



Environmental Management Plan

Glasserton Pilot Wells – PEL I, Gunnedah Basin

Prepared by:

RPS AUSTRALIA EAST PTY LTD

743 Ann Street
PO Box 1559
FORTITUDE VALLEY QLD 4006

T: 617 3237 8899
F: 617 3237 8833
E: Brad.Dreis@rpsgroup.com.au
W: rpsgroup.com.au

Report Number: 106107_EMP_NPA
Version / Date: Final – Rev B / June 2011

Prepared for:

SANTOS QNT PTY LTD

Level 22, Santos Place
32 Turbot Street
BRISBANE QLD 4000

T: 07 3838 3676
F: 07 3838 3700

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Document Status

<i>Version</i>	<i>Purpose of Document</i>	<i>Orig</i>	<i>Review</i>	<i>Review Date</i>	<i>QA Review</i>	<i>RPS Release Approval</i>	<i>Issue Date</i>
A	<i>Draft for Review</i>	LGT	BD	2/6/11	BD	BD	2/6/11
B	<i>Final Report</i>	LGT	BD	3/6/11	BD	BD	3/6/11
C	<i>Final Report</i>	HR	Blake Dawson	7/6/2011	BD	BD	7/6/2011

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1.0 Introduction

Santos QNT Pty Ltd (Santos) as operator for and on behalf of the titleholder is proposing to undertake drilling, completion and testing at three pilot wells, and ancillary activities, at a property known as “Glasserton” in the Gunnedah Basin. The purpose of the proposed activities is to investigate the potential coal seam gas resource within Petroleum Exploration Licence No. 1 (PEL 1).

RPS was engaged to prepare this Environmental Management Plan (EMP) to accompany the Review of Environmental Factors (REF) for the proposed activities to be submitted to the Department of Industry and Investment in accordance with the *Environmental Planning and Assessment Act 1979* (NSW). RPS has also prepared an ecological assessment (EA). Terms used in the REF and the EA have the same meaning in this EMP.

1.1 Description of the Action

1.1.1 Overview

Santos proposes to undertake drilling, completion and testing activities to assess the coal seam gas potential of the Gunnedah Basin in PEL 1.

A REF was submitted in October 2010 and approval granted by Department of Industry and Investment (DII) on 3 December 2010, for 3 pilot wells to be located in the flat, open agricultural land of the “Glasserton” property to the east of the subject site. Due to landholder concerns with that location, an alternative pilot well program is now being proposed, which is the subject of the revised REF.

The proposal includes drilling at three sites within George's Island (Glasserton 2, 3 and 4) to obtain information on coal depths, seam thickness, continuity and permeability. Coal seams of a particular interest will be cored in selected pilot wells for geo-mechanical analysis of coal seam permeability. Drill stem testing (DST) or equivalent downhole evaluation is also undertaken on coal seams to establish reservoir pressure and give an indication of permeability.

In addition, Santos proposes to install a wellhead and downhole gauge in the Glasserton 3 and 4 wells and in an existing well (George's Island 3) located on the other side of George's Island.

In summary, the process involves:

- Preparation of a level drill pad at the three drilling locations (also referred to as “well lease areas”);
- Placement of a drilling rig and ancillary equipment at the well lease;
- Drilling of the pilot wells including (on a per well basis):
 - » Drilling of surface hole;
 - » Casing and cementing of surface casing;
 - » Drilling of main hole;
 - » Collection and analysis of drill cores (as required);

-
- » Conducting of wireline evaluation (as required);
 - » Conducting of well tests (as required);
 - » Casing and cementing of main hole; and
 - » Creation of access to target formation (e.g. via underreaming of main casing).
- Completion of the wells via installation of required downhole equipment;
 - Partial rehabilitation of the well leases;
 - Construction of required water storage and surface facilities;
 - Operation of Glasserton 2 for not less than 60 days (in total), with a maximum water output of 10 ML;
 - Removal of equipment and imported materials;
 - Shut-in of the wells, with rehabilitation to minimal area around each well site;
 - Shallow Aquifer Monitoring Bore to remain;
 - Cessation of operations of temporary water storage and load out facilities;
 - Decommissioning of water storage facilities; and
 - Suspension and rehabilitation as required (see **Section 1.1.8**).

Glasserton 2 will be the central well, in which a wellhead and downhole pumping assembly will be installed for the purposes of lifting water. Glasserton 3 and 4 and George's Island 3 will have a wellhead and downhole pressure gauges installed for the purposes of monitoring the effect of the removal of water from the target formation in Glasserton 2. This will involve:

- Mobilising a wireline truck (dimensions approximately equal to a Isuzu 1400 tandem axle body truck) to conduct the wellhead installation and downhole gauge installation; and
- Construction of a data logger/telemetry skid at the wellhead.

A Shallow Aquifer Monitoring Bore (SAMB) will also be drilled within the disturbed drill lease area of Glasserton 3. The drilling of the SAMB will include:

- Constructing lined drilling sumps as required and otherwise preparing an area within the Glasserton 3 lease to accommodate the drilling rig and associated vehicles;
- Drill and completing the bore using a Truck Mounted Water Bore Drilling Rig;
- Drill 8" conductor hole to 5-10m and case with PVC casing to hold back unconsolidated soils;
- Drill hole (diameter 6") to 30m into Trinkey Formation using mud rotary and/or rotary air hammer methods as required;
- Conduct open hole logging as required;
- Conduct permeability testing as required;
- Install steel tubing in the hole (expected tubing grade is 2-3/8" 4.7# J55 EUE) with attached downhole equipment:

- » Quartz Pressure Gauges across key formations of interest; and
- » Gauge control and data lines with associated tubing clamps.
- Cement the downhole equipment in place utilising a bentonite/cement mixture;
- Install solar powered data logger and telemetry at surface; and
- Fencing off the surface monitoring systems once in place.

Water will be lifted to the surface through Glasserton 2 to complete a 60 day pump test and will be temporarily stored in a storage facility to be constructed to the south of Glasserton 2 in a disused gravel pit. Water will be transported from the Glasserton 2 wellhead via a buried pipeline to a 30m diameter bunded tank. Water will be offloaded from the tank to water tankers as required via means of a load-out facility adjacent to the tank. Water will then be transported from George's Island to an agreed licensed facility.

A scouting survey has been undertaken prior to drilling taking place to locate the three sites with an emphasis on minimisation of impacts on the environment and property operations. Santos has entered into a land access agreement for Lot 1 in DP 1099622 and a separate land access agreement with a separate landholder for Lot 27 in DP755494.

1.1.2 Site preparation & equipment

Various works will be required in order to prepare the subject site for the proposed activities, including preparation of the well leases, access track improvements/reinstatement and construction, as well as positioning the drill rig and associated temporary buildings on the subject site. The major equipment used on site during activities will be a drilling rig, water storage and surface facilities, civil works equipment and associated temporary buildings and vehicles. These works are summarised further in this section. Figures 3-1 to 3-3 illustrate the site layout for each of the three well leases.

During site preparation, there will be some soil disturbance as a level drill pad will need to be constructed at each proposed well lease. No earthworks will be required at George's Island 3.

Plastic lined drilling sumps will be constructed on the Glasserton 2, 3 and 4 leases. Temporary flaring facilities will be located at each site during drilling and will be removed at the end of drilling activities. A flare will be positioned at the Glasserton 2 site for the duration of the 60 day pumping test whilst flaring facilities at the other wellbores will be used during the drilling phase only. The area to be disturbed for drilling activity varies for each of the leases and is outlined in **Table 1.1**.

Table 1.1 Areas of disturbance & cut and fill for proposed well leases & water storage area

Well Lease	Total Disturbance Area	Pad Level
Glasserton 2	3,600 m2 (0.36 ha)	Cut and fill will be required to establish a pad level at approximately RL 319m AHD.
Glasserton 3	5,100 m2 (0.51 ha)	Cut and fill will be required to establish a pad level at approximately RL 307.7m AHD.
Glasserton 4	4,700 m2 (0.47 ha)	Cut and fill will be required to establish a pad level of approximately RL 317.5m AHD.
Water Storage Area	2,600 m2 (0.26 ha)	Cut and fill will be required to provide a level pad.

Well Lease Construction

- The access gate on Clift Road will be upgraded and widened to allow egress of required equipment;
- Civil works equipment will be moved to site including bulldozer, excavator, grader, roller, water trucks, other trucks and support and light vehicles;
- Portable amenities will be located on site during construction;
- Any topsoil will be stripped and stockpiled. If import material is required, clean fill will be sourced for use on site;
- Required sumps will be excavated and lined with an impermeable membrane such as plastic sheeting;
- The lease area will be graded and rolled;
- A 14" steel conductor casing will be pre-installed at approximately 10m depth by the civil works crews ahead of the rig arriving on site; and
- Trimming of grass regrowth at the existing well lease area at George's Island 3.

Access Track Improvements and Construction

There are existing tracks which provides access to all three well lease locations and to George's Island 3 (refer Section 3.3 of the REF for further detail). Some regrading, widening and in some cases minor realignment of the existing track will be required to access Glasserton 2, 3 and 4. The following is a list of the detailed works involved.

- Minor amounts of vegetation will be removed either side of the existing access tracks. Trimming of some vegetation may also be required. Removal of any vegetation will be conducted under the supervision of an appropriately qualified ecologist. Minimum vegetation will be removed to permit access for all required equipment;
- Minor realignment of tracks may be required in places to permit equipment access to Glasserton 2, 3 and 4 (e.g. to permit long loads to traverse sharp bends);
- Re-alignment of the existing track will occur between Glasserton 3 and 4 in order to provide more efficient and direct access and to remove the need to construct an access track across black soil. The proposed new alignment is able to avoid all significant and mature trees; and
- Some parts of the track may need to be filled at some point during the project in order to provide all weather access. Should this be the case, a geotextile fabric will be used as a base to ensure that all imported fill is removed from the site at the completion of activities.

Drill Rig Positioning and Operation

Equipment will enter/exit the site via the main access gate from Clift Road and will be positioned on site as per the site layouts in Figures 3-1 to 3-3 of the REF. Equipment will include generator units, lighting towers, site offices, stores and other various buildings and equipment required for the duration of drilling.

It is proposed that Glasserton 2 will be drilled first, followed by Glasserton 3 and 4, with the rig being relocated following completion of drilling at each lease. Operational difficulties may require the wells to be drilled in a different order than this.

It is planned to move the rig out via the entrance route at all lease sites except Glasserton 3, where the main track passes adjacent to the lease. Both access tracks to the north and south of Glasserton 2 and west and east of Glasserton 3 will be used to facilitate the rig move. At Glasserton 4 the rig will exit the lease via the entrance track. No new tracks besides those existing and detailed in the site drawings will be used.

Rigging up/down of equipment (i.e. installation and dismantling of rig equipment) is expected to take up to 3 days per lease (3 per rig up, 3 per rig down).

Ancillary equipment will be required on site during the course of the drilling activities, including but not limited to wireline trucks, cementing trucks and well testing service company vehicles.

1.1.3 Access

All vehicles will access the site from Clift Road. Glasserton 2, 3 and 4 will be accessed via the existing gate on the western side of Clift Road, which will be widened to allow trucks to enter the site. George's Island 3 will be accessed through Lot 2 via the existing gate and track on the eastern side of Clift Road.

Access to Glasserton 2, 3 and 4 will be via existing and re-aligned access tracks. The existing track is approximately 3-4 m wide and there will need to be some vegetation removal along the periphery of this track to enable the site machinery to access each of the pilot well locations. A track of maximum 8m width is required to enable manoeuvring of the drill rigs. This width may be reduced on straight sections of track where turning is not required. The track will only be widened as necessary to accommodate the drill rig and will not exceed 8 m.

Some trimming of grassy understorey vegetation along the existing access track to George's Island 3 and at the George's Island 3 wellhead may be required to enable the wireline truck to enter the site and to install the downhole pressure gauge. In 2006 the track was utilised by a drill rig carrier of significantly greater dimensions than the equipment required to install the downhole pressure gauge into the existing wellhead.

Vegetation removal will be minimised and only undertaken under the supervision of a qualified ecologist.

There will need to be some slashing undertaken to provide a looped access track at the Glasserton 2 site, as per Figure 3.1 of the REF. This is required to enable the drill rig to exit the lease area upon completion of drilling. Part of this looped access track will also be used during the pilot testing as a water tanker turnaround circle.

Slashing is also proposed to provide an alternative access route to Glasserton 4 in order to avoid the black soils on the site.

1.1.4 Water Storage

Sufficient on site storage is required for the water lifted as a result of the proposed activities. Santos are currently negotiating with Whitehaven Coal who are licensed to take all of the lifted water at their Werris Creek Mine. The water will be trucked from site by a licensed carrier.

A number of options were considered for water storage on site, both in terms of location of the site and size of storage facilities. The selection process was again based on the principles of harm avoidance and/or minimisation. The preferred option is for a single 30 m diameter tank, to be located within the disused quarry on the south western side of the existing access track at Glasserton 2. This location minimises the need for the clearing of vegetation and earthworks will be generally restricted to areas already disturbed as a result of quarrying operations. A level pad will be constructed at approximately 321.5 m AHD.

A lined bunded area will be constructed around the tank to provide containment of the water in the event of a spill or leak from the tank. The top of bund will be at a height of approximately 323.5 m AHD to provide a bunded volume equal to 100% of the tank volume. An area of approximately 60 x 55 m will be required to accommodate the tank and bunding (refer Figure 3.5 of the REF).

1.1.5 Drilling Activities

Pilot Wells

Each site will have a specific well design ensuring compliance with relevant legislation. An open hole of nominal 311 mm diameter will be drilled through any alluvial and/or weathered material into competent rock and a blow out preventer (BOP) casing cemented in place, which will have a BOP installed on top of it. The hole will be drilled using open hole rotary drilling to a depth above the primary target coal seams. An open hole of nominal 216 mm diameter will then be drilled to a depth below the target coal seams. Appendix E of the REF includes further details in relation to the design of the pilot wells.

On penetrating target coal seams, coring and well testing may be conducted to evaluate local variations in coal seam permeability. Any testing would be performed in accordance with legislative requirements. The closest well to the proposed activities is Glasserton 1A. Glasserton 1A was fully cored through the coal bearing sequence and is located 0.3 km to the north west of the proposed central pilot well, Glasserton 2. The Glasserton pilot wells will not be fully cored, rather selected coal seams may be cored for additional geo-mechanical permeability analysis to support drill stem test (DST) (or equivalent down hole evaluation) derived permeabilities.

Once each well has reached the total depth, geophysical wire-line logs will be run over the entire length of the hole to identify major stratigraphic units, intersected coal seam depth and seam thickness. Further DST (or equivalent downhole) evaluation may follow after completion of logging. A combination of steel and fibre glass casing will be run in the hole and pressure cemented ensuring total isolation of the well bore to the surrounding coal seams and any potential aquifers. The combination casing design allows fibreglass to be placed over potential future mineable coal seams whereas steel casing isolates all other non target rock types. Exemption will be sought for any incidental or unavoidable installation of steel casing over minor coal seams. The fibreglass is then under reamed over the target coal sequence providing a conduit for fluids to flow into the well bore.

Shallow Aquifer Monitoring Bore (SAMB)

The Glasserton Shallow Aquifer Monitoring Bore (SAMB) is an activity ancillary to the drilling, completion and testing of the Glasserton Pilot wells. The purpose of the SAMB activities is to obtain data regarding potential changes in shallow aquifer levels within the vicinity of the pilot test area prior to, during and following the single well pilot test activities at Glasserton.

The purpose of the SAMB activities is to provide Santos and the Regulator with data regarding potential changes in shallow aquifer levels within the vicinity of the pilot test area prior to, during and following the single well pilot test activities.

This data can then be used to objectively assess the impact on the aquifer systems due to CSG production activity and to differentiate it from potential impacts due to existing aquifer uses and natural variations.

The SAMB activities involve:

- Constructing lined drilling sumps as required and otherwise preparing an area within the Glasserton 3 drilling lease to accommodate the SAMB drilling rig and associated vehicles;
- Drill and completing a bore using a Truck Mounted Water Bore Drilling Rig;
- Drill 8" conductor hole to 5-10m and case with PVC casing to hold back unconsolidated soils;
- Drill 6" hole to 30m into Trinkey Formation using mud rotary and/or rotary air hammer methods as required;
- Conduct open hole logging as required;
- Conduct permeability testing as required;
- Install steel tubing in the hole (expected tubing grade is 2-3/8" 4.7# J55 EUE) with attached downhole equipment:
 - » Quartz Pressure Gauges across key formations of interest; and
 - » Gauge control and data lines with associated tubing clamps.
- Cement the downhole equipment in place;
- Install solar powered data logger and telemetry at surface; and
- Fencing off the surface monitoring systems once in place.

Access to the sites will be via the existing tracks. Vehicular activity will be minimised when the ground is soft after rain.

The number of employees present at the SAMB site is expected to be up to 10 persons. The hours of operation during the drilling will be on a 12-hour a day basis.

Drilling activities are temporary and will not have any long-term impact on the visual amenity of the area. The drilling and completion of the bore is expected to occur over a 7 day period not including lease preparation, completion operations or site restoration. Lease construction and rehabilitation activities of up to 30 days will be additional to this period and may not occur concurrently to the drilling activities.

The SAMB will be installed prior to the start of the pilot test. Formation Pore Pressure data will be continuously monitored by the SAMB and Santos will receive and record the data via the installed telemetry system. Data will be reported to stakeholders on a regular schedule which is to be agreed. No water will be lifted from the SAMB following completion so it will not be able to be used to measure water quality data.

Permeability testing is expected to be conducted up to three (3) times for the bore via the Lugeon testing method. The permeability tests are performed by isolating a specific interval with inflatable straddle packers via wireline through the drilling rods.

Prior to the start of the test, water is injected into the section isolated by the straddle packers to ensure the section to be tested is saturated. The test consists of injecting water into the isolated section at constant pressure and monitoring the water injection rate for ten minutes (or longer while the injection rate stabilises). The injection pressure is then increased in two steps with monitoring of the injection rate conducted for ten minutes as for the first part of the test. The injection pressure is then decreased in two steps with monitoring of the injection rate for ten minutes for each step. The water injection rate is recorded at one-minute intervals during each step.

A lugeon value is calculated from the injection pressure and injection rate for each pressure step in the test. The lugeon values determined from each of the five pressure settings is then assessed to determine the flow regime in the formation (laminar, turbulent, dilation, wash-out or void filling). From this analysis a representative lugeon value, which is converted to hydraulic conductivity, is determined for the geologic unit.

1.1.6 Completions

Pilot Wells

All completion activities will be contained within the proposed lease areas and therefore no additional disturbance will be required.

Completion activities will be in two stages. The initial stage will be to install equipment into the new well to be drilled at Glasserton 2. The drilling rig will be utilised to install the downhole pump assembly and hydraulic drive head with additional support equipment to be mobilised as required.

The proposal includes the installation of a wellhead and downhole gauge in the existing George's Island 3 well and in Glasserton 3 and 4 to monitor pressure data in the target Hoskissons coal seam. This will involve mobilisation of a wireline truck (dimensions approximately equal to a Isuzu 1400 tandem axle body truck) to install the wellhead and downhole gauges and construction of a data logger/telemetry skid at the wellhead.

Completions will require 3 days to install the progressive cavity pump and approximately 1 day per well to install the pressure monitoring equipment.

SAMB

All completion activities will be contained within the proposed lease areas and therefore no additional disturbance will be required.

Completion activities will be to install monitoring equipment into the new well. These activities will occur immediately following drilling.

If at the time of completing the activities Santos choose not to continue with the monitoring, the bore will be plugged and abandoned and all land disturbances will be rehabilitated.

1.1.7 Operation

Upon construction of surface facilities at the site, Santos will commission the surface facilities in accordance with Santos' EMP (refer Appendix F of the REF). A review of the completed surface facilities will be undertaken by a Gunnedah Basin Project Execution operations team.

The operational phase of the activities will involve lifting water from Glasserton 2 via a hydraulically driven Progressive Cavity Pump. Water and any associated gas lifted to the surface will be processed through a separator, which allows the water and gas to naturally separate in a pressure vessel. Any gas from the separator will be flared as required under legislation. Water from the separator will enter a transfer tank with a transfer pump delivering the lifted water to the water storage facility. Water trucks will cart water from the storage facility to a licensed facility at Whitehaven Coal. During this process Glasserton 3, Glasserton 4, and George's Island 3 will monitor the pressure within the target coal seam. Shallow Aquifer Monitoring Bores will also measure pressures in the formations above the target coal seam.

The activities will have a Supervisory Control and Data Acquisition (SCADA) system, allowing operations to be monitored and controlled by Santos. The pilot wells will also have automated shutdown systems triggered by the exceedance of preset operating windows designed to prevent environmental, health or safety risk.

1.1.8 Cessation of Operations and Rehabilitation

Wells

Following completion of not less than 60 days of pumping, the SAMB, Glasserton 2, 3 and 4 wells, as well as George's Island 3 will be shut-in and suspended. This process is slightly different for each well and will entail activities as follows:

- The SAMB is effectively abandoned to fluid flow in the subsurface from the time of drilling (the bore is cemented to surface) so this well will be maintained in its operational state following the initial 60 day pump test;
- At George's Island 3 and Glasserton 3 and 4 the tubing and annulus valves will continue to be isolated at the wellhead and the well suspended with the downhole equipment in place and continuing to monitor data whilst the well is suspended. The tubing and annular pressure gauges will be monitored to ensure the well is effectively shut-in;

- At Glasserton 2 the Blow-Out Preventer in the pumping wellhead will be secured against the PCP rod string, the annulus and tubing valves will be isolated at the wellhead and the downstream valve will be shut on the riser. The separator will be depressurised and emptied of fluid; and
- For all sites regular checking and maintenance of the wellheads and water storage facilities will be conducted by Gunnedah Operations. Physical checking of the sites will occur on a monthly interval as a minimum and more frequently as required. Monitoring of the data output from the SCADA telemetry system will be performed on a daily basis by the Gunnedah Operations team.

Glasserton 2, 3, 4 and George's Island 3 wells are proposed to be shut in (using the procedures outlined above) and suspended in accordance with relevant legislation. The lease facilities (telemetry system, separators, flaring system etc.) are proposed to be removed. Downhole completions will remain in the wells and the area around each wellhead will be rehabilitated back to an area of approximately 5m x 5m around each wellhead. These remaining areas immediately surrounding the wellheads are proposed to be maintained by the Operator as suspended petroleum well leases in accordance with legislative requirements. Isolation padlocks will be installed on wellhead valves to protect against vandalism and gas monitoring will be conducted at each suspended well on each site visit to check for leaks. The SAMB is proposed to remain in an operational state.

Once the drilling and testing activities are complete, any surplus compound area is proposed to be rehabilitated to an area of approximately 5 m x 5 m around each well head with appropriate mitigation measures and environmental safeguards implemented to minimise potential impacts. All rehabilitation works would be undertaken with maximum regard to environmental protection and rehabilitation, vegetation, subsoil and topsoil management, weed control, erosion and sedimentation management and revegetation in accordance with the relevant statutory requirements.

Rehabilitation is to be undertaken within regulatory timeframes. All private tracks used during operations are generally returned to their pre-operations state, or to a condition agreed by the landholder.

Water Storage Area

The temporary water load out facilities and water tanker turnaround circle will be decommissioned and removed from site. The area they impacted on will be rehabilitated.

The water tank and associated bunding and liner are proposed to remain in place for potential landholder or other use.

1.1.9 Duration

Assuming a commencement date in the third quarter of 2011, it is expected that all activities including rehabilitation will be finalised by mid 2012. **Table 1.2** identifies the expected duration of activities associated with the proposal.

Table 1.2: Duration of Drilling and Site Activities

Activity	Approximate Duration
Lease Build	30 days
Drilling	30 days
Completion	10 days
Lease Surface Facilities, Water Flowline and Water Storage Build	100 days
SAMB (including 30 days rehabilitation)	37 days
Operation	60 non-consecutive days
Rehabilitation	120 days

1.2 Site Particulars

1.2.1 Regional Location

The study area occurs on a topographical feature referred to as George's Island that is located approximately 40 km south of Gunnedah and approximately 35 km northwest of Quirindi within the Brigalow Belt South IBRA Bioregion and Liverpool Plains IBRA Subregion. Locally the study area is situated within the Gunnedah Local Government Area. George's Island is isolated from neighbouring woodlands within the locality, with the closest being Doona State Forest located approximately 5 km to the east, Spring Ridge State Forest approximately 7 km to the southwest and Breeza State Forest approximately 7.5 km to the north. Due to George's Island being fragmented and isolated from neighbouring woodlands, it can be considered as possessing 'island biogeography'.

1.2.2 Study Area Description

The study area is approximately 52.56 ha, which is a small portion of George's Island, which encompasses approximately 428.3 ha. The study area is comprised of a mosaic of grassy woodland vegetation communities and is bounded by similar vegetation to the east, northeast and south and agricultural land to the west and northwest. The study area contains two abandoned quarries previously used for gravel extraction; these quarries have since formed two small ephemeral waterholes. The study area is currently accessible via Cliff Road, which connects back to the Quirindi Premer Road.

1.2.3 Topography

The topography of the study area is flat to undulating with slopes in the order of 0-10 %. An east to west low lying ridge dominates the study area with a relatively flat and level area in the northwestern corner. Elevation across the study area ranges between approximately 310 m Australian Height Datum (AHD) in the northwestern corner up to approximately 330 m AHD along the southeastern corner adjacent to Cliff Road.

2.0 Environmental Management Plan

2.1 Purpose of the EMP

This EMP has been prepared to ensure that the proposed activities are undertaken in accordance with relevant legislation, policies and guidelines. The mitigation measures outlined within this EMP are designed to ensure that the impact upon the environment are minimised, and that any impacts that do occur are managed appropriately

2.2 Objectives

The objective of this EMP is to:

- Ensure cultural heritage sites are not impacted unnecessarily by land disturbance;
- Avoid sites of known scientific and natural significance;
- Minimise or where possible avoids clearance of trees and shrubs;
- Minimise risks to wildlife and stock;
- Avoid the introduction or spread of pest plants and animals and implement control measures as necessary;
- Minimise disturbance and avoid contamination to soil;
- Include erosion control measures in vulnerable locations;
- Ensure that noise and dust issues are adequately dealt with in order to minimise likely impacts upon the surrounding environments;
- Optimise (in order of most to least preferable) waste avoidance, reduction, reuse, recycling, treatment and disposal;
- Provide adequate measures in relation to bushfire protection and ignition that may affect the surrounding environments; and
- Consider post-construction land use.

2.3 Responsibilities

Responsibility for the environmental management will be structured and be both broad-based company policy related and individually assigned. While designated individuals will be responsible for certain aspects of the construction, operation, and decommissioning activities, all staff will be responsible for environmental management to a certain extent

The following information provides a summary of each of the defined roles.

2.3.1 Project Manager

During the George's Island activities the Project Execution Manager is responsible for the overall execution of the activities and will ensure appropriate environmental management and compliance throughout the project execution activities.

2.3.2 Drilling Contractor

During drilling operations and within the drilling lease areas the Drilling Rig Manager is the on-site person responsible for ensuring appropriate environmental management and compliance. Overall responsibility for ensuring drilling activity environmental management and compliance falls with the Santos CSG Drilling and Completions Environmental Advisor following site approval.

2.3.3 Civil Works Contractor

During civil works activities the responsibility for environmental management and compliance rests with the Santos Construction Supervisor. The Site Supervisor provided by the Civil Works Contractor is responsible for any immediate actions required to ensure on-site environmental management and compliance only in the on-site absence of the Santos Construction Supervisor and is responsible for timely reporting of any issues directly to the Santos Construction Supervisor.

2.3.4 Environmental Advisor / Auditor

The Santos Environmental Advisor is the field-based person responsible for advising the Drilling Contractor and Civil Works and other relevant parties on the requirements of the EMP to ensure that the requirements are implemented.

Such personnel need to be appropriately qualified and undertake activities such as the following:

- Inspecting construction works on a regular basis to ensure compliance with relevant requirements;
- Maintaining a written and photographic record of the construction activities for reference;
- Identifying potential problem areas and ensuring that they are treated adequately;
- Advising all construction staff on their environmental responsibilities;
- Reporting situations of non-compliance to the Santos Project Manager;
- Ensuring sensitive areas previously identified by studies (such as threatened plants or heritage items) are flagged out and that personnel are informed of their significance; and
- Monitoring environmental performance of the construction activities.

2.3.5 Heritage Supervisor

The Santos Heritage Supervisor will be consulted as required. They may be required to monitor the protection of Aboriginal artefacts or European heritage. They are also required to flag items of significance for construction workers to avoid.

2.3.6 Supervising Ecologist

The Supervising Ecologist is required to monitor all vegetation clearing and pruning activities to ensure vegetation and fauna management procedures are implemented. The Supervising Ecologist is to provide advice during the site rehabilitation and monitor revegetation. They are also required to prepare or provide input into required reporting.

2.3.7 Project Liaison

The Santos Project Liaison manager is responsible for regular and ongoing communication as required to external parties. The Santos Project Liaison manager is responsible for ensuring any public complaints are effectively managed.

2.4 Procedures

Procedures need to be put in place to ensure that there are set standards and management requirements that need to be considered. This EMP outlines procedures in the Construction Management, Operation Management and Decommissioning Management sections as to what procedures are, in relation to each environmental issue.

2.5 Training and Awareness

Training and awareness is an integral part of the protection of the environment and the implementation of an EMP. A comprehensive environmental training program will encompass inductions, job specific training, and environmental awareness programs.

2.5.1 Induction

Santos has a comprehensive, multi level induction program. All contractors and personnel will complete the Santos Level 1 induction as the basis of completing any works for the company and covers company values, policies, Environment Health and Safety Management System (EHS MS) and other core information.

The Gunnedah Level 2 induction covers EHS matters that are specific to the NSW and Gunnedah area in which the company operates, minimum standards and expectations.

The Site Level 3 is an on-site induction specific to a smaller area of work, such as a drill site or a pilot well site. Conditions and requirements for this site are covered in this induction.

2.5.2 Job Specific Training

Santos operators and staff undertake competency based training, in line with the requirements of their role. These are assessed periodically and identified gaps addressed in a training and development plan for each individual.

All Santos personnel and contractors are required to have a working knowledge of the Santos EHS MS, site specific conditions relating to works being completed on site.

2.5.3 Environmental Awareness

Prior to a scope of work commencing on a Santos site, an 'icebreaker' is held with all relevant parties to the work scope. Environmental conditions associated with the works in addition to any health and safety issues are identified and discussed in detail. Toolbox meetings are held at the start of each day where these requirements are refreshed to ensure that all persons on site are aware of the requirements and have opportunity to discuss concerns in an open forum.

2.6 Communication

Regular and ongoing communication will be required to inform external parties as to the progress and success of the environmental aspects of the activity. The primary point of contact will be the appointed project liaison person. External parties are likely to include:

- Landholders;
- Business;
- Local, State and Federal government;
- NSW Farmers Association;
- Namoi Catchment Management Authority;
- Utilities operators;
- Local Aboriginal Land Councils; and
- Special interest and activist groups.

2.7 Documentation and Reporting

A record of the implementation and results of the EMP is an important tool to enable internal and external authorities to check the procedures and the monitoring results. Assessment of compliance with statutory authorities, success in achieving objectives, any environmental outcomes and their significance and the effectiveness of the EMP will be documented.

Documentation and recording is proposed to include:

- Records of induction and training attendees;
- Inspection reports;
- Non-compliance reports;
- Accident or incident reports; and
- Audit result reports.

2.8 Review and Improvement

Given the short-term nature of the proposal, a review and improvement process is not required. However, in the event of a notable environmental incident, the EMP will be updated to reflect any required changes to management practises.

3.0 Construction Management

3.1 Overview

The construction phase incorporates the following activities:

- Construction of access tracks, including vegetation removal, grading and surfacing where required;
- Site preparation, including clearing and grading for drill pad;
- Drilling activities, including manoeuvring drilling rigs to site;
- Construction of required water storage and surface facilities;
- Completion of the wells via installation of required downhole equipment; and
- Site clean up, including removal of the drill rig and machinery.

The following environmental elements may be impacted through various components of the construction process:

- Vegetation;
- Fauna;
- Heritage;
- Erosion and Sedimentation;
- Land (access, clearing and grading)
- Waste;
- Noise;
- Dust;
- Weeds;
- Bushfire; and
- Diseases.

The sections below outline environmental issues and management actions to be implemented throughout the construction phase.

3.2 Sensitive Environments

An ecological assessment has been prepared by RPS for the study area. In summary, one Endangered Ecological Community, as listed under the TSC Act, and one Critically Endangered Ecological Community (CEEC) as listed under the EPBC Act, *White Box Yellow Box Blakely's Red Gum Woodland*, is located on the study area. The Koala (*Phascolarctos cinereus*), listed as Vulnerable under the TSC Act, was recorded on the study area and scats and scratches were observed at several locations. The Little Lorikeet (*Glossopsitta pusilla*), listed as Vulnerable under the TSC Act, along with the Rufous Fantail (*Rhipidura rufifrons*) and Rainbow Bee-eater (*Merops ornatus*), both listed as Migratory under the EPBC

Act, were also recorded on the study area. No threatened flora species were recorded. Several flora and fauna species were considered likely to occur in the study area and may utilise the habitat resources of the study area.

The extent (ha) of vegetation communities/ habitats and identified EEC that will be removed as a result of the proposal is provided in the following tables.

Table 3.1: Extent of Vegetation Communities Within Study Area and Area of Each to be Removed

Vegetation Community or EEC / Habitat Type	Total within Study area (ha)	Total to be Removed (ha)	Percentage (%) to be Removed
Bimble Box Woodland	8.38	0.71	8.47%
TSC Act - White Box Yellow Box Blakely's Red Gum Woodland EPBC Act - White Box-Yellow Box-Blakely's Red Gum grassy woodland and derived native grassland	37.83	0.65	1.72%
Silver-leaved Ironbark Woodland	2.90	0.19	6.55%
Plains Grass Grassland	2.85	0.08	2.8%
Disturbed Land	0.6	0.49	81.67%
Total	52.56 ha	2.12 ha	4.03%

Table 3.2: Extent of Habitat Type within Study Area and Total Area of Each to be Disturbed

Vegetation Community or EEC / Habitat Type	Total within Study Area (ha)	Total Area of Disturbance (ha)	Percentage (%) of each to be Disturbed
Woodland	49.11	1.55	3.16
Grassland	2.85	0.08	2.8
Disturbed Land	0.6	0.49	81.67
Total	52.56 ha	2.12 ha	4.03%

The temporary removal of 1.55 ha of woodland habitat represents disturbance to 0.6% of woodland habitat across the entire George's Island based on the Curlewis vegetation data. Similarly, the temporary removal of 0.64 ha of the White Box-Yellow Box-Blakely's Red Gum Grassy Woodland impacts on 0.34% of this community occurring on the Island.

The following sections discuss the above potential impacts, and proposed management measures.

3.3 Vegetation Management

3.3.1 Environmental Issues

The potential impacts associated with the proposal are short-term and temporary and arise from the establishment and operation of the well lease sites and the upgrading of access tracks. The proposed location of the Glasserton well heads has been sited within areas of past disturbance (such as the former gravel quarry and historically cleared areas) to minimise the amount of clearing and disturbance to the TSC Act and EPBC Act listed Box Gum Woodland. In addition, the configuration and design of the

proposed well sites has been prepared to minimise the footprint of each, including vegetation clearing requirements. The physical ground disturbance will be restricted to the actual rig platform including rod rack and transfer area. The remaining rig infrastructure will be placed on grade or elevated on blocks, bricks or timber to reduce the amount of ground disturbance.

3.3.2 Management Measures

The following vegetation management measures will be implemented throughout the construction phase.

- Well leases and water storage facility will be clearly fenced using temporary fauna exclusion fencing prior to vegetation clearing commencing;
- The extent of clearing required along access tracks will be clearly pegged, and all trees with a DBH of greater than 20cm requiring removal will be clearly flagged, as well as all habitat trees and Koala food trees;
- All contractors will be specifically advised of designated work area. The following activities are not to occur outside of designated work areas to minimise impacts on native vegetation:
 - » Vehicle movements;
 - » Storage and mixing of materials
 - » Vehicle parking;
 - » Liquid disposal;
 - » Machinery repairs and/or refueling;
 - » Construction site office or shed;
 - » Combustion of any material;
 - » Stockpiling of soil, rubble or debris; and
 - » Any filling or excavation including trenching, topsoil skimming and/or surface excavation.
- Sensitive tree clearing techniques will be implemented. Directional clearing will occur, beginning in disturbed areas, and working towards vegetated areas;
- All felled native trees will be recycled (milled, chipped or mulched) and re-used as mulched for rehabilitation, landscape works and/or erosion control;
- Any felled non-native vegetation will be disposed of at an appropriate waste disposal facility; and
- Stockpiling of felled trees and soils will occur only within the designated work areas. Ensure stockpiles are not:
 - » Located in an area which significantly isolate, fragments or dissects tracts of vegetation connectivity, or results in an increase in threatening processes;
 - » On slopes of greater than 10%;
 - » Do not impede vehicle, stock or wildlife movements;

- Install erosion and sediment control devices to ensure stockpile remains intact; and
- Habitat values (e.g. hollow logs) will be salvaged and placed in adjoining undisturbed areas.

3.4 Fauna Management

3.4.1 Environmental Issues

The proposal is likely to result in the removal of approximately 2.12 ha of viable habitat from the study area. This habitat provides foraging, breeding, roosting and sheltering resources that may currently be utilised by all the faunal groups identified in the study area. This will result in the displacement of native fauna across the study area. Displaced fauna will need to relocate into adjacent habitats, which will place short-term pressure on the available habitat resources within these habitats.

It is expected that six hollow bearing trees will be removed as a result of the proposal. Additionally the road widening may potentially impact hollow-bearing trees. These trees provide viable nesting, roosting and/or breeding resources for native birds, arboreal mammals and some reptile species. Four other hollow bearing trees, located just beyond the development footprint, may be subject to structural root zone impacts and may die back and turn into stag trees and as such the associated hollow bearing resources will not be lost.

The degree of displacement within the study area and the intensity of pressure placed upon adjacent habitats are considered to be minimal based upon the percentage of habitats to be lost in comparison to what will be retained in the study area. Additionally, like habitats are also available throughout George's Island and as such an even smaller percentage of habitat resources will be lost over the short-term from the wider study area.

The less mobile smaller species are also unlikely to be significantly impacted, as the area/ extent of habitats to be removed (2.12ha) in comparison to the area of habitats to be retained across the study area (52.56ha) should allow such species to migrate and disperse across George's Island successfully. Additionally, the size and shape of existing vegetation and habitats within the study area would be altered slightly based upon the proposed areas (ha) of disturbance.

It has been determined that the study area does provide suitable core breeding habitat for the Koala and that the study area does constitute Core Koala Habitat as defined in SEPP 44. This was based upon the presence of a small Koala population, abundance of Koala feed trees and the isolation of George's Island and its local importance for the Koala population present. Therefore a Koala Plan of Management (KPoM) has been developed for the study area.

3.4.2 Management Measures

The following fauna management measures to be implemented throughout the construction phase.

- Well leases and water storage facility will be clearly fenced using temporary fauna exclusion fencing prior to vegetation clearing commencing;
- Fencing is to comply with the following specifications:

-
- » Unclimbable, and constructed of plywood sheets, or mesh wire with a 'floppy' top that is at least 1.5m high;
 - » If mesh wire is used, a 600mm wide strip of smooth sheeting will be installed across the top of the fence to impede access;
 - » Fence bracing/supports will be located within the construction area;
 - » Fencing will have a gap of less than 100 mm between the ground and the bottom of the fence;
 - » The fence will be kept clear of fallen branches and vines; and
 - » No barbed wire or electric fencing will be used.
- All habitat trees and Koala food trees occurring within areas to be cleared will be clearly demarcated with flagging tape by the supervising ecologist;
 - A supervising ecologist will be on site throughout all vegetation clearing and pruning activities;
 - Construction equipment and vehicles will be stored within designated work areas, and not within areas of adjacent habitat;
 - All construction vehicles/machinery are to use the designated access tracks, and follow the speed limits; and
 - No domestic pets (including dogs or cats) will be allowed on site during construction.
 - All construction activities comply with the Koala Plan of Management.

3.5 Heritage Management

3.5.1 Environmental Issues

The site, including all lease pads and access tracks, was inspected by Santos' cultural heritage officer and an independent archaeologist in March 2011. No items of significance were identified, and no features which could contain archaeological deposits were found. A Cultural Heritage Assessment was subsequently prepared for the site, which concluded that Aboriginal objects are unlikely to occur in the subject area.

With regard to the water storage area, the assessment states that it is considered that *"The lease area has been severely impacted by agricultural activities over the past 80 years. Any future proposed disturbance (earthworks) [is] not likely to contribute to any existing disturbance"*.

A search of the Aboriginal Heritage Information Management System (AHIMS) was undertaken over the site in May 2011 and no cultural heritage objects or sites were identified. The investigation area was not found to be an "Aboriginal Place".

3.5.2 Management Measures

The following mitigation measures will be implemented throughout the construction phase to limit any potential impact on any unknown Aboriginal sites or objects:

- Minimise impact to areas outside the area of operation through appropriate on site induction of all employees and contractors attending site;
- Vehicle access is to remain within existing tracks where possible in order to minimise potential impacts on surrounding vegetation and reduce erosion;
- In the event that any vegetation clearing is required to allow large machinery access to a given area, soil disturbance will be kept to a minimum. Subject to ecological constraints, vegetation will be cut with a chain saw rather than bulldozed, and trees and bushes will be cut at their base just above ground level where possible;
- If works fall outside of the areas inspected for the purposes of the cultural heritage assessment or access routes are altered Santos will have those areas investigated by a qualified archaeologist;
- If an Aboriginal object or site is identified at any point during the proposed works, all works in the vicinity will cease immediately. That area will be temporarily fenced with high visibility tape or barrier fencing in order to prevent further impact and a suitably qualified archaeologist contacted. Works in that location will not proceed until the site has been registered with the OEH and an appropriate course of action determined by the archaeologist. In most instances this would involve applying for an Aboriginal Heritage Impact Permit (AHIP) from OEH in consultation with the Aboriginal Community; and
- In the event that skeletal remains are uncovered, work will cease immediately in that area and the area fenced. Employees to complete the Santos Discovery of Cultural Heritage Site Form located on the Santos intranet. Santos will then contact the NSW Police and follow the advised procedure. If the skeletal remains are determined to be Aboriginal, Santos will then contact the OEH and relevant Aboriginal Community Stakeholders in order to determine an action plan for the management of the skeletal remains prior to works commencing.

3.6 Access

3.6.1 Overview

Access tracks are required so that all personnel and materials can be efficiently directed to the construction site. It is important to ensure that while access to the site will be provided, the impacts upon the environment resulting from the use of such access will be controlled and minimised.

3.6.2 Environmental Issues

The following environmental issues have been identified as key issues potentially arising from the construction of access tracks:

- Increased safety hazard resulting from increases in traffic volume;
- Access track proliferation;
- Soil compaction, erosion and sediment release to land and water;
- Disturbance of significant flora and wildlife habitat;
- Incursion of disease, weeds, vermin or destructive influences to the site;

-
- Temporary disruption to landholders;
 - Degradation of existing road infrastructure; and
 - Unauthorised third party access to previously inaccessible areas.

3.6.3 Management Measures

The following management measures will be implemented throughout the construction of access tracks:

- Vegetation clearance shall be minimised, i.e. trees avoided or trimmed as an alternative to clearing;
- Cleared vegetation will be stockpiled within designated work areas;
- Topsoil will be removed prior to surface preparation and either stockpiled within designated work areas for respreading during restoration;
- During the creation of access tracks, erosion or sediment release will be controlled adequately; and
- Appropriate measures will be employed to prevent surface damage to public roads (e.g. limiting dirt track access during wet weather and protecting bitumen surfaces where tracked machinery is required to cross roads).

The following measures will be implemented throughout the construction phase to ensure access tracks are appropriately utilised:

- Access tracks will be speed limited to 20km/h; and
- Vehicle parking will be restricted to designated areas.

3.7 Clearing

3.7.1 Overview

Clearing is required to facilitate construction activities. The well lease and access track site selection process minimised the impacted area by utilising existing cleared areas and access tracks, however. Clearing comprises the removal of trees, shrubs and groundcovers, the pruning of selected trees along the access track.

3.7.2 Environmental Issues

The following issues have been identified as key issues potentially arising from vegetation clearing activities:

- Soil erosion;
- Sediment release;
- Removal of significant flora and wildlife habitat;
- Increased potential for weed species introduction; and
- Disturbance to heritage sites.

3.7.3 Management Measures

The following management measures will be implemented throughout the construction phase:

- Vegetation clearance will be minimised as far as practicable;
- Clearing will be limited to designated work areas;
- Cleared vegetation will be stockpiled separately in a manner which:
 - » facilitates respreading or salvaging;
 - » does not impede vehicles, stock or wildlife;
 - » avoids damage to adjacent live vegetation; and
- Surface rock will be stockpiled in an adjacent area for respreading.

3.8 Grading

3.8.1 Overview

Grading may be required along the access tracks. Grading comprises the removal of topsoil and subsoil and is required where the soil conditions cannot accommodate construction activities.

3.8.2 Environmental Issues

The following issues have been identified as key issues potentially arising from grading:

- Soil erosion and sediment release;
- Soil mixing, compaction and topsoil loss;
- Removal of wildlife habitat; and
- Increased potential for the spread of weeds and pathogens.

3.8.3 Management Measures

The following management measures will be implemented throughout the construction phase:

- Graded soil will be stockpiled separately from other materials (e.g. vegetation), where it can be readily recovered for respreading and where it will not be lost through wind or water erosion or other means;
- Graded soil will not be stockpiled where it has the potential to result in sedimentation or acidification of land; and
- Topsoil containment measures (e.g. berms and sediment fencing) will be used as necessary.

3.9 Clean Up and Waste Management

3.9.1 Overview

Drill cuttings and some general site operations waste will be produced as part of the proposed drilling operations. Any solvents, oils and other general waste would need to be managed in an appropriate manner to avoid health risks and contamination of land and waterways. Following drilling and removal of excess drilling fluid from the sump, dried cuttings will be removed and transported to an appropriate licensed waste facility.

Clean up involves the removal of waste materials and drilling equipment from the construction areas.

A regular service of amenities will be conducted and waste will be removed to a licensed facility.

3.9.2 Environmental Issues

The following issues have been identified as key issues potentially arising from vegetation clearing activities:

- Protection of soil and water quality;
- Erosion and sediment control; and
- Waste minimisation and appropriate disposal.

3.9.3 Management Measures

The following management measures will be implemented throughout the construction phase:

Solid Inert Wastes

Appropriate solid waste management measures will be applied during the construction phase, including:

- Encouraging suppliers to reduce and/or collect packaging;
- Stockpiling reusable and recyclable wastes, such as timber skids, pallets, drums, and scrap metals;
- Supplying designated collection bins at work sites for aluminium cans, glass and paper recycling; and
- Collecting and transporting general refuse to local Municipal Council approved disposal sites.

Liquid Inert Wastes

- Drilling muds will consist of approved water based products or synthetic lubricants, and will be contained within the fluid circulation system (i.e. drilling sumps, fluid pump system and drilling orifice) during drilling; and
- Drilling muds will be recycled for use where practicable, or disposed of in accordance with regulatory and requirements as set out in the REF.

Hazardous Wastes

Hazardous wastes are those which pose an immediate potential risk to human health and/or the environment, including cleaning chemicals, waste oils, and sewerage. Mitigation measures include:

- Managing hazardous wastes in accordance with all relevant regulatory requirements. Many hazardous wastes may also be declared as prescribed wastes under State or Territory legislation for which specific management requirements may be imposed (e.g. waste inventories, tracking systems and permitting);
- Sewage and sullage disposal via approved septic systems, mobile chemical treatment systems or alternatively disposed to municipal sewage treatment plants;
- All waste chemicals and other toxic materials will be stored and collected for safe transport off-site for reuse, recycling, treatment or disposal at locations approved by relevant regulatory authorities;
- Hydrocarbon wastes, including lube oils and oily sludges, will be collected for safe transport off-site for reuse, recycling, treatment or disposal at approved locations;
- Hazardous waste storage areas will be suitably designed to adequately contain any spills (e.g. bunded in accordance with statutory requirements); and
- Contaminated soils will be managed according to their concentration of contaminants, their leachability and the extent of area affected.

Putrescible Wastes

Putrescible wastes are those wastes able to be decomposed by bacterial action and may include, discarded food, domestic garbage, commercial wastes and garden clippings. Appropriate putrescible waste management shall be applied throughout the construction phase, including collection and transportation to a landfill approved by the relevant regulatory authority (this may include local government approval).

Housekeeping

The designated work areas will be maintained to an orderly and hygienic standard. Litter accumulation will be avoided by ensure litter bins are provided, and maintained, on site.

3.10 Erosion and Sediment Control

3.10.1 Overview

Erosion and Sediment Control measures are required in order to avoid soil loss and resultant sedimentation of low-lying environments. Construction activities involving earthworks increase erosion risks by exposing soils through the removal of protective features such as vegetation cover. Clearing and grading required for construction will involve risks in relation to this potential impact. As a result, various components within this EMP refer to activity-specific erosion and sediment control measures.

3.10.2 Environmental Issues

The following are considered to be the key environmental issues in relation to erosion and sediment control for the construction phase:

- Loss of topsoil and sub-soils;
- Siltation and sedimentation;
- Reduced potential for rehabilitation success; and
- Long term stability of disturbed areas.

3.10.3 Management Measures

The following erosion and sediment controls will be implemented throughout the construction phase:

- Any displaced soil gathered during operations will be stockpiled within designated work areas. This soil to be used as backfill at the conclusion of drilling operations;
- Maintain existing ground cover where possible;
- Stabilise entry/exit points to the work site;
- Install sediment fence at downstream limit of disturbance areas;
- If filling of track is required, geotextile fabric will be used as a base so that all imported fill can be removed following completion of works;
- Store all drill cuttings within the designated work area, and contain with sediment fence;
- Black soils will be avoided throughout the duration of works; and
- Rehabilitate the disturbed area upon completion of required pilot activities.

3.11 Noise Control

3.11.1 Overview

A Consideration of Noise Emissions report was prepared by SLR Consulting Australia Pty Ltd. The report also takes into account the sound power level associated with onsite plant including the drill rigs, diesel generator-powered lighting towers and tool shed equipment. The study found that Predicted noise emissions from Glasserton 4 are fully compliant with the NSW Industrial Noise Policy (INP). Predicted noise emissions from Glasserton 2 and 3 exceed the relevant noise criteria by between 1dBA and 6dBA depending upon the weather. This comprises a marginal noise level increase during calm weather and a moderate increase during in the event of a temperature inversion.

3.11.2 Environmental Issues

Environmental issues arising throughout the construction phase that are associated with noise control include:

- Noise pollution as a result of vehicles, machinery and drilling that may deter native fauna from utilising the study area and immediate surrounding areas as habitat; and
- Temporary impact to nearby residences.

3.11.3 Management Measures

The following mitigation measures will be implemented throughout the construction phase:

- Undertake noise reporting and response procedures;
- Implement a non-compliance/complaints handling procedure;
- Ensure that any community issues of concern are met with a prompt response;
- Undertake monitoring to refine on site noise mitigation measures and plant operating procedures where practical;
- Consideration will be given to the implementation of acoustical mitigation measures if required, at the nearest receiver;
- Consideration will be given to negotiated agreements with property holders, if required;
- Landholder notification will be given prior to commencement of drilling; and
- Equipment will be maintained so that noise levels remain constant.

3.12 Dust Control

3.12.1 Overview

The existing air quality of the locality is typical of a rural area with the majority of air emissions and pollutants arising from existing agricultural activities including stock grazing, land clearing and soil preparation, sowing and harvesting of crops, vehicle and heavy machinery movements; bushfires and burn-offs.

Dust control is required throughout the construction phase as construction activities may temporarily result in increased dust levels. Increased dust levels generally result from machinery operating in exposed soil conditions or from wind eroding exposed soils. As such a major related factor is soil erosion, which is referred to in relation to site-specific issues throughout this EMP and in the erosion and sedimentation section of this document. Additional measures are however required specifically in relation to the liberation of dust into the atmosphere.

The potential for the proposal to create dust would arise from the following sources:

- vehicle movements to and from the sites; and

-
- construction and rehabilitation of the proposed access tracks and well lease.

3.12.2 Environmental Issues

The key environmental issues associated with increase dust emissions include:

- Potential disruption to the pollination cycle and ability of native plants to regenerate (i.e. germination, revegetation and re-colonisation of existing plants);
- Soil erosion and sedimentation;
- Impacts to sensitive fauna; and
- Inconvenience to adjacent residents and construction workforce.

3.12.3 Management Measures

To minimise impacts on air quality the following actions will be undertaken:

- Access tracks will be maintained in a compacted state;
- Land disturbance areas will be minimised;
- Water will be applied to exposed soils as required to prevent dust generation. Water supplies will be of an appropriate water quality and will not lead to soil contamination (e.g. saline groundwater or contaminated waste water);
- Dust generated from soil stockpiles will be minimised by ensuring exposure time is minimised, applying water, covering stockpiles with protective materials (e.g. hessian, tarpaulins); and
- Slow speed restrictions will be enforced on internal site access tracks.

3.13 Weed Control

3.13.1 Overview

The proposal has the potential to create favourable conditions for introduced weed species within the study area, which could potentially lead to an increase of existing weed populations. This is most likely to occur where soil disturbance is to occur.

3.13.2 Environmental Issues

Key environmental issues associated with weed control include:

- The spread of weed species on and off site;
- Potential for unsustainable rehabilitation; and
- Competition from weed species and displacement of native flora.

3.13.3 Management Measures

- All plant and machinery will be washed down and cleaned of any foreign soil and seed prior to being transported onsite to prevent the potential spread of introduced weeds and pathogens;
- All cleared weed species will be stockpiled separately, and removed off site. Weed material is not to be re-used as part of site rehabilitation;
- Where practical, clearing will commence in areas of low weed infestation, and move towards areas of high weed infestation;
- Weed infestations identified by the supervising ecologist within and adjacent to access tracks and well leased will be eradicated by hand, with non-residual herbicide, or mechanical removal. Appropriate weed removal techniques are outlined in **Table 3.3**.

Table 3.3: Weed Removal Techniques

Weed Type	Removal Technique	Method
Woody Weeds	Cut and Paint	<ul style="list-style-type: none"> ▪ Make a horizontal cut through the stem close to the ground using secateurs, loppers or a bush saw; and ▪ Immediately apply herbicide to the exposed flat stump surface.
	Stem Injection	<ul style="list-style-type: none"> ▪ At the base of the tree drill holes at a 45 degree angle into the sapwood; ▪ Fill each hole with herbicide immediately; and ▪ Repeat the process at 5 cm intervals around the tree.
	Frilling or Chipping	<ul style="list-style-type: none"> ▪ At the base of the tree make a cut into the sapwood with a chisel or axe; ▪ Fill each cut with herbicide immediately; and ▪ Repeat the process at 5 cm intervals around the tree.
Small Plants	Hand removal	<ul style="list-style-type: none"> ▪ Remove any seeds or fruits and carefully place into a bag; ▪ Grasp stem at ground level, rock plant backwards and forwards to loosen roots and pull out; and <p>Tap the roots to dislodge any soil, replace disturbed soil and pat down.</p>
Vines and Scramblers	Hand removal	<ul style="list-style-type: none"> ▪ Take hold of one runner and pull towards yourself; ▪ Check points of resistance where fibrous roots grow from the nodes; ▪ Cut roots with a knife or dig out with a trowel and continue to follow the runner; ▪ The major root systems need to be removed manually or scrape/cut and painted with herbicide; and ▪ Any reproductive parts need to be bagged.
	Stem Scraping	<ul style="list-style-type: none"> ▪ Scrape 15 to 30 cm of the stem with a knife to reach the layer below the bark/outer layer; and ▪ Immediately apply herbicide along the length of the scrape.
Weeds with Underground Reproductive Structures	Hand removal	<ul style="list-style-type: none"> ▪ Remove and bag seeds or fruits; ▪ Push a narrow trowel or knife into the ground beside the tap root, carefully loosen the soil and repeat this step around the taproot; ▪ Grasp the stem at ground level, rock plant backwards and forwards and gently pull removing the plant; and ▪ Tap the roots to dislodge soil, replace disturbed soil and pat down.

Weed Type	Removal Technique	Method
	Crowning	<ul style="list-style-type: none"> ▪ Remove and bag stems with seed or fruit; ▪ Grasp the leaves or stems together so the base of the plant is visible; ▪ Insert the knife or lever at an angle close to the crown; ▪ Cut through all the roots around the crown; and ▪ Remove and bag the crown.
	Stem Swiping	<ul style="list-style-type: none"> ▪ Remove any seed or fruit and bag; and ▪ Using an herbicide applicator, swipe the stems/leaves.

3.14 Disease Control

3.14.1 Overview

Disease control is required due to the potential for particular plant / soil diseases to be spread, particularly *Phytophthora*. *Phytophthora* can be spread via unregulated exposure and movement of soils between areas of construction. Measures will therefore be implemented to avoid such disease facilitation from occurring.

3.14.2 Environmental Issues

The following are key environmental issues in relation to disease control:

- Damage to native vegetation possibly leading to death;
- Loss of biodiversity; and
- Poor regeneration.

3.14.3 Management Measures

- If machinery is transported from an area of confirmed infection to the site, stringent wash down will be completed before leaving the area, removing all soil and vegetative material from cabins, trays, and under carriages;
- Construction personnel will be trained adequately in pest management and hygiene procedures; and
- All machinery to be clean of foreign soil and propagative matter to avoid the importation of *Phytophthora*.

3.15 Bushfire Prevention

3.15.1 Overview

Bushfire prevention needs to be considered as there is the potential for bushfires to ignite as a result of the construction activities. This can occur as a result of vehicles operating in dry flammable areas, conducting construction activities, and as a result of equipment such as petrol-driven pumps and generators.

3.15.2 Environmental Issues

The following key environmental issues are associated with bushfires:

- Soil erosion and sedimentation;
- Damage to, or loss of, flora and fauna;
- Damage to, or loss of, wildlife habitat;
- Impacts to primary industry production; and
- Damage to, or loss of, third party infrastructure.

3.15.3 Management Measures

The following measures will be implemented throughout the construction phase:

- clearing all flammable material from around potential fire ignition sources;
- ensuring flammable materials are cleared from the immediate vicinity of field equipment which may pose a potential fire hazard e.g. petrol driven pumps, generators;
- maintenance and operation of all machinery so as to comply with relevant fire safety standards thus minimising fire risk;
- machinery and vehicles not in use will be parked in areas free of flammable material and vegetation (e.g. not parked over shrubs, tall grass or cleared vegetation residue);

Fire response preparation measures will be implemented throughout the construction phase, including:

- storage of appropriate fire fighting equipment in accordance with the requirements of the relevant State Fire Protection Regulations. Equipment will be of the required standard and be inspected and well maintained throughout the construction phase;
- equipping construction machinery and vehicles with fire fighting equipment at the appropriate times in accordance with the relevant Fire Protection Regulations;
- Construction workforce bushfire education and training shall be undertaken as appropriate detailing fire prevention and safety, personnel responsibilities and basic fire suppression.

4.0 Operation Management

4.1 Overview

The operation phase includes the following activities:

- Operation of Glasserton 2 for the purpose of lifting water to the connected water storage facility;
- Operation of Glasserton 3, 4, the SAMB and George's Island 3 for the purposes of pilot monitoring and surveillance;
- Regular visits by Santos operators and approved third party staff for inspection and maintenance of operating equipment;
- Regular visits from Water Haulage vehicles for the purposes of removing water from the storage tanks and cartage to an approved water disposal facility; and
- Visits from service companies (as required) to replace or maintain installed equipment.

Environmental issues potentially associated with the operation phase include:

- Soil and ground stability;
- Vegetation;
- Fauna;
- Weed and disease control;
- Bushfire;
- Noise.

The sections below outline environmental issues and management actions to be implemented throughout the operation phase.

4.2 Soil and Ground Stability

4.2.1 Overview

Erosion and Sediment Control measures are required in order to avoid soil loss and resultant sedimentation of low-lying environments, that may occur due to continued access and works within the site.

4.2.2 Environmental Issues

The following are considered to be the key environmental issues in relation to erosion and sediment control for the operation phase:

- Loss of topsoil and sub-soils adjacent to access tracks;
- Siltation and sedimentation; and

-
- Long term stability of disturbed areas.

4.2.3 Management Measures

- Erosion control structures will be routinely checked to ensure they are in good condition and continue to be effective. Measures will be taken to correct any structural problems;
- Access to the sites will be restricted to access tracks;
- Public access to the site will not be permitted unless that right already exists;
- Vegetation and soil erosion will be adequately controlled to allow continued access and safe navigation by vehicles;
- Vehicles and machinery will ensure weed washdown procedures are implemented; and
- If significant erosion is encountered, erosion and sediment control structures will be constructed as per Erosion and Sediment Control section.

4.3 Vegetation Management

4.3.1 Overview

It is anticipated that the operation activities will have minimal impacts on retained vegetation. While continued access to the site is required, it will be limited to designated access tracks. No additional earthworks will be required.

4.3.2 Environmental Issues

The key environmental issues are outlined below:

- Accidental damage to vegetation adjacent to access tracks and well leases;
- Erosion and sedimentation due to vegetation disturbance; and
- Weed invasion to sensitive environments.

4.3.3 Management Measures

- The access track will be kept navigable by adequately controlling vegetation growth;
- The access track will be clearly demarcated to ensure all access is limited to approved tracks;
- Works will be limited to designated work sites to ensure no additional vegetation is disturbed; and
- Weed management measures will be employed as required.

4.4 Fauna Management

4.4.1 Overview

Continued access will be required to the site throughout the Operation phase, which may result in the disturbance of fauna populations.

4.4.2 Environmental Issues

Key issues include:

- The potential for vehicle strike along access tracks, and injury caused by fauna accessing work sites; and
- Disturbances to fauna populations due to increased light and noise.

4.4.3 Management Measures

The following management actions will be implemented:

- Access tracks will be speed limited to 20km/h;
- If injured fauna are identified, the Environmental Advisor is responsible for contacting a local wildlife rescue service; and
- If fauna are encountered within designated work areas, they will be allowed to move out at their own accord.

4.5 Weed and Disease Control

4.5.1 Overview

Continual vehicle access could potentially lead to an increase of existing weed populations, or introduce *Phytophthora* to the site. This is most likely to occur where soil disturbance has occurred. Additionally, vehicles may potentially transport weeds off site.

4.5.2 Environmental Issues

The following are key environmental issues in relation to weed and disease control:

- The spread of weed species on and off site;
- Potential for unsustainable rehabilitation;
- Competition from weed species and displacement of native flora; and
- Damage to native vegetation possibly leading to death.

4.5.3 Management Measures

- Any foreign soil and seed will be removed from all plant and machinery prior to being transported onsite to prevent the potential spread of introduced weeds and pathogens; and
- Weed infestations identified by the supervising ecologist within and adjacent to access tracks and well leased will be eradicated by hand, with non-residual herbicide, or mechanical removal. Appropriate weed removal techniques are outlined in **Table 3.3**.

4.6 Bushfire Prevention

4.6.1 Overview

Bushfire prevention needs to be considered as there is the potential for bushfires to ignite as a result of the operation activities, such as the continued use of machinery and vehicles, as well as the potential storage of fuels and chemicals on site.

4.6.2 Environmental Issues

The following key environmental issues are associated with bushfires:

- Soil erosion and sedimentation;
- Damage to, or loss of, flora and fauna;
- Damage to, or loss of, wildlife habitat;
- Impacts to primary industry production; and
- Damage to, or loss of, third party infrastructure.

4.6.3 Management Measures

The following measures will be implemented throughout the operational phase:

- clearing all flammable material from around potential fire ignition sources;
- flammable materials will be cleared from the immediate vicinity of field equipment which may pose a potential fire hazard e.g. petrol driven pumps, generators;
- maintenance and operation of all machinery so as to comply with relevant fire safety standards thus minimising fire risk;
- machinery and vehicles not in use will be parked in areas free of flammable material and vegetation (e.g. not parked over shrubs, tall grass or cleared vegetation residue).

Additionally, fire response preparation measures will be implemented throughout the operational phase, including:

- storage of appropriate fire fighting equipment in accordance with the requirements of the relevant State Fire Protection Regulations. Equipment will be of the required standard and be inspected and well maintained throughout the construction phase;
- equipping machinery and vehicles with fire fighting equipment at the appropriate times in accordance with the relevant Fire Protection Regulations;
- Operation workforce bushfire education and training will be undertaken as appropriate detailing fire prevention and safety, personnel responsibilities and basic fire suppression.

4.7 Coal Seam Gas Management

The Glasserton 2 wellhead will be connected to a small separator, operating at low pressure (approximately 350kPag) that will separate any coal seam gas from the incidental water. The gas will be diverted to the flare and ignited safely. The incidental water will flow to a small water tank that is open to atmosphere so that any small amount of remaining dissolved gas is released safely.

4.8 Water Management

The incidental water will be pumped from the small water tank located on the well lease through a buried water flowline to the water storage facility. Water will be temporarily stored in a 30m diameter lined panel tank located in a lined bunded area. Water will be offloaded from the tank to water tankers as required via means of a load-out facility adjacent to the water storage facility. It is expected that a maximum of ten truck movements will be required per day, with trucking expected to occur only during daylight hours, Monday to Saturday. Wherever possible, truck movements will be scheduled outside of school bus pick-up / drop-off hours. Santos is currently negotiating with Whitehaven Coal who are licensed to take all of the lifted water at their Werris Creek Mine. The tank will be equipped with a high level trip to shutdown the down hole pump if a high level occurs in the tank, thereby mitigating against the risk of overflow. The tank level will be continuously monitored and transmitted via the Next G network to Santos offices so that any unexpected reduction in tank level, indicating a potential leak, can be managed promptly.

The maximum expected incidental water flow rate from Glasserton 2 is 160 kL/day. The duration of the pilot test will be 60 days, or less if the total quantity of incidental water reaches 10ML before 60 days.

Table 4.1 shows the expected quality of incidental water extracted from the Glasserton pilot, however this may vary over time. Water quality testing will be undertaken on a regular basis to ensure that the incidental water is within the limits of the Water Licence prior to discharge.

Table 4.1: Expected Incidental Water Quality

Parameter	Glasserton Pilot
pH	8
Conductivity	8 mS/cm
Total Dissolved Solids (TDS)	4,400 mg/L

4.9 Water Monitoring

4.9.1 Regional Bore Inventory

Private groundwater bores within a two kilometre radius of the pilot wells will be monitored on a regular basis. The groundwater bores will be monitored for water level and water quality and bore construction details will be collected.

The following in-field water quality parameters will be collected for all groundwater bores during testing:

- pH;
- Temperature;

-
- Dissolved Oxygen (DO);
 - Redox (Eh); and
 - Electrical Conductivity (EC).

Selected groundwater bores will be sampled for a range of parameters and the samples analysed by a National Association of Testing Authorities (NATA) accredited laboratory. The samples will be analysed for the following water quality parameters:

- pH;
- Electrical Conductivity;
- Total Dissolved Solids (TDS);
- Alkalinity (total, bicarbonate, carbonate and hydroxide as calcium carbonate);
- Sulphate (SO₄);
- Chloride (Cl);
- Cations: Calcium (Ca), Magnesium (Mg), Sodium (Na) and Potassium (K);
- Fluoride;
- Nitrite and Nitrate (as N);
- Ammonia (as N);
- Total Phosphorus;
- Dissolved Metals: Arsenic (As), Barium (Ba), Beryllium (Be), Cadmium (Cd), Chromium (Cr), Cobalt (Co), Copper (Cu), Manganese (Mn), Nickel (Ni), Lead (Pb), Vanadium (V), Zinc (Zn), Iron (Fe), Selenium (Se), Boron (B), Strontium (Sr), Molybdenum (Mo) and Mercury (Hg);
- Total Petroleum Hydrocarbons (TPH);
- Benzene, Toluene, ethylbenzene and total xylenes (BTEX);
- Total and Dissolved Organic Carbon (TOC/DOC);
- Ionic Balance; and
- Total Cyanide.

4.9.2 Incidental Water Quality

The quality of the incidental water extracted during pilot testing will be monitored on a daily basis and the results provided to the New South Wales Industry and Investment and Office of Water on a weekly basis.

In-field water quality measurements will be recorded on a daily basis for the following parameters:

- pH;
- Temperature;
- Dissolved Oxygen (DO);

- Redox (Eh); and
- Electrical Conductivity (EC).

Samples of incidental water will be collected on a weekly basis and sent to a National Association of Testing Authorities (NATA) accredited laboratory for analysis. The samples will be analysed for the parameters shown.

- pH;
- Electrical Conductivity;
- Total Dissolved Solids (TDS);
- Alkalinity (total, bicarbonate, carbonate and hydroxide as calcium carbonate);
- Sulphate (SO₄);
- Chloride (Cl);
- Cations: Calcium (Ca), Magnesium (Mg), Sodium (Na) and Potassium (K);
- Fluoride;
- Nitrite and Nitrate (as N);
- Ammonia (as N);
- Total Nitrogen as N (incl. NO_x and TKN);
- Total Phosphorus and Reactive Phosphorus;
- Dissolved Metals: Aluminium (Al), Arsenic (As), Barium (Ba), Beryllium (Be), Cadmium (Cd), Chromium (Cr), Cobalt (Co), Copper (Cu), Manganese (Mn), Nickel (Ni), Lead (Pb), Vanadium (V), Zinc (Zn), Iron (Fe), Selenium (Se), Boron (B), Strontium (Sr), Molybdenum (Mo) and Mercury (Hg);
- Total Petroleum Hydrocarbons (TPH);
- Benzene, Toluene, ethylbenzene and total xylenes (BETEX);
- Total and Dissolved Organic Carbon (TOC/DOC);
- Ionic Balance;
- Total Cyanide;
- Blue Green Algae (Cyanobacteria Count);
- PCB including Aroclors; and
- Gross alpha and Gross beta with Potassium 40 correction.

4.10 Management of Facilities / Site Management

4.10.1 Overview

Management of the facilities include, the surface equipment associated with the pumping well (primarily a pumping well head, separator, flaring facility, small water tank and pump, diesel hydraulic power unit, and water pipeline); the monitoring wells (primarily data loggers and wellheads) and the water storage

facilities (primarily a 30m diameter lined panel tank and load-out pump). Additionally, general site management measures are required, including waste management

4.10.2 Environmental Issues

Key issues associated with the management of the facilities include:

- Impacts to soil and water quality resulting from erosion and sedimentation, and poor waste management;
- Increased bushfire risk;
- Increased noise; and
- Waste minimisation and appropriate disposal.

4.10.3 Management Measures

The following management measures will be implemented:

- The bushfire prevention methods outlined in the Bushfire Prevention section will be implemented as appropriate;
- Fire fighting equipment shall be maintained on-site;
- Noise shall be managed in accordance with the Noise Assessment prepared by SLR;
- Facilities shall be kept in a clean and tidy condition;
- Areas for storage of liquids such as oil or chemicals will be bunded and the drains from the bunds kept clear of foreign material;
- Waste management procedures will be implemented, and include:
 - » stockpiling reusable and recyclable wastes such as timber skids, pallets, drums and scrap metal for salvage;
 - » supplying designated collection bins at work sites for aluminium cans, glass and paper recycling (where recycling facilities are available);
 - » collecting and transporting general refuse to landfill sites approved by the local authorities.

5.0 Decommissioning

Decommissioning involves the following activities:

- Cessation of operations of temporary water storage and load out facilities;
- Removal of equipment and imported materials;
- Shut-in of the wells and rehabilitation of the well leases, excluding the 5x5m well head area and a maintenance vehicle access track across the well lease to this area;
- Shallow Aquifer Monitoring Bore to remain; and
- Consideration of future uses for the water storage facilities.

Refer to **Section 1.1.8** for more detail pertaining to the decommissioning and rehabilitation of the well leases.

5.1 Site Rehabilitation

All rehabilitation works will be undertaken with maximum regard to environmental protection and rehabilitation, vegetation, subsoil and topsoil management, weed control, erosion and sedimentation management and revegetation in accordance with the relevant statutory requirements. During rehabilitation, diversion banks and ripping along the contour will be completed to prevent the concentration and momentum of water flow as required.

5.1.1 Timing and Objectives

Rehabilitation will occur within 6 months of decommissioning. Rehabilitation will ensure the site is restored to pre-operational quality or better, dependent on available soil quality. Rehabilitation will aim to:

- Ensure a stable landform is maintained;
- Re-instate the site to a stable landform that is representative of the pre-clearing vegetation condition and composition following decommissioning of the lease;
- All private tracks used during operations are generally returned to their pre-operations state, or to a condition agreed by the landholder;
- Provide fauna habitat, including Koala food trees; and
- Ensure a self-sustaining landform is achieved.

All private tracks used during operations to be returned to their pre-operations state or to a condition agreed by the landholder.

5.1.2 Rehabilitation Schedule

Rehabilitation will be carried out in accordance with the rehabilitation schedules provided in

Table 5.6: and Table 5.2. These tables outline the required rehabilitation activities, including rehabilitation methods, timing, performance criteria, monitoring, and maintenance requirements.

Rehabilitation species have been selected to reinstate the pre operational vegetation community, or better for each disturbance area. **Sections 5.1.2.1 - 5.1.2.4** outline the species selection for each vegetation community on site, and provide a summary of planting locations.

5.1.2.1 White Box / Yellow Box / Blakely's Red Gum Grassy Woodland

Glasserton 4, portions of the main access track, and portions of the access track joining Glasserton 3 and Glasserton 4 occur within this vegetation community, which is a listed CEC/CEEC under state and federal legislation. The following species will be re-instated within these areas.

Table 5.1: White Box / Yellow Box / Blakely's Red Gum Grassy Woodland Species Selection

Scientific Name	Common Name	Type	Planting Density
Canopy			
<i>Eucalyptus albens</i>	White Box	Tubestock	1plant / 25m ²
<i>Eucalyptus mellidorora</i>	Yellow Box	Tubestock	
<i>Eucalyptus blakelyi</i>	Blakely's Red Gum	Tubestock	
Shrubs			
<i>Alectryon oleifolius</i>	Western Rosewood	Tubestock	1plant / 25m ²
<i>Geijera parviflora</i>	Wilga	Tubestock	
<i>Olearia elliptica</i>	Sticky Daisy Bush	Tubestock	
Ground Cover			
<i>Aristida ramosa</i>	Purple Wiregrass	Seed	n/a
<i>Austrostipa scabra subsp. scabra</i>	Speargrass	Seed	
<i>Austrostipa verticillata</i>	Slender Bamboo Grass	Seed	
<i>Bothriochloa decipiens</i>	Redleg Grass	Seed	
<i>Chloris truncata</i>	Windmill Grass	Seed	
<i>Dichanthium sericeum</i>	Queensland Bluegrass	Seed	

5.1.2.2 Bimble Box Woodland

Glasserton 3, portions of the main access track, and portions of the access track joining Glasserton 3 and Glasserton 4 are located within this vegetation community. The following species will be re-instated within these areas.

Table 5.2: Bimble Box Woodland Species Selection

Scientific Name	Common Name	Type	Density
Canopy			
<i>Eucalyptus populnea</i>	Bimble Box	Tubestock	1plant / 25m ²
Shrubs			
<i>Geijera parviflora</i>	Wilga	Tubestock	1plant / 25m ²

Scientific Name	Common Name	Type	Density
Ground Cover			
<i>Austrostipa aristiglumens</i>	Plains Grass	Seed	n/a
<i>Austrostipa scabra subsp. scabra</i>	Speargrass	Seed	
<i>Bothriochloa decipiens</i>	Redleg Grass	Seed	
<i>Chloris truncata</i>	Windmill Grass	Seed	
<i>Dichanthium sericeum</i>	Queensland Bluegrass	Seed	

5.1.2.3 Silver-leaved Ironbark Woodland

Portions of Glasserton 2, the Glasserton 2 access track and portions of the main access track occur within this vegetation community. The following species will be re-established within these areas.

Species selected from the following list will be re-established within remaining disturbed area, where soil quality allows, to improve the ecological values of these areas.

Table 5.3: Silver-leaved Ironbark Woodland Species Selection

Scientific Name	Common Name	Type	Density
Canopy			
<i>Eucalyptus albens</i>	White Box	Tubestock	1plant / 25m ²
<i>Eucalyptus melanophloia</i>	Silver-leaved Ironbark	Tubestock	
Shrubs			
<i>Acacia salicina</i>	Cooba	Tubestock	1plant / 25m ²
Ground Cover			
<i>Austrostipa scabra subsp. scabra</i>	Speargrass	Seed	n/a
<i>Bothriochloa decipiens</i>	Redleg Grass	Seed	
<i>Sporobolus elongatus</i>	Slender Rat's Tail Grass	Seed	
<i>Chloris truncata</i>	Windmill Grass	Seed	
<i>Dichelachne micrantha</i>	Short-hair Plume Grass	Seed	
<i>Einadia hastata</i>	Berry Saltbush	Seed	
<i>Panicum effusum</i>	Hairy Panic	Seed	

5.1.2.4 Plains Grass Grassland

Small portions of the access track between Glasserton 3 and 4 occur within this vegetation community. Where rehabilitation is required, the sites will be seeded with species selected from the following list.

Table 5.4: Plains Grass Grassland Species Selection

Scientific Name	Common Name	Type	Density
Ground Cover			
<i>Austrostipa aristiglumis</i>	Plains Grass	Seed	n/a
<i>Austrostipa scabra subsp.</i>	Speargrass	Seed	

Scientific Name	Common Name	Type	Density
Ground Cover			
<i>scabra</i>			
<i>Bothriochloa decipiens</i>	Redleg Grass	Seed	
<i>Sporobolus elongatus</i>	Slender Rat's Tail Grass	Seed	
<i>Chloris truncata</i>	Windmill Grass	Seed	
<i>Dichelachne micrantha</i>	Short-hair Plume Grass	Seed	
<i>Einadia hastata</i>	Berry Saltbush	Seed	
<i>Panicum effusum</i>	Hairy Panic	Seed	

Table 5.5: Rehabilitation Management Schedule – Well Leases

Rehabilitation Management Schedule			
Performance Criteria	<ul style="list-style-type: none"> ▪ Self-sustaining vegetative cover; ▪ No signs of subsidence or erosion; ▪ Representative of species richness and diversity based on pre-clearing condition; ▪ Plants showing healthy growth and signs of recruitment; ▪ Free of declared pest plants; ▪ Provision of fauna habitat to a similar standard. 		
	Rehabilitation is considered finalised when the performance criteria outlined below are met. If they are not satisfactorily met at the end of the assessable period, further monitoring and maintenance will be required.		
	Element	60 days	1 Year
	<i>Plant Survival</i>	≥80% survival of planted stock	≥90% survival of planted stock
	<i>Plant Height</i>	Evidence of growth	All planted canopy & shrub stock ≥0.6m high
	<i>Native Species Richness</i>	≥75% of species from surrounding area	≥75% of species from surrounding area
	<i>Plant Cover</i>	≥20% of existing plant density (refer to Section 4.3.1 of Ecological Assessment).	≥30% of existing plant density (refer to Section 4.3.1 of Ecological Assessment).
	<i>Declared Weeds</i>	≤10% declared weed cover	0% declared weed cover
	<i>Environmental weeds</i>	≤20% weed cover	≤10% weed cover
	<i>Mulching</i>	≥50mm deep mulch cover around planted stock	≥50mm deep mulch cover around planted stock
<i>Threatened species habitat</i>	Koala food trees planted, woody material & rocks reinstated	Koala food trees planted, woody material & rocks reinstated	
<i>Stable / No erosion or subsidence</i>	Landform reshaped and topsoil respread. Seeding and/or revegetation completed. Erosion and sediment control measures in place.	No evidence of erosion. Stable and self-sufficient landform	

Rehabilitation Management Schedule		
Timing	Rehabilitation Actions	Responsibility
Upon Decommissioning	Stabilisation of Well Lease <ul style="list-style-type: none"> ▪ Drilling infrastructure will be decommissioned in accordance with the statutory requirements; ▪ Drilling infrastructure will be progressively removed and reused (where applicable), as per the appropriate guidelines ▪ Following decommissioning ensure erosion and sediment control measures are implemented to reduce runoff and disturbances prior to rehabilitation. 	Santos
Within 6 months of decommissioning (taking into consideration the wet season)	Final Rehabilitation of Well Lease <ul style="list-style-type: none"> ▪ Remove any declared weeds present on site; ▪ Rip soil to ensure no compaction where required. Ensure rip lines are spaced >1m apart to prevent soil mass movement; ▪ Respread topsoil; ▪ Re-plant tube stock identified within the species selection tables to encourage regeneration of canopy and shrub layer. Ensure tube stock is: <ul style="list-style-type: none"> - Preferably local provenance; - Healthy and displaying signs of active growth. Plants will be rejected if they display 'yellowing', leaf or stem damage or disease, root curling or restriction related to being 'pot bound', or have weed species in the container; - Minimum of 20cm tall for (75mm) tube-stock; and - Sun-hardened. ▪ Ensure tube stock is placed in a hole deeper than the pot, with the root ball just below the soil surface; ▪ Place plant in the centre of the hole, filled in with loose crumbly soil, and then firmed in with the hands to create a shallow watering depression; ▪ Replant as per densities outlined in the species selection tables; ▪ Water if rainfall has been insufficient ; ▪ Mulch all seedlings to a radius of 1m surrounding the plant at a depth of 100mm. Mulch will not touch plant stems; and ▪ Seed with native grass, herb and forb species identified within the species selection tables. 	Santos
Timing	Monitoring Tasks	Responsibility
Monitoring will be undertaken annually and will consist of vegetation surveys and photo monitoring		
	Maintenance Tasks / Corrective Procedures	Responsibility
Annually	<ul style="list-style-type: none"> ▪ Replace damaged / dead seedlings; ▪ Implement erosion & sediment control as required (e.g. . jute matting, mulch, sediment fencing in areas suffering erosion); ▪ Treat declared weed species and manage spread of other weeds; and ▪ Conduct feral animal management as required. 	Santos
Timing	Reporting	Responsibility
As works are completed	Completion of rehabilitation actions, monitoring and maintenance checklist.	Santos & Ecologist

Table 5.6: Rehabilitation Management Schedule – Access Tracks

Rehabilitation Management Schedule																																
<p>Performance Criteria</p> <ul style="list-style-type: none"> ▪ Self-sustaining vegetative cover; ▪ No signs of subsidence or erosion; ▪ Representative of species richness and diversity based pre-clearing condition; ▪ Plants showing healthy growth and signs of recruitment; and ▪ Free of declared pest plants. <p>Rehabilitation is considered finalised when the performance criteria outlined below are met. If they are not satisfactorily met at the end of the assessable period, further monitoring and maintenance will be required.</p>	<table border="1"> <thead> <tr> <th>Element</th> <th>60 days</th> <th>1 year</th> </tr> </thead> <tbody> <tr> <td><i>Plant Survival</i></td> <td>≥80% survival of planted stock</td> <td>≥90% survival of planted stock</td> </tr> <tr> <td><i>Plant Height</i></td> <td>Evidence of growth</td> <td>All planted canopy & shrub stock ≥0.6m high</td> </tr> <tr> <td><i>Native Species Richness</i></td> <td>≥75% of species from surrounding area</td> <td>≥75% of species from surrounding area</td> </tr> <tr> <td><i>Plant Cover</i></td> <td>≥20% of existing plant density (refer to Section 4.3.1 of Ecological Assessment).</td> <td>≥30% of existing plant density (refer to Section 4.3.1 of Ecological Assessment).</td> </tr> <tr> <td><i>Declared Weeds</i></td> <td>≤10% declared weed cover</td> <td>0% declared weed cover</td> </tr> <tr> <td><i>Environmental weeds</i></td> <td>≤20% weed cover</td> <td>≤10% weed cover</td> </tr> <tr> <td><i>Mulching</i></td> <td>≥50mm deep mulch cover around planted stock</td> <td>≥50mm deep mulch cover around planted stock</td> </tr> <tr> <td><i>Threatened species habitat</i></td> <td>Koala food trees planted, woody material & rocks reinstated</td> <td>Koala food trees planted, woody material & rocks reinstated</td> </tr> <tr> <td><i>Stable / No erosion or subsidence</i></td> <td>Landform reshaped and topsoil respread. Seeding and/or revegetation completed. Erosion and sediment control measures in place.</td> <td>No evidence of erosion. Stable and self-sufficient landform</td> </tr> </tbody> </table>	Element	60 days	1 year	<i>Plant Survival</i>	≥80% survival of planted stock	≥90% survival of planted stock	<i>Plant Height</i>	Evidence of growth	All planted canopy & shrub stock ≥0.6m high	<i>Native Species Richness</i>	≥75% of species from surrounding area	≥75% of species from surrounding area	<i>Plant Cover</i>	≥20% of existing plant density (refer to Section 4.3.1 of Ecological Assessment).	≥30% of existing plant density (refer to Section 4.3.1 of Ecological Assessment).	<i>Declared Weeds</i>	≤10% declared weed cover	0% declared weed cover	<i>Environmental weeds</i>	≤20% weed cover	≤10% weed cover	<i>Mulching</i>	≥50mm deep mulch cover around planted stock	≥50mm deep mulch cover around planted stock	<i>Threatened species habitat</i>	Koala food trees planted, woody material & rocks reinstated	Koala food trees planted, woody material & rocks reinstated	<i>Stable / No erosion or subsidence</i>	Landform reshaped and topsoil respread. Seeding and/or revegetation completed. Erosion and sediment control measures in place.	No evidence of erosion. Stable and self-sufficient landform	
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Timing	Rehabilitation Actions	Responsibility																														
Post Construction	<p>Rehabilitation</p> <ul style="list-style-type: none"> ▪ Remove weeds present on site; and ▪ Implement erosion and sediment control measures as required. 	Santos																														
Within 6 months of decommissioning (taking into consideration the wet season)	<p>Final Rehabilitation</p> <ul style="list-style-type: none"> ▪ Where widening has been required, the track will be progressively removed; ▪ Ensure erosion and sediment control measures are implemented as required; ▪ Re-spread topsoil, apply mulch (preferably site produced), and spread seed mix; ▪ Species will be native, and selected from the 	Santos																														

Rehabilitation Management Schedule		
	correct species selection tabless.	
Timing	Monitoring Tasks	Responsibility
Monitoring will be undertaken annually and will consist of vegetation surveys and photo monitoring		
Timing	Maintenance Tasks / Corrective Procedures	Responsibility
Annually	<ul style="list-style-type: none"> ▪ Monitor success of seeding; ▪ Implement erosion & sediment control i.e. mulch, sediment fencing in areas suffering; ▪ Treat declared weed species and manage spread of other weeds; and ▪ Conduct feral animal management as required. 	Santos
Timing	Reporting	Responsibility
As works are completed	Completion of rehabilitation actions, monitoring and maintenance checklist.	Santos & Ecologist

5.1.3 Maintenance and Monitoring Plan

Regular annual monitoring will be required at the completion of the rehabilitation works to ensure that the objectives of the rehabilitation schedule are being achieved. Monitoring will be undertaken by a suitably qualified person (e.g. restoration ecologist). A monitoring schedule is included within **Table 5.7**:

Specific monitoring criteria are outlined within each rehabilitation schedule, reflective of the performance criteria. Generally, the following indicators will be monitored:

- Indicators of growth and survival of all plantings;
- Plant height;
- Native species richness;
- Native species cover;
- Weed control – extent and adequacy of declared and environmental weeds, as well as any secondary weed responses to treatments;
- Indicators of the presence of threatened species and / or key habitat features;
- Adequacy of site preparation, mulching, tree (and plant) protection and maintenance; and
- Landform stability – evidence of soil erosion.

Table 5.7: Rehabilitation Monitoring Schedule

Time	Management Actions	Monitoring	Responsibility
Commencement of rehabilitation	Site preparation (as per Rehabilitation Schedule): <ul style="list-style-type: none"> ▪ Reshaping of landform (where applicable); ▪ Installation of erosion and sediment control measures; ▪ Respreading of topsoil; 	N/A	<ul style="list-style-type: none"> ▪ Santos

Time	Management Actions	Monitoring	Responsibility
	<ul style="list-style-type: none"> ▪ Weed control. Revegetation: <ul style="list-style-type: none"> ▪ Planting of tubestock; ▪ Fertiliser; ▪ Spread mulch around planted stock to a radius of 1m and 50mm depth; ▪ Watering as required. 		
2months	<ul style="list-style-type: none"> ▪ Weed control; ▪ Replacement of plant mortalities (as required); ▪ Watering as required; ▪ Reinstate erosion and sediment control measures (as required). 	<ul style="list-style-type: none"> ▪ Photo monitoring; ▪ Vegetation surveys; ▪ Erosion and sediment control effectiveness; ▪ Survival of planted flora. 	<ul style="list-style-type: none"> ▪ Santos (Maintenance) ▪ Ecologist (Monitoring)
Annually	<ul style="list-style-type: none"> ▪ Weed control; ▪ Replacement of plant mortalities (as required); ▪ Watering as required; ▪ Reinstate of erosion and sediment control measures (as required). 	<ul style="list-style-type: none"> ▪ Photo monitoring; ▪ Vegetation surveys; ▪ Erosion and sediment control effectiveness; ▪ Survival of planted flora; ▪ Evidence of fauna habitat features (e.g. food sources, woody material & rocks). 	<ul style="list-style-type: none"> ▪ Santos (Maintenance) ▪ Ecologist (Monitoring)

6.0 Reporting

A report will be prepared following decommissioning of the facility, including all records of the EMP implementation, as well as a summary of incidents and mitigation measures. The final report is to include an assessment of compliance with statutory authorities, success in achieving objectives, and any environmental outcomes. The report is to be completed within 6 months of decommissioning, and kept by Santos QNT Pty Ltd.

Ongoing rehabilitation will be undertaken after report completion, as per **Section 5.1**. Records of rehabilitation monitoring will be kept on file by Santos QNT Pty Ltd.