Santos

Southern Margins Seismic Program
T/32P, T/33P, T40P and VIC/P50

Environment Plan

January 2006

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Contents

Figures

Tables

Boxes

Appendices

1. Introduction

1.1 Project Outline

1.1.1 Seismic Survey

Santos Limited (Santos) proposes a 2D seismic exploration program (the 2006 Southern Margins Seismic Program), to be undertaken over approximately 30 days sometime in the period between March and May 2006, depending on vessel scheduling, in Petroleum Exploration Permits (PEP) T32/P, T33/P and T40/P located in Commonwealth waters off the west coast of Tasmania in the offshore Sorell Basin. In conjunction with the T32/P, T33/P and T40/P program, Santos proposes to undertake seismic exploration in the Otway Basin on behalf of Essential Petroleum Pty Ltd (EPRL) in petroleum exploration permits VIC/P50 (Figure 1.1). The surveys will be undertaken sequentially and all are expected to be completed during the period from March to May 2006. The precise commencement date and timing of each of the survey phases will be dependent upon any changes to the seismic vessel schedule that may occur as a result of a variety of factors including any particular environmental sensitivities that may arise from the consultation process.

Multiwave Geophysical Company's 'Pacific Titan' seismic survey vessel has been contracted to undertake the proposed seismic operations.

Table 1.1 summarises the activities to be undertaken for the Southern Margins Seismic Program.

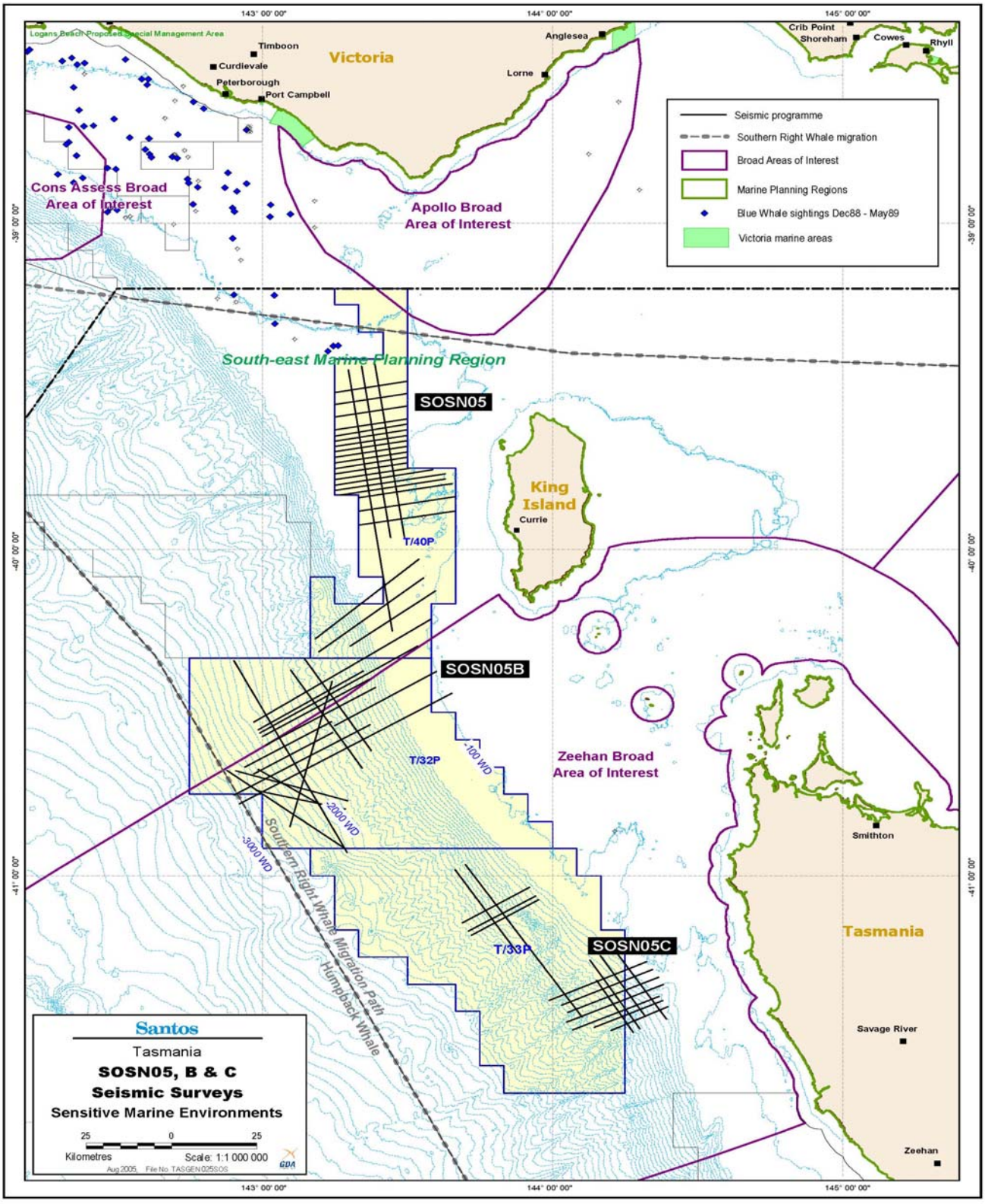
Table 1.1 Summary Southern Margins Seismic Survey activities

	T/32P, T/33P & T/40P (Tas)	VIC/P50
Seismic acquisition (km)	2184	344
Water depth (m)	100 – 2,900	200-2500
Nearest distance to coast (km)	15	30
Survey duration (days)	30	5

Tasmania (T/32P, T/33P & T/40P)

The main phase of the Southern Margins program will acquire up to 2184 surface km (2007km full fold) of 2D seismic data in Petroleum Exploration Permit Areas T32/P, T33/P and T40/P, which are located off the west coast of Tasmania, approximately 15 km west of King Island and 30 km from Strahan (Figure 1.2). The seismic survey is scheduled to occur over approximately 30 days (including approximately 8 days weather standby) and will be undertaken in Commonwealth waters between 15 and 160 km from the west coast of Tasmania in water depths ranging from 100 m to 2,900 m.

Figure 1.1 Location of proposed T32/P, T33/P and T40/P seismic survey



Victoria (VIC/P50)

In addition to the survey in T32/P, T33/P and T40/P, the vessel will acquire 344 km of 2D seismic data on behalf of EPRL in VIC/P50 off the southwest of Victoria in the Otway Basin (Figure 1.3). The most inshore part of the survey area lies approximately 30 km from the coast near Portland in Victoria. The main survey area extends from beyond the shelf break into deep water, covering depths ranging from 200-2500 m. The seismic program is scheduled to occur over approximately 5 days (including approximately 2 days weather standby).

1.1.2 Project Justification

Santos is the operator of petroleum exploration licences T32/P, T33/P and T40/P. EPRL is the operator of petroleum exploration licence VIC/P50. Table 1.2 summarises the joint venture partners for each permit area.

Table 1.2 Summary JV Participation

Permit	Issued	Term	JV Partners
T/32P	2002	6 Years	Santos Ltd 80% Inpex Alpha Ltd 20%
T/33P	2002	6 Years	Santos Ltd 50% Unocal South Asean 50%
T/40P	2005	6 Years	Santos Ltd 100%
VIC/P50	2002	6 Years	Essential Petroleum Resources Ltd 100%

The proposed seismic survey programs will be undertaken to meet exploration commitments and to further assess exploration potential in the permit areas.

1.1.3 Location

The three survey areas are located in Commonwealth waters within the offshore Sorell and Otway Basins of western Tasmania and western Bass Strait, respectively. Coordinates of the survey areas are listed in Table 1.3.

Figure 1.2 Location of proposed VIC/P50 seismic survey

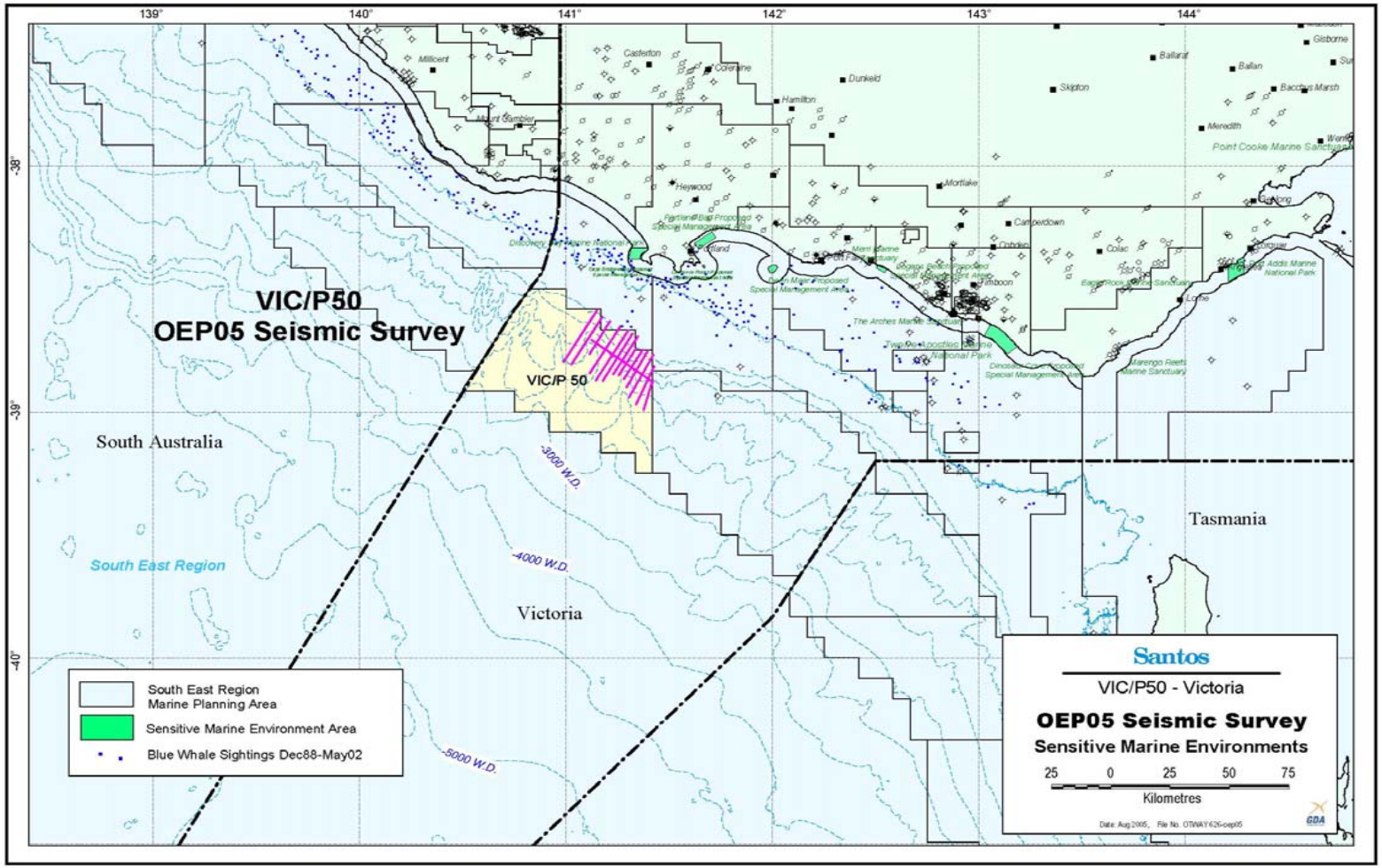


Table 1.3 Seismic survey program area coordinates

T/32P	
Latitude (GDA94)	**Longitude** (GDA94)
40 48 00S	142 49 00E
41 01 00S	143 18 00E
40 58 00S	143 23 00E
40 45 00S	143 23 00E
40 27 00S	143 47 00E
40 15 00S	143 37 00E
40 15 00S	142 49 00E
T/33P	
Latitude (GDA94)	**Longitude** (GDA94)
41 10 00S	144 21 00E
41 10 00S	144 10 00E
40 55 00S	143 55 00E
40 53 00S	143 42 00E
40 56 00S	143 35 00E
41 10 00S	143 35 00E
41 15 00S	143 40 00E
41 15 00S	143 45 00E
41 35 00S	144 03 00E
41 35 00S	144 15 00E
41 25 00S	144 35 00E
T/40P	
Latitude (GDA94)	**Longitude** (GDA94)
39 21 00S	143 09 00E
40 12 00S	143 09 00E
40 12 00S	143 04 00E
40 25 00S	143 04 00E
40 25 00S	143 20 00E
40 12 00S	143 46 00E
39 40 00S	143 46 00E
39 40 00S	143 41 00E
39 21 00S	143 41 00E
VIC/P50	
Latitude (GDA94)	**Longitude** (GDA94)
38 29 00S	141 08 30E
38 49 45S	140 52 30E
39 06 30S	141 25 45E
38 43 30S	141 34 00E

1.1.4 Survey Timeframe

Data acquisition is scheduled to occur in the period between March and May 2006. The precise commencement and completion dates are dependent on vessel availability, environmental/fishing sensitivities and weather conditions.

1.2 Project Proponent

Santos was formed in South Australia in 1954 and is now a major Australian energy company. The core business of the company is oil and gas exploration and production with interests in every major Australian petroleum province. Santos is the largest producer of natural gas for the Australian market supplying all mainland states and territories. Santos' head office is located in Adelaide with offices also located in Brisbane and Perth.

The core gas operations for Santos are in the Cooper Basin with gas being distributed to customers in South Australia, New South Wales, Queensland and the Australian Capital Territory. Santos also operates gas fields in the Northern Territory, Western Australia and Victoria, has exploration and production interests in the United States of America and Egypt and exploration acreage in Indonesia and Papua New Guinea.

Santos has been an operator of exploration acreage in the offshore Otway Basin since late 2001 and holds interests in three exploration permits (VIC/P44, VIC/P51 and VIC/P52) and is a joint venture partner in two retention licences (VIC/RL22 and VIC/RL7) offshore. Since this time Santos has undertaken seismic and exploration drilling activities in the Otway Basin exploration permit areas.

On behalf of its joint venture partners, Santos also operates five recently awarded Commonwealth exploration permits in the Sorell Basin off the Tasmanian coast (T/32/P, T/33P, T/35P, T/36P and T/40P). Santos has undertaken seismic in all but the T/40P permit area over the last three years. Santos has been contracted to act as Agent Operator for EPRL for the Southern Margins 2D seismic survey program due to its extensive operational experience within the Otway and Sorell Basins.

Santos' head office is located in South Australia at:

Santos House
91 King William Street
Adelaide, South Australia 5000.

1.3 Purpose of this Environmental Plan

This Environmental Plan (EP) has been prepared in accordance with the requirements of the Commonwealth Petroleum (Submerged Lands) (Management of Environment) Regulations 1999. It includes an assessment of the seismic acquisition program from an environmental risk-based context and includes environmental mitigation measures, performance objectives, standards and criteria.

The assessment aims to identify and assess the potential environmental impacts associated with the seismic survey and to recommend suitable mitigation measures to avoid and/or minimise any adverse impacts to the marine environment, including:

- A description of the marine environment in the proposed survey area.
- Identification of potential effects and risks.
- Procedures for minimising impacts and for monitoring.
- The implementation of strategy and responsibilities.
- Auditing and reporting.

For further details please refer to Section 2.2.1.

1.4 Background

Seismic exploration is undertaken to map the subsurface geology of an area and enable identification of potential petroleum reservoir rocks, such as sandstones. During a seismic survey, an acoustic pulse is generated by the rapid release of compressed air from a signal source (air-gun array) towed behind the seismic vessel. This pulse is reflected from the boundaries separating the rock layers in the subsurface, and the reflected signals are recorded by many hydrophones towed in a cable several kilometres long (Figure 1.5). This is a key step in exploration for hydrocarbons and there is currently no other method that has sufficient resolution to identify rock structure beneath the surface.

Marine seismic surveys are conducted using a specialised vessel towing the acoustic source and one or more hydrophone cables. The acoustic source for the Southern Margins Seismic Program will be comprised of one array, generating an acoustic (pressure wave) pulse at approximately 11 second (25 metre) intervals which travels as a seismic signal down through the geological layers. The seismic signals are reflected back and recorded by hydrophones towed behind the vessel in a single streamer cable between 5 and 7 km in length. The acoustic pulse is in the order of 220-240 dB re 1µPa within a few metres of the source at frequencies extending up to approximately 110 Hz (McCauley, 1994). These levels vary depending on sound propagation characteristics of the area (McCauley, 1994), such as water depth and seabed features, and with distance from the source. The acoustic source will have an operating pressure of about 2,000 pounds per square inch (psi) and a volume of 3,040 cubic inches.

The seismic survey vessel (the Multiwave ‘Pacific Titan’) will traverse the survey area along defined transects (or seismic lines), as shown in Figures 1.1 to 1.4. The hydrophone cable streamers are towed at a depth of approximately 7 metres below the sea surface depending upon sea conditions. Streamer depth is maintained by

mechanical devices called ‘birds’ that prevent the equipment from making contact with the seabed. Helicopter crew changes are not planned due to the short duration of the program. At-sea refuelling is not planned as part of normal operations.

1.5 Stakeholder Consultation

Impact mitigation planning and implementation relies significantly upon consultation with key stakeholders. In the course of planning seismic, drilling and development programs within the offshore Sorell and Otway Basins over the past three years, Santos has undertaken extensive consultation with all relevant stakeholders in the region to identify regulatory processes, potential environmental issues and management requirements. There is ample precedent for identification of issues and procedures for communicating day-to-day seismic operations for timely consultation with the appropriate stakeholders to be followed, given the small scale of the project and the issues previously raised. Stakeholders of relevance to the Southern Margins Seismic Program include:

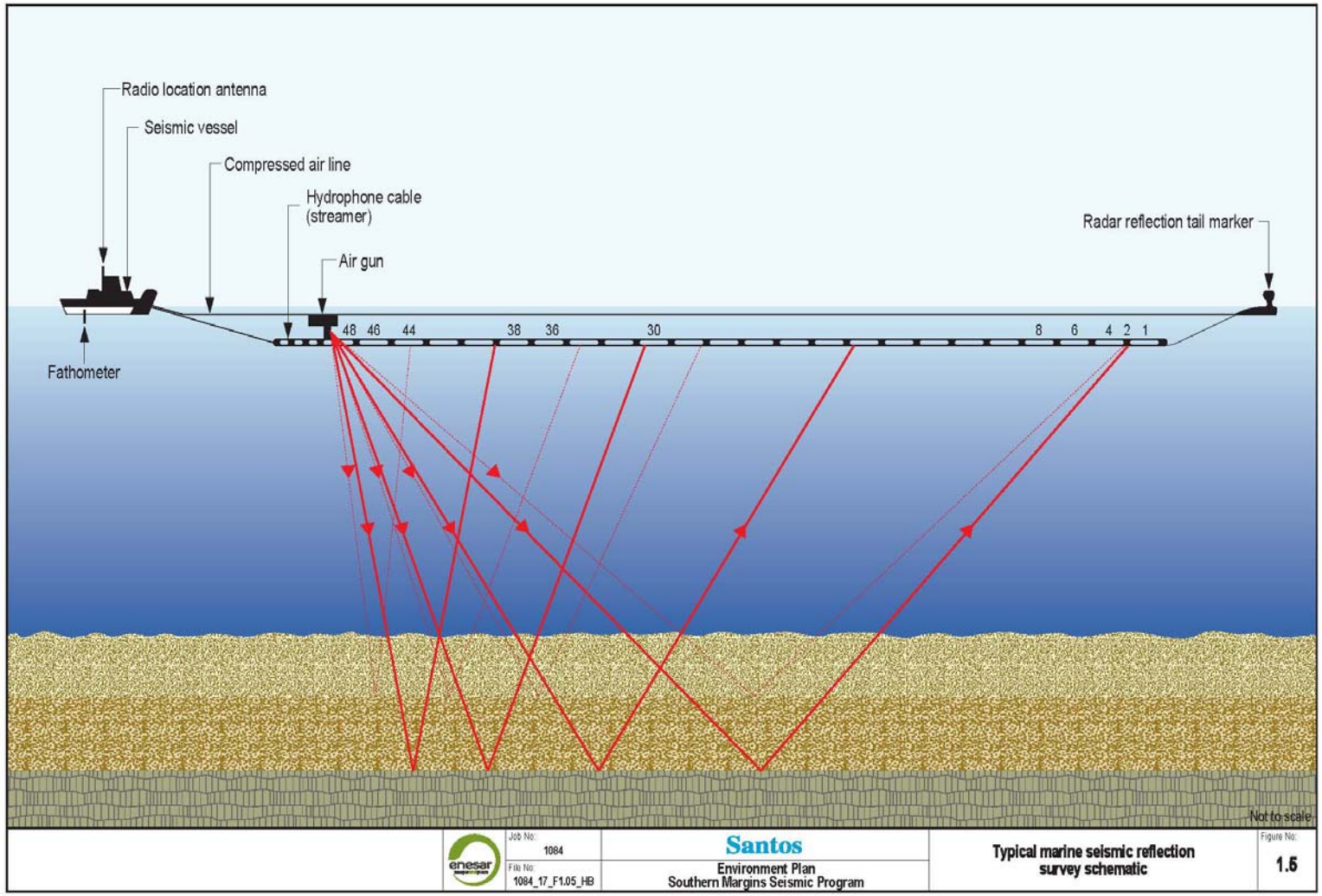
- Tasmania:
  - Department of Primary Industries, Water and Environment (DPIWE).
  - Department of Infrastructure Energy and Resources (DIER).
  - Tasmanian Fishing Industry Council (TFIC).
  - Tasmanian Rock Lobster Fishermen’s Association (TRLFA).
- Victoria:
  - Department of Primary Industries (DPI).
  - Seafood Industry Victoria (SIV).
  - Warrnambool Professional Fishermen’s Association.
  - Portland Professional Fishermen’s Association.
  - Port Campbell Professional Fishermen’s Association
  - Apollo Bay Professional Fishermen’s Association
- Commonwealth:
  - Department of Environment and Heritage (DEH).
  - Australian Fisheries Management Authority (AFMA)
  - Australian Maritime Safety Authority (AMSA)
  - Australian Marine Oil Spill Centre (AMOSC)

Consultation and information dissemination will be undertaken through a range of media including:

- Meetings with regulators.
- Meetings and correspondence with key stakeholders (see Appendix 2).
- Invitation for public comment on the EPBC referrals via the DEH website.
- Provision of detailed survey maps (refer Appendices 3 to 5).
- Daily schedule communications.
- Vessel communication systems with maritime traffic.

Santos will also report on the seismic program in accordance with regulatory requirements to demonstrate that the environmental performance objectives and standards outlined in this EP have been met (see also Section 6).

Figure 1.3 Typical marine seismic reflection survey schematic



2. Legislative Framework

A range of Commonwealth and State legislation, industry procedures and guidelines and international treaties and obligations may apply in relation to environmental considerations of the proposed offshore seismic exploration program. Key legislation and the statutory approvals processes governed by each are discussed in this section.

2.1 Applicable Legislation and Industry Standards

2.1.1 Commonwealth Legislation

- *Australian Heritage Commission Act 1975.*
- *Environmental Protection and Biodiversity Conservation Act 1999.*
- *Hazardous Waste (Regulation of Exports and Imports) Act 1989.*
- *Historic Shipwrecks Act 1976.*
- *Navigation Act 1912.*
- *Ozone Protection Act 1989.*
- *Petroleum (Submerged Lands) Act 1967.*
- Petroleum (Submerged Lands)(Management of Environment) Regulations 1999.
- *Protection of the Sea (Civil Liability) Act 1981.*
- *Protection of the Sea (Oil Pollution Compensation Fund) Act 1993.*
- *Protection of the Sea (Powers of Intervention) Act 1981.*

2.1.2 International Treaties and Obligations

Australia is a signatory to numerous international conventions and agreements that obligate the Commonwealth government to take action to prevent pollution and to protect specified habitats, flora and fauna. Those conventions and agreements relevant to offshore seismic exploration operations include:

- United Nations Framework Convention on Climate Change (1992).
- Vienna Convention on the Protection of the Ozone Layer (1985) and the Montreal Protocol; on Substances that Deplete the Ozone Layer (1987).
- Convention on Biological Diversity (1992).
- Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention) (1979).
- Bilateral Agreements on the Protection of Migratory Birds (1988).

- UN Convention on the Law of the Sea (1982).
- *London Convention (1972), and 1996 Protocol, formerly* London (Dumping) Convention (1972).
- International Convention for the Protection of Pollution from Ships (1973) and Protocol (1978).
- International Convention on Oil Pollution Preparedness, Response and Co-operation (1990).
- International Convention Relating to Intervention on the High Seas in Cases of Oil Pollution Casualties (1969).
- International Convention on Civil Liability for Oil Pollution Damage (1969).
- United Nations Convention on the Law of the Sea (UNCLOS) (1994).
- Convention on Conservation of Nature in the South Pacific (Apia convention) (1976).
- Japanese/Australian Agreement on the Protection of Migratory Birds (JAMBA) (1981).
- Chinese/Australian Agreement on the Protection of Migratory Birds (CAMBA) (1988).

2.1.3 Industry Codes of Practice and Guidelines

The petroleum exploration and production industry operates within an industry code of practice and individual member environmental policies, as follows:

- APPEA Code of Environmental Practice (1996).
- DEH Environment Protection and Biodiversity Conservation Act 1999 regulations in regard to the interaction between vessels and aircraft and cetaceans.
- IAGC Environmental Guidelines for Worldwide Geophysical Operations.
- ANZECC Code of Practice for Antifouling and In-water Hull Cleaning and Maintenance (1997). This Code of Practice applies to the use of products designed to keep marine vessels and structures free of marine organisms.
- Diving Medical Advisory Committee (1979). A Note Regarding Diving Distance from Seismic Surveying Operations.

2.2 Statutory Approvals

2.2.1 *Petroleum (Submerged Lands) Act 1982*

The proposed seismic program is subject to, and will be undertaken in accordance with the requirements of the Commonwealth *Petroleum (Submerged Lands) Act* 1967 (PSLA) for activities in Commonwealth waters. The Commonwealth *Petroleum (Submerged*

Lands) (Management of Environment) Regulations 1999 (PSLME) require an Environment Plan (EP), comprising a description of the environmental effects and risks and proposed mitigation measures, as well as detail of stakeholder consultation.

Part 2, Division 2.3 (sections 13, 14, 15 and 16) of the PSLME requires an EP, comprising a description of the environmental effects and risks and proposed mitigation measures, to be accepted by the Designated Authority prior to any activities being undertaken. The Designated Authority for seismic exploration proposals in state and Commonwealth waters and out to the Australian Exclusive Economic Zone at 200 nm rests with the adjacent states; for this seismic program they are DIER in Tasmania and DPI in Victoria, who both act on behalf of the Commonwealth.

The requirements of the EP, as specified in the PSLME Regulations, include:

Environmental Assessment

Description of the Activity

(1) The environment plan must contain a comprehensive description of the activity including the following:

(a) the location or locations of the activity;

(b) general details of the construction and layout of any facility or other structure;

(c) an outline of the proposed operations (for example, seismic surveys, exploration drilling or production) and proposed timetables;

(d) any additional information relevant to consideration of environmental effects and risks of the activity.

Description of the Environment

(2) The environment plan must:

(a) describe the existing environment that may be affected by the activity, as well as any relevant cultural, social and economic aspects of the environment that may be affected; and

(b) identify the particular relevant values and sensitivities (if any) of that environment.

Description of Environmental Effects and Risks

(3) The environment plan must contain an assessment of environmental effects and risks for the activity that:

(a) identifies and evaluates environmental effects and risks arising directly or indirectly from the normal operations of the activity (including construction where applicable); and

(b) includes an assessment of risk of the potential effects on the environment resulting from reasonably possible operations (whether accidental or otherwise) that are not normal operations for the activity.

Environmental Performance Objectives and Standards

(4) The environment plan must include environmental performance objectives, environmental performance standards and measurement criteria that:

(a) define the objectives, and set the standards, against which performance by the operator in protecting the environment is to be measured; and

(b) include measurement criteria for determining whether the objectives and standards have been met.

Implementation Strategy for the Environment Plan

(1) The environment plan must contain an implementation strategy for the activity in accordance with this regulation.

(2) The implementation strategy must include measures to ensure that the environmental performance objectives and standards in the environment plan are met.

(3) The implementation strategy must identify the specific systems, practices and procedures to be used to ensure that:

(a) the environmental effects and risks of the activity are reduced to as low as reasonably practicable; and

(b) the environmental performance objectives and standards in the environment plan are met.

(4) The implementation strategy must establish a clear chain of command, setting out the roles and responsibilities of personnel in relation to the implementation, management and review of the environment plan.

(5) The implementation strategy must include measures to ensure that each employee or contractor working on, or in connection with, the activity is aware of his or her responsibilities in relation to the environment and has the appropriate skills and training.

(6) The implementation strategy must provide for the monitoring, audit and review of the operator's environmental performance and the implementation strategy.

(7) The implementation strategy must provide for the maintenance of a quantitative record of emissions and discharges (whether occurring during normal operations or otherwise) to the air, marine, seabed and sub-seabed environment, that is accurate and can be monitored and audited against the environmental performance standards and measurement criteria.

(8) The implementation strategy must provide for the maintenance of an up-to-date emergency response manual (including an oil spill contingency plan) including detailed response arrangements.

(9) The implementation strategy must provide for appropriate consultation with:

(a) relevant authorities of the Commonwealth, a State or Territory; and

(b) other relevant interested persons or organisations.

(10) The implementation strategy must comply with the Act, the regulations and any other environmental legislation applying to the activity.

Reporting Arrangements

The environment plan must include arrangements for:

(a) recording, monitoring and reporting information about the activity (including information required to be recorded under the Act, the regulations and any other environmental legislation applying to the activity) sufficient to enable the Designated Authority to determine whether the environmental performance objectives and standards in the environment plan are met; and

(b) reporting to the Designated Authority at intervals agreed with the Designated Authority, but not less often than annually.

Other Information in the Environment Plan

The environment plan must contain the following:

(a) a statement of the operator's corporate environmental policy;

(b) a report on any consultations between the operator and relevant authorities, interested persons and organisations in the course of developing the environment plan;

(c) a list of all environmental legislation of the Commonwealth, or a State or Territory, that may apply to the activity.

2.2.2 *Environment Protection and Biodiversity Conservation Act 1999*

The Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), enables the Commonwealth to join with the States and Territories in a national scheme of environment protection and biodiversity conservation. Under the EPBC Act, actions that are likely to have a significant impact on a matter of national environmental significance will trigger Commonwealth assessment and approval.

Matters defined as nationally significant include:

1. World Heritage properties.
2. Ramsar wetlands of international importance.
3. Nationally threatened animal and plant species and ecological communities.

4. Internationally protected migratory species.
5. Commonwealth land and marine areas.
6. Nuclear actions.

A referral and assessment process determines the application of the EPBC Act. Where activities are deemed by the Minister to have a potential for significant impacts on matters of national environmental significance, the project is deemed to be a controlled action and assessment under the EPBC Act is triggered.

Santos submitted EPBC referrals with the DEH for the Southern Margins Seismic Program as separate referrals for each of the two campaigns, outlined below:

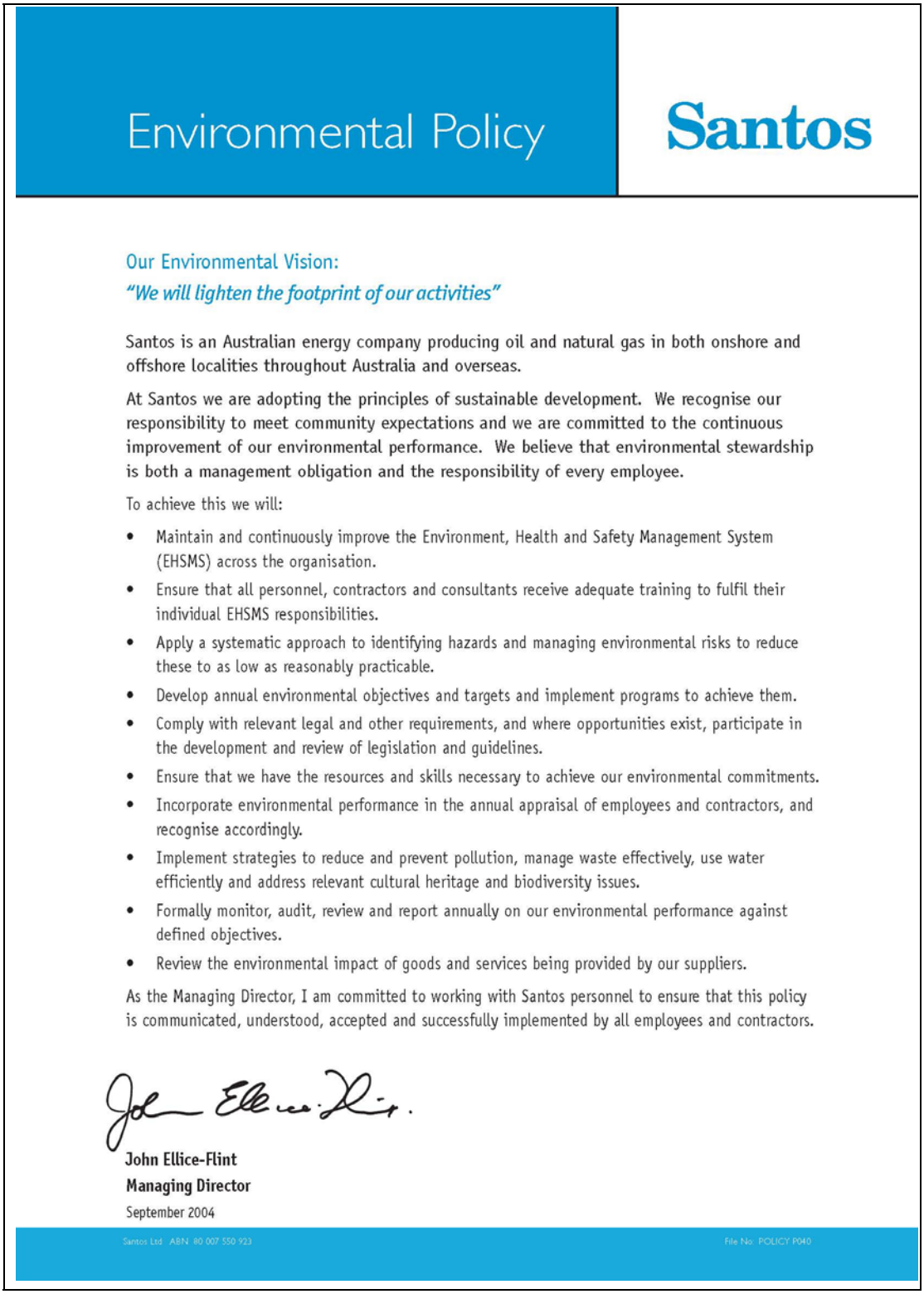
- T32/P, T33/P and T40/P campaign – Referred 6th September 2005, decision received 4th October 2005 determining that the action is not a controlled action – manner specified.
- VIC/P50 campaign – Referred 15th September 2005 decision received 7th October 2005 determining that the action is not a controlled action – manner specified.

The seismic campaigns are not expected to be deemed controlled actions based on their scheduling to avoid key whale migration seasons and recent precedents.

2.4 Environmental Policy Statement

The Santos environmental policy is outlined in Box 2.1 (overpage).

Box 2.1 Santos' environmental policy



Environmental Policy

Santos

Our Environmental Vision:

"We will lighten the footprint of our activities"

Santos is an Australian energy company producing oil and natural gas in both onshore and offshore localities throughout Australia and overseas.

At Santos we are adopting the principles of sustainable development. We recognise our responsibility to meet community expectations and we are committed to the continuous improvement of our environmental performance. We believe that environmental stewardship is both a management obligation and the responsibility of every employee.

To achieve this we will:

- Maintain and continuously improve the Environment, Health and Safety Management System (EHSMS) across the organisation.
- Ensure that all personnel, contractors and consultants receive adequate training to fulfil their individual EHSMS responsibilities.
- Apply a systematic approach to identifying hazards and managing environmental risks to reduce these to as low as reasonably practicable.
- Develop annual environmental objectives and targets and implement programs to achieve them.
- Comply with relevant legal and other requirements, and where opportunities exist, participate in the development and review of legislation and guidelines.
- Ensure that we have the resources and skills necessary to achieve our environmental commitments.
- Incorporate environmental performance in the annual appraisal of employees and contractors, and recognise accordingly.
- Implement strategies to reduce and prevent pollution, manage waste effectively, use water efficiently and address relevant cultural heritage and biodiversity issues.
- Formally monitor, audit, review and report annually on our environmental performance against defined objectives.
- Review the environmental impact of goods and services being provided by our suppliers.

As the Managing Director, I am committed to working with Santos personnel to ensure that this policy is communicated, understood, accepted and successfully implemented by all employees and contractors.

John Ellice-Flint
Managing Director
September 2004

Santos Ltd ABN 80 007 550 923 File No: POLICY P040

3. Description of Environment

3.1 Physical Environment

3.1.1 Climate

The climate of the seismic survey areas is summarised in Table 3.1, using the nearest towns as measurement tools.

Table 3.1 Climate of the seismic survey areas

Parameter	Cape Sorell (Tas)	Cape Nelson (Vic)
Distance to nearest seismic line	*70 km*	*50 km*
Climate classification[1]	No dry season, mild summer	No dry season, mild summer
Average annual rainfall (mm)	1354.1	784.8
Mean number of rain days	235.9	189
Mean daily maximum temperature (°C)	14.9	17.0
Mean daily minimum temperature (°C)	9.5	11.1
Mean relative humidity (9 am) (%)	83	80
Mean relative humidity (3 pm) (%)	79	76
Mean wind speed (9 am) (km/hr)	22.8	24.3
Mean wind speed (3 pm) (km/hr)	25.1	25.5

Source: Bureau of Meteorology, 2005.
[1] Based on the Koppen climate classification of Australia, 30-year climatology (1961-1990) (Bureau of Meteorology, 2004.).

3.1.2 Oceanography

Tasmania

The tidal velocity of the survey area ranges from 0.04 to 0.16 m/s (moving west to east), with velocity increasing closer to the coast. The National Oceans Office (2002) indicates a western wind shift in the western part of Bass Strait.

The main surface current running southward along the continental slope in summer is the Zeehan Current. It transports warmer water down the west coast of Tasmania, and is somewhat weaker than the East Australian current and the Leeuwin Current (in the Great Australian Bight). During winter, the Zeehan current also runs north of King Island, bringing with it cold, nutrient-rich waters (National Oceans Office, 2002).

Victoria

High energy wave conditions are characteristic of the survey area, with more severe wave conditions occurring in winter. Wave heights in the Port Campbell region commonly range between 2.0 to 3.5 m for 50% of time however in winter they can reach 7.6 m (BHP Petroleum and Santos (BOL) Ltd, 1999).

Tidal range is considered microtidal, 0.8 – 1.2 m (IMCRA, 1998). There are two high tides and two low tides per day with levels in Port Campbell varying from 0 to 1.1 m (Woodside, 2003).

Wind driven currents are the most predominant in the area, generally running parallel to the coast and in a majority of the cases from west to east (BHP Petroleum and Santos (BOL) Ltd, 1999; Woodside, 2003).

Tidal currents are in the order of 0.1 m/s and run in an east to south-east direction for most of the time, and occasionally currents swing around to the west and north-west (BHP Petroleum and Santos (BOL) Ltd, 1999).

The typical thermocline temperature is 16.5°C, with surface temperature varying from 14.5 to 19°C and bottom temperatures in the area of 13.5°C to 14.5°C. There is a seasonal thermocline at a depth of 30 m in December which moves to 100 m in May and is then rapidly destroyed as mixing occurs during winter months (BHP Petroleum and Santos (BOL) Ltd, 1999).

Upwelling is known to occur along the Bonney Coast (Robe, SA to Portland, Vic) and extends through to the study area throughout the summer period (November-March) (Butler et al., 2002). This 'Bonney Upwelling' is a result of south-east winds generating water movements to the surface away from the coast. This water is replaced by colder water drawn from greater depths off the continental shelf that is generally nutrient-rich and plays an important role in the generation of plankton blooms (Woodside, 2003).

3.1.3 Seabed Bathymetry

Tasmania

The T32/P, T33/P and T40/P 2D seismic survey is located in water depths ranging from 100 to 2,900m in depth on the continental shelf and continental slope between 15 and 160 km (8 nm and 86 nm) from the west coast of Tasmania.

The DEH characterises the area covered by the T32/P, T33/P and T40/P permits as continental shelf slope with numerous canyons (DEH, 2003).

Victoria

The VIC/P50 area is located in water depths ranging from 100 to 2,500 m in depth, on the continental shelf slope, where numerous canyons are present (DEH, 2003).

The geology of the seabed on the continental shelf is likely to reflect the coastline geology and therefore consist of calcarenite, limestone, sandstone and marl, with areas of sand of varying grain size. Seabed collections in Bass Strait (Wilson and Poore, 1987) were taken from grabs, sleds and trawls over a large area of Bass Strait shelf and those between Cape Otway and Warrnambool (mostly between 50 and 180 m water depth) were characterised by medium to coarse sand, some with varying proportions of shelly carbonate sand and rock. Visual information obtained from remote underwater camera of the pipeline routes for the Casino and Geographe Thylacine projects (Santos 2004,

Woodside 2003), shows the mixture of bare sand, coarse sand and shell, and patches of low-profile reef. Although these projects are located to the east of the proposed seismic survey, they are in similar depth ranges (70–100 m), and the types of seabed are likely to extend to the VIC/P50 survey area.

Less is known about the seabed bathymetry on the edge of the continental shelf and the shelf slope however the seabed is likely to consist of calcarenite, limestone, sandstone, marl and granite, with areas of sand of varying grain size. Benthic substrate can be expected to consist of sand, silt, gravel, calcareous gravel and calcareous ooze. Deep rocky reefs are likely to occur in much shallower waters north of the survey area.

3.2 Biological Environment

3.2.1 Marine and Coastal Classification

The Interim Marine and Coastal Regionalisation for Australia (IMCRA) (1998), has adopted an ecosystem-based classification system for marine and coastal environments. The area of the seismic survey encompasses several classifications, as outlined in Table 3.2 below. The hierarchy of marine classification commences with the province being the largest mapped unit, followed by biomes, provincial biomes, and sub-biomes.

Table 3.2 IMCRA bioregional classification of the seismic survey area

Name	Scale Hierarchy	Scale Area	Description
Entire Seismic Survey Area			
Southern Pelagic Province	Pelagic province	482,000 km^2	Extends from near Albany, WA, to Lakes Entrance, Victoria, encapsulating all of Bass Strait. Comprised of temperate species, with the endpoint disjunctions representing the southern limits for tropical species.
Tasmania & Victoria			
West Bassian Biotone	Demersal Province	89,000 km^2	Zone of faunal overlap of elements from the Tasmanian and Bassian Provinces to the east, and a small suite of extralimital species from the Central Eastern Province.
Otway	Meso-scale (Provincial)	100s-1000s of km	Characterised by very steep to moderate offshore gradients. Wave energy is high, currents are generally slow, and the waters are cold temperate, subject to localised, regular and cold nutrient-rich coastal upwelling.

Provinces are based on a classification of demersal fish species diversity and richness.

3.2.2 Marine Fauna

Fauna of national significance that may be encountered within the Southern Margins Seismic Program area are listed in Table 3.3. The list is based on a search of the DEH EPBC Online Database (DEH, 2005) for the coordinates of the proposed survey areas. Unless otherwise specified, the list applies to all survey areas (Tasmania and Victoria).

Table 3.3 Marine fauna of national significance that may occur in the seismic survey area

Species	Common Name	Status
Whales		
Balaenoptera acutorostrata	Minke whale	LC
Balaenoptera bonaerensis	Antarctic minke whale	M
Balaenoptera borealis	Sei whale	V, M (T32/P, T33/P &T40/P)
Balaenoptera edeni	Bryde's whale	M
Balaenoptera musculus	Blue whale	E, M
Balaenoptera physalus	Fin whale	V, M (T32/P, T33/P &T40/P)
Berardius arnuxii	Arnoux's beaked whale	LC
Caperea marginata	Pygmy right whale	M
Eubalaena australis	Southern right whale	E, M
Globicephala macrorhynchus	Short-finned Pilot whale	M
Globicephala melas	Long-finned pilot whale	LC
Kogia breviceps	Pygmy sperm whale	LC
Kogia simus	Dwarf sperm whale	LC (VIC/P50 Only)
Megaptera novaeangliae	Humpback whale	V, M
Mesoplodon bowdoini	Andrew's beaked whale	LC
Mesoplodon densirostris	Blainville's beaked whale	LC
Mesoplodon grayi	Gray's beaked whale	LC
Mesoplodon hectori	Hector's beaked whale	LC
Mesoplodon layardii	Strap-toothed beaked whale	LC
Mesoplodon mirus	True's beaked whale	LC
Orcinus orca	Killer whale	M
Physeter macrocephalus	Sperm whale	M
Pseudorca crassidens	False killer whale	LC
Tasmacetus sherpherdi	Tasman Beaked whale	LC (T32/P, T33/P &T40/P)
Ziphius cavirostris	Cuvier's beaked whale	LC
Sharks		
Carcharodon carcharias	Great white shark	V, M
Seals		
Arctocephalus pusillus	Australian fur-seal	L
Dolphins		
Delphinus delphis	Common dolphin	LC
Grampus griseus	Risso's dolphin	LC

Species	Common Name	Status
Lagenorhynchus obscurus	Dusky dolphin	LC
Lissodeplphis peronii	Southern right whale dolphin	LC
Tursiops truncatus s. str.	Bottlenose dolphin	LC
Birds		
13 species (genera *Diomedia, Phoebetria* and *Thalassarche*)	Albatross	M, L (3E and 10V)
4 species (genera *Halobaena*, *Macronectes* and *Phoebetria*)	Petrel	M (1E & 3V)
Catharacta skua	Great skua	L
Fish		
22 species	Pipefish	L
3 species	Pipehorse	L
2 species	Seahorse	L
2 species	Seadragon	L

L - listed, LC - listed cetacean, V - vulnerable, E - endangered, M – marine.

Those species and marine fauna groups that may occur in the project area at various times of the year (e.g., for feeding, breeding or migration) are discussed below.

Marine Mammals

Whales. The T32/P, T33/P and T40/P survey area lies approximately 50 km south of the southeastern margin of the Bonney Coast (which extends from Robe, South Australia to Cape Otway, Victoria). It is the nearest identified significant habitat (feeding, breeding and calving area) for species of whales including blue whales. The VIC/P50 survey area lies within the central region of the Bonney Coast.

Whales of Commonwealth conservation significance that may occur in the seismic survey area (see Table 3.3) include blue, southern right and humpback whales; they are discussed below.

Blue whales (*Balaenoptera musculus*) (listed as endangered) have widespread migratory paths and are not known to follow coastlines or oceanographic features (Bannister et al., 1996). Until 1999, there were fewer than 50 sightings in Bass Strait but since that time, feeding blue whales have been more regularly observed in the Discovery Bay area, near to Portland and more generally along the Bonney coast from Robe to Cape Otway. The time and location of the blue whale appearance generally coincides with the cold-water summer-autumn upwelling along this coast (now referred to as the Bonney Upwelling) and the associated aggregations of the krill species *Nyctiphanes australis* (Environment Australia, 2002a; Gill, 2002; Gill and Morrice, 2003) upon which the whales feed. Most sightings are centred along the 100m isobath between Robe and Portland, between late November and April, but because each season has a unique upwelling signature, the exact timing and location of first appearance is difficult to predict (Gill pers. comm., 2003). During the 2003 and 2004 seasons blue whales have been sighted in the first half of November during seismic survey operations.

Off Cape Bridgewater in Victoria, blue whale sightings are concentrated along the shelf break but are more dispersed over a wider shelf and deepwater area to the northwest and southeast (refer Figure 1.3 and 1.4). There are few sightings of blue whales off the western Tasmanian coast, although Bannister et al. (1996) reports sightings off east and west Tasmania. The survey area has not been identified a critical habitat (feeding, breeding or calving) for this species.

Southern right whales (*Eubalaena australis*) (listed as endangered) congregate every year from about May to October off the Warrnambool coast approximately 100 km east of the VIC/P50 survey area, 150 km northwest of the T32/P, T33/P and T40/P survey area. They have breeding cycles of three years (Environment Conservation Council, 2000). Logans Beach near Warrnambool is one of several known over-wintering and nursery areas for this species along the southern Australian coast. Southern right whales may migrate through the survey areas, travelling north from Antarctic waters, from early May to the end of June and south to Antarctic waters during late September to early November. There is no known critical habitat (feeding, breeding or calving) for the species in the survey areas.

Humpback whales (*Megaptera novaeanglia*) (listed as vulnerable) occur in coastal areas of Australia in winter and spring. Western Tasmanian and Victorian coastal waters are not a key location for this whale species. Most east coast humpbacks migrate along the east coast of Tasmania, between summer feeding grounds in the Antarctic and winter breeding and calving grounds in sub-tropical east coast Australia. A discrete population of humpback whales that uses the west coast of Tasmania and Bass Strait for this migration may pass the survey areas. Some animals have also been observed in the eastern Great Australian Bight (e.g., near Kangaroo Island) in early winter (Bannister et al., 1996). From these migratory patterns, their presence may be expected moving northwards during autumn and southwards in spring. However, exact timing is difficult to predict. During Santos' 2002 seismic surveys in the deep water Otway Basin several humpback sightings were made during November.

Sei whales (*Balaenoptera borealis*) are rare in Australian waters, but have been observed offshore of Tasmania and in the eastern Great Australian Bight (Bannister et al., 1996). Their distribution is mainly deep-water and not often found near coasts. They are known to undertake long migrations between warm water breeding grounds and colder water feeding grounds, but specific locations and migration paths are not well known. In general, just the one sei whale has been seen each season during Santos' extensive aerial survey and seismic observations along the Southern Margins.

Pygmy right whales (*Caperea marginata*) are generally found in temporal subantarctic waters, and oceanic, pelagic and inshore sightings have also been made. There have been sightings of this whale from Tasmania and South Australia, and the frequency of strandings (two or three a year) suggests that it is not rare in southern Australian waters (Bannister et al., 1996).

Killer whales (*Orcinus orca*) are commonly found in cold deep waters. Off Australia, they are often seen along the continental slope and on the shelf as well as often being seen near seal colonies (Bannister et al., 1996). Concentrations of the species are believed to

occur around Tasmania and South Australia (Bannister et al., 1996). Although not a migratory species, their movements vary seasonally and are related to food supply (Bannister et al., 1996).

Minke whales (*Balaenoptera acutorostrata*) tend to migrate in wide migration paths from cold water feeding grounds to warmer waters to breed during the winter period (Thiele and Gill, undated; Bannister et al., 1996). The mating period for minke whales occurs from August to September and calving occurs from June to July (Bannister et al., 1996). Their distribution is worldwide and oceanic but not restricted to deep waters. There are no specific habitats identified in the vicinity of the survey area.

There are two forms of the Bryde's whale (*Baleonopetra edeni*); an inshore and an offshore form. It is typically found in tropical and temperate waters from the equator to approximately 40°S both in deeper oceanic waters and inshore (IFAW, undated; Bannister et al., 1996). The seismic survey area is located at approximately 40°S. Mating occurs throughout the year for the inshore form and during autumn/winter for the offshore form (Bannister et al., 1996).

The sperm whale (*Physeter macrocephalus*) is found in deep waters off the continental shelf, with a strong preference for the 1,000 m depth contour (Perry et al., 1999; Anonymous, 2001) and rarely seen at depths less than 300 m (Anonymous, 2000). Concentrations of sperm whale populations are generally found where the seabed rises steeply from great depths. This may coincide with areas where potential food sources (cephalopods) are concentrated particularly in areas of upwelling (Bannister et al., 1996). According to Bannister et al. (1996) key localities for the sperm whale include waters off Tasmania's west and south coasts, and southwest of Kangaroo Island. The sperm whale mating season is between September to December, with calving occurring between November to March (Bannister et al., 1996; Perry et al., 1999). There are no known specific calving locations in Australian waters for the sperm whale but they are known to occur in temperate and tropical oceanic waters (Bannister et al., 1996). A number of sperm whale sightings have been made in deep waters between Western Tasmania and West of Kangaroo Island during seismic surveys conducted by Santos in 2002, 2003 and 2004.

Other Marine Mammals. Risso's dolphin (*Grampus griseus*) has not been recorded off Tasmania. It is considered a pelagic and oceanic species also frequently seen over the continental slope (Bannister et al., 1996). Dusky dolphins (*Lagenorhynchus obscurus*) predominantly occur in temperate subantarctic zones inshore but also pelagic at times (Bannister et al., 1996). The common dolphin (*Delphinus delphis)* is found in neritic, pelagic and oceanic habitats in all oceans. This species has been associated with high topographical relief of the ocean floor, escarpments and areas of upwelling (Bannister et al., 1996). The bottlenose dolphin (*Tursiops truncatus*) is generally found in coastal estuarine pelagic and oceanic habitats. In southern Australia, this species can occur close to shore (i.e., within a few hundred meters of the coastline) as well as in waters beyond the continental slope (Bannister et al., 1996) all year round.

A summary of the timing of peak whale activities in and around the Otway Basin is provided in Table 3.4. The timing of these activities are peak only, and individuals of the

species listed still have the possibility of occurring in the Otway Basin outside of the times indicated in Table 3.4.

Table 3.4 Summary of peak whale activities in the Otway Basin

Species	Activity	Month											
		J	F	M	A	M	J	J	A	S	O	N	D
Southern right whale	Migration, calving, nursing												
Blue whale	Feeding aggregation												
Humpback whale	Migration												
Sei whale	Probably feeding												
Fin whale	Probably feeding												
Minke whale	Probably feeding												
Beaked whale*	Probably feeding												

* Species unknown.

Sharks. There is a long-term decline in the abundance of white sharks (*Carcharodon carcharias)* in Australian waters. White sharks (*Carcharodon carcharias*) are uncommon but there are areas in Australian waters where they appear to be more frequent (Environment Australia, 2002b), including around seal colonies (e.g., Neptune Island and The Pages). Juveniles are most commonly encountered in inshore areas, often in the vicinity of open coast beaches. Western Tasmanian waters do not appear to provide any significant habitat for the species (i.e., they lack seal colonies that the shark appears to favour as feeding grounds) (Environment Australia, 2002b).

Grey nurse sharks (*Carcharias taurus)* are not common in southern Australian waters (Environment Australia, 2002c).

Pinnipeds. The Australian fur-seal (*Arctocephalus pusillus*) range includes South Australia, southern Tasmania, New South Wales and Victoria (Shaughnessy, 1999), but it breeds only on islands in Bass Strait (Strahan, 1995; Shaughnessy, 1999), and it has been recorded at Kangaroo Island. Preferred habitat is on rocky islands in exposed places close to the sea, on open slopes, shore platforms and reefs, pebbled beaches and caves (Strahan, 1995). The Australian fur seal diet consists of fish, cephalopods and seabirds (Shaughnessy, 1999), diving up to 200 m in search of prey (Strahan, 1995). Births occur from late October to late December (Strahan, 1995; Shaughnessy, 1999).

The Australian fur-seal (*Arctocephalus pusillus*) has established four breeding areas on islands in Victoria (Shaughnessy, 1999). The largest breeding colonies are at Lady Julia Percy Island and Seal Rocks in Victoria (Shaughnessy, 1999). There are several small non-breeding colonies, one of which is at Little Henty Reef near Apollo Bay (Woodside, 2003). Australian fur-seals are present in the region of the VIC/P50 survey all year round, however estimates of the numbers that utilise the area are lacking (Woodside, 2003).

A. pusillus has established five breeding areas on Tasmanian islands in Bass Strait (Shaughnessy, 1999), these include; Tenth Island, Moriarty Rocks, West Moncoeur,

Judgement Rocks and Reid Rocks, the latter two the largest breeding colonies in Tasmania. These islands are well east of the survey area, between Wilsons Promontory and Flinders Island.

New Zealand fur-seals (*Arctocephalus forsteri*) from populations at Kangaroo Island may also forage in western Victoria.

The Australian sea lion (*Neophoca cinerea*) is endemic to Australian waters and has its principal breeding colonies at Kangaroo Island and Dangerous Reef, near Port Lincoln (Shaughnessy, 1999). Sea lions stay relatively close to the colonies and do not undertake migrations. They come ashore on sandy beaches, and usually spend their entire life very close to their birth area. Its diet consists of fish, cephalopods, penguins, sharks and sea birds (Strahan, 1995; DPIWE, 2003a). Breeding females are benthic feeders on the continental shelf 20-30 km offshore, diving to depths of less than 150 m (DPIWE, 2003a).

Seabirds. Marine birds are not listed in Table 3.3 as they are mostly migratory, and may overfly the project area but are highly unlikely to be impacted by the activity. The Bay of Islands (west of Peterborough) and the offshore limestone stacks are important roosting and breeding colonies for many bird species, including the pacific gull (*Larus pacificus*).

There are 13 species of migratory albatross listed as occurring across all the survey areas, of which three species are endangered and nine are vulnerable. There are four threatened species of petrel, of which one is endangered and three are vulnerable.

Pipefish and Seahorses. Pipefishes, seahorses and seadragons are associated with kelp forests in sheltered to moderately exposed reef areas at a range of depths 0-50 m depending on the species (Edgar, 1997). They are unlikely to be found in high numbers in the areas where the seismic surveys will take place due the water depths in the project areas.

3.3 Socio-Economic Environment

3.3.1 Maritime Heritage

Shipwrecks are most commonly associated with submerged shallow reefs. Shipwrecks represent significant archaeological, educational and recreational (i.e., diving) opportunities for the general public, historians, students, and tourists. No known shipwrecks occur in the survey areas (Larcombe et al., 2002), nor are any expected due to the surveys being located in open seas a significant distance from coastal waters.

The nearest shipwrecks to the T32/P, T33/P and T40/P permit areas are situated along the northern part of the west coast, with a high concentration of shipwrecks along King Island's west coast, where about eight shipwrecks rest. Shipwrecks closest to the VIC/P50 area occur all along the west coast, also referred to as the 'Shipwreck Coast' (Larcombe et al., 2002).

3.3.2 Coastal Towns and Services

Tasmania

The communities closest to the T32/P, T33/P and T40/P permit area include Currie on King Island and Strahan. Currie a town of 800 people, is situated on the west coast of King Island and provides the regional services for the Islanders. Strahan, a tourist town of 550 people, is situated on Macquarie Harbour and provides port services to the commercial and recreational fishing industries, mainly for crayfish, abalone, giant crab and shark.

Victoria

The coastal communities of Portland and Warrnambool are the closest towns to the VIC/P50 permit area, with both providing services to the commercial and recreational fishing industries of western Victoria. Portland is Victoria's western most commercial port, and is a deep-water port with breakwaters sheltering a marina and boat ramp. The Port of Warrnambool has a breakwater and yacht club, and provides shelter for commercial fishing boats.

3.3.3 Petroleum Exploration and Production

Tasmania

The Sorell Basin has only been lightly explored. Santos undertook a 2D seismic program in T/32P and T/33P in late 2002 and another 2D seismic survey in T/35P (immediately northwest of T/32P). Only 3 seismic surveys have been conducted in T/36P during the last 25 years – in 1981, 1990 and 2004. The region has not yet undergone any offshore petroleum production development.

Victoria

Petroleum exploration (onshore and offshore) has been undertaken within the Otway Basin of Victoria since the early 1960s. Hydrocarbons discovered by these exploration activities have been developed or are now undergoing assessment for development.

Offshore from Port Campbell, several gas fields are in the process of development. All include offshore and onshore pipelines and connect to gas plants around Port Campbell. These include the:

- Minerva Gas Field (BHP Billiton and Santos), 10 km offshore from Port Campbell, in water deeper than 50 m. Production from this field is due to commence shortly.
- Geographe and Thylacine Gas Fields (Woodside and Origin Energy) are located further offshore, directly south of Port Campbell, in waters about 100 m in depth.
- Casino Gas Field (Santos), 30 km offshore from Port Campbell, in a water depth of 70 m. This project is currently in the final stages of development with first gas expected in early 2006.

Petroleum exploration and production has regional benefits for southwest Victoria. Not only have the numerous onshore and offshore studies undertaken for these developments led to a greater understanding of the region's terrestrial, coastal and marine environments, but they have resulted in a boost to the regional economy through the provision of services to project personnel and through the creation of employment in construction and project support.

3.3.4 Marine Conservation

There are no marine conservation parks in the vicinity of the survey areas as such parks are generally located closer to the coast.

3.3.5 Commercial Fisheries

Australia's fishing zone is the fifth largest in the world, but has a low productivity due to nutrient-poor ocean currents. About 10% of the known fish, crustacean and mollusc species are commercially fished, and commercial fishing is the fifth most valuable Australian rural industry (AFFA, 2003). Fisheries production relies heavily on the high unit value species such as prawns, tuna, rock lobster and abalone (AFFA, 2003).

A variety of marine species are commercially harvested from the Southern Margins Seismic Survey area. Table 3.5 outlines the commercial fisheries present within the survey areas.

Table 3.5 Commercial fisheries in the Southern Margins Seismic Program area

Fishery	T/32P, T/33P & T/40P (Tas)	VIC/P50 (Vic)
Commonwealth-managed fisheries		
South East Fishery (SEF)	Y	Y
Gillnet, hook and trap	Y	Y
Eastern tuna and billfish	Y	Y
Jack mackerel	Y	Y
Southern squid	Y	Y
State-managed fisheries		
Southern rock lobster	Y	Y
Giant crab	Y	Y
Scale fish	Y	-

The commercial fisheries present within the survey areas are discussed below.

South East Fishery

The South East Fishery (SEF) fishes more than 100 species, but 17 species or species groups provide the bulk (>80%) of trawl landings. Such species include the orange roughy, gemfish, flathead, blue grenadier, redfish, school whiting, warehou and jackass morwong (BRS, 1994; AFFA, 2003). Trawling is concentrated along the edge of the continental shelf.

All survey areas coincide with fishing in the SEF.

Gillnet, Hook and Trap Fishery

The Gillnet, Hook and Trap Fishery (formerly the Southern Shark Fishery and South East non-Trawl Fishery) extends from southeast Queensland to the South Australia/Western Australia border. Among the 21 species subject to quota arrangement include blue eye trevalla, blue grenadier, flathead, gemfish, john dory, orange roughy, royal red prawn and silver trevally (AFMA, 2003). Shark species caught include school and gummy shark, with school shark overfished (BRS, 2003). Methods of fishing include demersal longline, dropline, trotline and handline for scalefish, hook to target sharks, gillnets in waters deeper than 200 m and fish traps (AFMA, 2003).

All survey areas coincide with fishing in the Gillnet, Hook and Trap Fishery.

Southern Squid Jig Fishery

The Southern Squid Jig Fishery, which mainly targets the arrow squid (*Nototodarus gouldi*), is located in Commonwealth waters of southeast Australia in water depths ranging from 50 to 200 m, with peak catches being between January and June (AFMA, 2003). In August 2002, there were 84 squid jig entitlements. The 2000-2001 catch was 1,830 tonnes, worth $2.8 million (AFMA, 2003).

All survey areas coincide with fishing in the Southern Squid Jig Fishery. However, catches are mainly taken between Portland and Queenscliff in Victoria.

Eastern Tuna and Billfish Fishery

The Eastern Tuna and Billfish Fishery extends from the northern coast of Australia south to the Victoria/South Australia border, encompassing Tasmania. Species targeted using longline and minor line includes yellowfin tuna (*Thunnus albacares*), bigeye tuna (*Thunnus abesus*) and broadbill swordfish (*Xiphias gladius*), while purse seine fishing (yielding low quantities) targets the skipjack tuna (*Katsuwonus pelamis*) (AFMA, 2003). The fishery has 311 fishing concessions, and its estimated value in 2001-2002 was $56 million (AFMA, 2003).

All survey areas coincide with fishing in the Eastern Tuna and Billfish Fishery, but don't represent major fishing areas.

Southern Rock Lobster Fishery

The Southern rock lobster (*Jasus edwardsii*) occurs from the southwest of the Western Australian coast to southern New South Wales, including waters around Tasmania and New Zealand. The southern rock lobster fishery is an extremely valuable fishery (e.g., it was the second-most valuable fishery in Victoria in 2000/2001, worth $21.3 million (DPI, 2003a)).

Southern rock lobsters are abundant from the shoreline to depths up to 200 m (DPI, 2003a), but generally fished from rocky reefs in shallower waters up to 150 m deep. Commercial fishers mainly use lobster pots while recreational fishers use SCUBA and

hook netting (DPI, 2003a). Pot numbers and dimensions are restricted (pot and escape gap size) to ensure sustainable commercial harvests.

In Tasmania, there are 315 fishing licences and 228 vessels participating in the Southern Rock Lobster Fishery (DPIWE, 2004), and fishing occurs. The closed season for female rock lobster is May 1 to 5 November, and is closed between September 1 and November 5 for male rock lobsters (DPIWE, 2004).

The VIC/P50 survey area lies within the Victorian Western Zone, which extends from Apollo Bay to the South Australian border. There are 89 Rock Lobster Fishery Access Licences (RLFAL) in the Western zone, with 5,388 licensed pots (Hobday & Smith, 2001), out of a total of 139 licences for Victoria (2001/2002) (DPI, 2003a). There is a closed lobster fishing season for female rock lobsters from June 1 to November 15, and for males starting September 1 to November 15 (SIV, 2004).

Giant Crab Fishery

The giant crab (*Pseudocarcinus gigas*) is only found in southern Australian waters from central NSW to south western Australia, including Tasmania. Giant crabs occur at the continental shelf break and upper slope to depths greater than 400 m, however, they are most abundant at depths between 150 m to 350 m (DPI, 2003b), and primarily taken from depths between 140 and 270 m (DPIWE, 2003). The giant crab season is the same as that for the southern rock lobster (i.e., closed season for female giant crab is May 1 to 5 November, and is closed between September 1 and November 5 for male giant crab) (DPIWE, 2004).

All survey areas coincide with fishing in the Giant Crab Fishery.

3.3.6 Commercial Shipping

Major shipping channels are located through the VIC/P50 survey area. The south east marine region is one of the busiest areas for shipping in Australia, with freight and passengers carried between the mainland and Tasmania and between Australian ports and New Zealand (BRS, 2002).

The VIC/P50 permit area is dissected by the main southern Australia shipping freight channel that over 1,000 vessels travel through each year (to/from west and east coast ports, and international shipping) (BRS, 2002).

4. Description of Environmental Hazards and Consequences

This section provides a description of potential environmental hazards and consequences of the proposed seismic survey to the environmental values of the survey program area.

4.1 Potential Environmental Hazards

The environmental hazards (and main associated consequences) of the seismic program are:

- Discharge of high intensity sound.
  - Disturbance or injury to marine fauna.
- Physical presence of the vessel.
  - Disturbance or injury to marine fauna.
  - Interference with commercial shipping and fishing.
  - Collision with other vessels.
- Waste disposal (sewage, putrescible waste, chemicals and solid and hazardous wastes).
  - Increased nutrient levels.
  - Water contamination.
  - Low-level contamination of some fauna species.
- Hydrocarbon spills – spillage from the survey vessel or from the streamer.
  - Increased nutrient levels.
- Hull maintenance.
  - Low-level contamination of some fauna species.

These hazards are discussed below.

4.1.1 Discharge of High Intensity Sound

The initial 10 to 20 years of seismic survey occurred around the coast of Australia at a time when there was relatively little information of the potential impacts from seismic activity and little prima facie evidence that significant adverse impacts actually resulted. At the same time, little information was available about the nature of responses to underwater noise and the significance of any harm or disturbance that may have been caused. However, understanding of responses has improved with research, particularly since the 1990s. A Norwegian field study in 1993 indicated a temporary startle response

by fish (Engås et al., 1993). The independent scientific review (Swan et al., 1994) found no evidence of surveys grossly affecting marine animals (by way of death or severe injury). Since this (1994) scientific review, the Australian Petroleum Production and Exploration Association (APPEA) has funded an offshore seismic effects research project (McCauley et al., 2000), leading to the development of DEH guidelines for minimising acoustic disturbance to whales, and a number of other studies have been undertaken.

Sonic Disturbance

Marine seismic surveying involves the discharge of compressed air to create acoustic pulses that are reflected from layers under the sea floor and recorded back at the surface. Interpretation of these reflections is a key step in exploration for hydrocarbons. There is currently no other method that has sufficient resolution to identify rock structure beneath the surface.

An overview of the nature of underwater seismic sound has been provided in McCauley (1994) and McCauley *et al.* (2000). The predominant sound frequencies from seismic acoustic arrays are 10 to 300 Hz, although the main frequencies used in seismic surveying in Australian waters are generally in the 10 to 100 Hz range. The sound intensity, measured in decibels (dB), varies depending on the frequency. For frequencies of 10 to 100 Hz, which are the bulk of seismic frequencies, the sound intensity at one metre from a 2,678 cubic inch (cu in) acoustic array is quoted as 258 dB re 1 μPa peak-peak (McCauley et al., 1998), which is equivalent to approximately 243 dB re 1 μPa mean squared pressure, or root mean square pressure. However most values are given as peak to peak and this is assumed in the following discussion unless stated otherwise. In addition, it must be emphasised that the above quoted sound intensities are theoretical intensities based on modelled estimates of the sound just one metre from the airgun array, effectively achieved by summing the signals of each airgun in the array. Given that the airgun array has dimensions of 20m wide by 15m long there is no single point that can be considered to be one metre from every airgun. Thus, the actual sound intensity one metre from the edge of the array is significantly lower than the above quoted intensities. This concept of the actual sound intensity being lower than the modelled intensity is supported by the acoustic monitoring work carried out by Santos along the Southern Margins during recent years (see below).

The sounds produced during a seismic survey are not at an unusual level relative to other sounds in the ocean. Table 4.1 presents a comparison of some sounds heard underwater.

Table 4.1 Sound Intensity and pressure (dB re 1 μPa one metre from the source)

Source	Sound Intensity (dB re 1 μPa)	Frequency (Hz)
Undersea earthquake	272	50
Seafloor volcanic eruption	255+	Varied
Lightning strike on sea surface	250	Varied
Seismic acoustic source	230-255	< 200
Sperm whale clicks	Up to 235	100-30,000

Source	Sound Intensity (dB re 1 μPa)	Frequency (Hz)
Bottlenose dolphin click	Up to 229	Up to 120,000
Ship sound (close to hull)	200	10-100
Breaching whale	200	20
Blue whale vocalisations	190	12-400
Ambient sea sound	80-120	Varied

Source: APPEA, 2004.

Seismic sound intensity reduces with distance from the acoustic source, although the rate of reduction varies depending on a number of factors, including local conditions. Typically seismic sound reduces to background intensity within tens of kilometres, although long-range transmission of seismic signals increases slightly for surveys conducted in deeper water.

The near-horizontal energy output from the sound source if the most crucial when considering long-range transmission of underwater sound. The arrays towed by the seismic vessel are specifically orientated such that the sound waves are directed towards the sea floor. Therefore, most of the energy goes downwards and does not travel very far horizontally, creating a 'sound shadow' near the ocean surface and the more rapid decay of the high frequencies at various high azimuths (horizontal angle reckoned clockwise from the meridian).

Recent in-situ monitoring of sound intensity at various distances from seismic sources has been conducted (McCauley et. al., 2000). Records from a 2,678 cu in array with an output of 243 dB re 1 μPa at one meter from the source indicated sound intensities of approximately 170 dB re 1 μPa at 1 km, reducing to approximately 160 dB at 2 km and 145 dB at 6 km, with a variability of ±5 dB depending on the orientation from the sound source, bathymetry and ocean conditions.

Santos (through Dr R McCauley at Curtin University's Centre for Marine Science and Technology) is currently analysing seismic signal intensity recordings measured by bottom recorders during seismic surveys conducted during 2003 and 2004 in the Otway Basin, and which used a similar array to that now proposed, which is in the range from 2,500 to 3,500 cu in. Narrowband sound levels arriving at a recorder placed in 28 m of water near the end of a seismic line indicated that at 23 km distance there was no measurable sound level increase at the recorder (McCauley, 2004). The sound levels build up very slowly as the vessel approaches and it is not until the separation distance is less than about 4 km that the sound level builds rapidly (Figure 4.1). Despite this rapid build-up the maximum narrowband (or spectral) signal level, which occurs at 25 Hz, does not exceed 140 dB until the source is less than 1 km from the recorder, and does not exceed 150 dB until at a distance of 100 m (McCauley, 2004). Figure 4.1 also shows the equivalent peak-to-peak (190dB) and mean squared pressure (180dB) values of the recorded data. Although this narrowband sound level is not directly comparable with the broadband sound intensities quoted in the literature, preliminary calculations for comparable forms indicate that this is equivalent to or less than the sound intensity reported by McCauley et al. (2000) as discussed above (i.e., 170 dB re 1 μPa at 1 km for a 2,678 cu in array) (McCauley, 2004). Figure 4.1 shows the difference in decibel levels

between the narrowband (spectral) measurements at the bottom of the figure and the RMS and Peak to Peak measurement at the top.

4.1.2 Physical Presence of the Vessel

The main issue associated with the physical presence of the seismic vessel is its requirements for towing streamers and turning, thereby influencing commercial ship movements (major shipping channels are located through the VIC/P50 survey area) and the operational areas of fishing vessels. This potentially affects the areas of operation of fishing vessels that employ demersal longline, dropline, trotline and handline, hooks, gillnets and fish traps as well as lobster and crab pots.

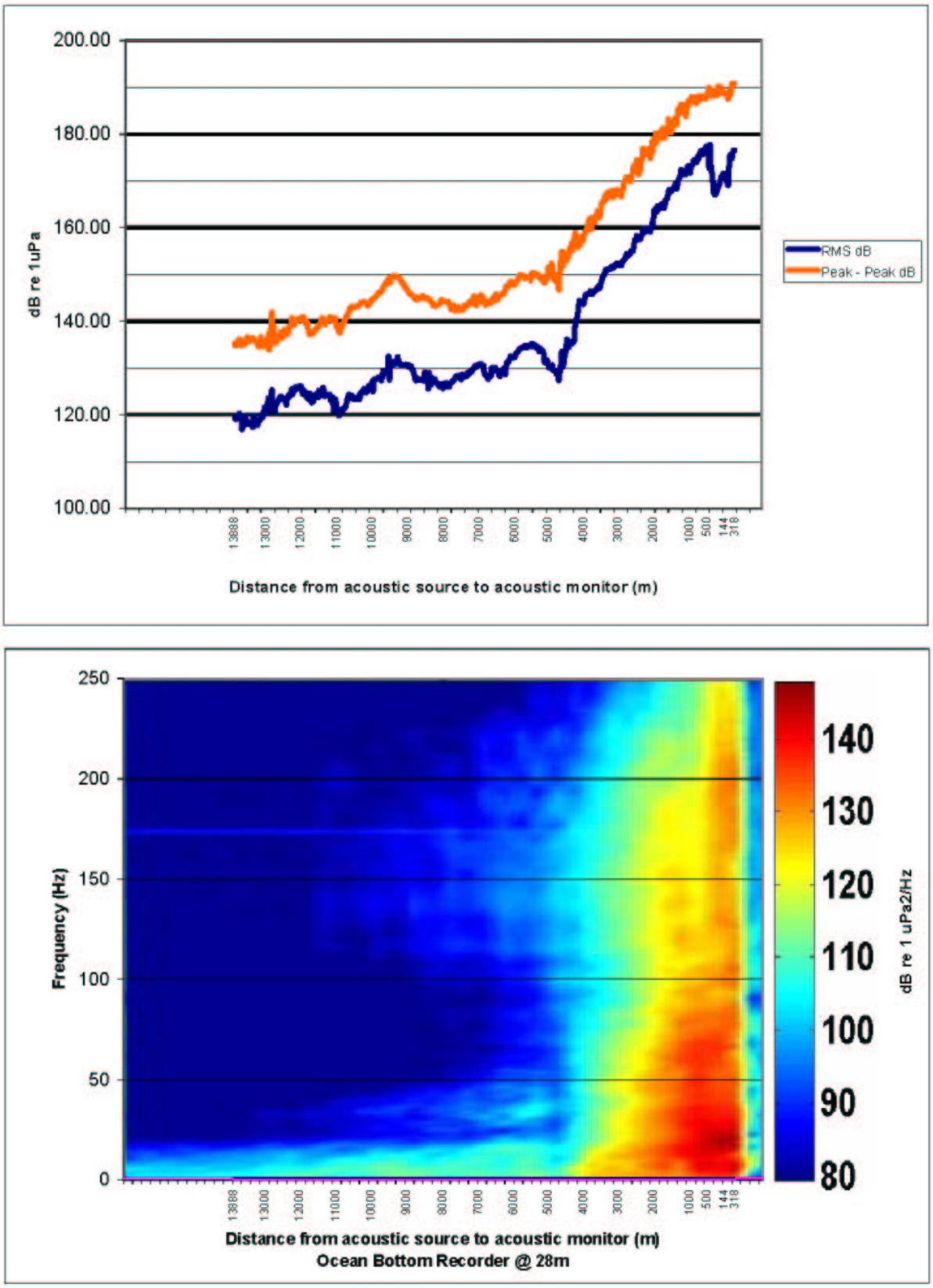


Figure 4.1 Seismic amplitude levels (a) and frequency (b) at distances between seismic source and acoustic monitor.

4.1.3 Waste Disposal

Routine discharges from seismic vessels are restricted to sewage and putrescible wastes (food scraps).

Sewage and Putrescible Wastes

Disposal of sewage and putrescible wastes overboard will be a routine discharge to the environment except when the vessel is within 3 nautical miles of the coast. Out side of this distance the disposal of sewage and putrescible wastes to the ocean that have been treated in accordance with the requirements of MARPOL Annex IV is considered to be best practice management for these waste types.

Solid Wastes

The seismic vessel also produces other solid and liquid wastes, including packaging and domestic wastes, such as aluminium cans, bottles, paper and cardboard. A variety of chemicals, such as lubricating oils and cleaning chemicals, are also stored and used on the vessel. Many of these items are consumed through use and are not accumulated in significant quantities as waste.

Hazardous Wastes

Hazardous wastes, generally of low quantity (mainly lithium batteries and small volumes of acids, solvents, paints and solvents), will be segregated and stored in sealed storage areas and transferred to onshore licensed hazardous material handlers for disposal to a licensed depot.

4.1.4 Hydrocarbon Spills

The following hydrocarbons may spill from the survey vessel:

- Fuel.
- Diesel (from power generation).
- Oil from hydraulic hoses and oil drums.
- Kerosene from the streamers.

The risk of fuel loss from the seismic survey vessel at sea is very low and would only be likely during a heavy collision with another large vessel or during a re-fuelling accident within port.

The hydrophone cables are segmented into 12.5 meter segments each containing 32-34 litres of Isopar M, which is a light, kerosene-like fluid that rapidly evaporates. Risks of rupture are low with occasional bites from sharks having been the main cause in the past, though entanglement with another vessel may also cause rupture. Because of the segmentation of the cable, loss of fluid is limited to that contained within the ruptured section. A spill of cable fluid, and of this order, will not pose a threat to the marine or coastal environment and is not an incident that would lead to detrimental impacts at the community, population or species level.

4.1.5 Hull Maintenance and Ballast Exchange

As with any vessel, the Pacific Titan undergoes regular anti-fouling of the hull (to prevent the build up of barnacles and other organisms that increase the drag on the vessel, leading to increased fuel consumption). The main chemical used in the anti-fouling agent, tributylin (TBT), persists in the environment by attaching itself to muds (accumulating in sediments), and in high concentrations can have toxic effects on marine organisms through bioaccumulation. The impact of TBT leaching off a single vessel in open waters has been found not to be detrimental to marine life (Fabris et al., 1995) and remains under the ANZECC Guidelines for Fresh and Marine Water Quality (2000) TBT trigger value of 0.0004 μgL^{-1} for the protection of 99% of species in marine waters.

As a non-cargo carrying vessel it is not necessary for the Pacific Titan to exchange ballast water during survey or other operations. The vessel also spends limited time in port to transfer people and supplies during the seismic programs. Depending upon the nature of the operations being undertaken port calls are usually undertaken on a monthly basis with the vessel spending less than 24 hours in port at each time.

4.2 Potential Environmental Consequences

The potential environmental consequences of the hazards described in Section 4.1 are outlined in this section.

4.2.1 Discharge of High Intensity Sound

Concerns about the potential impacts of seismic survey on marine animals are not new. Prior to 1969, ammonium nitrate explosive charges were used as the source of energy, and these were suspended below floats and detonated by radio signal. Studies undertaken in 1966 showed that rock lobsters held in pots survived and behaved apparently normally, but some dead fish were recovered after test explosions (Anon, 1966). In comparison, the impacts of compressed air may be less, but range from: lethality or pathological damage from close exposure to high sound levels; behavioural changes (including startle and alarm responses, or changes in schooling behaviour); avoidance; and temporary and permanent shifts in hearing thresholds and associated interference with acoustic signals (McCauley 1994; McCauley et al., 2003a). These impacts vary with seismic discharge intensity, distance from the source and species.

Impacts of Noise on Whales

Baleen whales (the group that includes the blue, southern right, and humpback whales, and listed as threatened under the EPBC Act) communicate by low frequency sounds and are therefore considered to be the most sensitive of the marine mammals to specific low frequency sounds. The hearing of baleen whales is thought to overlap the energy output of seismic related noise (McCauley, 1994; Evans, 1998). Baleen whales display a gradation of behavioural responses to seismic activities with evidence of subtle shifts in respiratory and diving patterns, suggesting that the seismic discharge is audible to whales at considerable distances from the source, but that the whales are not disrupted from normal activities (McCauley, 1994). Physical damage to the auditory system of

cetaceans is likely to occur at noise levels of about 230 to 240 dB which theoretically occur at a distance of 1 to 2 m from the energy source (Gausland, 2000). This is stated "theoretically" because the source from a seismic survey is from an array and not a point. Baleen whales appear quite tolerant of low and moderate level noise pulses from distant seismic surveys and usually continue normal activities when exposed to pulses with levels as high as 150 dB re 1µPa, and sometimes higher (Richardson et al., 1995).

Stone (2003) suggests that different groups of cetaceans adopt different strategies for responding to acoustic disturbance from seismic surveys with baleen and killer whales displaying localised avoidance, pilot whales showing few effects and sperm whales showing no observed effects. The good swimming and hearing abilities of marine mammals enables them to avoid approaching seismic vessels, and it is highly unlikely that any marine mammals could suddenly find themselves exposed to levels likely to cause pathological damage (McCauley, 1994).

McCauley et al. (1998) report that migrating humpback whales responded to the approaching seismic source at a distance of about 5 to 8 km, by adjusting course and speed to enable an avoidance range of about 3 km, although some animals were sighted within 1 to 2 km of the vessel. The apparent low risk for migratory animals was further supported in a study in Exmouth Gulf, which reported that humpback whales continued singing during seismic acoustic source discharges and after the discharges had ceased (Roc Oil, 2002). McCauley et al. (2000) also report that during an earlier experimental study that the acoustic signal produced by a humpback breaching had similar characteristics to that of an acoustic source signal. Very recent results from the acoustic monitoring conducted by Santos in the Otway Basin during late 2004 to June 2005 show that blue whales continue to call during seismic exploration and, in addition, the diurnal fish chorus continues unabated.

The discovery of blue whale summer feeding grounds in the Otway Basin during the late 1990s raised concerns that blue whales would be sensitive to noise detectable within a range of a few hundred kilometres, particularly as timing of seismic surveys to avoid the southern right whale winter season in the Otway Basin increased the potential risks of interactions with blue whales from seismic surveys during the summer months.

Initial estimates of likely blue whale response distances were taken from studies on bowhead whales (*Balaena mysticetus*) responses to seismic exploration in the Alaskan Arctic (Richardson, 1999). In these studies migrating bowheads maintained a distance of 20 to 30 km from a seismic sound source. As blue whales are considered potentially more acoustically sensitive than bowhead whales (their vocalisations more closely overlap the frequency range of acoustic source sounds) there has been initial estimates that the likely avoidance distance for blue whales would be in the range of 60 km or more (Gill and Morrice, 2003). Some credence was given to this figure when no blue whales were sighted within 65 km of 2D and 3D seismic survey conducted by Santos in November and December 2002 (Santos, 2003). However in 2D seismic surveys conducted by Santos during November 2003, blue whales were observed during aerial surveys, often in association with krill swarms between 17 and 23 km from the actively surveying vessel, with a number around 20 km moving slowly, and in various directions including towards the seismic source (Gill and Morrice, 2003). Santos' seismic survey

then moved to waters west of Kangaroo Island where blue whales were observed to remain to within about 3 km of the active seismic vessel (Hughes, pers. comm., 2004). Similar observations were made during the late 2004/early 2005 seismic surveys along the Southern Margins with several instances where blue whales (and sperm and pilot whales) came within 3km of the seismic vessel. These observations suggest that the total avoidance range of the species is significantly less than previously thought and is even less than 3km.

The unexpected presence of blue whales during these November surveys (timed to avoid blue whales) challenges the 'official start' of the blue whale feeding season on 1 December. In addition the presence of significant numbers of blue whales to the west of Kangaroo Island during December 2003 in an area not previously considered to be critical habitat demonstrates that there is the possibility of encountering blue whales and other listed cetacean species along the continental shelf and shelf break at unexpected times. However, it is very interesting to note that even though 48 blue whales were observed offshore of Kangaroo Island on 13th December 2003, during a similar aerial survey exactly one year later on 13th December 2004 only 5 blue whales were sighted. These 5 were sighted in the eastern part of the survey area and the total lack of sightings in the western part contrasted dramatically with the observations made in 2003. Thus, along with other aerial survey observations made during 2003 and 2004, the picture is beginning to emerge that blue whales move rapidly across large distances from area to area and certainly do not remain in one area for long periods of time. Santos' experience from seismic surveys in the Duntroon, Otway and Sorell Basins during the past three summers shows no evidence of any adverse impacts to whales with the radius of avoidance for blue whales appearing to be much less than originally surmised. It is uncertain whether the whales are demonstrating tolerance or habituation but the information base has improved enabling management of potential interactions when necessary.

The proposed T/32P, T/33P and T/40P seismic survey is not located or timed to coincide with any peak whale migratory paths, feeding or breeding grounds, and is not likely to have a significant impact on such whales in the area. As the survey is not expected to coincide with any local peak in migration or calving activity (Environment Australia, 2001, Kemper et al., 1997), encounters with blue whales are fairly unlikely. Even if some are present, recent experience with blue whales in the vicinity of the operating seismic survey vessel suggests some avoidance response, potentially as close as less than 3 km, which is not expected to have any impact on overall whale migration.

Toothed whales such as sperm and pilot whales may be expected within the Southern Margins Seismic Survey area at depths of around 200 m, which occur around the shelf break. These species were observed commonly during Santos' 2002 2D seismic program in T/32P and T/33P, when their observed approaches to operating vessels indicated comparative tolerance to seismic sounds (Santos 2003).

Impacts of Noise on Fish

No lethal effects have been observed for adult fish exposed directly to the sounds of individual acoustic sources or arrays (McCauley, 1994). However, direct physical damage may occur to fish within 1 to 2 m of the acoustic source (Gausland, 2000) and

McCauley et al. (2003a and b) reported damage to the sensory epithelia of the ears of fish held in cages and exposed as close as 5 m to operating air-guns with a source level of 222.6 dB re 1 µPa. Noise impacts on fishes are species-dependent. Those with a swim bladder closely connected to the inner ear are more susceptible to seismic pulses than those without (McCauley, 1994). Fishes with thin-walled, lightly damped, and large swim bladders with a resonant frequency near 100 Hz will be most susceptible to mechanical damage or trauma. Elasmobranchs (sharks and rays), family *Scombridae* (mackerels and tuna) and many of the flatfishes and flounder do not possess a swim bladder and so are not susceptible to swim bladder-induced trauma (McCauley, 1994).

Fish behavioural changes may occur at greater distances from the acoustic source. These are localised and temporary with displacement of pelagic or migratory fish populations having insignificant repercussions at a population level (McCauley, 1994). Trials of effects of nearby acoustic source operations on captive fish, undertaken by McCauley et al. (2003), showed a generic fish 'alarm' response of swimming faster, swimming to the bottom, tightening school structure, or all three, at an estimated 2 to 5 km from a seismic source. These fish had also sustained damage to their ears due to exposure as close as 5 m from the acoustic sources (McCauley et al., 2003b)

Preliminary results from the acoustic monitoring carried out by Santos and Curtin University (R. McCauley) on behalf of a number of operators (Santos, Woodside, Kerr McGee and Essential) along the Southern Margins during November 2004 to June 2005 has picked up a remarkable diurnal fish chorus which is at its peak at dusk (similar to cicada?). This fish chorus continues unabated before during and after the seismic acquisition period.

Impacts of Noise on Seals

It has been suggested that seals may tolerate seismic pulses of high intensity and may be able to approach operating seismic vessels to a close range, because their hearing is poor in low frequencies (McCauley 1994). The seals commonly found in Australian waters, including the Australian fur-seal, belong to the family *Otariidae* which are less sensitive to low frequency sounds (<1,000 Hz) than to higher frequencies (>1,000 Hz). Aerial sounds produced by Australian fur seal have strong tonal components at frequencies that are <1,000 Hz, although they all range up to 6,000 Hz with most energy between 2,000 to 4,000 Hz. If the low frequency components of calls are used then seals may also hear at low frequency and may be at some risk from seismic acoustic source arrays. Seals have been observed approaching seismic vessels during acoustic source discharge by cetacean observers in Bass Strait during 2001 and 2002 (Doodie, pers. comm., 2003; Pinzone, pers. comm., 2003). It may be that they are less affected in the seismic sound "shadow" area, above the downward focus of the acoustic pulse.

A concern for seals is that they may be indirectly affected if seismic pulses cause temporary "descending" or "tightening" of prey fish schools, out of forage range, particularly if this occurs during pupping seasons. It is not known whether or not this does happen but there is no prima facie evidence of adverse impacts on seals associated with seismic surveys.

The survey areas are well outside the Australian fur seal breeding areas, so few, if any impacts to seals are expected from the seismic survey program.

Impacts of Noise on Marine Invertebrates

Marine invertebrates lack sensory organs to perceive sound pressure, but many do have organs or tactile hairs that are sensitive to hydrostatic disturbances (McCauley, 1994). It has been postulated that shellfish, crustaceans and most other invertebrates can only detect seismic survey sounds at very close range, approximately less than 15 m away from the source (McCauley 1994). Any disturbance to benthic invertebrates immediately beneath an acoustic source array is likely to be short-lived as only a single 'shot' is fired before the array moves to the next firing location (25 m further on). The response of marine invertebrates at close range to the acoustic source arrays may be an alarm response such as closing the siphons in sponges or 'tail flip' response in crustaceans (McCauley, 1994).

Of the Australian invertebrates, rock lobster, some intertidal decapod crabs, snapping shrimps, stomatopods and some urchins have been reported to produce sounds (McCauley, 1994). Rock lobster uses sound for predator avoidance and there is currently no evidence to suggest that it is used for other purposes; no behavioural description has been attributed to sounds made by urchins (McCauley, 1994). Therefore no adverse impacts are expected to lobsters or crabs from the seismic surveys.

Pelagic invertebrates, such as squid and cuttlefish, are an exception and are capable of detecting vibrations. And, while the reaction to seismic surveys by cuttlefish in open water is unknown, McCauley et al. (2000) undertook three trials on caged squid (*Sepioteuthis australis*) to gauge their response to nearby acoustic source operations. These results are presented in Table 4.2.

Table 4.2 Summary of effects on caged squid of nearby acoustic source operations

Level (dB re1µPa rms)	Effects
174	Startle (ink sac fire) and avoidance to start up nearby.
166	Significant alteration in swimming speed patterns, possible use of sound shadow near water surface.
161-156	Noticeable increase in alarm behaviours.

Source: McCauley, 2000.

Part of the assessment by Parry et al. (2002) of environmental effects of seismic testing on the scallop fishery in Bass Strait found that the mortality and adductor muscle strength of scallops suspended 19 m below the surface in the path of the acoustic source array was not significantly different from scallops in a control area 20 km away.

Effects to sessile benthic fauna such as the sponges, hard and soft corals, bryozoans and tunicates (vertebrates however invertebrate in character) would be minimal due to their poorly developed mechanosensory systems (McCauley, 1994).

Impacts of Noise on Plankton and Planktonic Larvae

McCauley (1994) concluded that for planktonic organisms, including fish eggs and larval stages, lethal impacts could occur to those organisms within about 5 m of an acoustic source, and for a large seismic array, a pathological effect out to 10 m from the source would be a conservative value. Experimentally observed effects on varieties of fish, crustaceans of various ages and sizes have been within 1-5 m (Turnpenny and Nedwell, 1994). Even this may be conservative. For example, survival and development of Dungeness crab larvae was not significantly affected by exposure to seismic energy release as close as 1 m from a 13.8 litre array of seven air-guns, nor from mean squared sound pressure of 231 dB re 1µPa, considered the maximum likely to be experienced by planktonic crab larvae during a seismic survey (Pearson et al., 1994). The study by Parry et al. (2002) also found no evidence of large changes to planktonic taxa in the surface waters to a depth of 20 m. Calculations of the possible impacts to populations of lobsters, fish and prawns, assuming larvae are killed within 5 m of the guns during surveys all indicate that effects would be insignificant compared with the size of natural mortality rates and the planktonic population in a survey area (McCauley, 1994; Levings, 2004; Parry et al., 2002).

4.2.2 Physical Presence of the Vessel

Disturbance to benthic habitat from the survey is highly unlikely given the depth of water in the survey areas (ranging between 100 and 2,900 m) and the fact that the survey vessel will not be anchoring during the survey. The only possible activity that could have impacts on benthic habitats would be the accidental loss of equipment that could sink to the seabed as debris. Loss of equipment is unlikely and would be followed by recovery whenever possible and re-survey as necessary.

The seismic survey only has the potential to impact on the fisheries listed below if they have trawl gear or longlines or droplines deployed within close proximity of the seismic vessel streamers, where equipment could become tangled. The chance of this occurring, or of impacting on commercial shipping movements, is extremely low given the communications that will take place between vessels to advise of activities in the area, and the short duration of seismic survey in each permit area. All vessel operations will be conducted in compliance with the Australian Maritime Safety Authority (AMSA) Offshore Support Vessel Code of Safe Working Practice (OSV Code), which includes standards for radar monitoring and vessel communications.

South East Fishery.

Trawling along the shelf edge in the three survey areas could potentially take place. Communication systems with the commercial trawl operators will advise of day-to-day activities to avoid interactions.

Gillnet, Hook and Trap Fishery.

Shark gill netting and long lining may occur periodically along shelf edge depths in the three survey areas. Communication systems with the shark fishers will advise of day-to-day activities to avoid interactions.

Southern Rock Lobster Fishery

The potential exists for the seismic vessel's submerged gun arrays to snag and drag lobster pot lines, causing damage to, or loss of, lobster pots and loss of any lobsters caught in the pots. This would result in financial losses to the fishers concerned. However, given that lobster pots are generally set at water depths no greater than 200 m, and that the seismic surveys will take place in only small areas of shallow water targeted by lobster fishers.

The surveys will be carried out in waters deeper than those used by lobster fishers, so the potential impacts (as discussed above) to the fishery are likely to be minimal.

Consultation with rock lobster fishing groups will be undertaken to ensure mutual awareness of each other's planned activities.

Giant Crab Fishery.

Targeted crab potting operations may occur in shelf break and upper continental slope depths in all three survey areas. Communication systems with the crab fishers will advise of day to day activities to avoid interactions. As many are rock lobster fishers with licences endorsed to take crabs, the communications will be appropriate for both operations.

Southern Squid Jig Fishery

The Southern Squid Jig Fishery fishes areas mainly around Portland and Queenscliff in Victoria, close to the coast between January and June. The surveys will predominantly be carried out in areas other than those used by Southern Squid Jig fishers, so the potential impacts to the fishery are likely to be minimal.

Communication systems with the Southern Squid Jig fishers will advise of day-to-day activities to avoid interactions.

Eastern Tuna and Billfish Fishery.

The majority of are caught along the east coast of Australia and it is unlikely that impacts to the operations of this fishery will occur.

Abalone Fishery

The Southern Margins Seismic Survey areas are offshore, and in deeper waters than the commercially productive abalone reefs.

4.2.3 Waste Disposal

All vessels must comply with State and Commonwealth legislation for the control of pollution and dumping at sea.

Sewage and Putrescible Wastes

Disposal of sewage and putrescible wastes overboard may increase the nutrient content in the water column, acting as a food source for some organisms and temporarily altering the species diversity and richness in a localised area for a short time (i.e., a number of hours or days). Sewage will be treated through an on-board effluent treatment plant that meets regulatory requirements prior to being discharged to sea. Sewage and putrescible wastes will be macerated to less than 25 mm diameter prior to being discharged to sea. No sewage or macerated putrescible wastes shall be discharged within 3 nm of land (under the P(SL)Act).

Solid and Hazardous Wastes

Solid waste items (e.g., aluminium cans, bottles, paper and cardboard) released to the marine environment have the potential to pollute seabed habitats or injure or kill marine fauna through ingestion. This risk of this occurring during the survey is extremely low, as all solid consumable materials will be safely stored on board to prevent accidental releases to the ocean. Solid inert combustible wastes will be incinerated on-board. Non-combustible solids will be returned to shore for disposal. Hazardous wastes will be segregated and stored in sealed storage areas and transferred to onshore licensed hazardous material handlers for disposal to a licensed depot.

4.2.4 Hydrocarbon Spills

Hydrocarbon spills have the potential to cause adverse impact to marine organisms. Many marine species have a larval stage, which is free-floating and potentially vulnerable to an oil spill. Shellfish can become tainted if oil is ingested, even at low concentrations. Seabirds may suffer from hypothermia that can result in death as oil reduces the insulation properties of feathers. Embryo chicks in eggs may be prevented from receiving oxygen if their shells become coated with oil (on brooding parent's feathers). Seabirds may ingest the oil while feeding or preening and may be poisoned.

Oil may contaminate the skin and damage the digestive system of some cetacean species. Indirect effects may include the destruction of habitats and reductions in the population of staple prey.

Risks of any significant spills from seismic activities are low, because no refuelling at sea will be undertaken. Any spills will be recorded in a wastes and emissions log, reported to Santos and regulatory authorities advised in accordance with regulatory requirements. In addition, petroleum legislation requires a safety and emergency response plan to be submitted to the designated authority (either DIER or DPI) for approval prior to any activities commencing. Measures to minimise the risk of a fuel or oil spill include the following:

- Satellite navigation of survey vessel assisted by constant visual observation.

- Communications shall be constantly maintained with other vessels operating in the area to advise of the location of the survey vessel and avoid collision.
- The depth at which the hydrophone cables travel is controlled by 'birds' which ensure a constant depth of approximately 7 m.
- Tail buoys maintain the transect line of each hydrophone cable.
- The Vessel Master will cease operating and seek safe harbour (or deep water) where extreme conditions make it unsafe to continue survey operations.
- Santos may employ a support vessel as a precaution to assist the survey vessel.

The survey parameters are well inside safe operational requirements. The mitigation measures listed will reduce any potential fuel or oil spill risk to as low as reasonably practicable.

4.2.5 Hull Maintenance and Ballast Exchange

Unlike cargo vessels, the seismic vessel does not take on or discharge ballast water. The vessel may, however, potentially transport marine species on the hull, deck or seismic streamers. Prior to being contracted to Santos the Pacific Titan will have been undertaking seismic surveys in Victorian waters for several months for other operators. Due to the nature of the seismic vessels operations being predominantly in open waters within limited port visits and no ballast exchange the risk of introducing exotic marine pests is considered to be very low.

As discussed in Section 4.1.5 the risk of impacts in open waters from vessels treated with tributylin is not considered detrimental to marine life. However verification of anti-fouling of the hull will be provided by the survey contractor, who will advise when anti-fouling paint was last applied to ensure that the risk of exotic species introduction from the hull is being appropriately managed.

The trailing equipment of streamer lines and acoustic source arrays is all stowed on deck during the passage from the vessel's last deployment, rather than towed behind the vessel during non-survey periods. The risk of introducing exotic marine pests from the streamers is therefore very low.

5. Environmental Hazard and Risk Analysis

An analysis of environmental hazard and risk has been conducted for the Southern Margins Seismic Program. Its purpose is to:

- Identify and assess hazards to the public and the marine environment during the seismic program.
- Undertake a scenario-based risk assessment, using the risk management method developed by Santos based on the Australian Standards Risk Assessment (AS/NZS 4360: 1999).
- Identify and rank major hazards and determine appropriate risk reduction measures.

The following definitions are critical in the understanding of hazard and risk assessment.

Accident: an event capable of causing critical, major, moderate or minor damage to the environment, or negligible damage with no significant environmental effect.

Hazard: a physical situation with the potential for damage to the environment, human injury, damage to property or a combination of these.

Risk: the likelihood of a specified undesired event occurring within a specified period or in specified circumstances. It may either be a frequency (the number of specified events occurring in a time unit) or a probability (the probability of a specified event following a prior event), depending on circumstances.

5.1 Hazard Identification

The process of hazard identification and risk management are divided in three main sections (reproduced from AS/NZS 4360:1999):

- External and environmental hazards (global hazards):
  - Project-specific hazards (project implementation issues).
  - Personnel health hazards (a global hazard).
- Individual and special operations hazards during operations that are exceptional because of size, complexity or timing.
- General and routine work performed according to standard procedures.

5.2 Hazard Scenario

A scenario for realisation of each environmental and safety hazard was developed. Each scenario included:

- A description of the scenario and root cause of the hazard.
- Existing risk mitigation or prevention measures (that is, protection systems and management mechanisms) that are currently in place or are standard safety measures.

The likelihood and consequence of each hazard scenario was identified and assessed based on Santos' risk assessment tool (Table 5.1 and Table 5.2). To assess the consequence of an event the first step is to consider the area of impact. Santos has six impact areas to be considered:

- Physical damage.
- Financial.
- Environmental.
- Reputation.
- Safety.
- Production.

Each area has its own set of criteria for consequence measurement (Table 5.1).

Table 5.1 Qualitative measures of consequence or impact

		Physical Damage	Financial	Environmental	Reputation	Safety	Production
Catastrophic	**5**	Critical damage to plant and property.	Financial loss in excess of $50 Million.	Catastrophic ecological impact and/or international media exposure.	Critical impact on business reputation.	Fatality of employees, contractors, or the public.	Critical impact on production.
Major	**4**	Major or extensive damage to plant and property.	Financial loss $10 Million to $50 Million.	Significant ecological impact and/or national media exposure impact.	Significant impact on business reputation.	Extensive injury or hospitalisation of employees, contractors, or the public.	Significant impact on production.
Moderate	**3**	Significant damage to plant and property.	Financial loss from $1 Million to $10 Million.	Significant local environmental impact and/or regulatory intervention.	Moderate impact on business reputation.	Medical treatment of employees, contractors or the public.	Moderate impact on production.
Minor	**2**	Moderate to minor damage to plant and property.	Financial loss from $0 to $1 Million.	Minor local environmental impact and/or regulatory notification.	Some impact on business reputation.	First-aid treatment of an employee, contractor, or a member of the public.	Moderate to small impact on production.
Negligible	**1**	Minimal impact to any issue.	Minimal impact to any issue.	Minimal impact to any issue.	Minimal impact to any issue.	Minimal impact to any issue.	Minimal impact to any issue.

Source: Based on Santos' Risk Assessment Tool.

It is critical to remember that when choosing the likelihood of an event that it is made given the level of consequence chosen beforehand. More succinctly, it is the likelihood of the consequence of the particular event. Table 5.2 outlines the descriptors of likelihood including the criteria with which to make a decision.

Table 5.2 Qualitative measures of likelihood

Level	Descriptor	Description
A	Almost certain	Likely or certain to occur *Likely to occur several times per year*.
B	Likely	Likely, is expected to occur in most circumstances *Might occur once per year.*
C	Possible	Likely, will probably occur in most circumstances *Might occur once in 10 years.*
D	Unlikely	Unlikely, could occur at some time *Might occur once every 100 years.*
E	Remote	Highly unlikely, may occur in exceptional circumstances *Might occur once in 1000 years*.

Source: Based on Santos' Risk Assessment Tool.

5.3 Risk Matrix

Each scenario was then assessed using the risk matrix approach (Table 5.3). A risk estimate was made on the basis of the probability of the event occurring and the consequence. Matrix locations were chosen on the basis of operational and environmental judgement.

Table 5.3 Qualitative risk analysis matrix – level of risk

Likelihood		Consequences				
		Negligible 1	Minor 2	Moderate 3	Major 4	Catastrophic 5
		Level of Risk				
Almost certain	A	Substantial	Substantial	High	High	High
Likely	B	Moderate	Substantial	Substantial	High	High
Possible	C	Low	Moderate	Substantial	High	High
Unlikely	D	Low	Low	Moderate	Substantial	High
Remote	E	Low	Low	Moderate	Substantial	Substantial

5.4 Risk Reduction Measures

Risk reduction measures were applied to risks deemed to be too high, that is 'High' on the risk matrix.

The hazard scenario was then reassessed and so on. No risks unable to be reduced to an acceptable level were identified.

5.5 Environmental Hazard and Risk Assessment

Table 5.4 presents the environmental hazard and risk assessment for the Southern Margins Seismic Program. The risk analysis impact and likelihood (columns 4 and 5) draw from the definition of risk in Table 5.1 and likelihood in Table 5.2. The risk evaluation draws from the matrix in Table 5.3.

The safeguards and mitigation measures are based on the potential impacts discussed in Chapter 4. These measures have been developed from Santos' experience in offshore exploration environmental management in Australia and are based on Australian petroleum industry best practice environmental management guidelines, as defined by the APPEA Code of Environmental Practice (1996).

There are no activities assessed as being of 'high' risk for the Southern Margins Seismic Program. This reflects the temporary and low impact nature of the activity, and the application of appropriate mitigation measures.

Table 5.4 Environmental risk assessment

Risk Identification			Risk Treatment	Risk Analysis		Risk Evaluation
Activity	**Hazard/Risk**	**Potential Consequence**	**Safeguards/Mitigation Measures**	**Likelihood**	**Impact**	**Risk Ranking**
Acoustic source discharge	Impacts to cetaceans.	Alteration of cetacean behaviour, interfering with normal activities such as breeding, feeding and migration, temporary threshold shift. interactions with blue or other species may occur. Survey areas (T/32P, T/33P & T/40P) are located significant distances from key whale aggregation areas but interactions may occur. The VIC/P50 survey is closer, but predominantly offshore of main blue whale area. Surveys are likely to evoke avoidance response in whales only, but unlikely to displace species from key habitat or migration paths.	• Each survey is of short duration (between 5 and 30 days). • Santos is proposing to undertake aerial surveys across the seismic survey areas prior to the commencement, subject to weather conditions in the survey area. The need to undertake repeat surveys will be made based on the results of the initial survey at each survey area. • DEH (2001) cetacean observation and seismic operations guidelines will be employed (refer Appendix 1): • 90 minutes visual observation prior to soft start. • 30 minutes soft start following visual observation. Soft start not to commence if any larger cetaceans are within 3km of the vessel. • The vessel bridge crew will undertake observations during recording operations as part of their general duties. • Seismic operations will shut down if a whale comes within 3 km of the operating seismic vessel. • Seismic acquisition will not recommence unless the whale(s) have been seen to move outside of the 3 km range or have not been seen for at least 30 minutes. • Low volume acoustic source will remain operational during line changes. This will negate the need for pre-soft start observations prior to each line. • If the acoustic source is inactive for longer than 20 minutes then pre-start visual observations and soft start procedures will be followed.	C	2	Moderate

Table 5.4 Environmental risk assessment (cont'd)

Risk Identification			Risk Treatment	Risk Analysis		Risk Evaluation
Activity	**Hazard/Risk**	**Potential Consequence**	**Safeguards/Mitigation Measures**	**Likelihood**	**Impact**	**Risk Ranking**
Acoustic source discharge (cont'd)	Impacts to cetaceans (cont'd).		• All whale and dolphin sightings will be reported to the DEH. • Santos is considering the use of underwater acoustic loggers to build on previous research on whale vocalisations and noise attenuation, for purposes of improving understanding for future reference			
	Impacts to pinnipeds (seals).	No direct effects known due to apparent tolerance to high intensity seismic. May effect prey species (see fish).	• Each survey is of short duration (between 5 and 30 days) and not within close proximity to critical breeding or feeding habitat. • No action necessary	C	2	Moderate
	Impacts to plankton or planktonic larvae	Potential lethal or pathological effects in close proximity to air guns.	• Presence of any krill swarms will be noted.	B	1	Low
	Impacts to divers.	Potential health effects for divers within close proximity to acoustic source. Temporary displacement of recreational or commercial diving activities.	• Surveys in each permit area will be of short duration and will be undertaken in water depths generally deeper than those used by recreational or commercial divers. • Santos will liaise with any relevant diving associations prior to the seismic program. • The recommended operating buffer of 1,500 m advised for diving (DMAC, 1979) will be enforced.	D	3	Moderate

Table 5.4 Environmental risk assessment (cont'd)

Risk Identification			Risk Treatment	Risk Analysis		Risk Evaluation
Activity	**Hazard/Risk**	**Potential Consequence**	**Safeguards/Mitigation Measures**	**Likelihood**	**Impact**	**Risk Ranking**
Physical presence of vessel	Impacts to commercial fisheries.	Reduction in fish catches or interference with fishing activities likely to be localised and short term.	• Industry and government guidelines available on the avoidance of conflict with commercial fisheries will be adhered to. • Consultation with the commercial fishing industry groups will take place prior to the seismic program to agree impact mitigation measures. • Liaison and communication with commercial fishers regarding daily schedules and work plans will occur during operations. • Planned compensation agreements for actual commercial loses with be negotiated with affected fishers (if necessary).	C	1	Low
	Collision with large cetaceans.	Death or injury of large cetaceans.	• Program is 40-50 kilometres from key whale migration and aggregation areas. • Seismic vessels move slowly permitting greater response time for evasive action by vessel and/or whale to avoid collision (i.e., risk is less than for normal commercial shipping). • DEH (2001) cetacean observation and seismic operations guidelines (refer Appendix 1), and initial aerial surveys will be employed (refer to first row of this table).	D	3	Moderate

Table 5.4 Environmental risk assessment (cont'd)

Risk Identification			Risk Treatment	Risk Analysis		Risk Evaluation
Activity	**Hazard/Risk**	**Potential Consequence**	**Safeguards/Mitigation Measures**	**Likelihood**	**Impact**	**Risk Ranking**
Physical presence of vessel (cont'd)	Impacts to water based leisure craft recreation activities.	Temporary displacement of aquatic recreation activities and potential collision hazard.	• Seismic surveys undertaken in areas generally too far offshore for leisure boat activities. • All vessel operations will be conducted in compliance with the AMSA OSV Code (e.g., radar monitoring, vessel communications). • Watch will be maintained on survey vessel for other craft.	D	1	Low
Waste discharge to sea	Localised increase in nutrient levels for short period. Pollution of habitat.	Changes in planktonic or benthic communities due to altered water quality levels. Injury or death from ingestion of solid wastes.	• No waste discharges to the marine environment in State waters (3 nm from the coast). • Sewage will be treated prior to disposal offshore in accordance with MARPOL regulations (Annex IV). • Putrescible wastes will be macerated to a maximum particle size 25mm prior to being discharged to sea. • Solid wastes, hazardous wastes and liquids will be returned onshore for appropriate disposal. • Waste register will be maintained to record waste management practices and audited to verify compliance. • Procedures for disposal of minor discharges of treated sewage and macerated putrescible wastes will be detailed in the vessel's Health, Safety and Environment Plan.	D	2	Low

Table 5.4 Environmental risk assessment (cont'd)

Risk Identification			Risk Treatment	Risk Analysis		Risk Evaluation
Activity	**Hazard/Risk**	**Potential Consequence**	**Safeguards/Mitigation Measures**	**Likelihood**	**Impact**	**Risk Ranking**
Small volume hydrocarbon spill (e.g., from streamer cable rupture)	Reduced water quality.	Mortality of planktonic or benthic organisms due to hydrocarbon toxicity. Smothering of marine and coastal flora and fauna.	• The seismic program will not be conducted during extreme weather conditions. • Streamers (filled with light kerosene type petroleum, 95% of which evaporates or degrades (from light exposure) within 24 hours of spill) are segmented to limit potential spill volumes. • An Oil Spill Contingency Plan (OSCP) is in place. • All necessary oil spill contingency plant and equipment will be functional and accessible. • No refuelling at-sea is planned for the short survey. • Ensure that port refuelling operations are monitored by either the vessel's Master or First Officer. • Ensure that equipment and procedures used for transferring fuel (e.g., 'Dry-Break' hose couplings), conform to the AMSA Code for the safe working of support vessels. • The vessel will cease operating and seek safe harbour (or deep water) where extreme conditions make it unsafe, in the view of the Vessel Master, to continue survey operations.	D	3	Moderate

Table 5.4 Environmental risk assessment (cont'd)

Risk Identification			Risk Treatment	Risk Analysis		Risk Evaluation
Activity	**Hazard/Risk**	**Potential Consequence**	**Safeguards/Mitigation Measures**	**Likelihood**	**Impact**	**Risk Ranking**
Small volume hydrocarbon spill (e.g., from streamer cable rupture) (cont'd)	Reduced water quality (cont'd).		• In the unlikely event of a spill during fuel transfer (in port), ensure that the volume spilled is minimised by the automatic operation of shutdown pumps or safety valves and apply Emergency Response and OSCPs.			
Moderate fuel spill (e.g., rupture of fuel tanks resulting)	Widespread water surface oil slick, toxic water quality.	Mortality of planktonic or benthic organisms due to hydrocarbon toxicity. Smothering of marine and coastal flora and fauna.	• All vessel operations will be conducted in compliance with the AMSA OSV Code (eg. radar monitoring, vessel communications). • A daily communication schedule will be established with commercial fishing boats. • The seismic contractor's Emergency Response Manual and OSCP will be applied to the operation. • Satellite navigation of the vessel will be assisted by constant visual observation.	D	2	Low

Table 5.4 Environmental risk assessment (cont'd)

Risk Identification			Risk Treatment	Risk Analysis		Risk Evaluation
Activity	**Hazard/Risk**	**Potential Consequence**	**Safeguards/Mitigation Measures**	**Likelihood**	**Impact**	**Risk Ranking**
Moderate fuel spill (e.g., rupture of fuel tanks resulting) (cont'd)	Widespread water surface oil slick, toxic water quality (cont'd).		• Communications will be constantly maintained with other vessels operating in the area to advise of the location of the survey vessel and avoid collision. • The vessel will cease operating and seek safe harbour (or deep water) where extreme conditions make it unsafe, in the view of the Vessel Master, to continue survey operations. • Santos may employ a scout vessel as a precaution to assist the survey vessel. • Senior personnel on vessels are familiar with the contents of the Emergency Response Manual and OSCP such that the initial response to an oil spill is carried out efficiently. • All personnel will be made aware of the existence and location of the above-listed documents. • The OSCP will be maintained up-to-date and staff will appropriately trained in its implementation. • All the necessary oil spill contingency plant and equipment will be functional and accessible. • Any fuel spill clean-up will be undertaken in consultation with the relevant regulatory authorities in each state.			
Hull maintenance and ballast exchange	TBT leaching.	Toxic effects on epibenthic fauna and the foodchain.	• The 'Code of Practice for Antifouling and In-water Hull Cleaning and Maintenance' will be applied. • Hull anti-fouling records will be inspected.	D	2	Low

Risk Identification			Risk Treatment	Risk Analysis		Risk Evaluation
Activity	**Hazard/Risk**	**Potential Consequence**	**Safeguards/Mitigation Measures**	**Likelihood**	**Impact**	**Risk Ranking**
Hull maintenance and ballast exchange (cont'd)	Exotic pest species introductions.	Invasion of marine habitats.	• Seismic vessel will not undertake ballast exchange during surveys. • Streamers carried on deck during surveys. • Hull anti-fouling treatment.	D	3	Moderate

6. Implementation Strategy for the Environment Plan

This section describes the implementation strategy for the EP, specifically detailing the measures to ensure that the environmental performance objectives and standards are met.

This section outlines the aspects of the Santos Environment, Health and Safety Management System (EHSMS) applicable to the Southern Margins Seismic Program, as well as detailing the strategies that will be put in place to implement the management measures outlined in Table 5.4.

6.1 Santos Environment, Health and Safety Management System

The seismic survey will be conducted in accordance with the Santos EHSMS and Santos Environmental Policy (see Section 2.4). Santos developed the EHSMS based on international standards and industry best practice for application to all Santos operations (Figure 6.1). The Santos EHSMS consists of two sets of standards; “management” and “hazard”.

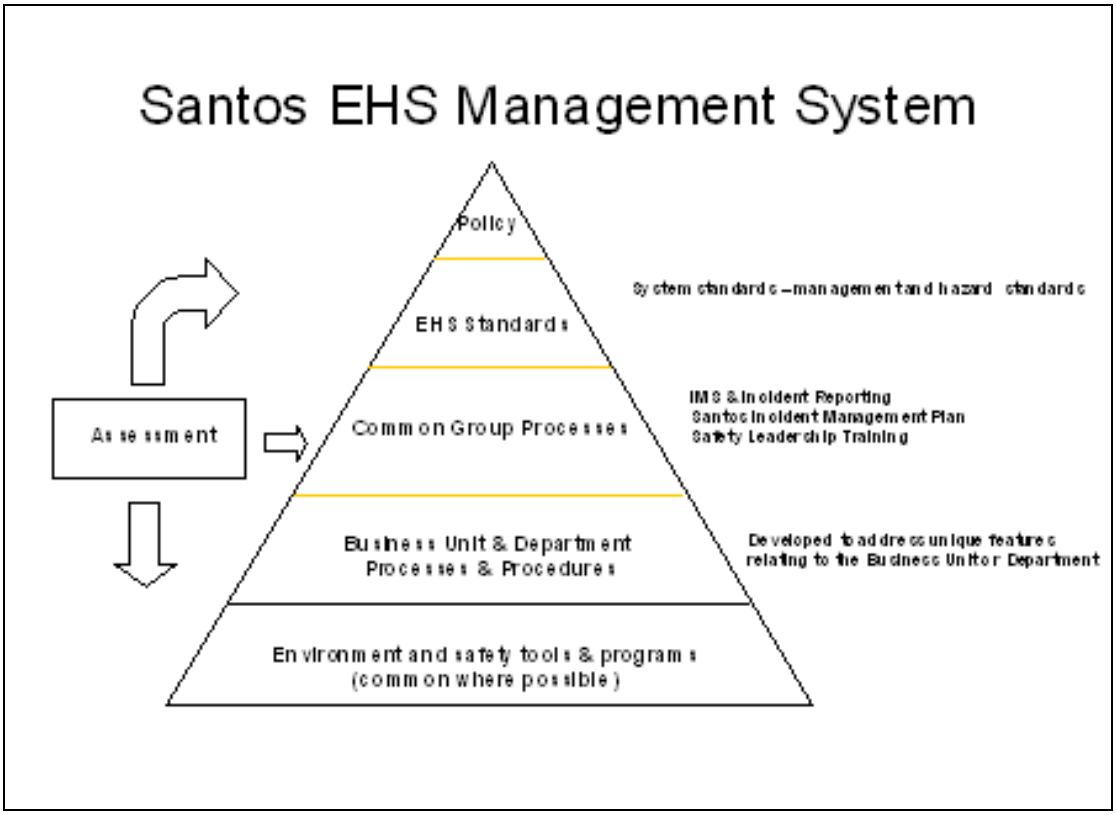


Figure 6.1 Santos EHS Management System

The framework has been developed to ensure that Santos' system is compliant with AS 4801: 2000 (Occupational Health and Safety Management Systems) and AS/NZS ISO 14001:1996 (Environmental Management Systems). Development of the Santos EHS Management Standards was completed and approved in July 2003. This has involved the drafting, management review, and approval of 18 Management Standards, which all sites are required to implement.

Management Standards are documents that define the requirements necessary to ensure that environmental, health and safety risks are systematically managed. Hazard Standards are documents which detail the specific controls required to manage the risks of specific hazards to acceptable levels.

For each standard, an assessment guide and auditor guide has been, or will be developed. The assessment guides are used to evaluate the status of implementation of the standard while auditor guides are used to determine the level of conformance to the standard. The auditor guides provide additional detail as to the requirements for practical implementation.

The contractor is required to implement and comply with the EHSMS procedures, or have equivalent procedures in place.

6.2 Environmental Objectives, Standards and Criteria

The performance objectives for the Southern Margins Seismic Program are directly linked with the identified risks and effects discussed in Chapter 4. This section identifies the standards (i.e., legislation, industry guidelines and codes of practice), by which operations will be carried out to achieve each stated environmental objective, consistent with industry best practice. Performance criteria by which Santos will measure its environmental performance are also presented. The performance criteria are measurable and relate directly to the environmental objectives. The criteria provide an overview to the commitments for environmental management detailed in the Implementation Strategy in Table 6.3.

The environmental objectives, standards and measurement criteria are outlined in Table 6.1.

Table 6.1 Summary of environmental management objectives, standards and performance criteria

Aspect	Objectives	Standards	Criteria
Policy	Communicate Santos Environmental Policy statement and procedures.	Santos Environment Policy statement (section 2.4).	Audit shows environment policy statement in place and personnel awareness undertaken.
Seismic operation	Minimise effects of acoustic source discharge to marine fauna.	DEH (2001) Administrative Guidelines for determining whether an action is likely to have a significant impact on a matter of national significance under the EPBC Act. Mitigation measures specified in Table 5.4 of this EP.	Documentation / verification of whale impact mitigation procedures.
	Minimise impact of seismic survey vessel on commercial fishing operations.	Mitigation measures specified in Table 5.4 of this EP.	Verification of consultation/ daily radio schedules with commercial fishing operators.
	Minimise impacts to commercial and recreational divers.	Mitigation measures specified in Table 5.4 of this EP.	Verification of mitigation measures (notifications and consultation) through audit.
Waste Management	Manage wastes to avoid any marine discharge and therefore any environmental impacts.	Mitigation measures specified in Table 5.4 of this EP.	Verification through review of waste log.
Fuel and oil spills	Manage operations to avoid spills and minimise safety and environmental risks.	Santos Environment Policy statement (section 2.4) Seismic contractor operating procedures.	Verification through review of the spill record database.
Training	To ensure personnel are aware of their roles, responsibilities, obligations and management procedures.	Santos Environment Policy statement (section 2.4). Seismic contractor operating procedures.	Audit verification via training log.

6.3 Training

Seismic crews undergo continual training covering general operational procedures including waste management, spill and other emergency response. In addition, crews shall undergo project specific inductions designed to ensure each crew member is aware of their responsibilities and have the necessary skills to complete the required tasks and meet project objectives and targets.

Inductions will be conducted at the commencement of project operations and will detail the requirements of the EP, in particular, this will include (but is not limited to):

- The Santos Environmental Policy and EHSMS, and requirements in this EP.
- Detail of significant environmental features of the survey area and surrounds.
- Detail of environmental hazards and consequences.
- Detail of observation, shut-down and notification procedures in the event of detrimental effects to fauna.
- Waste management procedures within coastal waters (i.e., zero waste discharge during survey).
- Near-shore operating requirements to minimise risk of collision or grounding.
- Understanding of emergency response system and knowledge of local contact numbers.

All relevant personnel will undertake an environmental induction, with attendances at inductions recorded in the training database and forwarded to Santos at the completion of inductions.

6.4 Environmental Roles and Responsibilities

All Santos and contractor personnel are required to comply with the EP and all relevant conditions of approval. Key environmental roles and responsibilities, and therefore chain-of-command, are identified in Table 6.2, whilst specific duties assigned to key personnel are outlined in Table 6.3.

Table 6.2 Southern Margins Seismic Program environmental responsibilities

Role	Responsibility
Chief Operations Geophysicist	• Ensuring the implementation of the EP at the system level. • Notifying the Designated Authority and other appropriate regulatory authorities of all reportable incidents.
Santos On Board Rep	• Client site representative during survey. • Conducting environmental inductions and training of survey vessel crew on relevant aspects of the EP, with assistance from specialist environmental advisers as appropriate. • Monitoring the performance of the survey contractor with regard to requirements of the EP and all conditions of approval. • Notifying the Chief Operations Geophysicist of all incidents.
Vessel Master	• Safe operation of the survey vessel. • HSE management onboard the vessel and ensuring environmental impact mitigation measures relevant to vessel operation are implemented, as specified in the EP and all conditions of approval. • Notifying the Santos Site Representative of any incidents/activities arising from vessel operations that may have a negative impact on the environment.

Table 6.2 Southern Margins Seismic Program environmental responsibilities (cont'd)

Role	Responsibility
Party Chief	• Safe execution of all data acquisition operations of the survey program. • Ensuring that environmental impact mitigation measures relevant to data acquisition are implemented, as specified in the EP and all conditions of approval (e.g., soft starts). • Ensuring compliance with all aspects of HSE reporting and incident/near miss investigations. • Notifying the Santos Site Representative of any incidents/activities arising from seismic data acquisition that may have a negative impact on the environment.

6.5 Reporting

6.5.1 Internal Reporting

Under EHSMS sections 14 (Monitoring, measurement and reporting) and 15 (Incident and non-conformance investigation, corrective and preventative action), Santos requires all environmental incidents to be internally reported, no matter how small, using the Incident Management System (IMS). Formal processes for environmental improvement and rectification include:

- Non-compliance reports (NCR) – issued when potential policy breaches are noted and investigation is required.
- Corrective action requests (CAR) – specifies the required rectification action.

The following list summarises the internal environmental reporting required for the proposed Southern Margins Seismic Program:

- Environmental induction register.
- Audit reports of conformance with environmental performance objectives and requirements of this EP.
- Non-conformance with Environmental Performance Objectives.
- Cetacean surveillance and sighting forms.
- Waste emissions log - in accordance with P(SL)A environmental requirements.
- Records of consultation/communication with stakeholders.
- Incident Reports.
- Emergency response reporting according to Contractor Emergency Response Plan and Santos Emergency Management Plan.

6.5.2 External Reporting on Routine Operations

Reporting to the DIER and DPI will be undertaken within 3 months of closeout of the seismic survey program. All cetacean sightings will be reported to the DEH at the completion of the program.

6.5.3 External Reporting on Non-routine Incidents

Santos will report any reportable incidents (e.g., oil spill) to DIER or DPI as required under Section 26 of the PSLME Regulations 1999.

Any incident that is outside the environmental performance conditions for this activity, as agreed by Santos and the regulatory authorities, will be reported in the annual report to these authorities in accordance with requirements of the PSLME Regulations 1999.

6.6 Monitoring

Santos is proposing to undertake an aerial survey across the proposed seismic program area prior to the commencement of seismic data acquisition, the occurrence and timing of which will be dependent upon appropriate weather conditions in the survey areas. A decision on the need to undertake repeat surveys will be made based on the results of the initial survey. The aerial surveys are likely to be undertaken in conjunction with, but in addition to, surveys being undertaken by the Deakin University Blue Whale Study (Victoria).

Santos is also investigating the feasibility of a number of other monitoring measures for the proposed survey. These monitoring measures include:

- The deployment of acoustic monitoring devices at some stage during the seismic surveys to build on acoustic monitoring research undertaken during seismic surveys in 2002, 2003 and 2004. The acoustic monitoring devices would be deployed to measure cetacean vocalisations in the vicinity of the seismic vessel and to further develop acoustic decay curves for seismic sounds in varying water depths. The scope of this study is being discussed with researchers at Deakin (Victoria) and Curtin (Western Australia) universities.
- The possibility of using the survey vessel as a platform from which to undertake cetacean observations in the survey areas. Santos has had preliminary discussions with Deakin University (Victoria) and University of Tasmania regarding the feasibility of having cetacean researchers on the vessel to undertake observations during the survey.

Santos will develop an appropriate monitoring strategy, which will assess compliance with mitigation measures, provide impact assessment verification feedback and also enable an operational response to any significant environmental threat that may arise during the survey.

6.7 Auditing

Santos will report on seismic operations to demonstrate that the environmental performance objectives and standards outlined in this EP have been met. Santos will undertake internal compliance checks as appropriate to show that the actions detailed in this EP have been undertaken. In addition, Santos will undertake an independent environmental audit at the completion of the survey. The audit protocol will include an assessment against the following:

- Southern Margins Seismic Program EP.
- Southern Margins Seismic Program EPBC Act referrals.
- EPBC Act referral determinations – manner specified conditions.
- APPEA Code of Environmental Practice (1996).
- DEH cetacean observation and seismic operations guidelines (2001).

6.8 Continual Improvement

Continual improvement is the process of enhancing the Santos EHSMS to achieve improvements in overall environmental performance, guided by the Santos Environmental Policy (Chapter 2). Both documents are updated as required (the latest revision of the environmental policy was September 2004) to include changes of procedure, corrective actions and new guidelines.

6.9 Implementation Strategy

The implementation strategy for the Southern Margins Seismic Program is summarised in Table 6.3. It identifies the role responsible for the various aspects of EP implementation, tasks to be undertaken and evidence of action for each task.

Table 6.3 Southern Margins Seismic Program implementation strategy

ID	Subject	Responsibility	Task	Evidence of Action
1	Approval to commence/continue operations	Chief Operations Geophysicist	Obtain written approval from the state regulatory authorities (DIER & DPI).	Letters of approval from DIER and DPI.
2	Auditing and Reporting	Chief Operations Geophysicist	Ensure that one compliance audit per year against the commitments proposed in this Environment Plan takes place during exploration, drilling and production operations.	Results of a compliance audit.
3		Santos On Board Rep	Ensure that the results of the compliance audit are forwarded to the Chief Operations Geophysicist who signs off the closeout report to the relevant Designated Authority (DPI and DIER). The report will include statements describing environmental performance.	Results of a compliance audit.
4		Santos On Board Rep	Report as soon as practicable to DPI any spills of petroleum of greater than 80L as required under the *P(SL)A*.	Results of a compliance audit.
5		Vessel Master or Party Chief	Report any oil or other chemical spill regardless of volume internally.	Results of a compliance audit.
6	Provision of standards and procedures.	Chief Operations Geophysicist	Provide as required, major Contractor(s) Person-In-Charge with access to all relevant operating standards and procedures such as the Environment Management Manual, Santos Emergency Response and Environmental Plan.	Included in HSE Plan documentation. Compliance audit.
7	Communication of standards and procedures	Chief Operations Geophysicist	Conduct as required, pre-site mobilisation induction for employees and contractors to ensure general environmental expectations and desired outcomes outlined in the Environment Plan are understood.	Results of a compliance audit.
8	Oil spill response	Survey contractor	Ensure that relevant staff involved in emergency response are AMOSC trained in the use of oil spill response equipment.	Results of a compliance audit.
9		Survey contractor	Ensure that all personnel are made aware of the existence and location of Emergency Response and Oil Spill Contingency documents on the seismic facilities.	Results of a compliance audit.

Table 6.3 Southern Margins Seismic Program implementation strategy (cont'd)

ID	Subject	Responsibility	Task	Evidence of Action
10	Oil spill response	Survey contractor	Ensure that senior personnel on seismic facilities are familiar with the contents of the Emergency Response and Oil Spill Contingency documents such that the initial response to an oil spill could be carried out efficiently.	Results of a compliance audit.
11		Survey contractor	Ensure that oil spill response equipment is available on the vessel. Further resources will be obtained via the AMOSC Plan (through AMOSC) as required.	Results of a compliance audit.
12	Disposal of wastes	Survey contractor	Ensure sewage and putrescible waste are treated in accordance with MARPOL requirements and all other wastes are packaged and transported to shore for disposal. Ensure waste log is implemented.	Results of a compliance audit.
13	Handling of hazardous substances	Vessel Master or Party Chief	Ensure all substances shall be handled in accordance with their respective material safety data sheets (MSDS). Material Safety Data Sheets must be held on the vessel by the seismic contractor for all chemicals used.	Results of a compliance audit.
14	Supply of equipment and supplies	Vessel Master or Party Chief	Ensure that storage on supply vessels and survey vessels is in accordance with various legislative requirements including the AMSA OSV Code and AMSA Marine Orders: Dangerous Cargoes, Cargo Stowage and Securing, Marine Pollution Prevention - Noxious Liquid Substances, and Marine Pollution Prevention - Packaged Harmful Substances. Ensure stocks of oil spill response equipment are regularly checked and replenished to ensure appropriate supply quantities are on hand at all times.	Results of a compliance audit.
15	Cetacean Mitigation Management Plan	Chief Operations Geopyhsicist Santos On Board Rep Vessel Master or Party Chief	Ensure that seismic vessel are familiar with whale monitoring program and data logging procedures. Ensure that the DEH guidelines for cetacean interactions (refer Appendix 1) are implemented during the program.	Results of a compliance audit.
16		Santos On Board Rep	Ensure that aspects of the cetacean monitoring program relevant to season and location are activated on the seismic vessel.	Results of a compliance audit.

Table 6.3 Southern Margins Seismic Program implementation strategy (cont'd)

ID	Subject	Responsibility	Task	Evidence of Action
17	Fauna and flora impact mitigation observation	Chief Operations Geophysicist	Ensure that the survey vessel and support vessel crews are aware of their responsibility for implementing a program of observation for adverse effects to cetaceans and other marine fauna, and subsequent shutdown in accordance with the procedure outlined in Section 8.1 of this EP and the DEH cetacean guidelines (refer Appendix 1).	Documentation of inductions.
18	Fishing interaction	Vessel Master	Establish routine communication times /frequencies to inform fishing operators / cooperatives of daily areas of seismic survey.	Maintain log of communication record.
19	Disposal of wastes	Vessel Master or Party Chief	All vessels must comply with State and Commonwealth legislation for the control of pollution and dumping at sea. No waste discharges in or adjacent to State waters. Sewage and putrescible wastes (eg. food scraps) shall be stored onboard for onshore disposal to a licensed facility. Solid wastes shall be stored and returned to the mainland for appropriate disposal. Hazardous wastes, generally of low quantity and mainly includes lithium batteries, paints, will be segregated and stored in sealed storage areas and transferred to onshore licensed hazardous material handlers for disposal to a licensed depot.	Documentation of compliance.
20	Loss of material	Vessel Master or Party Chief	Any spillage during loading, unloading, supply vessel transportation, storage or at the seismic location shall be reported immediately.	Written documentation and reporting of incidents.
21		Vessel Master or Party Chief	Any loss to the sea of liquid hydrocarbon or other hazardous substance that requires an operational response to contain or recover is to be managed in accordance with the OSCP. Ensure stocks of oil spill response equipment are regularly checked and replenished to ensure appropriate supply quantities are always available.	Written documentation, reporting of incidents, incident investigation report.

Table 6.3 Southern Margins Seismic Program implementation strategy (cont'd)

ID	Subject	Responsibility	Task	Evidence of Action
22	Refuelling	Vessel Master	Ensure that refuelling operations for the seismic and supply vessels will be conducted in accordance with refuelling procedures, including continuous visual monitoring and the use of Santos approved fittings. Refuelling is to be conducted at port only.	Results of a compliance audit.
23	Government liaison	Chief Operations Geophysicist	Advise the relevant regulatory authorities (DIER and DPI) of project execution progress on a regular basis (at least weekly).	Documentation of compliance (email, phone records).

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Appendix 1

Guidelines on the application of the Environment Protection and Biodiversity Conservation Act to interactions between offshore seismic operations and larger cetaceans October 2001

Guidelines on the application of the
Environment Protection and Biodiversity Conservation Act
to interactions between offshore seismic operations and larger cetaceans
October 2001

Purpose

The purpose of these Guidelines is to assist proponents of offshore seismic operations address certain of their obligations under the Environment Protection and Biodiversity Conservation Act 1999 (the Act) relevant to interactions with whales and certain other larger cetaceans.

Limitations

These Guidelines set out in plain English general advice about how Environment Australia intends to apply relevant provisions of the Act. They do not provide definitive advice relevant to any particular case. In each application of the Act, the particular circumstances of that case will need to be taken into account.

These Guidelines do not in any way fetter the discretion or responsibilities of the Minister for the Environment and Heritage or Environment Australia under the Act.

These Guidelines refer only to seismic operations and interactions with those cetaceans or whales listed at attachment 1. They do not relate to interactions with small cetaceans (such as dolphins) or other marine species (such as turtles or dugong). Whether a seismic survey will have a significant impact on a species at Attachment 3, other than those species listed at Attachment 1, should be considered prior to undertaking a survey. Other matters of national environmental significance such as the protection of World Heritage areas, Ramsar Convention listed wetlands of international importance, or the wider aspects of the Commonwealth marine environment trigger are also not addressed in these guidelines.

In relation to seismic operations and interactions with cetacean species other than those listed at Attachment 1, proponents need to determine the likelihood of the operation having a significant impact on the species or a population, or of interfering with individual animals of these species.

It is essential that all proponents make themselves familiar with the detail of their obligations under the Act. The Act can be found at www.ea.gov.au/epbc/about. The Government has separately published general Administrative Guidelines for the Act on whether a proposed action is likely to have a significant impact on any matter of national environmental significance. See www.ea.gov.au/epbc/assessapprov/guidelines/index.html or attachment 2.

When would a seismic operation that is likely to interact with whales require approval under Part 9 of the EPBC Act?

In the following circumstances a proposed seismic operation would be considered a 'controlled action' under the Act and so would require the approval of the Minister for the Environment and Heritage.

- Where a proposed seismic operation, whether in Commonwealth waters or in coastal waters, would be likely to have a significant impact on any threatened or migratory cetacean species. A full list of threatened or migratory cetacean species is at attachment 3.
- Where a seismic operation in Commonwealth waters would be likely to have a significant impact on any cetacean species.

Seismic operations will be regarded as being likely to have a significant impact on a cetacean species (including threatened and migratory cetacean species) in the following circumstances.

- Where the seismic operation is to be carried out in, or within 20 kilometres of, a feeding, breeding or resting area for a relevant cetacean species during the period when cetaceans are present.
  - The known feeding, breeding and resting areas for Southern right whales, Blue whales and Humpbacks - and the times when whales are believed to be present in these areas - are set out in the maps at Attachment 4. Areas for other species will be delineated in future as our knowledge increases.
- Under some circumstances seismic operations in or near migratory paths for cetaceans (as set out in maps at Attachment 5) at specified times may be likely to have a significant impact.
  - Proponents should consider referring relevant proposed operations in or near migratory paths to the Minister for decision on a case-by-case basis. Factors that may be relevant include: whether the migratory species is endangered; whether the seismic operations would be in a migratory path adjacent to a feeding, breeding or resting area; whether young calves or pregnant females may be affected; whether significant numbers (relative to the species or populations) of migrating cetaceans may be affected.

Should a proponent wish to remove uncertainty whether the action is a controlled action, the proposed action can be referred to the Minister for a decision about whether the action is a controlled action. Such a decision must be given in 20 days. (See section 75(5) of the Act.)

The undertaking of two surveys simultaneously in adjoining areas may lead to significantly greater interference than might be expected from a single survey and may lead to each of the surveys being considered to have a significant impact on the species.

When should you apply for a permit under Part 13 of the EPBC Act for a seismic operation that may interact with whales?

With limited exceptions, an action that will injure, take or interfere with a cetacean in Commonwealth waters is an offence under the Part 13 of the Act unless a permit has been granted. In general, permits will not be granted to injure or take cetaceans. Accordingly, these two circumstances will not be considered further here.

A seismic operation that would interfere with a cetacean in Commonwealth waters would not be an offence under Part 13 of the Act if a permit has been granted.

Interference is defined in the Act to include harass, chase, herd, tag, mark or brand the cetacean. For the purposes of these Guidelines a precautionary approach has been taken to the definition of interference; that is causing a significant change in behaviour, including a

significant deviation from their migratory path or a substantial change in respiration or swimming pattern, will be considered harassment and so interference.

Under the following circumstances Environment Australia may consider a seismic operation as interfering with a cetacean.

- Where a seismic operation is a controlled action under Part 3 of the Act (and so must be approved by the Minister) as a result of its potential interactions with cetaceans. In these cases the permitting and approvals processes will be managed together.
- Seismic operations that are not controlled actions under Part 3 of the Act, but nonetheless take place in or near migratory paths around the time when migrations may occur. Such seismic operations may cause any present whales to modify their behaviour (for example deviate from their migratory path) and so may interfere with them.
  - Maps of migratory pathways for Humpback whales, Blue whales and Southern right whales are at attachment 5. Seismic operations in these areas during the peak of the Humpback migratory season and for all of the Blue whale and Southern right whale migratory season will be considered to be likely to interfere with any present whales. As areas important for other species become known, additional areas will be delineated.

In general, a seismic operation will **not** be regarded as interfering with cetaceans under the following circumstances.

- The seismic operation will take place outside of the migratory pathways and migration period for whales and outside of the breeding, feeding and resting areas during the times when these areas are occupied; and
- the management prescriptions set out in attachment 6 are observed.
  - These management prescriptions are intended to ensure that the proponent will take proper efforts to identify whether whales are in the area where seismic operations are to commence, and should there be whales in the area that every reasonable effort is taken to undertake the seismic operations in a manner that eliminates or minimises impacts on them.

What is the relationship between Part 3 approvals and Part 13 permitting processes in the Act?

From the above it is clear that, given the different objectives of the approvals and permitting provisions under the Act, proponents of seismic operations should have regard to a number of possible outcomes. These are broadly set out below.

Some seismic operations will not require an approval and nor will the permit provisions apply.

- That is, where there is no significant impact on a cetacean species and there is no interference with any individual cetacean (and other NES matters are not affected).

For some seismic operations only the permit provisions will apply.

- For example, where a seismic operation in Commonwealth waters may interfere with migrating whales the permit provisions will apply, but if a significant impact on the species or a population of species is not likely no approval will be required.

Some seismic operations will require approval but the permit provisions will not apply.

- For example, a seismic operation in coastal waters that is likely to impact significantly on a population of a threatened cetacean will require approval. However, because the action is in coastal waters (and not Commonwealth waters) the permit provisions would not apply.

For some seismic operations in Commonwealth waters, both an approval will be required and the permit provisions will apply.

- This will be the case where a proposal will have both a significant impact on a species of cetacean and will also interfere with individual cetaceans. In such cases, approvals and permits will be processed together to avoid any delay or duplication. For practical purposes, there will be one process and the same documentation from the proponent can be used to meet both requirements.

What do you have to do for the Part 3 approvals process?

Where a proposed action has been referred to the Minister for the Environment and Heritage and found to have or be likely to have a significant impact on a matter of national environmental significance (a controlled action), the action will require the approval of the Minister. The process for obtaining approval is outlined at Attachment 7. Further information on the process can be gained at www.ea.gov.au/epbc/assessapprov/index.html.

What do you have to do for the Part 13 permitting process?

Under the EPBC Act applying for a permit to undertake an action that may interfere with a cetacean automatically requires that the action be treated like a controlled action.

From this step a similar process as described for the Part 3 approval is followed, though at the end of the process a permit is issued (or refused) rather than an approval being given (or refused). Conditions may be placed on the permit.

The permit process has a simultaneous step of advising persons on the Register for consultation about permits of the permit application and seeking their comment on the application.

Standard Conditions

As a general rule proponents of seismic operations should expect to be subject to conditions applying to approvals or permits.

The conditions will be based on the set of management prescriptions set out at Attachment 6. These are for guidance only and specific conditions will be determined for each proposal depending on the particular circumstances of the operational environment.

In general these conditions are intended to ensure that:

- every reasonable effort is taken to identify whether whales are in the vicinity of a seismic operation;
- should whales be in the vicinity, avoidance of interference and mitigating action takes place, and
- if whales do not appear to be in the vicinity, the operation is commenced and managed in a precautionary manner to minimise interference with whales that may not have been

identified and to cease operations quickly should whales be identified and interference be avoidable.

Supporting notes

Feeding, breeding and resting areas

Whales that are feeding, breeding and resting (in particular with calves) are considered susceptible to disturbance. Generally the conditions supporting these activities are unlikely to be available in other locations. Disturbing whales under these circumstances is likely to have an impact on the population of the species. The sensitivity of cow/calf pairs to disturbance when resting during migrations requires that a substantial buffer of 20 kilometres around these resting areas is applied to allow the calves to regain strength for the migration.

Migratory paths

Generally whales are robust animals able to travel long distances. Under most circumstances, a whale making a small deviation within its general migratory path to avoid seismic operation is unlikely to be adversely affected in terms of successful migration. However, in some circumstances precautionary management suggests that causing such deviations should be avoided where possible. These would best be judged on a case-by-case basis, considering factors such as the conservation status of the relevant species, or the likelihood of young calves or pregnant females being in the area.

Sound levels

The impact of sound from seismic sources is the subject to ongoing work in many parts of the world, including Australia. The impact of disturbance on whales in the short and long term is also unknown. Evidence to date shows that sounds heard by whales of over approximately 140db in feeding, breeding or resting areas may be considered likely to significantly disturb whales that are present. Sounds heard by whales of over 150db in other areas, such as migratory paths, may significantly disturb whales that are in the area. A document outlining the current justification for these sounds levels is available from Environment Australia).

Contact

For further information on the operation of these guidelines contact:

Director
Marine Species Section
Environment Australia
GPO Box 787
CANBERRA ACT 2601

Environment Australia, October 2001
ISBN 064254784X

List of whales species to which these guidelines relate

Common name	**Scientific name**
Shepherd's beaked whale	*Tasmacetus shepherdi*
Dense-beaked whale	*Mesoplodon densirostris*
Hector's beaked whale	*Mesoplodon hectori*
Longman's beaked whale	*Mesoplodon pacificus*
Andrew's beaked whale	*Mesoplodon bowdoini*
True's beaked whale	*Mesoplodon mirus*
Ginkgo-toothed beaked whale	*Mesoplodon ginkgodens*
Strap-toothed whale	*Mesoplodon layardii*
Gray's beaked whale	*Mesoplodon grayi*
Arnoux's beaked whale	*Berardius arnuxii*
Cuvier's beaked whale	*Ziphius cavirostris*
Killer whale	*Orcinus orca*
Long-finned pilot whale	*Globicephala melas*
Short-finned pilot whale	*Globicephala macrorhynchus*
Southern bottlenose whale	*Hyperoodon planifrons*
Sperm whale	*Physeter macrocephalus*
Southern right whale	*Eubalaena australis*
Pygmy right whale	*Caperea marginata*
Minke whale	*Balaenoptera acutorostrata*
Sei whale	*Balaenoptera borealis*
Bryde's whale	*Balaenoptera edeni*
Blue whale	*Balaenoptera musculus*
Fin whale	*Balaenoptera physalus*
Humpback whale	*Megaptera novaeangliae*

Criteria for significance under the three matters of NES, listed threatened species, listed migratory species and Commonwealth marine environment.

Listed Critically endangered and endangered species
An action will require approval from the Environment Minister if the action has, will have, or is likely to have a significant impact on a listed critically endangered or endangered species.

Criteria
An action has, will have, or is likely to have a significant impact on a critically endangered or endangered species if it does, will, or is likely to:

1. lead to a long-term decrease in the size of a population,
2. or reduce the area of occupancy of the species, or fragment an existing population into two or more populations,
3. or adversely affect habitat critical to the survival of a species,
4. or disrupt the breeding cycle of a population, or
5. modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline, or
6. result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat*,
7. or interfere with the recovery of the species.

(*Introducing an invasive species into the habitat may result in that species becoming established. An invasive species may harm a critically endangered or endangered species by direct competition, modification of habitat, or predation.)

Listed Vulnerable species
An action will require approval from the Environment Minister if the action has, will have, or is likely to have a significant impact on a listed vulnerable species.

Criteria
An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to:

1. lead to a long-term decrease in the size of an *important* population of a species,
2. or reduce the area of occupancy of an *important* population, or
3. fragment an existing *important* population into two or more populations, or
4. adversely affect habitat critical to the survival of a species, or
5. disrupt the breeding cycle of an *important* population, or
6. modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline, or
7. result in invasive species that are harmful a vulnerable species becoming established in the vulnerable species' habitat*, or
8. interferes substantially with the recovery of the species.

(* Introducing an invasive species into the habitat may result in that species becoming established. An invasive species may harm a vulnerable species by direct competition, modification of habitat, or predation.)

An important population is one that is necessary for a species' long-term survival and recovery. This may include populations that are:
1. key source populations either for breeding or dispersal,
2. populations that are necessary for maintaining genetic diversity, and/or
3. populations that are near the limit of the species range.

In addition to the above information, Commonwealth adopted Recovery Plans may also provide further guidance on whether an action is likely to be significant.

Listed Migratory Species
An action will require approval from the Environment Minister if the action has, will have, or is likely to have a significant impact on a listed migratory species.

Criteria
An action has, will have, or is likely to have a significant impact on a migratory species if it does, will, or is likely to:

1. substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat of the migratory species, or
2. result in invasive species that is harmful to the migratory species becoming established* in an area of important habitat of the migratory species, or
3. seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of the species.

(* Introducing an invasive species into the habitat may result in that species becoming established. An invasive species may harm a migratory species by direct competition, modification of habitat, or predation.)

An area of important habitat is:

1.Habitat utilised by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species, or
2.habitat utilised by a migratory species which is at the limit of the species range, or
3.habitat within an area where the species is declining.

Listed migratory species cover a broad range of species with different life cycles and population sizes. Therefore, what is an ecologically significant proportion of the population varies with the species (each circumstance will need to be evaluated)

Commonwealth marine environment
An action will require approval from the Environment Minister if the action has, will have, or is likely to have a impact on the environment of the Commonwealth marine area.

Criteria
An action has, will have or is likely to have a significant impact on the environment in a Commonwealth marine area if it does, will, or is likely to:

1. result in a known or potential pest species becoming established in the Commonwealth marine area*, or
2. modify, destroy, fragment, isolate or disturb an important or substantial area of habitat such that an adverse impact on marine ecosystem functioning or integrity in a Commonwealth marine area results, or
3. have a substantial adverse effect on a population of a marine species or cetacean including its life cycle (eg breeding, feeding, migration behaviour, and life expectancy) and spatial distribution, or
4. result in a substantial change in air quality** or water quality (including temperature) which may adversely impact on biodiversity, ecological integrity, social amenity or human health, or
5. result in persistent organic chemicals, heavy metals, or other potentially harmful chemicals accumulating in the marine environment such that biodiversity, ecological integrity, social amenity or human health may be adversely affected.

(* Translocating or introducing a pest species may result in that species becoming established.
** The Commonwealth marine area includes any airspace over Commonwealth waters.)

Guidelines for the Mining Industry

Guidelines on significance have been published for the mining industry. These include a reference to seismic activity in the marine environment which states:
'Seismic exploration (using air guns) is not likely to have a significant impact on a matter of national environmental significance unless the activity is undertaken in an area that contains habitat for threatened or migratory species and the seismic activity is likely to interfere with breeding, feeding or migration. Similarly, seismic exploration using air guns would not normally be expected to have a significant impact on the Commonwealth marine environment unless it was undertaken in an area that contains habitat for threatened or migratory species and the seismic activity is likely to interfere with breeding, feeding or migration. In addition, seismic activity in shallow or near shore environments in or adjacent to a Commonwealth marine area or a Ramsar wetland is likely to have a significant impact on a matter of national environmental significance.'

Cetaceans occuring in Australian waters that are listed as a listed threatened species or a listed migratory species or both.

At least 44 species of cetaceans have been reported in Australian and Antarctic waters. This includes 26 species of whale, 17 species of dolphins and one species of porpoise (which occurs in sub-Antarctic waters).

Five of the whale species found in Australian waters are also considered threatened and are listed as endangered or vulnerable under the Act. In addition, a number of the whale and dolphin species are migratory (visiting Australia for only part of the year or having populations that straddle international borders) and are listed under the Convention on the Conservation of Migratory Species of Wild Animals (the CMS or Bonn Convention).

Both a listed **critically endangered or endangered species** and a listed **migratory species**

Blue whale	(*Balaenoptera musculus*) - Appendix 1 Bonn Convention
Southern right whale	(*Eubalaena australis)*

Both a listed **vulnerable species** and a listed **migratory species**

Humpback whale	(*Megaptera novaeangliae)* - Appendix 1 Bonn Convention

Listed **vulnerable species**

Sei whale	*(Balaenoptera borealis)*
Fin whale	*(Balaenoptera physalus)*

Listed **migratory species**

Spectacled porpoise	(*Phocoena diotropica)* - listed Appendix 2 Bonn Convention
Indo-Pacific humpback dolphin	(*Sousa chinensis)*
Dusky dolphin	(*Lagenorhynchus obscurus)*
Indian Ocean bottlenose dolphin	(*Tursiops aduncus)*
Pantropical spotted dolphin	(*Stenella attenuata)*
Spinner dolphin	(*Stenella longirostris*)
Fraser's dolphin	(Lagenodelphis hosei)
Irrawaddy dolphin	(*Orcaella brevirostris)*

All cetaceans occurring in Commonwealth waters are protected. The impact a proposal may have on an important population of any cetacean species is considered under the marine environment matter of national Environmental Significance. A permit is required to interfere with any individual cetacean of any species within Commonwealth areas

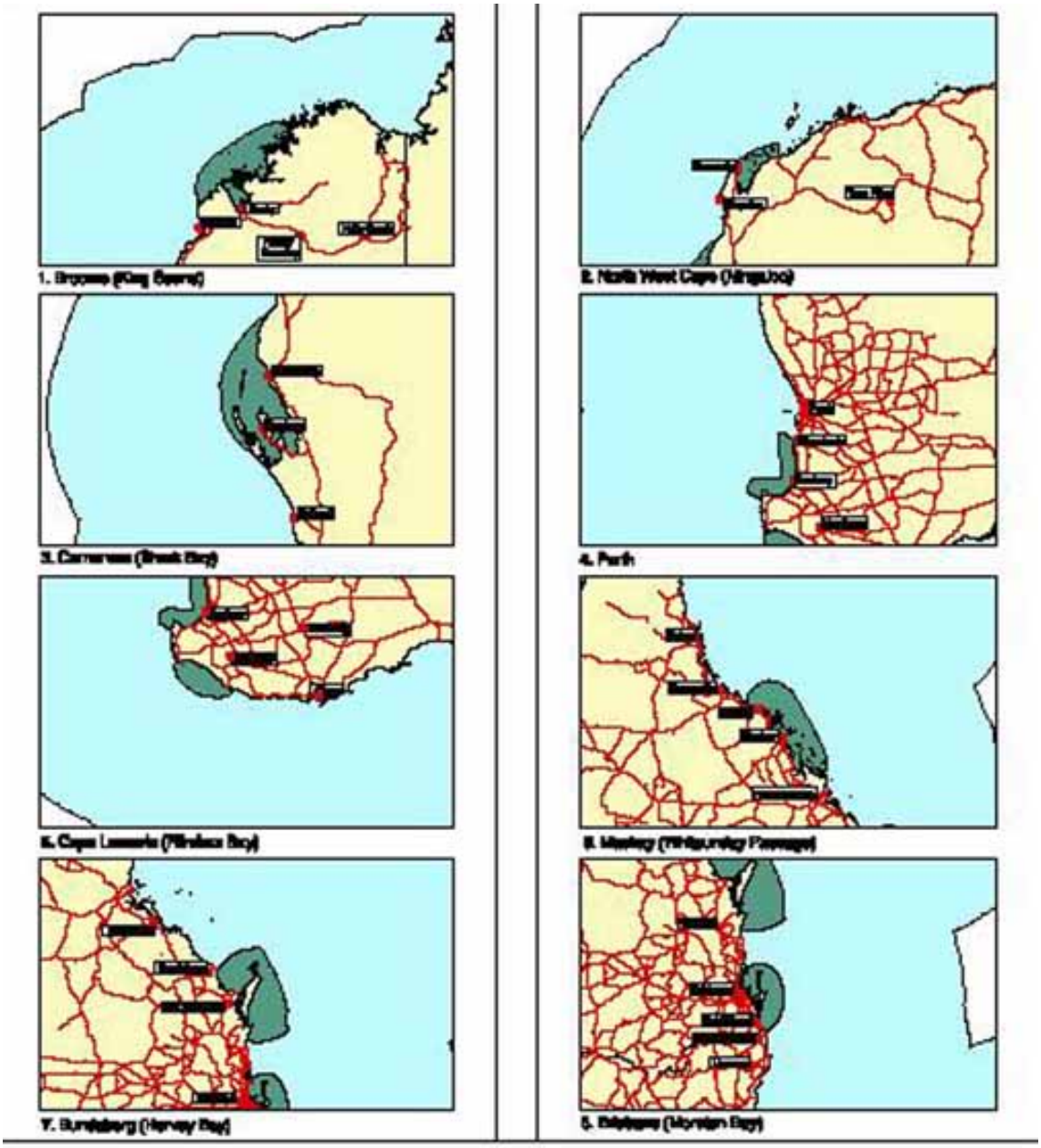
Recognised aggregation, breeding and resting areas

1. Rottnest, Western Australia

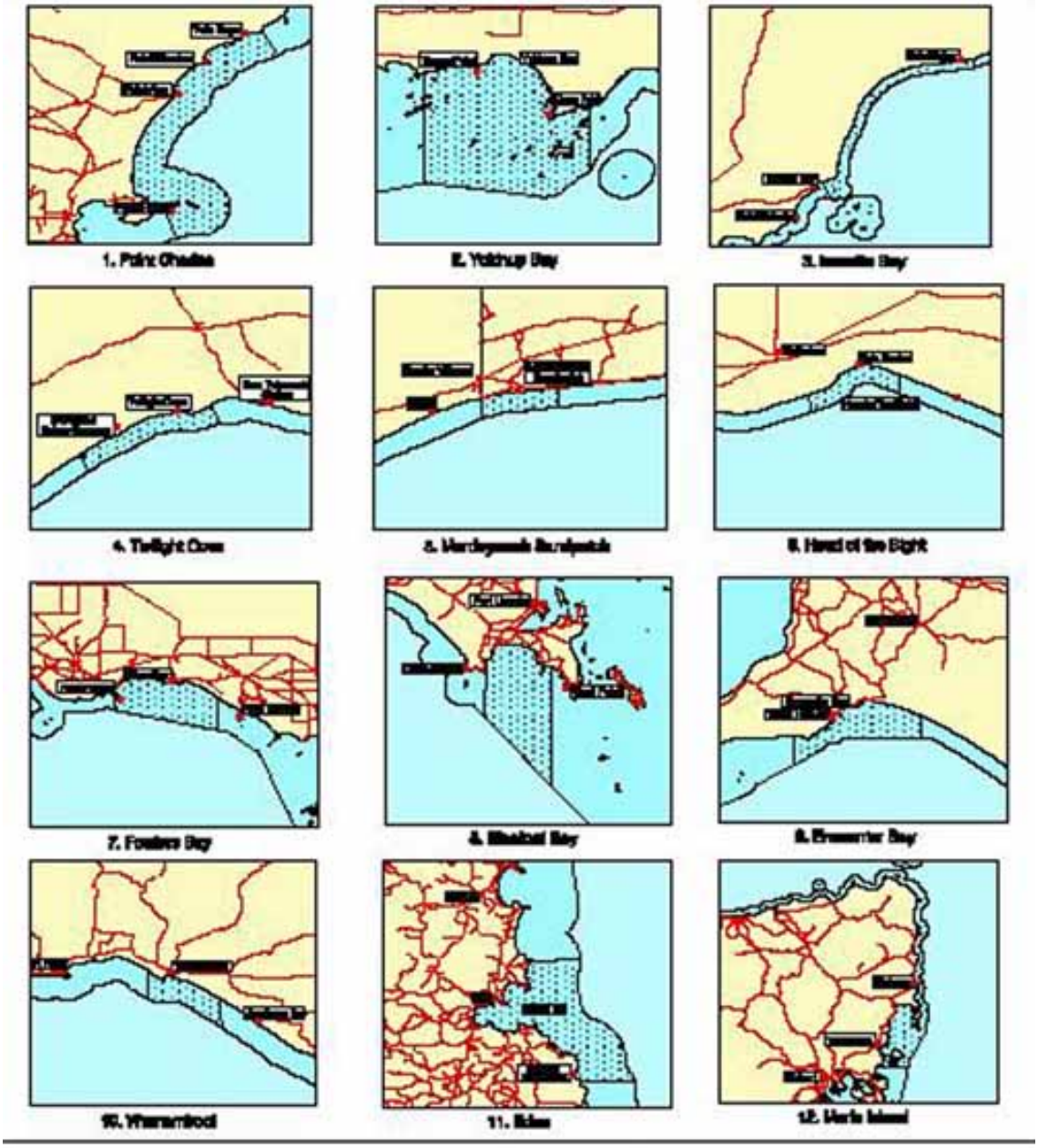
2. Otway, Victoria

3. Eden, New South Wales

Blue Whales - Recognised aggregation areas



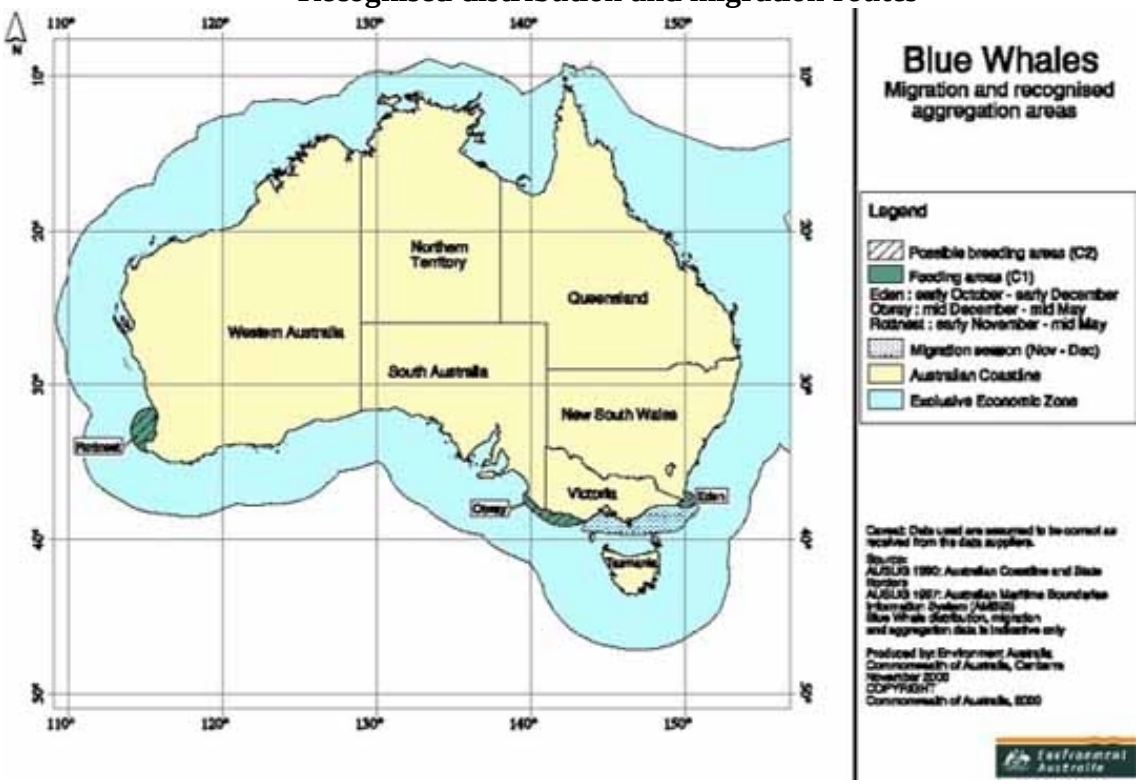
Breeding and resting areas of Humpback Whales (Megaptera novaeangliae)

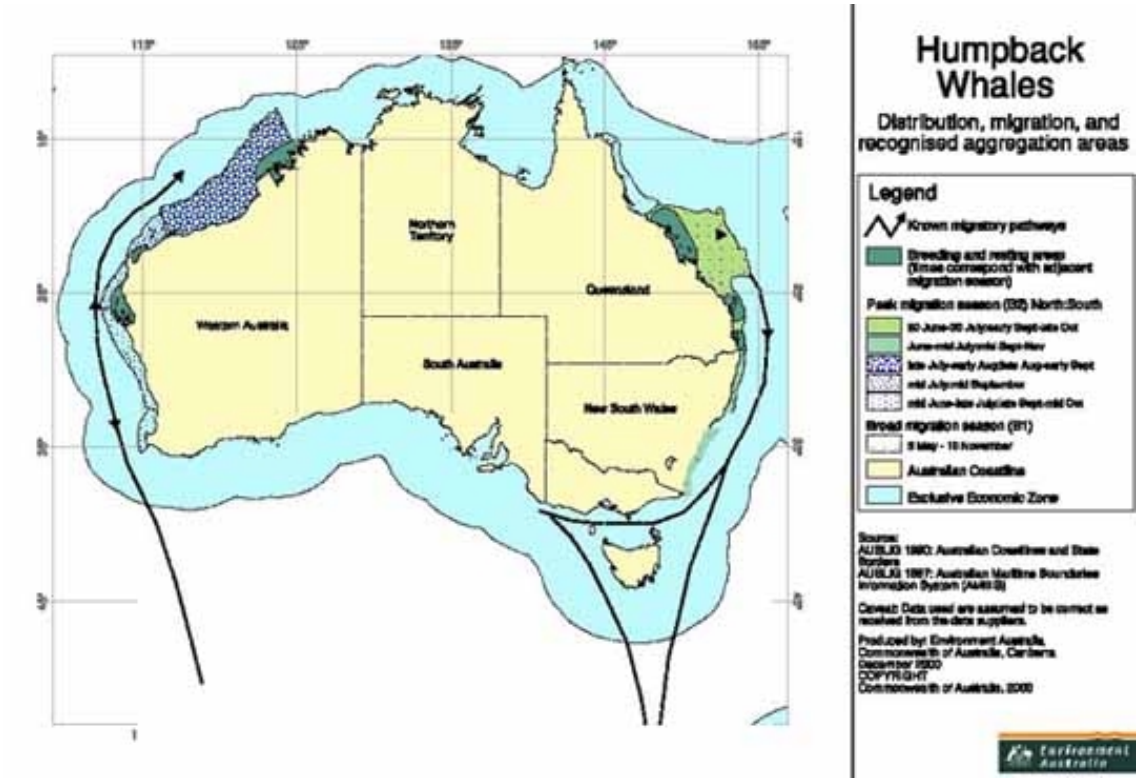


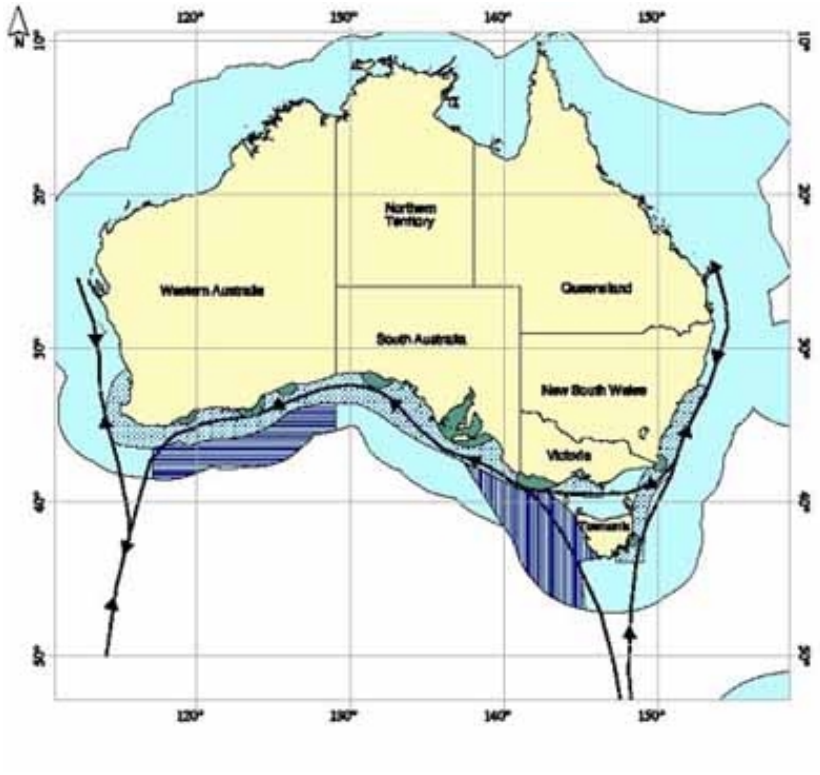
Aggregations of the Southern Right Whale

Aggregation area boundaries are given as an indication only and provide no basis for management.

Recognised distribution and migration routes







Southern Right Whales

Distribution, migration and recognised aggregation areas

Legend

- Breeding areas (C2) mid May - end September
- Known migratory pathways

Migration seasons
- mid May - end September (R2)
- early September - mid October (B2)
- early May - end June (B2)
- Australian Coastline
- Exclusive Economic Zone (200 nm)

Coast Data used are assumed to be correct as received from the data suppliers.

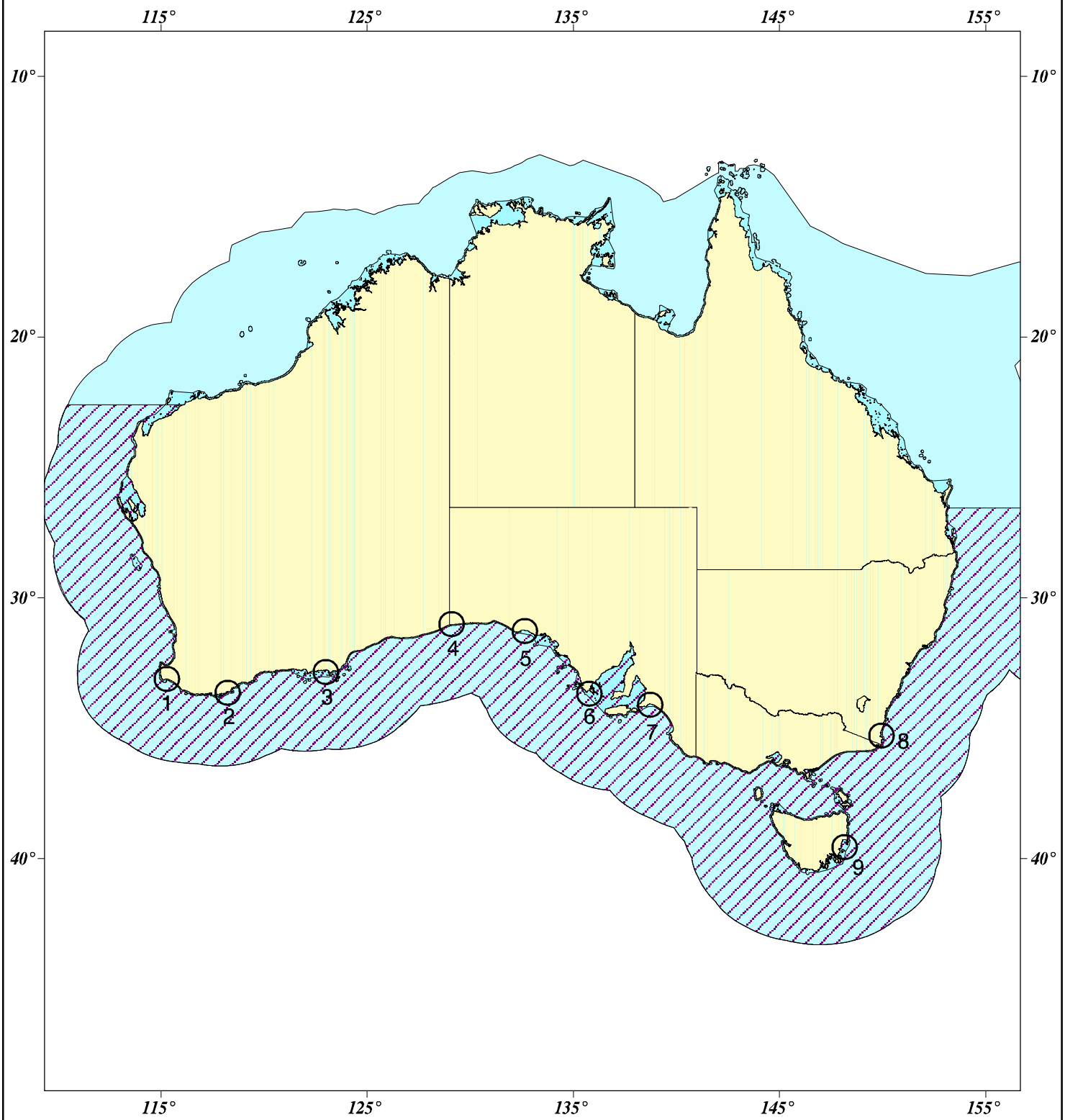
Source:
AUSLIG 1990b Australian Coastline and State Borders

AUSLIG 1997: Australian Maritime Boundaries Information System (AMBIS)

Southern Right Whale distribution, migration and aggregation data is indicative only

Produced by: Environment Australia
Commonwealth of Australia, Canberra
December 2000

Environment Australia



Southern Right Whale - Areas of frequent use

Legend

- Frequent use areas - letters refer to thumbnail maps
- Whale distribution within the EEZ (indicative only)
- Australian Mainland
- State Waters
- Exclusive Economic Zone (EEZ)

Frequent use area data was derived using State waters (3 nautical miles) and land-based geographic features as landmarks. They are indicative only.

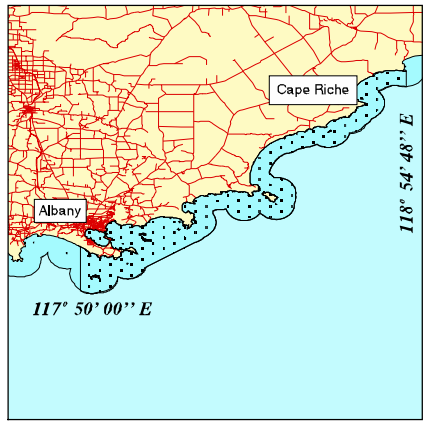
Source:
AUSLIG 2001: Australian Maritime Boundary Information System (AMBIS).
AUSLIG 1990: Australian Coastline and State Borders (100K)

Caveat: Data used are assumed to be correct as received from the data suppliers.

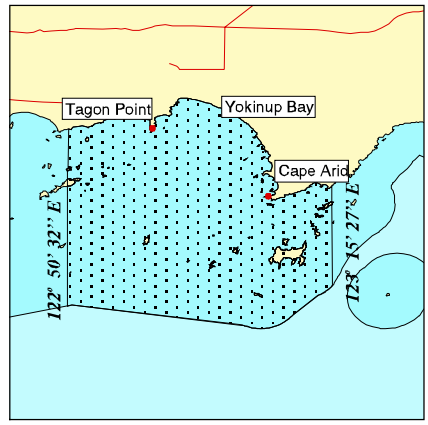
Produced by: Environmental Resources Information Network (ERIN), Environment Australia, Canberra.

Environment Australia

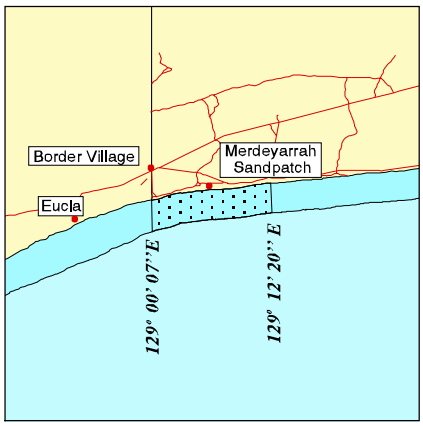
1. Flinders Bay



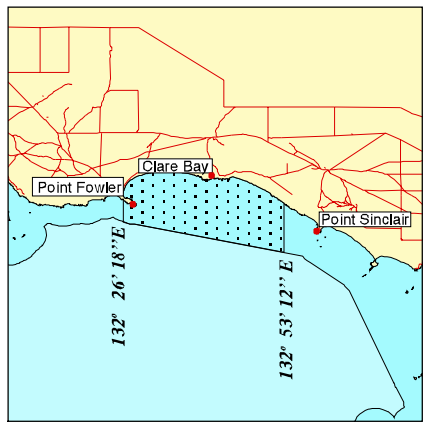
2. Albany/Cape Riche



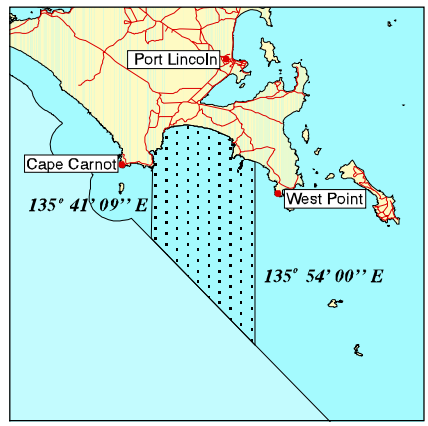
3. Yokinup Bay/Cape Arid



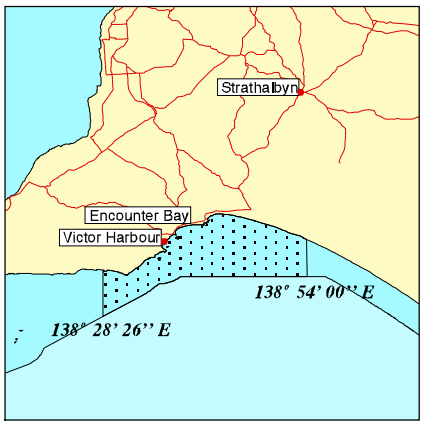
4. Merdeyarrah Sandpatch



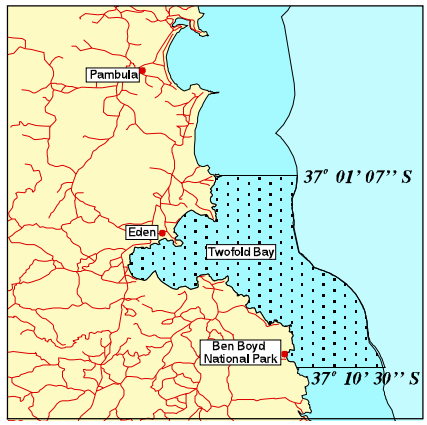
5. Fowlers Bay



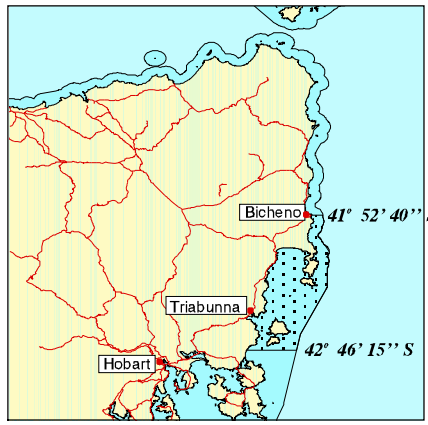
6. Sleaford Bay



7. Encounter Bay



8. Eden



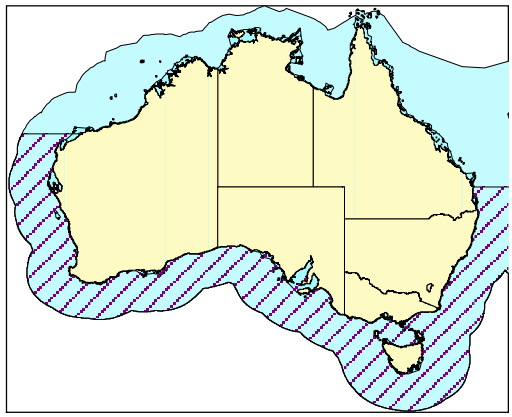
9. Maria Island

Southern Right Whale - Areas of frequent use

Legend

- Areas of frequent use
- Australian Mainland
- Main Roads
- Exclusive Economic Zone
- State Waters

Boundaries of these frequent use areas are given as an indication only and provide no basis for management. Dotted areas extend to the state waters although important habitat may stretch further offshore, or not as far as is shown in some localities.
Coordinate values are for guidance only and should not be used for navigation purposes



Source:
AUSLIG 2001: Australian Maritime Boundary Information System (AMBIS).
AUSLIG 1990: Australian Coastline and State Borders (100K)
AUSLIG 1996: Gazetteer of Australia.

Caveat: Data used are assumed to be correct as received from the data suppliers.

Produced by: Environmental Resources Information Network (ERIN), Environment Australia, Canberra.

June 2002

Environment Australia

Attachment 6

MANAGEMENT GUIDELINES FOR SEISMIC VESSELS OPERATING IN AUSTRALIAN WATERS SO AS TO AVOID OR MINIMISE INTERFERENCE WITH WHALES AND CERTAIN OTHER LARGER CETACEANS.

The following procedures should be followed by all seismic vessels operating in Australian waters during all seismic surveys so as to avoid interference with whales and other larger cetaceans as set out in the attached list.

PRE START-UP VISUAL OBSERVATION PROCEDURES

For all seismic surveys in all waters the following checks should be made:

- During daylight hours, visual checks (using binoculars from a suitable, high observation platform on the survey vessel) for the presence of whales will be undertaken before the commencement of operations.
- During night time operations, Infra-Red (IR) or night-vision binoculars will be used to undertake visual checks before the commencement of operations.
- Observations will begin at least 90 minutes prior to use of any high-energy acoustic sources, with particular focus on a 3 kilometres radius around the survey vessel. (See attached diagram).

⇒ For Information, indicators of whale activity may be in the form of blows and surface activity resulting in large splashes.

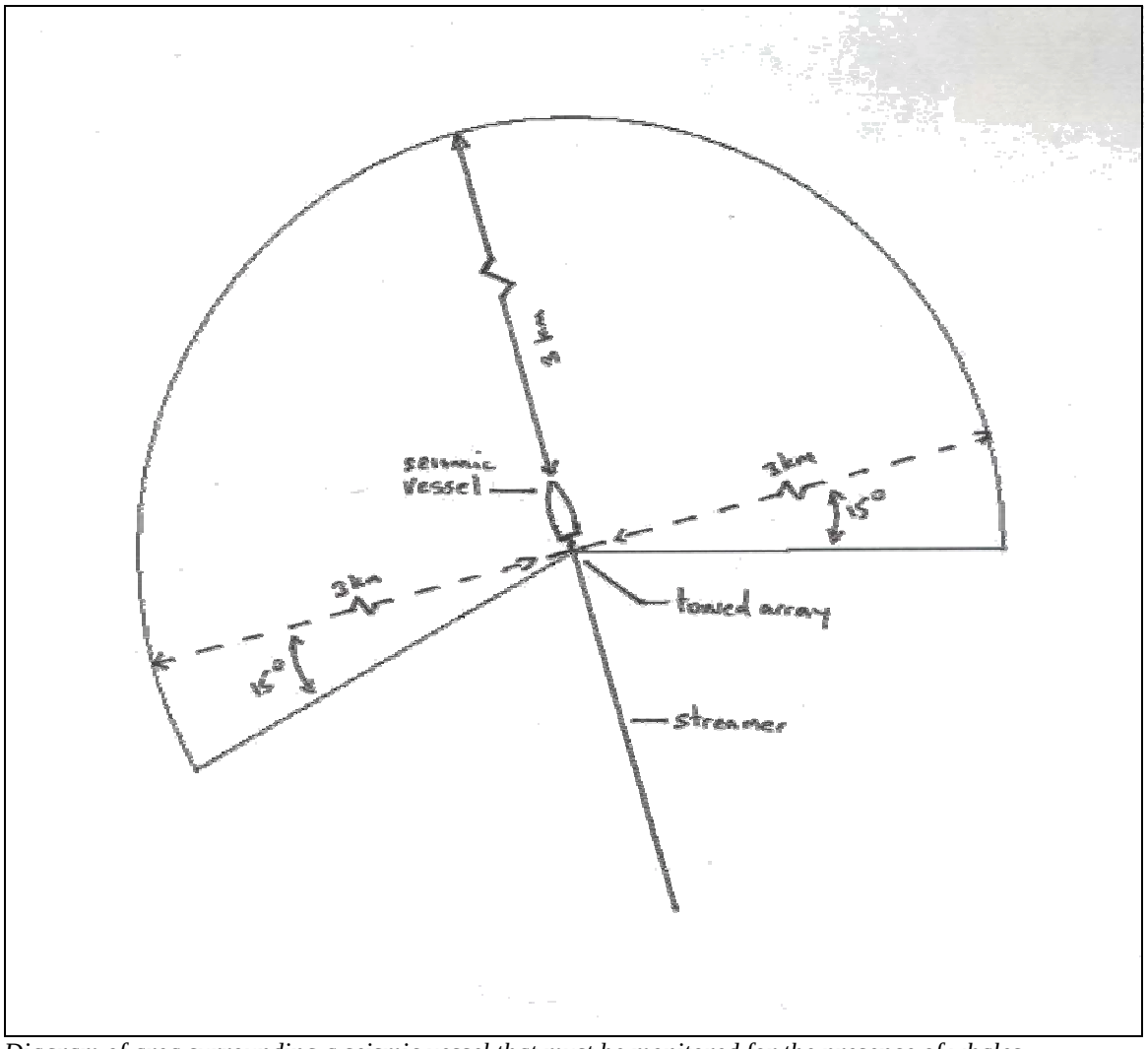


Diagram of area surrounding a seismic vessel that must be monitored for the presence of whales

⇒ For information, a practical and reliable method to accurately determine the range of a marine mammal from a ship's bridge is to measure the angle of the whale below the horizon. By then using standard formula which take into account the earth's curvature and refraction, and using the known height of eye of the observer, a reasonable estimate of the whale range can be calculated. The Norie's Nautical Almanac has standard tables and formula for calculating range from angles below the horizon. There are two methods of measuring angles below the horizon:

- Range finding binoculars which have a graticule of set angle increments fixed in one eyepiece. The number and fraction of graticule units from the whale to horizon gives the angle below the horizon;
- Sextant angles below the horizon. These provide the most accurate measure, and although require some experience at using and reading a sextant, are relatively easy to measure, although care needs to be taken whether reading the angle off or on the arc.

⇒ For information, acoustic monitoring, either ship based using signals taken from the streamer, or externally based from sonar buoys, is becoming an increasingly practical method of monitoring the presence of many whales species. There is merit in the continued exploration of this method of monitoring the presence of cetaceans. Where acoustic monitoring is used on a vessel, the signal should be continuously monitored on the bridge. The use of acoustic monitoring should be used to assist visual monitoring rather than replace it.

START-UP DELAY PROCEDURES

For all seismic surveys in all waters the following procedures should be followed:

- Discharge of the acoustic sources will not commence unless there are no whales within a minimum distance of 3 km from the survey vessel.
- If whales are detected within this zone the start up of acoustic sources will be delayed until they have been observed to move away outside the 3km radius or, if they are no longer observable, 30 minutes after the last sighting within 3km.

SOFT START PROCEDURES

For all seismic surveys in all waters the following procedures should be followed:

- A sequential build-up of warning pulses will be carried out at the commencement of all surveys. The whole array will not be fired without a full soft start. Soft starts will be used even if no whales have been seen.
- Visual observation will be maintained continuously during soft starts to establish the presence or absence of whales within 3 km of the vessel.
- If whales are sighted during this soft start procedure within the 3km zone, the seismic source will be shut down. Re-commencement of soft start procedures will take place after 30 minutes has lapsed since the last whale sighting within the 3km zone.
- There may be continued discharge of the acoustic source during line turns or changes. Discharge of only a limited number of air-guns in the acoustic array would be sufficient in this case.
- Alternatively the array may be completely shut down between the lines of a survey. In the event that the array is completely shut down between the lines of a survey, the full start-up delay and soft start procedures will be undertaken prior to the whole array being fired.

⇒ For information, the soft start procedure involves a gradual increase in the number of air-guns fired over a 20 minute period prior to commencement of a line, and serves to send out a series of warning pulses to whales and give them adequate time to leave the vicinity.

VISUAL OBSERVATION PROCEDURES DURING SURVEY LINE

For all seismic surveys in all waters where a permit under Part 13 Division 3 of the *Environment Protection and Biodiversity Conservation Act 1999* (the Act), or approval under Part 3 of the Act, is not required the following procedures should be followed at a minimum:

- Visual observations of 10 minute duration per hour will be carried out during seismic operations.
- During night time operations, Infra-Red (IR) or night-vision binoculars will be used for the hourly observations. Night time visual observations will also be of 10 minute duration per hour.
- Where a whale of a species included in Attachment 1 is seen as part of the observation procedures, continual observations should occur until 2 hours have passed since the last observation of a cetacean of a species included in Attachment 1.
- All cetacean observations, whether within 3km or not, should be documented and reported.

⇒ For information, the area to be monitored for the presence of whales is the same as that applying for pre-start surveys.

⇒ For information, wherever practicable a trained, independent observer should be used for the task of undertaking visual monitoring both to ensure that the required observations are undertaken and to ensure that the best information is obtained from these opportunties to monitor cetaceans.

⇒ For information, aerial surveys can increase the amount of information available on the presence of cetaceans in an area and assist in monitoring these animals. Where planning and safety considerations permit aerial surveys of the area to be surveyed could be undertaken to supplement shipboard observeration.

For all seismic surveys in circumstances where a permit or approval is required (feeding, breeding and resting areas and migratory routes, as identified in the accompanying maps) the following procedures will form the basis for the consideration of conditions. The exact conditions will be assessed on a case-by-case basis to ascertain if the requirements should be varied.

- In or near migratory paths, other than non-peak Humpback migration paths, 30mins per hour observation by a trained and dedicated cetacean observer will normally be required.
- In feeding, breeding or resting areas, continuous observation by a trained and dedicated cetacean observer will normally be required.
- In addition, an independent observer may be required to ensure that the best information is obtained from these opportunities to monitor cetaceans.

⇒ For information, the area to be monitored for the presence of whales is the same as that applying for pre-start surveys.

⇒ For information, the nominated observer is additional to standard bridge crew members and will have some experience with whale observationsNote: Whale observations become increasingly difficult as sea state increase. An upper limit for practical whale observation is sea state 5. This coincides with the operational weather limits for most seismic vessels.

⇒ For information, aerial or stand-off vessel observation is likely to be required as part of any permit or approval.

STOP WORK PROCEDURES

For all seismic surveys in all waters the following procedures should be followed:

- Where a seismic vessel with an operating acoustic source approaches within 3km of an individual whale or pod of whales, the acoustic source will be shut down.
- Where an individual whale or pod of whales approaches within 3 km of a seismic vessel, the acoustic source will be shut down unless the animal or animals are seen to be skirting the edge of the 3km limit.
- Seismic source operations will not recommence until the animal or pod has been seen to move outside of a 3 km range, or has not been seen for 20 minutes.

⇒ For information, the area to be monitored for the presence of whales is the same as that applying for pre-start surveys.

⇒ For information, it is important to monitor the behaviour of any whales that may be approaching the stop-work distance. Ascertain what the whale is doing and the direction it is travelling. If it is seen to be heading away from the seismic vessel and is outside the 3km zone, a shut down may not be necessary.

⇒ For information, particular care should be exercised in the monitoring for cetaceans under conditions of reduced visibility.

AERIAL SURVEY AND STAND-OFF VESSEL PROCEDURES

For all seismic surveys in waters where a permit or approval is required (feeding, breeding and resting areas and migratory routes, as identified in the accompanying maps), additional surveys are likely to be required as permit conditions or as part of the approval, if granted. These surveys will in most cases be aerial surveys except where vessel based surveys are required to collect special information or where aerial surveys are impractical. Two types of surveys are envisaged and the requirement for either or both will be assessed on a case-by-case basis.

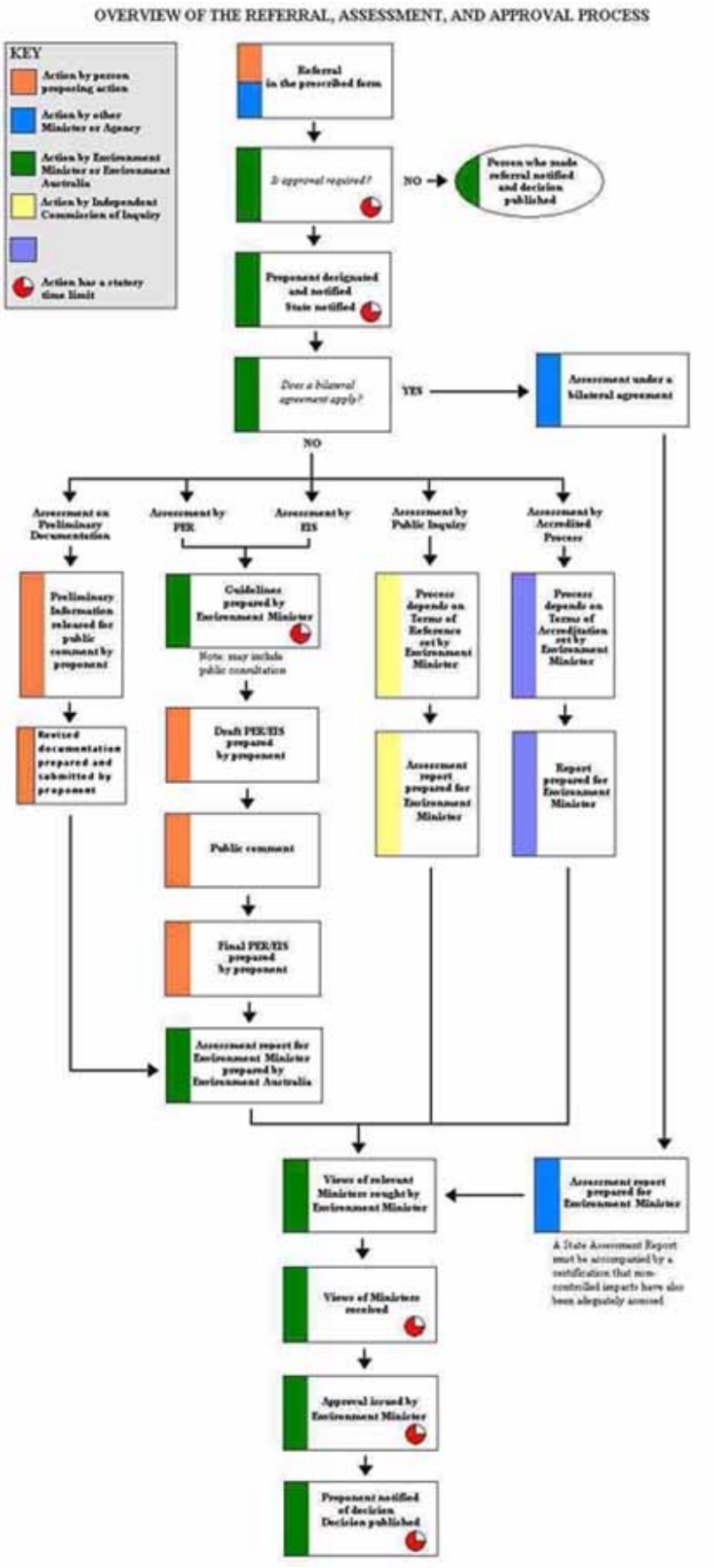
1. Surveys to identify where cetaceans are in relation to seismic activity and to identify when seismic vessels should be especially vigilant. These surveys would be run between the areas to be surveyed by the seismic vessel and the likely approach direction of cetaceans, or in the area in advance of the survey vessel.
2. Scientific surveys to identify which areas are important to cetaceans eg to identify feeding, breeding and resting areas and times of peak migration. In particular these surveys may be required in areas of potential increased sensitivity (areas C or D on the attached maps) where insufficient information currently exists to determine timing and appropriate management arrangements.

RECORDING AND REPORTING PROCEDURES

- Any whale sightings will be recorded on the *Environment Australia Whale and Dolphin Sighting Report* form (attached). This form is also available in electronic format and can be found at www.ea.gov.au/coasts/species.
- At completion of the seismic survey, copies of all report forms will be submitted to:

  Environment Australia
  Marine Species Section
  GPO Box 787
  Canberra ACT 2601

EPBC Act - basic referral, assessment and approval steps



Appendix 2

Fishing Industry Consultation Letter

Santos Ltd
ABN 80 007 550 923
Santos House
91 King William Street
Adelaide SA 5000

GPO Box 2319
Adelaide SA 5001
Telephone: 08 8224 7000

Environment, Health, Safety & Sustainability
Direct: 08 8218 5151
Mobile: 0407 395 815

Ref: 2005 Southern Margins Seismic Program

1 September 2005

Dear Fisher

2005 Southern Margins 2D Seismic Program

Santos Ltd (Santos) is proposing to undertake a total of four 2D seismic programs in Commonwealth waters off the coasts of Tasmania and Victoria in petroleum exploration permits T/32P, T/33P, T/40P and VIC/P50 (refer following maps) in a 30 day period during late October 2005 to May 2006 with the precise timing being dependent on vessel schedules. Santos is operator of permits T/32P, T/33P and T/40P on behalf of its joint venture partners. Santos will also undertake seismic on behalf of Essential Petroleum in VIC/P50 as agent operator.

Approval for these programs is currently being sought from the Commonwealth Department of Environment and Heritage (DEH) under the *Environment Protection and Biodiversity Conservation Act*, 1999 (EPBC Act) and the relevant State government departments under the *Petroleum (Submerged Lands) Act*, 1967.

Multiwave Geophysical Company's *Pacific Titan* seismic survey vessel has been contracted to undertake the seismic program and subject to obtaining all relevant approvals and vessel scheduling could commence operations in late October 2005. A single seismic streamer containing hydrophones will be towed behind the vessel during the survey operations. The streamer length will be 6 km for all the surveys. Due to the timing and location of the surveys it is unlikely that a scout vessel will be required to support the survey vessel. However, if the surveys are likely to coincide with active giant crab and lobster fishing areas then a scout vessel may be employed.

Permit	Operator	Distance from Shore	Water Depths	Approx. Timeframe
T/32P	Santos	35 – 110 km	100 – 2,900 m	- approx. 10 days
T/33P	Santos	30 – 75 km	100 – 1,900 m	- approx. 7 days
T/40P	Santos	15 – 60 km	50 – 3,000 m	- approx. 8 days
VIC/P50	Santos on behalf of Essential Petroleum	25 – 60 km	100 – 2,000 m	- approx. 5 days

Santos does not seek to exclude fishing activity within the entire survey area for the survey duration, however due to the potential for fishing equipment to become entangled in the seismic streamer (resulting in damage and possible loss of both) it is requested that fishing equipment is not deployed in the path of the survey vessel. As with previous seismic programs daily communications will be made from the vessel at 07:15 AEST on Channels HF 4535 and VHF 16 (Securite) then 77 to facilitate planning of fishing activities within the survey area. The daily report will provide an update on the proposed 24 and 48 hour line recording schedule. During this daily report reference will be made to seismic line numbers indicated on the enclosed detailed survey map. In addition the seismic vessel can be contacted at any time via radio or on Ph 0011 47 5140 7614.

If you have any questions or concerns associated with the proposed Southern Margins seismic program, please do not hesitate to contact me on Ph 08 8218 5151 or e-mail nick.fox@santos.com.

Yours sincerely,

Nick Fox
Environmental Adviser

Attach. (detailed survey maps)

Appendix 3

T/32P Detailed Survey Map

142° 30' 00"
139° 30' 00"
143° 00' 00"
143° 30' 00"
144° 00' 00"
-40° 30' 00"
-41° 00' 00"

Note:

Water depth contours in metres
Nautical Chart spot depths in metres

Please allow 8km buffer around survey area for vessel manoeuvring

Nautical Chart Aus 00445B

South-east Marine Planning Region

SOSN05B
Seismic Survey

T/32P

Southern Right Whale

Zeehan Broad
Area of Interest

Clam 1

-100 WD
-2000 WD
-3000 WD

Southern Right Whale Migration Path
Humpback Whale

SOSN05B seismic programme
Southern Right Whale migration
Broad Areas of Interest Areas
Marine Planning Regions

Approximate Survey Timing -- Oct 2005 - May 2006	
M/V PACIFIC TITAN	
M/V PACIFIC TITAN	.....0011 47 5140 7614 Bridge
JOHN HUGHES (Santos Chief Operations Geophysicist)	.....08 8224 7952 (wk) .....08 8278 6781 (a/h)

Notices to Mariners inclusive to 2003-237-450-497-820-

Santos

Tasmania

PERMIT - T/32P

SOSN05B

Seismic Survey

10 0 10 20

Kilometres Scale: 1:500 000

Aug 2005, File No. TASGEN 024

GDA

Appendix 4

T33/P Detailed Survey Map

143° 00' 00" 143° 30' 00" 144° 00' 00" 144° 30' 00" 145° 00' 00"

-41° 00' 00"

-41° 30' 00"

Note:

Water depth contours in metres
Nautical Chart spot depths in metres

Please allow 8km buffer around survey area for vessel manoeuvring

Nautical Chart Aus 00353

-2000 WD

-3000 WD

Southern Right Whale Migration Path
Humpback Whale

Southern Right Whale

South-east Marine Planning Region

Clam 1

T/33P

SOSN05C
Seismic Survey

01 02 03 04 05 06 07 08 09 10 11 12 13 15 17 19

Zeehan Broad
Area of Interest

SOUTHERN

TASMANIA

SOSN05C seismic programme
Southern Right Whale migration
Broad Areas of Interest
Marine Planning Regions

Approximate Survey Timing -- Oct 2005 - May 2006	
M/V PACIFIC TITAN	
M/V PACIFIC TITAN	.....0011 47 5140 7614 Bridge
JOHN HUGHES (Santos Chief Operations Geophysicist)	.....08 8224 7952 (wk) .....08 8278 6781 (a/h)

Santos

Tasmania

PERMIT - T/33P

SOSN05C

Seismic Survey

10 0 10 20

Kilometres Scale: 1:500 000

Aug 2005, File No. TASGEN 025

GDA

Appendix 5

T/40P Detailed Survey Map

Note:

Water depth contours in metres
Nautical Chart spot depths in metres

Please allow 8km buffer around survey area for vessel manoeuvring

Nautical Chart Aus 00445B

VICTORIA

TASMANIA

Apollo Broad Area of Interest

Thylacine 1

Prawn A 1

Whelk 1

Southern Right Whale

Southern Right Whale Migration Path

South-east Marine Planning Region

-1500 WD

-2000 WD

SOSN05 Seismic Survey

T/40P

Zeehan Broad Area of Interest

-39° 30' 00"

-40° 00' 00"

142° 30' 00"

139° 30' 00"

143° 00' 00"

143° 30' 00"

144° 00' 00"

- Blue Whale Sightings Dec 1988
- SOSN05 seismic programe
- Southern Right Whale migration
- Broad Areas of Interest Areas
- Marine Planning Regions

Approximate Survey Timing -- Oct 2005 - May 2006	
M/V PACIFIC TITAN	
M/V PACIFIC TITAN	.....0011 47 5140 7614 Bridge
JOHN HUGHES (Santos Chief Operations Geophysicist)	.....08 8224 7952 (wk) .....08 8278 6781 (a/h)

Santos

Tasmania

PERMIT - T/40P

SOSN05

Seismic Survey

10 0 10 20

Kilometres Scale: 1:500 000

Aug 2005, File No. TASGEN 023

GDA

Appendix 6

VIC/P50 Detailed Survey Map

Note:

Water depth contours in metres
Nautical Chart spot depths in metres

Please allow 8km buffer around survey area
for vessel manoeuvring

- Seismic Programme
- Blue_Whale Sightings Dec88-May 89
- Vic Marine Area
- Broad Area of Interest

OEP05 Seismic Survey

Victoria

South Australia

Cons Assess Broad Area of Interest

Nelson Broad Area of Interest

Portland Bay Proposed Special Management Area

Discovery Bay Marine National Park

Lawrence Rocks Proposed Special Management Area

DEPTHS IN METRES

Approximate Survey Timing --- Oct 2005 - May 2006	
M/V PACIFIC TITAN	
Essential Petroleum	PERMIT...VIC/P50
M/V PACIFIC TITAN	.....0011 47 5140 7614 Bridge
JOHN HUGHES (Santos Chief Operations Geophysicist)	.....08 8224 7952 (wk) .....08 8278 6781 (a/h)

Santos

Victoria

OEP05 Seismic Survey

10 0 10 20

Kilometres

Date: Aug 2005, File No. OTWAY 626nautical_05

GDA

WGS plotted

-38° 00' 00"

-38° 30' 00"

-39° 00' 00"

140° 00' 00" 140° 30' 00" 141° 00' 00" 141° 30' 00" 142° 00' 00"