampling replication required
☐	Consider data management requirements (e.g. data format, metadata, storage protocols, delivery schedule, and communication methods)
☐	Develop site-specific health and safety plan
☐	Develop survey/sampling plan incorporating the latest operational data
☐	GIS team to prepare survey maps from the latest data
☐	Check MSDSs and chemical handling procedures
☐	Undertake HAZIDs as required
☐	Develop site-specific health and safety plan, including JHAs

9.8 Logistics

These activities must be undertaken before mobilisation to the field.

Task	
☐	Assemble scientific survey team
☐	Undertake HAZIDs as required and consolidate/review field documentation including safety plans, emergency response plans, and daily field reports
☐	GIS team to prepare survey maps
☐	Confirm data formats and metadata requirements with data manager
☐	Purchase consumables
☐	Arrange survey platform (vessel, vehicle, aircraft) as required to survey or access monitoring sites
☐	Confirm information on sample holding times and the requirements for collecting and transporting tissue samples to Perth-based laboratories
☐	Coordinate NATA-accredited laboratories to confirm availability, limits of detection, obtain sample analysis quotes, and arrange provision of appropriate sample containers, CoC forms, eskies, and ice blocks
☐	Book flights, accommodation, and car hire
☐	Conduct pre-mobilisation meeting with the survey team
☐	Develop field survey schedules, detailing staff rotation

9.9 Equipment Preparation

These activities must be undertaken before mobilisation to the field to ensure equipment is working (for an equipment list, see Section 3.12).

Task	
☐	Confirm equipment resources and availability
☐	Check all GPS units and digital cameras are working and that sufficient spare batteries and memory cards are available
☐	Check field laptops, ensuring they have batteries, power cable, licences, login credentials, and are functional
☐	Check video cameras, ensuring they have sufficient batteries, storage media, power cables, and are functional
☐	Arrange transport of equipment to mobilisation point

9.10 Resources

The personnel required to undertake SCI5c, their roles, and relevant qualifications are listed in Table 9-5.

Table 9-5: Field Roles and Responsibilities

Role	Responsibility	Qualifications
Marine Mammal Observer/Field Lead	• Lead aerial/vessel surveys • QA/QC database each day	• Marine Mammal Observer certification • Experience in marine mammal aerial surveys (desirable), vessel surveys (desirable), and necropsy (essential)

Role	Responsibility	Qualifications
		• Able to identify species by tracks and hatchlings
Field Assistants	• Undertake aerial/vessel surveys • Input data into database each day	• Experience in aerial and/or vessel surveys
Veterinary and Pathology Expert	• Conduct necropsy	• Relevant degree • Able to advise on cause of death • Experience in marine mammal necropsy (desirable)

9.11 Equipment

The basic set of equipment required for SCI5c is listed below.

Item	
☐	Survey platform: e.g. rotary or fixed-wing craft (recommended AMSA Dornier 318 or CASA 212–400 fixed-wing aircraft), i.e. high-wing aircraft with downward visual capability or marine vessels, or long-distance capable drone
☐	Handheld video camera with date stamp and GPS
☐	Digital camera (with GPS) and telephoto lens
☐	GPS
☐	Clinometers
☐	Binoculars, 8 × 30 to 10 × 50 in size
☐	Nautical charts
☐	Log book/observation sheets
☐	Species Field Identification Guide
☐	Audio recorder
☐	Tissue sample collection kit

9.12 Standard Operating Procedures (SOPs)

9.12.1 Population Abundance/Status of Marine Megafauna

Marine mammal populations and population status will be assessed using field studies that are based on SOPs for surveying marine megafauna from the air and from vessels.

9.12.1.1 In-water Populations

The standard survey platforms used for assessing marine megafauna at sea are aerial (manned or unmanned) or marine vessels. This will use distance sampling population estimator using aerial transect surveys in reference and impact sites.

9.12.1.2 Aerial Surveys

The standard protocols for recording effort and sighting data recommend line-transect distance sampling methods.

9.12.1.3 Vessel Surveys

Vessel surveys for the presence of marine megafauna are likely to occur opportunistically, depending on the vessel type, and will provide a direct count of observed affected individuals. The survey guidelines listed in Table 9-6 will apply.

Table 9-6: Standard Survey Methods

<table>
<tr><th>Timing</th><th>Vessel Survey Methods</th><th>Aerial Survey Methods</th></tr>
<tr><td rowspan="3">Pre-survey</td><td colspan="2">Calibrate distance estimation for each observer</td></tr>
<tr><td colspan="2">Establish transects to be surveyed</td></tr>
<tr><td>Establish strip width for transects e.g. 400 m each side of the vessel and 100 m ahead
NOTE: For pelagic surveys, the entire area around the vessel will be scanned out to a maximum distance that still permits accurate identification</td><td>Establish strip width for transects to each side of the aircraft:
• 400 m for whales and dugong, and/or
• 750 m for Whale Sharks</td></tr>
<tr><td rowspan="6">During survey</td><td>Vessel speed: 10 knots (range 5–15 knots)</td><td>Aircraft speed: approximately 90–100 knots or as slow as safely possible; to be determined by the pilot
Altitude: approximately 500 ft
Beaufort state: <3</td></tr>
<tr><td colspan="2">Continuously record latitude and longitude (e.g. 30-second intervals) using a handheld data logger</td></tr>
<tr><td colspan="2">Marine mammal observations:
• Record observations of each individual or group in real time to a dedicated handheld data logger
• Count all observed individuals and record their identity (preferably to species level), and determine their age class (if possible)</td></tr>
<tr><td colspan="2">Take photographs and/or video to help identify and count species</td></tr>
<tr><td colspan="2">Record other variables including, as far as practicable:
• location
• vessel/aircraft speed and direction
• weather conditions, including:
– temperature
– precipitation
– wind strength and direction
– visibility (including glare)
• whether transect is in hydrocarbon-affected water.</td></tr>
<tr><td colspan="2">Confine observations to daylight hours, and suspend observations in heavy rain, heavy winds, fog, or rough seas</td></tr>
</table>

9.12.2 Marine Megafauna Exposure, Health, and Mortality

Step	
☐	Only trained personnel are to handle live or dead stranded marine megafauna
☐	Collect and freeze all stranded animals (as far as practicable)
☐	Undertake necropsy, as required (see Section 8.5.6)
☐	Take samples of carcasses of oil-affected marine megafauna

Step	
☐	Samples may include: • swabs from externally visible oiled marine megafauna • tissue from the lung, liver, and kidney • stomach and intestinal contents • bile secretions
☐	Place samples in a small esky with frozen ice bricks. Transfer to freezer when possible for storage
☐	Complete laboratory-specific CoC forms
☐	Label, record, and cross check all samples with field sheets and CoC forms
☐	Maintain appropriate CoC and secure samples

9.13 Forms and Tools

Refer to Appendix C.

10 SCI6 – Benthic Habitat Impact Study

10.1 Aims and Objectives

The primary aim of SCI6 – Benthic Habitat Impact Study (SCI6) is to determine the extent, severity, and persistence (including recovery) of impacts on subtidal benthic habitats and biological communities following a hydrocarbon spill and associated response activities.

The final scope of the subtidal benthic habitat monitoring depends on the habitats identified within the EMBA, as well as identified reference sites outside the affected area; collectively termed the study area.

SCI6 focuses on the subtidal zone—habitats seaward of LAT, separated into nearshore (shallower than 20 m depth) and offshore (greater than 20 m depth) environments. Habitats landward of LAT (e.g. the intertidal zone) are included in SCI3 – Coastal and Intertidal Habitat Impact Study.

The objectives of SCI6 are to:

- determine the extent, severity, and likely persistence of impacts to subtidal benthic habitats and associated biological communities arising from a hydrocarbon spill and subsequent response activities
- collect information to determine short-term and long-term (including direct and indirect) impacts of hydrocarbon (and implementation of response strategies) on benthic habitats and associated biological communities, post-spill and post-response recovery, remediation efforts, and areas where monitoring may need to continue for an extended time after termination of the response

10.2 Initiation and Termination Criteria

The initiation and termination criteria for this scientific monitoring program are provided in Section 5 of the OSMP. Implementation times for this scientific monitoring program are directly linked to the initiation criteria and are found in the same section of the OSMP.

10.3 Data and Information Requirements

Table 10-1 lists the inputs relevant to planning for the implementation of SCI6, once the notification to commence is initiated.

Table 10-1: Data Requirements Summary for SCI6

Baseline Information	Operational Information	Scientific Monitoring
• Access to consolidated project-specific baseline data and baseline summary report/data/maps/models for the relevant study area • External datasets (e.g. DAWE, DoF etc.) and information, including access to raw data and metadata statements outlining data collection methods • OSRA provided by AMSA • Additional baseline data may be available from I-GEMS	Outputs from MES activities, including: • spill type • spill volume and duration • spatial extent and movement of the spill Outputs from OPS3 and OPS4 activities, including: • consolidated data file including exceedances of benchmark levels (this information should be provided in electronic format, as it becomes available).	Information available at commencement of SCI6 on survey design or results from implemented scientific monitoring (primarily SCI1, SCI2, and SCI3)

10.4 Design

10.4.1 Monitoring Design

Benthic habitats may support various biological communities during all, or part of, the year. To help inform scientific monitoring, it is important to first determine what benthic habitats are at risk and what biological resources inhabit these areas. Monitoring will concentrate on activities that help understand impacts on the most sensitive areas and will involve a combination of these monitoring strategies:

- Physical: To provide observations and measurements that describe the physical environmental conditions during benthic surveys.
- Remote sensing: To initially determine potentially impacted habitats, habitats at risk, and reference areas (outputs from the MES scope may be suitable). Once the images are ground-truthed, remote sensing can potentially be a proxy for biological monitoring of large-scale changes on shallow benthic habitats (e.g. seagrass, macroalgae).
- Biological: To determine the extent, severity, and persistence (including recovery) of impacts on benthic habitats and associated biological communities.
- Chemical studies: To identify contamination in benthic habitats.

Monitoring to identify an impact on benthic habitats will be achieved by assessing commonly monitored ecological, population, and community parameters. As far as practicable, monitoring will also be carried out on the health and condition of sensitive receptors, such as corals, seagrass, macroalgae, and non-coral benthic macroinvertebrates. The monitoring approach needs to consider the data collected during MES and operational monitoring activities. The geographic extent of the area to be monitored will be based on the hydrocarbon distribution and predicted movement of the hydrocarbon spill, as determined through the MES outcomes, and measured hydrocarbons within the water column and sediments, as determined through OPS3 and OPS4. These outputs will identify potential impact areas to be sampled, which will allow comparison of results to baseline values. Table 10-2 summarises the monitoring designs recommended for various outcomes. Section 2.1 describes these approaches in detail.

Table 10-2: Monitoring Design Approaches Recommended for Different Spill Outcomes

MES and *OPS3* Outcomes Indicate Spill Extent	Monitoring Design[1]	Replicate Sites Required[2]
Hydrocarbon plume concentrated around source, dissipating with distance	Gradient Approach	Minimum of **two** replicate sites at each distance from source
Nearshore spill or spill reaches shoreline	BACI or IvC or Gradient Approach and/or Lines of Evidence Approach	Minimum of **three** replicate sites at impact and control locations or minimum of **two** replicate sites at each distance from source
Spill interacts with area of biological importance (bay/shoal/island)	BACI or IvC and/or Lines of Evidence Approach	Minimum of **three** replicate sites at each of impact and control locations

1 Reference sites required for each monitoring approach are detailed in Section 1

10.4.2 Monitoring Sites

Sampling sites will be defined once data and information on the habitats and biological indicators (as a guide, refer to Table 10-2) are reviewed. This will help identify sensitive habitats, associated parameters, and methods.

Monitoring locations will be defined taking into account these considerations:

- likelihood of hydrocarbon impact on benthic habitats
- select several impact and reference locations over a large spatial area
- similarity and representation of habitats, physical features, and sediment type between impact and reference locations
- select and prioritise impact sites within representative benthic habitats at greatest risk of impact within the EMBA, or those within areas of protection or conservation priority
- degree of hydrocarbon exposure or potential exposure of the benthic habitats
- when selecting reference sites, key physical factors (i.e. temperature, salinity, currents, aspect, habitat type, shore profile, substrate) should not differ significantly between these and impact sites
- determine location areas (typically 0.2–2 km^2) considering resolution needs. Replicate monitoring sites will be placed within benthic habitat locations
- accessibility of habitat types.

During a large spill, dispersion of the spill may be influenced by seasonal patterns; in this case, reference sites should be selected to allow for sufficient spatial separation from potential impact areas.

10.4.3 Monitoring Parameters

10.4.3.1 Physical Monitoring Parameters

Physical monitoring will describe the physical environment during benthic surveys. Data will be sourced from SCI1 and supplemented with additional physical monitoring parameters (and methods), as detailed in Table 10-3.

Table 10-3: Physical Parameters and Methods

Parameter	Method
Sea state and weather conditions	Visual observation i.e. Beaufort Scale
Observations of hydrocarbon slicks on surface	Visual observation (see AMSA [Ref. 17], Guideline M.3)
Depth, bathymetry, and bottom profiles	Vessel depth sounder
Habitat structure (e.g. substrate type)	ROV video/drop camera observation
Water currents	Visual observation

Observations on the sea state, weather, and currents can be further supplemented by data from meteorological stations and metocean buoys (if available).

10.4.3.2 Biological Monitoring Parameters

Table 10-4 lists the proposed range of biological parameters and associated survey methods that may be monitored.

Table 10-4: Proposed Biological Parameters (including remote sensing) within Intertidal Habitat

Habitat	Method	Biological Community	Suggested Biological Survey Method	Community Parameters	Population Parameter	Individual Parameters
Coral Reef	Fine-scale benthic surveys	Coral reef	Stratified haphazard transects (e.g. within zones of: lagoon, reef flat, crest, and slope as applicable) using towed camera, drop camera, ROV camera, or diver-swum camera surveys. Divers for collection and deployment of coral reproduction parameters	• Percentage cover of taxa • Diversity • Distribution • Dominant taxa • Percentage cover of other benthic organisms	• Coral recruitment (recruits) • Juvenile coral counts • Recent (whole colony) coral mortality	• Signs of bleaching, partial mortality, number of breaks • Colony and polyp level fecundity
		Coral reef	Remote sensing	• Large-scale distribution and extent (Coastal zone)	N/A	N/A
Macroalgae and seagrass	Broad-scale benthic surveys	Macroalgae Seagrasses	Stratified haphazard transects using towed camera or ROV and benthic grab for seagrass	• Percentage cover of taxa • Diversity • Distribution • Dominant taxa • Other benthic organisms	• Abundance (seagrass/algae) • Shoot density (seagrass) • Holdfast density (macroalgae) • Biota tissue sampling (where possible and appropriate) (macroalgae)	• Blade condition (signs of blackening and defoliation) • Growth rates
			Remote sensing	• Large-scale distribution and extent (Coastal zone)	N/A	N/A
Subtidal pavement, rocky reef, or hard substrate	Broad-scale benthic surveys	• Macroalgae • Filter feeders (sponges) • Corals • Hydroids	Stratified haphazard transects using towed camera	• Percentage cover/ density • Diversity • Distribution • Dominant taxa	• Biota tissue sampling	N/A

Habitat	Method	Biological Community	Suggested Biological Survey Method	Community Parameters	Population Parameter	Individual Parameters
		• Soft corals				
Soft-bottom	Broad-scale benthic surveys	Infauna	Sediment sampling using sediment grab	• Density • Diversity • Distribution • Dominant taxa	• e.g. ratio of polychaetes/ amphipods	N/A

10.4.3.3 Chemical Monitoring Parameters

The chemical monitoring parameters to be tested and the methods for water and sediments are described in detail in SCI1 and SCI2.

10.4.4 Monitoring Frequency and Duration

Following the initiation of SCI6, surveys will be undertaken at least once a year, although are likely to be at a greater frequency (e.g. every three months) in the first year, based on the biological indicators being monitored. Survey data will be reviewed annually and the frequency of any ongoing monitoring will be determined by the data collected to date, the spatial, temporal, and seasonal variability of the biological indicators being measured and may, for example, be seasonal, six-monthly, or annual until the termination criteria are reached.

10.4.5 Sample Integrity

10.4.5.1 Physical Monitoring Methods

Table 5-3 details the physical monitoring parameters and sampling methods to be used.

10.4.5.2 Remote Sensing Methods

Remote sensing may initially be used to determine potentially impacted habitats, habitats at risk, and reference areas (outputs from the MES scope may be suitable). If practicable, remote sensing will be used to assess biological parameters within the study area to measure the condition of these habitats during scientific monitoring.

The remote sensing technique (e.g. infrared thermal imaging, synthetic aperture radar, side-looking airborne radar, satellite images) used will depend on the intended parameter to be collected (i.e. presence/absence, percentage cover), which requires evaluation of the pixel size required (i.e. coarse, medium, fine) and cost. A guideline for implementing appropriate remote sensing monitoring equipment is provided by the Remote Sensing Research Centre (Ref. 27).

To correctly calibrate remote sensing imagery, field surveys will be required to ground-truth or validate field measurements from the target area to be monitored. Remote sensing techniques are not always practicable and will probably not be suitable to characterise benthic habitat within turbid nearshore waters or substrate beyond the coastal zone (>20 m depth).

10.4.5.3 Biological Monitoring Methods

Subtidal systems are highly complex and natural spatial and temporal variation in physical and biological structure is almost always high. Biological monitoring must target the main ecological components of benthic communities that reflect the particular sensitivities of the subtidal location and that can be used as an indicator for wider community health. Potential indicator flora and fauna for each broad habitat type are summarised in Table 10-4.

Marine Flora and Epifauna Surveys

Benthic surveys are intended to enable broad-scale but detailed observations of the physical and biological structures of benthic habitats. The survey methodology for benthic habitats involves recording imagery from transects for real-time and later analysis (e.g. stills and video footage from handheld camera, towed video, drop-down camera, or ROV).

The imagery will be assessed for:

- real-time habitat classification—used to verify and map the variety and extent of the benthic habitats at risk. Observations of benthic habitat features will be recorded at fixed time intervals, or when a feature of interest or a change in habitat type is observed. These methods ensure data are collected instantaneously and can be immediately used for generating maps, allowing information to be passed to other teams within useful time frames
- quantitative analysis of high-quality still images taken during benthic transect surveys—used to measure community and health parameters for indicator taxa (e.g. Ref. 56; Ref. 57; Ref. 58 ; Ref. 59). The georeferenced still photo images will be subsampled at a standardised spatial separation then grouped for detailed point-intercept analysis. Choice of indicator taxa will be based on advice from SMEs, but will likely include corals, non-coral benthic macroinvertebrates, seagrass, and macroalgae.

Habitat data will be classified according to a hierarchal system of biophysical characteristics designed to consistently define benthic habitats (e.g. CATAMI classification scheme [Ref. 60]). The most common or dominant taxa within each assemblage should be classified to the greatest practicable taxonomic resolution. This classification depends on the clarity of the video footage, which will vary with weather conditions and water clarity. Database software should be used with pre-programmed habitat types or biota of interest, with the associated data on position and depth recorded. In the absence of this software, the GPS position and depth should be recorded at regular intervals.

Infauna Sampling

Infauna is the assemblage of animals (often microscopic) that live buried or partially buried with the sediment matrix (e.g. worms, bivalves, crustaceans). Sediment sampling collects infauna found directly below the surface in soft-substrates. Sediment samples are typically collected using a grab, although can also use trawls, dredges, box corers, suction samplers, and handheld corers (see AMSA [Ref. 17], Guideline M.9). Usually the entire sample is sieved for benthic infaunal analyses or if chemical subsamples are required; care must be taken to ensure the subsamples are very small to avoid losing organisms. Once sieving is completed, the remaining organisms are washed, fixed using formalin or ethanol (consult the identifying laboratory), stored safely, then sent to a laboratory. Because infaunal communities may be variable or patchy, it is standard practice to take replicate samples from any one site to provide an average of species richness and abundance, and provide a representative sample of the species present.

Guidance on Methods and Assessment of Potential Population Parameters

Seagrass Above- and Below-ground Biomass

Sediment grab samples will be collected within seagrass sites for above-/below-ground biomass. Sediment samples for seagrass biomass will be wet sieved with a 125 µm sieve on site and all seagrass material removed, dried on tissue paper, and weighed and frozen, before sediment and seagrass is sent to the laboratory for analysis. Seagrass material will be weighed in the laboratory.

10.4.6 Sample Analysis

The data collected will be obtained in various ways:

- Samples: Water, sediment, or tissue samples that require preservation, transport, storage, and analysis. The procedures for sampling, storage, and analysis are provided in SCI1, SCI2, and SCI7.
- Field data: Includes results from field sampling and observations.
- Photo documentation: Photographic and video evidence ranging from aerial imagery to detailed still images.

Data should be recorded in a format for easy analysis and stored for comparison with data collected in later years. Data must be organised in a way that makes it easily accessible for future reference.

Many of the monitored parameters outlined for each benthic habitat will be measured and quantified from video and still photos collected in the field. Percentage cover of common and conspicuous organisms (e.g. adult corals) will be quantified with the aid of image analysis software such as point-intercept software CPCe (Ref. 33). For relatively small or discrete organisms (e.g. polychaetes), the density of organisms will be recorded per unit area.

To assess the health and condition of indicator species within each benthic habitat, qualifiers such as those in the CATAMI classification scheme (Ref. 60; Ref. 61) will apply during the point-intercept analyses described above (e.g. for corals – healthy appearance, partially or fully bleached; Ref. 62).

Where possible, image analysis and machine learning methods will be used (e.g. Ref. 63) after verifying they provide data of similar quality and accuracy as manual image analysis.

Surveys relating to BACI designs are intended to be analysed using appropriate and rigorous statistical procedures such as ANOVA (univariate and/or multivariate approaches) or similar. Evidence of impact will be based, in part, on whether there is a statistically significant interaction following the oil spill event (Ref. 64; Ref. 65). The appropriate number of replicates to achieve a desired level of power will be determined at the end of the monitoring period.

Surveys relating to gradient designs will be analysed, where possible, based on statistical procedures described in Ellis and Schneider (Ref. 66) and Lincoln-Smith and Cooper (Ref 67) or similar. Ellis and Schneider (Ref. 66) also proposed using ANOVA to investigate changes in abundance as a function of distance, transect area, replicate, sediment size, and depth.

10.5 Data Management

A guide for data management can be found in the AMSA Oil Spill Monitoring Handbook (see Appendix B; Ref. 17).

Monitoring activities may be undertaken over many months and are likely to result in data that may be obtained/generated from several sources in various formats:

- logs and forms
- photographs and video recordings
- annotated maps
- portable GPS/GIS units.

Managing generated data requires extensive data storage, analysis, backup, and archiving. Samples should be treated as legal evidence and secured against loss or tampering. Copies of datasheets and analysis should be archived.

10.6 QA/QC Procedures

QA/QC procedures will be used minimise observer bias during real-time habit classification. This may include a training assessment with expected habitats and indicator species to encourage consistent classification scoring between observers. A QA/QC procedure will be established to objectively remove any images that are not suitable for analysis (e.g. images that are blurred, out of focus, under-/over-exposed, or otherwise of bad quality). For QA/QC of the point-intercept image analysis, a random selection of images will be re-analysed by an experienced observer to double-check for inconsistencies or misclassifications.

Species lists of benthic infauna provided by taxonomy laboratories will be QA/QC checked using these methods:

- confirming current correct nomenclature and authorities using the WoRMS Taxon Match Tool (http://www.marinespecies.org/aphia.php?p=match)
- rationalising data to remove pelagic taxa (e.g. ctenophores, chaetognaths) that are not part of the benthic community, so as to remove 'ecological noise' from the dataset
- excluding juvenile life stages from the data for analysis. Juvenile stages can provide a false assessment of level of impact and recovery because they can exhibit significant natural post-settlement mortality, which can mask or be attributed to anthropogenic impacts. Juveniles may be analysed separately to determine potential recruitment.

It is essential that appropriate procedures for metadata recording, data storage, and data backup are implemented to avoid loss of data and information, and prevent confusion or misinterpretation of valuable data collected during the monitoring program.

10.7 Mobilisation Requirements

10.7.1 Survey Planning

This checklist outlines considerations as part of the survey planning phase.

Task	
□	Determine the scale of the study area
□	Select study area sites (including impact and reference sites if applicable)
□	Select sampling approach and techniques
□	Determine sampling replication required
□	Consider data management requirements (e.g. data format, metadata, storage protocols, delivery schedule, and communication methods)
□	Develop site-specific health and safety plan
□	Develop survey/sampling plan incorporating the latest operational data
□	GIS team to prepare survey maps from the latest data
□	Check MSDSs and chemical handling procedures

Task	
☐	Undertake HAZIDs as required
☐	Develop site-specific health and safety plan, including JHAs

10.8 Logistics

These activities must be undertaken before mobilisation to the field.

Task	
☐	Arrange survey vehicles/platform (vessel, 4WD vehicle, aircraft), as required to survey or access monitoring sites
☐	Plan site access points i.e. tracks, carparks etc.
☐	Book flights, accommodation, and car hire
☐	Confirm sample analysis requirements and arrange provision of sample containers, CoC, eskies, and ice bricks. Confirm sample holding times
☐	Arrange freight of any sampling equipment and laboratory sample jars
☐	Develop field survey schedules, considering staff rotation
☐	Assemble scientific survey team
☐	Conduct pre-mobilisation meeting with the survey team, confirm scope, schedule, HES requirements

10.9 Equipment Preparation

These activities must be undertaken before mobilisation to the field, to ensure equipment is working (for an equipment list, see Section 5.12).

Tasks	
☐	Confirm specialist equipment requirements and availability: • ROV/autonomous underwater vehicle (AUV)/drop camera/towed camera • subsea positioning (if required) i.e. ultra-short baseline (USBL) • dive spread (if required) • benthic grab • remote sensing platform
☐	Check if instrument calibration is required And that calibration certificates are on file
☐	Check if equipment redundancy is required
☐	Check if a DGPS is required
☐	Confirm installation of real-time classification software (if available)
☐	Book freight to mobilisation port

10.10 Resources

Support staff, including office-based personnel and taxonomic specialists, will be required to support onshore analysis of the data collected by the field team. Accurate identification of marine benthic biological communities and species will require specialist taxonomists, and a team to sort and curate specimens. Specialist marine ecologists with knowledge of the region will determine indicator taxa, undertake peer review of reports, and conduct QA/QC of image analysis. Field teams will use individuals who are trained in subtidal assessment techniques, procedures, and terminology. Team members must have a thorough understanding of the response goals and objectives.

The field personnel required to undertake SCI6, their roles, responsibilities, and relevant qualifications are listed in Table 10-5.

Table 10-5: Field Roles and Responsibilities

Role	Responsibility	Qualifications
Field Lead/ Party Chief	• Capture survey positional data • Coordinate with vessel master and field team • Manage HES compliance • Complete daily field survey reports • Plan survey schedule	• Minimum degree-level qualification in a relevant subject • Significant field experience (including ROV and grab operations) • Facility abandonment • Offshore medical
Marine Scientists / Data Management Personnel / Field Technician (as required)	• Undertake real-time habitat classification and QA/QC of still and video footage • Data management experience • Help deploy ROVs, cameras, CTDs, cores, or grabs • Sieve and preserve benthic infauna samples • Undertake physical site observations • Record survey and sampling data • Backup digital data (including images) • Maintain equipment and resolve technical issues	• Minimum degree-level qualification in a relevant subject • Field experience • Local ecological knowledge (including benthic habitat classification and ecology) • Facility abandonment • Offshore medical
Diver / snorkeller (if required)	• Collect samples	• Australian Diving Accreditation Scheme (ADAS) Pt 1 (for snorkelling) • ADAS Pt 2 (for surface supply diving)

10.11 Equipment

It may be necessary to mobilise a vessel for transport or intertidal access depending on the remoteness of the study area and scale of the hydrocarbon spill.

The basic set of equipment requirements for SCI6 are listed below.

Items	
□	Specialist equipment: • ROV/AUV/drop camera/towed camera • USBL positioning (if required) • dive spread • multiparameter probe/CTD • benthic grab • remote sensing platform
□	Is redundancy required?
□	DGPS
□	Echo sounder on each vessel

Items	
☐	Field laptops with relevant software (e.g. CPCe, video editing, CATAMI)
☐	Backup data storage for field data
☐	Tissue preservation material and sample jars
☐	Biota/coral sampling equipment • coring or sampling tools • dissecting microscope • tissue preservation material (10% formalin and/or 70% ethanol) • sample jars
☐	Specialist PPE (i.e. PFD, respiratory protective equipment [RPE])
☐	Book freight to mobilisation port

10.12 Standard Operating Procedures (SOPs)

Sampling techniques will vary depending on the type and location of the hydrocarbon to be collected. Consistent across all techniques is:

- the profiler may require a base with weights that will help the unit sink and also protect the sensors from contacting the sediments on the seabed.

10.12.1 Stratified Haphazard Transects – Pre-mobilisation

Step	
☐	Generate a field map with the location and coordinates of all monitoring sites, including reference sites, to meet the monitoring objectives
☐	Define monitoring parameters including habitat type, boundaries, number of sites, number of transects, length of transects, and number of quadrats per transect, to meet the monitoring objectives
☐	Prepare and assemble all field equipment, including redundancies
☐	Arrange access to vessel or other suitable monitoring platform

10.12.2 Stratified Haphazard Transects – In Situ Monitoring

Step	
☐	Assess percentage cover of each habitat type at each site using photo quadrats, taken along transects
☐	Randomly select the locations of transects at each site
☐	Record and georeference the start location (latitude and longitude) of each transect, as well as the bearing and distance of each transect
☐	Use a minimum of three replicate transects at each site
☐	Randomly locate photo quadrats along each transect. Photo quadrats will cover an area of 1 m^2 (either 1 × 1 m^2 photo, or 4 × 0.25 m quadrats, depending on water conditions and available equipment)
☐	Plan for a minimum of five photo quadrats per transact. The length of each transect and the number of photo quadrats along each transect will depend on habitat characteristics and the survey objectives. Note: Standardise the length of transects and number of quadrats across sites
☐	Take photos with a still camera, or as still images from video transect footage
☐	Maintain a consistent method of capturing photographs among surveys, and where possible, across all survey sites (Note: Technology improvements may be incorporated into surveys). If practicable,

Step	
	use sufficient lighting to capture high-quality still plan (downward-facing) images (taken from a still camera or still images from video transect footage)
☐	If practicable, mark the quadrat boundary within each image as either a solid boundary (i.e. frame placed on the transect) or use underwater lasers to mark out a scale
☐	Where possible, locate transects in similar depths within sites
☐	After retrieval, QA/QC check and backup data on site
☐	Analyse data using appropriate software to determine point-intercept estimates of multiple points to define benthic habitats

10.12.3 Benthic Samples

Step	
☐	Use sediment grabs (e.g. Van Veen; refer to SCI2 for SOP) to collect five samples (minimum 250 mL jar) from each site
☐	Check that samples are at least 10 cm deep, with a minimum surface area of at least 125 cm^2
☐	From each sample, separate biological samples (plants, algae), place in jars that have been pre-cleaned with Teflon or aluminium cap / alfoil barrier
☐	Complete and check jar labels and CoC forms. Store samples as directed by the laboratory

10.13 Forms and Tools

Refer to Appendix C.

11 SCI7a – Fisheries and Aquaculture Impact Study

11.1 Aims and Objectives

The primary aim of SCI7a – Fisheries and Aquaculture Impact Study (SCI7a) is to determine the extent of impact from hydrocarbons on fish and aquaculture resources in regards to hydrocarbons detected in fish tissue if a hydrocarbon spill impacts an area considered ecologically important for fish and aquaculture resources.

The objectives of SCI7a are to:

- identify, report, and monitor lethal impacts on fish as related to the hydrocarbon spill and/or to the hydrocarbon spill response
- determine the spatial and temporal extent of sublethal impacts on indicator species, which may impact commercial and recreational fish species, including:
  - health effects attributable to the spill and/or response activities
  - tainting of the flesh and/or bioaccumulation of toxins in fish

The actual scope of fish and aquaculture resources monitoring depends on the receptors identified within the EMBA by a hydrocarbon spill. SCI7a outlines how the effects of hydrocarbon spills on bony and cartilaginous fish and aquaculture species, such as bivalves will be assessed, excluding those fish assessed under other studies, i.e. SCI5c, which covers Whale Sharks and large sharks.

11.2 Initiation and Termination Criteria

The initiation and termination criteria for this scientific monitoring program are provided in Section 5 of the OSMP. Implementation times for this scientific monitoring program are directly linked to the initiation criteria and are found in the same section of the OSMP.

11.3 Data and Information Requirements

Table 11-1 lists the inputs relevant to planning for the implementation of SCI7a, once the notification to commence is initiated.

Table 11-1: Data Requirements Summary for SCI7a

Baseline Information	Operational Information
• Existing baseline data (as documented in Chevron internal databases3F3F3F3) for marine megafauna, which were identified as being at risk from exposure of hydrocarbons. Additional baseline data may be available from: – OSRA provided by AMSA – I-GEMS (WA only) • Review methods undertaken during baseline studies to ensure that data collected during SCI7a can be directly compared to the existing baseline data	Outputs from MES, OPS3, OPS8, SCI1, and SCI2 activities, including: • spill type • spill volume and duration • spatial extent and movement of the spill • identify and map sensitive resources and key receptors within the EMBA (OPS5 and OPS7) • data streams from marine water quality monitoring (OPS3 and SCI1), including the location and concentrations of hydrocarbons in marine waters Outputs from OPS8 activities, including: • consolidated data file

11.4 Design

11.4.1 Monitoring Design

The monitoring approach needs to consider the data collected during MES, OPS3, and OPS8 activities. The geographic extent of the area to be monitored will be based on the hydrocarbon distribution, as determined through the MES, OPS3, and OPS8 outcomes. These outputs will identify potential impact areas to be sampled, which will allow comparison of results to baseline values (if available). Table 11-2 summarises the monitoring designs recommended for various outcomes. Section 2.1 describes these approaches in detail.

Table 11-2: Monitoring Design Approaches Recommended for Different Spill Outcomes

MES and *OPS3, OPS8* Outcomes Indicate Spill Extent	Monitoring Design[1]	Replicates Required
Offshore hydrocarbon plume that dissipates from source	Gradient Approach and Lines of Evidence Approach	At least two sites at each distance from source
Hydrocarbon spill interacts with nearshore areas (e.g. coral reefs, seagrass etc.)	BACI or IvC and/or Lines of Evidence Approach	Will be determined as part of program finalisation

If sufficient baseline data are not available, wherever practicable, data representing the current state of the receptors of interest will be collected before the spill reaches them.

11.4.2 Monitoring Sites

Sampling sites will be selected once the outputs from MES and OPS8 activities are generated so that the type, depth, and extent of the spill can be incorporated into the survey design.

[3] Access to data from relevant third-party providers may be required for baseline information (including CSIRO and state conservation agencies e.g. DBCA)

11.4.3 Monitoring Parameters

Indicator Species

Given the number of fish species with the potential to be in an area at any one time, indicator species need to be selected for detailed tissue and health analysis. Indicator (target) fish and aquaculture species will be selected from the identified receptors at risk within the EMBA to represent impact to fish health and will include demersal and/or pelagic commercial and recreational species based on the species available in sufficient abundance within the EMBA. The selection of a fish species as an indicator species will be based on knowledge of which species represent the most sensitive component with reference to:

- abundance within the impacted area
- distribution within the impacted area
- availability of prior baseline information
- vulnerability to the impacts of a hydrocarbon spill.

The selected indicator species must be sufficiently widespread to allow sampling both inside and outside affected areas; where low numbers of preferred indicator species are collected, alternative species may need to be considered during the survey. Representative indicator fish species and aquaculture species will be collected using methods appropriate to the sampling habitat, characteristics of the target species, and the life-history stage. The samples collected in impacted areas will be compared to samples collected at suitable reference sites. If fish kill occurs, whole fish will be obtained and preserved for necropsy to attempt to determine the cause of death.

Table 11-3 summarises the monitoring parameters.

Table 11-3: Selection of Parameters for Assessment

Type	Parameter
Physiological indicators and biochemical markers	• Condition factor • Liver-somatic index • Gonadosomatic index and histological examination of gonads • Oxidative DNA damage • Liver detoxification enzymes • Biliary PAH metabolites • Sorbitol dehydrogenase (SDH) activity
Muscle tissue, biopsy, and gut content samples	• PAH and the standard USEPA list of 16 priority pollutants • Saturated hydrocarbons in the C10 to C36 range • Volatile hydrocarbons.
Blood serum	• SDH activity • Oxidative DNA damage (8-oxo-dG content)
Bile	• Biliary metabolites
Gonads	• Histology assessment
Fish mortality	• Dead fish count

11.4.4 Monitoring Frequency and Duration

The study will be undertaken at intervals determined appropriate at the time of commencement. The frequency and number of repeat studies required to meet the objectives for SCI7a will be determined by the level of impacts from the hydrocarbon spill and achievement of the termination triggers.

11.4.5 Sample Integrity

Methods for specimen handling were derived from Gagnon and Rawson (Ref. 44; Ref. 45) and Burns *et al*. (Ref. 43). In summary, the general requirements for samples are:

- Fish flesh for chemical analysis will be wrapped in HPLC-grade solvent-rinsed aluminium foil and frozen at 20 °C.
- Fish flesh for taint testing will be wrapped in food-approved ziplock bags and frozen at 20 °C.
- Biopsies of solid tissues and bile must be placed in a sterile cryovial and immediately frozen in liquid nitrogen at 190 °C.
- Biopsies of blood need to be centrifuged, serum isolated, and placed in a cryogenic vial at 190 °C.

Care should be taken not to contaminate samples; work spaces should be thoroughly cleaned and decontaminated between samples.

White flesh samples collected for taint testing and for chemical analysis must be treated as two different samples. Chemical analysis requires 25 g of flesh whereas taint testing requires 400 g.

Jars and plastic bags must be labelled with all relevant information including: species, location, identification number, and date. The sample number is related to a record containing species name, size, type of tissue, handling details, capture location, capture depth, and all observations of health, presence of visible hydrocarbons, etc.

11.4.6 Sample Analysis

Chemical analysis of fish tissues for hydrocarbon will follow the procedures outlined in Burns *et al*. (Ref. 43) and Gagnon and Rawson (Ref. 44; Ref. 45). Equivalent procedures may also be considered provided they are capable of yielding information of equivalent or superior quality. Onshore chemical analysis will, where relevant, be completed at an ecotoxicology laboratory.

Statistical analysis of fish tissue data will be undertaken and may include regression analysis relating hydrocarbon concentrations in the water column (or other relevant exposure index) to concentrations in fish tissues and various indexes and biochemical markers of fish health. Other analytical methods including mixed-effect linear models or analysis of similarities could also be used to examine before-after and impact-reference effects (and the interaction), in accordance with the sampling design implemented.

11.5 Data Management

Monitoring activities may be undertaken over several years and are likely to result in data that may be obtained/generated from several sources in various formats. All records will be kept in a field log. This log will be copied to an electronic spreadsheet/database at the end of each day.

Data (including GPS locations and photos) will be backed up to a separate location, e.g. external hard drive. This will result in two electronic copies. All field datasheets will be kept. All electronic and field data will be transported by the demobilising survey team at the completion of the surveys. Data analysis will occur in the office.

Data received from the laboratories (including backups) will be downloaded and stored on the contractor's computer system. This data will be received approximately two to three weeks after receipt of that batch of samples. QA/QC'd data will be presented in spreadsheet format and then transferred to Chevron as required.

Managing the generated data requires extensive data storage, analysis, backup, and archiving. Samples should be treated as legal evidence and secured against loss or tampering. Copies of datasheets and analysis should be archived.

11.6 QA/QC Procedures

For each fish collected, a datasheet will be completed, which will contain this information as a minimum:

- date
- site number
- species
- sample identification
- location of capture (coordinates)
- health of specimen (including abnormalities/signs of stress) as per Section 1.5.2
- basic morphological measurements (including length, weight, gonad weight, liver weight, sex, and reproductive stage) as per Section 1.5.2
- sample types taken
- photos of specimen taken (with sample identification visible in photograph)
- preservation method
- relevant CoC reference
- notes.

11.7 Mobilisation Requirements

11.7.1 Survey Planning

This checklist outlines considerations as part of the survey planning phase.

Task	
◻	Determine the scale of the study area
◻	Select study area sites (including impact and reference sites if applicable)
◻	Select sampling approach and techniques
◻	Determine sampling replication required

Task	
☐	Consider data management requirements (e.g. data format, metadata, storage protocols, delivery schedule, and communication methods)
☐	Develop site-specific health and safety plan
☐	Develop survey/sampling plan incorporating the latest operational data
☐	GIS team to prepare survey maps from the latest data
☐	Check MSDSs and chemical handling procedures
☐	Undertake HAZIDs as required
☐	Develop site-specific health and safety plan, including JHAs

11.8 Logistics

These activities must be undertaken before mobilisation to the field.

Task	
☐	Assemble scientific survey team
☐	Undertake HAZIDs as required and consolidate/review field documentation including safety plans, emergency response plans, and daily field reports
☐	GIS team to prepare survey maps
☐	Confirm data formats and metadata requirements with data manager
☐	Purchase consumables
☐	Arrange survey platform (vessel, vehicle, aircraft) as required to survey or access monitoring sites
☐	Confirm information on sample holding times and the requirements for collecting and transporting tissue samples to Perth-based laboratories
☐	Coordinate NATA-accredited laboratories to confirm availability, limits of detection, obtain sample analysis quotes, and arrange provision of appropriate sample containers, CoC forms, eskies, and ice blocks
☐	Book flights, accommodation, and car hire
☐	Conduct pre-mobilisation meeting with the survey team
☐	Develop field survey schedules, detailing staff rotation.

11.9 Equipment Preparation

These activities must be undertaken before mobilisation to the field, to ensure equipment is working (for an equipment list, see Section 3.12).

Task	
☐	Confirm equipment resources and availability
☐	Check all GPS units and digital cameras are working and that sufficient spare batteries and memory cards are available
☐	Check field laptops, ensuring they have batteries, power cable, licences, login credentials, and are functional
☐	Check video cameras, ensuring they have sufficient batteries, storage media, power cables, and are functional
☐	Arrange transport of equipment to mobilisation point

11.10 Resources

The personnel required to undertake SCI7a, their roles, and relevant qualifications are listed in Table 11-4.

Table 11-4: Field Roles and Responsibilities

Role	Responsibility	Qualifications
Fish pathologist, or suitably experienced marine scientist	• Develop sampling plan • Manage deck operations • Liaise with vessel crew and master • Confirm that work is undertaken safely and conditions are safe • Collect samples • Ensure sample integrity and data quality	• Minimum degree in relevant subject • Fish collection experience • TBOSIET • Offshore medical
Ecotoxicologists for collection and handling of biopsies	• Undertake on-board fish biopsies • May also assist in collecting samples if suitably qualified • Handle, store, and label samples according to guidelines	• Field biopsy experience • TBOSIET • Offshore medical

11.11 Equipment

Chemical analysis of tissue samples will require an extensive list of equipment for extracting the tissue and examining fish health; a complete list should be developed in consultation with the ecotoxicologist responsible for biopsy collection and handling.

Appropriate sampling equipment for collecting live specimens will also be required, and will depend on the specific receptors being examined, and the location of sampling. This will be established during the operational phase of the spill response.

Redundancy for key pieces of equipment should also be considered.

11.12 Standard Operating Procedures (SOPs)

11.12.1.1 Fisheries and Aquaculture Species Exposure and Health

Field studies to collect fish and other species will be undertaken at various reference and potentially impacted sites. As far as practicable, specimens collected for sampling must be sacrificed immediately for biopsy collection. These samples will be used to determine the extent of contamination in tissues (tainting), as well as assess associated physiological stress.

Table 11-5: Steps for Sampling Fish Health, Tainting, and Fish Mortality

Step	
Fish Health and Tainting Samples	
☐	Investigate potential indicator species once the location and extent of the spill is known
☐	Collect fish. Potential collection methods may include: netting, trawling, baited fish traps, spear fishing, and line fishing, depending on species selected and spill location
☐	Collect a target sample size of 20 individuals per species per site

<table>
<tr><th colspan="2">Step</th></tr>
<tr><td>☐</td><td>At each site, complete the field log , including details on:
• weather conditions
• time arrived at site
• environmental conditions at the site
• presence of a hydrocarbon slick
• sample details for individual samples/health assessments/fish mortality
• sample description notes
• location of each sample (GPS coordinates, place names e.g. Sandy Island – western side)
• full name of person taking sample
• full name of witness (if sampling for legal purposes)
• photograph numbers recorded at this site
• time departed site</td></tr>
<tr><td>☐</td><td>Take photographs throughout the sampling process and add the reference number to the field log</td></tr>
<tr><td>☐</td><td>Identify samples, look for any visible signs of abnormality or physical stress, photograph the sample, and record the geographic coordinates of the place of capture</td></tr>
<tr><td>☐</td><td>Take measurements of basic morphological data, including: length, weight, gonad weight, liver weight, sex, and reproductive stage</td></tr>
<tr><td>☐</td><td>If biopsies are not to be done straight after specimen capture, then keep specimens alive in oxygenated aquariums until ready for biopsy</td></tr>
<tr><td>☐</td><td>Obtain tissue and gut contents samples:
• a target of 400 g of white flesh per sample (fish) for hydrocarbon analysis (tainting) or equivalent for other species (e.g. bivalves)
• a target of 25 g of white flesh per sample (fish) for chemical analysis or equivalent for other species (e.g. bivalves)
Analyse tissues and gut contents for:
• PAH and the standard USEPA list of 16 priority pollutants via normal phase silica chromatography and GCMS
• saturated hydrocarbons in the C10 to C36 range via by flame ionisation GC
• volatile hydrocarbons via purge and trap into a GCMS</td></tr>
<tr><td>☐</td><td>Blood serum, gall bladder, bile, liver, and gonad samples will be processed and analysed at a suitable laboratory for the parameters listed in Section 12.5.1</td></tr>
<tr><td>☐</td><td>Handle and preserve samples appropriately; mark all samples with appropriate sampling information as listed in Section 12.5.1.</td></tr>
<tr><th colspan="2">Collecting Dead Fish</th></tr>
<tr><td>☐</td><td>If fish kill is observed, collect and preserve (freeze) whole, dead fish for necropsy. If many dead fish are evident, estimate the total number and retain a reduced number (~20 fish per species) of representative specimens for necropsy. Comply with the standard procedure for reporting fish kills to the relevant state fisheries authorities.</td></tr>
</table>

11.13 Forms and Tools

Refer to Appendix C.

12 SCI7b – Fish Impact Study

12.1 Aims and Objectives

The primary aim of SCI7b – Fish Impact Study (SCI7b) is to determine the extent of impact on populations and abundance of fish and fisheries resources if a hydrocarbon spill impacts an area considered ecologically important for fish and fisheries resources.

The actual scope of the fish and fisheries resources monitoring depends on the receptors identified within the EMBA by the hydrocarbon spill. SCI7b outlines how the indirect effects on bony and cartilaginous fish populations and abundance will be assessed, excluding those fish assessed under other studies, e.g. SCI6, which covers Whale Sharks and large sharks.

The objective of SCI7b is to determine whether the spill has directly or indirectly impacted the abundance and composition of fish assemblages.

12.2 Initiation and Termination Criteria

The initiation and termination criteria for this scientific monitoring program are provided in Section 5 of the OSMP. Implementation times for this scientific monitoring program are directly linked to the initiation criteria and are found in the same section of the OSMP.

12.3 Data and Information Requirements

Table 12-1 lists the inputs relevant to planning for the implementation of SCI7b, once the notification to commence is initiated.

Table 12-1: Data Requirements Summary for SCI7b

Baseline Information	Operational Information
• Access to consolidated project-specific baseline data (Excel file) and baseline summary report/data for the relevant location • For many fish species, a range of baseline datasets exists for both pelagic (e.g. State Fisheries) and demersal species (e.g. State Governmental Environmental Agencies) • Review methods undertaken during baseline studies, if available, to ensure that data collected during SCI7b can be directly compared to the existing baseline data.	Outputs from MES activities, including: • spill type • spill volume and duration • spatial extent and movement of the spill Outputs from OPS3 and SCI1: • data streams from marine water quality monitoring (OPS3 and SCI1), including the location and concentrations of hydrocarbons in marine waters

12.4 Design

12.4.1 Monitoring Design

The monitoring approach needs to consider the data collected during MES and OPS3 activities. The geographic extent of the area to be monitored will be based on the hydrocarbon distribution, as determined through the MES and OPS3 outcomes. These outputs will identify potential impact areas to be sampled, which will allow comparison of results to baseline values (if available). Table 12-2 summarises the monitoring designs recommended for various outcomes. Section 2.1 describes these approaches in detail.

Table 12-2: Monitoring Design Approaches Recommended for Different Spill Outcomes

MES and *OPS3, OPS8* Outcomes Indicate Spill Extent	Monitoring Design[1]	Replicates Required
Offshore hydrocarbon plume dissipating from source	Gradient Approach	Will be determined as part of program finalisation
Hydrocarbon spill interacts with nearshore areas (e.g. coral reefs, seagrass etc.)	BACI or IvC and/or Lines of Evidence Approach	Will be determined as part of program finalisation

If sufficient baseline data are not available, data representing the current state of the receptors of interest will be collected before the spill reaches them, where practicable.

Additional parameters, such as measured hydrocarbon concentrations at sample sites (obtained through other OPS and SCI activities) can help establish a cause and effect relationship. This highlights that an essential link exists between the sampling design developed for SCI7b, and that used during other OPS and SCI activities. As such, the sampling designs developed here for each objective should be considered when designing other relevant monitoring activities.

12.4.2 Monitoring Sites

Sampling sites will be selected once the outputs from the MES and OPS3 activities are generated so that the type, depth, and extent of the spill can be incorporated into the survey design.

If a spill event occurs and baseline data are not available and cannot be collected immediately before impact, greater sampling effort must be undertaken to ensure that the sampling design incorporates at least three reference sites and three potentially impacted sites (Ref. 44) to maximise the possibility for attributing cause and/or detecting change. Reference sites are those that are minimally disturbed regarding their physical, chemical, and biological characteristics (Ref. 68). Reference sites should be selected in the same bioregion as the impacted sites to have comparable physical, chemical, and biological characteristics.

12.4.3 Monitoring Parameters

Assessments of fish populations will use methods that relate to the particular species identified to be at risk.

Data will be obtained for replicate sites within the EMBA and at reference sites, and relative abundance of fishes (both total and for selected indicator species) and species richness will be determined using standard statistical procedures. The main parameters recorded will be:

- species identification
- fish counts.

12.4.4 Monitoring Frequency and Duration

The study will be undertaken at intervals determined appropriate at the time of commencement. The frequency and number of repeat studies required to meet the objectives for SCI7b will be determined by the level of impacts from the Level 3 hydrocarbon spill and achievement of the termination triggers.

12.4.5 Sample Integrity

Observations using baited remote underwater video stations (BRUVS) will, if practicable, be conducted during SCI7a. If possible, the vessel will move away from the catch area to a suitable site to conduct BRUVS while biopsies are conducted.

BRUVS footage will be downloaded and backed up (two copies) before leaving each site.

12.4.6 Sample Analysis

Statistical analysis will be undertaken using approaches suitable to the overall sampling design established, will involve evaluating differences between impact sites and suitable reference sites, and will consider any existing baseline data (where available). Wherever possible, direct quantitative information of exposure (e.g. ancillary data on the hydrocarbon concentrations of water and sediment samples) will be used to strengthen analysis conclusions. In addition, information from other SCI activities (e.g. SCI4) will be used as additional covariates in analyses to examine potential indirect effects so as to avoid confounding effects and improve statistical power. Ancillary information—such as habitat complexity and type—should also be collected (where feasible) to serve as additional predictors in statistical models to evaluate potential confounding factors and reduce error variance, thereby improving statistical power (Ref.69).

12.4.6.1 BRUVS Analysis

High-definition stereo BRUVS footage will be converted from .m2ts to .mpeg format using Elecard Converter Studio AVC HD V 3.0. EventMeasure and PhotoMeasure software (Ref. 70) will be used to view and analyse footage for measures of fish species richness, relative abundance for all species, and size structure for the ten most abundant species. All fish data and still reference images will be run through QA/QC procedures before being provided to Chevron.

12.4.6.2 ROV Video and Towed/Diver Video Analysis

Analysis of video transects will be conducted in two stages. First, taxon counts will be determined by viewing the video at normal speed and recording identifiable fish as they pass through the ‘gate’ formed by the two laser dots. Second, frame grabs will be extracted from the video at five-second intervals. The video footage and still images will be analysed for measures of fish species richness, relative abundance for all species, and size structure for the ten most abundant species. All fish data and still reference images will be run through QA/QC procedures before being provided to Chevron.

12.5 Data Management

Field data must be stored securely and maintained. To achieve this, the field team will follow these procedures:

- enter metadata for each video file recorded into prepared electronic spreadsheets
- download data at the completion of each site.

Data will be backed up to a separate location (e.g. external hard drive). This will result in two electronic copies. All field datasheets will be kept. All electronic and field data will be transported by the demobilising survey team at the completion of the surveys. Data analysis will occur in the office.

Managing the generated data requires extensive data storage, analysis, backup, and archiving. Samples should be treated as legal evidence and secured against loss or tampering. Copies of datasheets and analysis should be archived.

12.6 QA/QC Procedures

For each site sampled, a summary of high-level information will be captured in the datasheet, and will contain this information as a minimum:

- date
- site number
- GPS location
- general family/species
- numbers
- notes.

12.7 Mobilisation Requirements

12.7.1 Survey Planning

This checklist outlines considerations as part of the survey planning phase.

Task	
☐	Determine the scale of the study area
☐	Select study area sites (including impact and reference sites if applicable)
☐	Select sampling approach and techniques
☐	Determine sampling replication required
☐	Consider data management requirements (e.g. data format, metadata, storage protocols, delivery schedule, and communication methods)
☐	Develop site-specific health and safety plan
☐	Develop survey/sampling plan incorporating the latest operational data
☐	GIS team to prepare survey maps from the latest data
☐	Check MSDSs and chemical handling procedures
☐	Undertake HAZIDs as required
☐	Develop site-specific health and safety plan, including JHAs

12.8 Logistics

These activities must be undertaken before mobilisation to the field.

Task	
☐	Assemble scientific survey team
☐	Undertake HAZIDs as required and consolidate/review field documentation including safety plans, emergency response plans, and daily field reports

Task	
☐	GIS team to prepare survey maps
☐	Confirm data formats and metadata requirements with data manager
☐	Purchase consumables
☐	Arrange survey platform (vessel, vehicle, aircraft) as required to survey or access monitoring sites
☐	Confirm information on sample holding times and the requirements for collecting and transporting tissue samples to Perth-based laboratories
☐	Coordinate NATA-accredited laboratories to confirm availability, limits of detection, obtain sample analysis quotes, and arrange provision of appropriate sample containers, CoC forms, eskies, and ice blocks
☐	Book flights, accommodation, and car hire
☐	Conduct pre-mobilisation meeting with the survey team
☐	Develop field survey schedules, detailing staff rotation.

12.9 Equipment Preparation

These activities must be undertaken before mobilisation to the field, to ensure equipment is working (for an equipment list, see Section 3.12).

Task	
☐	Confirm equipment resources and availability
☐	Check all GPS units and digital cameras are working and that sufficient spare batteries and memory cards are available
☐	Check field laptops, ensuring they have batteries, power cable, licences, login credentials, and are functional
☐	Check video cameras, ensuring they have sufficient batteries, storage media, power cables, and are functional
☐	Arrange transport of equipment to mobilisation point

12.10 Resources

The personnel required to undertake SCI7b, their roles, and relevant qualifications are listed in Table 12-3.

Table 12-3: Field Roles and Responsibilities

Role	Responsibility	Qualifications
Fish biologist	• Develop sampling plan • Collect samples • Ensure sample integrity and data quality	• Minimum degree in relevant subject • BRUVS and/or ROV experience • TBOSIET • Offshore medical
BRUVS/ROV Operator	• Manage deck operations • Liaise with vessel crew and master • Confirm that work is undertaken safely and conditions are safe	• Qualified BRUVS/ROV operator • TBOSIET • Offshore medical

12.11 Equipment

Depending on the exact scope of the study and the receptors being examined, other necessary equipment may include equipment to record footage to be used to determine population and community status (e.g. ROV-based still or video camera for image capture for demersal fish surveys, or BRUVS equipment).

Redundancy for key pieces of equipment should also be considered.

12.12 Standard Operating Procedures (SOPs)

Assessments of fish populations will be carried out via field studies, based on methods that relate to the particular receptors identified at risk. Because fish populations can show considerable natural fluctuations and are subject to additional anthropogenic pressures from other sources (e.g. recreational and commercial fisheries), it can be difficult to isolate impacts from a single pressure. Thus obtaining useful baseline data is particularly important, especially in the case of a large spill when reference sites may be difficult to obtain. For all fish population surveys, data will be obtained for replicate sites within and outside the EMBA, and comparison of relative abundance of fishes (both total and for selected indicator species) and species richness will be determined using standard statistical procedures.

For pelagic fish species, trolling and/or BRUVS (Ref. 71) surveys will assess fish population status. If important commercial fisheries species are potentially impacted, methods that align with usual population assessment surveys will be adopted (e.g. Ref. 72). For demersal fishes, methods should align with standard government procedures (e.g. Ref. 73) and commercial methods, where relevant, and may involve video transects (Ref. 74) captured using suitable methods, e.g. ROVs or BRUVS surveys (Ref. 71).

Table 12-4: Steps for Sampling Fish Health~~, Tainting,~~ and Fish Mortality

Step	
☐	Use appropriate survey equipment/methods (e.g. BRUVS, ROV, towed video or diver-swum video transects), depending on species selected and spill location
☐	Deploy up to eight replicate BRUVS units/transects at each site
☐	Deploy BRUVS/other equipment from vessels using Hiabs or equivalent
☐	Separate sampling stations by at least 250 m between BRUVS to avoid overlapping bait plumes and reduce the likelihood of fish moving between deployments within the sampling period
☐	Deploy for at least 60 minutes to maximise measures of diversity and relative abundance of fish
☐	A detail description of BRUVS technological requirements, methods, and recommended procedures is found in Heyward *et al*. (Ref. 75) (Section 4.2.1 for camera set up and field sampling procedures, and Section 4.2.2 for fish community analysis and video processing, pp. 128–1332)

12.13 Forms and Tools

Refer to Appendix C.

13 SCI8 – Heritage (including Shipwrecks)

13.1 Aims and Objectives

The primary aim of SCI8 – Heritage (including Shipwrecks) is to determine the extent, severity, and persistence of impacts on heritage features—including shipwrecks—following a hydrocarbon spill and associated response activities.

The final scope of the subtidal benthic habitat monitoring depends on the habitats identified within the environment that may be affected (EMBA), as well as identified reference sites outside the affected area; collectively termed the study area.

SCI6 is focused on the subtidal zone, which is defined as habitats seaward of LAT and are separated into nearshore (shallower than 20 m depth) and offshore (greater than 20 m depth) environments. Habitats landward of LAT (e.g. the intertidal zone) are included in SCI3 – Coastal and Intertidal Habitat Impact Study.

The objectives of SCI6 are to:

- Determine the extent, severity and likely persistence of impacts to subtidal benthic habitats and associated biological communities arising from a hydrocarbon spill and subsequent response activities
- Collect information for the purposes of determining; short-term and long-term (including direct and indirect) impacts of hydrocarbon (and implementation of response strategies) on benthic habitats and associated biological communities, post-spill and post-response recovery, remediation efforts, and areas where monitoring may need to continue for an extended time following the termination of the response

13.2 Initiation and Termination Criteria

The initiation and termination criteria for this scientific monitoring program are provided in Section 5 of the OSMP. Implementation times for this scientific monitoring program are directly linked to the initiation criteria and are found in the same section of the OSMP.

13.3 Data and Information Requirements

Table 13-1 lists the inputs relevant to planning for the implementation of SCI8, once the notification to commence is initiated.

Table 13-1: Data Requirements Summary for SCI8

Baseline Information	Operational Information	Scientific Monitoring
• Access to consolidated project-specific baseline data and baseline summary report/data/maps/models for the relevant study area • External datasets (e.g. DAWE, DoF etc.), information, including access to raw data and metadata statements outlining data collection methods • OSRA provided by AMSA • Additional baseline data may be available from I-GEMS	Outputs from MES including: • spill type • spill volume and duration • spatial extent and movement of the spill Outputs from OPS3 and OPS4 including: • consolidated data file including exceedances of benchmark levels • this information should be provided in electronic format, as it becomes available.	Information available at commencement of SCI6 on survey design or results from implemented Scientific Monitoring (primarily *SCI1, SCI2*, and *SCI3 – Coastal and Habitat Impact Study*).

13.4 Design

13.4.1 Monitoring Design

Benthic habitats may support a variety of biological communities during all, or part of, the year. To assist in informing scientific monitoring, it is important to first determine what benthic habitats are at risk and what biological resources inhabit these areas. Monitoring will concentrate on activities to assist in understanding impacts on the most sensitive areas and will involve a combination of:

- Physical: To provide observations and measurements used to describe the physical environmental conditions during benthic surveys.
- Remote sensing: To initially determine potentially impacted habitats, habitats at risk and reference areas (outputs from MES scope may be suitable). Once the images are ground-truthed, remote sensing can potentially be used as a proxy for biological monitoring of large scale changes on shallow benthic habitats e.g. seagrass and macroalgae.
- Biological: To determine the extent, severity and persistence (including recovery) of impacts on benthic habitats and associated biological communities.
- Chemical studies: To identify contamination in benthic habitats.

Monitoring to identify an impact on benthic habitats will be achieved by an assessing commonly monitored ecological, population and community based parameters. Monitoring will, as far as practicable, also be carried out on the health and condition of sensitive receptors, such as corals, seagrass, macroalgae and non-coral benthic macroinvertebrates. The monitoring approach needs to consider the data collected during MES and operational monitoring activities. The geographic extent of the area to be monitored will be based on the hydrocarbon distribution and predicted movement of the hydrocarbon spill, as determined through the MES outcomes, and measured hydrocarbons within the water column and sediments, as determined through OPS3 and OPS4. These outputs will identify potential impact areas to be sampled, which will allow comparison of results to baseline values. Table 10-2 summarises the monitoring designs recommended for various outcomes. Section 2.1 describes these approaches in detail.

Table 13-2: Monitoring Design Approaches Recommended for Different Spill Outcomes

MES and *OPS3* Outcomes Indicate Spill Extent	Monitoring Design[1]	Replicate Sites Required[2]
Hydrocarbon plume concentrated around source, dissipating with distance	Gradient Approach	Minimum of **two** replicate sites at each distance from source
Nearshore spill or spill reaches shoreline	BACI or IvC or Gradient Approach and/or Lines of Evidence Approach	Minimum of **three** replicate sites at impact and control locations or minimum of **two** replicate sites at each distance from source
Spill interacts with area of biological importance (bay/shoal/island)	BACI or IvC and/or Lines of Evidence Approach	Minimum of **three** replicate sites at each of impact and control locations

1 Reference sites required for each monitoring approach are detailed in Section 1

13.4.2 Monitoring Sites

Sampling sites will be defined once data and information on the habitats and biological indicators (as a guide refer to Table 3) have been reviewed. This will aid with the identification of sensitive habitats, associated parameters and methods.

Monitoring locations will be defined using the following considerations:

- Likelihood of hydrocarbon impact on benthic habitats
- Select several impact and reference locations over a large spatial area
- Similarity and representation of habitats, physical features and sediment type between impact versus reference locations
- Impact sites will be selected and prioritised within representative benthic habitats at greatest risk of impact within the EMBA, or those within areas of protection or conservation priority
- The degree of hydrocarbon exposure or potential exposure of the benthic habitats
- When selecting reference sites, key physical factors (i.e. temperature, salinity, currents, aspect, habitat type, shore profile, substrate) should not differ significantly between these and impact sites
- Determine location areas (typically 0.2–2 km^2) considering resolution needs. Replicate monitoring sites will be placed within benthic habitat locations
- Accessibility of habitat types.

During a large spill, dispersion of the spill may be influenced by seasonal patterns; in this case reference sites should be selected to allow for sufficient spatial separation from potential impact areas.

13.4.3 Monitoring Parameters

Physical monitoring will describe the physical environment during benthic surveys. Data will be sourced from SCI1 and supplemented with additional physical monitoring parameters (and methods) detailed in Table 13-3.

Table 13-3: Physical Parameters and Methods

Parameter	Method
Sea state and weather conditions	Visual observation i.e. Beaufort Scale
Observations of hydrocarbon slicks on surface	Visual observation (see AMSA [Ref. 17], Guideline M.3)
Depth, bathymetry, and bottom profiles	Vessel depth sounder
Habitat structure (e.g. substrate type)	ROV video/drop camera observation
Water currents	Visual observation

Observations on the sea state, weather, and currents can be further supplemented by data from meteorological stations and metocean buoys (if available).

Quantifying biological response to oil is dealt with under other SCI monitoring components; however, if biological growth may affect heritage features (i.e. increased bacteria causing corrosion or breakdown of material), additional biological monitoring parameters on heritage features, including shipwrecks, may be done. This may include quantifying bacteria and algae growing on structures.

13.4.4 Monitoring Frequency and Duration

Following the initiation of SCI8, surveys will be undertaken at least once a year, although are likely to be at a greater frequency (e.g. every three months) in the first year, based on the biological indicators being monitored. Survey data will be reviewed annually and the frequency of any ongoing monitoring will be determined by the data collected to date, the spatial, temporal, and seasonal variability of the biological indicators being measured and may, for example, be seasonal, six-monthly, or annual until the termination criteria are reached.

13.4.5 Sample Integrity

Table 13-3 details the physical monitoring parameters and sampling methods to be used.

13.4.6 Sample Analysis

The data collected will be obtained in various ways:

- Samples: Water, sediment or tissue samples that require preservation, transport, storage and analysis. The procedures for sampling, storage and analysis are provided in SCI1, SCI2 and SCI7.
- Field data: This includes results from field sampling and observations.
- Photo documentation: Photographic and video evidence ranging from aerial imagery to detailed still images.

Data should be recorded in a format for easy analysis and stored for comparisons with data collected in later years. It is essential that data be organised in a way, which makes them easily accessible for future reference.

Many of the monitored parameters outlined for each benthic habitat will be measured and quantified from video and still photos collected in the field. Percentage cover of common and conspicuous organisms (e.g. adult corals) will be quantified with the aid of image analysis software such as point-intercept software Coral Point Count with Excel extension (CPCe) (Ref. 33). For relatively small or discrete organisms (e.g. polychaetes) the density of organisms will be recorded per unit area.

To assess the health and condition of indicator species within each benthic habitat, qualifiers such as those in the CATAMI classification scheme (Ref. 60; Ref. 61) will apply during the point-intercept analyses described above (e.g. for corals – healthy in appearance, partially bleached or fully bleached; Ref. 62).

Image analysis and machine learning methods will be used, where possible (e.g. Ref. 63), following verification they provide data of similar quality and accuracy as manual image analysis.

Surveys relating to BACI designs are intended to be analysed using appropriate and rigorous statistical procedures such as ANOVA (univariate and or multivariate approaches) or similar. Evidence of impact will be based, in part, on whether there is a statistically significant interaction following the oil spill event (Ref. 64; Ref. 65). The appropriate number of replicates to achieve a desired level of power will be performed at the end of the monitoring period.

Surveys relating to gradient designs will be analysed, where possible, based on statistical procedures described in Ellis and Schneider (Ref. 66) and Lincoln-Smith and Cooper (Ref 67) or similar. Ellis and Schneider (Ref. 66) also proposed using ANOVA to investigate changes in abundance as a function of distance, transect area, replicate, sediment size and depth.

13.5 Data Management

A guide for data management can be found in the AMSA Oil Spill Monitoring Handbook (see Appendix B; Ref. 17).

Monitoring activities may be undertaken over many months and are likely to result in data that may be obtained/generated from several sources in various formats:

- logs and forms
- photographs and video recordings
- annotated maps
- portable GPS/GIS units.

Managing the generated data requires extensive data storage, analysis, backup, and archiving. Samples should be treated as legal evidence and secured against loss or tampering. Copies of datasheets and analysis should be archived.

13.6 QA/QC Procedures

QA/QC procedures will be used minimise observer bias during real-time habit classification. This may include a training assessment with expected habitats and indicator species to encourage consistent classification scoring between observers. A QA/QC procedure will be established to objectively remove any images that are not suitable for analysis (e.g. images that are blurred, out of focus, under-/over-exposed or otherwise of bad quality). For QA/QC of the point-intercept image analysis, a random selection of images will be re-analysed by an experienced observer to double-check for inconsistencies or misclassifications.

Species lists of benthic infauna provided by taxonomy laboratories will be QA/QC checked using the following methods:

- confirming current correct nomenclature and authorities using the WoRMS Taxon Match Tool (http://www.marinespecies.org/aphia.php?p=match)

- rationalising data to remove pelagic taxa (e.g. ctenophores, chaetognaths) that are not part of the benthic community, so as to remove 'ecological noise' from the dataset
- excluding juvenile life stages from the data for analysis. Juvenile stages can provide a false assessment of level of impact and recovery because they can exhibit significant natural post-settlement mortality, which can mask or be attributed to anthropogenic impacts. Juveniles may be analysed separately to determine potential recruitment.

It is essential that appropriate procedures for metadata recording, data storage, and data backup are implemented to avoid loss of data and information, and prevent confusion or misinterpretation of valuable data collected during the course of the monitoring program.

13.7 Mobilisation Requirements

13.7.1 Survey Planning

This checklist outlines considerations as part of the survey planning phase.

Task	
☐	Determine the scale of the study area
☐	Select study area sites (including impact and reference sites if applicable)
☐	Select sampling approach and techniques
☐	Determine sampling replication required
☐	Consider data management requirements i.e. data format, metadata, storage protocols, delivery schedule and communication method
☐	Develop site-specific health and safety plan
☐	Develop survey/sampling plan incorporating the latest operational data
☐	GIS team to prepare survey maps from the latest data
☐	Check MSDSs and chemical handling procedures
☐	Undertake HAZIDs as required
☐	Develop site-specific health and safety plan, including JHAs

13.8 Logistics

These activities must be undertaken before mobilisation to the field.

Task	
☐	Arrange survey vehicles/platform (vessel, 4WD vehicle, aircraft), as required to survey or access monitoring sites
☐	Plan site access points i.e. tracks, carparks etc.
☐	Book flights, accommodation, and car hire
☐	Confirm sample analysis requirements and arrange provision of sample containers, CoC, eskies, and ice bricks. Confirm sample holding times
☐	Arrange freight of any sampling equipment and laboratory sample jars
☐	Develop field survey schedules, considering staff rotation

Task	
☐	Assemble scientific survey team
☐	Conduct pre-mobilisation meeting with the survey team, confirm scope, schedule, HES requirements

13.9 Equipment Preparation

These activities must be undertaken before mobilisation to the field, to ensure equipment is working (for an equipment list, see Section 5.12).

Tasks	
☐	Confirm specialist equipment requirements and availability • ROV/AUV/drop camera/towed camera • subsea positioning (if required) i.e. USBL • dive spread (if required) • benthic grab • remote sensing platform
☐	Check if instrument calibration is required, and calibration certificates are on file
☐	Check if equipment redundancy is required
☐	Check if a DGPS is required
☐	Confirm installation of real-time classification software (if available)
☐	Book freight to mobilisation port

13.10 Resources

Support staff, including office-based personnel and taxonomic specialists, will be required to support onshore analysis of the data collected by the field team. Accurate identification of marine benthic biological communities and species will require specialist taxonomists, and a team to sort and curate. Specialist marine ecologists with knowledge of the region will determine indicator taxa, undertake peer review of reports, and conduct QA/QC of image analysis. Field teams will use individuals who are trained in subtidal assessment techniques, procedures, and terminology. Team members must have a thorough understanding of the response goals and objectives.

The field personnel required to undertake SCI6, their roles, responsibilities and relevant qualifications are listed in Table 13-4.

Table 13-4: Field Roles and Responsibilities

Role	Responsibility	Qualifications
Field Lead/ Party Chief	• Capture survey positional data • Coordinate with vessel master and field team • Manage HES compliance • Complete daily field survey reports • Plan survey schedule	• Minimum degree-level qualification in a relevant subject • Significant field experience (including ROV and grab operations) • Facility abandonment • Offshore medical

Role	Responsibility	Qualifications
Marine Scientists / Data Management Personnel / Field Technician (as required)	• Undertake real-time habitat classification and QA/QC of still and video footage • Data management experience • Help deploy ROVs, cameras, CTDs, cores, or grabs • Sieve and preserve benthic infauna samples • Undertake physical site observations • Record survey and sampling data • Backup digital data (including images) • Maintain equipment and resolve technical issues	• Minimum degree-level qualification in a relevant subject • Field experience • Local ecological knowledge (including benthic habitat classification and ecology) • Facility abandonment • Offshore medical
Diver / snorkeller (if required)	• Collect samples	• ADAS Pt 1 (for snorkelling) • ADAS Pt 2 (for surface supply diving)

13.11 Equipment

It may be necessary to mobilise a vessel for transport or intertidal access depending on the remoteness of the study area and scale of the hydrocarbon spill.

The basic set of equipment for SCI8 are listed below.

Items	
☐	Specialist equipment: • ROV/AUV/drop camera/towed camera • USBL positioning (if required) • dive spread • multiparameter probe/CTD • benthic grab • remote sensing platform
☐	Is redundancy required?
☐	DGPS
☐	Echo sounder on each vessel
☐	Field laptops with relevant software (e.g. CPCe, video editing, CATAMI)
☐	Backup data storage for field data
☐	Tissue preservation material and sample jars
☐	Biota/coral sampling equipment • coring or sampling tools • dissecting microscope • tissue preservation material (10% formalin and/or 70% ethanol) • sample jars
☐	Specialist PPE (i.e. PFD,RPE)
☐	Book freight to mobilisation port

13.12 Standard Operating Procedures (SOPs)

Sampling techniques will vary depending on the type and location of the hydrocarbon to be collected. Consistent across all techniques are:

- the profiler may require a base with weights that will help the unit sink and also protect the sensors from contacting the sediments on the seabed.
- haphazard transects – in situ.

Step	
☐	Percentage cover of each habitat type will be assessed at each site using photo quadrats, taken along transects.
☐	The locations of transects at each site will be selected at random
☐	The start location (latitude and longitude) of each transect will be recorded and georeferenced, and bearing and distance of each transect similarly recorded.
☐	A minimum of three replicate transects will be undertaken at each site.
☐	Photo quadrats will cover an area of 1 m^2 (either 1 × 1 m^2 photo, or 4 × 0.25 m quadrats, depending on water conditions and available equipment (e.g. quadrats) and will be randomly located along each transect
☐	The length of each transect and the number of photo quadrats along each transect will depend on habitat characteristics and the survey objectives, but a minimum of five photo quadrats per transect should be planned. Note that the length of transects and number of quadrats should be standardised across sites.
☐	Photographs will be taken with a still camera, or taken as still images from video transect footage.
☐	The methodology of photograph capture will be kept consistent among a survey and where possible, across all survey sites, noting that technology improvements may be incorporated into surveys. If practicable, high-quality still plan (downward facing) images (taken from a still camera or still images from video transect footage), should be captured with sufficient lighting.
	If practicable, the quadrat boundary should be marked within each image as either a solid boundary (i.e. frame placed on the transect) or by underwater lasers marking out a scale.
☐	Where possible, transects will be located in similar depths within sites.
☐	Upon retrieval, data will be QAQC checked and backed up on site
☐	Data will be analysed using appropriate software to determine point-intercept estimates of multiple points to define benthic habitats.

13.13 Forms and Tools

Refer to Appendix C.

14 Acronyms and Abbreviations

Table 14-1 defines the acronyms and abbreviations used in this document.

Table 14-1: Acronyms and Abbreviations

Acronym / Abbreviation	Definition
#	Number
°C	Degrees Celsius
µg/g	Micrograms per gram
µg/L	Micrograms per litre
µm	Micrometer
4WD	Four-wheel Drive Vehicle
ABU	Australian Business Unit
ADAS	Australian Diving Accreditation Scheme
ALS	Australian Laboratory Services
AMOSC	Australian Marine Oil Spill Centre
AMSA	Australian Maritime Safety Authority
ANOVA	Analysis of Variance
ANZECC	Australian and New Zealand Environment and Conservation Council
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
AUV	Autonomous Underwater Vehicle
BACI	Before-After-Control-Impact
BRUVS	Baited Remote Underwater Video Station
BTEX	Benzene, toluene, ethylbenzene, and xylene
C_6, C_{40}, etc.	Carbon chain length
CATAMI	Collaborative and Annotation Tools for Analysis of Marine Imagery and Video; a classification scheme for scoring marine biota and substrata in underwater imagery
CJS	Cormack-Jolly-Seber
cm	Centimetre
cm^3	Cubic centimetre
CMR	Capture, mark, recapture
CoC	Chain of Custody
CPCe	Coral Point Count with Excel extension
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CTD	Conductivity Temperature Depth
dB(A)	Decibel, unit of sound loudness
DAWE	Department of Agriculture, Water and the Environment
DBCA	Department of Biodiversity, Conservation and Attractions (formally Parks and Wildlife)
DMSO	Dimethyl sulfoxide

Acronym / Abbreviation	Definition
DNA	Deoxyribonucleic Acid. A self-replicating material present in nearly all living organisms as the main constituent of chromosomes. It carries genetic information.
DoF	Western Australia Department of Fisheries
DOSS	Dioctyl sulfosuccinate
DoT	Western Australian Department of Transport
DotEE	Formally the Commonwealth Department of the Environment and Energy (now DAWE)
DPnB	Dipropylene Glycol n-Butyl Ether
EGMBE	Ethylene Glycol Monobutyl Ether
EMBA	Environment that May Be Affected
Emergency condition	Emergency conditions are defined in each activity-specific Environment Plan and Oil Pollution Emergency Plan
EMT	Emergency Management Team
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
g	Gram
GC	Gas Chromatography
GCMS	Gas Chromatography Mass Spectrometry
GIS	Geographic Information System
GPS	Global Positioning System
H_2S	Hydrogen sulfide
HAZID	Hazard Identification
HES	Health, Environment, and Safety
I-GEMS	Industry-Government Environmental Meta-database
IMG	Incident Management Guide
Impact Site	Site impacted by oil
Infauna	The assemblage of animals (often microscopic) that live buried or partially buried with the sediment matrix (e.g. worms, bivalves, crustaceans)
IvC	Impact versus Control
IvR	Impact versus Reference
JHA	Job Hazard Analysis
km	Kilometre
km^2	Square kilometres
kn	Knot
LAT	Lowest Astronomical Tide
LNG	Liquefied Natural Gas
m	Metre
MBACI	Multiple Before-After-Control-Impact
MES	Monitoring, Evaluation and Surveillance
mL	Millilitre

Acronym / Abbreviation	Definition
MPA	Marine Protected Area
MPRA	Marine Parks and Reserves Authority
mS/cm	Milli Siemen per centimetre; measure of conductivity
MSDS	Material Safety Data Sheet
N/A	Not Applicable
NATA	National Association of Testing Authorities
NEBA	Net Environmental Benefit Analysis
nm	Nautical mile
NMI	National Measurement Institute
NTU	Nephelometric Turbidity Unit
NWS	North West Shelf
OPEP	Oil Pollution Emergency Plan
OPS	Operational Monitoring Program
ORT	On-site Response Team
OSMP	Operational and Scientific Monitoring Plan
OSRA	Oil Spill Response Atlas
PAH	Polycyclic Aromatic Hydrocarbons
PAM	Passive Acoustic Monitoring
PERMANOVA	Permutational Multivariate Analysis of Variance
PFD	Personal Flotation Device
pH	The acidity or basicity of a solution
Photo documentation	Photographic and video evidence, ranging from aerial imagery to detailed still images
PPE	Personal Protective Equipment
PSD	Particle Size Distribution
Quadrat	A rectangle or square measuring area used to sample living things in a given site; can vary in size.
Reference Site	Specific area of the environment not at risk of being affected by the Project or existing developments, that can be used to determine the natural state, including natural variability, of environmental attributes such as coral health or water quality.
RFU	Raw Fluorometry Units
ROV	Remotely Operated Vehicle
RPE	Respiratory Protective Equipment
SCI	Scientific Monitoring Program
SD	Standard Deviation
SDH	Sorbitol dehydrogenase
SME	Subject Matter Expert
SOP	Standard Operating Procedure
SPRAT	Species Profile and Threats (database)

Acronym / Abbreviation	Definition
State Waters	The marine environment within three nautical miles of the coast of Barrow Island or the mainland of Western Australia
TBOSIET	Tropical Basic Offshore Safety Induction and Emergency Training
TOC	Total Organic Carbon
Transect	The path along which a researcher moves, counts, and records observations.
TRH	Total Recoverable Hydrocarbons
UME	Unusual Mortality Event
USBL	Ultra-short Baseline
USEPA	United States Environmental Protection Agency
VOC	Volatile Organic Compounds; organic chemical compounds that have high enough vapour pressures under normal conditions to vaporise and enter the atmosphere
WA	Western Australia
WoRMS	World Register of Marine Species

15 References

The following documentation is either directly referenced in this document or is a recommended source of background information.

Table 15-1: References

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Appendix A Indicative Transit Times for Mobilisation to Operational Areas

From	To	Distance in nm (sea)	Distance in nm (air)	Required					
				Vessel (hours)				Helicopter	Truck
				8 kn	11 kn	17 kn	25 kn	140 kn	60 km/h
Barrow Island	Thevenard Island	63	47	7.9	5.7	3.7	2.5	20 mins	-
Barrow Island	Onslow	63	51	7.9	5.7	3.7	2.5	22 mins	-
Barrow Island	Dampier	80	77	10.0	7.3	4.7	3.2	33 mins	-
Barrow Island	Exmouth	110	105	13.8	10.0	6.5	4.4	45 mins	-
Barrow Island	Platform	57	57	7.1	5.2	3.4	2.3	24 mins	
Thevenard Island	Barrow Island	63	47	7.9	5.7	3.7	2.5	20 mins	-
Thevenard Island	Onslow	12	12	1.5	1.1	0.7	0.5	5 mins	-
Thevenard Island	Dampier	116	107	14.5	10.5	6.8	4.6	46 mins	
Thevenard Island	Exmouth	54	65	6.8	4.9	3.2	2.2	28 mins	
Dampier	Exmouth	187	168	23.4	17.0	11.0	7.5	1.2 hrs	9.3 hrs
Dampier	Barrow Island	80	77	10.0	7.3	4.7	3.2	33 mins	
Dampier	Thevenard Island	116	107	14.5	10.5	6.8	4.6	46 mins	
Dampier	Onslow	230	238	28.8	20.9	13.5	9.2	1.7 hrs	9 hrs
Dampier	Platform	87	87	10.9	7.9	5.1	3.5	37 mins	
Exmouth	Barrow Island	110	105	13.8	10.0	6.5	4.4	45 mins	-
Exmouth	Thevenard Island	54	65	6.8	4.9	3.2	2.2	28 mins	-
Exmouth	Onslow	60	65	7.5	5.5	3.5	2.4	28 mins	6.7 hrs
Exmouth	Dampier	187	168	23.4	17.0	11.0	7.5	1.2 hrs	9.3 hrs
Onslow	Barrow Island	63	51	7.9	5.7	3.7	2.5	22 mins	-
Onslow	Thevenard Island	12	12	1.5	1.1	0.7	0.5	5 mins	-
Onslow	Dampier	230	238	28.8	20.9	13.5	9.2	1.7 hrs	9 hrs
Onslow	Exmouth	60	65	7.5	5.5	3.5	2.4	28 mins	6.7 hrs
Onslow	Platform	108	108	13.8	9.8	6.4	4.3	46 mins	

1. *Allow ~3 hours to travel from east to the west coast of Barrow Island via vessel*
2. *Total time = Activation time + travelling time, depending on the availability of the logistics*
3. *Vessel time-based on-site information and knowledge and http://ports.com/sea-route/*
4. *Estimated activation times are: Barrow Island – 2 hours; Thevenard Island – 1 hour; Onslow – 2 hours; Dampier – 1 hour; Exmouth – 2 hours*

Appendix B Guideline for Data Management

Oil Spill Monitoring Handbook

GUIDELINE FOR DATA MANAGEMENT	Q.1

Rationale

Data management is needed for all monitoring programmes but will depend on the scale, complexity and purpose of each programme. This Guideline provides a basic checklist for the development of a Data Management Plan.

Methodology

1	Data management pre-planning:	
	1.1	Develop standard forms for all field data.
	1.2	Establish a standard methodology for assigning location names, sample numbers and descriptors.
	1.3	Prepare and provide pre-printed photo or sample log forms, labels and/ or chain of custody forms.
	1.4	Establish data storage system (hard copy/computer database/GIS).
	1.5	Obtain and supply maps and other recording equipment as required.
	1.6	Establish sample handling/management procedures (Guideline G.1).
	1.7	Assign responsibilities for data management, overall and in the field.
2	Field data recording and handling:	
	2.1	Ensure that data is documented on standard format forms, log books, film, tape or disk.
	2.2	Assign the task of data recording task to one person per team. If more than one person or one team is involved in these tasks, then training and field calibration of measurements should be undertaken.
	2.3	Ensure that all data recorded in the field is recorded in a data log (data type, location, time, custodian and location of storage).
3	Initial data validation, compilation and storage:	
	3.1	Assign responsibility and procedure for checking data for errors and ensuring that corrective action is taken.
	3.2	All data (and all formats) should be backed-up as soon as possible.
	3.3	Ensure that all data and samples are properly stored.
4	Assessment and compilation of data (data reduction):	
	4.1	Assign responsibility for checking requests for analysis, calculations etc.
	4.2	Establish responsibility and procedures for assessment, verification and storage of data.
	4.3	Ensure that laboratory or third party responsibility and procedures for the internal review of all analysis, calculations etc. has been established.

	Page 1 of 2	Q.1

Q.1	**Methodology Continued**			
5	Data validation.			
	5.1	Ensure that data is assessed for accuracy, e.g:		
		5.1.1	Analysis requested against data supplied.	
		5.1.2	Blanks, duplicates and other QA/QC samples for errors.	
		5.1.3	Detection limits, holding times.	
		5.1.4	Calculations.	
	5.2	Ensure that, if needed, data is corrected. Note: If data is corrected by management, or other third party, then changes should be recorded and initialed.		
6	Data reporting and display.			
	6.1	The format and content of final reports will vary according to the purpose of the monitoring programme. Generally it should include:		
		6.1.1	All results (raw data).	
		6.1.2	Interpretation (if required).	
		6.1.3	A discussion of any data gaps, QA/QC issues.	
	6.2	Data display and dissemination methods may include:		
		6.2.1	Status Boards.	
		6.2.2	Hard copy maps	
		6.2.3	Digital maps and data (GIS/OSRA or other)	
		6.2.4	Restricted or public bulletins. These may be	
			a	Paper copy
			b	Digital; either distributed via e-mail or displayed on the internet.

Appendix C Forms

Form number	Description
1.	CoC forms
2.	Freight consignment form
3.	Marine Vessel Survey Log Form
4. 4.	Environmental Permit Application Forms

Form 1 – Chain of Custody

Chevron	Chain of Custody Form Environmental Sample Submission Sheet	

1.0 General Information				
Samples sent to: (contract laboratory)				
Attention:				
Chevron Charge Caption:		or	Service Order No.:	

2.0 Sample Information				
Samples From:			Sampled by:	
Sample Type:			Date Sampled:	
	Description of sample		Analysis required	
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
☐ Additional samples overleaf			☐ Preserved at 4°C	

3.0 Tracking			
☐ **Copy 1** To Contract Lab with Sample - Lab to acknowledge receipt of samples by signing below, and faxing a copy to EH&S representative. - Lab to mail this **original** copy to EH&S representative with completed results.			
☐ **Copy 2** Contract Lab to attach a copy to the invoice for this work.			
☐ **MEJ number must be included prior to analysis of samples.**			
Acknowledge receipt signature:		**Date:**	

Document ID: OE-11.01.34
Revision ID: 3.0. Revision Date: 16 November 2011.
Information Sensitivity: Company Confidential
Printed 21 December 2015.
Page 1 of 3

	Chain of Custody Form Environmental Sample Submission Sheet	

4.0 Reporting

☐ Chevron PO Box S1580, GPO Perth WA 6001	☐ Chevron phone number: (08) 9216 4000
☐ Fax: (08) 9216 4444	
☐ Environmental Advisor:	☐ HES rep. phone number:

5.0 Additional Samples

	Description of sample	Analysis required
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		

6.0 Additional Information

Chevron	Chain of Custody Form Environmental Sample Submission Sheet	

7.0 Chain of Custody

Samples Relinquished by:				
Name (Print)	Organisation	Date	Time	Signature
Samples Relinquished by:				
Name (Print)	Organisation	Date	Time	Signature
Samples Relinquished by:				
Name (Print)	Organisation	Date	Time	Signature
Samples Relinquished by:				
Name (Print)	Organisation	Date	Time	Signature
Samples Relinquished by:				
Name (Print)	Organisation	Date	Time	Signature
Samples Relinquished by:				
Name (Print)	Organisation	Date	Time	Signature

CHAIN OF CUSTODY

ChemCentre EXPERT SOLUTIONS

GOVERNMENT OF WESTERN AUSTRALIA

ChemCentre, Building 500 Resources and Chemistry Precinct,
Post: PO Box 1250, Bentley Delivery Centre WA 6983
PH: (08) 9422 9800 **FAX**: (08) 9422 9801 **Email**: ssd@chemcentre.wa.gov.au

Off Conlon Street, BENTLEY WA 6102

PAGE No: _____ **of** _____

COURIER NAME: .... CON NOTE No:	**NOTES**	ANALYSIS REQUIRED	**ChemCentre Job No:**
CLIENT (Billing): ADDRESS: CLIENT P/O No: .... SAMPLED BY: .... RESULTS TO:			**Please indicate if QC results are required:** ☐ **Method QC** ☐ **Batch QC** ☐ **Special LOD (use comments section)** *Method QC data refers to results from a lab blank and a lab verification standard. *Batch QC data refers to results obtained from duplicate and spiked samples supplied by client and incurs extra charges.

LAB ID	SAMPLE ID / DESCRIPTION	Sample Type	Depth	DATE COLLECTED	TIME COLLECTED							*Comments/ Sampling Details*
				/ /	:							
				/ /	:							
				/ /	:							
				/ /	:							
				/ /	:							
				/ /	:							
				/ /	:							
				/ /	:							
				/ /	:							
				/ /	:							
				/ /	:							

RELINQUISHED BY: DATE/TIME:	Ph No: Email:	Contract:	RECEIVED BY: DATE/TIME:
☐ **Normal Turnaround**	☐ **Urgent Turnaround (will attract a surcharge)**.	LAB COMMENTS:	

Form 2 – Freight Consignment Form

CVX Advanced Shipping Notification (ASN)

Order Ref No:	
Date:	

Company Name:	
Address:	
Phone No:	
A/H Contact:	
Submitted By:	
Email:	
Phone No:	
A/H Contact:	

Date Revised:	
Revision No:	
ROS Date:	

AFE/Cost Code/CVX PO:	
Project/Facility/Well Details:	

Expected Delivery/ Collection Date:	ED: CD:	Time:	
Collection Address: *(If pickup Required)*	N/A		
Contact Name:			
Email:			
Phone No:			
A/H Contact:			

Final Destination:	
Consignee:	
Delivery Address:	

Special Handling Instructions Where Applicable		YES	N/A
Lift Plan:		☐	☐
COG:		☐	☐
Oversize:		☐	☐
Fork tyne pockets in container:		☐	☐
Lifting assembly included:		☐	☐
Explosives no forklift handling:		☐	☐

Comments:

Check List confirming (with attachments where deemed necessary by business)

	YES	N/A
Is all material Quarantine compliant?	☐	☐
Are Dangerous Goods present?	☐	☐
Are DG's Chemalert approved?	☐	☐
Are current (<5yrs) Australian MSDS's attached?	☐	☐
AS1604 H3 Timber treatment certs?	☐	☐
Additional Certs (Heat, Hydrostatic,	☐	☐
Are lifting points certified?	☐	☐
QA/QC release	☐	☐
Chain of custody form	☐	☐
Customs clearance for imported pkgs	☐	☐
Timber treatment certificate for imported pkgs	☐	☐
Country of Origin declaration for imported pkgs	☐	☐
Export compliance certificate for goods ex USA	☐	☐

ASN TEMPLATE INSTRUCTIONS

Advanced Shipping Notification:

- This template is designed to upload material details into Chevron iLogistics system
- All the mandatory details as specified in below table **MUST** be populated in **Advanced Shipping Notification** work sheet before submission
- Material details should only be entered at item level or package level.
- The maximum number of characters against a field are represented in the column header. Ex: **Material Description can have max 30 characters. Above the limit characters will be truncated**

FIELD TITLE	REQUIRED	DESCRIPTION
SI No.	Not Applicable	
Order Type	Mandatory	CVX Type of order the materials being delivered against. By default this should be **external Ref** type, unless delivering against a PO number
Order Ref No. (15)	Mandatory	Reference number against which the materials are delivered. Each shipment must have its own unique number. This can be any number but **MUST** be prefixed by the first 3 letters of your company name (e.g. MONxxxxxxx)
Order Item Ref. No.(15)	Optional	Unique line item number in the Order
Invoice No.(15)	Optional	
Work Order No.(15)	Optional	
Material Description(30)	Mandatory	Description/Label of the material(s)
L(500)	Optional	Long description of material(s)
Material No.(10)	Optional	
Material type(30)	Optional	Type of material. Choose from existing list
Quantity (10)	Mandatory	Numbers of quantity
Est. Quantity-Units (10)	Mandatory	Units of Quantity. Please refer to Units table for unit code descriptions
Weight (10)	Mandatory	Weight of materials in numeric
Est. Weight-Units (10)	Mandatory	Units of weight
ROS Date(DD/MM/YYYY)	Mandatory	Required on Site Date
Remarks(500)	Optional	Remarks
Length (m) (10)	Mandatory	Length in meters
Width (m) (10)	Mandatory	Width in meters
Height (m) (10)	Mandatory	Height in meters
Delivery Type	Optional	Partial, Full or Over
HAZMAT(Yes/No)	Mandatory	Hazardous Material specification
Value of Material(10)	Not Applicable	
Currency	Not Applicable	
Custom Status	Not Applicable	
Rental(Yes/No)	Optional	Specify if the material is a rental equipment

Unit Code	Description
BD	Bundle
BE	Bale
BG	Bag
BK	Bucket
BN	Bulk
BR	Barrel
BT	Bottles
BU	Bushel
BX	Box
CA	Case
CD	Cylinder
CL	Coil
CR	Carton
CT	Caret
CU	Cubes
DR	Drum
DZ	Dozen
EA	Each
JR	Jar
JT	Joints
KI	Kit
LO	Lot
PA	Pail
PC	Pieces
PD	Pad
PK	Pack
PL	Pallet
PR	Pair
RE	Reel
RL	Roll
RM	Ream
SK	Sack
SL	Sleeve
SP	Spool
ST	Set
TB	Tube
TC	Tank Car
TI	Tin
TK	Tank
UN	Units

Header:

- Enter the Order reference number into ASN ref No field, against wich the materials can be tracked
- Fill in the collection details if pick up is required
- Please select all the special handling instructions where applicable
- Please mark the ASN check list and attach necessary documents were deemed necessary to the email

Form 3 – Marine Vessel Survey Log Form

BLUE PLANET MARINE

Gorgon LNG Project
Marine Fauna Observations

Chevron

Vessel:

Log to be maintained by the MFO

Week starting ____________

Date	Time (24 hour)	Latitude (dd.mm.mm) DEGREES & DECIMAL MINUTES	Longitude (dd.mm.mm) DEGREES & DECIMAL MINUTES	Your activity (ie transit, at anchor)	Distance in metres of fauna from vessel	Bearing of fauna from vessel	Species (if known * See note below)	Total number of animals	Mitigation activities if required (ie manoeuvred slowly away from whale)	Seastate (Beaufort)	Overall visibility (Very good, Average, Poor)

*If species unknown, use "turtle", "dolphin", "whale", "dugong" or "whale shark".

Page ____ *of* ____

Form 4 – Environmental Permit Application Forms

Department of Fisheries Western Australia
3rd Floor, The Atrium
168-170 St George's Terrace
PERTH 6000

Telephone (08) 9482 7333
Facsimile (08) 9482 7390

Office Use Only

Date Received	
Application Fee Paid	
Receipt No.	

Fish Resources Management Act 1994

APPLICATION FOR EXEMPTION

Section 7 & Regulation 6

This application is made to the Minister for Fisheries at the Department of Fisheries.

The applicant named in Part A, in accordance with Section 7 and Regulation 6 of the *Fish Resources Management Act 1994* and *Regulations*, hereby applies in respect of the purpose set out in Part B and in respect of the proposed activities set out in Part C for the grant of an Exemption from the provisions set out in Part D.

PART A

1. **Applicant:** ....

Address: ....

.... Post Code: ....

Telephone No: (........) .... Facsimile No.: (……)...................................

PART B

2.1 **Purpose for which Exemption is sought:** ....

....

....

....

....

2.2 **Identify the relevant paragraph of section 7(2) :**

....

....

PART C

3. **Proposed Activities**

....

....

....

....

15/11/11

PART D

4. **Provision of Legislation from which Exemption is sought**

....

....

....

PART E

5. **Declaration**
I/We declare that the statements made in this Application are true and correct.

6. **Execution of Application**
Please sign and date in the appropriate section below.

6.1 ***Individuals***

.... (signature)	.... (print name)	.... (date)
.... (signature)	.... (print name)	.... (date)
.... (signature)	.... (print name)	.... (date)
.... (signature)	.... (print name)	.... (date)

6.2 ***Corporation***

The Common Seal of the authorisation holder is hereunto affixed in accordance with the corporation's Constitution:

Affix
Seal
Here

Director : .... (signature) .... (print name) .... (date)

Director/Secretary: .... (signature) .... (print name) .... (date)

Declaration where sole director/secretary (if applicable):

I .... declare that I am the sole director and sole company secretary of
(print name)

.... (print company name) .... (signature) .... (date)

Attorney

Attorney under Power: .... (signature) .... (print name) .... (date)

Fish Resources Management Act 1994

APPLICATION FOR EXEMPTION

Section 7 & Regulation 6

This form is to be used to **apply** for an exemption from a provision or provisions of the Act or any subsidiary legislation made under the Act.

Applications for an exemption may be made to the Minister for Fisheries..

The address at which this application is to be **lodged** is the address of the Department of Fisheries Western Australia (please refer to the head of the Application).

Section 7 of the *Fish Resources Management Act 1994* states:

7. (1) The Minister may, by instrument in writing, exempt a specified person or specified class of persons from all or any of the provisions of this Act.

(2) The Minister may only grant an exemption under subsection (1) for one or more of these purposes -

(a) research;

(b) environmental protection;

(c) public safety;

(d) public health;

(e) commercial purposes;

(f) community education about and compliance with this Act ;

(g) enforcement of this Act.

An exemption is subject to any conditions specified by the the Minister for Fisheries, or a person to whom the Minister for Fisheries has delegated, under section 12 of the Act, the power to grant exemptions. A condition may be varied or cancelled by the Minister for Fisheries (or the Minister's delegate) by notice in writing.

A person who contravenes a provision of a condition of an exemption will be liable to a penalty of $10,000 ($20,000 if a body corporate).

A person who acts beyond the authority conferred by an exemption will be liable to a penalty for breach of the Act.

Application Fee
The Prescribed Application Fee must accompany this application

Note: Application Fees are set out in *Fish Resources Management Regulations 1995*, Schedule 1, Part 2. Fees may be subject to change.

Instructions for completing this Application

Please use block letters when completing this Application.

Address the application to the "Minister for Fisheries".

PART A

1. **Applicant** - state the full name, business address of the applicant. Enter the daytime telephone number at ☎.

PART B

2. **Purpose for which Exemption is sought** - give details of the reason(s) for wanting to carry on the Proposed Activities (to be set out in Part C). Give details as to why the purpose for which the Exemption is sought is one of the purposes set out in section 7(2) of the Act, and identify the relevant paragraph of section 7(2).

PART C

3. **Proposed Activities for which Exemption is sought** - give full details of the proposed activities, including (as appropriate) by reference to quantity of fish, place or area, dates and times, persons to be involved and gear (including boats) to be used. Attach copies of relevant documents where appropriate

PART D

4. **Provision(s) of Legislation from which Exemption is sought** - specify the provisions of the Act, Regulations or other subsidiary legislation which prohibit the proposed activities (or any part of them); [e.g. Section 46 and Regulation 10 (where the take of a totally protected fish is proposed)].

PART E

5. **Declaration** - there are penalties under the *Fish Resources Management Act 1994* for making false or misleading statements.

6. **Execution of Documents -**

   6.1 **Signatures** - if the exemption is to be recorded as being held by more than one person, then all persons to be named on the exemption must sign and date this Application.

   6.2 **Body Corporate** - if the exemption is to be held by a body corporate, the Application must be signed and sealed in accordance with the sealing clause of the Corporation's Article of the Association and dated.

   6.3 **Attorney** - if the Applicant has appointed an Attorney, the Attorney signing may be requested to produce the relevant Power of Attorney instrument for viewing and a copy for recording.

NOTE: Applicants should be aware that the details disclosed in this Application will be recorded on the Public Register and be available for public search.