The Narrabri Coal Seam Gas Project

Review of Environmental Factors

Bibblewindi West Lateral Pilot Gas and Water Gathering System

PAL 2, Gunnedah Basin

New South Wales

March 2009

Eastern Star Gas Limited
ABN 29 094 269 780

Level 7
51 Pitt Street
Sydney NSW 2000
Australia

Postal Address
GPO Box 4526
Sydney NSW 2001
Australia

Ph: (02) 9251 5599
Fax: (02) 9251 2299
office@easternstar.com.

1 Executive Summary

Eastern Star Gas Limited is the operator of the Narrabri Coal Seam Gas Project located in Petroleum Assessment Lease No.2, Northern NSW. The Bibblewindi West lateral pilot is located approximately 4km west of the Bibblewindi CSG Pilot and water management facility. This REF addresses the actual and likely impacts associated with the installation of a water and gas gathering system linking the four production wells at Bibblewindi West back to the water management facility at Bibblewindi.

This document compliments the current water and operations management plan governing the operation of all production assets across PAL2, namely the Bibblewindi Nine Spot (12 wells), the Bohena CSG Pilot (three wells) and the Bibblewindi lateral pilot (six wells). Currently, all water and gas produced from the three pilots is gathered for storage in lined evaporation ponds or is treated, reused and/or stored.

The completion of a pilot water treatment project at Bibblewindi suggests that the reverse osmosis treatment process is capable of providing the project with significant reductions in saline water storage requirements. With rates of recovery having exceeded 70% over the pilot period and water quality below 250mg/l, permeates discharged from the treatment plant are able to be reused or disposed of through all available means. As outlined in the current approved water and operations management plan, it is Eastern Stars intention to expand the capacity of the water treatment facility to permit the extension of production assets across PAL2.

The proposed disposal of up to 1ML of water per day into Bohena Creek is unlikely to create any long term detrimental effects on surface and groundwater systems associated with the creek system and accordingly unlikely to result in impacts contrary to the water quality and river flow guidelines in effect for the Namoi River catchment as defined by ANZECC and ARMCANZ.

The provision of this document fulfills the company's responsibility under Part 5, Section 111 of the *Environmental Planning and Assessment Act 1979* in which the determining authority (NSW Department of Primary Industries – Mineral Resources) is required to consider the likely and actual environmental impacts of the activity.

Table of Contents

Index of Figures

Index of Tables

Proponent Contact Information and Declaration

Eastern Star Gas Ltd
Level 7
51 Pitt St
Sydney
NSW 2000

Officer Responsible for document preparation

Tim Donnan, Manager - Environment
Eastern Star Gas Ltd
Level 7
51 Pitt St
Sydney
NSW 2000

Qualifications:

BSc (Environmental and Urban Horticulture), University of Technology, Sydney

Master of Environmental Management and Restoration, Charles Sturt University

Location of lands referred to by REF

The project area is situated approximately 40km south of Narrabri within the Pilliga East and Bibblewindi State Forest (**Figure 1**). The Bibblewindi West Lateral pilot is located 4km west of the Bibblewindi Nine Spot CSG Pilot, and will be linked by a buried low pressure gas and water gathering system.

Declaration

Eastern Star Gas Ltd declares the information contained within this document an accurate representation of the existing operational environment and the extent of impacts likely to occur as a result of the proposed development. Eastern Star has endeavoured to characterise the environment within which the project is located and with the assistance of Government agencies and external contractors mitigate environmental impacts and ongoing operational risks.

2 Introduction

Eastern Star Gas Ltd ("ESG") is the current operator of the Narrabri Coal Seam Gas ("CSG") Project, a joint venture ('JV') between Eastern Star (65%) and Gastar Exploration Ltd (35%). The recent focus of the JV has been the development of production assets within PAL2 which compliment the considerable corehole exploration drilling programs underway since 2007 (**Figure 1**). As an integral part of the reserves certification process, the demonstration of commercial gas production at various locations across the project area will continue throughout 2009.

To accompany the environmental review completed for the Narrabri Coal Seam Gas Project's Bibblewindi West Lateral Pilot, the REF describes the proposed installation and operation of gas and water gathering infrastructure linking the pilot to the water and gas management facility located at Bibblewindi approximately 4km to the east. The Gas Gathering System (GGS) will comprise two buried low pressure flow lines that will collect separated water and gas from the four production wells and convey them to the water treatment plant and gas compression site located adjacent to Bibblewindi-1 (figures 5 & 6).

The management of formation waters associated with CSG production is a critical aspect to the successful development of this natural resource. It has become apparent that the commercialisation of alternative sources of energy, in particular CSG, is no longer simply a matter of geology and engineering capabilities. The exploration for and the conversion of these hydrocarbon sources requires equal attention to be paid to the geology, engineering and environmental requirements of the regions that contain them. ESG and its joint venture partners are committed to developing the CSG gas reserves of NSW within the bounds of ecologically sustainable development protocols and in line with current NSW legislation.

ESG proposes to incorporate the production water component into the current approval to discharge treated water to Bohena Creek as environmental flow and passive aquifer recharge.

The provision of this document fulfills the company's responsibility under Part 5, Section 111 of the *Environmental Planning and Assessment Act 1979* in which the determining authority (NSW Department of Primary Industries – Mineral Resources) is required to consider the likely and actual environmental impacts of the activity.

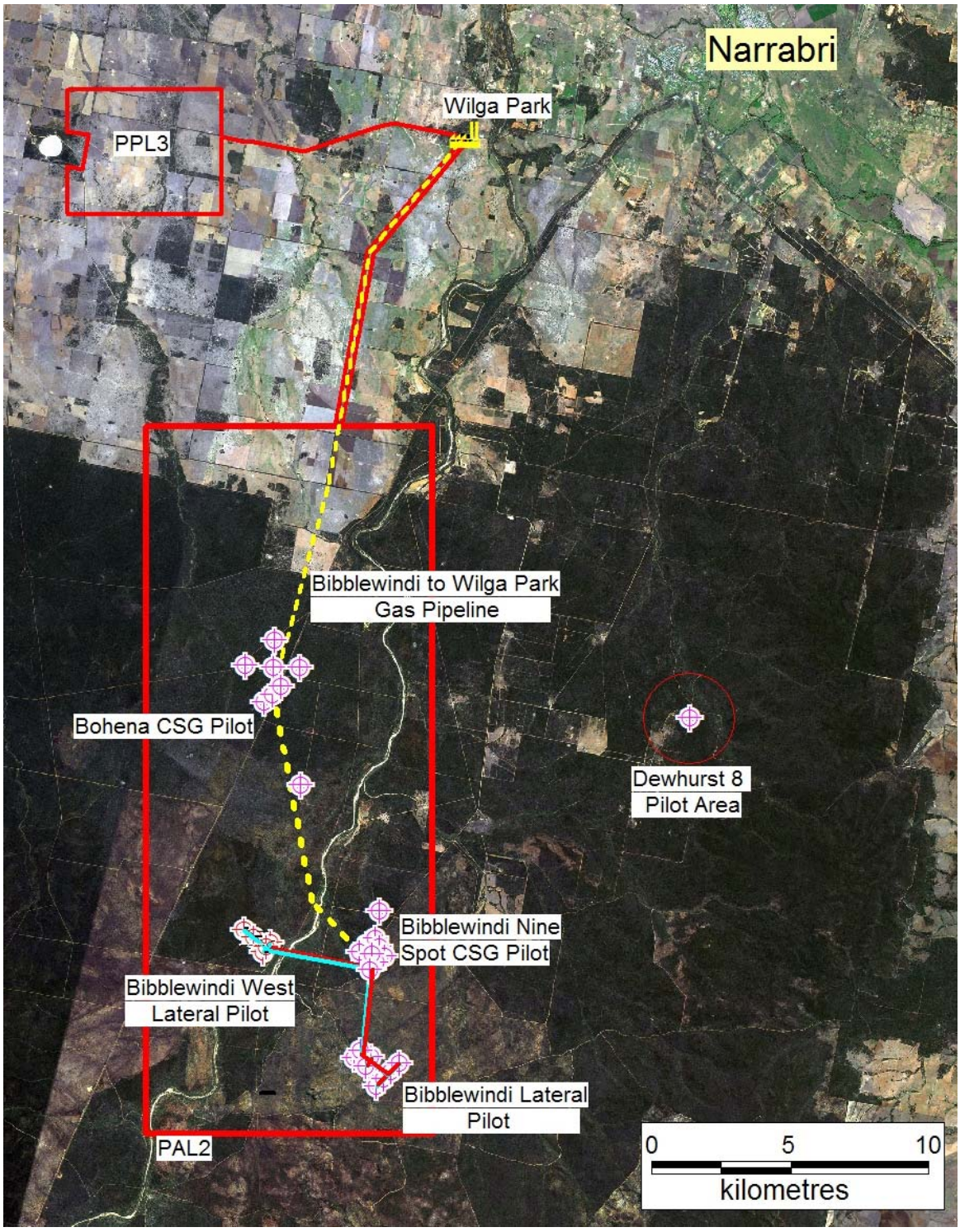

Figure 1 Current and proposed Narrabri CSG Project production assets

2.1 Existing Approvals

The operation of the Bohena and Bibblewindi CSG Pilots, collectively referred to as the Narrabri Coal Seam Project, occurs under a number of approvals and consents. These include:

- The terms and conditions of Petroleum Exploration Licence 238 (renewed 31/01/08 for period of 4 years);
- The terms and conditions of Petroleum Assessment Lease 2 (granted 30/10/07 for a period of 6 years);
- The approval to construct and operate the Bibblewindi Water Management Dam and subsequently dewater Bibblewindi-1-9 issued by DPI (Minerals and Petroleum).
- The approved water management plan in effect for the Bohena CSG Pilot
- The landholder consent provided by Forestry NSW; and
- The approval to dispose of treated water to Bohena Creek issued by DPI (Minerals and Petroleum).

2.2 Current Operations

Current operations involving the production and management of water as at March 2009 include:

2.2.1 CSG production from Bohena CSG Pilot

Gas produced from these three operational wells is consumed by the generator supplying power to the PCP and telemetry with excess gas vented to atmosphere. Water extracted from each well is managed in existing impoundments located at Bohena-3, 6 and Bohena South.

2.2.2 CSG production from the Bibblewindi CSG Pilot

Gas produced from the nine wells currently on production is consumed by onsite power generation for surface equipment and the powering of the water treatment plant with any excess gas vented to atmosphere. Water extracted from the nine wells is transferred directly from the wellhead to the water treatment pilot located at Bibblewindi-1. Permeate and concentrate streams are then directed into the existing impoundments located nearby. The clean water is generally consumed by various maintenance and operational activities including the core hole drilling currently underway in PAL2 and PEL238

2.2.3 Bibblewindi CSG Lateral Pilot Drilling

Approval from DPI (Minerals and Petroleum) to drill and complete a lateral production pilot adjacent to the Bibblewindi-11 corehole was received in August 2008. The pilot will involve the drilling of two parallel horizontal “in-seam” wells that will intersect up to 3 vertical production/pressure control wells each (illustrated below). As at 01/03/09, the drilling of the in seam lateral had commenced. Production testing of this pilot will commence soon after drilling and completion and is described in detail throughout this operations and water management plan. A gathering system linking the production wells has recently been completed that will provide means by which to transfer water and gas from the lateral pilot back to Bibblewindi.

2.3 Water Management Strategy

The current water management strategy for the operation of the 18 CSG production wells combines treatment and impoundment to effect zero discharge of any by-product of the activity.

2.3.1 Bohena CSG Pilot

Water produced at Bohena-3, 7 and 9 is collected from the wellheads and transferred by HDPE flow lines to the existing impoundments at Bohena-3, 6 and Bohena South-1. The network of flow lines (**Figure 3**) links the available impoundment capacity with the operational wells. The impoundments located at Bohena and Bohena South has and will continue to provide sufficient cumulative management capacity for the near and intermediate future given the current production volumes.

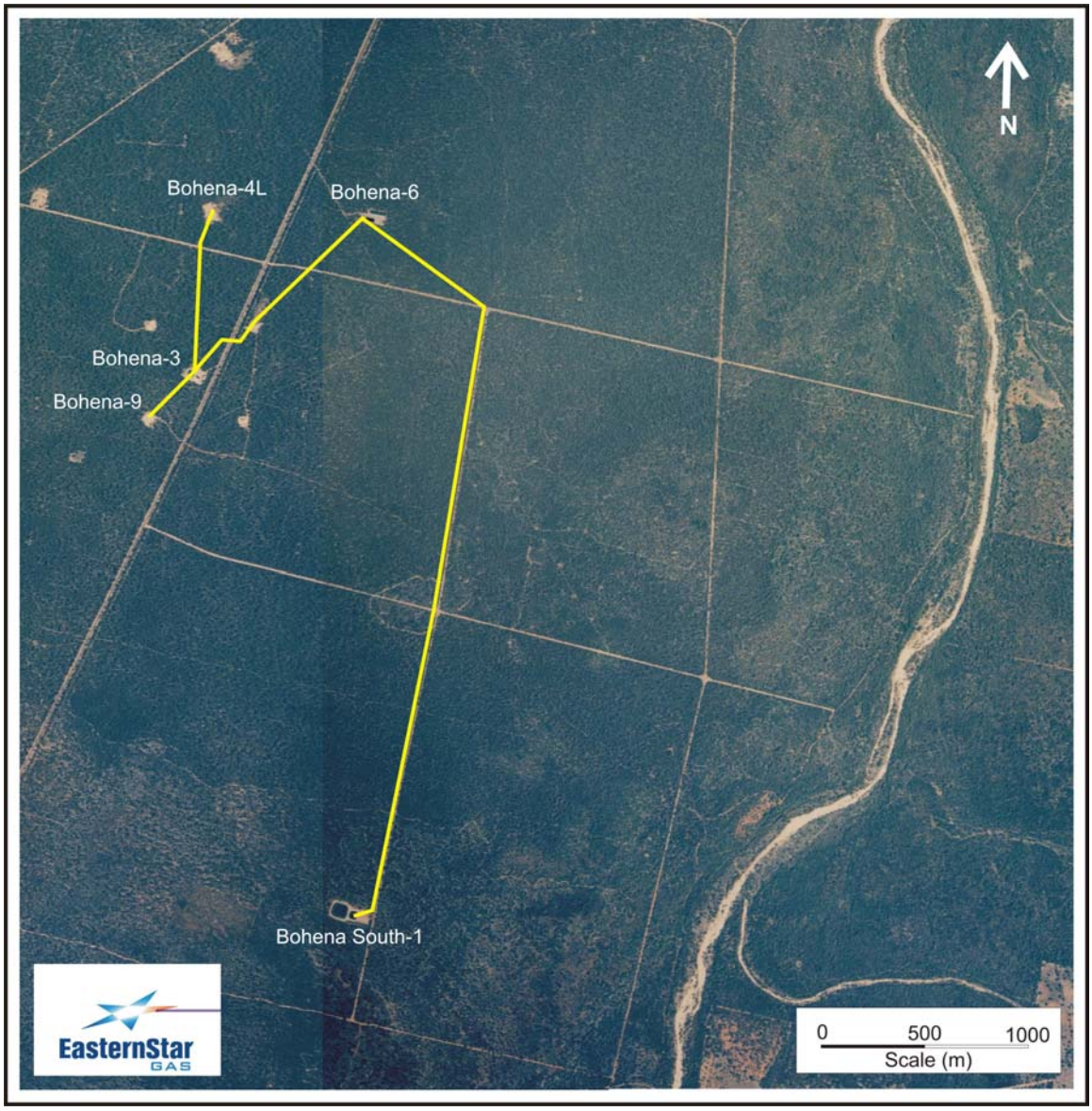

Figure 2 Existing water management infrastructure at the Bohena CSG Pilot

2.3.2 Bibblewindi CSG Pilot

Water and gas produced from the nine wells in operation at the Bibblewindi CSG Pilot is collected at each wellhead and transferred via buried gathering lines to the water and gas management facilities located next to Bibblewind1-1 (**Figure 4**).

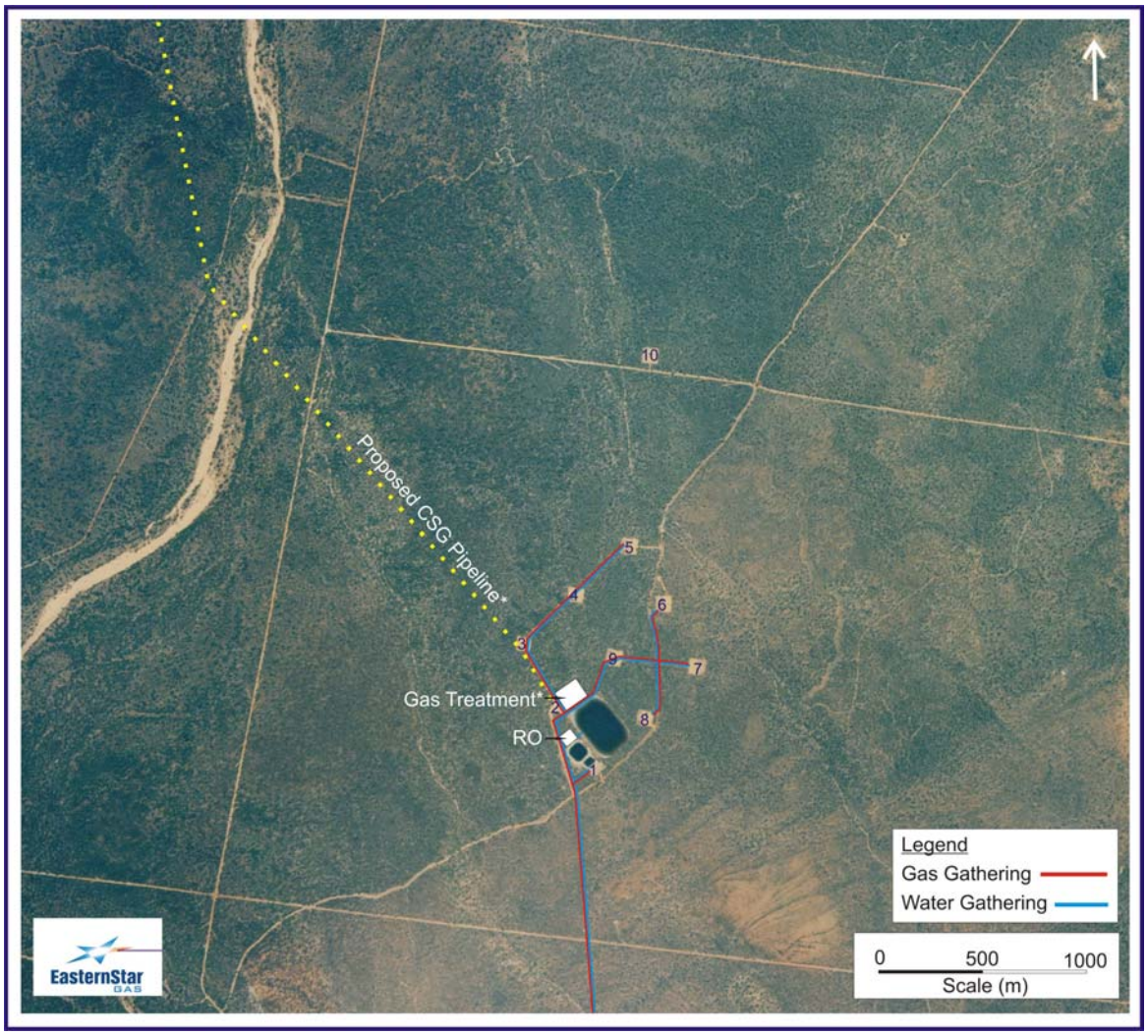

Figure 3 Existing water management infrastructure at the Bibblewindi CSG Pilot

2.3.3 Bibblewindi Lateral Pilot

Water and gas produced from the six wells in operation at the Bibblewindi Lateral Pilot is collected at each wellhead and transferred by buried gathering system to the water and gas management facilities adjacent to Bibblewindi 1 (**Figure 5**).

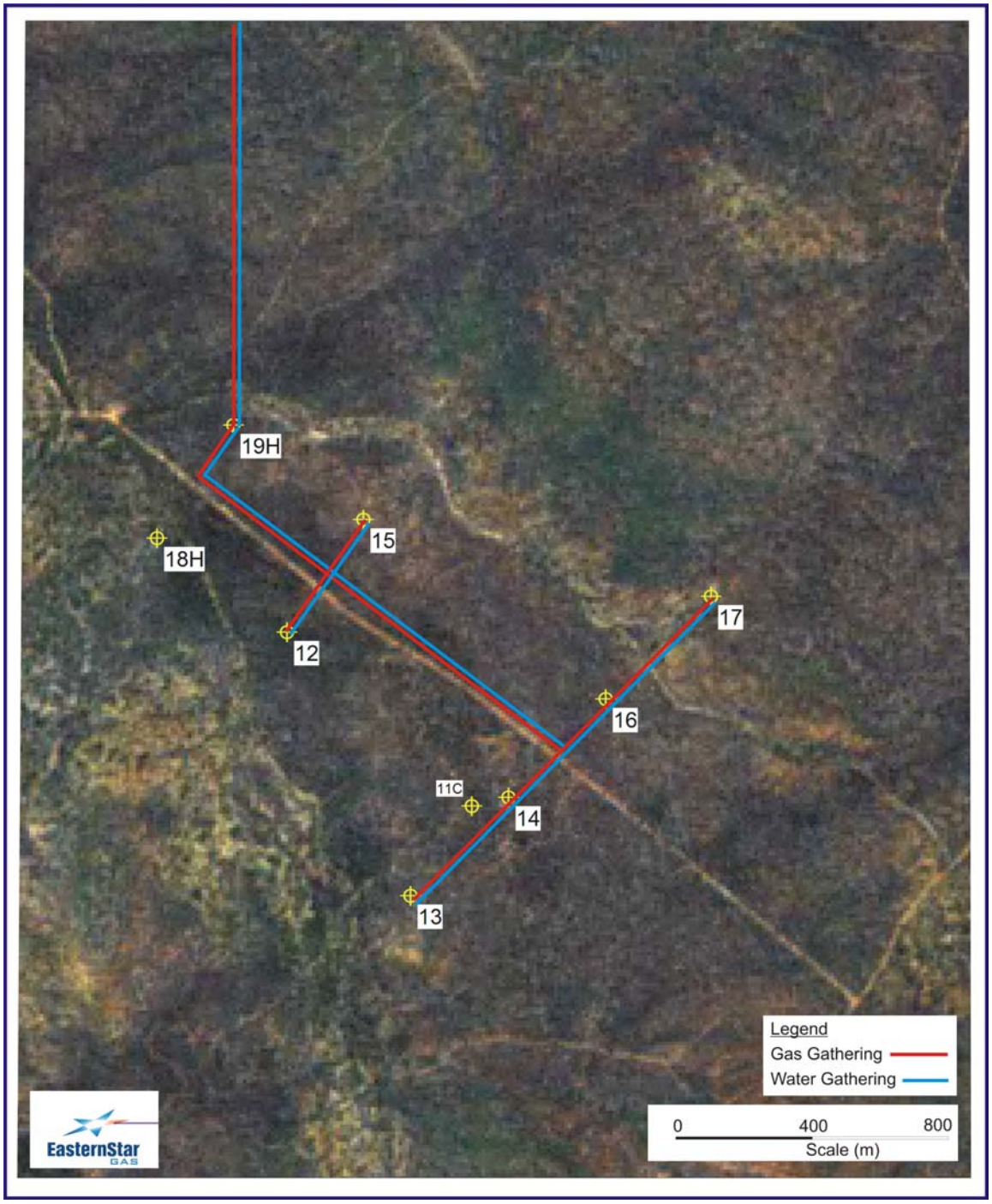

Figure 4 Existing water management infrastructure at the Bibblewindi Lateral Pilot

2.4 Water Treatment Pilot

The RO pilot was sized to accept up to 160 000L/1000 barrels of water per day and to date has achieved sustained operating efficiencies in excess of 70%. The plant is contained within a footprint of approximately 12m x 5m and includes a 5000L break tank and 20ft container which houses the filters, RO membranes and control systems (**Figure 6**).

The unit is set up adjacent to the three operational impoundments and is connected directly to an inlet manifold where water from the nine production wells enters the management system. The manifold directs the water into the break tank before being injected into the RO unit for separation into permeate (clean) and concentrate (saline) streams. The permeate is discharged into the smallest of the impoundments for reuse whilst the concentrate stream in discharged into the operational impoundment (either of the 2nd largest or largest).

The indicative permeate quality has been modelled at around 250 mg/L TDS however the most recent analysis of permeate discharged from the facility resulted in a calculated TDS of 150mg/L.

Figure 5 Reverse Osmosis pilot located at Bibblewindi-1

The current water management strategy has been effective at containing the water produced from all 12 operational CSG wells in PAL2.

2.4.1 Treatment Plant Expansion

The expansion of the treatment plant proposed in the current approved water and operations management plan will result in the ability to treat up to 1ML of production water per day. Based upon conservative recovery rates of 70%, approximately 700kL of clean 'permeate' will be available for

reuse or disposal while the remaining 30% or 300kL of brine will be discharged into the existing lined evaporation ponds.

3 Project Description

3.1 Introduction

The development of production based activities in PAL2 is an integral stage in the long term objectives of the Narrabri Coal Seam Gas Project. While core hole drilling across PEL238 continues to gather important data on the distribution, thickness, quality and gas bearing capacity of the underlying coal seams, the over arching objective of the project remains the demonstration of viable drilling and completion techniques to achieve production of gas at commercial rates.

ESG has submitted an REF for the proposed Bibblewindi West Lateral Pilot and proposes to install water and gas gathering infrastructure system linking the lateral pilot wells to the facilities at Bibblewindi-1 to permit production operations to commence at the completion of drilling activities (**Figure 7**).

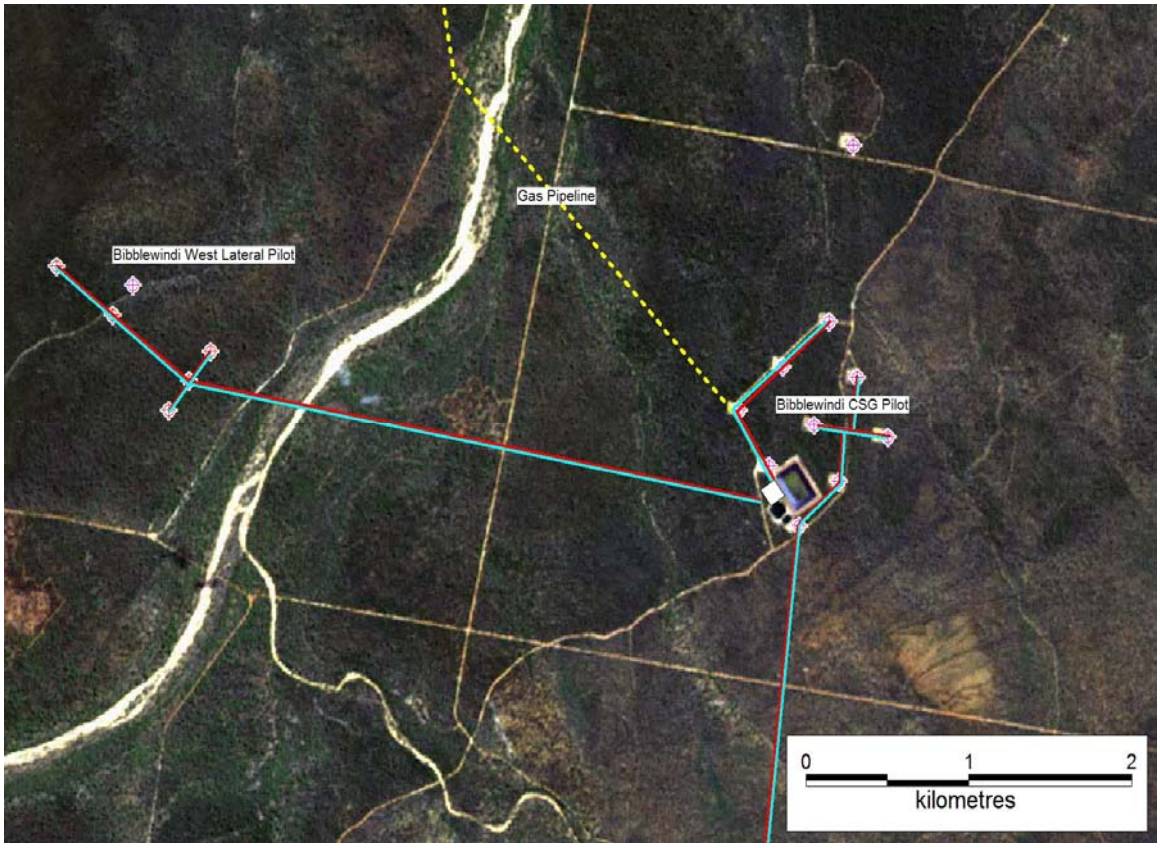

Figure 6 Location overview of the proposed Bibblewindi West Lateral gathering system

3.2 Water and Gas Gathering System

The proposed water and gas gathering system will comprise separate buried, low pressure flowlines for water and produced CSG linking the lateral pilot wellheads through to a centralised hub located on Bibblewindi-24, and then via buried flowline to the expanded water and gas management facilities located at the Bibblewindi CSG Pilot.

The gathering system will be located alongside access roads installed during the drilling program; by combining the working area for the roads and gathering system, the cumulative area of vegetation impacted by the proposal is reduced.

Figure 7 Conceptual layout of the proposed gathering system at the Bibblewindi West Lateral Pilot

3.2.1 GGS Corridor

The proposed GGS will be installed along a dedicated corridor between Bibblewindi-24 and Bibblewindi-1; the corridor will approximate 10-12 m in width to accommodate construction activities and to permit the adequate segregation of mulch, topsoil and subsoil stockpiles.

The GGS route follows the most direct pathway from the individual production wells back to Bibblewindi-24 and onto Bibblewinidi-1, which coincides with the location of access to be installed prior to drilling operations (subject to separate approval).

No other alternative routes were considered given the localised environment and likely impacts of the proposal; in terms of impacts on the biotic environment, no alternative route offers benefits in terms of a reduced area of cumulative vegetation/habitat modification.

3.2.2 GGS Specifications

GGS Component	Design Specifications
Length	5.5km
Diameter	Up to 12” O.D
Material	High Density Polyethylene (PE100)
Static Pressure Rating	To AS4130
Depth Cover	Minimum 750mm cover
Construction Right of Way	≈12m

Table 1 Gathering system specifications

3.2.3 Compliance with Australian Standards

The relevant Australian Standard for polyethylene pipes is AS4130; all construction materials, methods and work practices for the proposed GGS installation and operation will be designed in accordance with this and other pertinent standards (AS2885) to the satisfaction of DPI (Minerals and Petroleum).

3.2.4 Approvals Required

In order for the proposed GGS installation to proceed, ESG will seek the approval of DPI (Mineral Resources) in accordance with Part 5 of the *Environmental Planning and Assessment Act 1979* and under the terms of Petroleum Assessment Lease No 2.

Consent to construct and operate the GGS will be sought from Forestry NSW via the amendment of the occupation permit (pending) issued under the *Forestry Act 1916*.

3.2.5 Hours of Operation

The proposed construction activities will occur between 7am and 6pm or daylight hours.

3.2.6 Activity Timeframes

The proposed activity is expected to occur over a timeframe of approximately 3 months

3.2.7 Construction Activities

The installation of the GGS between the lateral pilot production wells will require the following component activities as illustrated in **Figure 9**.

Surveying the Gas Flow Line Corridor

The proposed gas flow line corridor will be surveyed by a registered surveyor before any preparatory activities take place.

Vegetation Clearance

All commercial forestry products will be removed and stored in the closest staging area for later collection by Forestry NSW or its contractors. All hollow-bearing trees felled will be relocated to adjacent bushland. All remaining vegetation will be mulched *in situ* and stockpiled at the edge of the corridor.

Topsoil Stripping and Stockpiling

The topsoil within approximately 3m of the flow line trench will be stripped to a depth of at least 100mm and stockpiled next to the retained vegetation

Trench Surveying

The location of the trench centreline will be marked within the surveyed corridor.

Trenching

A wheel or chain trencher will form the gathering system trench. An excavator may also be employed where required. Subsoils will be stockpiled in a windrow adjacent to the topsoil stockpile. In the event that any hard rock or hardpan layer is encountered during trenching, a rock saw or other suitable machinery will be employed to achieve and maintain the correct trench depth.

Backfilling and Restoration

The backfilling of the trench will commence at the completion of the system testing procedures. A magnetic identification/warning tape will be installed approximately 300mm above the flow lines. The compaction of the backfilled subsoil will be closely monitored to minimise the chances of subsequent settling within the trench. Additional fill may be imported from suitable local supplies (subject to Forestry approval). The topsoil stockpile will only be accessed once the trench has undergone sufficient backfilling and compaction. The respreading of topsoil will be closely followed by the respreading of mulched vegetative material (where available) to assist in soil stabilisation in accordance with agreed forestry protocols for site rehabilitation.

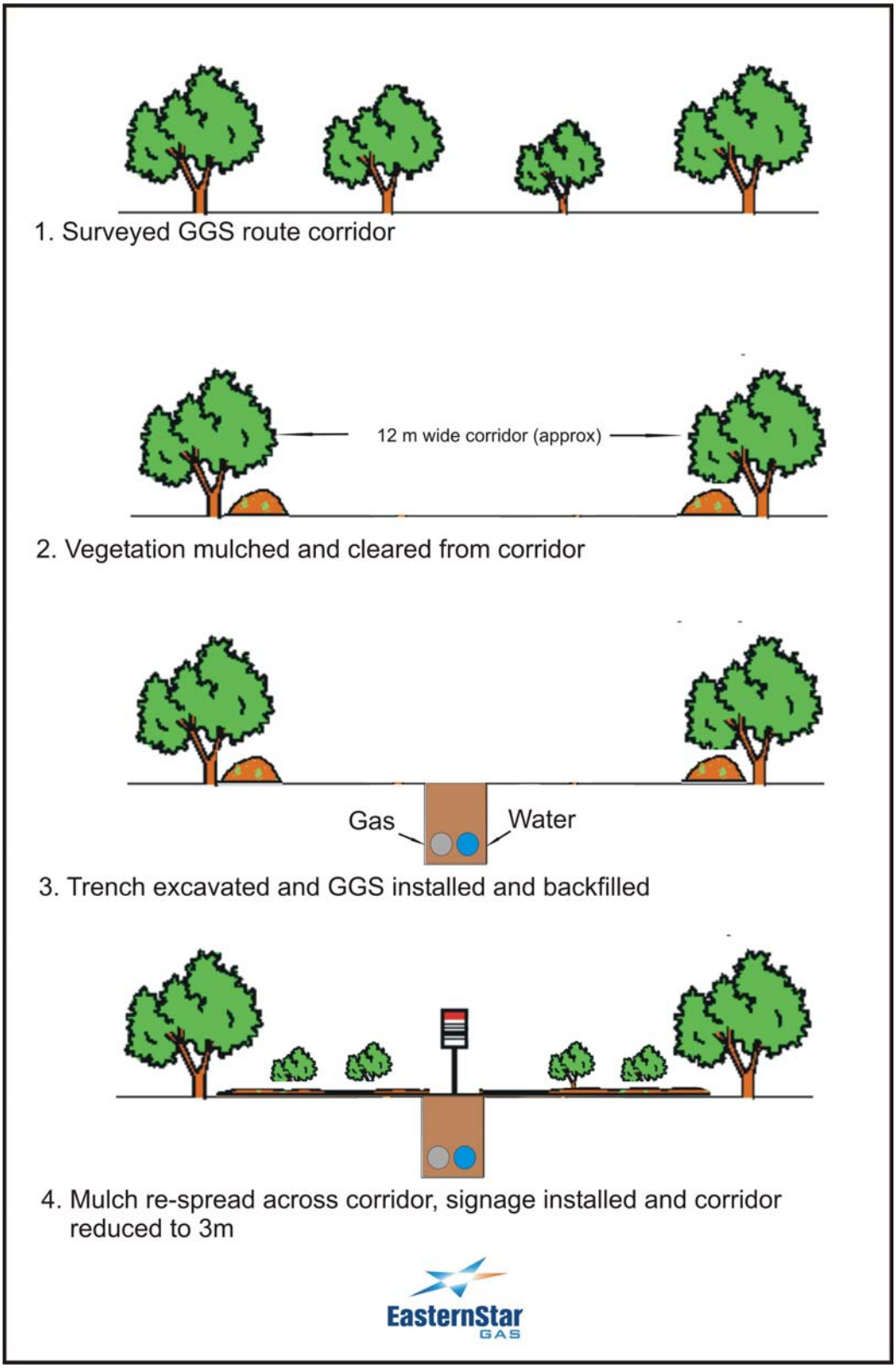

Figure 8 Indicative GGS installation sequence

3.2.8 Road Crossings

The crossing of roads intersected by the GGS will occur with minimal disruption to traffic and observe Forestry operations policy on road closures where required. The re-instatement of the roads surface will be undertaken as soon as practicable to ensure minimal disruption to traffic flow.

3.2.9 Bohena Creek Crossing

Horizontal directional drilling will be employed to install the GGS under Bohena Creek. At a point some 100m back from the creek bank, the contractor will locate the boring machine at surface level and commence drilling to depth to permit the intersection of the sand creek beds in excess of 2.5m below surface level.

The detailed work method statement for the creek crossing can be found in Appendix 3.

ESG has successfully completed the creek crossing exercise for the main gas pipeline to Wilga Park utilising this contractor and work method without any significant environmental impact.

3.2.9.1 Horizontal Directional Drilling Contractor

Austerberry specialises in the installation of pipeline infrastructure under impediments such as roads and water courses using horizontal directional drilling techniques.

A review of Austerberry's environmental policy indicates that the company is cognisant of the environmental impacts that the horizontal drilling technique may cause and has in place a range of environmental management plans to mitigate the risk of such occurrences. A copy of Austerberry's Environmental Control Plan for sedimentation, erosion and waste water management can be found in Appendix 4. This plan outlines in clear terms the process of managing potential environmental risks associated with the installation of the gas pipeline under Bohena Creek.

3.2.10 Equipment

The equipment utilised in the construction process is listed in the following table and may vary depending on the contractor employed.

Proposed Use	Machinery / Equipment
Logging/Vegetation Removal	2-5 x Husqvarna 375 or Stihl 044 Chainsaws
	1x Bell 125 Ultra Logger
Easement Preparation	1 x Caterpillar D6N Bulldozer
	1 x Mechanical Vegetation Mulcher
	1 x Caterpillar 140G Motor Grader
	1 x Hyundai 210C Excavator
	1 x Bobcat Skid Steer Loader
Pipe / Gas Flow Line Trenching	1 x Trencor 760 HDA Chain Trencher or equiv.
Transport/Support	2 x Prime Movers & Low Loaders
	1 x 10 000L Water Cart
	12 x Light 4WD Vehicles (Patrol/LandCruiser or eqiv)
	1 x Off-road forklift/front-end loader
	2 x Truck mounted HiAb flat-bed trucks

Table 2 Equipment required to install the GGS

3.2.11 Waste Management

Waste materials generated during the construction period will include:

- construction materials waste such as timber, plastic and small amounts of metals.
- general domestic refuse; and
- wastes such as engine lubricants and coolant fluids.

In accordance with good field practice, work crews will be required to dispose of all waste materials in designated receptacles or collected for disposal offsite at the completion of each shift. Wherever possible, waste materials will be collected for recycling and/or reuse or otherwise be transported for disposal at the Narrabri Waste Depot.

3.3 Rehabilitation

The rehabilitation of the GGS corridor will commence as soon as practicable after the construction activities have ceased. The main objective of the rehabilitation program will be to return a maximum area of the lands disturbed by the GGS installation back to previous land use.

Approximately 70% of the flow line corridor will be encouraged to regenerate naturally from seed stock contained within the topsoils and mulched material retained from the clearance process. The remaining 30% will be retained as foot based access. The retention of this area will permit access for future monitoring and maintenance (if required) and to reduce the potential for the regrowth of vegetation to impact on pipe integrity.

The replacement of mulched vegetative materials across the working area is expected to meet the longer term objectives of vegetation regrowth. However the shorter term objective will be the stabilisation of topsoils and therefore the minimisation of incidental erosion by surface flows during and after rainfall and wind. The method is quick, provides a physical barrier to erosion, and does not introduce any new materials that may harbour weeds and diseases. This method, also used on the main gas flowline from Bibblewindi to Wilga Park, together with retention and replacement of topsoil, will also facilitate germination and establishment of seed from the soil seed bank.

No additional over sowing of the disturbance corridor with native seed or seedlings is planned.

3.3.1 Monitoring and Maintenance

Aspects of the rehabilitation program that will be monitored for the duration of the operational period will include:

- Any evidence of slumping within the area of the GGS trench;
- Any suggestion of excessive erosion or topsoil instability; and
- Any issues with the adequate drainage of the corridor.

Remedial action will be taken where issues such as described or otherwise are evident. No time limits will be placed upon the duration of the monitoring and maintenance program.

4 The Existing Environment

The information contained in this section characterises the existing environment around the Bibblewindi West Lateral project and gathering system route, describes the likely and potential environmental impacts of the proposed development and accordingly discusses the scope for impact mitigation where an opportunity can be identified.

4.1 Topography

The project area is located in the Pilliga East and Bibblewindi State Forests. Indicative elevations of this area approximate 280m AHD and generally fall away to the west and northwest. The terrain is flat to very flat with slopes of less than 1° most common on the alluvial margins of Bohena Creek. To the east of the creek, topographic relief becomes slightly more apparent as the landscape rises up towards the Bibblewindi CSG Pilot and water/gas management facility.

4.2 Drainage

The project area lies within the Namoi River Basin Catchment, one of the main tributaries of the Barwon Darling River System. The Namoi River Basin covers an area of 43 000 km^2 and incorporates the regions major centres of Tamworth, Gunnedah, Narrabri and Walgett (Corkery and Assoc., 2004).

The Bohena Creek sub-catchment covers an area of 1500km^2, and is the major drainage feature in the area. It is ephemeral in nature and flows only with significant rainfall in the catchment further south of PAL 2 towards the northern margins of the Warrumbungle Ranges.

4.3 Land Use

The Bibblewindi West GGS will be wholly located upon lands designated Crown Lands State Forest under the *Forestry Act 1916*.

The *Brigalow and Nandewar Community Conservation Area Act 2005* redefined the land use classification for the Pilliga State Forests system. The objects of this Act are to reserve forested land in the Brigalow and Nandewar sub regions for the maintenance of Community Conservation Areas (CCA) which in turn provide a mechanism for the permanent conservation of land, protection of areas of natural and cultural heritage significance to Aboriginal people and sustainable forestry, mining and other appropriate uses. The project is located within a zone four CCA which wholly permits the continued exploration for and assessment of petroleum resources.

The vegetation surrounding the project site is predominantly native woodland vegetation within the Bibblewindi State Forest. This area is made up of forest types 190 (White Cypress Pine-Brown

Bloodwood) and type 189 (White Cypress Pine-Narrow leaved Ironbark) and in terms of commercial forestry operations is considered of low quality/low productive capacity.

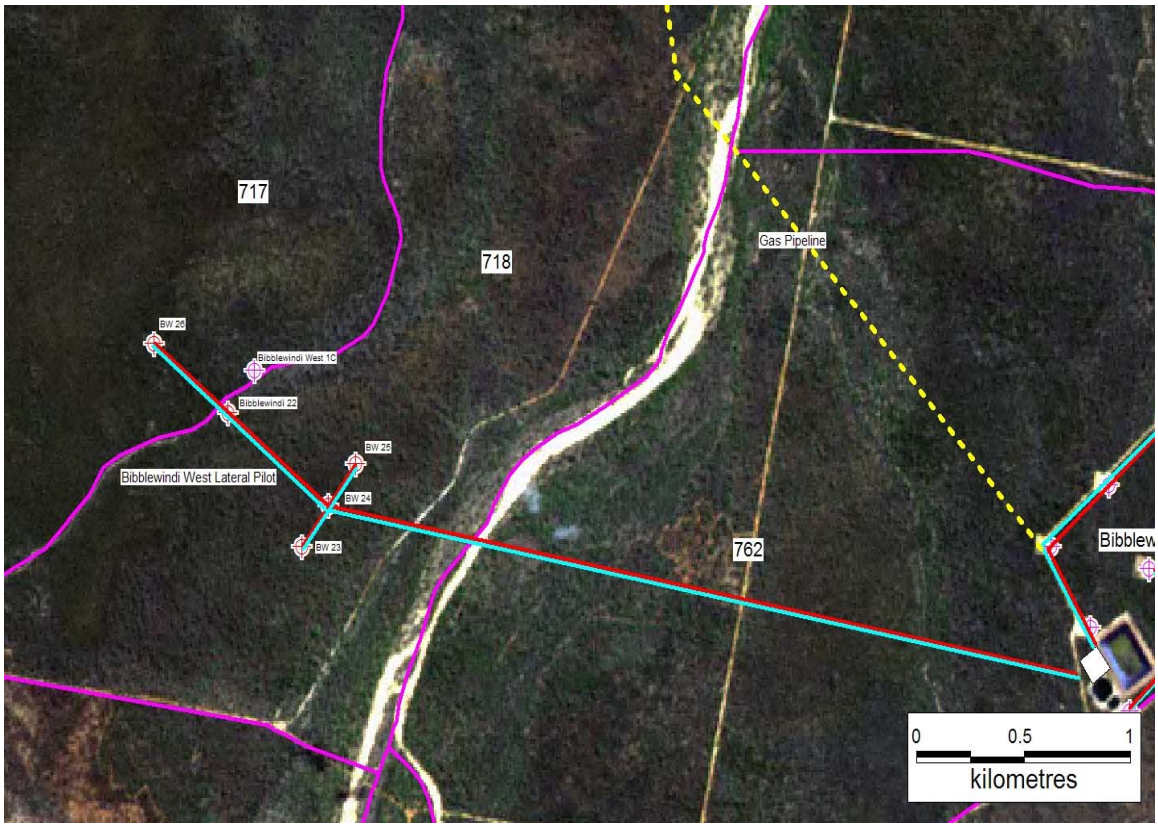

Figure 9 The project location within Bibblewindi State Forest compartments 763, 767 and 768.

The occupation of Forestry Lands for the purposes of petroleum exploration and assessment is subject to an occupation permit (pending as at 01/03/09) under the *Forestry Act* 1916. ESG will engage the assistance of Forests NSW in assessing the commercial value of forestry resources located on or adjacent to operational areas including the proposed GGS. Consultation with Forestry NSW indicates the current and future operations in the area include:

- Compartments 528, 529, 704, 705, 713, 714, 770, 708 and 709 have current or future harvest plans;
- Non commercial thinning operations are occurring in compartments 707, 709, 709, 528, 529: and
- Hazard reduction burning is planned for compartments 781, 782 and 784

4.4 Cultural Heritage

Throughout the development of the Narrabri CSG Project, the existing knowledge base on the extent of Aboriginal inhabitation across the region has steadily grown. Cultural heritage surveying has occurred frequently since Eastern Star commenced the active development of PEL238's CSG reserves in 2004.

Survey efforts carried out to date have included numerous site specific cultural heritage investigations for the installation of production and core hole well pads across PAL2, the surveying of the area impacted by the installation of the Bibblewindi water management facility and the proposed flowline linking the Bibblewindi and Bohena CSG Pilots to the Wilga Park Power Station. The surveys have been undertaken in consultation with the Pilliga Forest Aboriginal Management Committee and Narrabri Local Aboriginal Land Council. Heritage advisors representing these groups have been present at each survey effort to date.

The existing archaeological record for the region consists of various sources of cultural heritage information including the NPWS AHIMS database, the Forestry NSW/PFAMC site register and published reports on the extent of Aboriginal inhabitation of the Pilliga Forests. These sources corroborate on the understanding that Pilliga Forests were frequently utilised by Aboriginal communities for a range of uses and that a number of significant sites have been identified during subsequent survey efforts.

The information contained within the various published reports provides the basis for the cultural heritage investigations for the proposed GGS project.

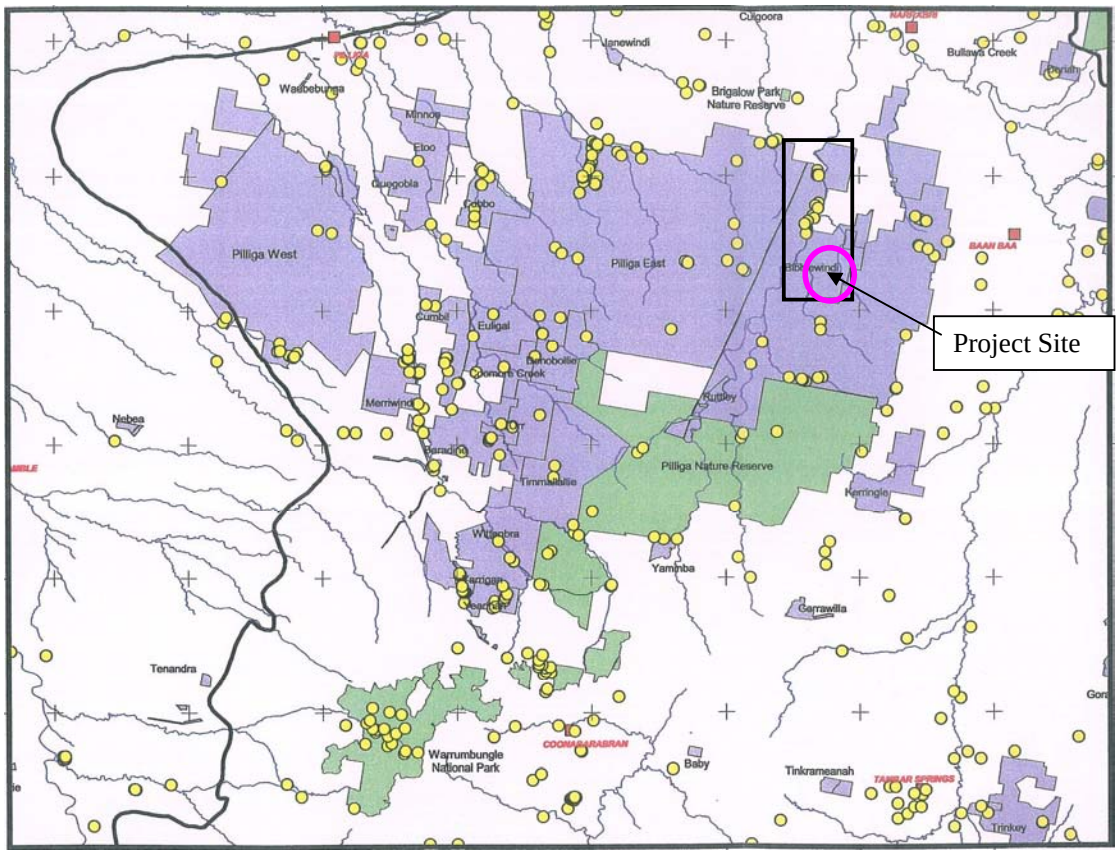

Figure 10 Site of significance within the Pilliga State Forests (RACD in Trindall, 2007)

4.5 Flora

Prior to the development of the Narrabri CSG Project, the Pilliga East and Bibblewindi State Forest received little detailed attention in terms of botanical surveying to assess the type and quality of floral composition or the presence of threatened floral species, populations or ecological communities and potential habitat for faunal species. The basis for this lack of structured floristic study of native flora across this region can be attributed to the commercial foundations of vegetation management; a majority of the mapping of native vegetation in the Pilliga East has been developed for commercial forestry management rather than ecological purposes.

Lindsay (1974) mapped a majority of the northern Pilliga East State Forests as Cypress Pine, Narrow leaf Ironbark and Forest Oak, which Binns and Beckers (2001) corroborate in describing the "Grassy White Pine-Ironbark" community containing an equivalent species composition. Survey efforts carried out by Mr Greg Elks of Idyll Spaces have been successful in adding to the existing knowledge base on the floristic composition of the operational areas in PAL2.

Preliminary desktop data analysis has been based upon GIS data provide by Forests NSW (Baradine) on dominant canopy species in the area surrounding the proposed GGS project. **Figure 12** indicates that the GGS will be located in and amongst vegetation communities dominated by Narrow leaf Ironbark/Bull Oak/White Cypress (COP) and White Cypress/Narrow leaf Ironbark/Bull Oak (PCO), although field verification of these communities cannot identify a consistent difference between the stated dominance of any one species.

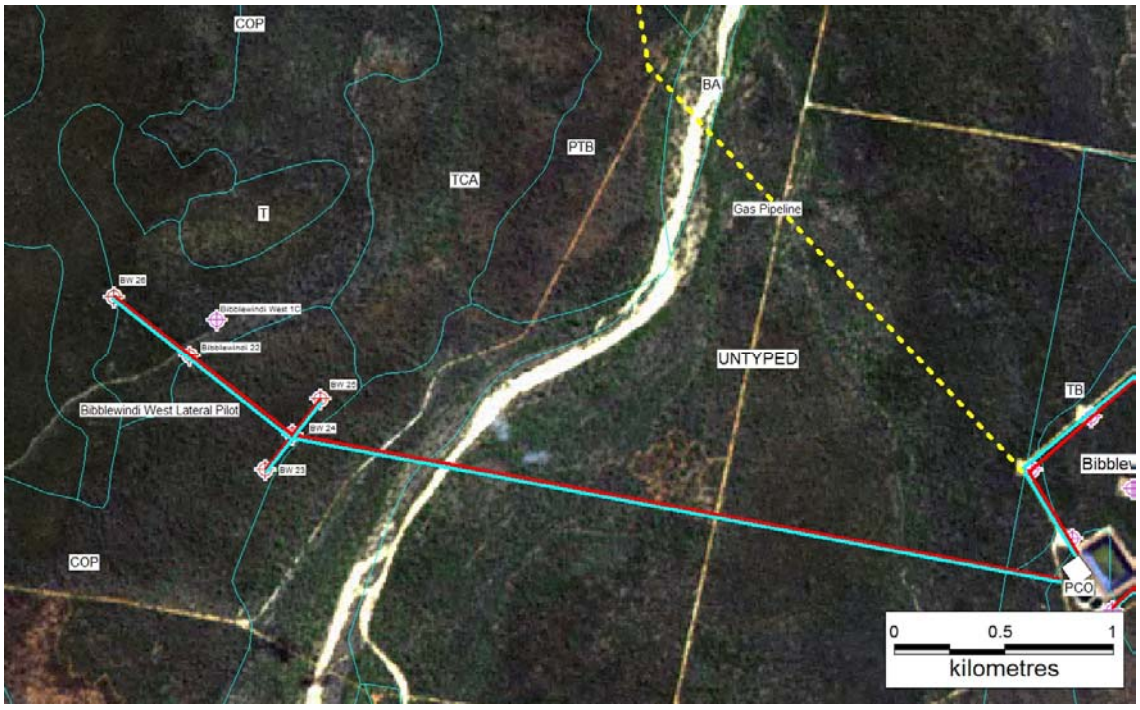

Figure 11 Dominant canopy species mapping of the area surrounding the GGS

Existing records from DECC databases indicate that threatened species and endangered ecological communities and threatened flora species have been observed within the Pilliga East State Forests and Nature Reserve and surrounding region. However no species of significance have been observed within the localised area (<5km) surrounding the project site. Records of these observations are shown in **Figure 13**.

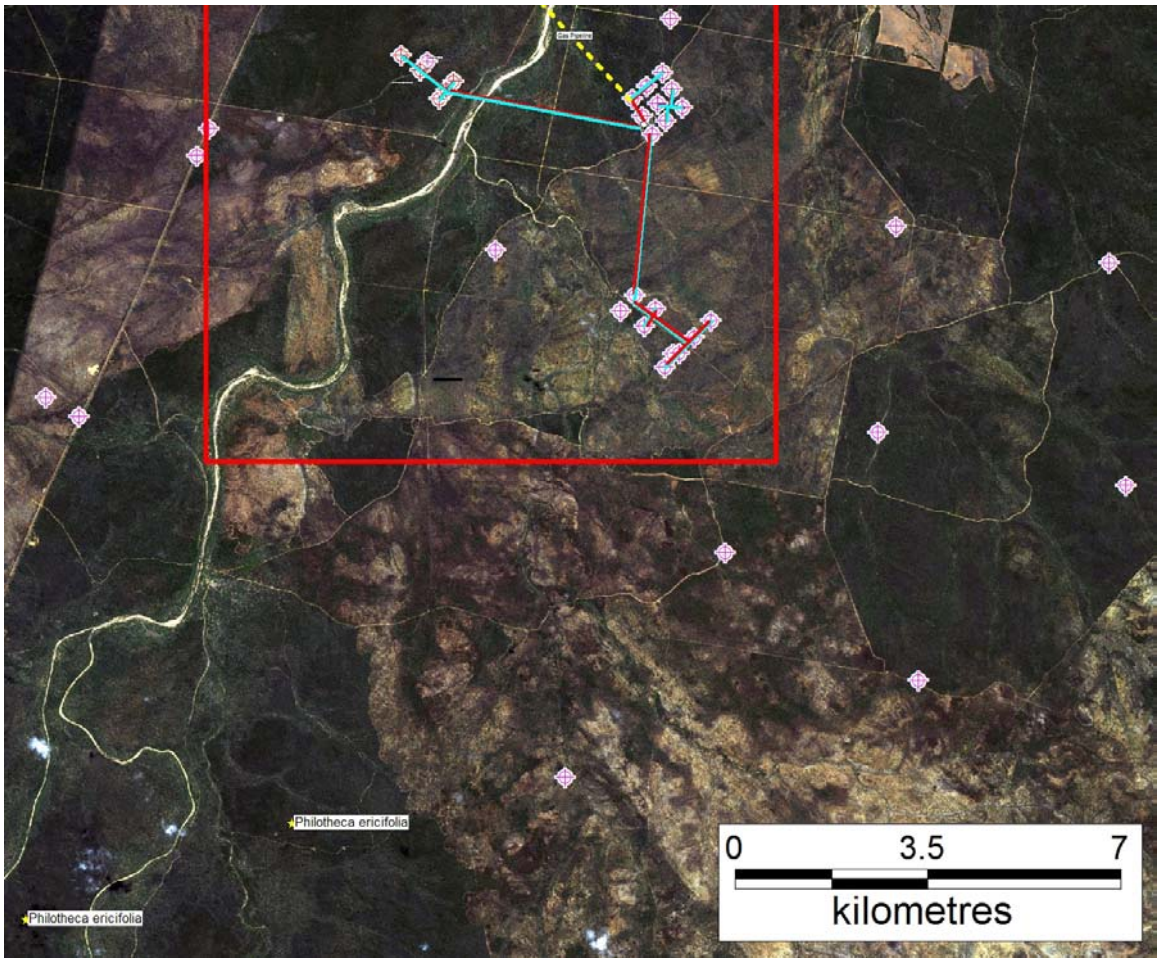

Figure 12 NSW DECC database records for threatened flora in the project area

4.6 Fauna

Prior to the development of the Narrabri CSG Project, the Pilliga East and Bibblewindi State Forest received little detailed attention in terms of systematic fauna surveying to assess the presence of threatened faunal species, populations or ecological communities and potential/actual habitat. Fauna studies completed for Eastern Star's Pilliga Seismic Survey by Smith (2002) suggest that the Pilliga State Forests and Nature Reserve, including Bibblewindi State Forest, form one of the largest forest remnants on the north-west slopes and plains of NSW. The remnant has national, state and regional conservation significance for the protection of biodiversity and threatened species due to its large size (>500 000 ha), high threatened species diversity and high quality habitat.

Since the initial fauna assessment in 2002, a number of fauna survey efforts have been carried out across PAL 2 during the development of the Narrabri CSG Project. The methodology for this impact assessment has focused on the compilation of existing data sources including the DECC threatened species records, significant fauna and fauna species habitat records held by Natural Resources and additional consultation with State and Federal schedules for the protection of threatened species and threat abatement plans.

Field surveys have generally been carried out on the basis of determining the relationships between habitat types and fauna distribution across the Pilliga and so have utilised the findings of Greg Elks in the various flora survey reports completed to date. ESG has employed Mr Keith Kendall of Kendall & Kendall Ecological Consultants to complete detailed fauna assessments on a number of project related developments. The impact assessments reports completed to date and recent database searches indicate that various threatened and endangered species have been observed within the Pilliga East State Forest. Many of the observations shown in **Figure 14** were registered by Kendall at the completion of the survey efforts carried out for ESG in the past 4 years (Kendall, 2005 and Kendall, 2006).

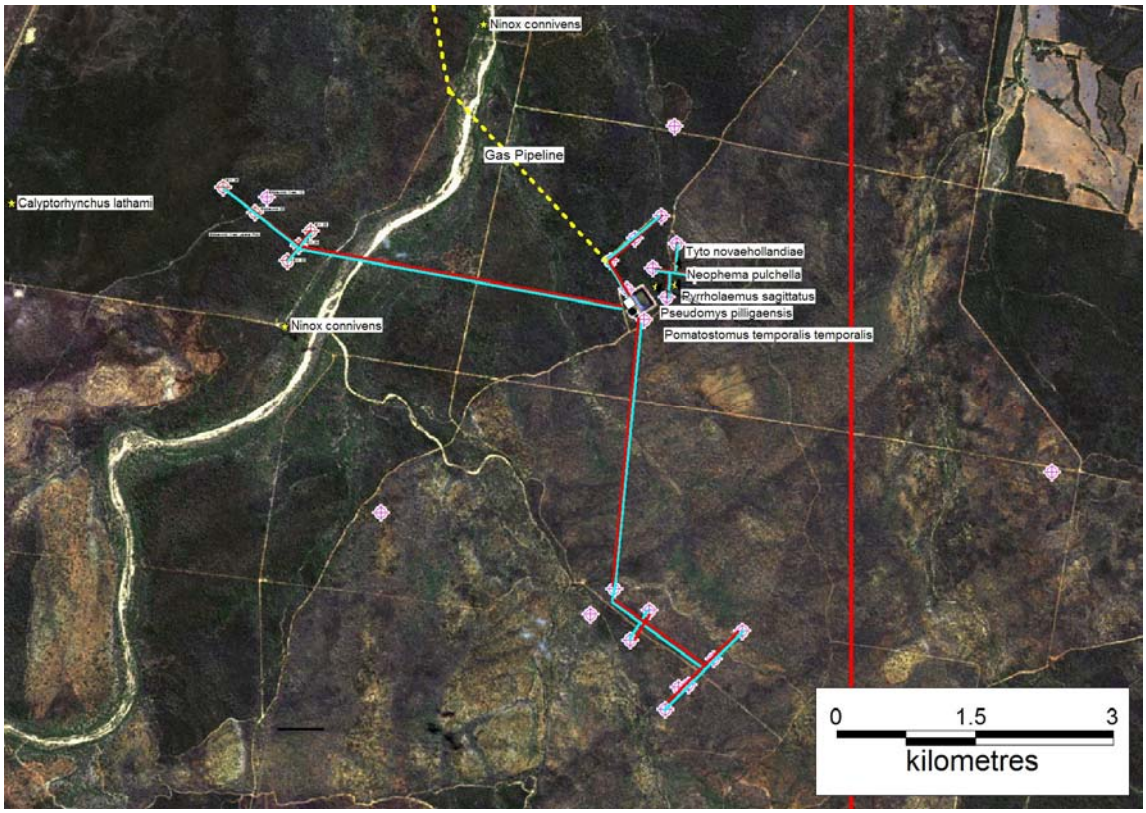

Figure 13 NSW DECC database records for threatened fauna in the project area

5 Environmental Impact Assessment and Mitigation

The assessment and prediction of the likely environmental impacts associated with the proposed activity is provided by ESG in response to Section 111 of the *Environmental Planning and Assessment Act 1979*. The level of detail contained in this REF document was determined by factoring together the intensity of the activity, the relative sensitivity of the environment and the likelihood of remediation at the completion of the construction phase.

5.1 Land

The confidence levels in predicting the impact of the GGS installation and operation at this location are high. The process of preparing the GGS corridor, the construction activity and the operation of the GGS to during the extended period of production testing is relatively small in scale and limited to a finite area. The GGS flow line corridor will approximate 4 km in total length and approximate 12m in width. The cumulative area of land impacted by the proposed activity will therefore approximate 4.8 ha.

The *E. crebra* dry open forest community , described in detail in section 5.7, within which the proposed activity is to occur is the dominant vegetation community in the Pilliga East and Bibblewindi State Forests and is the most widespread of the White cypress forestry types occupying around 40% of the total area of managed cypress forests (Forestry Commission in Elks, 2007). The modification of a further 4.8 ha of this regionally common vegetation type is unlikely to result in any measurable reduction in the value of the area as habitat or a commercial resource.

The sensitivity of the operational environment is well understood in terms of its resilience to disturbance; whilst the project is likely to occur over an extended period, the likelihood of a full reversion to the pre-existing condition is very high given the actions taken to preserve the natural regeneration potential of the site.

ESG considers the cumulative impacts as a result of this activity are relatively small and will occur over a short timeframe. The rehabilitation potential of the site is protected to a significant degree through the use of a vegetation mulching technique which protects the soil structure by leaving rootstock in place and by stockpiling topsoils and the existing seed stock required for natural regeneration.

5.2 Access

A major objective of Eastern Star's operations within Forests NSW Lands is to use existing roads and tracks as far as practicable. The extensive system of roads and tracks crossing the Pilliga East and Bibblewindi State Forests permits safe and efficient access to much of PAL2.

Access to the gathering system site GGS from Narrabri will be via the Newell Highway, X-Line Rd and Blue Nobby Rd. Current operational requirements for all-weather access has resulted in the significant

road surface upgrades to X-Line Rd with further improvements planned for Blue Nobby Rd prior to the drilling program commencing at Bibblewindi West. The improvements to existing access will be account for the entry of drilling and gathering system construction contractors and in future facilitate slight increases in daily operational traffic. This action will occur in consultation with Forestry NSW.

Any damage to existing roads/access caused by the operations activity remains the responsibility of ESG and will be rectified as soon as practicable under direction from Forestry NSW.

5.3 Drainage:

Topographic maps and aerial photographs indicate that the GGS will intersect Bohena Creek and one less defined drainage line leading to the Creek (**Figure 14**).

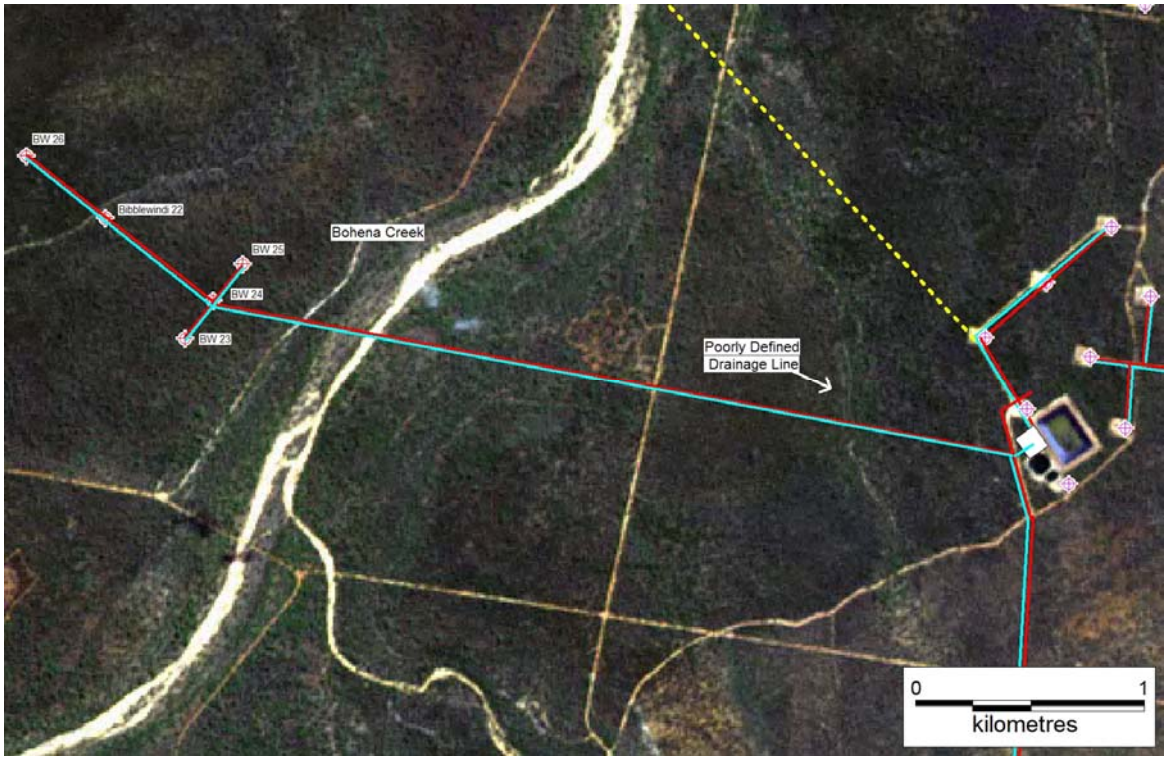

Figure 14 Drainage features intersected by the gathering system

The engineering design and construction methods employed for this project will include due consideration of the issues aligned with both the drainage of water from the corridor itself during operations and the installation of the GGS across existing creek beds.

The crossing of Bohena Creek will employ a subsurface, horizontal directional drilling technique that does not disturb the surface of the creek bed (see Section 3.2.7).

The crossing of the poorly defined drainage line some 750m west of the Bibblewindi Nine Spot Pilot will employ the open trenching technique used elsewhere during this project.

ESG's general erosion and sediment management plan (Appendix 1) has been revised to include specific requirements to install and maintain sediment barriers (**Figure 15**) for:

- The duration of the construction phase; and
- Until such time that vegetation regrowth is capable of limiting sediment mobilisation during rainfall events.

Figure 15 Sediment barriers installed on the downstream edge of drainage lines

5.4 Subsurface Impacts:

The extent of subsurface impacts likely to occur as a result of the GGS project is relatively minor given the proposed methods of construction. The GGS trench will be excavated to a maximum depth of 1m with topsoils and subsoils separated along the working area.

Further management actions to account for subsurface impacts, specifically soils management, are contained within the soils and land capability management plan (Appendix 1).

5.5 Air

5.5.1 Fugitive Dust Generation:

The dust generated by the mobilisation of the construction equipment to and from the project area is generally considered unlikely to cause any long term impacts on the localised or regional environment. In the event that the roads are excessively dry and may be expected to generate excessive amounts of dust, a water truck will be deployed to suppress road based dusts before and during the more intense periods of activity.

No dust suppression is expected to occur along the GGS corridor while under construction; specific directives in regard to the protection of soil structure were made by an independent soils scientist or the main gas flowline to Wilga Park. It is expected that these management actions will also apply for this project as the soil/vegetation types and rehabilitation objectives similar. Please refer to the soils and land capability management plan listed in Appendix 1 for further detail.

ESG considers these impacts to be small in scale, localised and short in length. No long term effects will be introduced where the management actions are adhered to.

5.5.2 Noise Impacts:

All of the equipment employed to complete the proposed construction activity are modern, well maintained and have noise silencing apparatus fitted as standard. Times of peak noise emissions from the operational site will be generally between the hours of 7am and 6pm or daylight hours.

The distances from any given point along the proposed GGS corridor to the nearest inhabitation will range from 8km to no less than 6km and therefore ESG is confident that the mobilisation of equipment and personnel and the construction of the GGS are unlikely to result in any measurable noise related impacts on existing point source receptors.

5.6 Water

5.6.1 Water Source

Any water required during the construction period will be sourced from the water treatment plant located at Bibblewindi-1 and transported via tanker to location.

5.7 Flora

The basis for the assessment of impacts on the native flora species and vegetation communities posed by the installation of the GGS is the existing knowledge base on flora impact assessments carried out across PAL2 to date. Survey reports from the following surveys have been consulted and are considered

sufficient to provide an understanding of the actual, likely and potential impacts associated with the proposed activity:

- ***Clements, A & Moore, R. (2002).*** *Survey Report and Review of Existing Flora Data: PEL238 Pilliga East Seismic Survey, Anne Clements & Associates Pty Ltd, North Sydney, NSW*
- ***Elks, G.N. (2005).*** *PEL238 Coal Seam Gas Flora Survey – Bibblewindi Nine Spot, Idyll Spaces Environmental Consultants, Bonville NSW*
- ***Elks, G.N. (2006).*** *PEL238 Coal Seam Gas Flora Survey – Water Management Facility, Idyll Spaces Environmental Consultants, Bonville NSW*
- ***Elks, G.N. (2007).*** *PEL238 Narrabri Coal Seam Gas Project Flowline Flora Survey, Idyll Spaces Environmental Consultants, Bonville NSW*

5.7.1 Background Information

The various databases available suggest that a number of threatened communities and species have been identified within the Narrabri region and the Pilliga State Forests and Nature Reserve.

Elks (2005, 2006, 2007) provides a comprehensive review of existing threatened species records across various State and Commonwealth registers (**Table 3**).

Database Search	Threatened Community/Species/Habitat
EPBC (2000) Act threatened communities	**Brigalow** (*Acacia harpophylla* dominant and co-dominant). Endangered community known to occur with the study area **Grassy White Box Woodlands** endangered community may occur within area locality
EPBC (2000) Act threatened species	*Bertya sp.* Cobar Coolabah (v) *Cadellia pentastylis* (v) *Digitaria porrecta* (e) *Diuris sheaffiana* (v) Goodenia macbarronii (v) *Lepidium aschersonii* (v) *Philotheca ericifolia* (v) *Pterostylis cobarensis* (v) *Rulingia procumbens* (v)
NSW TSC Act Endangered Ecological Communities	- Myall Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain, Murray-Darling Depression, Riverina and NSW South western Slopes - Fuzzy Box Woodland on alluvial Soils of the South Western Slopes, Darling Riverine Plains and Brigalow Belt South Bioregions - Coolibah - Black Box Woodland of the northern riverine plains in the Darling Riverine Plains and Brigalow Belt South bioregions - Brigalow within the Brigalow Belt South, Nandewar and Darling Riverine Plains Bioregions - Cadellia pentastylis (Ooline) community in the Nandewar and Brigalow Belt South IBRA regions - McKies Stringybark/Blackbutt Open Forest in the Nandewar and New England Tableland Bioregions - Semi-evergreen Vine Thicket in the Brigalow Belt South and Nandewar Bioregions - White Box Yellow Box Blakely's Red Gum Woodland
Threatened species records within 30km	*Bertya sp.* Cobar-Coolabah Vulnerable *Lepidium aschersonii* Vulnerable

(centroid)	*Philotheca ericifolia* Vulnerable *Rulingia procumbens* Vulnerable
Bionet search (TSC Act listed species) for Pilliga East and Bibblewindi SF	Goodenia macbarronii Vulnerable *Philotheca ericifolia* Vulnerable *Rulingia procumbens* Vulnerable
Threatened species known or predicted in the Pilliga Outwash CMA Subregion	*Cyperus conicus* (e) *Dichanthium setosum* (v) *Swainsona murrayana* (v) *Tylophora linearis* (e)

Table 3 Threatened communities, species and habitats occurring in the Pilliga State Forests

In summary, communities listed as threatened under the relevant state and federal jurisdictions are known to or likely to occur within the locality.

The dominant canopy species mapping sourced from Forestry NSW references two communities, Narrow leaf Ironbark/Bull Oak/White Cypress (COP) and White Cypress/Narrow leaf Ironbark/Bull Oak (PCO) as occurring at or around the proposed location, although field verification of these communities indicates no consistent difference between the stated dominance of any one species. **Table 4** summarises the community assemblage which has undergone field verification at various locations across PAL2.

Vegetation Community	Summary
Eucalyptus crebra Dry Open Forest	Narrow leaved Ironbark is always present and usually dominant. Other common species include White pine *Callitris glaucophylla* and bull oak Allocasuarina luehmannii. Midstratum of hopbushes *Dodonea spp*, *Calytrix tetragona*, wattles *Acacia spp*, broom and bitter pea *Daviesia genistifolia*. Ground layer most diverse, with mat-rushes *Lomandra spp*, sawsedge *Gahnia aspera*, flax lily *Dianalla longifolia*, wild onion *Bulbine semibarbata*, *Laxmannia gracilis*, *Calandrinia spp*, *Goodenia spp*, bluebells *Wahlenbergia spp*, cutleaf daisy *Brachycome multifida* and the fern *Cheilanthes austrotenuifolia* very common. Open stands of narrow leaved ironbark at around 20m tall with or without white cypress and bull oak over the midstratum with scattered stands or sparse individual sclerophyllous shrub. Sparse to mid-dense ground layer of forbs, grasses and graminoids. Community occurs on silty sand with adequate drainage.

Table 4 Summary of the *E. crebra* Dry Open Forest community

5.7.2 Assessment of Significant Effects

The assessment of significant effect on threatened species, populations or ecological communities or their habitats as per S5A (2) of the *Environmental Planning and Assessment Act 1979*, as applied to the Bibblewindi West gathering system project are such that:

a) **In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,**

Flora surveys conducted across the project area have found no evidence of any threatened species, populations, communities or critical habitat associate with the Narrow leafed Ironbark Dry Open Forest described by Elks (2007). Given the limited impact of the activity and likelihood of full rehabilitation, it is unlikely that this proposal will have any adverse effects on the life cycle of any threatened species such that a viable local population is likely to be placed at risk of extinction.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,

Flora surveys conducted across the project area have found no evidence of any threatened species, populations, communities or critical habitat associate with the Narrow leafed Ironbark Dry Open Forest described by Elks (2007). Given the limited impact of the activity and likelihood of full rehabilitation, it is unlikely that this proposal will have any adverse effects on the life cycle of any threatened species such that a viable local population is likely to be placed at risk of extinction.

c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,

No evidence of any endangered ecological community or critically endangered ecological community located in the localised or surrounding area has been identified during the flora surveys, hence

(i) the proposed activity is not likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction; or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

d) In relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,

The area impacted by the proposed activity represents a very small percentage of the dominant vegetation community mapped within PAL2, and will impact on less than 0.002% of habitat of similar quality in the locality.

There is no discernible difference in ecological integrity between habitat to be affected and habitat to remain. Furthermore, the small scale and spatial arrangement of the proposed impact is such that habitat is not likely to become fragmented or isolated from other areas of habitat.

The apparent absence of threatened flora species from the study area and the large areas of similar habitat in the region and locality suggest that the habitat to be removed is unlikely to be of importance for the long-term survival of the threatened species *Diuris tricolor*; *Goodenia macbarronii; Philotheca ericifolia; Rulingia procumbens* or *Tylophora linearis* in the locality.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),

Critical habitat as listed in the Register of Critical Habitat kept by the Director-General of DECC does not occur in the study area. The proposed activity is unlikely to have any adverse effect on critical habitat, either directly or indirectly.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,

No recovery plans or threat abatement plans are currently listed for *Diuris tricolor*; *Goodenia macbarronii; Philotheca ericifolia; Rulingia procumbens* or *Tylophora linearis.*

.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The proposed action will involve the key threatening process 'clearing of native vegetation'. It has the potential to contribute to the impact of 'invasion of native plant communities by exotic perennial grasses'. However this potential is likely to be low as most invasive exotic perennial grasses have been selected for their productive capacity in managed pasture and are likely to be poorly adapted for the relatively infertile sandy soils characteristic of forest in the study area. Clearing and weed competition are threats listed for *Philotheca ericifolia* and *Diuris tricolor*.

Weed invasion is listed as a threat for *Goodenia macbarronii*, and soil disturbances area listed as a threat for *Rulingia procumbens*.

The importation of weed and pest species onto site via seed and vegetative material is mitigated through the wash down of vehicles in Narrabri prior to entry to Forestry Lands (see section 5.5.4).

5.7.3 Conclusions

Given consideration of the above assessment, and in particular the small area of vegetation to be removed, both in absolute terms and in terms of the habitat for threatened species in the locality and region, and the apparent absence of threatened flora species from the subject site and study area, it is concluded that a Species Impact Statement would not be required.

Approximately 40,000ha of area mapped as the vegetation class 'Pilliga Outwash Dry Sclerophyll Forest' and a further 20,000ha of the floristically similar 'Western Slopes Dry Sclerophyll Forest' occurs in the locality but the habitat has been modified by grazing, modified fire regimes, and forestry activities (Elks, 2006).

The *E. crebra* dry open forest community within which the proposed activity is to occur is the dominant vegetation community in the Pilliga East and Bibblewindi State Forests and is the most widespread of the White cypress forestry types occupying around 40% of the total area of managed cypress forests (Forestry Commission in Elks, 2007).

Endangered communities listed in the NSW Threatened Species Conservation Act and Environmental Protection and Biodiversity Conservation Act (Cwth) have yet to be detected in the area and are assessed as unlikely to occur there.

Habitat requirements for five threatened flora species may be met in the study area, but as threatened flora species have not been previously recorded in the study area and have not been were not detected in surveying carried out to date, the possibility that they do occur there is considered to be low.

Given that the clearing of vegetation has been reduced to the smallest area possible and is spread across the landscape at known locations, it is considered that:

- the proposed activities would not be likely to have an adverse effect on the life cycle of a threatened flora species such that a viable local population is likely to be placed at risk of extinction;
- the extent to which habitat is likely to be removed or modified as a result of the action proposed is not likely to be significant;

- habitat is not likely to become fragmented or isolated from other areas of habitat as a result of the proposed action;
- the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of Threatened flora species in the locality is not likely to be significant, and
- the action proposed is not inconsistent with the objectives or actions of a recovery plan or threat abatement plan.

5.7.4 Weed Species

The risk of introduction of weeds and pests species to the site via the entry of vehicles and plant will be mitigated by the wash down of all vehicles, plant and ancillary equipment new to the region at the ESG maintenance yard in Narrabri. This will entail the complete removal of soils and organic matter from wheels, wheels arches, chassis and other sites capable of holding any material able to germinate or provide a means for the proliferation of any species of plant.

A weeds management plan is discussed in further detail in Appendix 1.

5.8 Fauna

The assessment of impacts on the native fauna posed by the installation of the GGS relies on the existing knowledge base on fauna impacts carried out to date. Survey reports from the following field surveys have been consulted and are considered sufficient to provide an understanding of the actual, likely and potential impacts associated with the proposed activity:

- ***Kendall, K. (2005).*** *Fauna Study PEL238 Coal Seam Gas Project - Bibblewindi Nine Spot, Kendall & Kendall Ecological Consultants, West Kempsey NSW*
- ***Kendall, K. (2006).*** *Fauna Study PEL238 Coal Seam Gas Project - Water Management Facility, Kendall & Kendall Ecological Consultants, West Kempsey NSW*
- ***Kendall, K. (2007).*** *Fauna Study PEL238 Narrabri Coal Seam Gas Project Flowline, Kendall & Kendall Ecological Consultants, West Kempsey NSW*
- ***Smith, A. 2002.*** *PEL238 Pilliga East Seismic Survey: Fauna Review, AUSTECO Environmental Consultants, Armidale, NSW*

5.8.1 Background Information

Records of threatened species, populations or communities as listed under the *Threatened Species Conservation Act 1995* (TSC Act) known to occur within 25 km of the study area were extracted from the New South Wales Wildlife Atlas database for the Baan Baa, Baradine, Narrabri and Wee Waa 1:100,000 map sheets. Under these search parameters, eight TSC Act threatened species recorded within 25 km of the study area on the DEC wildlife atlas; they include:

- Glossy Black-Cockatoo *Calyptorhynchus lathami*
- Barking Owl *Ninox connivens*
- Brown Treecreeper *Climacteris picumnus*
- Speckled Warbler *Pyrrholaemus sagittatus*
- Painted Honeyeater *Grantiella picta*
- Hooded Robin *Melanodryas cucullata*
- Koala *Phascolarctos cinereus*
- Black-striped Wallaby *Macropus dorsalis*
- Pilliga Mouse *Pseudomys pilligaensis*

TSC Act threatened fauna species not recorded within 25 km of the Study Area but known or predicted to occur in the Pilliga Outwash sub regions of the Namoi CMA and based on habitat requirements considered as possible or likely to occur on the study area

- Ninox connivens Barking Owl
- Hamirostra melanosternon Black-breasted Buzzard
- Melithreptus gularis gularis Black-chinned Honeyeater (eastern subspecies)
- Macropus dorsalis Black-striped Wallaby
- Burhinus grallarius Bush Stone-curlew
- Stagonopleura guttata Diamond Firetail
- Cercartetus nanus Eastern Pygmy-possum
- Anomalopus mackayi Five-clawed Worm-skink
- Pachycephala inornata Gilbert's Whistler
- Calyptorhynchus lathami Glossy Black-cockatoo
- Nyctophilus timoriensis Greater Long-eared Bat (south eastern form)
- Falco hypoleucos Grey Falcon
- Pomatostomus temporalis temporalis Grey-crowned Babbler (eastern subspecies)
- Melanodryas cucullata cucullata Hooded Robin (south-eastern form)
- Phascolarctos cinereus Koala
- Chalinolobus picatus Little Pied Bat
- Tyto novaehollandiae Masked Owl
- Grantiella picta Painted Honeyeater
- Hoplocephalus bitorquatus Pale-headed Snake
- Pseudomys pilligaensis Pilliga Mouse
- Aepyprymnus rufescens Rufous Bettong
- Dasyurus maculatus Spotted-tailed Quoll
- Lophoictinia isura Square-tailed Kite
- Petaurus norfolcensis Squirrel Glider
- Neophema pulchella Turquoise Parrot

EPBC Act significant species whose mapped habitat may occur within 25 km of the study area and have been subsequently assessed as possibly occurring within the study area

Birds

- Swift Parrot Lathamus discolor
- Superb Parrot Polytelis swainsonii
- Regent Honeyeater Xanthomyza phrygia
- White-throated Needletail Hirundapus caudacutus
- Rainbow Bee-eater Merops ornatus
- Regent Honeyeater Xanthomyza phrygia

Mammals

- Large Pied Bat Chalinolobus dwyeri
- Eastern Long-eared Bat Nyctophilus timoriensis
- Pilliga Mouse Pseudomys pilligaensis

Reptiles

- Five-clawed Worm-skink Anomalopus mackayi

5.8.2 Field Surveying and Assessment Reporting

Field surveys carried out to date in PAL2 have occurred on four separate occasions, the full results of which are contained within the aforementioned impact assessment reports. In summary, the impact assessments conducted to date conclude that:

- Critical habitat as listed in the Register of Critical Habitat kept by the Director General of Department of Environment and Conservation does not occur in the study area;
- No threatened ecological fauna communities or fauna populations listed on the schedules of the TSC Act occur in the study area;
- The cumulative study area is not potential habitat as defined in SEPP44 (Koala Habitat Protection);
- Many of the species identified during surveying are avian species with sufficiently large home ranges that, when combined with the extent of the regionally common *E. crebra* dry open forest habitat identified by Elks, is unlikely to result in any long term, significant impacts any species or community in the Pilliga East State Forests;
- Activities on this scale are such that habitat is not likely to become fragmented or isolated from other areas of habitat within the Pilliga Scrub;
- Sufficient mitigative action can be taken to limit the impact of the proposal on the hollow dependant species identified by Kendall;
- The proposed activity will not impact on habitat favoured by the Pilliga Mouse *Pseudomys pilligaensis* which includes recently burnt gullies, areas dominated by broombush and areas

containing an understorey of kurricabah (*Acacia burrowii*) with a bloodwood (*Corymbia trachyphloia*) overstory; and

- Habitat for the listed microbats is widespread and common in the study area, locality, and region.

5.8.3 Assessment of Significance

The assessment of significant effect on threatened species, populations or ecological communities or their habitats as per S5A (2) of the *Environmental Planning and Assessment Act 1979*, as applied to the Bibblewindi West gathering system project are such that

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,

Fauna surveys conducted across the project area suggest that no threatened species, populations, communities or critical habitat are at risk from the proposed activity. Given the limited impact of the activity, it is unlikely that this proposal will have any adverse effects on the life cycle of any threatened species such that a viable local population is likely to be placed at risk of extinction.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,

Flora and fauna surveys conducted across the project area have found no evidence of any threatened species, populations, communities or critical habitat or species/partial remnants that constitute a threatened, population, community or critical habitat. Given the limited impact of the activity, it is unlikely that this proposal will have any adverse effects on the life cycle of any threatened species such that a viable local population is likely to be placed at risk of extinction.

(c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,

As all endangered ecological communities are vegetation communities see section 5.5.2 (c) for consideration of this factor.

(d) In relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,

Approximately 40,000ha of area mapped as the vegetation class 'Pilliga Outwash Dry Sclerophyll Forest' and a further 20,000ha of the floristically similar 'Western Slopes Dry Sclerophyll Forest' occurs in the locality but the habitat has been modified by grazing, modified fire regimes, and forestry activities (Elks, 2006).

The area impacted by the proposed activity represents a very small percentage of the dominant vegetation community mapped within PAL2, and will impact on less than 0.003% of habitat of similar quality in the locality.

There is no discernible difference in ecological integrity between habitat to be affected and habitat to remain.

The small scale and spatial arrangement of the proposal is such that habitat is not likely to become fragmented or isolated from other areas of habitat.

The apparent absence of threatened flora species from the study area and the large areas of similar habitat in the region and locality suggest that the habitat to be removed is unlikely to be of importance for the long-term survival of the threatened species *Diuris tricolor*; *Goodenia macbarronii; Philotheca ericifolia; Rulingia procumbens* or *Tylophora linearis* in the locality.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),

Critical habitat as listed in the Register of Critical Habitat kept by the Director-General of DECC does not occur in the study area. The proposed activity is unlikely to have any adverse effect on critical habitat, either directly or indirectly.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,

Fauna surveys conducted across the project area have found no evidence of any threatened species, populations, communities or critical habitat in terms of the action being inconsistent with the objectives or actions of recovery and threat abatement plans.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

With respect to fauna, the removal of vegetation would not be likely significantly impact on the habitat of TSC Act threatened fauna species known to occur within the Study Area or considered as possible occurrences within the Study Area.

5.8.4 Conclusions

Based upon the assessment reports from the various fauna surveying and the available data from State and Commonwealth databases, the likelihood that the proposed activity will impact on a species of significance is negligible. Furthermore, the extent of removal, modification and fragmentation of vegetation associated with this activity is not considered significant.

Various strategies for the mitigation of threats to these species are discussed in the survey reports many of which are feasible for incorporation into the operational plans for the proposed GGS. They include:

- Finalising the GGS route that avoid any environmentally sensitive areas and habitat elements,
- Large (>40cm a.b.h.) living or standing dead trees should be left undisturbed unless no practical alternative exists

ESG is confident that the planned activity will not introduce any long term impacts on threatened species or the habitat favoured by them. All attempts to minimise the overall footprint of the activity have been made to date and will continue to be an integral part of the planning process.

5.8.5 Vegetation Offsets

The scope for an offsets program to account for the cumulative impacts of ESG's development activities in the Pilliga East has advanced considerably over the past 12 months.

The environmental assessment carried out for the Narrabri Gas Utilisation Project and the subsequent evaluation of the project by DECC has raised a requirement to initiate proceedings to achieve a stated offset against the cumulative impacts of the proposed gas flowline. Further to this requirement, ESG proposes to commit to an inclusive offsets program via negotiations with both DECC and the Namoi CMA that will account for the cumulative impacts (≈40-50ha) of all exploration activities carried out to date (2002-2008).

No further detail of this proposal are available at this stage, however planning documentation for the offsets program will be distributed amongst stakeholders upon completion of the construction and commissioning phases of the Narrabri CSG Utilisation Project.

5.9 Cultural Heritage

Throughout the development of the Narrabri CSG Project, the existing knowledge base on the extent of Aboriginal inhabitation across the region has steadily grown. Cultural heritage surveying has occurred prior to all exploration activities within the Pilliga East State Forest since Eastern Star commenced the active development of the Narrabri CSG Project in 2004.

Eastern Star Gas has on all occasions the Pilliga Forest Aboriginal Management Committee (PFAMC) to assist in the conduct of Aboriginal heritage investigations across the PAL2. The objectives of the surveys are to quantify the likely impacts an activity will have on known and previously undiscovered heritage places.

The existing archaeological record for the region consists of various sources of cultural heritage information including the NPWS AHIMS database, the Forestry NSW/PFAMC site register and a number of published reports on the Aboriginal inhabitation of the Pilliga Forests. These sources corroborate on the understanding that Pilliga Forests were frequently utilised by Aboriginal communities for a range of uses and that a number of significant sites have been identified during subsequent survey efforts.

To date, the project specific survey efforts have located one site of Aboriginal heritage significance in the Pilliga East State Forest; a possible scarred tree was located during surveying for Narrabri CSG Utilisation Project linking the Bibblewindi and Bohena CSG pilot to the Wilga Park Power Station. No other places or items of significance have been identified during the survey efforts.

The low number of sites identified during this survey is generally thought to be related to a range of environmental factors, primarily:

- a lack of permanent or semi-permanent water around which places (e.g. campsites) of cultural significance may have been based;
- the lack of landforms such as rocky outcrop or exposed rocks that would have provided shelter and a potential materials resources;
- the lack of sufficiently mature old growth trees from which definite or possible scars could be located; and
- the frequency of bushfire across much of the Project Site and there impact on indigenous vegetation.

Assessing the proposed activity for likely and actual impacts on Aboriginal heritage, sufficient evidence on the distribution and frequency of sites across PAL2 exists that indicates that the proposal carries no potential for direct impacts on the cultural heritage values of the project area or the wider Pilliga State Forests System.

A search of the DEC (NPWS) AHIMS database indicates that no sites of cultural heritage significance are located within the vicinity of the proposed sites.

A search of the Pilliga Forest Aboriginal Management Committee/Forestry NSW Aboriginal Site Register indicates that no sites of significance are likely to be impacted by the proposed activities.

To further reduce the risks of impact on the Aboriginal heritage values of the region, ESG will undertake site specific surveys of the proposed GGS route with the assistance of the PFAMC heritage advisors.

Based upon the information collated from previous heritage assessments and field surveying efforts, the following recommendations have been made by the PFAMC to account for any residual risks:

- The PFAMC are consulted when any changes are made to the proposed locations or where the project scope is altered in any significant way;
- Where changes are made to the project plans in regard to the proposed disturbance zones, further field based surveying is carried out; and
- If any potential places, sites or items of cultural significance are identified, all activities are to cease until such time as the appropriate representatives of the PFAMC have assessed the site and adequate site management plans have been devised.

5.10 Waste Disposal

Waste materials generated during the construction period will include (but are not limited to:

- Construction materials waste such as timber, plastic and small amounts of metals.
- General domestic refuse; and
- Wastes such as engine lubricants and coolant fluids.

In accordance with good field practice, work crews will be required to contain waste materials within rubbish cages located at regular points along the active construction zone. Wherever possible, waste materials will be collected for recycling and/or reuse or otherwise be transported for disposal at the Narrabri Waste Depot.

5.11 Visual Amenity

The proposal requires the creation of a corridor of approximately 12m in width and the longer term maintenance of a 3m wide corridor linking the Bibblewindi West Lateral Pilot and the Bibblewindi water/gas management facility. In terms of visual impact, this will require the modification of vegetation within the corridor for the entire length of the GGS.

The retention of approximately 3m corridor in a mostly vegetation free state is required for the operational life of the GGS. This cleared area will provide ongoing access for maintenance in addition to reducing the potential impact of vegetation growth and bushfire in the close vicinity of the buried pipes.

Given the relative isolation of the project site the visual impact of the proposed activity is not considered significant and will not be the subject of a specific mitigation strategy.

The marking of the GGS with adequate locational and safety signage is a key requirement that cannot be avoided. AS2885 is the overarching standard that applies to the operation of flow lines operating in excess of 1050kPa. However, the erection of signs indicating the location of the low pressure GGS will mitigate any residual risk of interference by forestry operations or the like. ESG will install and maintain signage at regular intervals the route such that a sign is visible at any given point. Additional signage will be installed at points where the GGS crosses existing roads and tracks.

6 Cumulative Impact Assessment

This review has identified and assessed the relevant environmental impacts associated with the proposed implementation and operation of gathering system linking the Bibblewindi West Lateral Pilot with the existing water and gas management facility at Bibblewindi. ESG remains confident that the project will not create any long term, detrimental environmental impacts likely to measurably alter the localised or regional environment.

In preparing this review, the existing knowledge base on the PAL 2 environment has been consulted to accurately characterise the biophysical environment around the project site and the potential and likely impacts of the proposal. In consultation with stakeholders and external contractors, significant efforts to reduce the cumulative impact of all project components have been made and safeguards, controls and mitigation measures incorporated where at all possible.

6.1 Biophysical Considerations

6.2 Flora and Fauna

The temporary modification of native vegetation/habitat has been reduced to the smallest area possible in light of the project design and construction specifications. No threatened species or communities listed as such under State and Commonwealth legislative instruments have been identified as likely to be impacted by the Project.

The project as described will require the modification of a maximum 4.8 ha of native vegetation although significant reductions in this area will be achieved by utilising existing roads & access tracks as part of the construction/working area. This strategy has the potential to reduce the impacts of native vegetation by 30%.

To date, the total area of operational lands within PAL2 approximates 50ha and less than 0.002% of the 26 500 ha of lands under the PAL2 title. The addition of up to 4.8 ha to accommodate the GGS will not result in a significant increase in this figure nor the likelihood of longer term impacts on the biotic environment as discussed in sections 5.7 and 5.8.

Further cumulative reductions in the impact of the ongoing exploration activities will be achieved through the creation of or participation in a suitable green offsets program. Details of the program will be forwarded to all Government stakeholders upon the completion of discussions with the Namoi CMA and DECC for the Part 3A project.

6.3 Aboriginal Heritage

The GGS project will not impact on any known places or items of Aboriginal heritage significance. The conduct of further heritage clearance of the site will furthermore reduce the risk of impacts on previously undiscovered places and items of significance.

6.4 Noise Impacts

Whilst the installation of the GGS will generate localised noise in excess of current background levels, the activities are not dissimilar to normal forestry operations in terms of noise impacts. Furthermore, the remote location and short construction time frames are unlikely to result in any specific noise related impacts that require mitigative action.

6.5 Socio-economic Considerations

The impact of the Project on the local and regional socio-economic environment has been determined as positive, with measurable increases in direct and indirect employment opportunities and the utilisation of the region's extensive network of retail and industrial service providers.

6.6 Greenhouse Gas Impacts

The operation of the CSG lateral pilot and the methane generated as a by product presents an ongoing concern in terms of its environmental impact as a greenhouse gas. ESG, in preparation for the submission of a major project application to Planning NSW, commissioned Heggies Pty Ltd to conduct a greenhouse gas assessment of the Bibblewindi and Bohena CSG Pilots and the relative benefits of gas capture and consumption at the Wilga Park Powerstation in preference to atmospheric venting and/or flaring.

The operation of the CSG project and currently includes 12 production wells across the Bibblewindi and Bohena CSG pilots, impacts considerably on the environment in terms of greenhouse gases. Heggies (2007) conducted a comprehensive review of the potential impacts of the current situation should no action be taken to consume methane being vented to atmosphere from the Bibblewindi and Bohena CSG Pilots. CSG gas vented directly to the atmosphere has a greater global warming potential than combusted CSG due to the high (≈88%) methane content of the gas, coupled with the GWP of methane (21 times the GWP of CO_2). Calculations of greenhouse gases from venting, in terms of CO_2^{-e} were calculated by Heggies from modeled throughput values and compared with State and National totals

Comparison Emissions Figures on the Project, Venting Option, State and National Figures

Source	Emissions (t CO_2-e)	% of National
Project	204 193 (predicted)	0.0365%
Atmospheric venting option	1 431 624 (predicted)	0.256%
NSW annual total	158 200 000	28.29%
National annual total	559 100 000	

Table 5 Comparison emission figures from the gas utilisation project (Heggies 2007)

The comparison of predicted emissions with the 2005 State and National emissions figures suggests that that the proposed combustion of the produced CSG at the Wilga Park Power Station would represent an increase of approximately 0.0365% the total baseline Australian emissions for 2005 or 0.265% from the venting of the CSG to atmosphere. A comparison of the two options demonstrates that equivalent emissions would be in the order of 7.2 times greater if the gas was vented to atmosphere preferentially over its collecting and combustion at the Wilga Park Power Station.

The conclusions of this report and the findings of ESG as the proponent of the major project that would gather and transport all gas produced at the CSG pilots suggest that considerable environmental and economic benefits can be gained from the proposal. Similarly, it is ESG's intention, as described in the current water and operations management plan, to collect all gas produced at the lateral pilot for consumption *in situ* (surface and subsurface equipment) or transportation via the gathering system back to Bibblewindi and into the main flowline to Wilga Park. Therefore in terms of the potential greenhouse impacts of the gases produced at the lateral pilot, it is planned to capture and consume as close to 100% of production as practicable for the life of the project.

6.7 Conclusions

The project presents a feasible option for the collection and transportation of gas and water produced at the Bibblewindi West lateral pilot. The Project has been designed to address the key issues likely to be raised at all levels of Government, landholders affected by the Project and the wider community.

The Project provides a pathway for the management of produced gases and water during the extended testing of CSG wells and consumption in electricity generation in preference to the venting of gases to atmosphere. In addition to the environmental benefits offered by the Project, the construction and operation of the project will continue to result in a significant economic boost to the Narrabri Region.

7 Water Treatment Plant

7.1 Water Treatment

The revised water treatment process implemented as part of this project expansion will be different to that currently in operation. **Figure 14** outlines in general terms the flow of water through the treatment system.

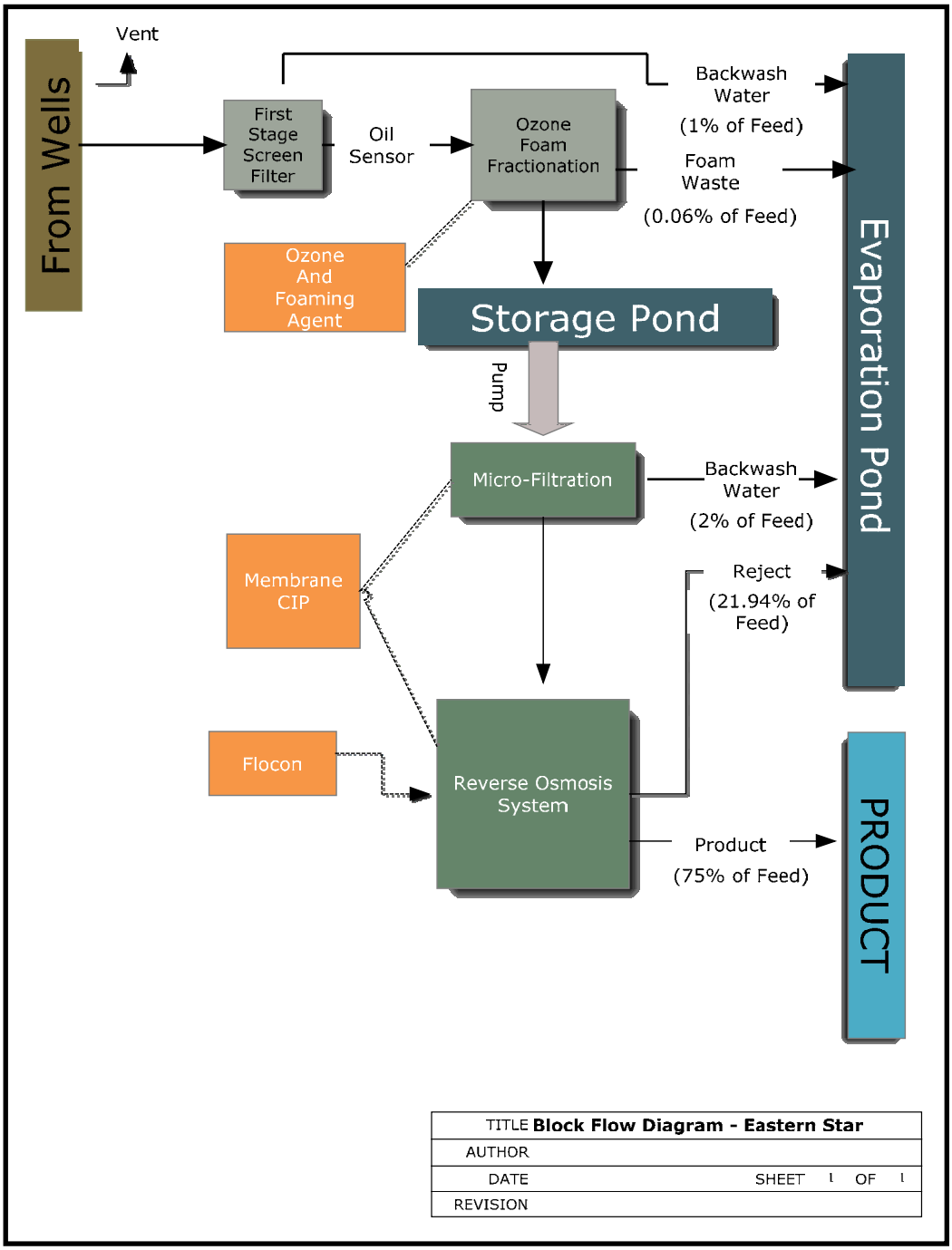

Figure 16 Flow diagram for the expanded water treatment facility

7.2 Permeate water quality

The rates of recovery from the expanded treatment plant are expected to range between 70 and 90% when running at full capacity. As the expanded plant has a maximum capacity of 1ML, this will result in daily permeate volumes of between 700 and 900 kL.

Estimated permeate qualities of less than 250mg/L TDS are expected however higher qualities are currently being achieved from the pilot plant. The most recent analysis of permeates indicates permeate water quality of around 150mg/L.

7.3 Concentrate water quality

The quality of concentrates discharged from the treatment units has been estimated by the manufacturer and is expected to approximate 42 154mg/l TDS.

7.4 Water Transport

Permeates discharged from the treatment unit will be collected and placed into the smaller of the two lined evaporation structures at Bibblewindi-1.

The water in this impoundment will then be pumped from site via surface flowline to the discharge point on Bohena Creek although various other reuse options will also utilise this supply (drilling, roads maintenance, fire fighting). The flowline will be laid in a location that makes efficient use of the approximately 20m of topographic relief between Bibblewindi and Bohena Creek. No excavation, dredging or other type of ground disturbance will be necessary for the placement of this transfer flowline.

7.5 Water Discharge

Permeates discharged from the treatment unit will flow along the transfer flowline and be discharged at the outlet manifold located on the sand bed of Bohena Creek. It is proposed that a device to minimise the velocity of discharge waters is employed to mitigate any potential for direct impacts caused by the flow of water from the transfer flowline.

The water will be allowed to flow under gravity from the outlet manifold and into the permeable sand beds of Bohena Creek as permitted under the current approval,

7.6 Concentrate Management

The concentrates discharged from the treatment unit will flow directly into the lined water management facility adjacent to Bibblewindi-1.

This is facility will contain a mixture of periodic inflows of raw formation waters, concentrates from the treatment plant and incidental rain fall inflows.

Currently there is no specific long term concentrate management plan, however various potential options to manage concentrates are being considere.

7.7 Reuse Options

The reuse of permeates obtained from the treatment unit will remain the preferred objective of this strategy.

There remains a need for water of suitable quality in the immediate area; roads maintenance and improvement, dust suppression, well maintenance and other minor operational requirements will consume a proportion of the permeates produced and stored in the existing impoundments.

ESG has discussed the provision of water to Forestry NSW for various purposes including road maintenance and fire fighting. No longer term, beneficial reuse options are currently available, generally due to the isolated location of the project components and the lack of infrastructure to transport water to any given reuse destination.

8 GGS Hazard and Risk Assessment

A desktop based hazard screening was conducted to assess the potential for any significant hazard or risk impacts associated with operating a buried gathering system. Further hazard and risk assessment is carried out during design and engineering stages (per AS4130/2885) however this internal assessment takes into account the potential land use conflicts associated with the project.

8.1 Description

The proposed GGS infrastructure linking the Bibblewindi West lateral pilot to the Bibblewindi water and gas management facilities will comprise two buried, 12 inch diameter low pressure HDPE pipes for the conveyance of gas and water.

The system will be buried for their entire length with a cover not less than **750mm** and will be located within a disturbance corridor typically 12m wide, then reduced to 3m in width after construction has been completed.

8.2 Construction Activities

The construction activities required to install the GGS will be confined to the disturbance corridor and roads installed to access the Bibblewindi West lateral pilot wells. Access to the construction zone will be via existing forestry tracks frequently traversing the disturbance corridor.

The construction activity will comprise the following key steps:

- Each section of the GGS will be pegged and field verified by certified surveyor;
- A representative of the PFAMC will inspect the GGS corridor for places or items of Aboriginal heritage significance;
- Forests NSW will inspect the corridor and assess harvestable forestry products for felling and removal;
- All remaining vegetation is to be mulched *in situ* and graded from the immediate working area for replacement across the corridor during site rehabilitation;
- The flowline trench will be excavated and water and gas lines placed installed to a minimum depth 750mm along the surveyed corridor;
- The trench is backfilled, magnetic marker tape installed and the working area rehabilitated
- Safety signage installed; and
- The mulch stockpile will be respread across the corridor

8.3 Hazard Screening

The screening of potential hazards associated with the activity is designed to determine whether further Preliminary Hazard Assessment is required. The screening of hazards is carried out using a method consistent with Australian Standard for gas and water flowlines including AS4130 (HDPE Piping) and 2885.1-1997 (Gas and Liquid Petroleum) and involves:

- Identification of general and location specific threats to the integrity of the proposed GGS; and
- Assessment of these threats through a general risk management process involving likelihood of occurrence and the consequences of such occurrences.

The consequences associated with each threat were considered from public, employee, environmental and economic perspectives and take into account the mitigation strategies incorporated into project design, construction and operations planning.

8.4 Overview of Flowline Route

The 4 km GGS will be located within a cleared corridor of approximately 3m in width (post construction) and traverse lands zoned Crown Lands State Forest. The occupation of this land will be administered under an occupation permit (pending) issued under S31 of the *Forestry Act 1916*.

8.5 Risk Mitigation Measures

The following measures have been incorporated into the project design as part of the risk mitigation strategy.

- The GGS will be buried for its entire length ensuring a minimum cover of **750mm** or greater where land use and infrastructure requirements (e.g. road crossings) dictate. AS 2885 will be applied in determining the appropriate depth of burial.
- The erection of clear signage along the flowline route as per AS 2885.
- The installation of magnetic marker tape for post rehabilitation flowline locating.

8.6 Frequency of Occurrence

The predicted frequency of each identified threat has been assessed according to the descriptions presented in the **Table 6**.

Frequency	Description
Frequent	Expected to occur typically once per year or more
Occasional	Expected to occur several times in the life of a flowline
Unlikely	Not likely to occur within the life of a flowline, but possible
Remote	Very unlikely to occur within the life of the flowline
Improbable	Have been known to occur, but not anticipated
Hypothetical	Theoretically possible, but not known to have occurred

Table 6 Frequency Categories for Hazard Screening

8.7 Consequences

The possible consequences of each identified threat, should it occur, have been assessed taking into account the potential for:

- Human injury or fatality;
- Environmental damage; and

- Economic impact resulting from loss of gas supply.

The severity of each identified threat has then been estimated according to categories set out in **Table 7**.

Severity	Description
Catastrophic	Only applicable where fatalities would result
Major	Loss of supply, major environmental damage
Severe	Injuries, supply restriction, minor environmental damage
Minor	No injuries or supply problems

Table 7 Severity Categories for Hazard Screening

8.8 Risk Ranking

According to estimated frequencies of occurrence and consequences, the risk ranking of each identified threat has been determined and is included in **Table 8**. Risk rankings have been formulated on the basis of the basis of the following risk matrix.

Frequency	Risk Rankings (Severity Class)			
	Catastrophic	Major	Severe	Minor
Frequent	High	High	High	Intermediate
Occasional	High	High	Intermediate	Low
Unlikely	High	High	Low	Low
Remote	High	Intermediate	Low	Low
Improbable	High	Intermediate	Low	Low
Hypothetical	Intermediate	Low	Negligible	Low

Table 8 Risk rankings for hazard screening

8.9 General and Specific Threats

The key threats to the structural and operational integrity of the proposed GGS are discussed and assigned a risk ranking.

8.9.1 Third party interference

Whether accidental or intentional, interference with the buried flow lines is a key threat. Examples of inference include construction activities (fences, dwellings), service or infrastructure development (water, telephone, electricity and roads maintenance) and forestry activities that may disturb the soils such that the GGS is unearthed.

Frequency: Unlikely to occur given the land use type, registration with Forestry NSW via occupation permit and high visibility safety signage installed

Consequence: Severe

Risk Ranking: Low

8.9.2 Failure of flowline

The materials utilised in the flowline manufacture and construction processes comply with the relevant codes and standards for gaseous and liquid petroleum transmission including the following:

- Materials and components comply with API 15 LR.
- Flowline shall be manufactured to comply with ASTM D2996.
- Flowline designed in accordance with ISO 14692 Part 3.

Frequency: Remote

Consequence: Severe

Risk Ranking: Low

8.9.3 Over pressure of flowline

The potential for transmission pipes to become over pressured leading to rupture and gas leaks is negligible. The flow lines will operate at low to very pressures and inlet control systems (installed where gas enters the flowlines) will incorporate duplicate (active and standby) overpressure control systems.

Frequency: Improbable

Consequence: Minor

Risk Ranking: Low

8.9.4 Escape of flammable contents

The risk of spontaneous explosions or an ignition of leaking gas is dependant upon three main factors which include a source of gas (i.e. leak, failure or third party interference), the introduction of oxygen in critical quantities and the presence of a source of ignition itself. When considered with quickly dispersive physical properties of methane, the risk of explosion is very small if not negligible.

Frequency: Remote

Consequence: Severe

Risk Ranking: Low

8.9.5 Road crossings

The flowlines will intersect low traffic forestry tracks and public roads.

The GGS will be installed across access tracks and public roads by open-trenching and occur as per published RTA guidelines and Forestry approved management plans for partial road closures. The crossing design will be engineered to avoid road subsidence and pipe stress.

The key threat to the installed flowline at or near road crossings will be exposure of the pipe to accidental interference. In these terms, the stated requirements for the construction of a flowline across a shire road is that the depth to the top of the flowline must be a minimum for 1.5m below the existing table drain.

Frequency: Improbable
Consequence: Minor
Risk Ranking: Low

8.9.6 Creek crossing

The proposed gas flowline will intersect a small, unnamed creek at two locations. As the creek is ephemeral in nature and subsurface water flow is quite minimal, the crossing will be constructed using either a plough in or open cut technique. The flow lines will be installed at reasonable depth to ensure the pipe is bedded into firm substrate and additionally anchored with pre-cast concrete ballast.

Frequency: Improbable
Consequence: Minor
Risk Ranking: Low

8.10 GGS Hazard Conclusions

For each of the general and specific threats, Industry standard practices are available for mitigation of hazards associated with the proposed gas flowline system.

Sufficient design and operational safeguards have been incorporated into the Project to account for potential risks.

Risks arising from development and operation of the Project have been assessed as low and in these terms it is not necessary to undertake a Preliminary Hazard Assessment.

9 Conclusions

This REF addresses the actual and likely impacts associated with the installation of a water and gas gathering system linking the four production wells at Bibblewindi West back to the water management facility at Bibblewindi. This document compliments the current water and operations management plan governing the operation of all production assets across PAL2, namely the Bibblewindi Nine Spot (12

wells), the Bohena CSG Pilot (three wells) and the Bibblewindi lateral pilot (six wells). All water and gas produced from the three pilots is gathered for storage in lined evaporation ponds or is treated and reused.

The completion of flora, fauna and cultural heritage surveys suggests that the proposed activities for can be completed without any long term impacts on species or communities of significance and items of Aboriginal heritage. ESG is confident that:

- No ongoing land use or locally/regionally significant infrastructure such as roads will be significantly impacted by the activity;
- A sufficient buffer zone (distance and physical barriers) exist between the drilling locations and the nearest inhabitation; and
- The bulk of the activity will occur over a relatively short time frame limiting any further impacts associated with noise, visual amenity and any other incidental impacts.

The completion of a pilot water treatment project at Bibblewindi suggests that the reverse osmosis treatment process is capable of providing the project with significant reductions in saline water storage requirements. With rates of recovery having exceeded 70% over the pilot period and water quality below 250mg/l, permeates discharged from the treatment plant are able to be reused or disposed of through all available means.

The proposed disposal of up to 1ML of water per day into Bohena Creek is unlikely to create any long term detrimental effects on surface and groundwater systems associated with the creek system and accordingly unlikely to result in impacts contrary to the water quality and river flow guidelines in effect for the Namoi River catchment as defined by ANZECC and ARMCANZ.

The proposed activity will not result in any significant, long term impacts on the biophysical environment including flora, terrestrial and aquatic flora or sites of cultural heritage significance.

The provision of this document fulfills the company's responsibility under Part 5, Section 111 of the *Environmental Planning and Assessment Act 1979* in which the determining authority (NSW Department of Primary Industries – Mineral Resources) is required to consider the likely and actual environmental impacts of the activity.

10 References and Bibliography

Binns, D & Beckers, D,. 2001. Floristic Patterns of the Pilliga in

Dargavel, J., Hart, D & Libbis, Brenda (Eds), 2001. Perfumed Pineries: Environmental History of Australia's Callitris Forests

Centre for Resource and Environmental Studies, Australian National University, Canberra

Clements, A & Moore, R. 2002. Review of Existing Flora Data: PEL238 Pilliga East Seismic Survey
Anne Clements & Associates Pty Ltd, North Sydney, NSW

Smith, A. 2002. PEL238 Pilliga East Seismic Survey: Fauna Review
AUSTECO Environmental Consultants, Armidale, NSW

Lindsay, A.D, (1974) Forest Types of the NSW Cypress Zone
Technical Paper 8, Forestry Commission of New South Wales

Corkery, R.W & Company (2004). Petroleum Production Environmental Operations Plan: Coonarah Gas Project
R.W Corkery & Company Pty Ltd, Orange, NSW

Elks, G.N. (2005). PEL238 Coal Seam Gas Flora Survey – Bibblewindi Nine Spot
Idyll Spaces Environmental Consultants, Bonville NSW

Elks, G.N. (2006). PEL238 Coal Seam Gas Flora Survey – Water Management Facility
Idyll Spaces Environmental Consultants, Bonville NSW

Kendall, K. (2005) Fauna Study PEL238 Coal Seam Gas Project - Bibblewindi Nine Spot
Kendall & Kendall Ecological Consultants, West Kempsey NSW

Kendall, K. (2006) Fauna Study PEL238 Coal Seam Gas Project - Water Management Facility
Kendall & Kendall Ecological Consultants, West Kempsey NSW

RACD (2000) Aboriginal Cultural Heritage Assessment. Brigalow Belt South Bioregion Stage 1. NSW Western Regional Assessments (WRA14), Resource and Conservation Assessment Council, NSW State Government

Trindall, E. (2005) Aboriginal Heritage Investigations For Review of Environmental Factors (REF)"Bibblewindi Nine Spot Project"
Trindall Cultural Advisory Services, Narrabri NSW

Trindall, E. (2006) Aboriginal Heritage Investigations For Review of Environmental Factors (REF)"Bibblewindi Nine Spot Project" Water Management Facility
Trindall Cultural Advisory Services, Narrabri NSW

11 Appendix 1 - Environmental Management Plans

Access EMP

The nature and frequency of access to the flowline disturbance corridor will vary considerably according to the two main land use types encountered, the specific flowline disturbance corridor rehabilitation objectives and the extent of proposed maintenance.

Management Measures
• Access to the flowline disturbance corridor during construction and operation should be limited to essential traffic and personnel to the greatest extent. The disturbance corridor is not to be used as general thoroughfare. • Access to the working and staging areas should utilise existing roads, tracks and access as far as practicable to ensure minimal disturbance of flowline disturbance corridor. Sufficient existing access is available throughout the Bibblewindi and Pilliga East State Forests. • Public access to the flowline disturbance corridor during construction and operation should not be permitted unless the access already exists. • The safeguards, controls and mitigation measures discussed in the flora and soils impact assessment reports shall be strictly adhered to, most specifically: 1. The clearance envelope is to be marked before commencement of clearing, and movement of plant, machinery or materials beyond the clearance boundary is to be rigorously avoided; 2. the period when the trench is open should be limited to minimise the potential for soil erosion; and 3. excessive driving of vehicles on the area adjacent to the trench should be avoided to preserve soil structure • The safeguards, controls and mitigation measures discussed in the weed management plan shall be strictly observed at all times; • Speed limits shall be strictly observed by all contractors and their employees • Vehicular parking shall be limited to designated staging areas

Soils and Land Capability EMP

Management Measures
• The safeguards, controls and mitigation measures discussed in the soils impact assessment reports within the Part 3A project Statement of Commitments shall be strictly adhered to, most specifically: 1. The clearance envelope is to be marked before commencement of clearing, and movement of plant, machinery or materials beyond the clearance boundary is to be rigorously avoided; 2. The period when the trench is open should be limited to minimise the potential for soil erosion; and 3. Excessive driving of vehicles on the area adjacent to the trench should be avoided to preserve soil structure 4. No stockpiling of soils should be undertaken. Instead, the soil materials from topsoil stripping should be windrowed on one side of the excavated trench and the excavated subsoil material on the other side. The period when the trench is open should be limited to minimise the potential for soil erosion 5. Profile inversion should be avoided completely as the subsoil dispersibility will cause major erosion problems should subsoil material be placed on the surface of the rehabilitated trench line; 6. Soils shall not be worked if excessively moist in order to avoid structural degradation. 7. Topsoil should only be removed from the immediate vicinity of the trench where subsoil excavation is to occur. • The rehabilitation of the disturbance corridor within the State Forests is to occur as soon as practicable post construction. The re-instatement of the subsoil and topsoil profiles is to immediately precede the replacement of vegetation or 'brush' retained from the clearing activity.

Vegetation and Weed Management EMP

Management Measures
• The clearance of vegetation along the disturbance corridor should be minimised as far as practicable • The retention of non-harvestable vegetation ('brush') shall be maximised to permit the rehabilitation of the disturbance corridor as described in the flora impact assessment report • The movement of plant, machinery or materials beyond the disturbance corridor boundary is to be rigorously avoided; • Habitat trees or those with significant natural, heritage or amenity value may be retained on or adjacent to

the disturbance corridor. An assessment of these trees will be made on a case by case basis in consultation with Forestry NSW and the safety guidelines for operations within Forestry Lands

- Clearing shall aim to maximise the retention of understorey and groundcover root stock within the disturbance corridor
- Slashing of understorey and groundcover shall be preferred to the use of bull dozers or graders as means to retain root stock material on areas away from the trenching zone
- The regrowth of trees within 3m and shrubs within 1.5m of the trench centreline shall be removed at seedling or sapling stage so as to mitigate the risk of damage to the flowline
- Key features of the weed management plan include:
    1. Plant and vehicle hygiene standards are to be maintained throughout the construction period to minimise the risk of weed and pathogen transfer.
    2. Plant and vehicle wash down to occur at ESG maintenance depot on arrival in region or, for local contractors, prior to commencement of works. Wash down will focus on the removal of all soils, mud and vegetative matter.
    3. Plant and vehicle wash down to occur after exit from Forest and prior to entry onto pasture/cropping lands in a specified wash down bay with appropriate seed, vegetative material and sediment collection devices.
    4. Soils disturbed during stripping/stockpiling and trench spoil must remain at the point source as far as practicable. Any materials imported to the disturbance corridor must be from landholder approved sources.
    5. As per the rehabilitation and monitoring plan, weed monitoring and control of weeds will occur during the construction period and on a quarterly basis or as specified in individual land holder access agreements.

Dust Management EMP

Management Measures
• Access to the flowline disturbance corridor during construction and operation should be limited to essential traffic and personnel to the greatest extent. The disturbance corridor is not to be used as general thoroughfare. • Access to the working and staging areas should utilise existing roads, tracks and access as far as practicable to ensure minimal disturbance of flowline disturbance corridor. Sufficient existing access is available throughout State Forests and Agricultural lands • Slashing of understorey and groundcover shall be preferred to the use of bull dozers or graders as means to retain root stock material on areas away from the trenching zone • Vehicle speed limit restrictions on all unsealed roads and access tracks must be observed to minimise fugitive dust generation • Existing unsealed road surfaces will be subject to dust control up to twice daily depending on projected vehicular movements and weather conditions. The deployment of a water cart to suppress dusts will be at the discretion of the site foreman and Eastern Star's field representative • Any physical construction activities such as vegetation clearance, topsoils/subsoil stripping or trenching shall cease during periods of high winds and high temperatures • The suppression of dusts generated along the disturbance corridor during construction is to occur as per recommended soils management guidelines taking specific notice that all soils will be subject to structural degradation if worked when too moist. • Topsoils and subsoils stockpiled in windrows should be replaced as soon as practicable; the time the trench is open should be limited to minimise the potential for soil erosion • Where the trench is required to be open for longer periods, suitable physical protection of windrows should be afforded to limit the potential for dust generation caused by high winds

Waste Management EMP

Management Measures
• In accordance with good field practice, work crews will be required to contain waste materials within rubbish cages or recycling stockpiles located at each staging area along the disturbance corridor • Where possible, materials capable of being recycled and/or reused will be stockpiled and transported to the recycling centre at the Narrabri Waste Depot • General domestic refuse will be collected regularly from rubbish cages located at staging areas and collected for disposal at the Narrabri Waste Depot

- Material wastes such as engine lubricants and coolant fluids will be stored and disposed of according to manufacturers and government guidelines.
- Portable ablution/portaloo units will be placed at the staging areas for the duration of the construction period and serviced regularly by local service providers

Erosion and Sediment Control EMP

Management Measures
• The main objectives of the erosion and sediment control plan is to minimise to the greatest extent the incidental mobilisation and hence loss of soil resources by wind and water; • Topsoils from SMU1 are to be rapidly protected by mulches or retained vegetation at the completion of construction activities; • Strict limitations on the timeframes that subsoils through all SMU's are exposed on the surface; • No long term stockpiling of soils is to occur; • Limiting the time the trench is open; • Ensuring that profile inversion is avoided; • Excessive driving of vehicles on the area adjacent to the trench should be avoided • The separate retention of topsoil and subsoil stockpiles on opposite sides of the cleared corridor is designed to retain of a majority of potentially sediment laden water within the cleared corridor where it can infiltrate naturally; • The installation of sediment controls including straw bales, silt top fencing and protective surface mulches will occur where minor changes of slope occur and where a need to do so is identified by the site supervisor; • The rehabilitation of the disturbance corridor within the State Forests is to occur as soon as practicable post construction. The re-instatement of the subsoil and topsoil profiles is to immediately precede the replacement of vegetation or 'brush' retained from the clearing activity.

Fauna Management (Open Trench) EMP

Management Measures
The excavation and retention of an open trench presents some risk to the native fauna which inhabit the operational environment. The objective of the fauna management (open trench) EMP is to mitigate the risks that the open trench poses to the normal movements of fauna across and around the working zone where the trench remains open during the overnight period. The following actions will be taken to achieve this objective • The operational zone and hence length of open trench shall be minimised to the smallest length possible; • The period over which any part of the trench remains open should be limited to the smallest timeframe practicable; • Fauna ramps will be placed in the trench (max 250m intervals) at the completion of each day shift where the trench will remain open overnight; • At the commencement of each days shift, a visual inspection of the open trench by qualified person/s will occur to locate any fauna that has fallen into the trench and assist in its relocation off the working area; • Where the trench will remain open for extended periods throughout the day time, additional inspections will be scheduled and fauna refuge devices placed within the open trench to provide shelter.

Monitoring EMP

Management Measures
• The main objectives of the monitoring program are to maintain the standards of environmental management incorporated into the project construction and operations plans for the life of the project • The structured monitoring of the disturbance corridor will ensure that the objectives of the vegetation/weed management, soils/land capability and access management plans are met and that the rehabilitation of the disturbance corridor is completed/maintained to an adequate standard

- Monitoring of the disturbance corridor will occur on a weekly schedule from the completion of the construction phase for a period of 3 months, and then monthly until the rehabilitation has been signed off be each landholder
- The disturbance corridor will be visually inspected once per week for evidence of:
  1. Unauthorised access to the disturbance corridor;
  2. Soils instability, trench zone slumping and incidental erosion of topsoils whilst groundcover vegetation is reinstated;
  3. Post rehabilitation weed emergence

  As a result of scheduled monitoring, the remediation of specific issues is to occur as soon as practicable. No action is to be taken without the direct consent of each landholder affected, specifically where any action will impact on current farming activities or where the application of herbicides is required.

12 Appendix 2 – Austerberry Environmental Policy

Environmental Policy

Protection of the environment is of primary importance to Austerberry Directional Drilling Services. Our organisation is committed to the development, implementation and continual improvement of environmental best practice across all operational activities.

The expectations of the community, our cliental and the requirements of relevant legislation will be addressed during the delivery of all Company services. All personnel are expected to fully engage in this process and are actively encouraged in developing a genuine respect for the environment and its protection.

Austerberry Directional Drilling Services' commitment will be evidenced by the development & implementation of appropriate environmental management plans, provision of suitable personnel & resources and ongoing consultation with all stakeholders to address environmental concerns and sensitivities.

Shayne Austerberry

Director,

Austerberry Directional Drilling Services.

November 2008

Enviromental Policy.DOC

13 Appendix 3 - Austerberry Creek Crossing Work Method statement

AUSTERBERRY
DIRECTIONAL DRILLING SERVICES

Methodology

Trenchless Creek Crossing Narrabri:

- A tool box meeting will be held on site to insure that all personnel are aware of all the procedures and to insure that all safety and environmental measures are met.
- JSA are filled out and signed by all personnel on site.
- The directional drill rig will be set up on the Eastern side of the creek with the mud mixing system and the recycling plant.
- Before any works can begin all services will be located and the sonde will be placed in the drill head and calibrated.
- An entry and exit hole will be needed as this will be used to contain the drill slurry
- This slurry will either be recycled or removed and disposed of.
- Only a small drill crew will be required. A drill operator, mud mixer/vacuum operator and a tracking equipment operator.
- The tracking operator electronically tracks the progress of the drill head beneath the creek using a hand held tracker.
- He then gathers data from the sonde located in the drill head just behind the drill bit. The sonde gathers data such as location, depth, roll angle, pitch/grade, and temperature to help the driller adjust the direction of the bit and control the bore path.
- During this process a return line will be laid on the surface. This will help us to recycle the drill cuttings.
- The operator must also estimate the load applied to the pipe during pullback and select an appropriate pipe for the project. This also has been predetermined (400mm Polyethylene pipe)
- As he drills the bore path, a bentonite mix is injected into the hole to stabilize the hole, remove cuttings, reduce torque, lubricate the pipe, and cool the bit.
- This fluid will be recycled as much as possible all excess will be removed by the Vacuum tanker and sent away to be disposed of.
- When the pilot hole has been bored and the bit emerges in the exit pit, the drill bit is removed. A reamer is placed on the end of the Drill string and pulled back to enlarge the borehole.
- It is soil dependent whether or not to pre-cut the bore hole. The reamed hole slightly larger than the bore pipe.
- The lengths of polyethylene pipe will be placed in the Western side of creek behind the exit hole where they will be fused together and then De beaded.
- This pipe is heated and the molecules are transformed into a crystalline state that enables a seamless joining of the pipe. Each weld takes about 2- 3 hours. The end result is a fusion joint that is as strong as or stronger than the pipe itself. Strong fusions are essential, as service pipe is subject to soil loads without side support from the surrounding hole. This load requirement is a major difference between HDD pipe and pipe installed in a trench.
- All welding and testing will be carried out by KenKar Plastic.
- A swivel is attached to the reamer as the drill string is pulled back the pipe will be pulled in.
- Drill fluid will be pumped in this will help remove surplus material and will grout around the bore pipe.
- All slurry will be removed by Vacuum tanker and disposed of at site nominated by ADTECT.
- Once the bore pipe is installed all equipment will be remove from site.

14 Appendix 4 – Austerberry's ECP for Sedimentation, Erosion and Wastewater Management

Environmental Control Plan

Sedimentation, Erosion and Wastewater Management

PROJECT TITLE _____

OBJECTIVE(S) : To protect the quality and integrity of the local environment

TARGET OUTCOME(S) : Ensure that appropriate control measures are put in place to prevent sediment run-off and wastewater contaminating surrounding land, watercourses & stormwater systems.

SITE ASSESSMENT & CONTROLS:

POTENTIAL ENVIRONMENTAL RISK	PROPOSED CONTROLS
Sedimentation from site operations contaminates surrounding land, waterways or stormwater systems.	Sediment control devices are to be erected around all disturbed areas, stockpiles, drilling machines and placed around storm water drains located within the risk area. Sediment Control Structure Installation & Usage: ➢ Straw bale sediment filters *Installation* - place lengthwise across drainage line, indented by 0.1m with ends firmly butted together; drive two stakes through each bale to hold in place *Usage* - max. catchment = 4 000 m^2 max. slope grade = 1 in 2 Max. slope length = 40m ➢ Sediment fences *Installation* – install support posts max 1.8m apart, excavate a trench 0.1m wide by 0.2m deep, attach geotech filter material to uphill side of posts, lay base of material in trench & backfill *Usage* - max. catchment = 6 000 m^2 max. slope grade = 1 in 2 max. slope length = 60m ➢ Perimeter banks (for prevention of clean water flowing onto site) *Installation* – Earth Bank : excavate across the length of the disturbed area excavate a trench 0.2m wide by 0.1m deep and build an earth mound behind the trench 0.5m high by 2.5m wide with batter slopes less than 1 in 2 Straw Bales : see 'straw bale sediment fences' above *Usage* - max. catchment = 20 000 m^2 (earth) or 4 000 m^2 (straw) max. slope grade = greater than 1 in 2 max. slope length = N/A ➢ Stormwater sediment filters *Installation* – lift grate from drain, place geotech filter material across entrance and replace grate to hold in place; place sandbags / containment stockings in gutters and around source of liquid waste to contain in immediate area for removal. *Usage* - containment of waste water/slurry prior to vacuum truck removal, additional protection against unexpected storm events
Acid sulphate soils are present	Retained water from directional drilling operations must be adjusted to a neutral pH (7) before disposal – use lime to adjust pH & test to ensure compliance

POTENTIAL ENVIRONMENTAL RISK	PROPOSED CONTROLS
Erosion of disturbed area & resultant depositional soil movement onto adjacent ground	Sediment (erosion) control devices are to be erected around all disturbed areas and stockpiles (where present) located within the risk area. See above for details of installation & usage of the following control devices: ➢ Straw bale sediment filters ➢ Sediment fences ➢ Perimeter banks (for prevention of clean water flowing onto site) Keep open excavations to a minimum and backfill as much as is practical at the end of each days activities All disturbed soil is compacted immediately upon completion of construction activities Provide surface protection on steep slopes eg. jute, geotech fabric All disturbed vegetation is replaced / replanted with appropriate species as soon as affected areas have stabilised Ensure original soil surface profiles are restored with no depressed or bunded areas that may collect water or allow water to concentrate and run along an undesirable course All erosion & sediment control devices are to be left in place and maintained until the site has sufficiently recovered
Existing pits / manholes require de-watering	When de-watering pits: ➢ Do not attempt to pump out water, even if it appears clean, unless pumping into a liquid waste vehicle for appropriate disposal. ➢ Manually remove sedimentation that has accumulated at the bottom of the pit and dispose of appropriately.
Spills & leaks from plant and equipment on-site	Undertake pre-operative plants and equipment checks (where required), and undertake periodic checks during the period of operation All operational teams carry a spill kit in case of accidental liquid spills and are trained in appropriate deployment techniques. If there is a spill: 1. Stop the source. 2. Contain the spill. 3. Report the incident to the person responsible for the site (if necessary, arrange for specialist disposal personnel to be notified). 4. Collect the spilled material for correct disposal. Complete an Incident Report.
Sediment control devices become ineffective after storm events or protection margin degrades over course of works	Check all sediment control devices after storm events, prior to starting operations each day and before leaving site at the completion of the day's activities