MEETING MINUTES

June 18, 2013

Minutes: Santos Community Committee - Narrabri Shire
Tuesday, 18 June 2013
Narrabri Shire Council Chambers, Narrabri

Attendance: David Ross (Chair), Tony Pickard, Michael Guest, Terry Hinch, Brendan Warnock, Ian Duffy, Annie Moody (Santos), Sofia Oliver (Santos)
Apologies: Ken Flower, Victoria Hamilton, Ron Campey, Annie Alexander, Jon Maree Baker, John Tough.

	Discussion	**Action/By Whom**
1. Welcome and introductions	The chair opened the meeting at: 5.37pm Chair welcomed committee.	
2. Previous meeting's minutes	List of actions from previous meetings was discussed and updated. See Appendix 2 May 2013 Action Items request response. **Actions**: ***Santos to advertise for vacant committee members.*** Santos would like to look into the option of formalising the committee, and look at the need to recruit new members following the investigation of this process. This would involve including someone from Department of Resources and Energy on the CCC. - Chair asks committee if they have any issues regarding formalising committee. Committee member asks if the committee is to be formalised will the standing committee members still be present. Santos responds they would have to investigate this further but cant see any reason why ministerial approval would have a problem with current membership. - Committee member comments that Santos has previously mentioned the Narrabri CCC within their documents included in REFs, if the committee is informal why is the CCC mentioned as part of community consultation in this document? Santos responds that the current CCC is a community consultation process which Santos places great importance in; formalising the committee will mean that it may get greater involvement from the NSW Government. - Santos notes that they have not completed action with respect to CCC member's bore as they are still obtaining background information. Santos said that they intend to organise a meeting with that CCC member before next CCC meeting. Chair requests to be	Santos to investigate the process of formalising this committee while still seeking to get new CCC members. Santos will give committee further information at next meeting in August.

	present as well. **Questions from Actions:** Chair asks in regards to the water plan that the committee have been provided, how does this high level plan translate into actions / responsibilities? Santos responds that underneath that plan there is the REF, at a project level we need to assess how the direction of the Water Plan is translated into action on the ground. Comment from Chair, in regards to the contaminated sites procedures or standards this document talks about what is required in QLD or SA but not NSW? Santos points out that these are Santos standards across the board of the company and legislation is different in various states but the outcome should be same, Santos agrees that this is a good point and that the documents need to be reflective of NSW. Committee member refers to the Land farming document that talks about hydrocarbons, asks does this apply to what Santos are doing in the Pilliga State Forrest or is that exclusively for the spill that happened in QLD. Santos representative will check this, but there understanding is that those standards apply to all sites where they have operations. **Committee accepts previous minutes.**	Santos to find out if the Land Farming document, as provided in attachments is for the Rehabilitation being carried out at the various spill sites in the Pilliga State Forest of PEL238, as it talks about hydrocarbons and puts the area onto plastic sheets.
3. Developing Reviews of Environmental Factors - Sofia Oliver Regulatory Approvals Coordinator	Chair introduces Sofia Oliver - Regulatory Approvals Coordinator in the environment and water team of Santos based in Brisbane office. Olivia is speaking about the request from the CCC to present an overview on the process of a Review of Environmental Factors (REF) Please see appendix 1 for presentation slides. **Presentation notes:** EPA - Environmental planning and assessment act which is a NSW State Act.	

EPBC - Environment and Protection Biodiversity Consultation Act - Commonwealth legislation. Santos approvals may trigger requirements for assessments from both levels depending on what the impacts are. The Presentation will focus on the state process and in particular the REF process.

On the State side Santos activities can be assessed under Part 4 or Part 5 of the EPA. Part 5 processes are the REF, which is managed by the Office of Coal Seam Gas previously known as the DRE. In relation to the assessment process under the Mining and Petroleum State Environmental Planning Policy if there are 5 or less wells within a 3 km radius that falls under Part 5 of the EP Act and the same for flow lines or pipe lines, however if there are more than 5 wells than it's an EIS process which comes under Part 4 of the act. To build a REF is not something Santos takes lightly, lots of work, money and time. Santos has specialist consultants who develop them.

The process involves desktop investigation and then site scouts.

At the back of a REF we have specialist reports that support the REF.

Once the REF is prepared Santos submits it to the Office of Coal Seam Gas and they undertake their assessment of it. They provide it to other agencies like the Dept of Primary Industries, EPA, Office of Water etc, who all do their own assessment and then feedback directly to the Office of Coal Seam Gas. They then usually send back their recommendations or further requests, we then supply them with what they have requested, they then receive that information back and send us either an approval or refusal, if it is an approval they can also put conditions on that approval.

The REF sets out the details of the existing environment and the potential impacts of the biological, chemical, waste all the different topics and then categories are assigned in terms of the risk. There are government guidelines on what an REF is to include.

Towards the back of the REF you will find (refer to page 88) statement of commitments, which is a summary of Santos key commitments. What Santos sees as their key rules. Taken very seriously by Santos and this is what other agencies look at closely. There are many commitments that are necessary for Santos to make in the REF around ground

water monitoring, rehabilitation etc.
As a requirement Santos must put in a place a security deposit for rehabilitation based on disturbance on the site.

Questions:
- Committee member asks: Is that security deposit over and above the amount you put in for your exploration licence? Santos responds that whenever they get an approval, they are required to do an assessment of what disturbances would be related to that approval. The requirement is that the security deposit must be made before they undertake the activity.

- Committee member asks when Santos is putting a REF together does the team get given a budget to work from, total cost? Santos replies that they need to factor in the entire cost at the start, so everyone is clear that they have mitigation measures that need to be costed into the budget. Santos need to have an authority for expenditure which will cover the whole project from the land access team going out to speak and negotiate with the landholder through to the assessments, the drilling and then onto the rehabilitation.

- Committee member comments that Biblewindi 31 and 32 is within the 3km zone, underneath the existing multi laterals. Whoever checked the maps are miles out, the scale is out in the request for DGR. Committee member has previously pointed this out to another Santos employee. The committee member asks Santos if they have to get approval from the Department of Planning because they actually went under the other area and went within the 3km limit and there is already more than five wells there? Santos responds yes. Committee member goes onto ask if while it is with the department of planning does the public get a chance to comment on the EIS. Santos responds that yes they do. Santos clarifies that REFs as a final are available for public view on Santos website and on the Office of Coal Seam Gas website.

Committee member goes on to comment that Santos mentioned that at Kiandool you do groundwater monitoring if you go within 2 km of a well, in Dewhurst 22 - 25 REF you say 3km, so why the difference? Santos responds that they are not sure and will have to investigate

Santos will find out why there

	what is in that area, Committee member responds that they have a bore in that area. Santos asks if the committee member is within the 3km limit? If the committee member goes by actual distance they are 3.2 km, but if they go by the scale in the REF, which is incorrect they are 2.4km. Santos responds that if they are within the 3km commitment then they will make the offer to the committee member to undertake ground water monitoring. Santos comments that it may be a difference in distance due to the fact that the example is a core hole compared to a pilot well, but will look into it further.	is a difference between the 2 and 3 km and why it varies between the two REFs. And if the committee member is within the distance that is in the REF to have the monitoring done.
	Chair asks Santos with REFs you have plenty of mitigating measures and lots of works taking place on site, do ground staff have a copy of the REF on them? Santos responds that no they do not, Santos has two positions that are solely dedicated to compliance; creating, implementing and auditing the compliance plan, every site where there is activity undertaken Santos has a compliance plan which outlines all the obligations of everyone and everything associated with that site. There are more than just the approvals and conditions under the REF there are a whole lot more approvals / agreements that need to be taken into consideration at sites. Compliance plan is issued to all key site personnel and Santos also has an icebreaker meeting where a representative from a number of different departments will be present and briefed too. Santos also does an induction to the landholders. The chair goes onto ask in the circumstance where an oil spill takes place is it the compliance plan that includes the contingencies plan? Santos responds that they would conduct a risk assessment associated with a spill, with something like this it triggers the OH&S reporting standards, but the compliance plan would form part of the investigation and it would be reviewed to see what had happened.	
	Committee member asks, what paper work would a driller have on site? Santos replies that they would have a copy of the compliance plan, they would have all the safety standards, Santos representative was unaware of everything they would have, but can find out. They would not have the REF but they could get access to it if it was required.	
	Committee member comments that the Land use maps in the REF example are out of date. And believes that the land use in this area has changed dramatically in that time. Santos	

	replies that this kind of information comes from government departments, Santos do vegetation checks and have an ecologist who comes along to scout the surrounding area. Committee member asks who is the first person from Santos that visits a potential site. Santos replies that it is the land access team who visit first. The process is that a geologist will send the land access team a map with a area highlighted and ask if this is a suitable place, and on occasion the land access team might request them to move the location slightly if they deem it as unsuitable due to factors like they are aware of a threaten species in the area or a land holder who doesn't want to allow land access. Committee member comments that there is a plant species in the Pilliga State Forrest that is rare and don't actually come up annually. If a species like this was to come up in an area of operation what happens then? Santos replies that they will ask and find out what happens if that is the case, however within the REF they are not only looking at what environmental factors are happening at the time when the specialists do site visits but also look into historical data, records and mapping on habitats and the environment etc.	Santos to report back to CCC on how infrequently appearing plants are assessed and managed
5. General Business	- Chair follows up question from committee member who is not present at meeting regarding a comment that David Knox had said in the media. Santos responds that this is ongoing; they are still trying to follow this up. **Santos Update:** Refer to update that was sent to committee members the week before the meeting. Only other update is the Northern and Southern flow lines proposal. Flow lines are proposed to be constructed along road reserves. REFs for these have not been lodged for approval. These flow lines will take the water from Dewhurst 22-25 to the Bibblewindi water collections area and the water from Dewhurst 26-29 will be linked to the existing flow lines from the Bibblewindi laterals. Chair asks Santos where we are at and explains that it is vital for the CCC to be brought up to	

	date and educated on CSG and what it involves. It would be great to get a sense of when the work will begin. Committee member comments that in the REFs Santos has made a commitment to make the CCC aware four weeks prior to drilling. Santos explains that there is also a monthly update in the local paper, as well as the CCC will get an update before the work takes place, but at this stage we haven't got the approvals to begin work. If it is a really significant body of work Santos is happy to provide a presenter to come and brief the CCC about the project. Santos comments that if there is something that the CCC wants followed up and it is in the actions list of a meeting they will endeavour to follow it up. Committee member states that the biggest concern for those he represents has been the construction and integrity of the dam walls at Leewood, Santos responds that they have had presenters come and speak about this topic before. Chair asks the rest of the committee if they have any questions that would like raised with Santos in regards to the Leewood site. Committee member comments that they would just like to be kept updated with progress of work on that site. Santos responds that they do have approval for Leewood phase 1, and they are happy to provide regular updates, currently there is nothing happening other than at some stage they will be putting industrial water bore in. Committee member asks how much water will they be expecting to get out of this bore? Santos replies an estimate of 50 Mega Litres a year is what Santos is licensed for (Santos wants to comment that this figure might not be 100% accurate). Committee member comments that on Leewood Santos has drilled a few holes which have blue casing on the top of them can you explain what they are? Santos responds that they have no idea. Committee member would like to discuss the Information Request Item (see Appendix	Santos will investigate and find out what the blue casing on top of the pegs at Leewood are for.

3). In particular the statement that says " At this stage Santos will not carry out exploration activities in other parts of NSW" and the question for Santos is, for how long? And why? Santos responds that they hold a number of Petroleum exploration licence areas across the state and to date the main area has been PEL238 which is the Pilliga Forest in the Narrabri area. Due to a whole range of factors Santos has decided that this area will be their main focus, producing gas out of PEL238 to supply gas to the domestic NSW market. Licenses will be retained for other areas. The majority of the work will be focused around PAL 2 area (the forest and the associated area); Santos would expect to stay focused in this area for at least the next couple of years. Committee member asks what would be the biggest factor that would make you slow down in the development of this area? Santos replies that there are a couple of things; cost huge investment, the commercial quantities would have to be viable to develop into a production site for long term.

Committee member comments that PAL 2 doesn't cover the Dewhurst set up for the present time and it just covers the multilaterals. Santos responds that they are not actually producing gas at the moment. Committee member asks are you going to use PAL 2 across to opposite the Dewhurst areas? Santos responds that they can find out. Santos responds that they are not actually producing gas at this point in time so if Santos was successful in getting the approval for the EIS and the pilot wells proved it would be viable then we would have to go through a whole other process to start producing. At this stage its exploration and appraisal only.

A committee member asks, does this announcement mean that Santos will not be exploring further in the Liverpool Plains? Santos responds that at this point in time they will not be carrying out exploration activities in other parts of NSW. Santos still holds the licence to do so. Santos also stresses that they have a policy of voluntary access to land. Santos has never gone onto a landholders property without them giving voluntary access.
Committee member would like to ask a question regarding Santos in the Pilliga Forest

	and the court action that is currently in the media. Santos replies that they have provided the committee with a statement from the Financial Review but are unable to speak about it due to constitution action. Santos distributes a copy of a Santos media release regarding this topic for the committee to read (see appendix 4). Chair asks committee for feedback on the chairing of the meetings. Committee member comments that they have recently had an issue that they spoke to the Chair about and since then it has improved. Chair would like to thank Santos representative for answering and checking off actions recently in a timely manner. Santos would like to suggest some framework for the process of answering questions and responding to actions. Action items arising from a meeting will be attended to in an information request response format and will aim to be provided to the committee a week before the meetings. Questions out of session Santos will get to them when they can, and aim to follow up preferably before the next meeting, other than that it will be a 10 working day response for out of session questions. CCC members agreed to this. In regard to questions responding to media articles, Santos is not able to respond to general media articles unless a member of the committee actually specifically asks a relevant question that is in relation to Santos operations here. **Next Meeting:** 13th of August 2013. - Santos suggests going on another site visit in November. Next meeting may take place at Santos depot so that CCC members can look at behind the scenes.	Santos to send committee update of works in July regardless of their not being a meeting and will include in that update information on what is happening at Leewood
Meeting Closed:	7.26pm	

Attachment 1. Actions

Action Raised	Date Raised	Progress Made
Santos to provide response to questions on Namoi Water Study - data presented by ESG.	9th October	Completed

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Action for Santos to provide committee with full soil analysis including analysis of bacteria of the Leewood site next year when it is available. As well as providing regular soil checks to ensure no contamination is occurring.	11th December	Ongoing
Specialist to answer questions on aquifer monitoring research that is being conducted.	11th December	Ongoing.
Santos to advertise for vacant committee positions- chairman to select the members	14th May	Ongoing. Pending formalisation process of committee
Santos to give a process to try and resolve committee members issue with his bore	14th May	Ongoing.
Action for Santos to explore the option of formalising the committee.	18th June	Ongoing
Santos will investigate and find out what the blue casing on top of the pegs at Leewood are for.	18th June.	
Santos to send committee update of works in July regardless of their not being a meeting and will include in that update information on what is happening at Leewood	18th June	

Appendix 1: Presentation Review of Environmental Factors

Appendix 1.1: Example of review of environmental Factors Kiandool 1 core hole - PEL 238 Gunnedah Basin NSW

Appendix 1.2: Kiandool 1 Core Hole, PEL 238 REF Supplementary Information - Dec 2012.

Appendix 2: Narrabri CCC Information Request - information requested in previous meetings actions.

Appendix 2.1: Water Management Plan.

Appendix 2.2: Water Sampling Map

Appendix 2.3: Profile Annie Moody

Appendix 2.4: EHMS08 Contaminated Sites Hazard Standards

Appendix 3: Information Request Response: 130618_NCCC Energy NSW Narrabri Focus.

Appendix 4: Santos Media Release - Statement on Pilliga Forrest.

Narrabri CCC

Information Request Response

Reference:	130611_NCCC
Subject:	Outstanding Information Request Items Narrabri CCC 14 May 2013
Request date:	21 May 2013
Requested by:	David Ross Chair Narrabri CCC
Background Request:	**May 2013 Action Items:** 1. Santos to provide committee with a copy of Water Management Plan 2. Santos to provide the committee with maps with locations of where Sulphate Reducing Bacteria (SRB) water sampling has been undertaken 3. Three members of the CCC to review future media release the day they are drafted 4. Annie Moody to provide biography profile of background to be provided to members 5. Santos to provide committee with the EHSMS updated literature 6. Santos to pass on to public relations department that misleading language used regarding NSW gas being imported needs to be rectified 7. Santos to look into Dewhurst 1 from previous upcoming works - April report which mentioned access agreement - May report says Dewhurst 1 will be plugged and abandoned 8. Santos to give a process to try and resolve committee members issue with his bore
Response:	**Item 1 – Water Management Plan** • In accordance with Condition 14 (c) of Petroleum Exploration Licence No.238 (PEL 238), Santos has provided a copy of the Produced Water Management Plan to NSW Trade and Investment-Division of Resources and Energy (DRE). The Plan has been approved - **Attachment 1**. **Item 2 - Water Sampling Maps** • General plan showing SRB levels in Gunnedah and Narrabri (based on the sampling undertaken by URS/CH2M HILL in December 2012) is included at **Attachment 2A** • Site specific data around Bibblewindi WTP for bores and ponds is included at **Attachment 2B**.

	Item 3 – Media Releases • Noted that the Chair has advised that two or three committee members will assist in the forming and drafting of the release, with a Santos representative to be one of the members. **Item 4 – Biography** • A biography for Annie Moody is attached – **Attachment 3**. **Item 5 – EHMS** • A copy of the Santos EHS08 Contaminated Sites Hazard Standard is attached **– Attachment 4** **Item 6 – Media language** • The Manager, Public Affairs has been advised of the committee members concerns in relation to the use of the term "imported" in relation to NSW gas. **Item 7 – April/May Upcoming Works** • The reference to Dewhurst 1 in both the April and May Upcoming Works was incorrect **–** the work listed was in reference to the plug and abandon (P&A) of the Bibblewindi 1 site. **Item 8 – Committee Member's Bore** • Ongoing
Briefing Officer:	Annie Moody Team Leader, Community and Land
Date:	11/06/2013

Narrabri CCC

Information Request Response

Reference:	130614_NCCC
Subject:	Out of Session Information Request Items Narrabri CCC
Request date:	5 June 2013
Requested by:	David Ross Chair Narrabri CCC
Background Request:	**Email Request 5/6/2013**: 1. In regards to the Santos presentation at the last meeting re: stopping spills, a member would like to know why a spill occurred in Santos' oil field in central Australia and took nearly two weeks to detect?
Response:	**Item 9 – Zeus Oil Spill** • A leak was detected at first light on an operating oil well head in the Zeus field in the Cooper Basin in remote south-west Queensland on 15 May 2013. • The well was not leaking late on the afternoon of 14 May. Operators visit the site daily. • The Queensland Government regulators were immediately advised of the leak at the time it was detected. • The leak involved the release of limited amounts of oil from the well head. The oil released was largely contained within the well operational area. • The impacted area is less than one hectare. • The site has been assessed for any environmental impact and necessary remediation is near completion. • Environmental consultants engaged by Santos are conducting a thorough assessment to validate that no further work is required. • Incidents of this nature are extremely rare and Santos treats them very seriously.
Briefing Officer:	Annie Moody Team Leader, Community and Land
Date:	14/06/2013

Santos

NARRABRI GAS FIELD

PRODUCED WATER MANAGEMENT PLAN

Rev	Version	Date	Prepared by	Endorsed by	Approved by
A	1	6 Dec 2012	MF/JL	CW	MK

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1 INTRODUCTION

Santos Ltd (Santos) is the developer of the Narrabri Gas Fields (the Fields), located within Petroleum Exploration Lease (PEL) 238. The activity involves the extraction of natural gas and produced water from deep-seated coals in the vicinity of the township of Narrabri, NSW.

The Produced Water Management Plan (PWMP) forms part of the overarching Water Management Strategy and is designed to meet condition 14 of the PEL238 Licence.

Produced Water is water that has been extracted from coal seams in order to reduce pressure and allow gas to flow. Produced water presents a resource that can be harnessed for the benefit of the local and regional community. Santos is committed to safely and appropriately managing the produced water resulting from its operations.

In November 2011, Santos acquired Eastern Star Gas (ESG) and as a result is expanding its Coal Seam Gas (CSG) exploration into the Bohena sub-basin within the Gunnedah Basin in northern New South Wales (NSW), known as the Narrabri Gas Fields. Santos NSW Fields are shown in Figure 1-1.

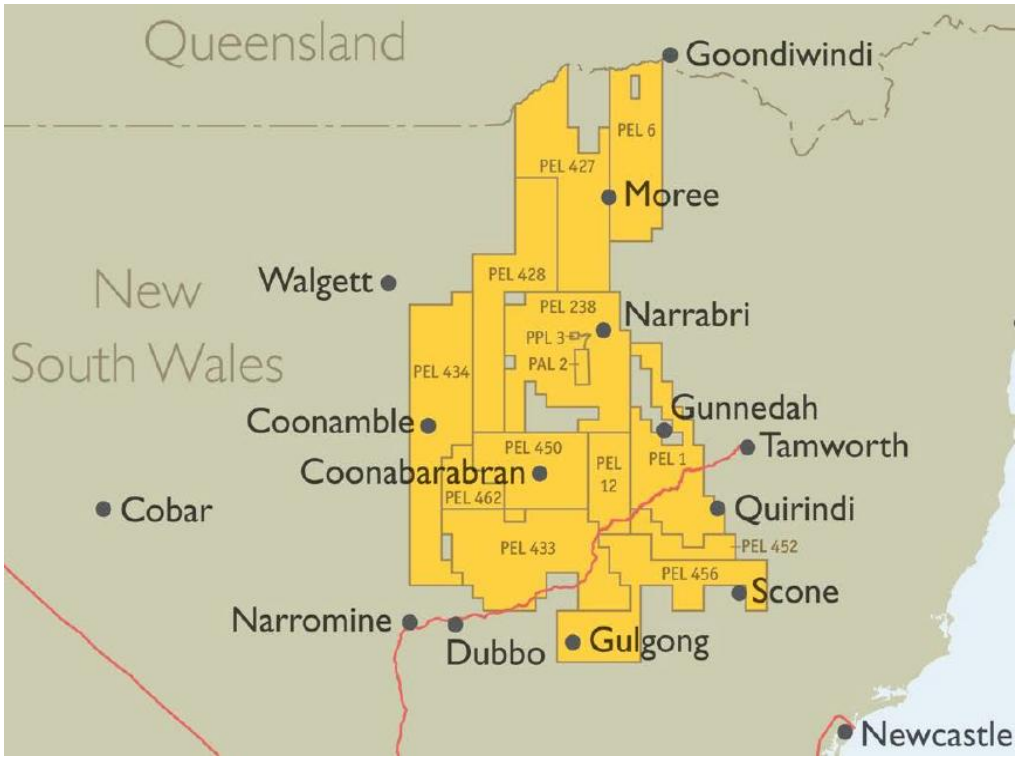


Figure 1-1 Energy NSW Field Area

It is anticipated that primary activities within the gas fields over the next 3 years (2013 to 2016) will be exploration and appraisal activities.

This PWMP applies to the Narrabri Gas Field current and future CSG activities, including exploration and appraisal activities and will be updated for future operational phases of work. To ensure the PWMP is as robust as possible, it is designed to be a regularly updated document. The PWMP therefore contains information based on Santos' knowledge of site conditions, potential for impact

from CSG activities and baseline conditions prior to CSG disturbance activities. The Plan allows for update as new knowledge is developed such as changes in technology, regulation and learning from on-going monitoring during exploration, appraisal and operations.

1.1 PETROLEUM EXPLORATION LEASE 238 LICENCE

Conditions 14 and 15 of PEL 238 Licence state the following:

Produced Water Management Plan

14. Prior to conducting prospecting operations with the potential to generate more than 3 megalitres per year of produced water (as a result of cumulative prospecting operations within the exploration licence area), the licence holder must:
    a) Prepare a Produced Water Management Plan in consultation with the NSW Office of Water and the Environment Protection Authority;
    b) Ensure that the produced water Management Plan describes:
        (i) the expected sources and estimated quantity of the produced water;
        (ii) the proposed containment and treatment measures for the produced water;
        (iii) the proposed beneficial reuse or disposal methods for the produced water;
        (iv) the controls to be implemented to prevent and/or minimise pollution;
        (v) how records of all relevant parameters for the quality, quantity, transport and disposal of all water will be maintained;
        (vi) describes the staging process for implementation of the plan; and
        (vii) is prepared in accordance with any additional requirements prescribed by the Director-General.
    c) Have the Produced Water Management Plan approved by the Minister; and
    d) Implement and comply with the approved Produced Water Management Plan.

Note: (a) Discharge to receiving waters may require licensing under the Protection of the Environment Operations Act 1997.

(b) A water access licence under the Water Management Act 2000 may be required for petroleum prospecting operations taking more than 3 megalitres of water from groundwater sources per year. A licence may be required under the Water Act 1912 where that Act applies.

15. Except where approved under condition 2 or a Produced Water Management Plan under condition 14, produced water must not be discharge to land.

This report specifically addresses PWMP requirements of PEL 238 licence. Discharge to land for irrigation purposes has been identified as a potential beneficial reuse option, however will not be

permitted until suitable investigations have been completed and this has been approved by regulators.

1.2 Purpose and Scope

This Produced Water Management Plan (PWMP) builds on the overarching Water Monitoring Strategy (WMS). This plan ensures sustainable management of produced water from the Narrabri Gas Fields. The PWMP provides flexibility to continually review and improve the plan as new data becomes available and as CSG development activities progress. The current version of PWMP is for near-term appraisal activities.

The PWMP is designed to provide the reader with the following information regarding how Santos will operate coal seam water management for the Narrabri Gas Field, including:

- How coal seam water will be managed;
- The control measures that will be implemented for each coal seam water management option to prevent unauthorised environmental harm;
- The monitoring program that will be implemented to prevent unauthorised environmental harm; and
- The procedures for managing incidents that may arise during the course of the coal seam water management practices.

This is the first version of the PWMP and has been developed in accordance with the following:

- Halcrow (2012), *Narrabri Gas Project – Water Demand Study*, prepared for Santos Limited, September 2012.
- Halcrow (2012), *Narrabri Gas Project – CSG Water Management Strategy,* prepared for Santos Limited, December 2012.
- EHS Support (2012), *Water Monitoring Strategy*, prepared for Santos Limited, November 2012.
- URS (2012), *Narrabri Gas Project – Narrabri MAR*, Stage 1 Assessment, Draft Report, prepared for Santos Limited, April 2012.
- Halcrow (2012), *Narrabri Gas Project – Groundwater Impact Assessment*, prepared for Santos Limited, December 2012.
- Halcrow (2012), *Narrabri Gas Project – Narrabri Gas Project and Gunnedah CSG Project, Pre-Feasibility Surface Water Discharge Study*, prepared for Santos Limited, November 2012.

1.3 Objectives

The objectives of the PWMP are to:

- Maintain the environmental condition of operating leases to best practice environmental management standards;
- Develop an adaptive water management plan that maximises beneficial use opportunities, ensures the supply of produced water does not exceed the established theoretical demand and can be updated periodically and continually improved with new CSG production rates, new monitoring data and with advances in science and technology (e.g. water treatment);
- Provide the best net environmental, social, economic and sustainable outcomes for the region, whilst considering Santos' operational requirements; and
- Ensure Santos' interests regarding the management of produced water is clear to Regulatory agencies (e.g. NSW Office of Water (NOW) and Department of Sustainability, Environment, Water, Population and Communities (SEWPAC)).

1.4 PWMP Summary Table

A brief summary of the content of the PWMP and reference points are provided in Table 1-1.

Table 1-1: PWMP Summary Table

Key PWMP Requirements	Section Reference
The expected sources and estimated quantity of the produced water.	Section 3
The proposed containment and treatment measures for the produced water.	Section 3
The proposed beneficial reuse or disposal methods for the produced water.	Section 4
The controls to be implemented to prevent and/or minimise pollution.	Section 5
How records of all relevant parameters for the quality, quantity, transport and disposal of all water will be maintained.	Section 6
Describes the staging process for implementation of the plan.	Section 1 – *This plan is applicable to near term exploration and appraisal activities*
Is prepared in accordance with any additional requirements prescribed by the Director-General.	NA

1.5 Background

Exploration activities in the Pilliga commenced in 1998 and have included seismic surveys, stratigraphic corehole drilling, pilot well drilling and production appraisal activities including

management of water and gas products. Santos is undertaking a range of water management studies and scientific assurance studies which will enable the Field to proceed.

1.5.1 History of Coal and CSG Appraisal and Development At Narrabri

Coal was discovered in the Gunnedah Basin in a well sunk in 1877 and mining commenced in 1889 around Gunnedah. Extensive coal exploration programmes were conducted across the Gunnedah Basin during the 1970s and 1980s including some forty cored bores and 8593 metres of drilling comprising the Narrabri Joint Venture Drilling Programme (a joint venture between the Electricity Commission of NSW and the NSW Department of Mineral Resources). The Wilga Park No.1 bore revealed natural gas in 1985, sparking initial petroleum exploration across the locality.

Modern CSG exploration activities commenced in 1998 with drilling at the Bohena CSG pilot area. This confirmed the presence of coals and a potential CSG resource. Further direct exploration and drilling up until early 2004 was undertaken consisting of an additional seven wells across the area now defined by PAL 2 and over five hundred kilometres of 2D seismic surveys.

From 2004 to 2006, eleven additional CSG wells were drilled. In 2006, the scale of the CSG Field was extended through the drilling and operation of the Bibblewindi CSG pilot comprising nine wells (Bibblewindi 9-Spot), water and gas gathering infrastructure and water management facilities. These wells have been in continuous operation since completion, though are currently suspended.

In 2007, a programme of reserve certification was conducted comprising six fully cored wells mainly to the north and west of the Bibblewindi 9-Spot CSG Pilot. The sixth core hole in this series, Bibblewindi 11C, was located 4.3 km south-east of Bibblewindi 9-Spot pilot and was successful in delineating a new prospect area around which the 2008 core hole programme was based and thereafter the Bibblewindi Lateral Pilot project has been situated.

In 2008, the Dewhurst series of core holes commenced with the first of five core holes located to the east and southeast of Bibblewindi based upon the positive results gained at Bibblewindi 11C. Subsequent Dewhurst core holes and wells have each confirmed a significant CSG resource. The coals in the Bohena trough (Bohena sub-basin) are characterised by vertical fractures (referred to as master cleats) oriented northeast-southwest running parallel through the full thickness of the coal, with limited secondary cleats. Taking this into consideration, the Bibblewindi lateral pilot was drilled in late 2008 to early 2009, consisting of horizontal wells with approximately 1 km of in-seam exposure, intersecting vertical production wells. The installation of buried gas and water gathering infrastructure to link the new pilot to existing water and gas management facilities at Bibblewindi followed and the pilot was put into operation.

In 2009, the in-seam drilling methodology was replicated at the Bibblewindi West lateral pilot although in modified configuration. The drilling of the Bibblewindi West 1 core hole identified the Namoi coal seam at this location and formed the basis to the completion of this additional pilot. Results from both pilots to date have confirmed this is an effective solution for CSG extraction from the Maules Creek Formation rather than vertical wells that may require fracture stimulation. With a number of coal seams present in the Maules Creek Formation, the planned development would consist of a stacked horizontal well design with multi-lateral wells intersecting each vertical well. Each single well-set would consist of one horizontal well and one vertical well.

In April 2011, Tintsfield lateral pilot was initiated targeting the Hoskissons coal seam.

All pilot trials are currently suspended.

An extensive coring programme is planned by Santos commencing during extending through until 2014. Core holes will be drilled to prove the extent and characteristics of primary target seams in the Maules Creek Formation and may be extended to prove basement.

1.6 Existing Water Management Approvals

Any abstraction of water from the ground (including produced water) requires a licence from the regulator, New South Wales Office of Water (NOW) under the *Water Management Act 2000.*

The Narrabri Gas Field is subject to regulation and approval by the New South Wales and Australian Governments. Table 1-2 lists key water management activities that have received approval.

Table 1-2: Approved Water Activities

Approval Date	Approved Activity	Relevant REF Document Referenced in Approval
11 April 2007	Approval given to treat produced formation water from BWI-9 by reverse osmosis and to dispose of the treated water to Bohena Creek.	• *The Bohena Coal Seam Gas Project Review of Environmental Factors: Water Treatment and Disposal Project, PEL 238, Gunnedah Basin NSW (2006)*
29 October 2008	Approval to conduct the Narrabri CSG Lateral Program, Lateral Production Pilot A	• *The Bohena Coal Seam Gas Project Review of Environmental Factors Water Treatment and Disposal Project PEL 238, Gunnedah Basin (*2006) • *REF 2008 Narrabri CSG Lateral Program, Lateral Production Pilot A (*2008) • *The Narrabri Coal Seam Gas Project Operations and Water Management Plan* (2008)
1 October 2009	Approval to modify the existing water management operations to have a short term transfer of a quantity of production water, currently contained at the Bibblewindi water management facility, by pipeline via the existing transfer corridor to the existing Bohena South water storage dams. This will be done to undertake maintenance works for the implementation of the approved	• *REF- Proposed Production Water Transfer Bibblewindi to Bohena South PAL 2 Gunnedah Basin, Rev 2 (29 September 2009)*

Approval Date	Approved Activity	Relevant REF Document Referenced in Approval
	Operations and Water Management Plan	
29 October 2010	Approval to extend the discharge of treated water to Bohena Creek.	• *The Bohena Coal Seam Gas Project Review of Environmental Factors Water Treatment and Disposal Project PEL 238, Gunnedah Basin (2006)* • *REF 2008 Narrabri CSG Lateral Program, Lateral Production Pilot A (2008)* • *The Narrabri Coal Seam Gas Project Operations and Water Management Plan (2008)*
28 October 2011	Approval to extend the discharge of treated water to Bohena Creek	• *The Bohena Coal Seam Gas Project Review of Environmental Factors Water Treatment and Disposal Project PEL 238, Gunnedah Basin (2006)* • *REF 2008 Narrabri CSG Lateral Program, Lateral Production Pilot A (2008)* • *The Narrabri Coal Seam Gas Project Operations and Water Management Plan (2008)*
22 February 2012	Approval for the temporary transfer of water from Bibblewindi Pond 3 and Bohena South ponds to Tintsfield Pond 2	• *Temporary Lifted Water Management – Bibblewindi Review of Environmental Factors Pond 3 (2012)*

2 SITE BACKGROUND

2.1 PRODUCED WATER SOURCE

The Fields will primarily target gas reserves associated with Early Permian coal seams of the Maules Creek Formation, located at depth in the northern portion of the Gunnedah Basin.

The primary target seams (Bohena, Parkes, Namoi and Rutley seams) of the early Permian Maules Creek Formation occupy the basal part of the Bohena Trough within the northern part of the Gunnedah Basin. Overlying the target seams are approximately 600-800 m of Permian and Triassic strata. Jurassic-age strata belonging to the Surat Basin, a south eastern extension of the Great Artesian Basin, overly the Permo-Triassic strata and are themselves overlain in part by more recent consolidated and unconsolidated alluvial sediments.

2.2 OVERVIEW OF CSG OPERATIONS

To date, produced water extracted from existing wells has been managed using a combination of water treatment and holding ponds. The former Bibblewindi pilot Water Treatment Plant (WTP) was located approximately 45 km south of Narrabri, along the Newell Highway, towards Coonabarabran. The purpose of the Bibblewindi pilot WTP was to treat produced water to a quality suitable to be discharged to the nearby Bohena Creek[1]. Subject to approval, Santos intends to construct a brine and water storage facility at Leewood (a property owned by Santos south of Narrabri along the Newell Highway) to receive brine from the existing ponds to allow those existing ponds to be rehabilitated. It will also allow exploration and appraisal to recommence. Subsequently approval will be sought for a water treatment facility.

2.3 RECEIVING ENVIRONMENT

2.3.1 GEOLOGY

Geological and stratigraphical data in the vicinity of the site have mainly been sourced from geological and geophysical logging undertaken by Santos to determine potential CSG resources in the Narrabri area[2]. Further regional information has been sourced from published reports and datasets.

The local geology of the Narrabri Gas Field Area is characterised by unconsolidated alluvial and colluvial deposits overlying Jurassic Surat Basinal strata, which in turn unconformably overlie indurated Permo-

[1] The approval conditions for the treated water discharge from the Bibblewindi treatment plant were outlined in a letter from Department of Primary Industries (DPI) to ESG regarding PAL 2: Approval of Operations and Water Management Plan - to treat and dispose of produced formation water from Narrabri CSG Field dated 29 October 2008

[2] Halcrow, December 2012, *Narrabri Gas Project – Groundwater Impact Assessment*

Triassic Gunnedah Basin sediments of the Bohena Trough, resting on early Permian and older meta-volcanic basement rocks.

The Surat Basinal strata present in the vicinity of the Field area include the Keelindi Beds, Pilliga Sandstone, Purlewaugh Formation and basal Garrawilla Volcanics. The Gunnedah Basin strata locally present beneath the Surat sediments include the Triassic Deriah, Napperby and Digby Formations unconformably overlying the Late Permian Black Jack Group, Middle Permian Millie Group and the Early Permian Bellata Group.

The local geology consists of Jurassic or Early Cretaceous sedimentary strata overlain in places by alluvium and colluvium/piedmont deposits. Underlying the Field Area is the Pilliga Sandstone of the Surat Basin, considered to comprise the lowest (and most easterly) intake beds of the Great Artesian Basin (GAB). The Pilliga Sandstone ranges from 0-250 metres (m) in thickness with a general westerly dip. Underlying the Pilliga Sandstone is the Purlewaugh Formation comprising mudstones, shales and siltstones and beneath these, the Garrawilla Volcanics consisting of flows and intrusions of dolerite, basalt, trachyte, tuff, and breccia. Overlying the Pilliga Sandstone in the north western half of the Field Area are interbedded mudstone and sandstone strata of the Keelindi Beds, the lateral equivalents to the west of the Early Cretaceous Orallo Formation. Alluvial deposits are present in the valleys of ephemeral watercourses (Bohena Creek Alluvium (BCA)), whilst the Upper and Lower Namoi Alluvial formations are present upstream (south-east) and downstream (north-west) of Narrabri township respectively. Colluvium and sand plain deposits occupy much of the remaining area.

A detailed discussion of the geology is available in the Narrabri Groundwater Impact Assessment[3].

2.3.2 HYDROGEOLOGY

Currently, groundwater abstracted in the area is largely for domestic, stock and irrigation purposes. The predominant source of abstraction is from the Namoi Alluvium, although a lesser number of bores abstract from the underlying Pilliga Sandstone. A review conducted of the NSW Office of Water (NOW) Pineena Database, indicated no water abstraction bores extend beyond the Pilliga Sandstone across the Narrabri Gas Field area. It remains possible that some bores may exist that intercept strata beneath the Pilliga Sandstone, however, this is consideredunlikely given the superior aquifer characteristics of the Pilliga Sandstone over deeper strata.

Groundwater in the Pilliga Sandstone flows primarily from outcrop in the east towards the north west and then west. The Purlewaugh Formation and Keelindi Beds are understood to comprise aquitards, impeding the vertical flow of groundwater. Hence, groundwater infiltrating the Pilliga Sandstone outcrop, in the east and south-east of the Field Area, is prevented from percolating into the Purlewaugh and may be confined in the north-west by the Keelindi Beds. Locally, groundwater in the Pilliga Sandstone in the northern part of the Narrabri Gas Field area may flow northwards, influenced by the hydraulic gradient within the Namoi Alluvials (Gunnedah & Narrabri Formations).

[3] Halcrow, 2012, *Narrabri Gas Project – Groundwater Impact Assessment*, prepared for Santos Limited

Groundwater level monitoring from adjacent areas in the Namoi Catchment indicates a declining trend of groundwater levels in the alluvial deposits and Pilliga Sandstone. This is most likely to be a consequence of intense agricultural abstraction. CSG abstraction operations are not expected to impact significantly on groundwater levels in the Pilliga Sandstone or overlying Namoi Alluvium. However, ongoing groundwater level monitoring will be important to establish the baseline conditions prevailing before the commencement of pilot trials.

2.3.3 TOPOGRAPHY AND DRAINAGE

The Narrabri CSG Field area falls within the Namoi catchment, which represents some 3.8% of the total Murray-Darling Basin (MDB). It is bounded to the east by the Great Dividing Range, to the north by the Gwydir catchment, to the south by the Castlereagh, Macquarie and Hunter catchments and to the west by the Barwon Darling catchment.

The CSG Fields are located predominately in the Lower Namoi sub-catchment. The Lower Namoi sub-catchment commences at Narrabri with this location considered to be the start of the true riverine zone of the Namoi catchment due to the increased frequency of lagoons, the low gradient of the channel and the development of several anabranches and effluent channels[4].The lower Namoi is regulated by two major weirs downstream of Narrabri – Mollee Weir and Gunidgera Weir.

2.3.4 SURFACE WATER

The main surface water system within the Namoi catchment is the Namoi River with flow contributed by major tributaries including Macdonald River, Manilla River, Peel River, Mooki River, Cox's Creek, Maules Creek, Bohena Creek, Bundock Creek and Baradine Creek.

2.3.5 GROUNDWATER

Groundwater management areas in the vicinity of the Field area include:

- Groundwater sources overlaying the Great Artesian Basin (GAB) aquifers (shallow alluvial aquifers);
- GAB – Southern Recharge Area (Pilliga and Purlewaugh Formations); and
- Porous Rocks of the Gunnedah-Oxley Basin portion of the MDB (Including the Permian and Triassic strata in the Bohena Sub-basin).

As detailed previously, Groundwater usage in the vicinity of the site can be summarised as being mainly for domestic, stock and irrigation purposes with the predominant source of abstraction occurring within the shallow alluvium associated with the Namoi River, and the shallow GAB formations of the Southern Recharge Zone.

[4] New South Wales Office of Water, 2011, *Water resources and management overview – Namoi catchment*

2.4 WATER QUALITY AND OBJECTIVES

As described in Figure 2-1, Water Quality Objectives (WQOs) and River Flow Objectives have been developed for NSW rivers and estuaries including the Namoi River. Objectives consist of three parts: environmental values, their indicators and their guideline levels. The objectives comprise community-based environmental values and their associated national criteria drawn from the ANZECC 2000 Guidelines[5]. They provide the statewide context for taking this work forward into catchment action plans, regional strategies and local environmental plans[6].

Water Quality and river flow objectives categories for the Narrabri Field area include:

- "Major Controlled River" (Namoi River downstream of Keepit Dam);
- "Mainly forested area" (Bohena and Baradine Creeks headwaters) and
- "Uncontrolled streams" (Mooki River and all other streams close to the Narrabri Field).

Objectives for the Namoi Catchment are as follows.

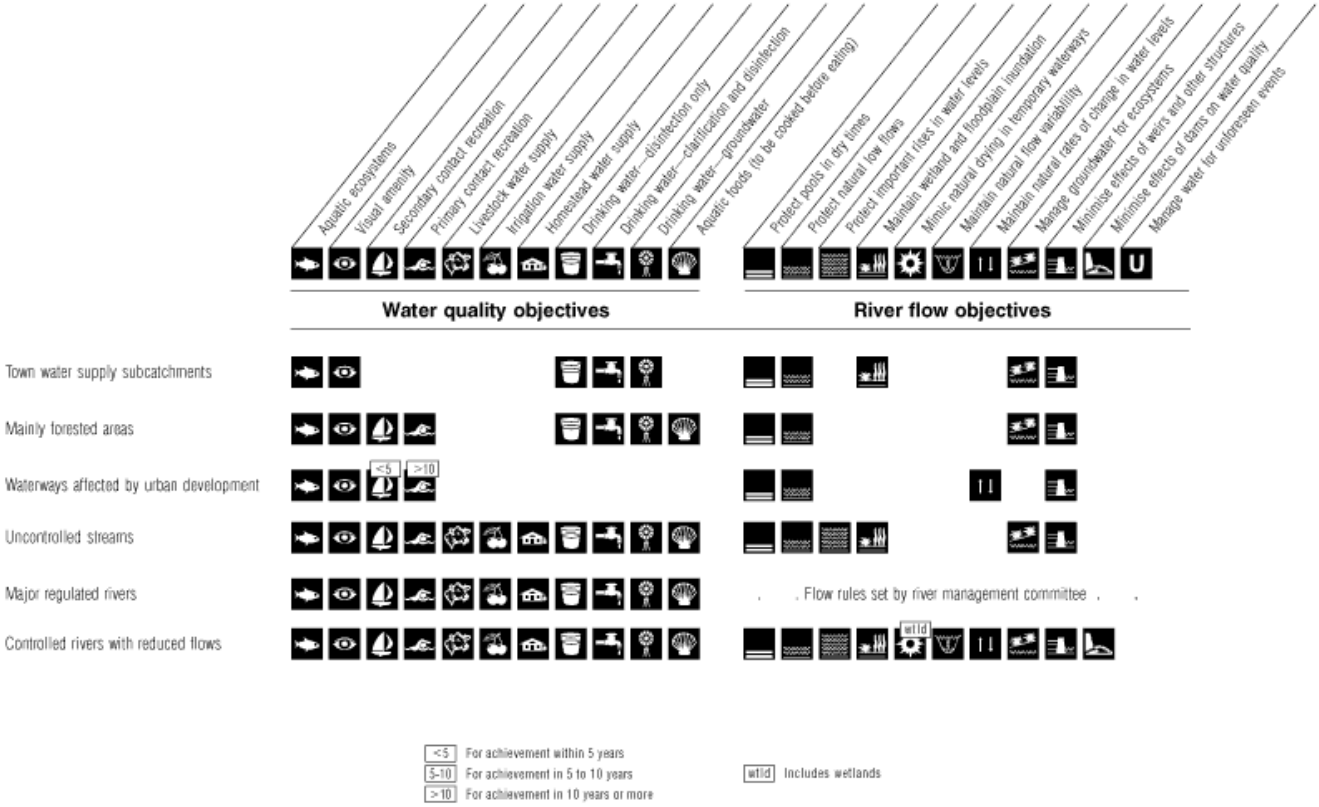


Figure 2-1 Namoi Catchment Water Quality and River Flow Objectives

[5] Australian and New Zealand Environment Conservation Council (ANZECC), 2000, *Australian and New Zealand guidelines for fresh and marine water quality*

[6] Department of Environment and Conservation NSW, 2006, *Using the ANZECC Guidelines and Water Quality Objectives in NSW*

Example water quality guidelines are provided to ensure compliance with each of the stated objectives. Suggested numerical criteria are drawn from the ANZECC Guidelines. For aquatic ecosystems the following guideline levels for the Namoi catchment have been established in Table 2-1. Additional discussion points included in Namoi Catchment WQOs has also been reproduced.

Table 2-1 Namoi Catchment Example Water Quality Objectives

Indicator	Lowland rivers	Units	Namoi Catchment Discussion WQOs
Total Phosphorus	50	µg/L	For rivers in the Murray-Darling Basin. Total phosphorus levels above 100 micrograms/litre have been consistently recorded in the areas of the Peel and Mooki Rivers, Pian Creek and the Namoi around Walgett. Development of local guideline trigger values for these areas may be necessary. See "Tailoring Water Quality Objectives to local conditions".
Total nitrogen	500	µg/L	No additional comment.
Chlorophyll-a	5	µg/L	No additional comment.
Turbidity	6-50	NTU	For turbidity trigger values: In general values in the lower part of the range will be found in rivers and streams during low flows and/or in more vegetated catchments. Values in the higher part of the range will be found in rivers and streams in high flows and lower in the catchment (particularly inland catchments). For lakes and reservoirs, in general the higher values will be found in waterbodies that are shallow or in areas with dispersive soils.
Salinity (electrical conductivity)	125–2200	µS/cm	No additional comment.
Dissolved oxygen	85–110%		Dissolved oxygen values were derived from daytime measurements. Dissolved oxygen concentrations may vary diurnally and with depth. Monitoring programs should assess this potential variability
pH	6.5–8.5		Changes of more than 0.5 pH units from the natural seasonal maximum or minimum should be investigated
Temperature	See ANZECC Guidelines, table 3.3.1.		
Chemical contaminants or toxicants	See ANZECC Guidelines, chapter 3.4 and table 3.4.1		
Biological assessment indicators	This form of assessment directly evaluates whether management goals for ecosystem protection are being achieved (e.g. maintenance of a certain level of species diversity, control of nuisance algae below a certain level, protection of key species, etc). Many potential indicators exist and these may relate to single species, multiple species or whole communities. Recognised protocols using diatoms and algae, macrophytes, macroinvertebrates and fish populations and/or communities may be used in NSW and interstate (e.g. AusRivAS).		

In the absence of detailed baseline data collection, the definition of trigger values specific to the Field area, or other ecological assessments, the Namoi Catchment example water quality objectives have been accepted as an interim measure. Trigger values appropriate to the Field area will be defined in future Field studies prior to beneficial reuse option implementation.

The ANZECC Guidelines also provide trigger values for an extensive list of contaminants that are potentially harmful to fresh and marine ecosystems. It is noted there is no requirement to monitor for each contaminant listed, but all should be, at least, considered prior to creating a sampling programme, as to the potential level of impact that the particular scheme may create.

Current available literature does not establish ecosystem condition for the Namoi Catchment as advocated by the ANZECC Guidelines (e.g. High conservation/ecological value systems; slightly to moderately disturbed systems; highly disturbed systems). In the absence of this information, given the extensive agricultural use of the catchment, it is likely that many of the streams within the Namoi catchment would be described as "slightly to moderately disturbed systems". The ANZECC Guidelines also state "that in most cases, the 95% protection trigger values should apply to ecosystems that could be classified as slightly–moderately disturbed, although a higher protection level could be applied to slightly disturbed ecosystems where the management goal is no change in biodiversity"[7]. Until trigger values appropriate to the Field area are defined, the ANZECC Guidelines trigger values for the protection of 95% of aquatic species has been accepted an interim measure, unless specific investigations advise otherwise.

2.5 Groundwater Dependent Ecosystems

A review of the NOW GDE database, WSPs and literature review indicated that there are two documented high-priority GDE locations and a third anecdotal spring location in the near vicinity of the Field area: Hardys Spring and Eather Spring, listed by the NOW database as well as the Mayfield Spring, described by Aquaterra[8]. The NOW identified GDEs are summarised as follows:

- Hardys Spring is located at: 771588.1, 6604095.58 (MGA 94, Zone 55);
- Hardys Spring is approximately 1.8 km to the north of Eather Spring;
- Eather Spring is located at: 771541.42, 6602247.49 (MGA 94, Zone 55);
- Both Springs are located on the junction of the Pilliga Sandstone and Purlewaugh Formation at outcrop;

Mayfield Spring is characterised as follows:

- Mayfield Spring is located at: 774771.71, 6613871.915 (MGA 94, Zone 55);

[7] Refer to page 3.4-3 of Australian and New Zealand Environment Conservation Council (ANZECC), 2000, *Australian and New Zealand guidelines for fresh and marine water quality*

[8] Aquaterra Consulting Pty Ltd, 2009, *Narrabri Coal Mine Stage 2 Longwall Project, Hydrogeological Assessment for Whitehaven Coal – Narrabri Coal Operations Pty Ltd*, Reference 674/1

- the Spring coincides with a topographic sub-crop of the Purlewaugh Formation and emanates within a low lying topographical area within a valley which acts as a drainage pathway;
- the Spring is approximately 10.9 km toward the north northeast of Hardys Spring; and
- spring flow is utilised for stock watering; and
- discharge rates are very low at less than 1 L/s.

GAB springs are classified into three broad categories[9]:

- water course (or base flow) springs;
- discharge springs; and
- recharge springs.

The Hardys, Eather and Mayfield Springs are considered to represent recharge springs, sustained by rejection of rainfall recharge that did not enter the main GAB aquifer. Recharge rejection occurs within the GAB intake beds when the rate of recharge to the shallow aquifers exceeds the capacity for deep drainage into the GAB intake beds, principally due to low hydraulic conductivity of formations. The result is preferential discharge of excess shallow groundwater as springs or base flow to local watercourses, which are often controlled by surface topography and changes in hydraulic conductivity at formation contacts.

[9] Department of Natural Resources and Mines, 2012, *Great Artesian Basin Resource Operations Plan*

3 SCHEME DESCRIPTION

This Section identifies ***the expected sources and estimated quantity of the produced water*** and ***the proposed containment and treatment measures for the produced water*** as required by PEL238 licence condition 14b (i) and (ii)

3.1 PROPOSED CSG EXPLORATION AND APPRAISAL PROGRAM

The Narrabri Gas Field near-term appraisal infrastructure (2013 – 2015) is likely to include:

- A storage facility for brine and produced water as an interim measure to allow existing ponds to be rehabilitated and appraisal to recommence;
- Proposed water treatment facilities (e.g., Reverse Osmosis (RO) plant, produced water collection ponds and brine management ponds), enabling the gathered produced water to be desalinated and amended as required and used for local beneficial uses (managed aquifer recharge, irrigation and provision to third parties for use, etc); and
- Production wells distributed uniformly across the field.
- Gas compression facilities located in the field area;
- Beneficial use infrastructure potentially including desalination and brine treatment systems, associated storage pond and distribution pipelines;
- Storage and lay down areas and ancillary activities;
- Power supply to gas wells from the compression facilities or from the existing electricity network; and
- Access roads to gas wells, associated infrastructure and pipelines.

3.2 Produced Water Quantity

Gas trapped in coal is adsorbed onto the coal surface in cleats and joints or micro pores and held in place by reservoir and water pressures. To extract the gas it is necessary to reduce the pressure by first removing water (known as produced water). Typically, produced water production is higher earlier in the life of a CSG field and declines as gas production increases (refer Figure 3-1).

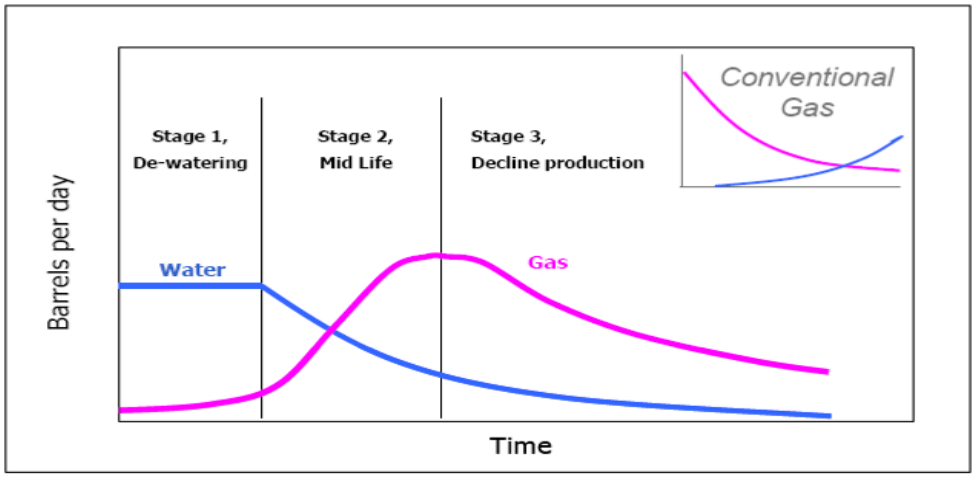


Figure 3-1 Stages of Produced Water and Gas Production

CSG development is, by its nature, an incremental activity involving modelling, exploration, proving and establishment of gas wells in a step-wise fashion. For this reason, the exact location, timing, quality and volumes of water discharges are unknown until investigations are complete. The estimated coal seam water production forecast for the Narrabri Gas Field has been developed by:

- Analysing production data to define typical 'type' wells;
- Defining production 'type curves' based on initial rate, ramp period, peak rate, abandonment rate, etc;
- Calculating expected recovery of 'type curve' for gas and water and calibrate with volumetrics;
- Populating undeveloped areas of field with wells and Well Groups (groups of wells expected to have similar production characteristics);
- Defining expected production for Well Groups in terms of type curves;
- Defining schedule of future drilling; and
- Summing up the forecasts for Well Groups to produce a field forecast.

3.3 Produced Water Quality

The quality of coal seam water is primarily dependent upon the geology of the area in which the gas wells are located. For the Narrabri Gas Field, the produced water quality is generally expected to

remain within the quality ranges presented below for the Maules Creek Formation. With confidence in defining these ranges increasing as development of the field grows and more water quality data is obtained.

The dot points below are based on actual samples collected by Santos and historical operators'. The data represents a combination of the Bibblewindi and Bohena wells (that has passed a quality control and verification process) available to date.

While water production volumes from CSG wells will decline over the life of the well, water quality will generally remain consistent. However, as the field develops into different regions of the Narrabri Gas Field, the coal seam water quality will vary, but is expected to remain within current quality ranges. Santos' monitoring program and adaptive scheme management has the capacity to identify such changes in produced water quality and will initiate and implement appropriate action/response.

Typical untreated produced water brought to the surface from the Narrabri Gas Field is compared with surface waters in the Namoi below:

- Produced water TDS of 14,500 mg/L to 31,000 mg/L.
- Depending on season, temperature is up to approximately 22 degrees Celsius warmer than stream temperatures in the Namoi.
- TSS is slightly less than mean surface water stream concentrations in the Namoi Catchment.
- Higher alkalinity, predominately comprising bi-carbonate.
- Higher sodium and chloride concentrations;
- Slightly higher potassium concentrations;
- Lower concentrations of calcium and magnesium;
- Higher concentrations of other inorganic non metallic elements including fluoride, silica;
- Higher nitrogen concentrations comprised mostly of ammonia.
- Phosphorus levels generally less than surface waters in the Namoi.
- Elevated concentrations of strontium, barium and boron.
- Slightly elevated concentrations of arsenic, chromium, cadmium, mercury, molybdenum, antimony, selenium, uranium and lead.
- Generally lower concentrations of manganese, aluminium and iron.

3.4 PRODUCED WATER MANAGEMENT PROCESSING

The main components of the Narrabri Gas Field water management scheme for 2012 to 2015 are anticipated to include:

- Gathering system;
- RO treatment; and
- Investigations into beneficial uses / coal seam water management measures.

Options for the produced water management for the Narrabri Gas Field is depicted in a schematic in Figure 3-2. The individual components and their inter-relations are described in the following sections.

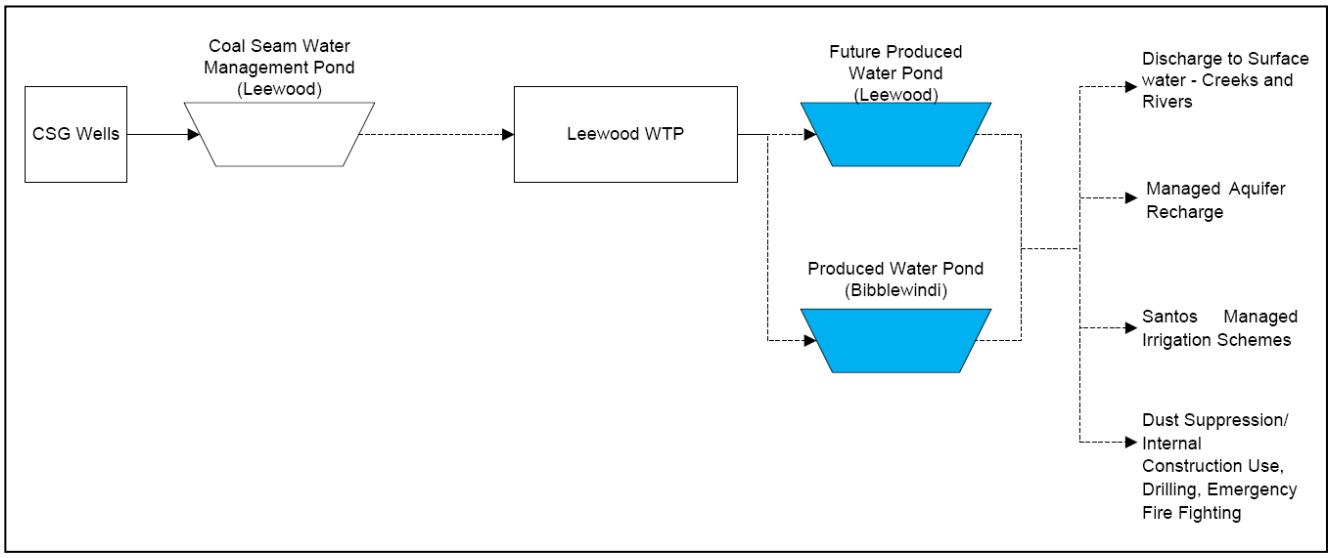


Figure 3-2 Narrabri Gas Fields - Produced Water Management Options

3.4.1 GATHERING SYSTEM

The gathering system includes all infrastructure (e.g. pipelines and storages) required to transfer coal seam water from CSG producing wells to the coal seam water management storages and treatment plants. Existing and future water management infrastructure is described in

Table 3-1.

Table 3-1 Existing and future water management infrastructure

Name of Pond	Volume (ML) *	Status **
Produced Water Management Ponds		
Bibblewindi Pond 1	5	E
Leewood Pond 1^	300	F
Permeate Ponds		
Leewood Pond 3^	40^	F
RO Concentrate Ponds		
Bibblewindi Pond 3	170	E
Leewood Pond 2	300	UC

^Pond number / pond subject to change

* Volume = Full Supply Volume (i.e. spillway level volume)

** Status: E = Existing; F = Future; UC = Under Construction

The produced water from the wells will be piped (via gathering lines) into coal seam water management storage. Coal seam water management storages are designed as with no external catchment and in accordance with NSW Dam Safety Committee guidelines (DSC)[10], with design plans submitted to the regulator for approval. The function of the coal seam water management storages includes:

- Hydraulic capacity to accommodate system reliability;
- Hydraulic capacity to accommodate varying demand for reuse options; and
- Natural treatment (i.e. natural processes that occur in any lake or pond, including settlement of solid particles, temperature reduction from well head temperature to closet to ambient and ground temperature (depending on the travel distance from the wellhead to the storage), partial oxidation of metals due to water surface oxygen exchange which depends on the residence time in the storage).

The coal seam water is then transferred from the coal seam water management storage(s) to the treatment facilities.

3.4.2 TREATMENT

In order to improve the suitability of produced water from the Narrabri Gas Field for a range of beneficial uses, produced water will be treated and amended to meet the required water quality objectives. This involves the desalination of the produced water by RO (at the WTP), which would reduce the TDS of the water prior to beneficial use. This will produce a comparatively large volume of good quality water and a small volume of concentrated brine (approximately 20% of the total

[10] New South Wales Dam Safety Committee, 2010, *DSC3A - Consequence of Dam Failure*

volume[11]), which would need to be stored and disposed of or further treated to create "dry" salt for sale or disposal.

3.4.2.1 Desalination

Desalination is used to remove TDS from produced water so that it may be used for beneficial use, where TDS concentrations preclude the use of untreated produced water. RO is the preferred WTP technology for the removal of dissolved solids in produced water for the Narrabri Gas Field. The principal reasons for this are as follows[12]:

- The technology is well proven and readily available in Australia from several reputable vendors with a proven track record;
- The method is readily scalable and will achieve a final water quality that is suitable for a range of proposed uses; and
- The technology can be readily leased or purchased.

Desalination steps include:

- Pre-treatment that includes filtration, clarification, ion exchange and bio-fouling control;
- Desalination; and
- Post treatment as required by final water use (includes ammonia removal, dechlorination, calcium and magnesium addition and pH adjustment).

Conceptually, the desalination process is likely to be conducted as follows. The WTP will treat produced water delivered to the Produced Water Management Pond. A desalinated water pond will be located downstream of the RO plant, with the function of storing desalinated water, providing hydraulic capacity to accommodate varying demand for beneficial use options and providing hydraulic capacity to accommodate system reliability. The brine from the WTP will then be sent to the Brine Containment Pond.

Desalination typically has five steps as shown in Figure 3-4:

1. Pre-treatment (potentially including coagulation and flocculation);
2. Filtration;
3. Ion exchange (where required);
4. Desalination; and
5. Post treatment as required by final water use. Typically this comprises calcium dosing to adjust SAR to appropriate levels.

[11] AMEC for Eastern Star Gas, May 2011, *Concept Selection Report – Water and Brine, Vol 3, ESG Upstream Gas Project*.

[12] URS, 2009, *Water Facilities Decision Support Document*

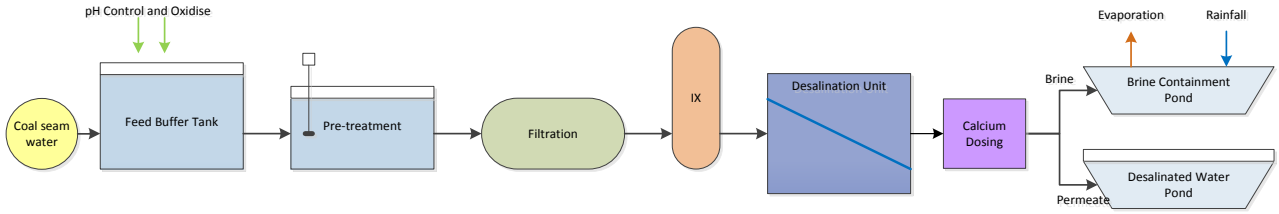


Figure 3-3 Desalination Process

Amendment is sometimes undertaken to treat the produced water to lower the SAR to acceptable levels for the desired beneficial uses. Amendment of produced water in the Narrabri Field, post RO, will likely involve SAR adjustment using Gypsum and/or Magnesium Sulfate. Some beneficial uses, such as MAR and discharge to surface water, may require additional post-treatment. Any such requirements will be determined through the respective feasibilities studies.

A desalinated water storage, or permeate storage, is located downstream of the RO plant, with the function of:

1. Storage of desalinated water from the RO plant;
2. Hydraulic capacity to accommodate varying demand for beneficial use options; and
3. Hydraulic capacity to accommodate system reliability.

The preferred RO plant configuration is to install pre-fabricated RO skids to a fixed building on site, in 5 ML/day modules.

Desalinated water storages are designed with 30 days' retention time for the peak RO plant desalinated water production. They are designed as turkey's nest storages (i.e. no external catchment).

3.4.3 CONTAINMENT AND STORAGE OF BRINE

Initially brine containment ponds will be constructed to temporarily store brine prior to development and approval of the agreed approach for brine disposal. Brine containment pond design is required to include the following functions:

- Hydraulic retention to avoid overtopping;
- Minimise footprint of brine storage; and
- Reduce risks for loss of brine as low as reasonably possible.

Options for brine management are being evaluated. These options may include:

- Salt recovery. Treating brine and any salt residues to create useable/saleable products (this option also results in more treated produced water that needs to be managed);
- Inject brine into suitable underlying (basement) formations or preferably depleted coal seams. Hydrogeological modelling is to be undertaken to ensure that the geological unit is not regionally consistent and extensive and is isolated above and below by an aquitard or

aquicludes within the hydraulic impact zone. Groundwater investigations including monitoring and modelling is also required to demonstrate this can be done with acceptably low risk of leakage in the long term.

- Disposal of solid salt (not including brine) in a licensed waste facility.

The brine management approach and preferred and reserved options will be subject to detailed analysis, feasibility study and trialling. Energy and greenhouse gas emission implications of different brine management options will need to be considered as part of any feasibility study.

4 PRODUCED WATER MANAGEMENT USE

This Section identifies ***the proposed beneficial reuse or disposal methods for the produced water*** as required by PEL238 licence condition 14b (iii)

4.1 Feasibility Assessment of Potential Production Water Management Options

It is planned that produced water will in the short term be stored in the double lined Leewood storage facility. Eventually it will pass through a new Water Treatment Plant (WTP) and ultimately will be beneficially reused in options that may include:

- Discharge to Surface water - Creeks and Rivers
- Managed Aquifer Recharge
- Irrigation water supply
- Dust Suppression/Internal Construction Use, Drilling, Emergency Fire Fighting

The near-term exploration and appraisal activities will not involve all of the above potential produced water management options. The development of these options is subject to the development of rigorous studies, baseline monitoring, acceptance and approval by regulators and to meet Santos needs.

5 MEASURABLE CRITERIA (THE MANAGEMENT CRITERIA)

This Section identifies the controls to be implemented to prevent and/or minimise pollution as required by PEL238 licence condition 14b (iv)

5.1 INTRODUCTION

Chapter 2 of the *Protection of the Environment Operations Act 1997* details Protection of the Environment Policies (PEPs). PEPs may be made for the purpose of declaring policies to be observed with respect to protecting the environment in New South Wales and, in particular, for the purpose of:

a) furthering the objectives of the EPA as set out in section 6 of the Protection of the Environment Administration Act 1991,

b) managing the cumulative impact on that environment of existing and future human activities.

The *Protection of the Environment Operations Act 1997* requires that the contents of a PEP to include environmental protection goals, standards, guidelines and protocols with performance indicators by which the achievement of that goal is to be measured.

In order to provide measurable criteria for which the impact of coal seam water management activities can be assessed against, Environmental Values (EVs) consistent with the ANZECC Guidelines, have been adopted as an interim measure to guide development environmental protection goals, standards, guidelines and protocols. The development of future plans will include updated goals, standards, guidelines and protocols, based on trigger values specific to local waterways and water bodies in the Namoi Catchment.

There will be no reuse of water until those activities have been thoroughly investigated and appropriate regulatory approvals sought.

5.2 METHODOLOGY FOR DEVELOPMENT OF MEASURABLE CRITERIA

Interim Measurable Criteria have been developed by Santos using the following:

- Namoi Catchment River Water Quality and River Flow Objectives (NSW Government of Environment and Heritage Office, Department of Environment, Climate Change and Water);
- NSW Aquifer Interference Policy;
- Santos' internal Environmental, Health and Safety Management System (EHSMS);
- National and International guidelines, including ANZECC and NHMRC;

- Assessment of the baseline data for the groundwater, surface water, soil and vegetation systems on which Santos operates and will operate; and
- Development of criteria that accords with approval conditions, industry best environmental practices and to ensure the protection of identified EVs.

5.3 Narrabri Gas Field Measurable Criteria

The Narrabri Gas Field has the potential to impact the following Environmental Values:

- Surface water;
- Groundwater; and
- Land.

A description of the EVs to be protected and measurable criteria to demonstrate that this is being achieved are presented in Table 5-1.

5.4 Operating Procedures

Santos will develop operating procedures for the operation of the coal seam water management scheme. For any new facilities, procedures will be developed before the water management facilities are commissioned. The specific operating levels and triggers for coal seam water management infrastructure will be provided in those Operating Procedures. The parameters will be tested in a comprehensive whole of site water balance model, currently under development.

Table 5-1 Interim Environmental Values, Objectives, Strategy, Controls and Indicators

Natural Resource	Environmental Value	Objective	Strategy	Controls	Measurable Indicator
Description	*These are interim values defined and may change subject to full assessment of the Namoi Catchment. Further information is provided in Section 2.5*	*To define the outcomes that are intended to be achieved*	*To achieve the objective*	*The levels, limits or targets that are to be used in auditing the performance of management and control strategies to demonstrate that they are achieving objectives.*	*The values that are to be measured to gauge whether the objectives are being achieved.*
Surface Water	The following environmental values have been identified based on the Namoi River by *NSW Government of Environment and Heritage Office, Department of Environment, Climate Change and Water* and review of water uses in the catchment. Santos also consider these environmental values applicable to Namoi River tributaries. - Aquatic ecosystems; - Primary industries (irrigation and general water uses, stock drinking water, aquaculture and human consumption) - recreation and aesthetics; - drinking water; - Industrial water; and - Cultural and spiritual values.	No statistically significant measurable impact for median values on surface water from production water management activities and outside the mixing zone for a point source release.	To achieve the surface water objective, the follow strategy will be undertaken: - Design of Production Water Management infrastructure in line with available Australian guidelines, Australian Standards and best practice; - Commissioning of infrastructure in line with Australian Standards (pressure testing of pipelines etc); - Management of the ProductionWater Management system as per future Management Plans and future Operational Procedures; - Operation of the future Water Treatment Plants in accordance with operational procedures and water management plans; and - Routine water quality monitoring (operational and environmental) followed by investigation in the event of exceedance of trend.	Surface water monitoring conducted in accordance with the current receiving environment monitoring plans. Outflow water quality from Water Treatment Plant(s) will be as per future conditions specify.	Compliance with future release limits.. No unauthorised release from production water infrastructure to waters that would be reportable incidents to the NSW EPA.
Groundwater	The following environmental values have been identified for groundwater quality and quantity: - stock and domestic purposes; - irrigation; - potable water; and - Groundwater Dependent Ecosystems	Meet the Minimal Impact Considerations for aquifer interference activities as specified in the NSW Aquifer Interference Policy	To achieve the groundwater quality objective, the follow strategy will be undertaken: - Design of Production Water Management infrastructure in line with available Australian guidelines, Australian Standards and best practice; - Commissioning of infrastructure in line with Australian Standards (pressure testing of pipelines etc); - Management of the ProductionWater Management system as per future Management Plans and future Operational Procedures; - Water quality monitoring as per the future Environmental Monitoring Plan (groundwater); - Productionwater concentrate/brine reinjection in accordance with future plan; - Irrigation in accordance with future plan; and - Dust suppression in accordance with future plan.	A change in water table, water pressure or water quality in excess of minimal impact considerations specified in the NSW Aquifer Interference Policy will trigger additional monitoring and comparison with regional data.	Groundwater is not contaminated by production water management activities.
Land	The following environmental values have been identified for soils: - primary industries such as cropping and grazing; - viability for flora and fauna; and - cultural and spiritual values.	Preserve productivity of soils within areas irrigated with production water. Ensure that natural revegetation can occur in biologically diverse and important areas.	To achieve the soil objective, the follow strategy will be undertaken: - Design of ProductionWater Management infrastructure in line with available Australian guidelines, Australian Standards and best practice; - Commissioning of infrastructure in line with Australian Standards (pressure testing of pipelines etc; - Management of the ProductionWater Management system as per future Management Plans and future Operational Procedures; - Soil monitoring as per the future Environmental Monitoring Plan; - Irrigation in accordance with future plan; and - Dust suppression in accordance with future plan.	Beneficial Use Approval – Soil Monitoring Requirements	Compliance with future release limits.. No unauthorised release from production water infrastructure to waters that would be reportable incidents to the NSW EPA.

6 MONITORING

This Section ***identifies how records of all relevant parameters for the quality, quantity, transport and disposal of all water will be maintained*** as required by PEL238 licence condition 14b (v)

Monitoring is undertaken for the Narrabri Gas Fields as a part of all coal seam water management activities, including:

- Environmental – interim objectives (default ANZECC Guideline trigger values for the protection 95% aquatic species and NSW Aquifer Interference Policy for groundwater) to protect the environmental values of the receiving environment;
- Operational – objectives set to manage the operation of the gathering systems, treatment, beneficial uses (irrigation, dust suppression etc) and coal seam water concentrate/brine management;
- Environmental Assets; and
- Facilities.

A Water Monitoring Strategy and Plan applicable to all Santos Energy NSW Operations will provide a framework for monitoring and reporting requirements for existing and proposed CSG activities. Although the strategy and plan are currently in development, the intention is to apply the Strategy and Plan to the Narrabri Gas Fields.

The objectives of the Water Monitoring Strategy are defined as follows:

- Present the regulatory framework, community concerns and environmental characteristics of the Field area;
- Describe the proposed CSG activities, identify potential risks and specify how the monitoring strategy provides for development of monitoring and response actions to demonstrate risks may be managed or mitigated; and
- Establish a framework for monitoring and reporting consistent with the regulatory requirements and framework applicable to the Fields.

The Water Monitoring Plan will focus on the implementation of the Strategy and will provide specifics on what, where and when environmental and operational monitoring will be undertaken.

6.1 ENVIRONMENTAL MONITORING

6.1.1 SURFACE WATER

The Water Monitoring Strategy specifies the requirement for monitoring of water quality in surface water adjacent to operational facilities and the Field area. The Water Monitoring Plan (in

development) will identify suitable baseline water quality monitoring points for the Field area and surrounding region and reference monitoring sites. The Water Monitoring Plan will also specify the locations for surface water monitoring dependent on the proposed CSG activities and infrastructure along with the required sampling suites and monitoring schedule.

Since February 2012, Santos has been collecting surface water samples from natural watercourses upstream and downstream of the location in which treated produced water was previously discharged to Bohena Creek, and throughout the Narrabri area from the Namoi River and its tributaries. This has required the development of an interim water quality monitoring plan. It is anticipated that this monitoring program will be continued prior to and throughout the Field appraisal activities and be expanded during the development phase of the Field.

Surface water monitoring of ephemeral and perennial water courses running through the lease areas and beyond is currently being assessed against default ANZECC Guideline trigger values for the protection 95% aquatic species and WQOs for the Namoi Catchment. Future monitoring system will also be designed cognisant of any possible Environmental Assessment requirements and Environmental Protection Licence requirements.

6.1.2 GROUNDWATER

The following sections present the monitoring strategies for shallow and deep groundwater aquifers. This monitoring includes provision to detect and quantify potential impacts on Groundwater Dependent Ecosystems (GDEs), such as those associated with surface springs or seeps.

6.2 FACILITIES MONITORING

6.2.1 STORAGES

Coal seam water management storages will be monitored at varying frequencies depending on their classification and regulatory requirements. Monitoring frequencies will also vary depending on the end use of the contained water.

Monitoring of shallow groundwater around storages will be carried out through the installation of monitoring wells around the perimeter of the dams. Such monitoring wells are already in place at Bibblewindi and Wilga Park and will be installed around dams proposed at the “Leewood” Site.

Flows into and out of the storages will also be monitored, as well as storage water level will also be carried out to provide accurate data for water balance calculations.

The appropriate water quality monitoring suite will be selected depending on the water being stored in the storage and its classification (regulated or non-regulated).

6.2.2 WATER TREATMENT FACILITIES

Future Water Treatment Plants (WTPs) will likely have online basic monitoring chemical and physical water quality parameters (such as pH, ORP, EC) measured as well as flow volumes in and out of the

facility. If required for operational factors, further more detailed monitoring will be carried out based on the analytes of the CSG Characterisation Suite.

Both these facilities will be monitored at inflow and outflow points at a frequency designed to maintain compliance with any regulatory approvals, and for operational performance. The specifications of the monitoring parameters and frequencies are yet to be developed and will be included in future Field monitoring plans.

6.2.3 IRRIGATION FACILITIES

One of the beneficial reuse options identified is irrigation. Should irrigation occur at the "Leewood" Site, the irrigation scheme would be subject to on-line and periodic and soil, water, and in-ground monitoring. This monitoring will aid in the operation of the irrigation areas and provide information on soil types and profiles to inform future expansion of new areas. The specifications and parameters of the soil monitoring suites are in the process of being developed.

6.3 MONITORING SCHEDULES

The schedule of frequency of monitoring each location and infrastructure type will need to be established once the monitoring locations and potential impact areas have been defined. Once the baseline conditions have adequately been characterised, a typical monitoring schedule may broadly be:

- Daily automated readings (e.g. from VWP data loggers for groundwater levels);
- Monthly manual groundwater level readings from groundwater monitoring bores and surface water features; and
- Quarterly water quality monitoring.

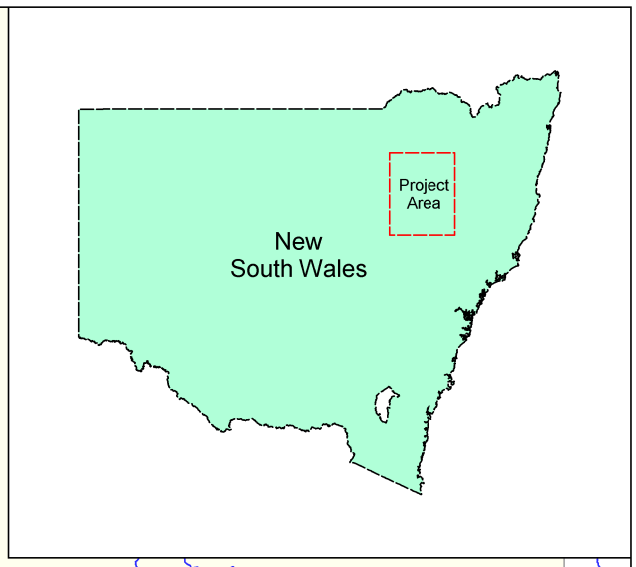
A review of the monitoring schedule should be undertaken at six month intervals to ensure the data collection is sufficient and there are no issues or opportunities to optimise the monitoring schedule.

6.4 MONITORING DATA MANAGEMENT AND QUALITY ASSURANCE/ QUALITY CONTROL

A comprehensive data management plan is in the process of being developed to outline the policies and procedures to acquire, control, protect, deliver and enhance the value of the data collected. The data management plan requires the data to be managed in a consistent, efficient and effective manner in order to provide value. At present interim monitoring plans guide the management of data.

All current monitoring is subject Quality Assurance (QA) and Quality Control (QC) protocol and procedures to ensure that data is usable. Data is subjected to consistent validation and verification procedures. Data that has not passed QA and QC procedures is not used as part of current reporting, nor will be made available for future use.

- QA: For each batch of samples sent to the laboratory, results are validated against the analysis requested on the chain of custody (COC) to ensure all results have been received.
- QC: All results, including Quality Control Samples (QCS) including method blanks, laboratory control samples, matrix spikes samples, surrogate samples must fall within the specific quality control limits. Appropriate field quality control samples (i.e. duplicates, field blanks, trip blanks and triplicate samples, etc. will be utilised to also assist in the quality control of the data obtained from the monitoring programs.
- Program monitoring guidelines (minimum and maximum values) will likely be configured in the Environmental Database for each monitoring compliance requirement or to detect anomalous results. The guidelines act as quality control measures to verify that data falls within an acceptable range. It is planned that an email and/or SMS will be sent to the relevant parties for action. Potential types of action include:
    - Re-checking the laboratory quality control report to ensure data has indeed been verified;
    - Considering CSG and non-CSG influencing factors;
    - Requesting the laboratory to retest samples, and
    - Re-sampling.



N
W
E
S

NAR_7534_SURF_W
460orgs/mL

NAR_7535_SURF_W
460orgs/mL

NAR_7513_SURF_W
23orgs/mL

NAR_7533_SURF_W
43orgs/mL

NAR_7528_SURF_W
0orgs/mL

NAR_7532_SURF_W
15orgs/mL

NAR_7536_SURF_W
460orgs/mL

NAR_7515_SURF_W
23orgs/mL

NAR_7531_SURF_W
15orgs/mL

NAR_7529_SURF_W
43orgs/mL

NAR_7538_SURF_W
43orgs/mL

Narrabri

NAR_7504_SURF_W
93orgs/mL

NAR_7517_SURF_W
150orgs/mL

NAR_7518_SURF_W
43orgs/mL

NAR_7503_SURF_W
240orgs/mL

GUN_2800_SURF_W
240orgs/mL

NAR_7502_SURF_W
460orgs/mL

MAULES CREEK

Whitehaven Coal Mining

Boggabri

Tarrawonga

NAR_7509_SURF_W
0orgs/mL

GUN_2822_SURF_W
93orgs/mL

NAR_7507_SURF_W
4orgs/mL

GUN_2830_SURF_W
240orgs/mL

Newell Highway

Kamilaroi Highway

KEEPIT DAM

NAMOI RIVER

GUN_2820_SURF_W
11orgs/mL

GUN_2821_SURF_W
93orgs/mL

GUN_2842_SURF_W
210orgs/mL

Sunnyside

Gunnedah

COXS CREEK

GUN_2802_SURF_W
460orgs/mL

Oxley Highway

GUN_2831_SURF_W
150orgs/mL

GUN_2836A_SURF_W
9orgs/mL

Kamilaroi Highway

Coonabarabran

GUN_2803_SURF_W
23orgs/mL

LAKE JORAN

GUN_2832_SURF_W
21orgs/mL

GUN_2810_SURF_W
9orgs/mL

QUIRINDI CREEK

Werris Creek

GUN_2835_SURF_W
0orgs/mL

GUN_2838_SURF_W
23orgs/mL

GUN_2811_SURF_W
43orgs/mL

Quirindi

GUN_2833_SURF_W
93orgs/mL

GUN_2813_SURF_W
75orgs/mL

Wilga Park

0 30.00
kilometers

Legend

- Existing Coal Mining Sites
- NOW Surface WQ Locations
- Major Waterways
- Primary Roads
- Tenement Boundaries

Sulphate Reducing Bacteria for Surface Water Samples
orgs/mL (count)

250 to 500	(5)
150 to 250	(6)
50 to 150	(5)
3 to 50	(16)
Below Laboratory Detection Limits (<3)	(3)

Santos
We have the energy.

Halcrow
A CH2M HILL COMPANY

SPATIAL REFERENCE: WGS 84
DATA SOURCE: SANTOS; NOW

Project: Santos Data Management

Title: Sulphate Reducing Bacteria Concentrations - Gunnedah and Narrabri Project Areas, December 2012

Job Number: 201439 **Figure:** 1

Rev	Date	By	Approved
A	17/01/2013	NC	MF
B	11/02/2013	CH	

NAR_BHNSPZ5_BORE_W | 160 orgs/mL

NAR_BHNSPZ1_BORE_W | 4.9 orgs/mL

NAR_BHNSPZ2_BORE_W | 7.9 orgs/mL

BOHENA

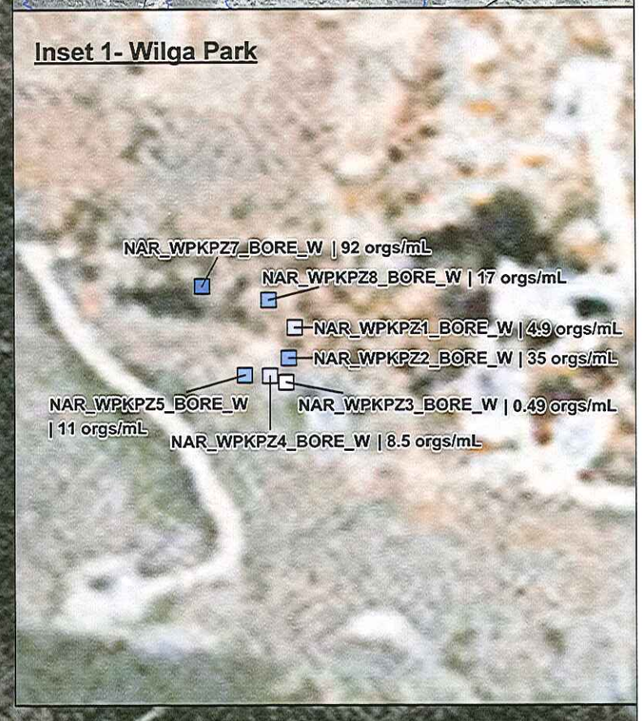
NAR_BWDPD3_DAM_W | 150 orgs/mL

NAR_BWDPD2_DAM_W
| 23 orgs/mL

NAR_BWDPD1_DAM_W | >1,101 orgs/mL

Overview

Inset 1- Wilga Park



Legend

- Major Waterways
- Primary Roads
- Water Treatment Pond

Sulphate Reducing Bacteria
orgs/mL (count)

>1,100	(1)
50 to 200	(3)
20 to 50	(2)
10 to 20	(2)
3 to 10	(4)
Below Laboratory Detection Limits (<3)	(1)

Santos
We have the energy.

Halcrow
A CH2M HILL COMPANY

SPATIAL REFERENCE: WGS 84
DATA SOURCE: SANTOS; NOW

Project: Santos Data Management

Title: Sulphate Reducing Bacteria Concentrations - Gunnedah and Narrabri Project Areas, Feb - Oct 2012

Job Number: 201439 **Figure:** 2

Rev	Date	By	Approved
A	17/01/2013	NC	MF
B	11/02/2013	CH	

Biography

Annie Moody

Annie was appointed Team Leader for Community and Land, Energy NSW for Santos in January 2013. She is based out of Narrabri in New South Wales.

Prior to joining Santos, Annie had sixteen years working with the Queensland Government within various departments, the majority of time with the Queensland Parks and Wildlife Service.

Her most recent appointment was as the Executive Director, Regional Operations East with the Queensland Parks and Wildlife Service within the Department of National Parks, Recreation, Sport and Racing. In this position she was responsible for the Field Management Program for the Great Barrier Reef Marine Park, Moreton Bay Marine Park, Great Sandy Marine Park and the management of terrestrial parks south of Gladstone and west to the Great Dividing Range.

Prior to that appointment, Annie was Executive Director for Terrestrial Parks which included the management of land based protected areas and State forests in Queensland. This involved an estate area of more than 12 million hectares, encompassing three World Heritage properties; a staff base of approximately 700 people; a recurrent budget in excess of $100 million and a capital budget of around $15 million annually.

In her previous role as Director, Office of the Director-General for the Environmental Protection Agency, Annie had a strong governance and advisory role to the Director-General including managing the Executive Services Unit, Ministerial Correspondence Unit and the Cabinet Liaison Office; and was the Agency Liaison Officer for the Crime and Misconduct Commission, Queensland Ombudsman and the Coroner. Other responsibilities included internal and external audit, industrial relations and statutory reporting.

Prior to joining the Queensland Government, Annie spent a number of years working in rural areas of South West Queensland, the Gulf of Carpentaria, New South Wales and the Northern Territory.

Annie has a graduate certificate in Public Sector Management.

Santos

Santos EHSMS

EHS08 Contaminated Sites

Hazard Standard

Santos Ltd
60 Flinders Street
Adelaide
South Australia
5000

Revision 2
June, 2010

Contents

1. Background

1.1 Purpose

The purpose of this standard is to define the minimum acceptable standards for the protection of occupational health and the environment, where site contamination has or may have occurred at Santos operated or leased sites.

1.2 Scope

This standard applies to all Santos operated sites, leased sites and Santos owned pipeline networks.

This standard applies to all potential and actual contaminated sites within exploration and production leases managed by Santos in Australia and overseas. The scope of this standard includes contamination associated with all land, soil (surface and sub-soils) and water bodies (surface and groundwater) resulting from any Santos exploration, production or transfer facilities and/or related work activities, including those conducted directly by contracted third-parties (contractors). Contamination may extend beyond boundaries to non-Santos owned land, including crown land.

Currently, this standard continues to be limited to on-shore operations and activities, unless a Santos owned/operated off-shore facility is subject to an incident involving accidental loss of product to the environment (inclusive of ocean, ocean sediments or impacted coastland). Application of this Standard, under these conditions, will be conducted on a case-by case basis.

- This standard does not apply to the following facilities/activities:
  - operation and maintenance of underground storage tanks and bunds (refer EHS02 USTs and Bunds), although contamination created from leaks and/or spills from USTs and bunds is covered by this standard
  - produced formation water (refer EHS03 Produced Water)
  - waste management (refer to EHS04 Waste)
  - sewage and grey water (refer to EHS10 Water Resources)
  - Santos sites located outside Australia should utilise relevant sections of this standard to guide their activities and ensure that they have identified, and comply with, all relevant in-country legislative requirements relevant to their area of operations.

1.3 Key Operational Requirements

(1) All suspected or identified contaminated sites shall be listed within the Contaminated Site Register.

(2) All sites on the Contaminated Site Register shall have at a minimum a Contaminated Site Review completed.

(3) Contaminated Site Reviews and Assessments shall be undertaken by appropriately qualified and experienced personnel.

(4) Liaison with relevant authorities shall be done by the relevant Environmental Adviser.

1.4 Behavioural Requirements

For the mandatory requirements listed in this Standard to be effective, there are critical behaviours that personnel must adhere to. These behaviours are divided into 3 areas of responsibility:

Everyone must learn and use the standards, procedures and rules that apply to them.

Supervisors must visit the worksite regularly to check conformance with the standards and ensure their team has the skills, experience and training (competence) to complete their tasks.

Managers must demonstrate through their actions, their commitment to a safe workplace. They must regularly explain safety expectations and ensure that their personnel understand and conform with the standards

2. Elements of the Contaminated Sites Standard

This Standard describes the controls associated with the management of contaminated sites, and consists of the following twelve (12) elements:

Element 1: Background Information

An overview of legal obligations and stakeholder expectations for managing facilities and related work activities to prevent adverse impacts to the environment and/or human health.

Element 2: Legal and Other Obligations

The legal framework that applies to contaminated site management is generally state-specific, with Santos obliged to understand and follow the legal context within each state that it operates. Heavily regulated legal obligations apply to the identification and assessment of contaminated sites, their reporting to and registration by state governments and any required remediation and clean-up.

Element 3: Santos Legal Responsibilities (Contaminated Sites)

- The relevant Santos Environmental Adviser is responsible for liaising with the relevant authorities on all issues associated with potential and actual contaminated sites, which include but are not limited to:
- relevant environmental authority (licence) applications and renewals
- reporting of all potential or actual contaminated sites within Santos production or exploration leases
- liaison for any required site clean-up or remediation project(s).

Element 4: Incident Notification

Element 5: Clean-up of Minor Spills

Element 6: Notifiable Activities (Qld), Notification of Contaminated Land (SA) and Duty to Notify (NSW)

Element 7: Santos Contaminated Sites Register

Santos maintains a centralised Contaminated Sites Register for the registration of all potential or actual contaminated sites that are present on Santos owned or leased land in Australia.

Element 8: Contaminated Site Reviews

Element 9: Contaminated Site Assessments

The purpose of a contaminated site assessment is to assess whether the site contamination poses a potential risk to human health and/or the environment, either on or off the site and if it is of sufficient magnitude to warrant remediation appropriate to the current or any proposed land use.

Element 10: Risk Assessment

The purpose of conducting a risk assessment is to assess whether the site contamination identified in a Contaminated Site Assessment poses an actual or potential risk to human health and/or the environment (on or off site).

Element 11: Contaminated Site Management Plans (CSMPs)

Contaminated Site Management Plans (CSMP) are used to formally manage contamination on the site in a manner which protects human health and the environment and ensures that the site is suitable for the specified use.

Element 12: Disposal of Materials

3. Standard Requirements

3.1 Background Information

Site contamination can be an issue of significant concern and if not adequately recognised, considered and addressed resulting risks to human health and the environment can readily occur.

With changing community standards and redevelopment of former industrial and agricultural land, there is increasing recognition of the problems associated with contaminated sites.

Santos' Environmental Vision is to "lighten the footprint of our activities." This means that we aim to manage facilities and related work activities in manner that prevents any adverse impacts to the environment and/or human health. In addition, Santos has legal obligations to comply with and community and key stakeholder expectations to meet.

Flowcharts summarising the following are included:

- contaminated site reporting and management (Figure 1)
- potentially contaminating activity reporting (Figure 2)

State contaminated site legislation and regulations (Section 3.2) now apply within all Australian States and Territories. In addition, there is an increase in stakeholder understanding and expectations associated with industrial sites, to ensure that these facilities are managed to prevent land and water body (surface and groundwater) contamination occurring.

Contaminated site management requires effective design, operational and maintenance processes and procedures to be fully implemented to prevent land contamination occurring. Where former or historical contamination has occurred, Santos is legally obliged to understand the level and type of contamination at each facility. This process is normally conducted via a formal Contaminated Site Review or Assessment on all potentially contaminated sites. Once completed, information and data on all sites is collated by Santos into a centralised Contaminated Sites Register.

3.2 Legal and Other Obligations

The legal framework that applies to contaminated site management is generally state/territory-specific, with Santos obliged to understand and follow the legal context within each state that it operates. Heavily regulated legal obligations apply to the identification and assessment of contaminated sites, their reporting to and registration by state governments and any required remediation and clean-up.

Mandatory Requirement

a) In addition to the legal requirements specified in this Standard, legislative and other requirements relating to contaminated site management shall be identified in accordance with the requirements in EHSMS02 Legal and Other Obligations.

Guidance

As of late 2009, the principal legal obligations associated with "site or land contamination" for each relevant Australian state include:

- **Commonwealth** – *Australian National Environment Protection (Assessment of Site Contamination) Measure 1999 (NEPM)*
- **New South Wales** – *Contaminated Land Management Act 1997* and *Contaminated Land Management Regulations 2008*.
- **Queensland** – *Environmental Protection Act 1994* and *Environmental Protection Regulations*
- **South Australia** – *Environment Protection Act 1993* and *Environment Protection Regulations 2009*
- **Victoria** – *Environment Protection Act 1970* and *Environmental Protection (Scheduled Premises and Exemptions) Regulations 2007* and *SEPP (Prevention and Management of Contamination of Land) June 2002* and *SEPP (Groundwaters of Victoria) March 2002*

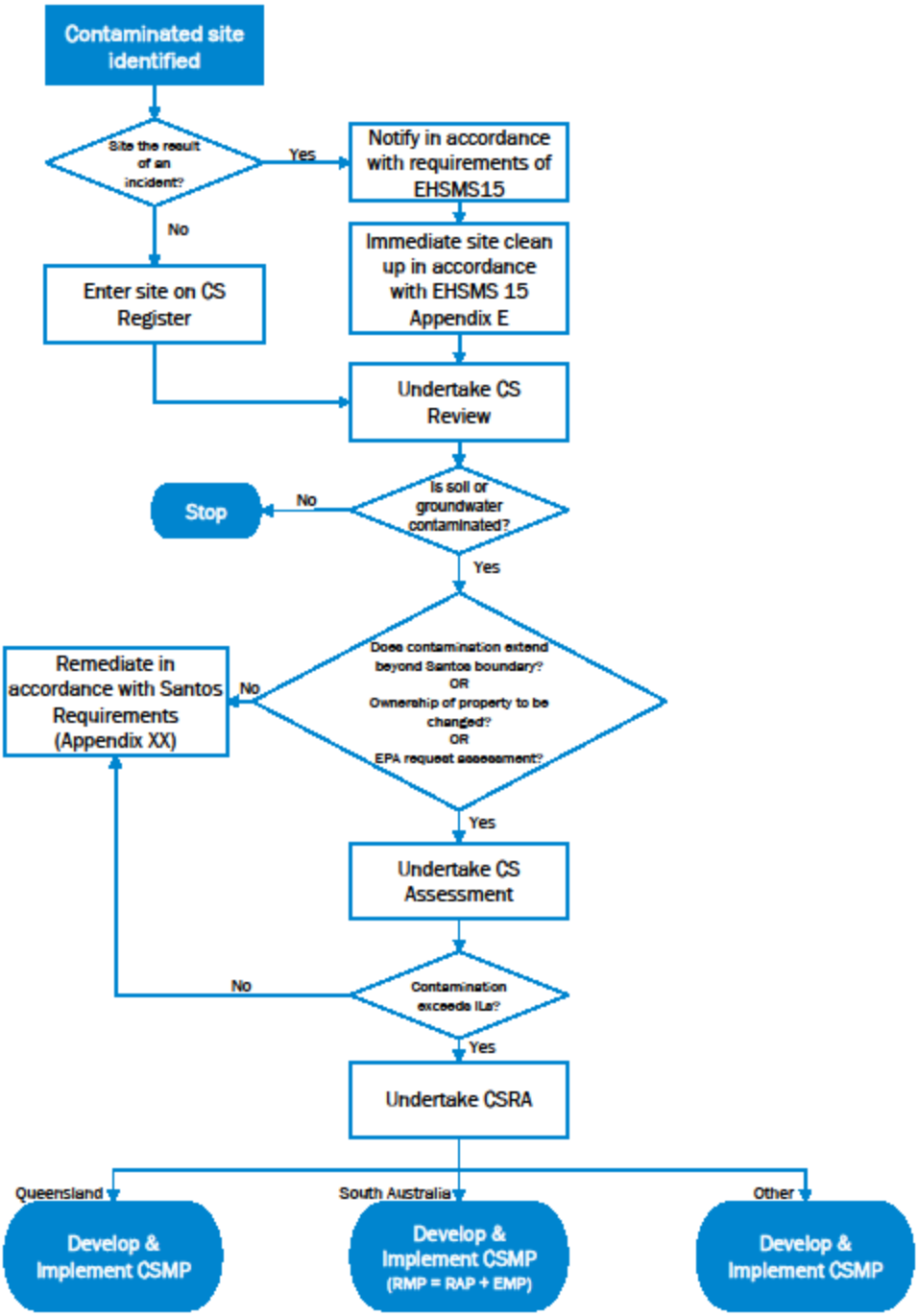


Figure 1. Contaminated Site Management Process

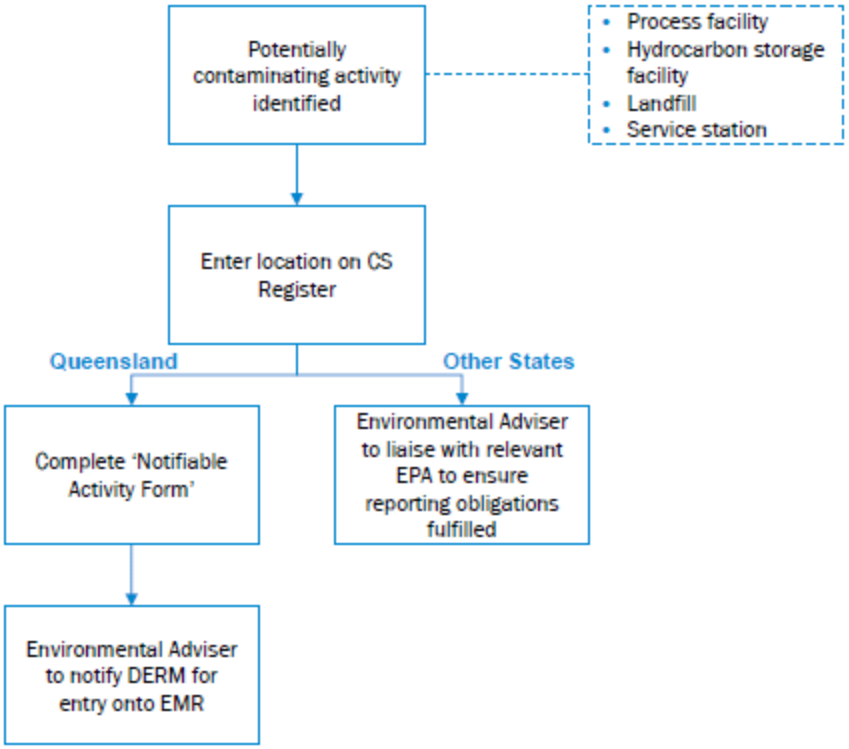


Figure 2. Potentially contaminated activity notification

Santos is also legally bound to manage soil and water body (surface and groundwater) contamination risks arising from its activities, under any applicable conditions defined in environmental authorisations (licences) of its operations (issued by relevant authorities).

Appendix F Statutory and Technical References for Contaminated Sites and Bioremediation Methods provides a listing of relevant legislation and guidance documents for each jurisdiction.

Commonwealth

Guidance

Contaminated land management at a Commonwealth government level is relatively limited, as management of contaminated sites is fundamentally a state government responsibility.

The primary legal requirement associated with contaminated sites at a Commonwealth level is limited to the Australian National Environment Protection (Assessment of Site Contamination) Measure (NEPM). This NEPM has been made under the National Environment Protection Council Act 1994 (Commonwealth) and the equivalent environmental legislation in each state and territory of Australia. Generally NEPMs are enacted as environmental protection policies in each state.

This NEPM establishes a nationally-consistent approach to the assessment of site contamination, to ensure sound environmental management practices are adopted by regulators, site assessors, contaminated land auditors, land owners, developers and industry.

The NEPM contains two schedules:

- Schedule A, which is included in the NEPM, identifies the recommended process for the Assessment of Site Contamination
- Schedule B of the NEPM comprises 10 general guidelines for the Assessment of Site Contamination (Schedules B(1) – (10)).

As of September 2009, the NEPM is currently undergoing a legislated five-year

review.

New South Wales

Guidance

In NSW, the management of contaminated land is shared by the Department of Environment, Climate Change and Water (DECC), the Department of Planning (DOP) and planning consent authorities (usually local councils).

Under the Contaminated Land Management Act (CLM Act), DECC regulates contaminated sites where the contamination is significant enough to warrant regulation. Contaminated sites that are not regulated by the DECC are managed by local councils through land-use planning processes.

DECC also administers the NSW site auditor scheme under the CLM Act, makes or approves guidelines for use in the assessment and remediation of contaminated sites, and administers the public record of regulated sites under the CLM Act.

Queensland

Guidance

In Queensland, the Department of Environment and Heritage Protection (DEHP) administers the Environmental Protection Act (EP Act), for which Part 8 and 9B of this Act deals with managing contaminated land.

Two registers are created, the environmental management register (EMR) is a land-use planning and management register. Land that has been or is being used for a notifiable activity is recorded on the EMR. Most Santos operations in Queensland are notifiable activities. The EMR provides information on historic and current land use – including whether the land has been or is currently used for a notifiable activity, or has been contaminated by a hazardous contaminant.

In addition to the EMR, DEHP also maintains a second public access register, containing land-use planning information. This Queensland Contaminated Land Register is maintained for all registered contaminated sites in the state.

South Australia

Guidance

In November 2007, the South Australian Parliament updated the Environment Protection Act, and created the Environment Protection (Site Contamination) Regulations, to include contaminated site review, assessment and management.

This legislation now does the following:

- assigns responsibility for site contamination
- lists potentially contaminating activities
- establishes a statutory audit system and provides templates for use by contaminated site auditors
- gives the Environment Protection Authority (SA EPA) powers to deal with site contamination.

The Environment Protection Act interacts with a number of other pieces of legislation including:

- *Development Act 1993*
- *Land and Business (Sale and Conveyancing) Act 1994*

Victoria

Guidance

In Victoria, the Environmental Protection Act and Environmental Protection (Scheduled Premises and Exemptions) Regulations define the main broad legal requirements associated with contaminated land.

This legislation is supported by two State Environmental Protection Policies including:

- SEPP (Prevention and Management of Contamination of Land)
- SEPP (Groundwaters of Victoria) – this policy overrides all existing groundwater

protection provisions in other SEPPs.

The SEPP (Prevention and Management of Contamination of Land) establishes:

- general uses of land in Victoria and provides a mechanism for determining whether these uses are being protected
- identifies the links between the environmental audit system and the statutory planning system;
  - sets out requirements for the prevention of contamination
  - identifies measures by which people can access relevant information on site contamination.

The Victorian EPA has a key responsibility in protecting beneficial uses of land to prevent contamination of land and water bodies (surface and groundwater). Sites that present an unacceptable risk to human health or to the environment and must be dealt with as a priority and are typically subject to clean up and/or management under EPA directions.

3.3 Santos Legal Responsibilities (Contaminated Sites)

All individuals undertaking activities that have potential to create contamination or affect already potentially contaminated sites have legal responsibilities.

Mandatory Requirements

a) The Activity or Asset Manager shall ensure that all internal and regulatory requirements relevant to contaminated sites management, in the jurisdiction in which the activity or asset is located, are identified, known and communicated to relevant personnel.

b) All Santos employees and contractors shall ensure that all operations, facilities and work activities are conducted in a manner that minimises any potential for contamination of soil and water bodies (surface and groundwater) by, for example, hydrocarbons, heavy metals, salts (saline water) or other chemicals. This list of potential contaminants is indicative only. Other substances may cause contamination.

c) The relevant Santos Environmental Adviser is responsible for liaising with the relevant authority (usually state government level) on all issues associated with potential and actual contaminated sites, which include but are not limited to:
  - relevant environmental authority (licence) applications and renewals
  - reporting of all potential or actual contaminated sites within Santos production or exploration leases
  - liaison for any required site clean-up or remediation project(s)

Guidance

A list of the Australian State Government Departments responsible for contaminated sites and their contact details is provided in Appendix B State Government Departments Managing Contaminated Sites.

3.4 Incident Notification

Mandatory Requirement

a) Any incident that has resulted in contamination shall be recorded in the Santos Incident Management System (IMS) via the EHS Toolbox in accordance with requirements in EHSMS15 Incident & Non-Conformance Investigation, Corrective & Preventative Action.

3.5 Clean-up of Minor Spills

Guidance

Requirements associated with the clean-up of minor hydrocarbon spills is not included within this Hazard Standard but is defined in EHSMS15 Incident & Non-

3.6 Reporting Notifiable Activities and Contaminated Land to Relevant Authorities

A legal obligation exists in all Australian states and territories for the reporting and notification of:

- activities that may lead to land contamination
- potentially or actually contaminated land.

The processes adopted and implemented by the South Australian, Queensland and New South Wales state governments differ and subsequently has been defined in more detail in Appendix A Notifiable Activities.

Mandatory Requirement

a) The relevant Environmental Adviser shall ensure that regulatory notifications are provided within the appropriate timeframes in accordance with the requirements outlines in Appendix A.

Guidance

In Queensland, industry's obligation to notify DEHP is clear and well established.

In South Australia, the there is no formal obligation for industry to notify the SA EPA of an actual or potentially contaminated site, unless the contaminated site can potentially lead to water body (surface and groundwater) contamination. Under these conditions, reporting is a legal obligation in this state

In NSW, Draft Guidelines on the "duty to notify" DECC of contaminated land were released in April 2009 and these are waiting finalisation.

A list of the Australian State Government Departments responsible for contaminated sites and their contact details is provided in Appendix B State Government Departments Managing Contaminated Sites.

3.7 Santos Contaminated Sites Register

Santos maintains a centralised Contaminated Sites Register for the registration of all potential or actual contaminated sites that are present on Santos owned or leased land in Australia.

Mandatory Requirement

a) The relevant Line/Site Manager shall ensure that suspected or identified contaminated sites shall be listed within the Contaminated Sites Register.

Guidance

Entry of data and information into the Contaminated Sites Register is via an InfoPath form that is used to create each contaminated site register entry.

Mandatory Requirement

b) The following information shall be recorded on the register for each potential or actual contaminated site:
   - Contamination status
   - If a Contaminated Site Review is required and copies when completed
   - If a Contaminated Site Assessment is required and copies when completed
   - Details of contamination areas/volumes
   - Location and type of monitoring points
   - Details of any related incidents that caused the contamination
   - Site information
   - Environmental factors
   - Attachment of any photos taken

c) The Santos Contaminated Site Register shall form the basis for formal reporting of both notifiable activities and contaminated sites to state governments in the future.

d) The relevant Environmental Adviser shall ensure that the Santos Contaminated Sites Register is audited periodically to ensure that all information within the register is correct and up-to-date.

3.8 Contaminated Site Reviews

Contaminated Site Reviews are an initial review at locations where contamination is suspected. They confirm that contamination (if any) exists and the nature and extent of that contamination.

Mandatory Requirement

a) All Santos sites listed in the Santos Contaminated Sites Register shall have, as a minimum, a Contaminated Site Review completed, to facilitate the entry and retention of information within this register.

Guidance

Details of how to conduct a Contaminated Site Review are provided in Appendix C Completion of a Contaminated Site Review.

A Contaminated Site Review should investigate and record information relating to former and/or existing operational or transfer facilities and/or past and present activities that may have resulted in the release of contaminants that adversely impact soil and/or water body (surface and groundwater) quality.

Mandatory Requirements

b) All Contaminated Site Reviews shall be conducted by personnel who are competent in completing these reviews. Guidance as to competency is given in Appendix C.

c) As part of the review, a site plan shall be produced that clearly defines all areas of potential or actual contaminated areas.

d) Site reviews shall be updated at a frequency appropriate to the assessed level of risk, not exceeding every four years.

e) The Contaminated Site Review shall also be completed or updated whenever:

f) A facility is to be constructed or upgraded

g) A facility is to be decommissioned

h) Management responsibility is transferred to another business

3.9 Contaminated Site Assessments

The purpose of a contaminated site assessment is to assess whether the site contamination poses a potential risk to human health and/or the environment, either on or off the site and if it is of sufficient magnitude to warrant remediation appropriate to the current or any proposed land use.

Mandatory Requirement

a) A Contaminated Site Assessment must be conducted if the Contaminated Site Review (Section 3.8) finds information that indicates any of the following:

- the soil and/or water body (surface and groundwater) has been contaminated
- nature and extent of the contamination may pose a significant risk to human health or the environment
- contamination has resulted from activities controlled by the company and may extend to groundwater and/or into an area which is not owned or leased by the company (i.e. adjacent property)
- area is subject to any form or type of acquisition, divestment or acceptance or termination of a lease
- relevant statutory authority has validly directed that a quantitative assessment be performed.

Guidance

Details of how to conduct a Contaminated Site Assessment are provided in Appendix D Completion of a Contaminated Site Assessment.

Generally, Contaminated Site Assessments are to be conducted in accordance with the requirements of the Australian National Environment Protection (Assessment of Site Contamination) Measure (NEPM).

In Queensland, in addition to the NEPM, they are required to follow the Guidelines

for the Assessment and Management of Contaminated Land in Queensland.

In South Australia, in addition to the NEPM, they are required to follow a range of Guidelines, released by the South Australian EPA in 2008-2009 and these are available on the SA EPA Site Contamination website.

Mandatory Requirements

a) A Contaminated Site Assessment shall include assessment of:
   - Health risks
   - Ecological risks (flora, fauna, soils, climate, etc)
   - Water body (surface and groundwater) contamination risks
   - Aesthetics

   with a primary outcome being the derivation of Investigation Levels (ILs) for the site.

b) Where the Contaminated Site Assessment identifies contamination in excess of ILs (as specified in the NEPM or other statutory guidelines), further assessment to delineate the contamination and/or a risk assessment shall be performed in accordance with the NEPM.

c) Contaminated site assessments shall be undertaken by competent personnel (as defined in Appendix D). Appoint of these personnel shall be approved by the Santos Team Leader Environment.

3.10 Risk Assessment

The purpose of conducting a risk assessment is to assess whether the site contamination identified in a Contaminated Site Assessment poses an actual or potential risk to human health and/or the environment (on or off site).

Mandatory Requirements

a) Contaminated Site Risk Assessments shall be undertaken by competent personnel (as defined in EHSMS09 Hazard Identification, Risk Assessment and Control).

b) The scope of work for any planned risk assessments and the outcomes of these assessments shall be reviewed and endorsed by the Santos Team Leader Environment.

c) Where the outcome of the risk assessment indicates an unacceptable level of risk, as determined in accordance with EHSMS09 Hazard Identification, Risk Assessment and Control, a Contaminated Site Management Plan shall be drafted in accordance with the requirements of Section 3.11.

3.11 Contaminated Site Management Plans

Contaminated Site Management Plans (CSMP) are used to formally manage contamination on the site in a manner which protects human health and the environment and ensures that the site is suitable for the specified use.

Guidance

In Queensland, CSMPs are stand-alone public documents which become conditions on the use of the land. Their purpose is to clearly summarise the contamination issues and conditions associated with the use of the site, without the need for reference to site investigation reports. Once an SMP is prepared and accepted by the administering authority and the site is listed on the EMR, the SMP is attached to the search result for that particular parcel of land when searching the public register.

In South Australia, remediation generally starts with the preparation of a Remediation Action Plan (RAP) and an Environmental Management Plan (EMP). The RAP should detail the methods, processes and controls of the remediation activities. The EMP should address all environmental management issues. These

two plans may be combined to form a Remediation Management Plan (RMP).

Santos has elected to utilise a single process for the development of a suitable plan for individually managing each contaminated site, which is applicable in all states that Santos operates in.

The design, development and monitoring requirements associated with drafting a Contaminated Site Management Plan (CSMP) are included in Appendix E Development of a Contaminated Site Management Plan.

Reporting Requirements and Stakeholder Communication Plans

Mandatory Requirements

a) Where required by legislation, information regarding contaminated sites shall be provided to the relevant authorities (for inclusion into the State Contaminated Sites Register or equivalent).

b) All personnel are required to refer to the relevant Environmental Adviser for advice on contaminated site management and notification.

c) Where a contaminated site assessment has been undertaken and reporting to stakeholders is required by legislation, a plan shall be developed by the relevant Environmental Adviser for the communication of information to relevant stakeholders and relevant authorities.

Remediation and Treatment of Contaminated Land

Guidance

In Australia, regulations governing the approval of on-site containment for the remediation of contaminated soil are generally controlled by individual State/Territory relevant authority.

Mandatory Requirements

d) CSMPs shall outline, if required, any planned remediation activities, which shall be based on a consideration of the NEPM hierarchy for site remediation. This includes:

- On site treatment and reuse, or
- Off site treatment and reuse

If these are not practicable, then

- Consolidation and/or isolation of contamination on site utilising appropriately designed (engineered) barriers, or
- Removal of contaminated soil/water to an approved site/facility for treatment or disposal

e) Where remediation would have no net environmental benefit or a net adverse environmental effect, the CSMP shall outline an appropriate management strategy which shall be subsequently implemented and monitored.

Guidance

If other contaminants are not present, bioremediation can be used for treating hydrocarbon contaminated soil and water bodies (surface and groundwater) resulting from all industrial sites including oil and gas operations. This method of treatment may be utilised either on-site/in-situ or off-site dependent on site specific requirements and state legislative requirements. Appendix F Statutory and Technical References for Contaminated Sites and Bioremediation Methods provides some cross-references that provide technical guidelines relating to contaminated site management and bioremediation.

3.12 Disposal of Materials

Mandatory Requirement

a) Contaminated materials (excluding contaminated soil and water) are to be disposed of in accordance with each individual site Waste Management Plan (refer EHS04 Waste) and relevant regulatory obligations.

3.13 Document retention

Mandatory Requirements

a) The following documents are produced to fulfil requirements of this standard. Each document shall be retained on file (hard or electronic) for at least the period of time stated next to the document

Regulatory contaminated site notifications	For perpetuity
Contaminated site review reports	For perpetuity
Contaminated site assessment reports	For perpetuity
Contaminate site risk assessment reports	For perpetuity
Contaminated site management plans	For perpetuity

4. Responsibilities

Refer to the Santos EHSMS Responsibilities page for a list of positional responsibilities used in this standard.

5. Appendices & Auditor Guide

Document	Name
Appendix A	Notifiable Activities
Appendix B	State Government Departments Managing Contaminated Sites
Appendix C	Completion of a Contaminated Site Review
Appendix D	Completion of a Contaminated Site Assessment
Appendix E	Development of a Contaminated Site Management Plan
Appendix F	Statutory and Technical References for Contaminated Sites and Bioremediation Methods
Auditor Guide	EHS08 Contaminated Site Management Auditor Guide

6. Forms & Templates

Document	Name
Form	Contaminated Site Register
Form	Notifiable Activities Register

7. Supporting Documentation

Document	Name
NEPM	Australian National Environmental Protection (Assessment of Site Contamination) Measure 1999
DEHP Guideline	Guidelines for the Assessment and Management of Contaminated Land

	in Queensland
Santos EHSMS standard	EHSMS02 Legal and Other Obligations
Santos EHSMS standard	EHSMS09 Hazard Identification, Risk Assessment and Control
Santos EHSMS standard	EHSMS15 Incident & Non-Conformance Investigation, Corrective & Preventative Action
Santos Environmental Hazard Standard	EHS02 USTs and Bunds
Santos Environmental Hazard Standard	EHS03 Produced Water
Santos Environmental Hazard Standard	EHS04 Waste
Santos Environmental Hazard Standard	EHS10 Water Resources

8. Definitions & Acronyms

Refer to the Santos EHSMS Definitions & Acronyms list for definitions of other terms and acronyms used in this standard.

9. User Feedback & Document Control

Users of the Standard are encouraged to report any mistakes or confusing information, or to provide suggestions for improvement by contacting the EHSMS Coordinator.

Document control of the EHSMS is managed by the Standard Custodian. The controlled copy of this standard is located on the EHSMS topics page on the Santos intranet. Users of a printed copy of the standard are responsible for ensuring they have the current version. This can be achieved by ensuring the revision number in the footer of each page of the printed copy is the same as the revision number displayed against the standard on the Santos intranet.

This Standard will be reviewed by the Standard Custodian and Technical sponsor at a minimum on a three yearly basis.

10. Document Control

10.1 Document Status

Revision: 2	Technical Sponsor: Scott Shomer	
Action	**Name & Position**	**Date**
Prepared By	Emma Dyer	May 2010
Reviewed By	Steve Tunstill, Kirsty McCulloch	June 2010
Approved By	Scott Shomer	8 June, 2010
Document Review Schedule:	This document is due for review on 9th June 2013	

10.2 Document Amendment Record

Revision	Date	Prepared by	Change description
1	29/11/2005	Emma Dyer	Original issue
2	8/6/2010	Emma Dyer	Updated to reflect regulatory changes in SA to bring into line with Qld

Appendix A Notifiable Activities

1 Statutory Notification Requirements for Contaminated Sites

In Australia, the notification process for actual and potential contaminated sites is managed and administered at a state government level. Currently, processes for notification and reporting marginally differ between Australian states and generally, the notification process for contaminated sites is state specific (i.e. no national process currently exists).

The requirement to standardise legal requirements to the highest level of statutory obligations enforceable in any Australian state is described in EHSMS02 Legal and Other Obligations. Santos has elected to apply a common highest standard (across all relevant states) when the level of legal obligations differs across states and territories in Australia.

As a result, the information required to be collected for statutory notification and reporting obligations in Queensland shall be collected for contaminated sites in all Australia states. The information reported externally will vary depending on the jurisdiction.

Information provided about specific jurisdictions is limited to Queensland and South Australia. When Santos' operations expand into other jurisdictions, this Appendix and the Standard will be updated. The relevant Environmental Adviser shall provide information about notifiable activity reporting in other jurisdictions upon request.

Responsibility for externally reporting notifiable activities and identified contaminated sites lies with the relevant Environmental Adviser.

2 Santos Contaminated Sites Register

Santos maintains a centralised Contaminated Sites Register for the registration of all potential or actual contaminated sites that are present on Santos owned or leased land.

All suspected or identified sites in all states are required to be listed within this Register. Entry of data and information into the Santos Contaminated Sites Register is via an InfoPath form that is used to create each contaminated site register entry.

The Santos Contaminated Site Register will form the basis for formal reporting of both notifiable activities and contaminated sites to state governments in the future.

3 Notifiable Activities

All notifiable activities owned or conducted by Santos in all Australian states are required to be entered and recorded in the Santos Contaminated Sites Register using the Notification of Land form.

The information required to be completed on this form meets the direct reporting requirements in Queensland.

Queensland

Activities that have been identified as likely to cause land contamination are listed in Schedule 3 of the Queensland *Environmental Protection Act 1994* (the Act). Those notifiable activities relevant to Santos's operations include:

28. Petroleum or petrochemical industries including—

    (a) operating a petrol depot, terminal or refinery; or

    (b) operating a facility for the recovery, reprocessing or recycling of petroleum based materials.

29. Petroleum product or oil storage — storing petroleum products or oil—

    (a) in underground tanks with more than 200 L capacity; or

    (b) in above ground tanks with—

        (i) for petroleum products or oil in class 3 in packaging groups 1 and 2 of the dangerous goods code—more than 2 500 L capacity; or

        (ii) for petroleum products or oil in class 3 in packaging groups 3 of the dangerous goods code—more than 5 000 L capacity; or

        (iii) for petroleum products that are combustible liquids in class C1 or C2 in Australian Standard AS 1940, 'The storage and handling of flammable and combustible liquids' published by Standards Australia—more than 25 000 L capacity.

20. Landfill – disposing of waste (excluding inert construction and demolition waste).

22. Livestock dip or spray race operations – operating a livestock dip or spray race facility

34. Service stations – operating a commercial service station

South Australia

Activities that have been identified as likely to cause land contamination are listed in the South Australian Environmental Protection Regulations 2009.

Under these regulations, those notifiable activities that may be relevant to Santos's operations include:

- Fire training areas – operation of premises for fire training involving the use of liquid fuel, fire accelerants, aqueous film forming foam or similar substances
- Fuel burning facilities – burning of solid or liquid fuel (including for generation of power or steam at rate of heat release exceeding 1MW)
- Gasworks operation – of gasworks or gas holders
- Laboratories – operation of laboratories
- Landfill sites – operation of sites for disposal of waste onto or into land
- Motor vehicle – repair or maintenance
- Operation of premises – for repair or maintenance of motor vehicles or parts of motor vehicles (including engine reconditioning works)
- Service stations – operation of retail fuel outlet
- Waste depots – reception, storage or treatment (including recycling) of waste or disposal of waste to land or water
- Wastewater – storage, treatment or disposal
- Storage – (including in tanks, lagoons and ponds) or treatment (including recycling) of wastewater or disposal of wastewater to land or water

As of October 2009, there are no requirements for these activities to be reported to the South Australian Environment Protection Authority (SA EPA).

4 Statutory Registration of Notifiable Activities

Queensland

Land that has been or is being used for a notifiable activity is recorded on the Queensland Environmental Management Register (EMR), which is maintained by the Queensland Department of Environment and Heritage Protection (DEHP).

The EMR provides information on historical and current land use, including whether the land has been or is currently used for a notifiable activity, or has been contaminated by a hazardous contaminant. Sites on the EMR in most circumstances pose a 'low risk' to human health or the environment under their current land use. Entry on the EMR does not mean that the land must be cleaned up or that the current land use must cease.

Under the Act, landowners and local government must inform the DEHP that land has been or is being used for a notifiable activity.

Statutory registration of notifiable activities in Queensland is required to be conducted via the form Notification of Land (from DEHP's website).

South Australia

Santos has a legal obligation to ensure that all relevant notifiable activities are registered in all relevant Australian states. Currently, there is no formal process in South Australia for the registration of notifiable activities. Close liaison with the relevant Environmental Adviser is required to ensure appropriate notifications occur.

5 Statutory Registration of Contaminated Land

Queensland

The Contaminated Land Register (CLR) in Queensland is a register of 'risk' sites – proven contaminated land which is causing or may cause serious environmental harm. Land is recorded on the CLR when scientific investigation shows it is contaminated and action needs to be taken to remediate or manage the land. Generally, actions could include either:

- technical measures to prevent migration of contaminants
- full removal of contaminants and off-site treatment to prevent serious environmental harm or public health risks.

Further information relating to searching this Register can be obtained from the Guidelines for the Assessment and Management of Contaminated Land in Queensland.

South Australia

There is no known equivalent Contaminated Land Register in South Australia.

Nevertheless, the SA EPA is required by Regulations under the *Land and Business (Sale and Conveyancing) Act 1994* to provide environmental information relating to a property.

In relation to site contamination these regulations require the SA EPA to answer questions set out in the section 'Particulars Relating to Environment Protection' which identify whether the SA EPA holds a copy of a report on any environmental assessment of the land or part of the land by, or on behalf of, any of the following:

- the owner or occupier pursuant to certain sections of the *Environment Protection Act 1993*, or for the purposes of a notification under Section 83
- the SA EPA (alone or jointly with another authority)
- an Auditor.

In addition, the SA EPA has to answer questions in relation to the historical operation of waste depots, the production of certain wastes and the deposition of waste on land in relation to approvals or authorisations under specific former legislation and certain SA EPA authorisations.

This information is then provided in the form of a Section 7 EPA response letter.

6 Proactive Statutory Reporting of Contaminated Land

Queensland

Landowners and occupiers, including Santos, have responsibilities under the Act to notify DEHP when they become aware that their land has been or is being used for a notifiable activity or contaminated by a hazardous contaminant. When a landowner notifies the DEHP that the land has been used for a notifiable activity, the land is recorded on the EMR.

Local governments also notify DEHP of land in their local government area that has been used for a notifiable activity or has been contaminated by a hazardous contaminant. Before land is entered on the EMR, the DEHP informs the landowners of the notification. The landowners may make a submission to DEHP about the notification if they believe the information to be incorrect DEHP decides whether or not to record the land on the EMR.

DEHP issues written notices to landowners and local governments advising them when the land is recorded on the EMR.

South Australia

There is no formal process in South Australia for the proactive notification or registration to the SA EPA of any potential or actual land contamination, unless this land contamination has the potential to result in groundwater contamination.

In the event that potential or actual groundwater contamination can occur from the contaminated land, then notification to the SA EPA is required, under Section 83A of the Environment Protection Act 1993. This requires completion and lodgement of the form included as an attachment to the Site Contamination Notification Guidelines.

Notification of site contamination of underground water is required by either:

a) an owner or occupier of a site
b) a site contamination auditor or a site contamination consultant engaged by Santos for the purposes of making determinations or assessments in relation to site contamination on or below the surface of a site.

The SA EPA must be notified in writing by Santos as soon as reasonably practicable after becoming aware of the existence of site contamination at the site or in the vicinity of the site (whether arising before or after the commencement of this section) that affects or threatens water occurring naturally under the ground or introduced to an aquifer or other area under the ground.

7 Removal of Land from the EMR or CLR

Queensland

Land can be removed from the EMR if, at any time, the landowner or local government provides evidence to DERM that no notifiable activity has occurred on the site, or that the land has not been, or is no longer contaminated following remediation.

When land has been investigated by a suitably qualified person or consultant, a site investigation report about the land is submitted to DEHP for assessment. If DEHP is satisfied that the land is not contaminated, the land is removed from the EMR

Land is also removed from the CLR after work has been done to remediate the land and a site investigation report satisfies DEHPthat the land no longer poses a risk to the environment or public health. In addition, land can be transferred from the CLR to the EMR where there is a site management plan for the land to manage the contamination so it no longer causes environmental harm or poses a risk to human health.

8 Local Government Responsibilities

Queensland

Local governments have obligations under the Act relating to the identification, notification and management of contaminated land. Under the Act, all local governments in Queensland are required to notify DEHP of land that has been or is currently used for a notifiable activity within their local government area. This information is gathered by local governments through sources such as historical information, local knowledge and town planning records.

Appendix B State Government Departments Managing Contaminated Sites

1 New South Wales - DECC

Telephone	131 555 (pollution reporting, environment information and publication requests – local call cost) (02) 9995 5555
Email	info@environment.nsw.gov.au
Fax	(02) 9995 5999
Postal address	PO Box A290 Sydney South 1232 NSW

2 Queensland – DEHP

Telephone	(07) 3225 1827
Postal address	Contaminated Land Unit Department of Environment and Heritage Protection PO Box 15155CITY EAST QLD 4002

3 South Australia - EPA

Telephone	1800 623 445 (freecall – non metropolitan callers only) (08) 8204 2000 (general enquiries – local call)
Email	epainfo@epa.sa.gov.au
Postal address	GPO Box 2607 Adelaide 5001 South Australia

4 Victoria - EPA

Telephone	(03) 9695 2722
Fax	(03) 9695 2780
Postal address	GPO Box 4395QQ Melbourne 3001 Victoria

Appendix C Completion of a Contaminated Site Review

1 Introduction

All Santos sites listed in the Santos Contaminated Sites Register are required to have, as a minimum, a Contaminated Site Review completed, to facilitate the entry and retention of information within this register.

This Appendix describes the process for conducting an initial Contaminated Sites Review for each site planned to be entered into the Register.

This Appendix does not discuss the requirements and processes for conducting a Contaminated Sites Assessment, which is discussed in Appendix D Completion of a Contaminated Site Assessment.

2 Santos Contaminated Sites Register

All potential contaminated sites within land owned or leased by Santos or potentially impacted by Santos operations, infrastructure or activities is required to be entered into the Santos Contaminated Sites Register.

All suspected or identified sites relating to Santos operations/activities in all states are required to be listed within this Register. Its purpose is to collate and maintain all records and data associated with contaminated sites across all of Santos. This register is administered and maintained on an ongoing basis by relevant personnel in the Santos Adelaide office.

Entry of data and information into the Santos Contaminated Sites Register is via an infopath form that is used to create each contaminated site register entry.

The Santos Contaminated Site Register can be found at the following hyperlink: http://teams.santos.com/sites/contaminatedregister-00401-c/.

The Santos Contaminated Sites Register clearly requests the initial status of the following for all site entries:

a) status of the contaminated site being entered (e.g. reported but not substantiated)
b) information in a description field, concerning the "status update"
c) if a Contaminated Site Review is required
d) if a Contaminated Site Assessment is required.

3 Contaminated Site Reviews

All Santos sites listed in the Santos Contaminated Sites Register are required to have, as a minimum, a Contaminated Site Review completed, to facilitate the entry and retention of information within this register.

A Contaminated Site Review should be the initial step to record information relating to former and/or existing operational or transfer facilities and/or past and present activities that may have resulted in the release of contaminants that adversely impact soil and/or groundwater quality.

The primary purpose of the review is to determine if contamination is likely or unlikely to be present at each site in question. In the event that soil and/or groundwater contamination is present or likely

to be present, then this would trigger the next stage which would include a Contaminated Sites Assessment (See Appendix D – Completion of a Contaminated Site Assessment).

The following information shall be collected and included within any Contaminated Site Review that is conducted at a specific Santos location or site:

a) Information relating to the location of the actual or potentially contaminated site, inclusive of GPS coordinates and a text description
b) A historical description of the infrastructure, facility or work activities that may have lead to the contamination in question (e.g. incident, corroded underground pipeline etc)
c) The current visual status of the site in question
d) The development of a site plan that clearly defines all areas of potential or actual contaminated areas
e) The recording of photographic evidence of the site, to support the visual description of the site
f) The results of any preliminary soil samples that have been collected at the site
g) Any information or data relating to potential or actual contamination areas/volumes
h) If the site has the potential or is likely to be contaminating groundwater resources
i) Any monitoring requirements that may be needed to determine if the site warrants a formal contaminated site assessment
j) The potential or actual human health or environmental risks associated with the site.

Landowners, including Santos, are usually responsible for the investigation of their land for contamination and remediation (inclusive of both Contaminated Site Reviews and Contaminated Site Assessments).

4 Personnel Conducting Contaminated Site Reviews

Personnel responsible for conducting Contaminated Site Reviews, within or on behalf of Santos, are required to be appropriately qualified and experienced to enable an accurate assessment of each site to be completed and recorded within the Santos Contaminated Sites Register.

Contaminated Site Reviews are normally conducted in the absence of any extensive field sampling and sample analysis. They are essentially a information and data collecting exercise, to identify if more detailed and formal field investigations are required (i.e. Contaminated Sites Assessment). The intent is that Contaminated Site Reviews are completed primarily on the basis of visual observations, knowledge of historical land uses, incidents etc.

Based on information above, Santos personnel have a responsibility to ensure that personnel assigned to complete Contaminated Site Reviews have suitable knowledge and experience to enable these reviews to be effectively completed. These individuals are required to have an in-depth knowledge of soil science, environmental chemistry and the industrial processes associated with the cause of the contamination.

Note that all personnel responsible for conducting more detailed and formal Contaminated Site Assessments must be suitably and formally registered by the state government as a Contaminated Sites Auditor within the state where the site/assessment is required to be completed (refer to Appendix D – Completion of a Contaminated Site Assessment). Typically, Contaminated Site Assessments are conducted under contract by a suitably registered environmental consultant.

5 Data Management from Contaminated Site Reviews

It is critical that all data, records and information from completed Contaminated Site Reviews is collated and held (i.e. electronically attached) to the relevant entry in the Santos Contaminated Sites Register.

This should include, but not be limited to the any of the following:

a) internal or external reports associated with the review
b) information about the qualifications and experience of the environmental professional that conducted the review
c) historical information and/or notes relating to the facility or activity that resulted in the actual/potential contamination
d) developed site plan that clearly defines all areas of potential or actual contaminated areas
e) field sheets, chain of custody forms etc associated with any preliminary field samples collected
f) soil or groundwater analytical results from external/commercial laboratories
g) photos of the site and its surrounds
h) any interpretative reports that may exist, that may also recommend any remedial actions for each individual site.

6 Updating Contaminated Site Reviews

All Contaminated Site Reviews shall be updated at a frequency appropriate to the assessed level of risk, but not exceeding every four years. The Santos Contaminated Sites Register will identify the entry and last review dates for all sites listed in the Register.

A Contaminated Site Review shall also be completed or updated whenever:

a) a facility is to be constructed or upgraded
b) a facility is to be decommissioned
c) management responsibility is transferred to another business.

The Santos Contaminated Sites Register will be periodically audited to ensure that all information within the register is correct and up-to-date, in accordance with the requirements of EHS08 Contaminated Sites Management and the associated Appendices.

Appendix D Completion of a Contaminated Site Assessment

1 Introduction

This Appendix is provided to provide guidance to Santos personnel when assigned responsibility to manage and/or conduct a Contaminated Site Assessment at a specific Santos site.

The purpose of a contaminated site assessment is to assess whether the site contamination poses a potential risk to human health and/or the environment, either on or off the site and if it is of sufficient magnitude to warrant remediation appropriate to the current or any proposed land use.

Due to the potentially costly nature of these assessments, formal contaminated site assessments must only be conducted when specific criteria has been met (as defined in this appendix).

All Santos sites scheduled for a Contaminated Sites Assessment must initially be listed in the Santos Contaminated Sites Register and secondly, must have had a Contaminated Sites Review completed in accordance with the requirements of Appendix C Completion of a Contaminated Site Review. Only once a formal Contaminated Sites Review has been completed, may a Contaminated Sites Assessment commence (as the Contaminated Site Review will also form the basis for the establishing the "scope" of the Contaminated Site Assessment).

2 Santos Contaminated Sites Register

Initially, all potential contaminated sites within land owned or leased by Santos or potentially impacted by Santos operations, infrastructure or activities is required to be entered into the Santos Contaminated Sites Register.

All suspected or identified sites relating to Santos operations/activities in all states are required to be listed within this Register. Its purpose is to collate and maintain all records and data associated with contaminated sites across all of Santos. This register is administered and maintained on an ongoing basis by relevant personnel in the Santos Adelaide office. The Santos Contaminated Site Register can be found at the following hyperlink:http://teams.santos.com/sites/contaminatedregister-00401-c/ .

3 Completion of a Contaminated Site Review

All sites listed in the Santos Contaminated Sites Register are required to have, as a minimum, a Contaminated Site Review completed, to facilitate the entry and retention of information within this register.

This Appendix does not discuss the requirements and processes for conducting an initial Contaminated Sites Review, which is discussed in Appendix C Completion of a Contaminated Site Review.

Once a Contaminated Site Review has been completed, and has confirmed that contamination is present and is likely to have an adverse human health or environmental impact, then a Contaminated Sites Assessment can be scoped and completed.

4 Criteria for Initiating a Contaminated Site Assessment

A Contaminated Site Assessment must be scheduled and conducted, when resources permit, if the Contaminated Site Review (Appendix C Completion of a Contaminated Site Review) finds information which indicates that the soil and/or groundwater has been contaminated and:

a) nature and extent of the suspected contamination may pose a significant risk to human health or the environment
b) contamination has resulted from activities controlled by the company and may extend to groundwater and/or into an area which is not owned or leased by the company (i.e. adjacent property)
c) area is subject to any form or type of acquisition, divestment or acceptance or termination of a lease
d) relevant statutory authority has validly directed that a quantitative assessment be performed.

5 Statutory Requirements Associated with Contaminated Site Assessments

Generally, Contaminated Site Assessments are to be conducted in accordance with the requirements of the Australian National Environmental Protection (Assessment of Site Contamination) Measure 1999 (NEPM).

In Queensland, in addition to the NEPM, they are required to follow the Guidelines for the Assessment and Management of Contaminated Land in Queensland.

In South Australia, in addition to the NEPM, they are required to follow a range of Contaminated Land Guidelines, released by the South Australian EPA in 2008-2009 and these are available on the SA EPA website at www.epa.sa.gov.au/guidelines.html.

6 Scoping Contaminated Site Assessments

In the event that the initial Contaminated Site Review has confirmed that contamination is present and may pose a significant risk to human health or the environment, then a Contaminated Site Assessment must be scoped on the basis of the information gathered from the former Contaminated Site Review.

The scope of all Contaminated Site Assessments conducted by Santos shall include a formal assessment of all of the following:

- health risks
- ecological risks (flora, fauna, soils, climate, etc)
- groundwater contamination risks
- aesthetics

with a primary outcome being the derivation of Investigation Levels (ILs) for the site.

Where the Contaminated Site Assessment identifies contamination in excess of ILs (as specified in the NEPM or other statutory guidelines), further assessment to delineate the contamination and/or a risk assessment shall be performed in accordance with the NEPM.

The scope of each Contaminated Site Assessment must be site specific and documented accordingly. The scope must be based on and utilise the information sourced from the Contaminated Site Review. External consultants should be able to confidently cost a proposal based on the scope of work provided. The NEPM provides statistical guidelines for the number of sample points etc based on former site use, property size etc.

A suitably experienced professional within Santos shall be authorised to develop each scope of work to ensure that the objectives of the Contaminated Site Assessment are met and the assessment is completed in a timely and cost-effective manner. Typically the individual drafting the scope of work should also have responsibility as the Project Manager for the Contaminated Site Assessment.

7 Personnel Authorised to conduct Contaminated Site Assessments

Contaminated site assessments shall be undertaken by personnel who have the appropriate qualifications and experience, in accordance with the relevant state EPA requirements relative to the location of the contaminated site.

Most Australian state government have implemented a program for the registration of personnel that are authorised and approved to conduct contaminated site assessments and contaminated site audits. The requirements for this registration process and those individuals that are registered or approved are typically listed on the EPA website for that individual state.

For example, see 'Appendix 6 Professional Competencies' of the Guidelines for the Assessment and Management of Contaminated Land in Queensland.

Ideally, proposals should be requested from a range of approved consultants, based on the documented scope of work. Based on experience, capability and cost, the favoured consultant should be identified. Once identified and prior to appointing the consultant and proceeding with the work, the favoured consultant/personnel are required to be endorsed by the Santos Team Leader Environment.

8 Conducting Contaminated Site Assessments

Once the relevant consultant has been endorsed and appointed, contaminated site assessments shall be undertaken by personnel in the following sequence:

a) Reconfirm the scope of work with the consultant and ensure that it meets the proposal and quotation provided
b) Provide the consultant with all historical information, to allow the assessment methodology and plan to be developed (including required laboratory analysis)
c) Conduct an initial reconnaissance of the site with the appointed consultant, to determine the approach and methodology to be taken, number of sampling sites required, depth of samples, required sampling equipment such as augers/backhoes, the potential for migrating contamination, the required analysis suite for all samples collected etc
d) Prior to commencing any field work, ensure that all underground services have been located and clearly marked on field plans and in the field. Ensure that all other safety measures have been communicated to the consultant and their sub-contractors and agreed. Hold an initial meeting with all involved personnel to ensure that all communicated requirements have been understood, with formal signatures from all participating personnel
e) Ensure that a NATA Accredited laboratory has been secured for all sample analysis (for each and every analytical test requested) and the consultant has all relevant QA/QC processes in place (i.e. field sampling sheets, chain of custody forms, procedures, experienced field personnel etc)
f) Commence field work and ensure that all field personnel are appropriately supervised as required. During field work, any major deviations from the agreed methodology or scope of work should be agreed between both parties in writing
g) The agreed reporting requirements and timelines are required to be met by the consultant, to ensure that the site assessment is completed in a timely manner. Ensure that the Contaminated Site Assessment report submitted by the consultant is worded in a manner that facilitates decision making by relevant Santos Managers (i.e. with regard any potential clean-up and/or remediation)
h) If clean-up or remediation of the site is planned, consider utilising the same consultant to assist in drafting a Contaminated Site Plan (Queensland) or a Remediation Management Plan (South Australia).

9 Data Management from Contaminated Site Assessments

It is critical that all data, records and information from completed Contaminated Site Assessments are collated and held (i.e. electronically attached) to the relevant entry in the Santos Contaminated Sites Register.

This should include, but not be limited to the following:

- All external consultant reports associated with the Contaminated Site Assessment inclusive of all soil or groundwater analytical results from external/commercial laboratories, photos of the site contamination etc
- Information about the qualifications and experience of the environmental professional/ consultant that conducted the site assessment
- Any additional historical information and/or notes relating to the facility or activity that resulted in the actual/potential contamination
- Any completed risks assessments relative to the contamination identified
- An updated site plan that clearly defines all areas of potential or actual contaminated areas
- Any interpretative reports that may exist, that may also recommend any remediation and/or clean-up actions for the site.

10 Contaminated Site Management Plans

Based on a formal risk assessment, in the event that unacceptable soil and/or groundwater contamination has been identified, then a Contaminated Site Plan (Queensland) or a Remediation Management Plan (South Australia) shall be drafted (See Appendix E Development of a Contaminated Site Management Plan).

Contaminated Site Management Plans (CSMPs) are used to formally manage the contamination on the site in a manner which protects human health and the environment and ensures that the site is suitable for the specified use.

Appendix E Completion of a Contaminated Site Management Plan

1 Introduction

This Appendix provides guidance to Santos personnel when assigned responsibility to develop and implement a Contaminated Site Management Plan (CSMP) at a known and/or verified contaminated site.

Based on a formal risk assessment, in the event that unacceptable soil and/or groundwater contamination has been identified, then a Contaminated Site Management Plan (CSMP) (Queensland) or a Remediation Management Plan (RMP) (South Australia) shall be drafted.

Santos has elected to utilise a single process for the development of a suitable plan for individually managing each contaminated site, which is applicable in all states that Santos operates in. The design, development and monitoring requirements associated with drafting a CSMP are included in this appendix.

In summary, these plans are used to formally manage contamination on the site in a manner which protects human health and the environment and ensures that the site is suitable for the specified use. Contamination may include, but not be limited to hydrocarbons, heavy metals, salts (saline water), other chemicals.

2 Queensland Regulatory Requirements Relevant to CSMPs

In Queensland, CSMPs are stand-alone public documents which become conditions on the use of the land. Their purpose is to clearly summarise the contamination issues and conditions associated with the use of the site, without the need for reference to site investigation reports.

3 South Australian Regulatory Requirements Relevant to RAPs/EMPs/RMPs

In South Australia, remediation generally starts with the preparation of a Remediation Action Plan (RAP) and an Environmental Management Plan (EMP). The RAP should detail the methods, processes and controls of the remediation activities. The EMP should address all environmental management issues. These two plans may be combined to form a Remediation Management Plan (RMP).

Note: In addition to the information contained in this Appendix, the development, submission and implementation of a RAP, EMP and RMP in South Australia, must also meet the requirements of Appendix B Remediation Plans in the *EPA Guidelines for Environmental Management of On-site Remediation (November 2008).* The key requirements of Appendix B are defined at the end of this document on pages 5 to 6.

4 Preparation of a Contaminated Site Management Plan

Santos CSMPs shall be stand-alone public documents which become conditions on the use of the land. They are to clearly summarise the contamination issues and conditions associated with the use of the specific Santos site, without the need for reference to site investigation reports.

If located in Queensland, CSMPs will be recorded on the Queensland Environmental Management Register (EMR) and made available to the public. As a result, they should be concise and written in plain English. Consultants' limitations clauses are not to be included in CSMPs. CSMPs may often be

satisfactorily completed in two A4 pages or less. However, some larger CSMPs may have appendices including plans which provide details of the location and design features of structures such as containment cells, leachate collection systems and monitoring wells.

5 Required Contents of a Contaminated Site Management Plan

All Santos draft CSMPs must:

- contain a summary report on the extent, nature and concentration ranges of contaminants (including scaled plans identifying contaminated zones in relation to existing buildings etc., where applicable)
- state the objectives to be achieved and maintained under the plan (e.g. measures proposed to be taken to manage the risk of serious environmental harm to persons, animals or any other part of the environment posed by the hazardous contaminants, both during redevelopment works and in the long term)
- state how the objectives are to be achieved and maintained (e.g. placement and maintenance of barriers between users of the site and the contamination and the application of controls on site excavation works)
- make provisions for monitoring and reporting compliance with the plan.

An example of a CSMP is included as Attachment 1.

Note: A draft CSMP must be accompanied by a statement from Santos agreeing to the draft plan.

6 Lodgment of a Contaminated Site Management Plan in Queensland

A draft Site Management Plan may be submitted for approval in Queensland:

- when a decision is made to leave some or all contamination on-site
- a detailed site investigation report has been assessed
- a qualitative or quantitative risk assessment has been conducted to demonstrate that the contamination can be adequately managed so that it does not pose an unacceptable health or environmental risk
- after the owner's consent to the draft site management plan has been obtained.

Submitted documents are to be secured but not bound. Electronic submission or provision of disks is generally acceptable (contact the Queensland Environmental Protection Authority (QEPA) – Contaminated Sites Unit for further details).

All references to companies or consultants involved in CSMP preparation, including document reference numbers, are to be deleted.

Plans attached to CSMPs are to be submitted in triplicate for public recording purposes; one copy is returned to the applicant. Attached drawings are not to exceed A3 in size.

The QEPA can request amendments to the draft CSMP, or approve the plan as submitted, or prepare another plan. Santos must ensure that the conditions placed on the use of the land are complied with and the plan objectives are achieved and maintained.

7 General Site Management Plan Issues

7.1 Design Considerations

In developing an CSMP, the primary design consideration should be to minimise the need for continuing maintenance and monitoring without conflicting with the primary objectives of the plan. For example, capping designs with an engineered life of greater than 30 years is normally preferred by regulators and would limit maintenance requirements to Santos and regulator inspections only.

When on-site contaminated site soil repositories are proposed, reference should be made to the NEPM for establishment of on-site containment facilities.

When the site is subject to development, CSMP conditions should be developed for both the development phase and the post-development phase.

7.2 Excavations

A Workplace Occupational Health and Safety (WOHS) Plan, which satisfies the requirements of the *Workplace Health and Safety Act 1989* (Queensland) and subordinate legislation, must be prepared by Santos for any site excavations. The CSMP should contain specific safety conditions which are limited to the particular risks and control measures associated with chemical contamination. It is not a requirement of an CSMP to develop a detailed WOHS plan covering all site safety issues involved in excavations, e.g. machinery use, noise, trench shoring and electrical safety.

The CSMP should stipulate that workers involved in any site excavation are to be provided with all relevant safety information and training relating to contamination before commencing site works. All contamination safety and excavation processes are to be documented and records kept which demonstrate CSMP compliance.

Site works relating to excavation, removal and/or disposal of soil must include provisions which ensure that the environment is protected e.g. preventing spread of contamination by controlling site runoff, spillage from haulage trucks or improper disposal of contaminated stormwater or seepage.

7.3 Containment

Where on-site containment or capping is required as part of the CSMP, strategies for managing leachate and ensuring the long-term stability of the area must be included by Santos. In cases where the integrity of the capped or contained area cannot be breached, or when structures cannot be erected in the area, appropriate safeguards such as fencing, signage or risk communication strategies need to be included.

Where short-term disturbances of the cap can be tolerated in order to perform redevelopment work on the site, mechanisms for managing the disturbance and reinstatement must be documented.

7.4 Monitoring and Compliance

To ensure compliance with the CSMP, monitoring and reporting details must be stipulated by Santos in the CSMP. For example, the frequency of inspections of the cap (by a qualified person) should be recorded.

Long-term monitoring may be necessary to confirm that the site is not posing an unacceptable health or environmental risk. Full details of the monitoring locations, parameters, duration and frequency should be proposed. Documentation of relevant monitoring data, including excavation details, soil disposal and safety records may be necessary. Reporting intervals (e.g. annual, twice yearly etc.) to the QEPA Contaminated Sites Unit in relation to compliance to CSMP conditions are to be established.

8 Remediation Management Plans (South Australia)

This section is intended to outline specific requirements associated with the submission of contaminated site management plans in South Australia. These requirements should be considered as additional to those listed in the Contaminated Site Management Plans (SMPs) specified in this Appendix.

All plans in South Australia are expected to provide sufficient detail to demonstrate that the person undertaking the remediation has clearly identified and considered the issues that are likely to occur throughout the duration of the project and how they will manage or mitigate these issues.

There are essentially four types of plans that need to be considered by Santos in South Australia, which are described in the following sections.

8.1 Remediation Management Plan (RMP)

Generally, a Remediation Management Plan (RMP) is a detailed document. It can incorporate the EMP and RAP (see below) and, if relevant, the bioremediation management plan (BMP). The preparation of an RMP avoids the need to produce numerous documents and provides sections on remediation management, environmental management and, if applicable, bioremediation management.

An RMP is useful on both small and large projects because it can save cost and time in document preparation and avoid duplication. It is not a summary document and in no way diminishes a person's responsibility to prepare a well constructed, detailed and clear plan for the entire remediation project.

8.2 Remediation Action Plan (RAP)

The preparation of a detailed RAP, or components of it on smaller projects, is expected for all remediation projects. The RAP should:

- set remediation goals that ensure that, on completion of the remediation and validation, the site will be suitable for the proposed use and will provide adequate protection of human health, property and the environment
- document the nature and extent of remediation necessary (for soils and groundwater) and describe the rationale for the recommended remedial option or combination of options
- detail all procedures and plans to reduce human health and/or environmental risks to acceptable levels for the proposed site use
- establish the environmental safeguards required to complete the remediation in an environmentally acceptable manner
- identify and include proof of the necessary approvals and licences required by regulatory authorities.

A RAP should focus on the remediation technology and its expected effectiveness, especially with respect to the remediation goals. The RAP should detail the following information:

- technology to be used
- expected by-products, wastes, discharges and outputs (including the management of these substances)
- timelines for on-site and off-site activities
- expected endpoints and outcomes
- results of trials on similar sites or the same site
- how the technology will be implemented
- contingency plans for equipment failure.

8.3 Bioremediation Management Plan

A Bioremediation Management Plan (BMP) is a specific document forming part of a bioremediation process. Bioremediation is a unique type of remediation that generally requires considerable time and careful planning to achieve successful outcomes. Details for preparing a BMP are provided in the SA EPA Guideline Soil Bioremediation. The BMP can stand-alone or form part of an RMP or RAP.

8.4 Environmental Management Plan

An Environmental Management Plan (EMP) must detail how the proposed remediation activities will affect the environment and the nearby receptors, and how these effects will be managed or mitigated. The EMP should demonstrate to all stakeholders that all of the potential environmental impacts from the proposed remediation activities have been considered, and that the recommended control measures take into account site-specific conditions. The document must be clearly articulated and not vague when discussing aspects, impacts and management measures.

Attachment 1. Example of a Contaminated Site Management Plan

Summary of Contamination

Hydrocarbon contamination remaining on Lot ___ on RP _____ is the result of fuel leakage from two underground fuel storages.

The extent of the contamination is identified on Figure XX with soil total petroleum hydrocarbon (TPH) concentrations in the identified contaminated area approaching 1500mg/kg in the C6-C14 range.

Objective of plan

To manage the hydrocarbon contamination remaining on Lot ___ on RP _____ in a manner which protects human health and the environment. This objective will be achieved through:

- the placement and maintenance of a barrier which safely separates users of the site, the contamination as well as restricting contaminant migration; and
- the application of controls on site excavation works.

Achievement and management of objectives

Santos (or Santos's agent) is to ensure the following conditions are complied with to ensure that the plan objectives are achieved and maintained:

1. The area of contamination identified in Figure XX is to be capped with concrete or bitumen paving (or similar) or with a minimum of 0.5m of compacted clean clay fill.
2. A Workplace Health and Safety Plan which satisfies relevant obligations of the Qld Workplace Health and Safety Act 1989, subordinate legislation or its equivalent is to be developed for all site work involving excavation of the identified contaminated area. This Workplace Health and Safety Plan must specifically address hydrocarbon dermal and inhalation exposures.
3. Approval under section 118ZZF of the Environmental Protection Act 1994 (or equivalent) must be obtained before removing any soil off-site from the identified area of contamination.
4. Site works relating to excavation, removal and/or disposal of soil from the contaminated area must include provisions which ensure that the environment is protected — e.g. preventing spread of contamination by controlling site runoff, spillage from haulage trucks or improper disposal of contaminated stormwater seepage. All contamination safety and excavation processes are to be documented and records kept which demonstrate site management plan compliance.

Monitoring requirements

A biennial review of the site including a review of excavation, soil disposal and safety records is to be undertaken by Santos and records kept. The QEPA Contaminated Sites Unit will undertake periodic inspections of the site. The biennial period is to commence from _____.

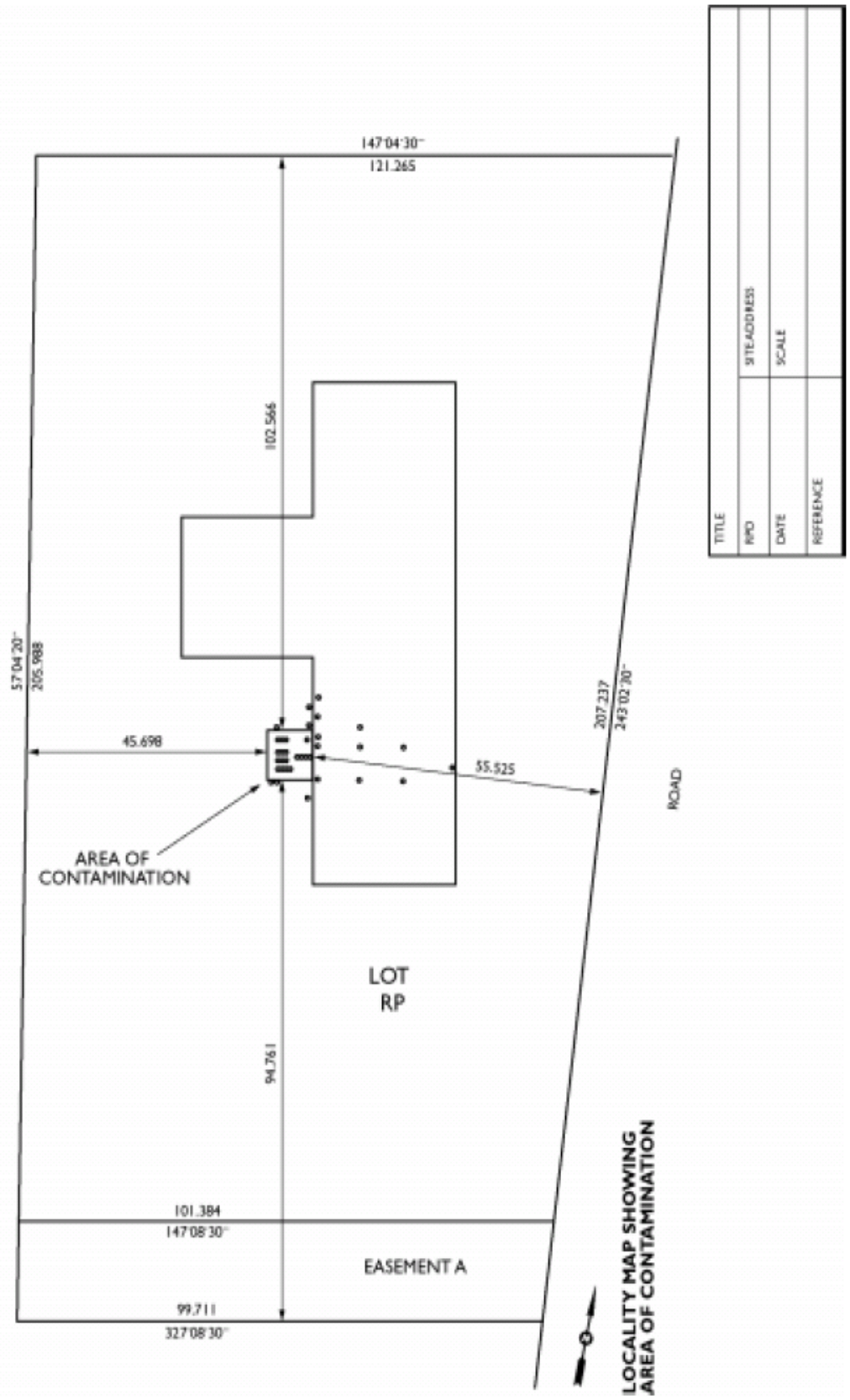


Figure 1. Example of simple but suitable site plan

Appendix F Statutory and Technical References for Contaminated Sites and Bioremediation Methods

1 Statutory References

1.1 Commonwealth Government/National Standards

› Standards Australia (1997) Australian Standard. Guide to the Sampling and Investigation of Potentially Contaminated Soil. Part 1: Non-volatile and Semi-volatile Compounds. AS 4482.1 — 1997. Standards Australia: Homebush.

ANZECC and NHMRC Publications

› http://www.environment.gov.au/about/councils/anzecc/index.html
› http://www.nhmrc.gov.au/guidelines/index.htm
› Australian and New Zealand Environment and Conservation Council (ANZECC) and the National Health and Medical Research Council (NHMRC) (1992) *Australian and New Zealand Guidelines for the Assessment and Management of Contaminated Sites*, January 1992
› ANZECC and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*, Paper No 4, October 2000
› ANZECC (1996) *Guidelines for the Laboratory Analysis of Contaminated Soils*. Australian and New Zealand Environment and Conservation Council: Canberra.
› NHMRC (1997) *Draft Cancer Risk Assessment for Environmental Contaminants*. National Health & Medical Research Council: Canberra.

National Environment Protection Council Publications

http://www.scew.gov.au/nepms/

National Environment Protection (Assessment of Site Contamination) Measure 1999.

The Measure consists of a policy framework for the assessment of site contamination, Schedule A (Recommended General Process for the Assessment of Site Contamination) and Schedule B (Guidelines). Schedule B guidelines include:

› B(1) Guideline on Investigation Levels for Soil and Groundwater
› B(2) Guideline on Data Collection, Sample Design and Reporting
› B(3) Guideline on Laboratory Analysis of Potentially Contaminated Soils
› B(4) Guideline on Health Risk Assessment Methodology
› B(5) Guideline on Ecological Risk Assessment
› B(6) Guideline on Risk Based Assessment of Groundwater Contamination
› B(7a) Guideline on Health-Based Investigation Levels
› B(7b) Guideline on Exposure Scenarios and Exposure Settings
› B(8) Guideline on Community Consultation and Risk Communication
› B(9) Guideline on Protection of Health and the Environment During the Assessment of Site Contamination
› B(10) Guideline on Competencies & Acceptance of Environmental Auditors and Related Professionals

EnHealth Publications (formerly National Environmental Health Forum monographs)

- Lock, W. H. (1996) *Composite Sampling*, National Environmental Health Forum Monographs, Soil Series No.3, 1996, SA Health Commission, Adelaide
- Department of Health and Ageing and EnHealth Council (2002) Environmental Health Risk Assessment: Guidelines for assessing human health risks from environmental hazards, Commonwealth of Australia, June 2002

1.2 South Australian State Government/SA EPA

http://www.epa.sa.gov.au

Guidelines

Available from http://www.epa.sa.gov.au/about_epa/types_of_publications

- *Guidelines for the Assessment and Remediation of Groundwater Contamination* (Feb 2009)
- *Assessment of Underground Storage Systems* (Feb 2005)
- *Composite soil sampling in site contamination assessment and managemen*t (March 2005)
- *Determination of background concentrations* (Dec 2008)
- *Environmental management of On-site Remediation* (Nov 2008)
- *Honesty in reporting* (Dec 2008)
- *How to determine actual or potential harm to water that is not trivial resulting from site contamination* (Dec 2008)
- *Notification of site contamination that affects or threatens underground water pursuant to section 83A of the Environment Protection Act 1993* (Dec 2008)
- *Responsibility for assessment and remediation of site contamination* (May 2009)
- *Site Contamination and the Environment Protection Act (1993)* pamphlet (Jan 2008)
- *Soil bioremediation* (Nov 2005)
- *Transfer of Liability* (Sept 2009)
- *What is site contamination?* (Jan 2009)

Audit System Information Sheets

- Overview of the site contamination audit system (Oct 2010)
- Using a site contamination auditor (Sept 2009)
- Information about site contamination audit reports and audit statements (Oct 2010)
- Implementing conditions of site contamination audit reports (Oct 2010)

1.3 Queensland State Government

http://www.ehp.qld.gov.au/

- Guidelines for the Assessment and Management of Contaminated Land in Queensland
- Management of Contaminated Land – website information exists relating to:
  - How is land contaminated?
  - *Sustainable Planning Act 2009*
  - *Environmental Protection Act 1994*
  - The Environmental Management Register (EMR)
  - Contaminated Land Register (CLR)
  - How is land recorded on the registers?
  - How is land removed from the registers?
  - Local government responsibilities

- Owner responsibilities
- What are site management plans?
- Safeguards for land purchasers
- Searching the registers
- Forms

1.4 New South Wales State Government

www.environment.nsw.gov.au

Guidelines

- *Guidelines on the duty to report on Contamination under the Contaminated Land Management Act 1997*

Guidelines from the NSW DECC

http://www.environment.nsw.gov.au/clm/guidelines.htm

- Guidelines for Assessing Service Station Sites, December 1994
- Guidelines for the vertical mixing of soil on former broad-acre agricultural land, January 1995
- Sampling Design Guidelines, September 1995
- Guidelines for Consultants Reporting on Contaminated Sites, September 2000
- Guidelines for the NSW Site Auditor Scheme (2nd edition), April 2006
- Guidelines for the Assessment and Management of Groundwater Contamination, March 2007

Management of Contaminated Land in NSW

Website information exists relating to:

- Role of DECC (including steps in regulating sites under the CLM Act)
- Role of planning authorities
- Policy on former unhealthy building land sites
- The NSW site auditor scheme aims to ensure proper management of contaminated land by providing a pool of accredited 'site auditors' who can be engaged to review investigation, remediation and validation work conducted by contaminated land consultants
- Details of all guidelines under the CLM Act made or approved by DECC
- Environment protection notices issued under the CLM Act, the names of sites and owners or occupiers and copies of site audit statements
- Information on engaging a consultant for contaminated site investigations and remediation in NSW
- Information on remediation of former gasworks sites
- Laws applying to underground petroleum storage systems
- Information on preventative approaches
- Frequently asked questions about contaminated land

1.5 Victorian State Government

http://www.epa.vic.gov.au

http://www.epa.vic.gov.au/land/

Contaminated Land Contaminated site information systems and Priority Sites Register:

- What are priority sites?
- What is the Priority Sites Register?
- Listing sites on the Priority Sites Register

- Removing sites from the Priority Sites Register
- Further information
- Guidance document to assist responsible planning authorities State Environment Protection Policy (Prevention and Management of Contamination of Land)
- How the environmental audit system can be used within the planning system Planning Practice Note: Potentially Contaminated Land.
- EPA Contaminated Site Information Systems Priority Sites Register
- *Policy Impact Assessment, State Environment Protection Policies – Land* (June 2002)
- *SEPP (Prevention and Management of Contamination of Land* (June 2002)

2 Bioremediation

- Cairney, Tom (1998) *Contaminated Land: Problems and Solutions* 2 edition, Taylor & Francis.
- Department of Environment, WA (2007) *Contaminated Site Management Series* (2001 – 2007).
- Nathanail C. Paul, and R. Paul Bardos (2004) *Reclamation of Contaminated Land*, Modules in Environmental Science.
- Petts, Judith, Tom Cairney and Mike Smith (1997) *Risk-Based Contaminated Land Investigation and Assessment*, Wiley.
- Riser-Roberts, Eve (1998) *Remediation of Petroleum Contaminated Soils: Biological, Physical, and Chemical Processes*, CRC-Press.
- Strange J. and N. Langdon (2007) *Contaminated Land: Investigation, Assessment and Remediation*, 2nd Edition, Ice Design & Practice Guides.

EHS08 Contaminated Sites

Santos

Appendix G Landfarm Guide

Contents

Revision 1

Prepared by	Mack Dreyer	Principal, Birchwood Environmental Services	July 2012
Reviewed by	Emma Dyer	Senior Environmental Adviser	August 2012
Approved by	Scot Shomer	Senior Environmental Adviser	August 2012

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1 Purpose and Scope

This landfarm guide provides the basic principles of landfarming, including:

- design fundamentals
- typical operation and maintenance methods
- typical performance monitoring practices
- end point determination
- final disposition of treated soils

The document is intended to provide guidance on landfarming, where:

- annual rainfall is moderate (neither flooding nor in prolonged drought)
- water tables are at least 15m below grade and infiltration of impacted water is minimal
- contaminated soil does not extend below the reach of tilling equipment (e.g. 0.5m below grade)
- landfarming is in constructed treatment cells

This guideline may also be applied to insitu landfarms provided the first three of the above criteria are fulfilled.

Should a landfarm be proposed in a location where conditions do not meet these criteria, additional requirements may be required (e.g. lining, leachate collection, placing in windrows). Additional requirements may also be required to ensure compliance with legal requirements, including environmental authorisations.

2 Introduction

One of the most effective and cost effective methods of remediating crude oil impacted soil is by landfarming. Landfarming stimulates aerobic bacteria to degrade petroleum hydrocarbons like crude oil and refined fuels into carbon dioxide and water. Landfarming optimises the health, population and capacity of the bacteria to digest the carbon source, by fertilising and watering the contaminated soil and then aerating it by turning the soil.

Potential constraints for the landfarm operations include:

1. *Location* – landfarms are remote from resources
2. *Electricity* – electricity may not be available. Portable generators may be used
3. *Rainfall* – too much rain may fall in the wet season and too little in the dry season
4. *Water* – water resources may not be near the landfarm. Depending on the circumstances, it may be necessary to transport water to the landfarm.
5. *Labour and equipment* – labour, equipment, and materials for construction and operation are likely limited and expensive
6. *Soil profile* - top soil must be handled and treated separately from deeper excavated soils

Practical landfarm construction and operation should be simplified wherever possible. For example:

- impermeable bottom liners (made from concrete, asphalt, plastic, or imported clay) will generally not be installed in landfarms located in areas of very low expected rainfall and/or infiltration capacity
- liquid leachate collection and management may not be installed in landfarms located in areas of very low expected rainfall
- mechanical irrigation and aeration by mechanical forced ventilation methods may not be feasible in remote harsh environments.

The primary means and methods for construction and operation are conventional fuel-driven and/or towed-behind construction or farm equipment. It is reasonable to expect that labour and equipment could be sourced from local earthmoving or agricultural suppliers.

3 Landfarms – How They Work

Landfarming is the stimulation of aerobic bacteria to degrade petroleum hydrocarbons in soil by tilling, fertilising and watering soil. Landfarming can be performed either in place, for shallow soil contamination less than 0.5 metres below grade, or in constructed treatment cells.

The term landfarming was coined because soil remediation methods resemblance to conventional farming during its ploughing, tilling, fertilising, and planting stages.

A typical landfarm setup is shown in Figure 1. Photographs of typical landfarming operations are shown in Plates 1 to 9.

Landfarming is well-established in the petroleum industry as a simple, effective, and cost effective means of reducing hydrocarbon contaminants in soil. Treatment to reasonable end points can take as little as a few months for lighter more-biodegradable hydrocarbon fractions or as long as several to many years to effectively degrade heavier hydrocarbons. Fortunately, heavier harder-to-degrade hydrocarbons are less soluble in water and less mobile than their lighter counterparts.

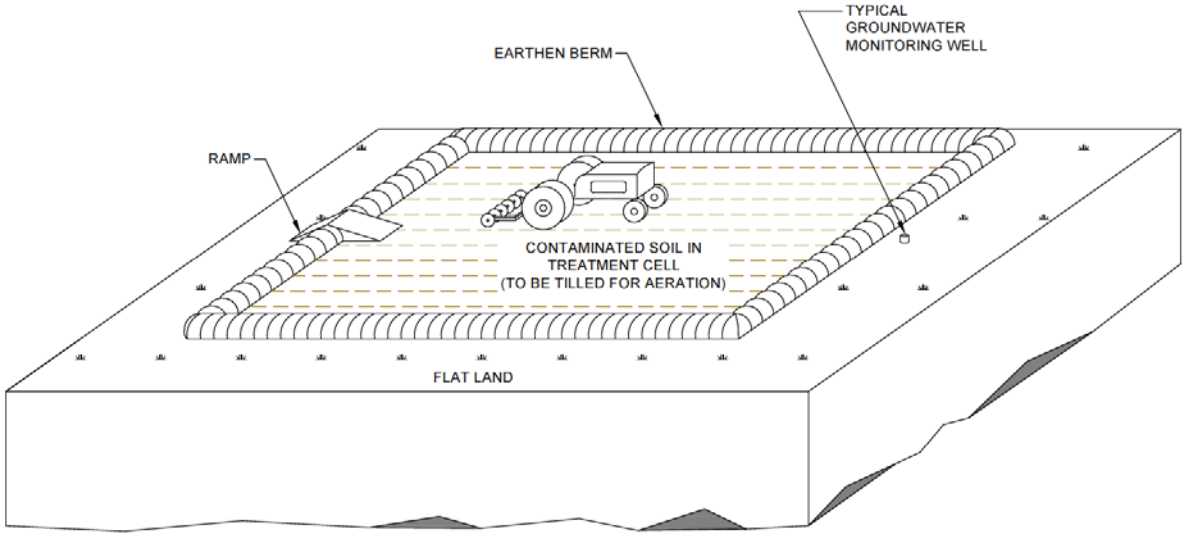


Figure 1. Typical landfarm schematic

Plate 1. Earthen berm

Plate 2. Tilling using a tractor attachment

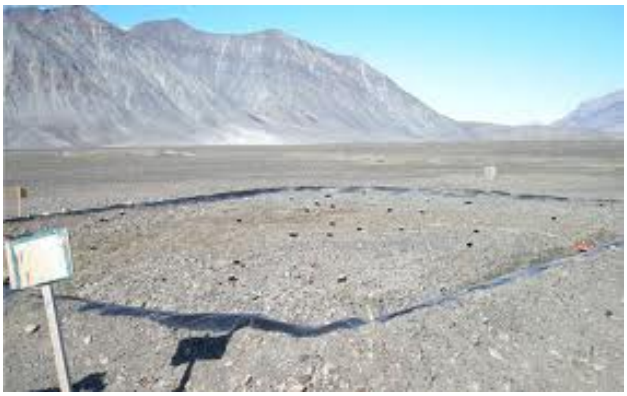


Plate 3. Working landfarm

Plate 4. Tractor aerating contaminated soil

Plate 5. Dozer preparing landfarm site by moving topsoil and compacting the base

Plate 6. Active landfarm with stockpiled soil waiting for treatment at the rear and aerated, tilled soils in foreground

Plate 7. Two-cell landfarm - right hand landfarm has had recent application of heavily contaminated soil

Plate 8. Landfarm during construction with impermeable (plastic) liner being applied

Plate 9. Initial construction of a landfarm

The essential elements for effective biodegradation of hydrocarbons are:

1. *Food* – dissolved hydrocarbons provide the food. Competition from other food sources such as organic bulking material (like wood chips) can inhibit effective treatment.
2. *Essential nutrients* – fertiliser adds essential nutrients (mostly nitrogen and phosphorus). But too much nutrient inhibits optimum biodegradation. As soil moisture levels at landfarms are likely to be low (<5% (by weight)), nitrogen to moisture ratios (N:H20) greater than 0.005 (0.5%) should be avoided to prevent metabolic inhibition by osmotic shock. The recommended maximum nitrogen requirement for these soils is 250 mg/kg (ppm) as N. Phosphorus should be maintained at concentrations between 125 are 250 mg/kg (ppm) as P. A 50 ppm increase in nitrogen and phosphorus can be afforded for every 1% increase in minimum moisture content above 5% by weight. [A C:N:P ratio of 100:2:1 is typical for well-watered moisture-controlled landfarms; however, it is reasonable to expect site conditions at the subject landfarms to be on the low range of optimal to sub-optimal most of the time.]
3. *Water* – optimum moisture content is between 5 and 25 percent (%) by weight; too much limits effective oxygen transport (effectively drowning the aerobic bacteria), too little results in wilting or die-off of the beneficial bacteria. Note that if the landfarm becomes flooded the treatment process must cease and water must be removed from the landfarm to permit the continued treatment of the hydrocarbon impacted soils.
4. *Bacteria* – hydrocarbon degrading bacteria are usually naturally-occurring in soil, but specialty bacteria are readily available for seeding.
5. *Oxygen* – oxygen is introduced into the soil pores from ambient air by tilling and/or diffusion.
6. *Protection from harsh conditions* – extreme conditions include temperature, pH, moisture, and toxic inhibition. Suitable environment includes typical ambient temperatures between 10 and 40 °C, pH between 6.5 and 8, moisture content between 5 and 25% by weight, and free of toxic inhibitors such as pesticides, heavy metals and high salinity.

4 Consultation and Approval

Whilst the principles of landfarming are straightforward, applying them will vary from site to site.

Early, ongoing and close liaison with the relevant Environmental Adviser is required to ensure all aspects of a landfarm are managed well.

Where necessary, the relevant Environmental Adviser shall seek technical guidance from a contaminated sites or landfarming expert.

Prior to any on-ground activity, internal environmental approval must be granted by the relevant Environmental Adviser. At this time, any additional (e.g. external regulatory) approvals will be identified. External approvals may take some time to obtain.

Additional environmental approvals are required if:

- additional treatment cells are required (i.e. expansion)
- changes to soil contaminants being added are identified (e.g. other chemicals are found in the contaminated soil)
- landfarming activity ceases and rehabilitation is proposed

5 Design

Conceptual landfarm design is shown in Figure 2.

5.1 Location, layout, and depth

Landfarms can be located wherever practical. Landfarms constructed to treat contaminated soil from a single source should be located close to the source. Landfarms constructed to treat contaminated soil on an ongoing basis from many sources should be constructed close to facilities that can provide personnel, machinery, water, nutrients and electricity.

A landfarm should be located on a flat or gently sloping site (less than 1% grade) with reasonable access to and from the untreated soil stockpile. Low permeability soils are preferred over high permeability soils.

Landfarms should not be constructed:

- in flood plains
- in or near drainage features susceptible to excessive erosion
- within 50metres of a surface water body
- where groundwater is less than 10metres below grade
- in close proximity to stormwater drains or service trenches
- in close proximity to water wells
- within 500metres of residential dwellings or site camps
- within 50metres of odour-sensitive receptors e.g. facilities
- in areas of significant environmental value

A landfarm can be constructed to any practical shape, as dictated by space and topography constraints. The location of an access ramp for machinery should be considered. The shape of the landfarm should consider how aeration by tilling will be undertaken.

The depth of the contaminated soil in the landfarm will be limited by the equipment available to aerate the soil, which is not usually greater than 0.5m. Windrows may be higher (e.g. 2m to 3m). In this case, contact the relevant Environmental Adviser for design and management advice.

Additional land area around the landfarm will be required for containment berms and access.

If flooding is likely to be periodic, installation of a leachate drainage system or placement of soil into windrows may be required. The resultant leachate will require appropriate treatment and disposal.

If a landfarm is being constructed for ongoing receipt of petroleum hydrocarbon contaminated soils then consideration must be given to making the landfarm large enough to manage the incoming soils so that they can be segregated on arrival to separate old soils with advanced bioremediation from fresh, highly impacted material.

5.2 Size

The size and dimensions of a typical landfarm can be defined using the following:

$A_{tc} = V_f/D_s$
$= V_f/0.5$
$= 2V_f$

where A_{tc} = nominal area of a treatment cell (m^2)
D_s = design depth of landfarm soil layer (m) – typically 0.5m
V_f = fluffed volume (m^3)

$V_f = 1.3V_{ip}$

where 1.3 = the "fluffing (or bulking) factor"
V_{ip} = in place volume (m^3)

Example scenario:

Hydrocarbon-impacted soil was excavated to 5m deep across a 50m x 20m area. The top 1m of excavated soil is defined as "top soil" and shall be treated separately from the remaining excavated soil. Landfarm design depth is 5m.

V_{ip} = 5m x 50m x 20m
= 5000m3

$V_f = 1.3V_{ip}$
= 1.3 x 5000
= $6500m^3$

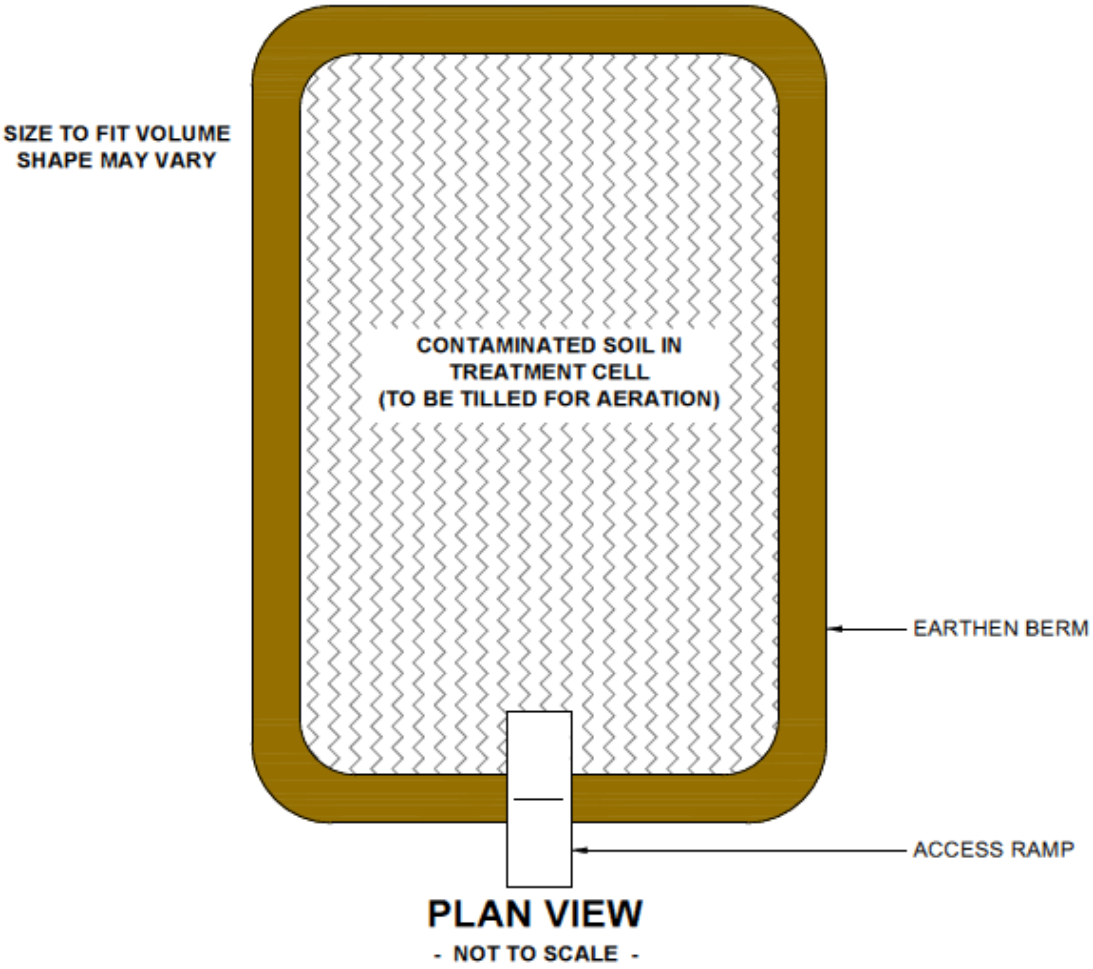
V_f(top soil) = 6500 x (1m/5m)
= $1300m^3$
V_f (underburden) = $6500m^3$ – $1300m^3$
= $5200m^3$

Area of treatment cells:

A_{tc}(top soil landfarm) = V_f/ D_s
= $1,300m^3/0.5m$
= $2600m^2$
A_{tc}(underburden landfarm) = V_f/ D_s
= $5,200m^3/0.5m$
= $10\ 400m^2$

Reasonable dimension for the two landfarm treatment cells might be:

Top soil landfarm dimensions (LxW) = 52m x 50m
(= $2600m^2$)
Underburden landfarm dimensions (LxW) = 104m x 100m
(= $10\ 400m^2$)



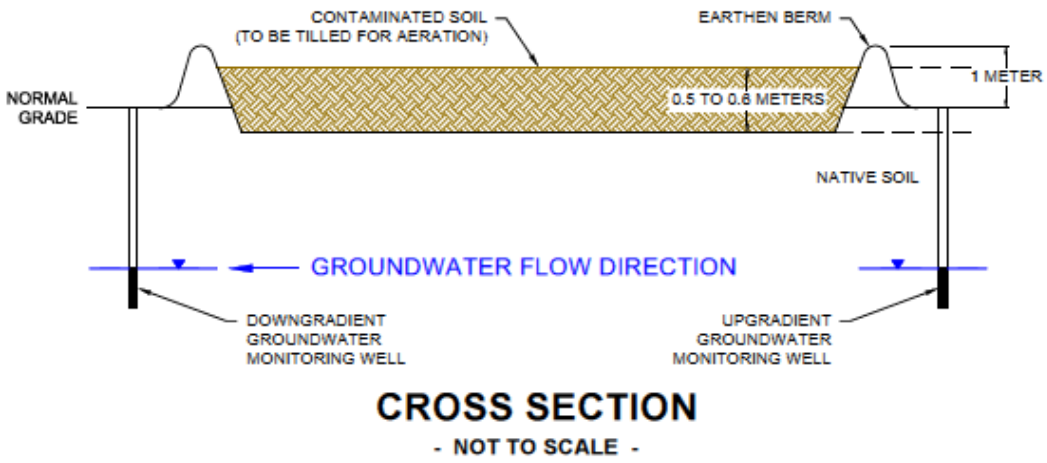


Figure 2. Typical Landfarm Design

5.3 Lined vs unlined

Generally a landfarm will be unlined, but be cleared of vegetation and proof-rolled to minimise infiltration and verify the treatment cell platform is sufficient to withstand repeated tilling. Where indicated by proof-rolling, the treatment cell platform shall be compacted until it is suitable. It is recommended that the relevant Environmental Adviser be consulted if there is any doubt as to the suitability of the treatment cell platform (e.g. high permeability (sandy) soils).

It is not expected that leachate collection will be necessary unless periodic saturation of the landfarm is likely.

5.4 Earthen berms

Landfarm treatment cells should be encompassed in an approximately 1metre high earthen berm. There needs to be sufficient freeboard within the berm to accommodate water from high rainfall events. Spoil from clearing operations may be suitable for constructing perimeter earthen berms. One or more earthen access ramps will provide access into and out of the landfarm. Earthen berms for landfarms shall be maintained as per EHS02 USTs and Bunds.

5.5 Stormwater Management

Control of stormwater runon and runoff is necessary to prevent water saturation of the treatment cell, washout of the soils in the landfarm, and to minimise the potential for infiltration of impacted water. Generally earthen berms are all that is needed to prevent runon. However, to intercept and divert stormwater flow, grading or ditches may be required. The treatment cell capacity will be of sufficient volume and that there will be enough evaporation and percolation between rain events that overflow is unlikely.

For landfarms located in areas of higher rainfall, further measures should be considered, such as increasing the height of the perimeter berms or incorporating a stormwater retention pond within the landfarm.

5.6 Watering

It may be possible to have watering infrastructure at landfarms located near existing facilities e.g. Moomba landfarm, Jackson landfarm. In drought conditions, periodic watering of the landfarm may be required to maintain the population of oil consuming microbes. This can be easily achieved with the use of farm sprinklers or a water truck with directional spray capacity.

5.7 Monitoring infrastructure

If a landfarm receives contaminated soil for treatment on an ongoing basis, rather than to treat a single spill, it is likely that groundwater monitoring will be required.

Monitoring may be also required if groundwater is within 15m of grade. Legal obligations, including conditions of environmental authorisation, may also require that groundwater monitoring be undertaken.

Groundwater quality will be monitored with wells constructed upgradient and downgradient of the landfarm. Generally, specialist drilling equipment is required to construct monitoring wells to minimise the risk of contamination.

Groundwater monitoring must be assessed on a site-by-site basis by the relevant Environmental Adviser, who will advise:

- whether groundwater monitoring is required
- number and location of monitoring wells
- proposed sampling regime (analytes and frequency)

6 Preconstruction Planning

Planning for construction involves:

- selecting a site
- completing detailed design
- preparing a project plan
- reviewing legal requirements and permitting
- liaising with regulators
- health and safety planning
- obtaining funding
- purchasing and contracting
- undertaking preliminary characterisation of contaminated soil to determine
  - if the soils are suitable for landfarming (e.g. high metal concentrations, high salinity or sludges may require the investigation of alternative treatment/disposal methods)
  - initial fertiliser dosage and whether or not bacterial seeding is required
- consulting with relevant Environmental Adviser to determine site specific conditions that may require modifications to optimise performance

7 Site preparation and initial application

Site preparation involves:

- removing vegetation with some top soils in the footprint of the treatment cells to achieve a flat platform
- constructing perimeter earthen berms around the treatment cell (spoils from clearing and grading may be used)
- proof-rolling the treatment cell platform and compacting to minimise infiltration or delineate the base of the landfarm treatment cells
- constructing groundwater monitoring wells, if required

No on-ground activity can commence without at least internal environmental approval and may require external regulatory approval. Refer to Section 4 for more information.

Onground activities undertaken include:

- baseline monitoring sampling and analysis of groundwater (if required)
- baseline sampling and monitoring of treatment cell platform soil
- staging and placing of impacted soil into the treatment cell
- baseline sampling and analysis of contaminated soil
- initial fertilisation
- initial bacteria seeding, if indicated)
- initial aeration
- initial pH adjustment if required. (Optimal soil pH should be in the range 6.5 to 8)

8 Landfarm Operation and Maintenance

8.1 Soil placement

Contaminated soil should be placed in the landfarm to a uniform thickness not to exceed 0.5m. Soil thickness will be limited by the ability of the chosen tilling equipment to fully turn the soil layer.

Contaminated top soil should be kept separate as it may have properties (e.g. structure, nutrients) that once the impacted soils are remediated will make it easier to revegetate the site if it is reapplied as a top soil.

If a landfarm is being constructed for ongoing receipt of hydrocarbon contaminated soils then the landfarm should be made large enough to segregate incoming soils on arrival. **The landfarm should be zoned with old soils with advanced bioremediation separated from fresh, highly impacted material. Mixing soils at different stages of bioremediation will lengthen the treatment time of the soil already in the landfarm and ultimately limit the volume of soil able to be treated in the landfarm**.

8.2 Aeration

Frequent and complete aeration will result in better (faster) treatment. The more plastic (less granular, clayey) the soil, the more important it is to turn the soil regularly, both for aeration and for mixing. Generally soils with more clay are of this type.

Aeration will be typically accomplished on a batch basis using single-pass or multi-pass motorised or pull-behind tilling equipment at regular intervals ; typically monthly. More frequent aeration frequencies (e.g. weekly to bimonthly) should result in faster treatment times. Cost and regulatory requirements (e.g. maximum treatment duration) are likely to influence aeration frequency.

8.3 Fertilisation

It is likely that macro-nutrients nitrogen and phosphorus will have to be supplemented at landfarm inception. Additional supplements may be required to a lesser degree as the landfarm becomes operational.

Fertiliser should be applied with cast-spreading and tilling of granular fertiliser. Slow-release fertilisers are preferred over instant-release varieties. For example, urea releases nitrogen at a slower rate than ammonium nitrate.

The approximate initial macro-nutrient application rate, assuming negligible native nitrogen and phosphorus content, is of the order of 1,000kg/ha as N and 500kg/ha as P.

Fertiliser addition should be reduced over time as the nutrient builds up in the soil. Annual fertiliser additions should be made to keep the concentration of nitrogen in the range of 150 to 350mg/kg and the phosphorus concentration in the range of 75 to 150 mg/kg. Nitrogen and phosphorus concentrations in treated soil should be monitored yearly or twice yearly to determine further fertiliser adjustments.

Essential micro-nutrients such as calcium, iron, magnesium, potassium, sodium, and sulfur should be available in the native soil at quantities sufficient to support effective biodegradation throughout the life of the landfarm. In any case, most fertiliser blends contain these micro-nutrients.

Literature values for optimum C:N:P ratio range from 100:10:1 to 100:1:0.5. The actual optimum C:N:P depends on:

- the nature and concentration of the petroleum hydrocarbon in in soil
- degree of acclimation of the bacteria at the time fertiliser is added
- adequacy and uniformity of moisture, temperature and pH

It is important not to overdose fertilisation. Regular testing for nitrogen and phosphorus will assist in dosing correctly. It is difficult or impossible to "undo" an overdose of nitrogen (or phosphorus).

Remedies include:

- time
- water flushing
- loss through percolation
- addition of "food"
- dilution by addition of supplemental soil

With the exception of time, the remedies above for over dosing nutrients are impractical at remote landfarms.

8.4 Bacteria Seeding

Most landfarms will find that native bacteria are sufficient for bioremediation. Seeding with commercially-available hydrocarbon-degrading bacteria of choice is only required if initial performance is below expectations. Some bacteria products can be cast-spread as a powdered material while other bacteria cultures come in concentrated liquid form for application with a conventional hand-pump sprayer, and others (liquid or solid) require dilution with water prior to application and are best applied with conventional farm-type liquid fertiliser delivery equipment.

8.5 Soil pH

Soil pH should be maintained between 6.5 and 8 to provide a suitable environment for microbial growth and to stabilise soil metals. Optimum pH is 7.2 to 7.5.

Adding enough lime at inception to raise the soil pH of 7.2 to 7.5 (or, rarely, aluminium nitrate or aluminum sulfate to reduce soil pH) should be sufficient to maintain appropriate pH throughout the life of the landfarm. Lime in the form of ground agricultural limestone ($CaCO_3$) is preferred over quicklime and other forms because it is less expensive and applying excess amounts should not adversely affect bioremediation activity. Generally, about 2000 kg/ha of limestone will raise the soil pH by 1.

8.6 Moisture Control

It is expected that water will be derived from precipitation. Depending on the landfarm's proximity to a facility, tankering and applying water to the facility may be possible. Water application will be beneficial if soil moisture drops below 5% and there is a requirement to remediate the soils in a relatively short timeframe. Where water is readily available, soil moisture should be maintained between 5 and 25 % by weight. Farm sprinklers or a water truck with directional spray capacity may be used.

Care should be taken not to saturate landfarm soils during watering. **If saturation occurs and is likely to be that way for some time, bioremediation will cease and the risk of creating environmental harm (e.g. release of contaminated water) is also increased**. Refer to Section 8.7 for more information about managing saturation.

8.7 Flooding

If a landfarm is likely to remain saturated for an extended period of time, the landfarm's ability to degrade the hydrocarbon impacted soil will be restricted or stopped. The risk of environmental harm resulting from the landfarm (e.g. release of contaminated water) is also increased.

If a landfarm becomes flooded, any other activity (e.g. tilling or fertilising) must cease and water be removed from the landfarm. Contact the relevant Environmental Adviser immediately to identify water management requirements (e.g. testing, treatment, disposal options).

After the water has been removed, impacted soils may be piled into windrows to facilitate further draining of soils.

If flooding is likely to be periodic, installation of a permanent leachate drainage system may be required. The resultant leachate will require appropriate testing, treatment and disposal. There may be legal requirements about leachate disposal. Contact the relevant Environmental Adviser for more information.

8.8 Maintenance and reporting

The following are required to ensure the landfarm remains in good operating condition:

- maintenance of earthen berms
- maintenance of stormwater drainage
- maintenance of access roads
- maintenance of groundwater monitoring wells

In addition, the following are required:

- record-keeping (volume/date)
  - soil delivered/stockpiled/added for treatment/removed
  - water applied
  - fertiliser applied
  - pH adjusted
  - bacteria seeding
  - aeration
- performance monitoring (refer to Section 9)
- performance reporting, including any reports to regulators

9 Monitoring and Validation Requirements

Landfarm soils should be monitored regularly to determine concentrations of the following:

- hydrocarbon
- nitrogen
- phosphorus
- soil pH

Monitoring requirements may be varied depending on legal requirements or project plan. In addition, site-specific environmental authorisation conditions may require different testing and or frequency.

Baseline sampling for all analytes should be conducted prior to the landfarm development.

Analyses may be performed by a variety of field instrumentation or test kits, or analysed in a laboratory.

The results from periodic monitoring should be compared to baseline or typical values and used to optimise landfarm performance including adjusting:

- aeration method and/or frequency
- nutrient application
- soil pH
- moisture

The sampling strategy should be developed by the relevant Environmental Adviser. Sampling should be undertaken in accordance with the requirements of Australian Standard 4482.2 (Standards Australia, 1999).

Typical monitoring parameters and frequencies are shown in Table 1. Depending on the nature of the soil contaminants, it may be necessary to monitor soil metals concentrations.

Baseline, performance monitoring, and validation sampling should combine a sufficient number of randomly-selected or grid determined soil samples to provide a representative profile of the soils in the treatment cell. Soil samples should be uniformly distributed throughout the treatment cell, both spatially and with depth. There should be consideration of variability in soil heterogeneity and analyte concentration levels across the treatment cells. However, treated soils will become more homogeneous over time due to mixing.

The number of samples collected and analysed should be adequate to provide a statistically reliable result, taking into account the intended use of the soil. Table 2 shows the recommended number samples per volume of landfarm soils.

Treatment is complete when target end points have been achieved, or it can be demonstrated that the residual concentration of a chemical substance will not pose a risk to human health and/or the environment, including leaching to groundwater.

The following resources include suitable sampling and analysis methods:

- *Draft National Environment Protection (Assessment of Site Contamination) Measure 2011* (National Environmental Protection Council, 2011) (the Draft NEPM)
- *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods* (SW-846) (United States Environmental Protection Agency, nd)

Analyte	Landfarm soils	Landfarm platform or sub-platform soils	Groundwater
Total petroleum hydrocarbons (TPH) and/or other prescribed organics	• Baseline • Quarterly – first year • Annual thereafter	• Baseline • After removal of farmed soils	• Baseline • Quarterly – first year • Biannual thereafter to coincide with wet and dry seasons
Nitrogen (as N)	• Baseline • Quarterly – first year • Annual thereafter	Optional	Optional
Phosphorus (as P)	• Baseline • Quarterly – first year • Annual thereafter	Optional	Optional
pH	• Baseline • Quarterly – first year • Annual thereafter	Optional	Optional
Groundwater elevations	Not applicable	Not applicable	• Baseline • Quarterly – first year • Biannual thereafter to coincide with wet and dry seasons
Soil hazard characterization analytes Monocyclic aromatic hydrocarbons Polycyclic aromatic hydrocarbons Benzene C_6 – C_9 petroleum hydrocarbons C_{10} – C_{36} petroleum hydrocarbons	• Baseline • Pending end point determination	Optional	Optional
Moisture content	Not applicable	Not applicable	Not applicable
BTEX	Optional	Optional	Optional
Metals	• Baseline • Ongoing as required	Optional	Optional
Total phenols	Optional	Optional	Optional
TOC	Not applicable	Optional	Optional
TOX	Optional	Optional	Optional
Dissolved solids	Not applicable	Not applicable	Optional
Cation exchange capacity	Optional	Optional	Not applicable

Table 1. Typical Monitoring Parameters and Frequencies

Landfarm soil volume (m^3)	Minimum number of samples or composite sample aliquots for 95% UCL[1]
100	4
200	8
300	10
400	10
500	10
600	10
700	10
800	10
900	10
1000	10
1500	10
2000	10
2500	10
3000	12
4000	16
4500	18
5000	20
>5000	1 per every 250 m^3

Table 2. Recommended Number of Soil Samples for Landfarm Performance/Validation Monitoring[2]

10 End Point Criteria

End point criteria for landfarms should be developed on a site-by-site basis. The end point remediation criteria depend on a number of factors including, but not limited to:

- location of treated soils
- final land use for treated soils
- owner of land (e.g. Santos vs non-Santos)
- expected ongoing management controls
- legal requirements

Liaison with the relevant Environmental Adviser will be required to determine appropriate remediation end point criteria for soil at each landfarm.

As a general guide, it is recommended that initially end point criteria be based on the environmental screening levels (ESL) for TPH fractions, BTEX compounds and benzo(a)pyrene found in the Draft NEPM (NEPC, 2011).

Note that human health screen criteria have not been included in developing the ESL criteria referenced in Table 3. However, ESL criteria for hydrocarbons are generally lower than human health screening criteria. In addition, landfarm treated soils are unlikely to be used in a scenario where human exposure is a complete exposure pathway. Human health screening criteria will need to be reviewed if

[1] The 95% upper confidence limit (UCL) provides 95% confidence that the true average analyte concentration in soil represented by the data set is at or below the average or composite concentration reported.
[2] Pursuant to Table 3 of Industrial Waste Resources Guideline for Soil Sampling IWRG702-2009

there is some likelihood that the landfarmed soils will be used in a scenario where the human exposure pathway is complete.

Note also that heavy metal end point remediation criteria have not been included developing the ESL criteria referenced in Table 3. Heavy metal contamination is dependent on the source of the contaminated soil. Generally heavy metal contamination will not be of concern in Santos hydrocarbon contaminated soil. However, if required, end point heavy metal criteria may be developed from the Draft NEPM (NEPC, 2011).

Soils with hydrocarbon concentrations above those identified in Table 3 may still be suitable for on-site use, for example, as landfill day cover.

Chemical	Soil type	ESLs (mg/kg dry soil) low reliability for various land uses		
		National parks and areas of significant environmental value	Urban residential and public open space	Commercial and industrial
F1 C_6 – C_{10}[3]	Generic	125	180	215
F2 >C_{10} – C_{16}[3]		25	120	170
F3 >C_{16} – C_{34}	Coarse	-	300	1700
	Fine	-	1300	2500
F4 >C_{34}	Coarse	-	2800	3300
	Fine	-	5600	6600
Benzene	Coarse	10	50	75
	Fine	10	65	95
Toluene	Coarse	10	85	135
	Fine	65	105	135
Ethylbenzene	Coarse	1.5	70	165
	Fine	40	125	185
Xylenes	Coarse	10	105	180
	Fine	1.6	45	95
Benzo(a)pyrene	Coarse	0.7	0.7	0.7
	Fine	1.4	1.4	1.4

Table 3. ESL End Point Criteria

Source: Draft National Environmental Protection (Assessment of Site Contamination) Measure, 2011

[3] Moderate reliability ESLs

11 Final Deposition

Treated soil is removable when the soil reaches its prescribed end point concentrations. Options for use of treated soil include, but are not limited to:

- top soil: spread locally and revegetated
- sub soil: local fill material

Prior to deposition, it is necessary to demonstrate that proposed uses do not pose unacceptable risk to human health or the environment.

There may be additional legal requirements that must be met prior to disposal. Approval from the relevant environmental regulatory authority may be required prior to removal. Contact the relevant Environmental Adviser for more information.

12 Closure and rehabilitation

For landfarms constructed to treat contaminated soil from a single source, closure may commence when end point criteria has been reached and appropriate regulatory approval has been granted.

Landfarms constructed to treat contaminated soil on an ongoing basis from many sources are likely to be closed some time after activities cease in the area.

In all cases, it will be necessary to demonstrate that the site does not pose unacceptable risk to human health or the environment. At sites where groundwater has been identified as requiring monitoring, it will be necessary to demonstrate that groundwater has not been adversely affected and pose an unacceptable risk to human health or the environment.

At minimum, the following requirements must be fulfilled prior to closing a landfill:

- remove any remaining contaminated soils for further treatment or disposal elsewhere.
- remove all surface infrastructure (e.g. watering systems)
- cap monitoring bores
- reprofile surface to be consistent with surrounding landforms

Further remediation may be required if groundwater has been impacted.

In some cases (e.g. single source landfarms) the landfarm can be abandoned in place simply by levelling the site and revegetating the area.

There may be additional closure requirements to ensure compliance with legal obligations.

Post rehabilitation monitoring to assess revegetation and erosion should be undertaken 6 months, 1 year and 2 years after rehabilitation and initiate any remedial work as required

Further ongoing monitoring may be required if issues are identified.

13 Glossary

Areas of significant environmental value	An area, however large or small, assessed to be of significant environmental value due to its: • contribution to maintaining biological diversity and integrity • having intrinsic or attributed scientific value • importance in providing amenity, harmony or sense of community Examples of areas of significant environmental value include: • large tracts of remnant vegetation • wildlife corridors • habitat for plants and animals of conservation value • areas of significant biodiversity or ecosystem function value (e.g. established riparian zones of waterways) Areas of significant environmental value include areas identified by legislation to be of significance, including but not limited to: • World Heritage Areas • Conservation Area • Endangered Regional Ecosystems • Marine Parks • Habitat of Threatened Species • National Parks • Mapped Environmentally Sensitive Areas in Queensland
Bioremediation	The use of micro-organisms to remove pollutants
ESL	Environmental screening level Used to evaluate: • whether or not potentially contaminated soils need to be remediated • whether or not a site-specific risk evaluation should be performed • if an area has been adequately cleaned. These screening levels are based on general assumptions and therefore do not reflect site-specific exposure conditions.
In-situ	In place – referring to undertaking bioremediation of a contaminated site at the site itself. Contrary to ex situ, where contaminated soil is excavated and cleaned elsewhere, off site
Landfarming	Stimulating aerobic bacteria to degrade petroleum hydrocarbons like crude oil and refined fuels into carbon dioxide and water by fertilising, watering aerating the contaminated soil
Osmotic shock	A sudden change in the solute concentration around a cell (e.g. bacteria), causing a rapid change in the movement of water across its cell membrane. Under conditions of high concentrations of either salts, substrates or any solute in the supernatant, water is drawn out of the cells through osmosis. This also inhibits the transport of substrates and cofactors into the cell thus "shocking" the cell.

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[4] It is recognised that the draft NEPM does not currently carry endorsement from the NEPC or any member government. However, it is likely to be finalised in the coming months. When the draft NEPM document is finalised, it is recommended that this Landfarm Guide be reviewed to ensure any required changes are made. It is noted that the ESL criteria in the draft NEPM have been developed from the Canadian Council of the Ministers of the Environment (CCME) documentation with modification to be consistent with the Australian methodology. As result the draft ESL criteria are considered the best Australian based environmental petroleum hydrocarbon screening criteria currently available.

Narrabri CCC

Information Request Response

Reference:	130618_NCCC
Subject:	Information Request Item Narrabri CCC
Request date:	3/06/2013
Requested by:	David Ross Chair Narrabri CCC
Background Request:	**Request 3/6/2013**: 10. Further information on recent announcements in relation to the realignment of the project and focus on Narrabri and the Pilliga as requested by one of the members.
Response:	**Item 10 – Energy NSW Narrabri Focus** • Santos has substantial quantities of natural gas reserves in the Narrabri area and is investigating the viability of a natural gas project focussed in the Pilliga State Forest. • To gather the information needed to proceed with this project, Santos is narrowing the focus of the exploration and appraisal program in the State to a number of pilots in the Pilliga. • At this stage, Santos will not carry out exploration activities in other parts of NSW. • The planned exploration operations in the Pilliga will not impact strategic agricultural land, will not be situated close to town centres and most activity will take place in a section of the State Forest specifically set aside by the Government for recreation, timber and the resources industry. • Santos will also commence work on the approved Leewood Produced Water Facility within the next six weeks, which is a crucial part of the rehabilitation work in the State Forest. • Santos will continue to increase our understanding of the local area by undertaking environmental studies including air and water monitoring programs and ecological studies. • Santos' increased focus on Narrabri will mean further investment and ongoing community engagement in the area.
Briefing Officer:	Deena McMullen Manager, Stakeholder Relations
Date:	18/06/2013

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Santos pilloried over Pilliga

There is miserable synchronism to news of an unlikely alliance between the oil industry, its union and the nation's biggest employer lobby in the cause of coal seam gas extraction in NSW that comes but 24 hours after the state government triggered prosecutions of Santos over past drilling practices in the Pilliga forest .

Santos's issues in the Pilliga are informative of the reasons why coal seam gas is such a sensitive regional issue, of the ability of the anti-drilling lobby to create a sense of crisis where there is none, and of the lack of reason that sits at the heart of the state government's preference for stasis over progress.

Meanwhile, on the back of updated risk analysis from ACIL Allen Consulting of the risks of maintaining the state's tacit freeze on coal seam exploration and extraction, the Australian Workers' Union has aligned itself with industry lobbies APPEA and AIG in informing Premier Barry O'Farrell that his policies threaten state investment, undermine energy security, cost jobs and will drive up energy costs.

PHOTO: JACKY GHOSSEIN

Let's deal with Santos and its Pilliga dilemma first.

Back in November 2011, Santos paid $924 million for a successful junior CSG player called Eastern Star Gas. And by successful, I mean only that Eastern Star actually found some very productive coal seams and seemed set for a reasonable future until a previous state government stanched the company's progress.

As it was, Santos bought a business that hadn't drilled a well in 18 months and that appears to have allowed some of its processes to slip into unacceptable disrepair.

Through 2011, Eastern Star suffered minor but avoidable equipment failures at its Pilliga facilities that resulted in two leaks from the main storage pond, that on 11 occasions resulted in water discharges from the plant into Bohen Creek that exceeded mandated limits of dissolved solids, and that resulted in a close-run thing with one main pond. The dam was saved from collapse, but only after water had leaked.

Worst of all, as it turns out, a lot of those issues of those issues were poorly recorded and documented and some were not reported at all to the relevant NSW authorities.

How do we know all of this?

Well, because in February 2012 Santos told us so. Having completed a three month post-acquisition review of Eastern Star, Santos published a report that detailed in excruciating detail the poor practice past.

That review triggered a state government investigation. So it is that, 16 months on, Santos is facing prosecution on nine distinct counts under the state's Petroleum Onshore Act and the state government is pursuing amendments to the act that will enable prosecution of directors personally in similar circumstances in the future.

None of the directors of Eastern Star can be pursued for the issues that Santos now faces. Not that those issues are so desperately serious. Santos has been called to account for Eastern Star's reporting standards rather than for any of the lapses in operational outcomes.

We need to be clear on this point only because the facts of these matters continue to be either ignored or misunderstood by those resisting the coal seam gas industry.

Take the Wilderness Society, for example. In a statement as heavy with high dudgeon as it was distortion, it used announcement of the prosecutions as fuel enough to call for a permanent cessation of drilling in the Pilliga.

"Santos must withdraw from the disaster-plagued Gunnedah coal seam gas project after the NSW Government today announced it would prosecute the company over the many toxic spills in the Pilliga forest," its statement railed.

"Santos cannot keep blaming previous owner Easter Star Gas for the spills when spills have occurred on its watch and has lied about it."

Well now, first of all, Santos has not lied about spills in the Pilliga. It has continued to report to the state authorities minor incidents of leakage from the three active storage ponds it manages in the Pilliga. Two of those ponds are now effectively empty. A third continues to be troublesome. All of them were constructed before Santos took over Eastern Star and none of them will survive the new owners' review of what it bought.

The fact is that since putting $924 million on the table for Eastern Star, Santos has done nothing but work to resolve the environmental issues it acquired.

A lack of government approvals has meant that it has done no new drilling and that the one rig it has in the forest invests its time in working over and shutting down the well drilled by the former operator.

But, critically, none of the problems present or past are understood to have resulted in sustained or serious damage to Pilliga. How do we know? Well, because the authorities would have pursued prosecutions across a broader pallet than merely reporting lapses if there had been impacts more serious than Santos has flagged.

As it is, according to the bloke now accountable for Eastern Star, Santos's VP Eastern Australia James Baulderstone, the confirmation of prosecutions is something that needed to happen.

"This is actually something that needed to occur; we need it to finish this cycle [of] the Eastern Star gas development. We reported this. The government has done its job. It has issued notices that we were fully expecting.

"The green groups are going to try and bash it up as a new incident, but in the end we are on a small footprint in a big area. And our issues are about report standards, not impact.

"In the end, we can comply with any regulation the government wants to put upon us," Baulderstone concluded. "But an overly zealous regulatory environment will result in a cost and that cost will eventually be passed on to future gas customers."

Overly zealous regulation will result in a cost passed on to gas customers.
Santos's James Baulderstone

Just for the record, Santos has applied to drill eight pilot wells on its licences in the Pilliga and early last week it was gifted with a request for more information by the new Office of Coal Seam Gas and from the EPA.

The OCSG wanted to know more about Santos's rehabilitation strategy; the EPA requested further detail on a range of matters including water management "taking into consideration [the] suspected leak at the main holding pond at Bibblewindi".

Oh, and to help us understand what the cost of continued anti-CSG zealotry might be, I recommend chewing over some of the numbers prepared for APPEA, AIG and the AWU by Allen Consulting.

It is estimated, for example, that a permanent freeze on CSG exploitation in NSW would see gas prices rise 24 per cent more than they otherwise might. A freeze would leave NSW missing out on $4 billion in direct investment and another $3 billion in indirect spending and a real reduction in NSW gross state product of $14 billion by 2035.

And in the end, oddly enough, none of this is going to reduce the state's dependence on coal seam gas. All it will mean is that NSW will import that gas from fields in other states. Because, in a classic case of NIMBY, coal seam gas already accounts for 30 per cent of the state's gas diet.

Behind Rio's Eagle sale

Rio Tinto's decision to sell its Eagle nickel project is a wee bit more important than the numbers involved.

The half-finished $US500 million ($A526 million) nickel and copper project in Michigan is to be sold to Canadian Lundin Mining for $US325 million. The mine is due for completion some time next year and the planned annual output at Eagle of 16,000 tonnes of nickel and 13,000 tonnes of copper leave it looking far more suited to the likes of Lundin than it does to a global major like Rio.

Nonetheless Eagle is indicative of the sea change in strategy at Rio in the wake of Tom Albanese's shock departure earlier this year, and its divestment marks the end of a long-held strategy to enter the nickel sector.

Albanese very much liked Eagle because of its high grades and because, as small at is going to be, it offered Rio a toe-hold in the nickel.

Like several generations of Rio executive management, Albanese liked the cut of nickel's gib. Nickel is used in steel generally and stainless steel particularly. And stainless steel, like aluminium (though for different reasons) is regarded as a second-gen metal in the sort of economic transition happening in China.

NSW GOVERNMENT Resources & Energy

ESG2: Environmental Impact Assessment Guidelines

For exploration, mining and petroleum production activities subject to Part 5 of the *Environmental Planning and Assessment Act 1979*

Including content requirements for a Review of Environmental Factors (REF)

MARCH 2012, WWW.MINERALS.NSW.GOV.AU

NSW Trade & Investment - Mineral Resources Branch

Title: ESG2: Environmental Impact Assessment Guidelines

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Contents

Introduction

The Mineral Resources[1] Branch of NSW Trade & Investment is responsible for the administration of authorisations under the *Mining Act 1992*[2] and petroleum titles under the *Petroleum (Onshore) Act 1991*[3]. Authorisations are defined as exploration licences, assessment leases, mining leases, mineral claims and opal prospecting licences. Petroleum titles include exploration licences, assessment leases and production leases.

As part of this role, Mineral Resources has a statutory obligation under s.111 of the *Environmental Planning and Assessment Act 1979*[4] (EP&A Act) to "examine and take into account to the fullest extent possible all matters affecting or likely to affect the environment" when determining certain applications in relation to authorisations and titles. This obligation applies where activities have not previously been approved under the former Part 3A or Part 4 of the EP&A Act, or assessed by another Government agency in accordance with Part 5.

In order to assess these impacts, Mineral Resources may require the authorisation/title holder to prepare a Review of Environmental Factors (REF) or Environmental Impact Statement (EIS).

These Guidelines have been developed to provide a framework for industry to use in assessing the potential environmental impact of activities requiring the preparation of a REF, EIS or other supporting documentation.

(A) What is a Review of Environmental Factors (REF)?

A REF is a document used by Government determining authorities in considering the potential environmental impacts of an activity requiring approval. In the case of prospecting, mining and petroleum production activities requiring approval, a REF is prepared by, or on behalf of, the holder of the authorisation or title who wishes to undertake the activity.

The purpose of a REF is to inform Mineral Resource's consideration of the likely environmental impact of the activity under Part 5 of the EP&A Act.

(B) When is a REF required?

Part 5 of the EP&A Act applies where an activity is subject to approval under the *Mining Act 1992* or *Petroleum (Onshore) Act 1991* and the activity:

- is permissible without consent under an environmental planning instrument[5]; or,
- has existing use rights; and,
- the activity has not previously been approved under Parts 3A or 4 or assessed under Part 5.

Activities that are generally subject to assessment under Part 5 include:

[1] www.minerals.nsw.gov.au

[2] www.legislation.nsw.gov.au/maintop/view/inforce/act+29+1992+cd+0+N

[3] www.legislation.nsw.gov.au/maintop/view/inforce/act+84+1991+cd+0+N

[4] www.legislation.nsw.gov.au/maintop/view/inforce/act+203+1979+cd+0+N

[5] www.legislation.nsw.gov.au/maintop/view/inforce/epi+65+2007+cd+0+N

- mineral prospecting (exploration) activities
- petroleum prospecting (exploration) activities
- opal mining pursuant to a mineral claim in a mineral claims district

The requirement to obtain an approval prior to carrying out a specific type of activity may be triggered under the *Mining Act 1992* or *Petroleum (Onshore) Act 1991*, subordinate regulations or (most commonly), the conditions of the authorisation/title.

Legal advice to the effect that Part 5 applies to an activity may be required to support the application in some circumstances.

A REF will be required to support all applications that require assessment in accordance with Part 5 unless Mineral Resources is satisfied that an assessment of the activity has previously been carried out by Mineral Resources or another public authority and remains current. In such circumstances, Mineral Resources would expect the applicant to provide details or copies of those previous assessments with the application.

(C) Who prepares a REF?

REFs are prepared by or on behalf of the authorisation/title holder.

Applicants should ensure that REFs are prepared by a person with appropriate qualifications or experience to ensure that the REF appropriately addresses all relevant issues and does not contain false or misleading information.

The provision of false or misleading information in an application under the Mining Act 1992 or Petroleum Act 1991 is a criminal offence.

(D) What information must be included in a REF?

The content requirements for a REF are defined in these Guidelines. All REFs submitted to Mineral Resources in support of an application for approval of an activity under the *Mining Act 1992* or *Petroleum (Onshore) Act 1991* must comply with the REF content requirements set out under the heading Content requirements for a REF. Non-complying submissions may be rejected.

Where the approval of another Government agency is also required, applicants must have regard to any guidelines published by that agency. In such circumstances, it is appropriate to prepare a single REF document that addresses the requirements of both agencies.

Special note – activities relating to, or adjoining, land reserved or acquired under the National Parks and Wildlife Act 1974

The Office of Environment & Heritage[6] (OEH) is responsible for management of lands reserved or acquired under the *National Parks and Wildlife Act 1974*[7]. State Conservation Areas (SCAs) are the only category of reserved land where mining and petroleum activities are legally permissible, subject to approval from the OEH or Minister for the Environment.

- REFs accompanying applications relating to land within SCAs must be prepared in

[6] www.environment.nsw.gov.au

[7] www.legislation.nsw.gov.au/maintop/view/inforce/act+80+1974+cd+0+N

accordance with the appropriate OEH guidelines and template. Proponents should liaise with the relevant OEH regional office[8] prior to commencing the REF.

- REFs for activities on land adjoining land administered by the OEH must have regard to the OEH publication "*Guidelines for developments adjoining land and water managed by the Department of Environment Climate Change and Water*"[9].

A REF can be very short or very detailed depending on the nature of the activity, the sensitivity of the environment and the proposed environmental safeguards. The REF must clearly demonstrate that the authorisation/title holder has identified and sought to avoid and minimise adverse impacts on the natural environment and communities to the fullest extent practicable.

(E) Extra information required for some activities

Additional requirements may apply to specific activities or circumstances. Applicants should contact the Mineral Resources Environmental Sustainability Unit to confirm whether any additional requirements apply to the proposed activity.

(F) REF or Environmental Impact Statement?

If, in reviewing the REF, the Government decision-maker forms the opinion that the impacts on the environment are likely to be significant, an Environmental Impact Statement (EIS) must be prepared. The purpose of an EIS is to provide a thorough public examination of a proposed activity that is likely to have a significant impact on the environment, and to inform a decision as to whether that activity should proceed.

Is an EIS Required – Best Practice Guidelines for Part 5 of the Environmental Planning and Assessment Act 1979 (Department of Planning, 1995) is a useful guide to assist an applicant to determine whether an EIS is likely to be required.

The form, content and process for preparing and exhibiting an EIS are set out in the *Environmental Planning and Assessment Act 1979* and associated regulations. Director General's Requirements must be sought from the Department of Planning & Infrastructure[10] prior to preparing an EIS.

(G) Species Impact Statements

If an activity is likely to have a significant impact on threatened species, populations, or ecological communities, a Species Impact Statement (SIS) is required to be considered as part of the activity assessment process. A SIS must be prepared for any activity that will have an impact on critical habitat, regardless of the magnitude of the impact.

The form, content and process for preparing a SIS are set out in the *Threatened Species Conservation Act 1995*[11] or the *Fisheries Management Act 1994*[12] (as applicable to the impacted species). Director General's Requirements must be sought prior to preparing a SIS.

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[8] www.environment.nsw.gov.au/NationalParks/parksearchatoz.aspx

[9] See www.environment.nsw.gov.au/resources/protectedareas/10509devadjdeccw.pdf

[10] www.planning.nsw.gov.au

[11] www.legislation.nsw.gov.au/maintop/view/inforce/act+101+1995+cd+0+N

[12] www.legislation.nsw.gov.au/maintop/view/inforce/act+38+1994+cd+0+N

(H) Part 5 assessment process

The activity application and accompanying REF will be reviewed by the Mineral Resources Environmental Sustainability Unit. Additional information may be requested during the review process.

An assessment of the activity will generally be prepared by the Environmental Sustainability Unit under Part 5 of the EP&A Act (in accordance with Department of Planning & Infrastructure guidelines) for consideration by the decision maker (the determining authority). In some circumstances the Part 5 assessment may be undertaken by another agency.

Special note – assessment of REFs for activities in State Conservation Areas (SCAs)

The OEH is responsible for assessing REFs for prospecting activities in SCAs. The OEH may require additional information during the review process.

If the approval of the Minister for the Environment is required for an activity, the OEH will assess the REF and submit a determination report for consideration of the Minister.

The determining authority must determine whether the activity is likely to:

- have a significant impact on the environment, in which case an Environmental Impact Statement (EIS) is required; or
- significantly affect threatened species, populations, ecological communities, or critical habitat, in which case a Species Impact Statement (SIS) is required.

(I) Activity approval process

Following the completion of the Part 5 assessment process, Mineral Resources may issue a written approval under the *Mining Act 1992* or *Petroleum (Onshore) Act 1991*. If the activity is within a SCA, written approvals may also be issued by either the OEH or Minister for the Environment.

In most cases, the approval will be issued subject to conditions. The authorisation/title holder should be aware that these conditions will usually require compliance with any commitments made in the REF. Consequently, environmental protection and conservation measures should not be proposed if they are impractical, unrealistic or not financially viable.

The conditions may also require the authorisation/title holder to prepare additional plans, undertake specific mitigating measures or limit the proposed activity in some way to minimise harm to the environment.

In carrying out the activity, the authorisation/title holder must ensure compliance with all regulatory requirements, including:

- compliance with the conditions of the authorisation/title
- compliance with the conditions of approval (and any additional approvals required)
- that the activities undertaken are consistent with those described in the REF and any associated documentation
- requirements under other relevant legislation

(J) Changing an activity after approval

Changes to an activity after approval may require further assessment and approval by Mineral Resources. This may require submission of a new or revised REF. The Mineral

Resources Environmental Sustainability Unit should be contacted to discuss case-specific requirements.

(K) Will I be audited?

Mineral Resources may conduct an audit at any time to determine whether:

- the activities being carried out by the authorisation/title holder are consistent with those described in the REF and set out in the conditions of approval
- the actual impacts are consistent with those described in the REF

Failure to comply with the terms of approval may trigger enforcement action.

(L) Public access to REFs

REFs are made available on the Mineral Resources website for unrestricted public access following lodgement of the application.

(M) Privacy considerations

Where personal information is supplied to Mineral Resources as part of a REF and/or associated documentation, the *Privacy and Personal Information Protection Act 1998* requires that the individual is made aware that the information is being collected for the purpose of making a determination under Part 5 of the *Environmental Planning & Assessment Act 1979* and that this information will be made available to the public via the Mineral Resources website. Applications cannot be processed unless this information is supplied.

All personal information submitted to Mineral Resources as part of a REF and/or associated documentation is accessible by contacting the Mineral Resources Environmental Sustainability Unit as per the details provided in the inside cover of this document.

At the request of the individual to whom the personal information relates, Mineral Resources may make appropriate amendments (whether by way of corrections, deletions or additions) to ensure that the personal information is accurate, relevant, up to date, complete and not misleading.

Content requirements for a REF

All REFs submitted to Mineral Resources in support of an application for approval of an activity under the Mining Act 1992 or Petroleum (Onshore) Act 1991 must comply with the content requirements set out under this section (except for activities within SCAs). Non-complying submissions may be rejected.

As noted in the Introduction, REFs for activities within SCAs must be prepared using guidelines issued by the Office of Environment and Heritage.

Additional REF content requirements may be applied to specific activities or circumstances.

1 The proposed activity

1.1 Summary of the activity

A brief statement or table summarising the activity must be included in the REF. This must include a description of the:

- authorisation/title number (e.g. EL123)
- titleholder (e.g. Company A Pty Ltd)
- operator (e.g. Company B Pty Ltd)
- activity type
- activity scope
- activity location
- activity duration
- type of approval being sought

1.2 Regional location map

A map showing the location of the proposed activity at a regional scale must be included in the REF. The map must clearly show:

- the boundaries of the authorisation/title
- the location of the proposed activity
- major regional features
- scale
- orientation

1.3 Stakeholder consultation

Note. Effective consultation is essential to the identification of potential impacts and can also assist in minimising future disputes. Please check www.minerals.nsw.gov.au for any consultation codes or guidelines that may be relevant to the proposed activity.

The REF must describe (in relation to the proposed activity):

- details of any consultation already undertaken (including the results of that consultation)

- how the outcomes of the consultation influenced the design and management of the proposed activity
- ongoing consultation arrangements
- procedures for managing conflicts with stakeholders.

In preparing a REF, consultation must be considered with the following parties:

- local Councils
- adjoining, and/or affected, landholders
- adjoining, and/or affected, authorisation or title holders
- affected infrastructure authorities (electricity, telecommunications, water, pipeline, road, rail, port authorities etc.)
- relevant Government agencies
- local Aboriginal communities
- the general community

If consultation has not been undertaken with any party identified above, the REF must include a justification as to why this has not occurred.

The level of consultation must be consistent with the scale and potential impacts of the activity. Larger activities or projects that have attracted significant community interest must undertake broader community consultation prior to submission of a REF.

1.4 Justification of the activity

The REF must justify why it is necessary to carry out the activity, with particular regard to the objectives, methods, scale, location and timing of the activity.

The justification must be clearly set out in terms of the following principles of ecologically sustainable development[13]:

a) the precautionary principle, namely, that if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. In the application of the precautionary principle, public and private decisions should be guided by:

   (i) careful evaluation to avoid, wherever practicable, serious or irreversible damage to the environment, and

   (ii) an assessment of the risk-weighted consequences of various options,

b) inter-generational equity, namely, that the present generation should ensure that the health, diversity and productivity of the environment are maintained or enhanced for the benefit of future generations,

c) conservation of biological diversity and ecological integrity, namely, that conservation of biological diversity and ecological integrity should be a fundamental consideration,

[13] Proper consideration of the principles of ecologically sustainable development is required to satisfy the objects of the *Environmental Planning and Assessment Act 1979*.

d) improved valuation, pricing and incentive mechanisms, namely, that environmental factors should be included in the valuation of assets and services, such as:

(i) polluter pays, that is, those who generate pollution and waste should bear the cost of containment, avoidance or abatement, and

(ii) the users of goods and services should pay prices based on the full life cycle of costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any waste, and

(iii) environmental goals, having been established, should be pursued in the most cost effective way, by establishing incentive structures, including market mechanisms, that enable those best placed to maximise benefits or minimise costs to develop their own solutions and responses to environmental problems.

1.5 Analysis of alternatives

The REF must include an analysis of any feasible alternatives to the carrying out of the activity, having regard to its objectives, including the consequences of not carrying out the development or activity.

The REF must identify whether any lower impact alternatives to the activity were available, e.g. by varying the activity in terms of:

- use of different methods or materials
- location
- timing
- applying different, or more extensive mitigation or rehabilitation options

If lower impact alternatives are available, the REF must justify why they were rejected.

1.6 Description of the activity

The REF must contain a full description of the proposed activity. The description should be clear to a person who is not familiar with the proposed activity or location.

It is essential that all aspects of the proposed activity which have the potential to impact on the environment are included in the description. The type, maximum likely scope, intensity and duration of the activity and any ancillary works must be clearly identified to allow the potential impacts of the activity to be properly assessed. Quantitative figures must be used where practicable, e.g. area of disturbance, volume of water used, length of access tracks, etc.

The description must include, but should not be limited to:

- the size of the proposed activity footprint
- surface disturbance area
- a description of any ancillary activities, for example, additional roads, infrastructure or bush fire hazard reduction works which are ancillary to the activity
- a description of all stages of the activity, including the pre-construction, construction, operation, decommissioning, and rehabilitation stages
- a description of any likely maintenance activities, future extensions or additions
- any earthworks or vegetation clearing, including re-use and disposal of cleared material (including use of spoil on-site)
- an estimate of on-site employee or contractor numbers

- hours of operation

1.7 Mitigation strategy

The REF must describe any measures proposed to prevent, control, abate or mitigate environmental impacts associated with the proposed activity, reduce risks to human health and prevent the degradation of the environment.

Mitigation measures may include, but need not be limited to, biodiversity conservation, Aboriginal cultural and other heritage protection, pollution, noise, dust, erosion and sediment controls, and waste management measures.

The REF should also outline any proposed approach (such as an Environmental Management Plan) that will demonstrate how commitments made in the REF will be met. Measures that should be described include:

- operational procedures
- site supervision arrangements
- training programs
- community consultation programs
- complaint management mechanisms
- incident management and reporting procedures
- monitoring protocols (for assessing the effectiveness and reliability of the mitigation strategy and any residual impacts)
- strategies for continual improvement

Where best practice guidelines are available for the proposed activity these should be referred to in describing the activity. Best practice guidelines are not a replacement for the preparation of REFs, but provide greater consistency and certainty in assessing the likely impacts of the activity.

Water source protection strategy

Where the proposed activity has the potential to impact on water sources within the project area, the REF must describe the management controls which will be implemented to:

- prevent pollution of water sources
- prevent depletion of water sources
- account for any water extraction
- monitor impacts
- account for, mitigate or avoid impacts
- comply with any statutory requirements, regulatory controls or standards applicable to the conduct of the activity and its impacts on water

Waste management strategy

Where the proposed activity has the potential to generate non-trivial volumes or types of waste, the REF must describe:

- the volume and type of waste that will be generated (including drilling wastes)
- reuse, recycle and disposal methods for each material

- how waste will be stored and treated on site
- statutory requirements under the *Protection of the Environment Operations Act 1997*[14][15] applicable to the likely types of waste.

The REF must describe how waste will be characterised and disposed of in accordance with the relevant OEH waste classification guidelines[16].

If waste is proposed to be disposed of on-site (including drilling waste and waste water), the REF must clearly describe and justify how this will be undertaken and managed.

Noise management strategy

The REF must describe how noise will be managed with regard to relevant OEH guidelines[17]. For most prospecting activities, this will be the Interim Construction Noise Guideline (ICNG) and any associated application or practice notes. At a minimum, the REF must identify and describe:

- sensitive noise receivers
- hours of operation
- noise assessment methods
- noise management levels

Where the activity is likely to affect an individual or sensitive land use for more than three weeks in total, a quantitative noise assessment should be made in accordance with Section 4 of the ICNG.

1.8 Access arrangements

The REF must list:

- all access arrangements[18] that are required to be in place prior to the commencement of the activity
- the status of these access arrangements

1.9 Other approval requirements

The assessment and approval of an activity under the *Mining Act 1992* or *Petroleum (Onshore) Act 1991* does not generally affect requirements to obtain an approval, licence, permit or concurrence under other legislation. Examples of legislation imposing such requirements include the *Fisheries Management Act 1994, Forestry Act 1916, Heritage Act 1977, National Parks and Wildlife Act 1974, Protection of the Environment Operations Act 1997, Roads Act 1993, Rural Fires Act 1997* and *Water Management Act 2000*.

[14] www.legislation.nsw.gov.au/viewtop/inforce/act+13+1990+first+0+N

[15] www.legislation.nsw.gov.au/maintop/view/inforce/act+95+2008+cd+0+N

[16] www.environment.nsw.gov.au/waste/classification.htm

[17] www.environment.nsw.gov.au/noise/

[18] Access arrangement requirements are set out in Part 8, Division 2 of the *Mining Act 1992* and Part 4A of the *Petroleum (Onshore) Act 1991*

Accordingly, the REF may be drafted to cover assessment requirements for a number of different approvals and Government agencies.

The REF must clearly identify:

- all approvals required from Mineral Resources and other Government agencies
- why Part 5 of the EP&A Act applies
- the aspects of the REF that apply to the different approval requirements

The authorisation/title holder is responsible for gaining all required approvals or licences prior to commencement of the activity.

2 The site

2.1 Site description

The REF must describe the site of the proposed activity. This description must include a table specifying MGA94 coordinates (Zone, Easting and Northing) for the location of key features of the activity.

2.2 Site plan

The REF must include a site plan at an appropriate scale showing:

- the layout of the proposed activity (including dimensions and alignments where appropriate)
- access routes
- existing structures and infrastructure (including dimensions and alignments where relevant)
- environmental sensitivities
- topographic contours
- Lot/DP numbers and boundaries
- scale
- orientation

Additional plans, sections, diagrams, photographs (including aerial imagery where available) should be provided where these will assist with describing the activity.

3 The existing environment

Note. The REF must include a description of the existing environment of the site and surrounding area that may be affected by the proposed activity as set out under headings 3.1 to 3.6. This description provides the context and identifies aspects of the existing environment against which potential impacts are assessed (under Heading 4 of these Guidelines).

The detail provided in this section of the REF must be appropriate to the nature, scale, intensity and potential impacts of the proposed activity.

3.1 General description

The REF must include a general description of the existing environment of the site and surrounding area that may be affected by the proposed activity.

The description should focus on features that will magnify or limit the potential impacts of the proposed activity. For example, likely episodes of high rainfall may be important and may need to be considered along with annual rainfall, while the condition of vegetation on the site may be as important as the vegetation type.

The general description of the existing environment must provide enough detail to place the activity in its local and regional environmental context, including relevant information on:

- climate and weather
- topography
- vegetation cover type, density and condition
- soil types and properties (including susceptibility to compaction, erosion and dispersion; presence of acid sulfate soils and potential acid sulfate soils)
- existing land uses that may be affected by the proposed activity (including agricultural land uses)
- availability of services

Additional maps, photographs etc. may be required to ensure that this description is clear to a person who is not familiar with the site.

3.2 Description of surface and groundwater sources

Note. This section applies to the description of existing water sources. The assessment of potential impacts on water sources is covered under Headings 4.1 and 4.4 of these Guidelines. This section of the REF is intended to provide the site-specific information on which the assessment is based.

The REF must include a general description of any surface or groundwater sources that occur in the area which are likely to be affected by the activity. The study area must extend as far as is reasonably necessary to take all potential impacts of the activity into account.

Where the proposed activity has the potential to impact on water sources within the project area, the REF must:

- describe the current level of use, water quality and reliability of the water source
- identify if a Water Sharing Plan[19] is in force for any water sources likely to be affected
- identify if the activity is located within a drinking water catchment
- describe the management controls which will be implemented to:
    (i) avoid, minimise or mitigate impacts to water sources
    (ii) monitor impacts
    (iii) account for any water extraction

[19] www.water.nsw.gov.au/Water-management/Water-sharing-plans/Plans-commenced/plans_commenced/default.aspx

(iv) comply with any statutory requirements, regulatory controls or standards applicable to the conduct of the activity and its impacts on water

Note. The Water Management Act 2000, Water Act 1912 and Protection of the Environment Operations Act 1997 identify the regulatory framework for water.

3.3 Description of threatened species, populations and ecological communities

Note. This section applies to the description of existing threatened species, populations and ecological communities. The assessment of potential impacts on threatened species, populations and ecological communities is covered under Heading 4.2 of these Guidelines. This section of the REF is intended to provide the site-specific information on which the assessment is based.

The REF must identify whether or not threatened species, populations and/or ecological communities, or critical habitats are likely to occur in the area affected by the activity. The study area must extend as far as is reasonably necessary to take all potential impacts of the activity into account.

If the activity is likely to affect fauna species or their habitat, the REF must describe the area, condition and value of the habitat to be affected, and compare this with the total habitat in the subject site, study area, and the larger region.

If the activity is likely to affect an ecological community of conservation significance, the REF must describe the area, condition and value of the habitat to be affected and compare this with the total habitat in the subject site, study area, and the larger region.

Note. An ecological community is 'an assemblage of species occupying a particular area' and includes, but is not limited to, micro-organisms, fungi, vertebrate and invertebrate fauna.

If vegetation is to be cleared or modified, the REF must describe the number of individuals or area of plants or vegetation communities to be cleared or modified and compare this with the total number of individuals or area of plants or vegetation communities in the general location of the proposed activity, and the larger region.

The following references are essential to the preparation of this section of the REF:

- Threatened species listings and information – terrestrial[20] and aquatic/marine[21]
- Register of critical habitat – terrestrial[22] and aquatic/marine[23]
- OEH "*Field survey methods*"[24]
- OEH draft "*Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities*" [25]
- DPI Fisheries *"Policy and Guidelines for Aquatic Habitat Management and Fish Conservation*"[26]

[20] www.threatenedspecies.environment.nsw.gov.au

[21] www.dpi.nsw.gov.au/fisheries/species-protection/conservation/what-current

[22] www.environment.nsw.gov.au/criticalhabitat/CriticalHabitatProtectionByDoctype.htm

[23] www.dpi.nsw.gov.au/fisheries/species-protection/conservation/what/register

[24] www.environment.nsw.gov.au/threatenedspecies/surveymethodsfauna.htm

[25] www.environment.nsw.gov.au/resources/nature/TBSAGuidelinesDraft.pdf

Threatened species protection

In NSW, threatened species, populations and ecological communities are protected by the *Threatened Species Conservation Act 1995* (TSC Act) and Part 7A of the *Fisheries Management Act 1994* (FM Act). These species are listed in the schedules of both the TSC Act and FM Act.

Both the TSC Act and FM Act provide for the identification, conservation and recovery of threatened species and their populations and ecological communities. They also aim to reduce the threats faced by those species. The Office of Environment & Heritage administers the TSC Act and the Department of Primary Industries (Fisheries) administers the FM Act.

3.4 Description of Aboriginal cultural heritage values

Note. This section applies to the description of existing Aboriginal cultural heritage values. The assessment of potential impacts on Aboriginal cultural heritage values is covered under Heading 4.5 of these Guidelines. This section of the REF is intended to provide the site-specific information on which the assessment is based.

The minimum requirements set out below align with those identified in the following Due Diligence Codes (to the extent that these codes apply to the identification of Aboriginal cultural heritage values likely to occur in the area affected by the activity).

- *Due Diligence Code of Practice for the Protection of Aboriginal Objects in New South Wales*[27]
- *NSW Minerals Industry Due Diligence Code of Practice for the Protection of Aboriginal Objects*[28]

While all effort and care has been taken to ensure the requirements of approved Due Diligence Codes are accurately reflected in these Guidelines, applicants are responsible for ensuring that they understand the provisions of the relevant Code and have satisfied themselves that all applicable steps have been followed.

The REF must identify whether or not Aboriginal cultural heritage values are likely to occur in the area affected by the activity. The study area must extend as far as is reasonably necessary to take all potential impacts of the activity into account.

Due diligence

At a minimum, the information provided in this section of the REF must:

- identify whether the proposed activity will disturb the ground surface
- identify whether any culturally modified trees occur in the area affected by the activity
- contain copies of Aboriginal Heritage Information Management System (AHIMS) database search results[29]

[26] www.dpi.nsw.gov.au/fisheries/habitat/publications/policies,-guidelines-and-manuals

[27] www.environment.nsw.gov.au/resources/cultureheritage/ddcop/10798ddcop.pdf

[28] www.environment.nsw.gov.au/resources/cultureheritage/ddcop/ddcop-minco.pdf

[29] www.environment.nsw.gov.au/licences/AboriginalHeritageInformationManagementSystem.htm

- if the results of the initial AHIMS search indicate that AHIMS contains information about recorded Aboriginal objects in the area of the proposed activity, those records must be appended to the REF (subject to any restrictions in providing culturally sensitive information)
- identify any other sources of information used to identify whether or not Aboriginal objects are likely to be present in the area

The REF must also identify whether Aboriginal objects are likely to be in the area of the proposed activity by defining whether the proposed activity is:

- within 200m of waters, or
- located within a sand dune system, or
- located on a ridge top, ridge line or headland, or
- located within 200m below or above a cliff face, or
- within 20m of or in a cave, rock shelter, or a cave mouth and is on land that is not disturbed land

Note. See the Due Diligence Codes for definitions of the above terms.

Where the Due Diligence Codes indicate that further investigation is required, the REF must describe the outcomes of these investigations.

Native title claims, indigenous land use agreements and joint management arrangements

The REF must identify any native title claims, indigenous land use agreements or joint management arrangements likely to be affected by the proposed activity.

Note. The Commonwealth Native Title Act 1993 provides for the identification of native title holders or claimants. A search for native title claims may be undertaken by visiting the National Native Title Tribunal website.

When an area is subject to a native title claim, the claimants should be consulted as to their view on the activity proposed. When the native title claimants do not support the proposed activity, strong justification will be required for the impact to be considered to be a level other than medium or high adverse.

Similarly, in the case of areas that are the subject of an indigenous land-use agreement or joint management agreement, proponents should ensure consultation with the relevant Aboriginal stakeholders.

Aboriginal heritage values

Aboriginal people have occupied the NSW landscape for at least 50,000 years. The evidence and important cultural meanings relating to this occupation are present throughout the landscape, as well as in documents and the memories, stories and associations of Aboriginal people. Therefore, an activity that impacts on the landscape may impact on Aboriginal cultural heritage.

For Aboriginal people, the significance of individual features is derived from their inter-relatedness within the cultural landscape. This means that features cannot be assessed in isolation, but must be considered in a holistic manner. This may require a range of assessment methods with the close involvement and participation of Aboriginal people.

The assessment must cover lands, waterways, landscape features and native plants and animals that are culturally significant to Aboriginal people.

As with the heritage of all peoples, Aboriginal cultural heritage provides essential links between the past and present for Aboriginal people. It is an essential part of Aboriginal identity.

Protection

Aboriginal heritage is protected under the *National Parks and Wildlife Act 1974*[30] (NP&W Act). The Act sets up knowing and strict liability offences for harming or desecrating Aboriginal objects and Aboriginal places. Harm is defined in the NP&W Act and encompasses destroying, defacing, damaging or moving.

In addition, the NP&W Act (s.87) and *National Parks and Wildlife Regulation 2009*[31] (NP&W Reg) (cll.80A and 80B) provide defences to the 'strict liability' offence of harming an Aboriginal object (this type of offence may apply even if a person was unaware that they were harming an Aboriginal object). The defences include:

(a) that the proponent can demonstrate that they had exercised due diligence to determine whether the proposed activity was likely to harm an Aboriginal object and, on the basis of that assessment, had reasonably determined that harm would not occur. Under cl.80A, due diligence requires compliance with an approved Due Diligence Code[32][33]

(b) that the proposed activity was classed as a 'low impact activity' under cl.80B. Examples include maintenance of existing trails and utilities, soil conservation works, flood mitigation works, exempt development on disturbed land and certain types of mining exploration work. The NP&W Reg prescribes the types of low impact activities that can occur and provides examples.

Assessment

The key purpose of the Aboriginal Heritage Impact Assessment is to determine the cultural significance of the Aboriginal heritage site of concern in consultation with the Aboriginal community and to avoid impacts as far as practicable.

The OEH has prepared a "*Code of Practice for Archaeological Investigation of Aboriginal Objects in NSW*"[34]. This has been developed to support the process of investigating and assessing Aboriginal cultural heritage. It specifies the minimum standards for archaeological investigation undertaken in NSW under the NP&W Act. An Aboriginal Cultural Heritage Assessment that requires an archaeological investigation to be undertaken must be done in accordance with the requirements of this Code.

The *Code of Practice for Archaeological Investigation of Aboriginal Objects in NSW* establishes requirements for:

(a) undertaking test excavation as a part of archaeological investigation without an AHIP – if you comply with these requirements and you harm an Aboriginal object when undertaking test excavations, your actions will be excluded from the definition of harm and as such you will not be committing an offence of harm to an Aboriginal object

(b) carrying out archaeological investigation in NSW where an application for an AHIP is likely to be made – under the NP&W Act, the Director-General can require that certain information

[30] www.legislation.nsw.gov.au/maintop/view/inforce/act+80+1974+cd+0+N

[31] www.legislation.nsw.gov.au/maintop/view/inforce/subordleg+427+2009+cd+0+N

[32] www.environment.nsw.gov.au/resources/cultureheritage/ddcop/10798ddcop.pdf

[33] www.environment.nsw.gov.au/resources/cultureheritage/ddcop/ddcop-minco.pdf

[34] www.environment.nsw.gov.au/licences/archinvestigations.htm

accompanies an application for an AHIP. This Code explains what that information is in relation to archaeological investigations.

An AHIP is still required for archaeological excavations where the Code does not apply e.g. within an Aboriginal Place.

For activities that require an AHIP, the consultation requirements that must be carried out prior to lodging an application for an AHIP are specified in the *National Parks and Wildlife Regulation 2009*[35]. Further guidance on consultation with Aboriginal people and communities can be found in "*Aboriginal Cultural Heritage Consultation requirements for proponents*"[36].

Information sources

The OEH keeps a register of all recorded Aboriginal objects and Aboriginal places in NSW. The register is called the Aboriginal Heritage Information Management System (AHIMS). An online search of AHIMS can be undertaken to discover if an Aboriginal object has been recorded, or an Aboriginal place declared, on a parcel of land. Information on AHIMS searches can be found on the OEH website[37].

A report from AHIMS lists recorded sites only and does not represent a comprehensive list of all Aboriginal objects or Aboriginal places in a specified area. In any given area there may be a number of undiscovered and/or unrecorded Aboriginal objects.

If the applicant is aware of any other sources of information, these need to be used to identify if Aboriginal objects are likely to be present in the area. Other sources of information can include previous studies, reports or surveys that have been commissioned or are known to exist. Refer to the relevant Due Diligence Code for a range of examples and publications which may also assist in identifying Aboriginal objects.

Further information on Aboriginal heritage regulation can be found on the OEH website[38].

3.5 Description of historic cultural or natural heritage values

Note. This section applies to the description of existing non-Aboriginal heritage values. The assessment of potential impacts on non-Aboriginal heritage values is covered under Heading 4.6 of these Guidelines. This section of the REF is intended to provide the site-specific information on which the assessment is based.

The REF must identify any items of historic cultural or natural heritage which have the potential to be impacted by the proposed activity. The study area must extend as far as is reasonably necessary to take all potential impacts of the activity into account.

At a minimum, the REF must identify:

- items listed on the National Heritage List[39] (a statutory register established by the Australian Government to list places of outstanding heritage significance to Australia)

[35] www.legislation.nsw.gov.au/maintop/view/inforce/subordleg+427+2009+cd+0+N

[36] www.environment.nsw.gov.au/licences/consultation.htm

[37] www.environment.nsw.gov.au/licences/AboriginalHeritageInformationManagementSystem.htm

[38] www.environment.nsw.gov.au/licences/ACHregulation.htm

[39] www.environment.gov.au/heritage/places/national/index.html

- items listed in the State Heritage Register[40] (a statutory register listing items which are recognised as being of State heritage significance).
- items listed in the heritage schedule of a local council's local environmental plan (LEP) or a regional environmental plan (REP)[41] (statutory registers listing items which are recognised as being of local heritage significance).

4 Impact assessment

The REF must include an analysis of the impacts of the proposed activity on the environment, including any cumulative impacts. Specific environmental issues that must be addressed in the REF are set out under individual headings within this section (Headings 4.1 to 4.8). The extent and nature of the impacts will assist in determining whether or not there will be a significant impact.

Note. The requirements set out in this section are generally derived from Is an EIS required? Best Practice Guidelines for Part 5 of the Environmental Planning and Assessment Act 1979, (NSW Department of Planning,1995).

The assessment needs to consider impacts at all phases of the activity including site preparation, construction, routine operation, rehabilitation, and decommissioning if relevant.

The REF should take into account:

- *relevant NSW government guidelines*
- *best practice guidelines*
- *relevant research and reference material*
- *relevant preliminary studies or reports for the proposed activity*
- *consultation with stakeholders*

The detail provided in this section of the REF must be appropriate to the nature, scale, intensity and potential impacts of the proposed activity.

Methodology to characterise impacts

The extent, size, scope, intensity and duration of each impact need to be assessed in order to categorise the impacts as:

- negligible
- low adverse
- medium adverse
- high adverse
- positive

For instance, impacts should be ranked as having a high adverse impact if they are very intense or affect a large area or significant numbers of individuals or species over a long period of time. Impacts that adversely affect threatened species or environmentally significant areas would also attract a ranking of high impact.

[40] www.heritage.nsw.gov.au/07_subnav_02.cfm

[41] www.heritage.nsw.gov.au/07_subnav_04.cfm

The potential importance of each impact should be estimated, taking into account all the criteria used to analyse the nature of the impact, including the following:

- the level of confidence in predicting the impact
- the reversibility of the impact
- the effectiveness of the proposed methods to manage or mitigate the impact
- compliance with any relevant policies or plans
- the extent of public interest
- whether further information is required to confidently determine the impact of the activity

For instance, impacts should be ranked as high adverse if there is a high level of uncertainty about the impacts themselves. Proposed activities which do not comply with standards or policies should also be regarded as having the potential to have a medium or high adverse impact. In some instances the overall benefits of a proposed activity will be positive. Where this is the case, the positive aspects of the impact should be commented upon.

The table below provides a guide of how to categorise the impacts. However, applicants will also need to use their own judgment, particularly if the activity is, for example, small in size but of a high intensity.

Guide to categorising the extent of the impact

Analysis of impact	Low adverse	High adverse
Size	Small scale size/volume	Large scale/volume
Scope	Localised	Extensive
Intensity	Small impact dispersed over a long period	Large impact over a short or long period
Duration	Short term	Long term
Level of confidence in predicting impacts	High confidence/knowledge and past experience	Low confidence, numerous uncertainties and unknowns
Level of reversibility of impacts	Impacts are reversible and rehabilitation likely to be successful	Reversibility impossible or unlikely due to cost or other factors
Ability to manage or mitigate the impacts	Effective mitigation measures available	Mitigation measures untested or unavailable
Ability of the impacts to comply with standards, plans or policies	Total compliance	Uncertain or part compliance
Level of public interest	Low interest and predictable impacts on community	High interest and uncertain impacts on community
Requirement for further information on the impacts of	High level of understanding and information on the impact	Low level of information on and understanding of key issues

the activity or mitigation

4.1 Assessment of physical and chemical impacts

Is the proposed activity likely to impact on soil quality or land stability?

The REF must assess whether the activity is likely to have significant impacts on soil quality or land stability.

Impacts on soil quality and land stability may include:

- degradation of soil quality from contamination, salinisation or acidification
- loss of soil or soil degradation from wind or water erosion
- loss of structural integrity of the soil
- increased risk of land instability with high risks from landslides or subsidence

In determining the likely impact, the following matters should be considered:

- the extent of the proposed disturbance in terms of area, and how this compares to the surrounding landscape
- prior disturbance to the ground surface (e.g. mechanical scraping, ripping, quarrying, ploughing, trenching, digging, filling or excavating)
- whether the impact is likely to occur in an area which is sensitive to disturbance such as:
    - (i) buried building foundations, or sub-surface archaeological remains or on-ground scatters or features
    - (ii) a water catchment, an area in which there are natural waterbodies, wetlands or a groundwater recharge area
    - (iii) coastline or dunes, alpine areas, karst features or other unique landforms
    - (iv) erosion prone areas or areas with slopes greater than 18°
    - (v) subsidence or slip areas
    - (vi) areas with acid sulphate, sodic or highly permeable soils
    - (vii) areas with salinity or potential salinity problems
    - (viii) areas with degraded or contaminated soil or contaminated water

When disturbance will occur to previously undisturbed ground or to an area which is sensitive to disturbance, it is likely that the level of impact is medium or high adverse. If the applicant determines that the impacts are not medium or high adverse in these sensitive environments, the REF will need to provide strong justification for this conclusion.

If work is proposed in a subsidence or slip area, any conclusion as to the likely impact must be based on geotechnical advice.

Is the activity likely to affect a waterbody, watercourse or wetland or natural drainage system?

The REF must assess whether the activity is likely to have significant impacts on a waterbody, watercourse or wetland or natural drainage system.

Waters include the whole or any part of any river, stream, lake, lagoon, swamp, wetland, unconfined surface water, natural or artificial watercourse, dam, tidal waters (including the

sea) and groundwater. Waters will be affected if the activity pollutes water, uses water contained in it, interferes with the natural movement of water in either surface or groundwater, or involves the storage of water.

The types of impact on water should be identified as follows:

- the redirection of flow
- changes to the area, volume or flow of a waterbody
- the actual, or likely, pollution of waters[42]

In assessing possible impacts on waters, applicants should reference the ambient Water Quality and River Flow Objectives for the receiving waters[43]. These refer to the community's agreed environmental values and human uses endorsed by the Government as goals for ambient waters.

The REF should assess if the proposed activity will maintain or protect the environmental values listed for the catchment and waterway type relevant to the proposed activity objectives or make a contribution to the objectives being met over time.

Note: a consolidated and approved list of environmental values is not available for groundwater resources. Where groundwater may be affected, the REF should identify appropriate groundwater environmental values and justify the choice.

The level of impact will be medium or high adverse if the impact occurs in sensitive areas. Sensitive areas include:

- *water catchments, wetlands or groundwater recharge areas*
- *coastline or dunes, alpine areas, karst features or other unique landforms*
- *erosion prone areas or areas with slopes greater than 18°*
- *subsidence or slip areas*
- *areas with acid sulphate, sodic or highly permeable soils*
- *areas with salinity or potential salinity problems*
- *areas with degraded or contaminated land or water*

If the applicant determines that the impacts are not medium or high adverse in these sensitive environments, the REF will need to provide strong justification for this conclusion by clearly explaining and justifying how impacts will be avoided or mitigated.

Note. Contact the Commonwealth Department of the Environment, Water, Heritage and the Arts for guidelines on assessing the impact on the ecological character of a Ramsar wetland under the Environmental Protection and Biodiversity Conservation Act 1999 (EPBC Act)[44].

***Activities that impact on "water land" as defined under Part 7 of the Fisheries Management Act 1994* (FM Act)**

The Department of Primary Industries (Fisheries) protects fish habitats under Part 7 of the *FM Act*

[42] Applicants should refer to s.120 and the Dictionary of the *Protection of the Environment Operations Act 1997* for a definition of water pollution.

[43] See www.environment.nsw.gov.au/ieo

[44] www.environment.gov.au/epbc/protect/wetlands.html

and Part 5, Division 3 of the *Fisheries Management (General) Regulation 2002* (Regs). There are several permits which can be issued under these Parts of the FM Act and Regs and these are described below:

(i) Dredging and Reclamation

Division 3 of Part 7 of *the FM Act* states that it is an offence to dredge or reclaim any "water land" (as defined under s.198A of the FM Act) in NSW without a permit from DPI or authority from another NSW public authority.

Note. If an applicant or proponent has already obtained approval for these works from another relevant public authority (not a local government authority) such as the NSW Office of Water (e.g. a controlled activity approval under the Water Management Act 2000), a second approval from DPI is NOT required.

(ii) Harm to Marine Vegetation

Division 4 of Part 7 of the FM Act deals with the protection of marine vegetation. Section 205(2) states *"that a person must not harm any such marine vegetation in a protected area, except under the authority of a permit"*. Harm in relation to marine vegetation means, gather, cut, pull up, destroy, poison, dig up, remove, injure, prevent light from reaching or otherwise harm the marine vegetation or any part of it. Protected area means any public water land below mean high water mark, or any area that is the subject of an aquaculture lease.

(iii) Blocking Fish Passage

Under s.219 of the FM Act, the passage of fish is not to be blocked unless under the authority of a permit under the FM Act or another Act. This section notes that obstructions can include nets, netting or other material, construction or alteration of a dam, floodgate, causeway or weir, any other obstruction across or within a bay, inlet, river or creek, or around or across a flat.

Is the activity likely to change flood or tidal regimes, or be affected by flooding?

The REF must assess whether the activity is likely to significantly change flood or tidal regimes, or be significantly affected by flooding.

When the proposed activity will result in alteration to flood or tidal regimes or sea level rise, of either a temporary or permanent nature, or the activity will be affected by flooding (give some indication of flood frequency (e.g. 1:20 years)), it is likely that the level of impact is medium or high adverse.

If the applicant considers that the impact will not be medium or high in these sensitive environments, then the REF will need to provide strong reasons for this conclusion.

Other medium or high adverse impacts will result if the impact is likely to occur in areas sensitive to such disturbance including:

- a water catchment, wetland or groundwater recharge area
- coastline or dunes, alpine areas, karst features or other unique landforms
- erosion prone areas or areas with slopes greater than 18°
- subsidence or slip areas
- an area with acid sulphate, sodic or highly permeable soils
- an area with salinity or potential salinity problems
- an area with degraded or contaminated land or water.

If the applicant considers that the impact will not be medium or high in these sensitive environments, then the REF will need to provide strong reasons for this conclusion.

Is the activity likely to affect coastal processes and coastal hazards, including those under projected climate change conditions?

The REF must assess whether the activity is likely to significantly affect coastal processes and coastal hazards, including those under projected climate change conditions.

Erosion is a major risk along the NSW coast. Current projections for sea level rise and increased storm activity and impacts will exacerbate existing risks and pose new challenges for the management of coastal reserves. Areas likely to be affected include lands along the coastline, beaches, coastal lakes, estuaries, tidal reaches of coastal rivers and low-lying land surrounding these areas.

In determining the likely impact of proposed activities in these areas, the following criteria from the Department of Planning and Infrastructure publication "*NSW Coastal Planning Guideline: Adapting to Sea Level Rise*"[45] should be applied to assess whether the proposed activity:

- avoids or minimises exposure to immediate coastal risks (within the immediate hazard area or floodway)
- provides for the safety of residents, workers or other occupants onsite from risks associated with coastal processes
- does not adversely affect the safety of the public offsite from a change in coastal risks as a result of the development
- does not increase coastal risks to properties adjoining or within the locality of the site
- infrastructure, services and utilities onsite maintain their function and achieve their intended design performance
- accommodates natural coastal processes including those associated with projected sea level rise
- coastal ecosystems are protected from development impacts
- existing public beach, foreshore or waterfront access and amenities are maintained

Impacts are likely to be considered medium or high if there is a reasonable risk of adverse consequences based on consideration of the proximity and exposure to coastal hazards, and the likely severity of impacts on a particular type of activity.

Does the proposed activity involve the use, storage or transport of hazardous substances or the use or generation of chemicals which may build up residues in the environment?

The REF must assess the significance of any risks to the environment likely to result from the use, storage or transport of hazardous substances or the use or generation of chemicals which may build up residues in the environment.

Hazardous substances are materials presenting a hazard to people, property and the environment and include flammable, explosive, toxic, radioactive, carcinogenic or mutagenic substances. Chemicals which may build up a residue in the environment include fertilisers, herbicides and pesticides.

[45] www.planning.nsw.gov.au/LinkClick.aspx?fileticket=VYjmQirQlAk%3d&tabid=177&language=en-US

The type of impact on the environment should be determined. For example, the use or generation of hazardous substances or chemicals which build up residues in the environment could potentially:

- affect air quality with associated economic, health, ecosystem or amenity impacts
- affect water quality with associated economic, health, ecosystem or amenity impacts
- cause a degradation of soil quality due to contamination, salinisation or acidification

In determining the likely impact, the following matters in particular should be considered:

- the level of information/degree of confidence regarding the potential impact on the environment of the hazardous substance(s)
- the degree of community interest/concern with respect to the transport, use or generation of the substance(s)
- the requirements of the *Radiation Control Act 1990*[46] and associated Regulations and the *Dangerous Goods (Road and Rail Transport) Act 2008*[47] and associated Regulations.

Where the chemical or hazardous substance is being transported and used in line with an approved best practice guideline, a low level of impact may be more easily demonstrable. If no such guideline exists, then the REF will need to demonstrate that the impacts are low and can be acceptably managed.

This type of impact in environmentally sensitive areas is likely to be medium or high adverse. Environmentally sensitive areas include:

- *water catchments, wetlands, groundwater recharge areas or natural water bodies*
- *areas with acid sulphate, sodic or highly permeable soils*
- *areas with salinity or potential salinity problems*
- *areas with degraded or contaminated land or water*
- *areas with degraded air quality*

If the applicant determines that the impacts are not medium or high adverse in these sensitive environments, the REF will need to provide strong justification for this conclusion.

Does the activity involve the generation or disposal of gaseous, liquid or solid wastes or emissions?

The REF must assess whether the activity is likely to pose any significant risks to the environment resulting from the generation or disposal of gaseous, liquid or solid wastes or emissions.

The definition of emissions includes greenhouse gases or chemicals which are ozone-depleting or produce photo-chemical smog.

[46] www.legislation.nsw.gov.au/viewtop/inforce/act+13+1990+first+0+N

[47] www.legislation.nsw.gov.au/maintop/view/inforce/act+95+2008+cd+0+N

The type of potential impact should be identified taking into account the generation or disposal of waste, the emission of greenhouse gases, ozone-depleting chemicals or precursors to photochemical smog, and the potential to:

- affect air quality with associated economic, health, ecosystem or amenity impacts
- affect water quality with associated economic, health, ecosystem or amenity impacts
- cause a degradation of soil quality due to contamination, salinisation or acidification

In determining the likely impact level, the following matters should be considered:

- whether there are approved processes for waste disposal that will be used
- whether the activity complies with OEH and Workcover guidelines
- whether the activity will have a long-term impact
- whether the generation and/or disposal of waste will provoke strong community interest
- whether the activity complies with OEH policies where they exist

When the generation and/or disposal of waste, greenhouse gas emissions, or chemicals affecting the ozone layer or photochemical smog is not in line with approved guidelines, processes or policies, or when a long-term impact may result or when there is strong community interest in the issues, the REF will need to provide strong justification as to why the applicant considers the impact to be other than medium or high adverse.

Medium or high impact levels are likely to occur in areas sensitive to this type of impact such as:

- *water catchments, wetlands, groundwater recharge areas or natural waterbodies*
- *coastlines or dunes, alpine areas, karst features or other unique landforms*
- *erosion prone areas or areas with slopes greater than 18°*
- *subsidence or slip areas*
- *areas with acid sulphate, sodic or highly permeable soils*
- *areas with salinity or potential salinity problems*
- *areas with degraded or contaminated land or water*
- *areas with degraded air quality*

If the applicant determines that the impacts are not medium or high adverse in these sensitive environments, the REF will need to provide strong justification for this conclusion.

Will the activity involve the emission of dust, odours, noise, vibration, or radiation in the proximity of residential/urban areas or other sensitive locations?

The REF must assess whether the activity will involve any significant risks to the environment resulting from the emission of dust, odours, noise, vibration, or radiation in the proximity of residential/urban areas or other sensitive locations.

Where the emission of dust, odours, noise, vibration or radiation is not in line with approved guidelines, processes or policies, where a long term impact may result or where there is strong community interest in the issues, the REF will need to provide strong reasons as to why the impact is considered to be other than medium or high adverse.

Noise must be assessed with regard to relevant OEH guidelines. For most prospecting activities, this will be the Interim Construction Noise Guideline (ICNG) and any associated application or practice notes.

Medium or high impact levels are likely to occur in areas sensitive to this type of impact such as:

- *a water catchment, wetland, groundwater recharge area or natural waterbody*
- *an area with degraded or contaminated land or water*
- *areas in close proximity to residences or other sensitive receivers*
- *an area with degraded air quality*

If the applicant determines that the impacts are not medium or high adverse in these sensitive environments, the REF will need to provide strong justification for this conclusion.

4.2 Assessment of biological impacts

Is any vegetation to be cleared or modified (including vegetation of conservation significance)?

The REF must assess whether the activity will result in any significant risks to the environment resulting from vegetation clearing or modification (including vegetation of conservation significance).

Note. Clearing or modifying vegetation includes pruning or destroying individual plants, thinning, ringbarking, and felling. It also includes clearing or modifying marine vegetation such as seagrass, mangroves, kelp (in which case consultation and a permit from the Department of Primary Industries may be required).

In determining the likely level of impact, the following matters should be considered:

- the status of the species, population or vegetation community. Species, populations or vegetation communities listed as threatened are of greatest concern, followed by rare or threatened Australian plants (ROTAPs) and species or vegetation communities known to be of regional or local significance.
- whether protected native plants[48] will be affected
- whether the individual, species or vegetation community is of any other particular value (e.g. economic or social value)
- whether the vegetation provides important habitat for native species including threatened species (e.g. hollow-bearing trees, critical food resources such as winter flowering eucalypts, roosting sites etc.)
- the nature and extent of the clearing or modification proposed
- the condition and size of the vegetated area to be cleared or modified and its proximity to other areas of native vegetation (e.g. local or regional vegetation corridors)
- the likely response of the species, population or vegetation community to the type of disturbance proposed (list references)

[48] www.nationalparks.nsw.gov.au/npws.nsf/content/protected_species

- the likely response of exotic/introduced flora, and how this impacts on native species
- the potential for regeneration reduced by the proposed activity
- the result of the Assessment of Significance

Where clearing or modification is proposed to an individual plant, species, population or vegetation community of particular conservation value, or where the extent of clearing of native vegetation is medium-large in the local context, it is likely that the level of impact is medium or high adverse. If the applicant determines that the impacts are not medium or high adverse in these sensitive environments, the REF will need to provide strong justification for this conclusion.

Is the activity likely to have a significant effect on threatened flora or fauna species, populations, or their habitats, or critical habitat; or an endangered ecological community or its habitat? (aka the threatened species *assessment of significance*)

*Threatened species impact assessment is an integral part of an environmental impact assessment. The **assessment of significance** is the first step in considering potential impacts. When a significant effect is likely, further consideration is required and is more appropriately carried out when preparing a Species Impact Statement (SIS).*

The assessment of significance is a statutory requirement under s.5A of the Environmental Planning and Assessment Act 1979 and applies to all assessments under Part 5 of that Act. The objective of s.5A is to improve the standard of consideration afforded to threatened species, populations and ecological communities, and their habitats through the planning and assessment process, and to ensure that the consideration is transparent.

The REF must address each of the following factors and draw an overall conclusion of the significance of any impacts from all factors in combination. Where there is reasonable doubt regarding the likely impacts, or where detailed information is not available, a Species Impact Statement should be prepared:

(a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,

(b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,

(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

  (i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

  (ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,

(d) in relation to the habitat of a threatened species, population or ecological community:

  (i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

  (ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,

(e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,

(g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

Note. In completing the assessment of significance, applicants must refer to the OEH publication Threatened Species Assessment Guidelines - The Assessment of Significance[49]. These Guidelines have been prepared to help applicants interpret and apply the factors of assessment set out below which need to be considered when assessing whether an activity is likely to significantly affect threatened species, populations or ecological communities, or their habitats.

A Species Impact Statement (SIS) is required if the assessment of significance indicates that there will be a significant effect on threatened species, populations and communities, or their habitats. The requirements for a SIS are set out under Division 2, Part 6 of the Threatened Species Conservation Act 1995[50] and under Division 6, Part 7A of the Fisheries Management Act 1994[51].

Guidelines for assessing the impact on threatened entities listed under the EPBC Act are available from the Commonwealth Department of Sustainability, Environment, Water, Population and Communities[52].

Does the activity constitute or is part of a key threatening process?

The REF must describe whether the proposed activity constitutes or is part of a key threatening process[53] and if so, to what extent this contributes to the potential impacts of the activity.

Does the activity have the potential to endanger, displace or disturb fauna (including fauna of conservation significance) or create a barrier to their movement?

The REF must assess whether the activity has the potential to significantly endanger, displace or disturb fauna (including fauna of conservation significance) or create a barrier to their movement.

Note. Displacing or disturbing fauna includes modification of habitat.

In determining the likely impact, the following matters should be considered:

- the conservation significance of the species or population

[49] www.environment.nsw.gov.au/resources/threatenedspecies/tsaguide07393.pdf

[50] www.legislation.nsw.gov.au/maintop/view/inforce/act+101+1995+cd+0+N

[51] www.legislation.nsw.gov.au/maintop/view/inforce/act+38+1994+cd+0+N

[52] www.environment.gov.au/epbc/protect/index.html

[53] http://threatenedspecies.environment.nsw.gov.au/tsprofile/home_threats.aspx

- whether the affected fauna are protected native fauna[54]
- whether the species or population is of any other particular value (e.g. economic or social value)
- whether the fauna species is at the limit of its natural distribution
- the nature, extent and duration of the disturbance proposed
- the likely response of the species or population to the type of disturbance proposed (list references)
- whether the species or population will be able, and likely, to use the area once the disturbance is over
- the likely response of exotic/introduced fauna, and how this impacts on native species
- if a barrier to movement is to be created, whether this affects the lifecycle of the species and whether this is permanent or temporary
- the results of the threatened species assessment of significance

When displacement or disturbance of a species or population of a particular conservation value is proposed, or when a barrier to movement will be created, it is likely that the level of impact is medium or high adverse. If the applicant determines that the impacts are not medium or high adverse in these sensitive environments, the REF will need to provide strong justification for this conclusion.

Is the activity likely to impact on an ecological community of conservation significance?

The REF must assess whether the activity is likely to significantly impact on an ecological community of conservation significance.

In determining the likely impact, the following matters should be considered:

- whether the ecological community has additional values (e.g. economic or social values)
- the nature, extent and duration of the disturbance proposed
- the condition and size of the ecological community area to be cleared or modified
- the likely response of the community to the type of disturbance proposed (list references)
- whether the community will be able, and is likely to, use the area once the disturbance is over
- the likely response of exotic/introduced fauna, and how this impacts on the community
- if a barrier to movement is to be created, whether this impact will affect the lifecycle of the species making up the community and whether this is permanent or temporary
- the results of the threatened species assessment of significance

[54] www.nationalparks.nsw.gov.au/npws.nsf/content/protected_species

If the activity is likely to cause a threat to biological diversity or the ecological integrity of a community, it is likely that the level of impact is medium or high adverse. If the applicant determines that the impacts are not medium or high adverse in these sensitive environments, then the REF will need to provide strong justification for this conclusion.

Is the activity likely to cause a threat to the biological diversity or ecological integrity of an ecological community?

The REF must assess whether the activity is likely to cause a significant threat to the biological diversity or ecological integrity of an ecological community.

Note. An ecological community is not limited to those of conservation significance. Threats may be direct (e.g. clearing) or indirect (e.g. creation of a bushfire risk to a community sensitive to bushfire, impact on a physical or chemical landscape component essential to a species, endangered ecological community such as groundwater dependent ecosystems, or hydrological behaviour).

Where a proposed activity is likely to cause a threat to the biological diversity or ecological integrity of an ecological community, it is likely that the level of impact is medium or high adverse.

If the applicant determines that the impacts are not medium or high adverse in these sensitive environments, the REF will need to provide strong justification for this conclusion.

Is the activity likely to introduce noxious weeds, vermin, feral species or genetically modified organisms into an area?

The REF must assess whether the activity is likely to introduce noxious weeds, vermin, feral species or genetically modified organisms into an area.

When an activity is likely to introduce noxious weeds, vermin, feral species or genetically modified organisms into an area, it is likely that the level of impact is medium or high adverse. If the applicant determines that the impacts are not medium or high adverse in these sensitive environments, the REF will need to provide strong justification for this conclusion.

4.3 Assessment of community impacts

Is the activity likely to affect existing community services or infrastructure?

The REF must assess whether the activity is likely to significantly affect existing community services or infrastructure.

Note. Infrastructure includes roads, power, water, drainage, waste management, educational, medical or social services.

When the impact will be great enough to cause concern within the community, or community services or infrastructure will be affected, it is likely that the level of impact is medium or high adverse. If the applicant determines that the impacts are not medium or high adverse in these sensitive environments, the REF will need to provide strong justification for this conclusion.

Does the activity affect sites of importance to the local or broader community for their recreational or other values or access to these sites?

The REF must assess whether the activity is likely to significantly affect sites of importance to the local or broader community for their recreational or other values or access to these sites.

Note. Sites of importance include places of conservation, heritage or cultural significance. These are discussed in more detail under Headings 4.5 and 4.6.

As part of the impact assessment, the REF must consider the extent and nature of the impact, and the importance of the sites to the community.

When sites of importance to the community for their recreational or other values will be affected to the degree that consultation is deemed to be appropriate, it is likely that the level of impact is medium or high adverse. If the applicant determines that the impacts are not medium or high adverse in these sensitive environments, the REF will need to provide strong justification for this conclusion.

Is the activity likely to affect economic factors?

The REF must assess whether the activity is likely to significantly affect economic factors. This assessment must consider any impacts that may affect economic activity (both positive and negative), have a cost to the community or individuals, or impact on the community's economic stability, taking into account the unique economic circumstances of the area and community.

In general, impacts that have a direct adverse effect on local economies are likely to be rated at a medium to high level.

Is the activity likely to have an impact on the safety of the community?

Note. Impacts on safety from bushfire are considered under the next heading.

The REF must assess whether the activity is likely to have a significant impact on the safety of the community.

When the activity is likely to create a safety risk for the community, it is likely that the level of impact is medium or high adverse. If the applicant determines that the impacts are not medium or high adverse in these sensitive environments, the REF will need to provide strong justification for this conclusion.

Is the activity likely to cause a bushfire risk?

The REF must assess whether the activity is likely to cause a significant bushfire risk.

Note. The NSW Rural Fire Service publication Planning for Bushfire Protection[55] provides guidance on assessing the level of bushfire risk. Buildings or other constructions may require an asset protection zone in accordance with the guidelines and may also be required to comply with the necessary Building Code of Australia standards[56].

[55] www.rfs.nsw.gov.au/file_system/attachments/State/Attachment_20070301_0A17F845.pdf

[56] www.abcb.gov.au/

When an activity is likely to cause or be subject to a high bush fire risk in an area of particular conservation value or public use, it is likely that the level of impact is medium or high adverse. If the applicant determines that the impacts are not medium or high adverse in these sensitive environments, the REF will need to provide strong justification for this conclusion.

Is the activity likely to cause impacts on the visual or scenic landscape?

The REF must assess whether the activity is likely to cause significant impacts on the visual or scenic landscape.

In determining the likely impact, the following matters should be considered:

- the viewshed of the activity (i.e. from what area will the activity be able to be seen)
- whether there are any particular points within the viewshed of the activity which may cause concern (e.g. lookouts, popular walking tracks, neighbours)
- whether there are any impacts such as loss of privacy, glare or overshadowing of members of the community
- whether the design of the activity such that it is visually sympathetic to the surrounding environment and blends in, or will it stand out as an obvious feature.

When an activity is likely to cause a noticeable impact to the visual or scenic landscape, it is likely that the level of impact is medium or high adverse. If the applicant determines that the impacts are not medium or high adverse in these sensitive environments, the REF will need to provide strong justification for this conclusion.

4.4 Assessment of natural resource impacts

Is the activity likely to result in the degradation of an area reserved for conservation purposes?

The REF must assess whether the activity is likely to result in the significant degradation of an area reserved for conservation purposes.

Note. Areas reserved for conservation purposes include National Parks and reserves as well as land zoned Environmental Protection under a local environmental plan, aquatic reserve under the FM Act, heritage items or land which is the subject of a conservation agreement.

An activity which degrades land reserved for conservation purposes is likely to have a high adverse impact and may not be permissible.

Is the activity likely to affect the use of, or the community's ability to use, natural resources?

The REF must assess whether the activity is likely to significantly affect the use of, or the community's ability to use, natural resources.

Note. Natural resources include land and soil, water, air, and minerals.

With regard to impacts on water resources, the REF must consider the impact on water quality or quantity where the community is relying on water catchments and water supplies.

If the proposed activity is located within the Sydney Drinking Water Catchment, the REF must include an assessment of whether the activity will have a neutral or beneficial effect on water quality under cl.12 of the *State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011*[57].

When an activity is going to impact on water quality or quantity, it is likely that the level of impact is medium or high adverse. If the applicant determines that the impacts are not medium or high adverse in these sensitive environments, the REF will need to provide strong justification for this conclusion.

Is the activity likely to involve the use, wastage, destruction or depletion of natural resources including water, fuels, timber, or extractive materials?

The REF must assess whether the activity is likely to involve significant use, wastage, destruction or depletion of natural resources including water, fuels, timber, or extractive materials.

When a considerable amount of natural resources are to be used, it is likely that the level of impact is medium or high adverse. If the applicant determines that the impacts are not medium or high adverse in these sensitive environments, the REF will need to provide strong justification for this conclusion.

4.5 Assessment of Aboriginal cultural heritage impacts

Will the activity disturb the ground surface or any culturally modified trees (e.g. a scar tree)?

The REF must assess whether the activity is likely to disturb the ground surface or any culturally modified trees (e.g. a scar tree) based on the information provided under Heading 3.4.

Activities that disturb the ground surface or culturally modified trees will have a higher potential to harm Aboriginal objects.

Does the activity affect known Aboriginal objects or Aboriginal places?

The REF must assess whether the activity is likely to affect known Aboriginal objects or Aboriginal places based on the information provided under Heading 3.4.

Is the activity located in areas where landscape features indicate the presence of Aboriginal objects?

The REF must assess whether the activity is likely to be located in areas where landscape features indicate the presence of Aboriginal objects based on the information provided under Heading 3.4.

Activities that are located in areas where landscape features indicate the presence of Aboriginal objects will have a higher potential to harm Aboriginal objects.

[57] www.legislation.nsw.gov.au/maintop/view/inforce/epi+28+2011+cd+0+N

Can harm to objects or disturbance of landscape features be avoided?

The REF must assess whether harm to objects or disturbance of landscape features can be avoided based on the information provided under Heading 3.4.

If the answers to the previous questions indicated that Aboriginal objects or landscape features are known or likely to be present in the area of the activity, then the REF (under Heading 3.4) must demonstrate the steps that will be taken to avoid harm to these as the first priority. Possible solutions include reducing the proposed footprint of a project, re-positioning particular elements, or controlling and limiting access to areas.

Consultation with the Aboriginal community is critical to ensure they have early input into the design and decision-making stages, on the necessary steps to avoid impacts. This should involve an inspection of the site with representatives of the relevant Aboriginal groups and may also involve persons with appropriate qualifications or training in locating and identifying Aboriginal objects.

If it is clearly demonstrated that harm can be avoided (or that no objects or places are known or likely to be present), then assessment of the proposed activity can proceed with caution, without the need for further investigation or the preparation of an AHIP application.

If there is still potential for harm or disturbance to occur to objects or landscape features, and it cannot be avoided for certain, then the applicant should proceed to the next step. Refer to the Due Diligence Codes and the OEH website for further information.

If it is considered that an activity is likely to impact on Aboriginal objects or Aboriginal places then the proponent will need to redesign the proposed activity to avoid impacts as the first priority. If impacts are unavoidable, the authorisation/title holder will need to apply for an Aboriginal Heritage Impact Permit (AHIP) under s.90 of the NP&W Act. Applicants should refer to the OEH publication "Applying for an Aboriginal Heritage Impact Permit - Guide for applicants".

Does the proposed activity affect areas subject to native title claims, indigenous land use agreements or joint management?

The REF must assess whether the proposed activity is likely to affect areas subject to native title claims, indigenous land use agreements or joint management arrangements based on the information provided under Heading 3.4.

4.6 Assessment of historic cultural or natural heritage impacts

What is the impact on places, buildings, landscapes or moveable historic heritage items?

The REF must describe and assess whether the activity is likely to significantly impact on places, buildings, landscapes or moveable historic heritage items.

Note. The REF must not only deal with the physical impacts of the activity but with the impact on the heritage values of the place.

When an activity is likely to have a significant impact on known heritage items, and is inconsistent with a conservation management plan, there will need to be strong justification

to proceed. It is good practice, where there is going to be a significant impact to historic heritage, to prepare a separate heritage impact statement. This document will set out the justification for the impacts and the mitigating measures to be taken to ameliorate any identified impacts. Guidelines on the preparation of such a document can be found on the Heritage Branch website[58].

Activities that impact on heritage may require additional approvals under the Heritage Act 1977[59]. In some cases there are shortened processes (exemptions and exceptions) for activities which fall below certain significance or impact thresholds. Full details of the exemptions and all relevant forms can be found on the Heritage Branch website[60].

Applications that require one of these additional approvals must be accompanied by a heritage impact statement.

Is any vegetation of cultural landscape value likely to be affected (e.g. gardens and settings, introduced exotic species, or evidence of broader remnant land uses)?

The REF must assess whether the activity is likely to significantly impact any vegetation of cultural landscape value (e.g. gardens and settings, introduced exotic species, or evidence of broader remnant land uses).

Note. This question relates to exotic plantings, landscapes and site features as part of the context and setting for historic heritage places or broader scale cultural landscapes. Cultural landscapes, for instance, may include evidence of former land uses such as pastoralism and grazing, and other forms of land clearing. As with historic structures, it is only possible to assess the impacts of an activity once the heritage values are properly understood. A Heritage Impact Statement for such an activity will describe the values in the context of the landscape or item of historic heritage.

If the activity is likely to reduce these values, and the impacts cannot be ameliorated, there will need to be good reasons for progressing with the activity.

4.7 Is the proposed activity likely to impact on matters of national environmental significance under the *Environmental Protection and Biodiversity Conservation Act 1999*?

The REF must assess whether the activity is likely to significantly impact on matters of national environmental significance under the *Environmental Protection and Biodiversity Conservation Act 1999*.

Note. Listed matters of national environmental significance include certain threatened species and ecological communities, migratory species, Ramsar wetlands, the Commonwealth marine environment, and world or national heritage listings. The REF must consider potential impacts on these matters to identify whether referral to the Commonwealth is required. Applicants should refer to the Commonwealth Significant Impact Guidelines[61] for further information.

[58] www.heritage.nsw.gov.au/docs/hm_statementsofhi.pdf

[59] http://www.legislation.nsw.gov.au/maintop/view/inforce/act+136+1977+cd+0+N

[60] www.heritage.nsw.gov.au/14_index.htm

[61] www.environment.gov.au/epbc/publications/nesguidelines.html

4.8 Assessment of cumulative impacts

The REF must assess whether the activity is likely to have any significant cumulative impacts by identifying and taking into account interactions with existing and proposed activities in the immediate locality and the region. Particular regard should be given to cumulative impacts resulting from interactions with other exploration, mining or petroleum production activities. Any cumulative impacts must be identified and specifically addressed under this heading.

5 Summary of impacts

The REF must summarise the impacts of the activity (preferably in tabular form) and consider the total impact of the activity based on the classification of individual impacts as low, medium or high adverse, negligible or positive.

Note. When considering the likely environmental significance of the impacts associated with the proposed activity, applicants should consider:

- *how extensive are the impacts?*
- *how adverse are the impacts on environmentally sensitive areas?*
- *how acceptable are the impacts considering the nature of the impacts?*

In addition to medium and high impacts, consideration should also be given to the overall effects of the low impacts. Although impacts may be of only low to medium concern when considered individually, the total effect of the impacts could be substantial.

Further guidance is given below:

Extensive impacts are likely to be significant

In deciding if the impacts of an activity are likely to significantly affect the environment, the type, degree and range of each impact must be considered on its merits. If an impact is extensive in terms of spatial or time dimensions and intensity or severity there is potentially a high risk to the environment.

Impacts which adversely impact on environmentally sensitive areas are likely to be significant

The impacts of activities undertaken in environmentally sensitive areas are more likely to be significant than similar activities proposed in less sensitive locations. Relatively small activities carried out in sensitive locations can result in substantial impacts on the environment. A precautionary approach should be adopted for activities proposed in locations known to be environmentally sensitive, including careful investigation of alternatives and mitigation strategies. Activities that are likely to indirectly affect sensitive locations may also be considered to significantly affect the environment.

Impacts with a low level of acceptability because of the nature of the impacts are likely to be significant

When considering the impacts of an activity, the extent of the potential impacts is only one factor to be considered. Impacts that are not very extensive may still significantly affect the environment.

Any impact that results in a threat to the health or safety of individuals or the community has a low acceptability level. In considering the risks to the community, particular attention should be given to the welfare of children, the aged or any disadvantaged group.

Any impact that threatens biodiversity also has a low level of acceptability and has the potential to significantly affect the environment.

Activities that will adversely affect a community's amenity, or unacceptably change or transform a locality, or place at risk items, buildings or localities that are particularly valued by the community will be considered significant.

6 Conclusions

The REF must describe whether:

- there is likely to be a significant effect on the environment (if so, an EIS is required)
- there is likely to be a significant effect on threatened species, populations, ecological communities or their habitats (if so, a SIS is required)
- the activity is in respect of land that is, or is part of, critical habitat (if so, a SIS is required)

In considering whether there is likely to be a significant effect on the environment, the applicant must describe whether the activity as a whole will have a significant effect on the environment and explain the reasons for this conclusion.

Note. The ranking of the potential significance of the individual impacts of an activity must be considered as well as the aggregation of all the impacts of the activity. The cumulative effect could result in the activity as a whole having a significant effect.

A medium or high level of impact is considered to be significant. Examples of activities that have the potential to have significant effect on the environment include, but are not limited to, circumstances where:

- *the impacts from the proposed activity would result in a permanent and adverse change to the environment*
- *there is a low level of confidence in forecasting outcomes. In this case the risks may be high. If the risks to the environment are high, then impacts can be judged to have the potential to significantly affect the environment*
- *the risks of irreversible change may be high due to the environment's natural sensitivity and/or induced sensitivity because of cumulative impacts*
- *it is known that the environment is already stressed and therefore the acceptability of activity that will further degrade the environment may be significantly reduced.*

7 Statement of commitments

The REF must include a consolidated summary statement of any commitments included in the REF. This statement will form the basis of any activity approval conditions imposed under the *Mining Act 1992* or *Petroleum (Onshore) Act 1991*.

If the Statement of Commitments is inadequate to define and constrain the potential impacts of the activity, an EIS may be required, or relevant approval conditions may be imposed at the discretion of the Department.

The statement of commitments must be consistent with the content of the REF.

Example Statement of Commitments:

ITEM	COMMITMENT
Activity type	
Activity location	
Activity scope (*including any ancillary activities*)	
Hours of operation	
Activity duration	
Proposed commencement date	
Proposed completion date	
Maximum area of disturbance	
Rehabilitation commitments and timeframes	
Erosion and sediment controls	
Protection of water sources	
Chemical use	
Waste	
Noise	
Aboriginal heritage	
Other heritage	
Biodiversity (threatened species)	
Other regulatory approvals required	
Community consultation	
Complaint management	
Incident management	
Monitoring	
Continuous improvement	
Reporting	
Other (as applicable)	

Proposed work activities

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SANTOS UPDATE - June

Proposed upcoming work program – Narrabri Area

Time frames are indicative as schedules are dependent on factors such as approval times, weather and rig availability.

Decommissioning of wells:

- Plug and Abandon (P&A) of Wilga Park 2 and Wilga Park 5 completed
- June proposed schedule to P&A Coonarah wells 3 and 1 and Wilga Park 4

Drilling of exploration core holes:

- No core holes scheduled to be drilled in June

Other work:

- Construction of the first stage of the Leewood water storage facility is scheduled to begin later in the month and is a major component of the Pilliga rehabilitation.
- When complete, the new Leewood storage ponds will allow coal seam gas water to be removed from the ponds at Bibblewindi in the Pilliga State Forest.
- Cleaning of Bibblewindi Pond 2 has been completed
- Ecological surveys are underway in the Pilliga State Forest to gather additional information about native fauna species.

Pilliga rehabilitation:

- Irrigation is continuing as part of the rehabilitation of the Bohena and Bibblewindi sites in the Pilliga.
- Appropriate seeds will be planted at Bibblewindi this month to aid revegetation.

Site visits:

- We will be holding the next community site visits to the Pilliga on June 27. To register your interest in attending please contact Annie Alexander on 02 6729 9035 by June 20.

Community:

- Santos are sponsors of the Sustaining Rural Communities conference held in Narrabri on 5 and 6 June. Santos will host an information stand at the conference.
- Santos are sponsors of the Cycling North West Tour which will be held in Narrabri and Gunnedah from the 19 to 21 June 2013. Further information available from http://www.nsw.cycling.org.au