29

DECOMMISSIONING AND REHABILITATION

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29 Decommissioning and Rehabilitation

29.1 Introduction

The following section of the EIS provides a conceptual decommissioning and rehabilitation strategy for the Project. It provides details on the:

- Decommissioning and rehabilitation objectives;
- Regulatory requirements;
- Stakeholder engagement process;
- Managing the decommissioning process;
- Rehabilitation requirements; and
- Specific decommissioning and rehabilitation activities required for the proposed Project including the CSG fields, the central gas processing facilities (CGPFs), field compression facilities (FCFs), integrated processing facilities (IPFs), and other related infrastructure.

The Project infrastructure will be progressively decommissioned and the land rehabilitated throughout the Project life. Final decommissioning and rehabilitation will be undertaken at individual infrastructure sites once production is complete in that area, for example production wells will be decommissioned and rehabilitated following the cessation of production at the well. Decommissioning and rehabilitation will be undertaken in accordance with the relevant approvals and regulatory requirements.

A cross reference to the locations where each of the requirements of the ToR has been addressed is given in Appendix B which references both the study chapters (Sections 1 through 34) and/or Appendices (A through EE).

29.2 Decommissioning and Rehabilitation Objectives

The objectives of the decommissioning and rehabilitation strategy are to ensure that:

- **Decommissioning and rehabilitation activities meet stakeholders expectations and comply with relevant regulatory requirements and/or industry best practices** – Decommissioning and rehabilitation of the disturbance areas will be completed in accordance with the *Environmental Protection Act 1994* (EP Act) and industry guidelines that outline the timing, objectives, activities required, specific goals and performance criteria to determine when the objectives have been achieved.
- **Above ground infrastructure developed for the purpose of the Project will be decommissioned, safely removed and appropriately disposed of** – While opportunities may exist to re-use or on-sell infrastructure developed for the Project, for the purpose of this study it is assumed that all above ground infrastructure will be removed, or where appropriate and authorised by the regulator, infrastructure such as dams or roads will be transferred to the landholder. In general pipelines will be left in-situ to minimise the environmental disturbance associated with excavating pipelines.
- **Opportunities for progressive rehabilitation will be maximised** – Where appropriate the progressive rehabilitation of disturbance areas will be undertaken throughout the life of the Project.

- **The final landform is stable and an acceptable final land-use for the disturbance area is achieved** – The Project area will be rehabilitated to a stable, self-sustaining landform with a post-closure land-use comparable to the land-use prior to disturbance; unless an alternate suitable and agreed land-use is identified.
- **The potential for adverse environmental impact is minimised** – Including but not limited to contaminated run-off into local waterways, air quality from dust, soil contamination from hydrocarbons or other chemicals, and minimising further disturbance during rehabilitation activities.

Specific objectives, indicators and appropriate closure criteria will be developed during detailed closure planning, that will include where relevant consultation with appropriate stakeholders, including the relevant regulatory agency and landowners.

29.2.1 Land Suitability Pre and Post-Facility Life

29.2.1.1 Land Suitability

The land suitability assessment undertaken as part of the soils and land assessment (Soils and Land Suitability chapter (Section 12) and Soils and Land Suitability Technical Report (Appendix K) of this EIS) showed that the area has predominantly been used for broad acre cropping and beef cattle grazing. The land suitability assessment identified six representative soil types for dryland (rainfed) broad acre cropping and ten representative soil types for cattle grazing. In addition, the dominant Agricultural Land Class's (ALCs) for the Project area were Class C1 (34%) and C2 (36%), indicating that most of the land can be managed for good to moderate quality grazing.

A total of 26 land systems were identified within the Project area, including high tablelands and mountains to lowlands and undulating alluvial plains. The dominate land systems are Humbolt and Monteagle. The Humbolt land system is an extensive landscape of weathered clay plains with Blackbutt and Brigalow on texture-contrast and cracking clay soils. The Monteagle land system is an extensive landscape of lowlands and plains with savannah woodland, and dissected Tertiary underlying geology.

29.2.1.2 Good Quality Agricultural Land

Good Quality Agricultural Land (GQAL) is described as land that is capable of sustainable use for agriculture, with a reasonable level of inputs, without causing degradation of land or other natural resources. To evaluate the likely presence of GQAL, the Central Highlands Regional Council, Isaac Regional Council, and Whitsunday Regional Council planning schemes were reviewed. The review indicates that approximately 52% of the Project area is considered GQAL (Classes A-C1).

29.2.1.3 Strategic Cropping Land

As part of the soils and land assessment (Soils and Land Suitability chapter (Section 12) and Soils and Land Suitability Technical Report (Appendix K) of this EIS), a preliminary Strategic Cropping Land (SCL) assessment was completed. The assessment was undertaken by conducting a desktop study using EHP trigger maps, field investigations and observations, and laboratory analysis of selected soils samples. A total of seven assessed sites were shown to be potential SCL. The preliminary SCL

assessment indicated that trigger mapped SCL areas accounted for 11% of the Project area. Development of infrastructure on SCL will be undertaken in accordance with the *Strategic Cropping Land Act 2011* (SCL Act).

29.2.2 Post-Facility Life Conceptual Land Use

The site has been used predominantly for agricultural use, typically broad acre cropping and beef cattle grazing. Pre-development landform is required to be re-established as soon as practicable post-development.

Disturbance areas will be rehabilitated to land suitability classes consistent with the pre-development land classes, namely Class C1 and Class C2. That is the land can be managed for good to moderate quality grazing.

29.2.3 Conceptual Post-Facility Life Landform

Rehabilitation will generally be designed to achieve a stable final landform compatible with the surrounding environment. Should any slopes exceed 18˚, additional drainage and revegetation works would be implemented to achieve sediment and erosion control and groundcover establishment. Re-contouring the disturbed area will be undertaken so that it is commensurate with the surrounding natural landforms wherever possible.

It is currently proposed that the final land use for the rehabilitated areas is returned to the pre-disturbance land suitability class, and that maintenance requirements are no greater than that required prior to disturbance. Where a short term stable landform is required (i.e. around gas wells), appropriate erosion controls and revegetation will be required. The strategy for revegetation of the disturbance area is provided in Section 29.7.7.

29.3 Regulatory Requirements

29.3.1 Legislation and Guidelines

Rehabilitation and decommissioning of the Project gas fields and associated infrastructure shall be undertaken in compliance with the following regulations and guidelines:

- EP Act;
- *Petroleum and Gas (Production and Safety) Act 2004* (Qld) (P&G Act);
- *Petroleum Act 1923* (Qld);
- *Environmental Protection (Waste Management) Policy 2000* (Qld);
- SCL Act (Qld);
- *Draft Guidelines for the Assessment and Management of Contaminated Land in Queensland (1998)*;

- *Coal Seam Gas Water Management Policy,* June 2010[1];
- *Code of Practice for Constructing and Abandoning Coal Seam Gas Wells in Queensland, November 2011*;
- The Australian Pipeline Industry Association Ltd (APIA), March 2009, *Code of Practice Onshore Pipelines*;
- The Australian Petroleum Production and Exploration Association (APPEA), October 2008, *Code of Environmental Practice*; and
- AS 2885.0-2008 *Pipelines – Gas and liquid petroleum, Part 0 – General Requirements*, August 2012.

Environmental Protection Act 1994 (Qld)

As stated in the EP Act, *"*The object of this Act is to protect Queensland's environment while allowing for development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends (ecologically sustainable development)."

The decommissioning, rehabilitation and closure strategy for the Project has been developed generally in accordance with the requirements of the EP Act. In particular, Section 310D of the Act is satisfied through the preparation of the Project EM Plan.

Petroleum and Gas (Production and Safety) Act 2004 (Qld)

As stated in P&G Act, *"*The main purpose of this Act is to facilitate and regulate the carrying out of responsible petroleum activities and the development of a safe, efficient and viable petroleum and fuel gas industry, in a way that … has regard to the need for ecologically sustainable development.*"*

Decommissioning is specifically nominated in Section 672 as the fourth stage of an "operating plant" in the Project life-cycle for a CSG operation.

Division 4 of Part 10 (s292-294), *Decommissioning of petroleum wells, water observation bores and water supply bores*, of the P&G Act, and Schedule 3, *Requirements for plugging and abandoning petroleum wells and bores,* of the Petroleum and Gas (Production and Safety) Regulation 2004 were considered in the preparation of this decommissioning and rehabilitation strategy.

Petroleum Act 1923 (Qld)

The *Petroleum Act 1923* regulates petroleum and natural gas in Queensland in relation to certain petroleum tenements prior to 2004. This Act provides for the ownership of pipelines and equipment.

Sections 75A, Division 5*, Obligation to decommission pipelines,* and 78W of Division 6, *Right of access for authorised activities includes access for rehabilitation and environmental management*, of *The Petroleum Act 1923* are applicable to this Project.

[1] The DERM Coal Seam Gas Water Management Policy 2010 was superseded by the DEHP Coal Seam Gas Water Management Policy 2012 on the 21/12/2012, subsequent to the compilation of the Draft Bowen Gas Project EIS. Arrow are reviewing the updated policy at the time of the Bowen Gas Project EIS being published, and may undertake further amendments to the Arrow CSG Water and Salt Management Strategy (Appendix AA) in keeping with the updated DEHP policy, as part of a supplementary report to the EIS.

Strategic Cropping Land Act 2011 (Qld)

The purpose of the SCL Act is to protect land that is highly suitable for cropping, manage the impacts of development on that land and preserve the productivity of that land for future generations. A financial assurance may be required if SCL is to be impacted by the Project. If SCL is identified within the Project area, additional conditions may be applicable.

Environmental Protection (Waste Management) Regulation 2000 (Qld)

The goal of the *Environmental Protection (Waste Management) Policy 2000* is to achieve the objective of the EP Act in relation to waste management. Specifically, s.4 "the object of this regulation is to protect the environment by – (a) minimising the impact of waste on the environment including, in particular, the impact of waste so far as it directly affects human health; and (b) establishing an integrated framework for minimising the managing waste under the principle of ecological sustainable development." This Policy identifies environmental values to be enhanced or protected, provides a framework for the development of consistent and fair decisions in relation to waste management. The policy also provides the framework for the preparation of waste programs and of industry waste reduction programs and for government planning for waste management.

Draft Guidelines for the Assessment & Management of Contaminated Land in Queensland (1998)

The *Draft Guidelines for the Assessment & Management of Contaminated Land in Queensland (1998)* outlines assessment criteria (environmental investigation levels) and a tiered assessment approach, which have been considered in the preparation of this decommissioning and rehabilitation strategy.

Coal Seam Gas Water Management Policy, June 2010[2]

The objective of the *Coal Seam Gas Water Management Policy (2010)* is to ensure that salt produced through CSG activities does not contaminate the environment. The policy also encourages the beneficial use of treated CSG water. Preferred and non-preferred management options for CSG water are also outlined in the policy.

The *Coal Seam Gas Water Management Policy* has been considered in preparing this decommissioning and rehabilitation plan.

Code of Practice for Construction and Abandoning of Coal Seam Gas Wells in Queensland, November 2011

The *Code of Practice for Construction and Abandonment of Coal Seam Gas Wells in Queensland* (2011) has been "developed to ensure that all CSG wells are constructed and abandoned to a minimum acceptable standard resulting in long term well integrity, containment of gas and the

[2] The DERM Coal Seam Gas Water Management Policy 2010 was superseded by the DEHP Coal Seam Gas Water Management Policy 2012 on the 21/12/2012, subsequent to the compilation of the Draft Bowen Gas Project EIS. Arrow are reviewing the updated policy at the time of the Bowen Gas Project EIS being published, and may undertake further amendments to the Arrow CSG Water and Salt Management Strategy (Appendix AA) in keeping with the updated DEHP policy, as part of a supplementary report to the EIS.

protection of groundwater resources." This Code has been considered in the preparation of this decommissioning and rehabilitation plan.

The Australian Pipeline Industry Association Ltd, March 2009, Code of Environmental Practice Onshore Pipelines

The APIA *Code of Environmental Practice Onshore Pipelines* gives guidance on the best techniques and methods to mitigate or to eliminate the environmental impacts of onshore pipelines. The decommissioning section of the code provides an overview of potential environmental issues that may be encountered during decommissioning.

This Code has been considered in preparing this decommissioning and rehabilitation plan.

APPEA Code of Environmental Practice (2008)

The APPEA *Code of Environmental Practice* gives guidance on objectives to be achieved when managing environmental impacts associated with petroleum exploration and production. The decommissioning section of the code provides an overview of potential environmental issues that may be encountered during decommissioning.

AS 2885.0-2008 *Pipelines - Gas and liquid petroleum, Part 0 – General Requirements*

The AS 2885 series of standards are intended to provide safe design, construction, inspection, testing, operation and maintenance requirements for pipelines. These requirements relate to protecting the public, operating personal and the environment.

29.3.2 Arrow Guidelines and Procedures

Rehabilitation and decommissioning of the Project gas fields and associated infrastructure will be completed in accordance with the following Arrow guidelines and procedures:

Well Abandonment Guideline (99-D-GLD-0002, Rev. 0)

Arrow's *Well Abandonment Guideline* has been prepared based on the requirements provided in the Petroleum and Gas (Production and Safety) Regulation 2004. The guideline is intended to provide current procedures, standards and recommendations to assist in the safe, cost effective and functionally successful execution of well abandonment.

The minimum requirements for well abandonment, as outlined in the guideline include:

1. "Well abandonment shall be planned and executed to assure that the chance of the following hazards occurring is as low as reasonably practicable:
   - flow of fluids to the environment;
   - unintended flow of fluids underground; and

- interference with farming, building or other human activities due to equipment or debris left behind, or third party access.

2. Well abandonment planning shall be an integral part of the late life strategy of a field and shall include an assessment of mechanical well status and zonal isolation integrity.
3. An optimal well abandonment programme shall be part of the Plug & Abandonment procedure. This equally applies to new wells, side tracks and branches.
4. Verification of the completeness and correctness of records of both well construction and intervention activities shall be part of the annual audit plan or an equivalent recurring method to verify well records of a sample of wells. Records will include cementing, fluids, completion, well head, overburden gas, kicks / losses, signed well status diagrams and integrity.
5. An abandoned well that is leaking shall be treated as a HSE incident and reported, investigated and actioned upon."

Rehabilitation Procedure (99-V-PR-0088, Rev. 3)

Arrow's *Rehabilitation Procedure* "established minimum standards that are mandatory for rehabilitating disturbed land following drilling activities, construction, operation and maintenance of plant and equipment at Arrow Energy Australia controlled sites." The procedure applies to partial rehabilitation for stabilising operating project sites (i.e. production wells, power lines) and final closure rehabilitation to stabilise the land following the decommissioning of infrastructure (plugged and abandoned wells, pipelines, power line easements etc.).

The intent of the procedure is to "facilitate the return of the land to a stable state, where either the former land use or another specified state agreed by the Government and landholder, can be resumed." Rehabilitation objectives include ensuring that the site is safe to humans and wildlife, non-polluting, stable and able to sustain an agreed land use.

Rehabilitation Monitoring Procedure (99-V-PR-0037)

Monitoring will be conducted on areas of disturbed land following drilling activities, construction, operating and maintaining plant and equipment at the Project site. This procedure establishes an approach for evaluating the successful implementation of rehabilitation activities by monitoring.

Arrow aims to "minimise the disturbance to vegetation, land and animals, including native flora and fauna, and farm and infrastructure such as crops, pasture and stock. Any disturbed vegetation or land shall be rehabilitated as soon as practicable to ensure the identified land use can occur."

Coal Seam Gas Management Strategy

The intent of Arrow's *Coal Seam Gas Management Strategy* is to define and communicate the management framework for CSG water, including regulatory requirements. The strategy outlines the approach and principals adopted for the management of CSG water, and seeks to maximise the beneficial reuse and minimise the environmental impacts associated with CSG water use and disposal.

29.3.3 Terms of Reference

The decommissioning and rehabilitation study has been prepared with specific reference to the EIS ToR. In particular, the decommissioning and rehabilitation plan has considered:

- Decommissioning of wells that are proved not viable or from which gas supplies are exhausted;
- Rehabilitating drilling sites and well sites (in part during production phase and fully after cessation of production and plug and abandonment of well);
- Rehabilitation and decommissioning of gas pipelines used for gathering and transferring gas from the production wells to distribution mains;
- Rehabilitating areas of associated infrastructure (flowlines, access tracks, utility lines);
- Decommissioning and rehabilitating gas processing / compression facility sites;
- Decommissioning and rehabilitating water treatment facility sites; and
- Decommissioning and rehabilitating raw water, treated water, and waste water dams.

29.4 Stakeholder Engagement

Progressive decommissioning and rehabilitation will be undertaken in consultation with the appropriate landholders impacted by the specific activities. Infrastructure and disturbance areas to be decommissioned and rehabilitated at the cessation of operations may require additional consultation. This will be included in the detailed decommissioning and closure planning process as each stage of the Project approaches completion. The consultation process may include:

- Identifying all stakeholders and preparation of a stakeholder engagement strategy;
- Discussion regarding the opportunities for the re-use of infrastructure constructed for the Project (including water storage ponds, roads and tracks etc.);
- Detailed discussion on the final land-use for disturbance areas; and
- Identifying any other issues, key risks and information needs regarding decommissioning and rehabilitation of the Project area.

29.5 Planning for Decommissioning

The following section outlines the typical decommissioning and demolition strategy that would generally be implemented for large infrastructure (i.e. IPFs and CGPFs) developed for the Project.

29.5.1 Planning and Management

Decommissioning and demolition plans will be developed by suitably qualified personnel for all surface infrastructure required for the duration of the Project. This may include engaging structural engineers, appropriate technical experts and the application of relevant standards and guidelines (e.g. AS 2601-1991 *The Demolition of Structures*). A detailed investigation of all structures will be completed to determine the appropriate techniques, equipment required, and the sequence for decommissioning and removal.

Demolition activities will be managed by a suitably experienced and qualified demolition supervisor. The demolition supervisor will ensure that demolition activities are carried out in accordance with relevant standards and guidelines.

29.5.2 Post Closure Monitoring and Environmental Management

At the end of the gas field lifetime, relevant sections of the environmental monitoring program established for the operations phase of the Project will be maintained until all decommissioning and rehabilitation works have been completed. Where required, additional assessment and potentially monitoring may be required, depending on the nature of the decommissioning works and in response to possible sources of environmental pollutants.

The type and location of the monitoring and/or assessments will be determined by the nature of the land use activities undertaken and where required, the outcomes from the Phase 1 and/or Phase 2 contamination assessment (see Section 29.5.7 for further information). Other relevant inputs identified during the closure planning will be considered during the decommissioning phase of each site.

The post closure monitoring is discussed further in Section 29.8.

29.5.3 Investigation of the Key Infrastructure Areas

An investigation of the larger infrastructure items such as the IPFs and CGPFs will be conducted to confirm the following:

- The type, location and extent of underground services such as conduits, cables, pipe work;
- The location and extent of underground structures to be retained and those to be removed;
- The location, type and extent of overhead services and structures such as power cables, gantries, light poles and pipe work, etc.;
- The location and condition of all tanks and vessels (with emphasis on remaining combustible materials and methods required for their removal);
- The presence of contaminated and hazardous materials and the classification and disposal of these materials;
- The general condition of adjacent structures; and
- Any infrastructure to remain (including roads and tracks) following decommissioning.

29.5.4 Investigation of the Structures

An investigation of the structures will be completed to identify the following:

- The structures current condition with regard to their state of disrepair or deterioration;
- The presence of heavy steel within structures that may require specialised demolition equipment and/or techniques; and
- Confined spaces and techniques required to be implemented in order to avoid entering such spaces.

29.5.5 Restricting Site Access

If required, temporary fencing may be used to enclose the demolition site. The site would be secured at all times to prevent unauthorised entry of persons or vehicles. Provisions would be made for ready access of emergency services persons and vehicles.

29.5.6 Site Preparation

Prior to the commencing demolition activities and to avoid the potential for contamination within the key infrastructure areas, the following tasks will be undertaken:

- All pipelines will be drained and isolated (capped), gas pipelines will be flushed with an inert gas;
- Sumps will be dewatered and any residual solid material tested for contaminants and if required treated onsite for re-use or disposal, or transported to an appropriate facility;
- All items will be decommissioned, de-oiled and depressurised; and
- All hazardous materials will be removed and transported to appropriately licensed disposal facilities.

29.5.7 Contaminated Materials

At closure, a preliminary sampling and analysis program (Phase 1) will be undertaken. This will be used to determine whether a detailed assessment (Phase 2 – detailed investigation of contamination involving drilling, etc.) should be conducted to assess the nature and extent of contaminated material (if any) that may require remediation.

Potential contaminants may include:

- Oily water from compressors and on-site storage and handling of oily water;
- Tri-ethylene glycol used for gas dehydration at the IPFs and CGPFs;
- Lubricating oils used during power generation;
- Trace metals and nutrients associated with CSG water (associated water) storage areas;
- Biocides used in water gathering systems;
- Chemicals used on water treatment; and
- Salts, biocides, hydrocarbons, and chemicals associated with processing in the brine dams.

29.6 Infrastructure Removal

The proposed Project covers an area of approximately 8,000 km^2- to the west of Mackay, with the bulk of the area extending from approximately 100 km north to 100 km south of Moranbah. The proposed Project area is expected to include approximately 17 production areas. Each production area is expected to have a radius of approximately 12 km for gathering gas and water to a central surface production facility, either an FCF, CGPF or IPF. Up to 6,625 production wells are anticipated to be drilled throughout the Project area over the Project lifetime of approximately 40 years.

Where practicable the infrastructure to be decommissioned from the Project area includes:

- Gas wells and associated well head facilities;

- FCFs;
- Low pressure gathering systems and medium pressure infield pipelines;
- CGPFs;
- IPFs;
- Water treatment facilities (WTFs);
- Pipeline laterals;
- Supervisory control and data acquisition (SCADA) and telecommunications ;
- Power supply and distribution networks;
- Water monitoring wells;
- Reinjection wells;
- Access roads and tracks;
- Water aggregation ponds;
- Borrow pits / quarries; and
- Other associated facilities including weather stations, workshops, warehouses, offices and other operating infrastructure.

For specific details regarding the infrastructure see the Project Description chapter (Section 4) of this EIS.

29.6.1 Decommissioning Domains

The infrastructure associated with the Project has been separated into domains; each domain includes areas that have similar rehabilitation requirements. However, as the final location of the infrastructure has not been confirmed, a Domain Plan has not been prepared. The domains include:

- Domain 1: FCFs, IPFs, CGPFs and WTFs;
- Domain 2: Production wells;
- Domain 3: Infrastructure corridors, including roads, tracks, pipelines, telecommunications and electrical distribution and transmission; and
- Domain 4: Other lands.

In addition to the above domains, information regarding the rehabilitation during construction of the gathering systems has been included in Section 29.7.1.

29.6.2 Domain 1: FCFs, IPFs, CGPFs and WTFs

Infrastructure

Prior to decommissioning activities commencing the gas and water pipelines leading into the FCFs, CGPFs and IPFs will be drained and isolated, and gas pipelines will also be flushed with an inert gas. In addition, tanks and vessels will be pumped dry and services that are not required for demolition will be disconnected.

All buildings, and other surface infrastructure, including the compressors, drive engines and/or motors, separators, electrical panels, pipework, pig launcher / receiver, SCADA, control rooms, etc., will be demolished and disposed of in a suitable approved location. Opportunities for the sale and/or re-use of

assets and recycling of scrap steel will be maximised where possible. All associated infrastructure, for example fencing, security systems and closed-circuit television (CCTV), will also be removed.

Concrete footings and pads will be broken up to at least 1.5 m below the surface and removed. Options for the re-use of this material (i.e. crushed and used for road and track stabilisation) will be investigated as the facilities approaches closure. If re-use / recycle opportunities aren't available, all 'non-contaminated' waste material will be disposed of in a suitable approved location.

Note that buried services may remain in-situ if they will not impact on the future land use, i.e. buried cables are at sufficient depth that they will not interfere with farming activities. Pipelines located in critical locations, for example infrastructure crossings, environmentally sensitive areas and/or riparian zones, will be filled with inert material (i.e. concrete) where required.

Oily Water Systems

Oily water systems will be emptied prior to decommissioning activities commencing, the contents will be disposed or recycled at a licensed facility. All infrastructure associated with the oily water system will be reused or demolished and disposed of in a suitable approved location. Care will be taken to ensure that oily residues are contained and not released to the environment.

Water Transfer Station (CGPFs only)

The pipework leading into the water transfer stations will be drained, flushed with inert gas and isolated prior to decommissioning activities commencing. In addition, all residual water will be drained and disposed of at an approved location.

All water transfer infrastructure will be demolished and disposed of in a suitable approved location. Opportunities for the sale and/or re-use of assets and recycling of scrap steel will be maximised where possible.

CSG Water Storage Dams and Clean Water Dams

At the cessation of operations the CSG water storage dams will be drained with the water preferably passing through the water treatment plant. The clean water dams will be drained using existing infrastructure where possible. If this is not practicable, the residual water in the dams will be pumped out using a road tanker or similar and disposed of at an approved location.

The sediment within the dams will be sampled and analysed for contaminants. Based on the results of the sediment sampling it will be treated and/or disposed of at a suitable approved location.

Opportunities for utilising the water storage dams and clean water dams by surrounding land owners will be investigated as part of the consultation process during detailed closure planning. If there is an agreed reuse for the dam, which has been agreed in writing with the landowner and/or the regulator, the dam may be left on-site following the removal of any residual produce water and sediment (if assessed and determined not to be suitable for the proposed use). If the dam is to remain, the leak detection system will be decommissioned and made safe.

If an alternative use cannot be identified, the decommissioning and removal will include:

- Draining the water from the dam, and removal of any wildlife to a suitable location;
- Sampling and analytical testing of the sediment within the dam, and appropriate treatment or disposal of the sediment based on the analytical results;
- Removal of the liner, leak detection system including any piezometers and disposal at a suitable approved location;
- Backfilling of the dam and reshaping to a landform similar to that of the surrounding undisturbed areas;
- If required topsoiling and/or amelioration the disturbed area; and
- Revegetating with species that are commensurate with the surrounding vegetation and previous land use.

Water Treatment Plant

Prior to decommissioning activities commencing, the water pipelines will be drained and isolated. In addition, tanks and vessels will be pumped dry and services that are not required for demolition will be disconnected.

All buildings, and other surface infrastructure, including the reverse osmosis units, pre-treatment equipment, control rooms, etc, will be dismantled or demolished and recycled or disposed of in a suitable approved location. Opportunities for the sale and/or re-use of assets and recycling of scrap steel will be maximised where possible.

Concrete footings and pads will be broken up to at least 1.5 m below the surface and removed. Options for the re-use of this material (i.e. crushed and used for road and track stabilisation) will be investigated as the operation approaches closure. If re-use / recycle opportunities aren't available, all 'non-contaminated' waste material will be disposed of in a suitable approved location.

Associated Infrastructure

All associated infrastructure, for example chemical storage sheds, fencing, CCTV, sumps, etc. will be removed. Concrete footings and pads will be broken up to at least 1.5 m below the surface and removed. Options for the re-use of this material (i.e. crushed and used for road and track stabilisation) will be investigated as the operation approaches closure. If re-use / recycle opportunities aren't available, all 'non-contaminated' waste material will be disposed of in a suitable approved location.

29.6.3 Domain 2: Production Wells

29.6.3.1 Production Wells

Once the useful life of the well(s) is reached, they will be decommissioned and rehabilitated in accordance with relevant regulatory requirements and industry best practice.

The aim of CSG well decommissioning is to prevent the leakage of gas and water. The outcomes for the decommissioning of the CSG wells include:

- Isolation of zones of different pressure or water quality;

- Isolation of groundwater aquifers from each other;
- Isolation of hydrocarbon zones;
- Plugging the top of the casing with a surface cement plug; and
- Removal of the well head.

The general strategy for decommissioning of an exhausted well site includes:

- Re-clearing of vegetation and removal of imported gravel in the vicinity of the well head;
- Removing the well head and associated infrastructure;
- Plugging the well with cement slurry;
- Cutting the upper pipe casing to a minimum depth of 1.5 m below the surface;
- Backfilling the hole with material suitable for revegetation;
- Recreating the original ground surface levels while allowing for any subsidence;
- Re-establishing drainage lines with appropriate surface erosion controls in place;
- Re-establishing vegetation species commensurate with the surrounding land use, by ripping / scarifying soil, re-spreading of topsoil, application of soil ameliorants / fertilizers and seeding operations;
- Placing an identification marker over the top of the well;
- Removing any waste products from the site;
- Registering the abandoned well site with the Department of Sustainability, Development, Infrastructure and Planning (Petroleum & Gas Inspectorate);
- Monitoring of rehabilitation for plant recruitment / germination / growth, erosion and weeds until criteria are met and relinquishment can be achieved;
- Maintaining a complete and accurate record of the abandonment procedure; and
- Removal from the rehabilitation register once successful rehabilitation has been demonstrated through compliance with the rehabilitation criteria.

29.6.4 Domain 3: Infrastructure Corridors

29.6.4.1 Roads and Tracks

Roadways and/or tracks may be required to remain to provide on-going access to monitor rehabilitation. Alternatively, roads and/or tracks may remain on-site if agreed in writing by the landowner and/or the relevant government department.

Access roads and tracks that are not required by landowners, car parks and hardstand areas (e.g. workshop, administration areas, etc.) will be scalped to approximately 0.3 m below the surface to remove stabilised and compacted material. The inert waste will be recycled or disposed of in a suitable location (i.e. a quarry or an approved landfill off-site as appropriate).

Contaminated or unsuitable material (e.g. gravel) will be removed from the roads and hardstand surfaces and disposed of at an approved location. Minor reshaping work will be undertaken to ensure surface level consistency with the surrounding areas. Any creek crossings (e.g. culverts) will be removed and the pre-existing drainage line re-instated by revegetation and rehabilitation.

Where practicable, the area will be rock raked to remove all surface rocks to a size of less than 0.5 m and ripped to a depth of at least 0.5 m.

29.6.4.2 Pipelines

General Decommissioning of Pipelines

It is anticipated that the buried pipelines will be used for between 15 and 40 years depending on their location. Prior to decommissioning; the pipelines will be drained, flushed with an inert material and isolated.

Generally pipelines will be capped and remain in-situ. This is due to the risk of disturbing the re-established vegetation within the pipeline corridor through excavation and removal. When assessing the preferred decommissioning methodology, consideration will be given to the environmental significance of the area that the pipeline is located.

The location of pipelines that are to remain in-situ will be recorded in an abandoned services register.

The same methodology will be applied for buried water pipelines installed for the Project.

Pipelines located in critical locations, for example infrastructure crossings, environmentally sensitive areas and/or riparian zones, will be filled with inert material (i.e. concrete) where required.

Road and Water Course Crossings

Where appropriate the methodology for crossing roads or watercourses (bored crossing or directional drilling) outlined in the APIA *Code of Environmental Practice* will be implemented during construction of the pipeline. After decommissioning, if in “sensitive areas” (i.e. major roads or major water courses), there is the potential for deterioration and loss of integrity of the pipeline resulting in subsidence, opportunities to fill the abandoned pipe with an inert material will be considered during detailed decommissioning and closure planning.

Railway Crossings

Pipelines installed in railway corridors and under railway lines will be decommissioned and removed in accordance with relevant standards and guidelines (i.e. AS 4799-2000 *Installation of Underground Utility Services and Pipelines within Railway Boundaries).*

Rehabilitation

After removal of all infrastructure developed for the pipeline, the disturbance area will be reshaped and trimmed to make a landform that is consistent with the surrounding topography and ripped to reduce compaction. Embankments in the area will be graded to a maximum of 10 degrees. The regrading will be done in a way that enables the free drainage of surface runoff from the site. Surface water management structures (contour banks and drains) will also be constructed to minimise the risk of erosion from water leaving the landform.

Topsoil will be spread over the disturbance area, lightly tilled to provide a seed bed prior to revegetation.

29.6.4.3 Telecommunications

The SCADA equipment and facility specific equipment, including CCTV, is covered separately in the infrastructure domains.

Fibre Optic Cable

It is anticipated that the buried fibre optic cable will be used for the life of the Project depending on its location. Where appropriate, due to the significant revegetation that will have occurred, removal of the fibre optic cable may not be the preferred environmental or commercial option.

The location of fibre optic cables that are to remain in-situ will be recorded in an abandoned services register.

Radio Towers

Any equipment and/or infrastructure that can be sold, re-used or recycled will be removed prior to demolition activities commencing. All surface infrastructure will be demolished and disposed of in a suitable approved location, consistent with the waste management hierarchy. Opportunities for the sale and/or re-use of assets and recycling of scrap steel will be maximised where possible. All associated infrastructure, for example fencing and CCTV, will be removed.

Concrete footings and pads will be broken up to at least 1.5 m below the surface and removed. Options for the re-use of this material (i.e. crushed and used for road and track stabilisation) will be investigated as the operation approaches closure. If re-use / recycle opportunities aren't available, all 'non-contaminated' waste material will be disposed of in a suitable approved location.

29.6.4.4 Electricity Generation and Supply

Electricity Generation Infrastructure

All buildings, and other surface infrastructure, including the gas engine generating sets, gas metering facilities, gas treatment facilities, sub stations, switchgear, oil storage facilities, workshops, control / switchroom, etc. will be demolished and disposed of in a suitable approved location.

Opportunities for the sale and/or re-use of assets and recycling of scrap steel will be maximised where possible. All associated infrastructure, for example fencing and CCTV, will be removed.

Concrete footings and pads will be broken up to at least 1.5 m below the surface and removed. Options for the re-use of this material (i.e. crushed and used for road and track stabilisation) will be investigated as the operation approaches closure. If re-use / recycle opportunities aren't available, all 'non-contaminated' waste material will be disposed of in a suitable approved location.

Electricity Transmission Lines

Opportunities for utilisation of the electricity transmission network by the surrounding community and/or service providers will be investigated as part of the consultation process undertaken prior to

decommissioning. If an alternative use for the infrastructure can be agreed with the relevant stakeholders it will remain in-situ. Alternatively it will be decommissioned as outlined below.

Power transmission infrastructure (including but not limited to power poles and transmission lines) will be demolished and disposed of in a suitable approved location. Opportunities for the sale and/or re-use of assets and recycling of scrap steel will be maximised where possible.

29.6.5 Domain 4: Other Lands

The other lands domain consists of all land within the Arrow CSG production acreage that is not captured in the other eight domains. This may include:

- Groundwater monitoring wells;
- Light vehicle tracks; and
- Mobile workshops and security fencing.

Groundwater Monitoring Wells

Groundwater monitoring wells will be decommissioned in accordance with Arrow Standards and relevant regulatory requirements.

The aim of well decommissioning is to prevent the leakage of gas and water. The outcomes for the decommissioning of the wells include:

- Isolating zones of different pressure;
- Isolating groundwater aquifers from each other;
- Isolating hydrocarbon zones;
- Plugging the top of the casing with a surface cement plug; and
- Removing the well head.

Light Vehicle Tracks

Roadways and/or tracks may be required to remain to provide on-going access to monitor rehabilitation. Alternatively, roads and/or tracks may remain on-site if agreed in writing by the landowner and the relevant EA. This may require a change in land use application. Access roads and tracks that are not required by landowners, car parks and hardstand areas (e.g. workshop, administration areas, etc.) will be scalped to approximately 0.3 m below the surface to remove stabilised and compacted material. The inert waste will either be recycled or be disposed of in a suitable location.

Contaminated or unsuitable material (e.g. gravel) will be removed from the roads and hardstand surfaces and disposed of at an approved landfill. Minor reshaping work will be undertaken to ensure surface level consistency with the surrounding areas. Any creek crossings (i.e. culverts, etc.) will be removed and the pre-existing drainage line re-instated.

Where practicable, the area will be rock raked to remove all surface rocks to a size of less than 0.5 m and ripped to a depth of at least 0.5 m.

Associated Infrastructure

All workshops and fencing etc. will be removed. Re-use / recycle opportunities will be investigated, or alternately all 'non-contaminated' waste material will be disposed of in a suitable approved location. Potentially contaminated waste material will be sampled and analysed to confirm if contamination is present. If the waste material is confirmed to be contaminated, it will be disposed of off-site at an approved licenced landfill.

29.6.6 Conceptual Decommissioning Schedule

The development schedule has been designed to ensure that the gas requirements are met throughout the Project life. Once the initial stage wells reach the end of their productive life they will be decommissioned in accordance with Arrow Standards and regulatory requirements and a new well will be drilled to ensure the gas requirements are met.

Construction for the Project is proposed to commence between 2014 and 2016, with the first phase of production to begin in 2017. The preliminary development schedule has been used to create a conceptual decommissioning schedule (Table 29–1).

Table 29-1 Conceptual Decommissioning Schedule

Production Area	Production Station Type	Onstream Date (assume 1 January)	Projected Decommissioning Date
4	IPF	2017	2038
5	IPF	2017	2039
6	CGPF	2017	2037
7	IPF	2017	2041
8	FCF	2020	2039
9	CGPF	2020	2055
10	FCF	2039	2055
11	GCPF	2021	2051
12	FCF	2032	2053
13	FCF	2041	2055
14	FCF	2043	2055
15	FCF	2041	2055
16	FCF	2047	2055
17	FCF	2032	2054
18	FCF	2034	2055
19	IPF	2035	2055
20	FCF	2048	2055

29.7 Rehabilitation and Revegetation Strategy

29.7.1 Progressive Rehabilitation - Pipelines

A significant length of pipeline will be required to service the Project. The area disturbed within corridors during the laying of gathering lines will be progressively rehabilitated as soon as practicable after completion of the pipeline installation. Fences, roads and tracks and other existing infrastructure impacted during construction of the pipeline will be repaired and/or replaced as required [B594]. Where required, rehabilitation will occur in consultation with the relevant landholders [B595].

To maximise the potential for meeting the proposed rehabilitation success criteria, the following practices will also be implemented:

- The area disturbed within the pipeline corridor during the laying of the pipelines will be progressively rehabilitated as soon as practicable after completion of the pipeline installation. Fences, roads and tracks and other existing infrastructure impacted during construction of the pipeline will be repaired and/or replaced as required [B549].
- Regular inspections of pipeline alignments will be undertaken to ensure that disturbed surfaces are stable and not subject to concentration of flows or erosion. Repair works will be undertaken proactively to prevent erosion from occurring or worsening [B298].
- Suitable topsoil should be re-spread directly onto rehabilitation areas where practicable. Topsoil should be spread, ameliorated (if required), treated with fertiliser and seeded in one consecutive operation to reduce topsoil loss potential to wind and water erosion. Where possible, soil ameliorants will be applied prior to topsoil stripping to ensure adequate mixing [B059].
- Implement best practice erosion and sediment control measures during decommissioning works in accordance with the requirements of the International Erosion Control Association (IECA) (2008) *Best Practice Erosion and Sediment Control* manual [B337].
- Prevent subsurface water flows and erosion along the backfilled trench by appropriate means, such as trench blocks and compaction of backfilled soils [B074].
- Woody debris, logs and rocks should be retained for use in rehabilitation. Where practical, these should be piled along the edge of the cleared corridor. However, spreading these features over part or all of the corridor is preferred as it will provide refugia for crossing fauna. Systematic removal of surface debris should be avoided and cleared timber should never be burnt [B161].

The determination of any site specific rehabilitation criteria will be influenced by the original land use and the presence of any pre-existing areas of nature conservation value in the area. Typically areas will be revegetated to consider the pre-disturbance ecosystem requirements. Rehabilitation measures will be applied to all areas disturbed by the pipeline construction that are not required for the operational phase.

29.7.2 Rehabilitation Management Strategy and Objectives

This section of the plan outlines the overall rehabilitation strategy for the Project, including descriptions of key components of the rehabilitation strategy integral to the anticipated final landform. The rehabilitation strategy will be flexible to allow for the integration of successful rehabilitation activities, and will be amended if new rehabilitation techniques are developed.

The strategy includes the following key aspects:

- An outline of the general objectives of the rehabilitation strategy;
- Land-form design and planning (including objectives);
- Progressive rehabilitation requirements for the disturbed areas;
- The management of topsoil resources for use in rehabilitation of the site;
- A description of the planned revegetation of disturbed areas; and
- The rehabilitation monitoring and maintenance requirements that will apply.

Surrendering of EAs will be undertaken in accordance with Sections 142 and 143 of the EP Act, including sign-off by the landholder where appropriate (i.e. if assets are required to be transferred to the landholder) and relevant EA.

29.7.3 Rehabilitation Objectives

The general rehabilitation objectives for disturbed land at the Project site are:

- Surface drainage lines are re-established and the quality of surface water released from disturbance areas does not contaminate the surrounding water courses;
- The water quality of any residual water bodies is suitable for the nominated use and does not have the potential to cause environmental harm;
- The potential for water and wind-induced erosion is minimised, including the likelihood of environmental impacts caused by the release of dust;
- The final landform is stable and not subject to slumping or erosion, which would result in the agreed post closure landform not being achieved; and
- Suitable species of vegetation are sown / planted and established to achieve the nominated post facility closure land use.

Where practicable, vegetation cleared for construction of the Project will be either mulched and/or spread across the disturbance area. Other features such as rocks and logs will also be re-positioned within the disturbance areas to provide fauna habitat and help to restabilise the ground and assist with revegetation. It may be necessary to treat some plant matter (i.e. contaminated through heavy weed infestation) which will be done in accordance with relevant regulatory requirements.

29.7.4 Progressive Rehabilitation Requirements

Where appropriate, progressive rehabilitation of disturbed lands associated with the Project shall proceed as soon as reasonably practicable to minimise the potential for erosion and contamination of surrounding water ways, or reduced air quality. However, particular components of the rehabilitation process may be delayed as part of the required comprehensive decommissioning and demolition strategy. The period of time between construction and the initial phase of progressive rehabilitation will be minimised to prevent degradation and loss of exposed soils.

29.7.5 Topsoil Management

Topsoil Stripping and Handling

Where topsoil stripping and transportation is required, the following proposed topsoil handling techniques as detailed in the Soils and land Suitability Technical Report (Appendix K) of this EIS would be adopted to prevent excessive soil deterioration:

- Suitable topsoil should be re-spread directly onto rehabilitation areas where practicable. Topsoil should be spread, ameliorated (if required), treated with fertiliser and seeded in one consecutive operation to reduce topsoil loss potential to wind and water erosion. Where possible, soil ameliorants will be applied prior to topsoil stripping to ensure adequate mixing [B059];
- Separation of soils into windrows for later collection or re-spreading to minimise compression effects of heavy equipment [B053];
- Soil transported by dump trucks may be placed directly into storage. Soil transported by scrapers is best pushed to form stockpiles by other equipment (e.g. dozer) to avoid tracking over previously laid soil to minimise compaction [B054];
- Surface of soil stockpiles should be left in as coarsely structured a condition as possible to promote infiltration and minimise erosion until vegetation is established or suitable erosion controls have been applied, and to prevent anaerobic zones from forming [B055];
- A maximum stockpile height for topsoil of 2 m is maintained as a general rule. Clay soils should be stored in lower stockpiles for shorter periods of time compared to coarser textured sandy soils [B056];
- For long term soil stockpiling, seed and fertilise stockpiles as soon as possible [B057];
- Subsoil and topdressing will be spread to depths dependent on target land suitability [B058]; and
- Topsoil should be re-spread directly onto rehabilitation areas where practicable. Topsoil should be spread, ameliorated (if required), treated with fertiliser and seeded in one consecutive operation to reduce topsoil loss potential to wind and water erosion. Where possible, soil ameliorants will be applied prior to topsoil stripping to ensure adequate mixing [B059].

The proponent recognises the importance of appropriate soil identification, stripping, and management practices for successful rehabilitation and the achievement of the desired post-closure land use(s). A description of appropriate topsoil resources within the Project site and their management is included in the Soils and Land Suitability Technical Report (Appendix K) of this EIS.

Topsoil Respreading and Seedbed Preparation

Where possible, topsoil would be respread directly onto reshaped landforms. Where topsoil resources allow, topsoil would be spread to a nominal minimum depth range of 0.1 to 0.3 m on all areas to be rehabilitated.

The methodology for seedbed preparation will incorporate seedbed preparation to optimise establishment and growth of vegetation, including topsoiled areas lightly contour-ripped (after topsoil spreading) to create a ‘key’ between the topsoil and the subsoil. Ripping would ideally be undertaken on the contour and the tynes lifted for approximately 2 m every 200 m to reduce the potential for channelised erosion on slopes greater than 10 degrees. Ripping will be undertaken where practical,

when soil is dry to achieve best results in fracturing the compacted soils. The respread topsoil surface will be scarified prior to or during seeding to reduce erosion, provide niches for seeds and litter and increase infiltration.

For areas requiring long duration topsoil stockpiling, such as the IPFs and CGPFs, opportunities will be investigated into the application of additional ameliorants (e.g. biosolids) and burial to assist with the regeneration of the desirable microorganism activity in the soil.

29.7.6 Erosion and Sediment Control

A certified Erosion and Sediment Control Plan will be prepared for each site and mitigation measures implemented prior to commencing construction activities to minimise erosion, and prevent sediment-laden drainage water from disturbed areas contaminating local waterways [B062]. The following principles will be considered in the planning, design, construction, and operation of the facility:

- Planning for erosion and sediment control during the design phase of the infrastructure, and before any earthworks begin, including assessment of site constraints;
- Discharge water from Project activities at a rate and location that will not result in erosion and install additional erosion protection measures [B075];
- All run-off water needs diversion into clean water drainage lines and off site into natural drainage systems [B076];
- Localised erosion and sediment control and energy dissipation structures [B290];
- Minimising the area of disturbance and vegetation clearing [B114], and therefore exposure to erosion;
- Soil to be stockpiled and used for rehabilitation onsite. Stockpiles will be located away from water sources and in clear areas [B407];
- Where practicable, place stripped material directly onto area to be rehabilitated and spread immediately (if rehabilitation sequences and weather conditions permit) to avoid the requirement for stockpiling [B052];
- Topsoil will be stockpiled away from drainage lines to reduce chances of erosion [B294];
- Soil ripped or scarified by suitable technique in highly trafficked areas to promote free drainage [B605];
- Implement best practice erosion and sediment control measures during decommissioning works in accordance with the requirements of the IECA (2008) *Best Practice Erosion and Sediment Control* manual [B337]; and
- Maintaining erosion and sediment control measures appropriately.

A detailed assessment of the specific surface water management requirements are outlined in the Surface Water Technical Report (Appendix N) of this EIS.

29.7.7 Revegetation

29.7.7.1 Revegetation Program Implementation

An effective revegetation strategy is proposed for the Project that seeks to complement desirable post-closure land use objectives while maintaining effective erosion and weed controls in the longer term. Revegetation activities will be planned to occur after the completion of reshaping, topsoil application and construction of drainage structures. Where appropriate areas will be shallow ripped / scarified to provide a suitable environment that encourages water infiltration into the soil [B605].

Where possible, the timing of these preparation works would be scheduled to enable immediate sowing of appropriate vegetation. This would minimise the potential for soil erosion and weed invasion, limit surface crusting and sealing, and enhance the likelihood of successful seed germination and vegetation establishment.

Where required, sterile cover crops will be used in revegetation to provide an effective groundcover until the specific vegetation is established. This would minimise the likelihood for erosion and weed invasion during the initial establishment phase of the rehabilitation [B606].

29.7.7.2 Species to be used for Rehabilitation

The general aim for rehabilitated areas is to return them to the pre-disturbed land use; therefore, revegetation of disturbance areas will be completed with specific consideration of the pre-disturbance ecosystem requirements. Species being particularly suitable for rehabilitation of the disturbance areas are provided within the Terrestrial Ecology Technical Report (Appendix P) of this EIS.

Plant selection for areas to be rehabilitated to pre-existing conditions will focus on those species that will successfully establish on the available growth medium, bind the soil and will result in a variety of structure and food / habitat resources. Native species will be established through direct seeding or planting of tube stock / nursery-raised stock from local propagules. Seed will be collected or sourced locally where possible to ensure it is adapted to environmental conditions in the area.

Prior to application, some of the native seed species may need to be pre-treated (i.e. inoculated and scarified) in order to break dormancy restrictions to promote earlier germination, develop more robust seedlings, wider and more uniform germination and increased germination rates.

A combination of native and introduced grass species may be used on the disturbance areas (if present in pre-disturbance vegetation) to ensure the quick establishment of a continuous groundcover, thereby reducing the risk of erosion. Legumes may also be selected to assist in the supply of bio-available nitrogen to the soil.

Where appropriate, native grass species (warm season perennial, cool season perennial, yearlong green perennial and annual) will be sown. If steep slopes are present and it is not practicable to re-shape the area and/or there is a high risk of erosion on the site, sterile cover crops (such as Millet, cereal rye etc.) will be sown as their growth provides more extensive coverage of the soil and stabilisation in a shorter time.

Ground broadcasting of seed by hand or machinery is the preferred revegetation methods and grazing may be restricted whilst the vegetation is establishing.

All revegetated areas will be monitored to ensure long-term vegetation establishment and successfully meeting rehabilitation criteria as stated in relevant EA conditions. Revegetation techniques will be continually developed and refined over the life of the Project through an ongoing process of monitoring at site level, quantitative research and recognition of other industry improvements and experiences.

29.7.7.3 Special Treatment Areas

Additional erosion control measures will be considered where necessary, particularly in drainage lines and steeper areas. Erosion control measures may include application of composted mulch blanket or jute mesh under sown with grass species. These controls protect the soil surface against raindrop impact, improving the micro-environment for seed germination and establishment by reducing evaporation losses, and assisting in the control of surface erosion caused by overland water flow. Rehabilitation areas to be revegetated with native grass or woodland vegetation types would require a weed free soil profile (to reduce competition for light, moisture and nutrients), therefore any mulch or compost used would be certified as weed and pathogen free.

Opportunities for the use of potential soil ameliorants to accelerate the rehabilitation process will also be considered where appropriate. Fertilizers that are planned for use in native revegetation areas to enhance germination and establishment may need to have a low phosphorus content due to some species (particularly Proteaceae family) having adverse effects to high soil phosphorus levels and would be advised on a site by site basis.

29.7.8 Weed Management

The presence of weed species has a potential major impact on revegetation and regeneration outcomes. In addition to this, the presence of weed species within the surrounding land has the potential to significantly impact on the biodiversity value of the rehabilitated areas. Weed management will be a critical component of the rehabilitation activities. The Terrestrial Ecology Technical Report (Appendix P of this EIS) identifies the prevalence of weeds and the typical weed species that occur on the Project area.

Weeds will be managed across the Project area through a series of control measures, including (but not limited to):

- Designated light vehicle roads and track delineated around the site and adequate weed hygiene practises for vehicles operating within rehabilitation areas;
- Provision of adequate wash down and clean down facilities to prevent the spread of weeds [B172];
- Herbicide spraying or scalping weeds off topsoil stockpiles prior to respreading;
- Ensuring materials sourced utilised during rehabilitation are free of weeds [B180];
- Develop a declared weed and pest management plan in accordance with the *Petroleum Industry – Pest Spread Minimisation Advisory Guide* (Biosecurity Queensland, 2008); and
- Undertaking species-specific management for identified key weed species at risk of spread through Project activities. Increasing weed control efforts in areas particularly sensitive to invasion. The

pest management plan should include, as a minimum, training, management of pest spread, management of pest infestations and monitoring effectiveness of control measures [B191].

If weed control measures are required, they would be undertaken in a manner that minimises soil disturbance. Any use of herbicides would be carried out in accordance with appropriate requirements to minimise the risk of impact on downstream water quality and with approval from landholder to ensure no agricultural organic or export produce certifications are breached. Records would be maintained of weed infestations, and control programs would be implemented according to accepted management practice for the weed species concerned.

All weed management personnel would be trained in the use of herbicides. Herbicides listed under international conventions, such as the World Health Organisation and the Stockholm Convention, would only be used according to the requirements of those conventions.

29.7.9 Rehabilitation completion Criteria

Preliminary success criteria (or completion criteria) for the rehabilitation of the CSG production areas and associated infrastructure have been provided in the EM Plan (Appendix Z) of this EIS. The completion criteria are performance objectives or standards against which rehabilitation success in achieving a sustainable system for the proposed post-facility life land use is demonstrated. Satisfaction and maintenance of the success criteria (as indicated by monitoring results) will demonstrate that the rehabilitated landscape is ready to be relinquished from Arrow's financial assurance and handed back to stakeholders in a productive and sustainable condition.

The further development of each criterion will be based on results of research, monitoring of progressive rehabilitation areas and risk assessments. The success criteria will be reviewed every three to five years with stakeholder participation to ensure the criteria remain realistic and achievable.

Rehabilitation shall be considered successful when the following conditions have been met:

- The site can be managed for its designated land-use (e.g. consistent with surrounding undisturbed land);
- Evidence that the agreed rehabilitation criteria have been met;
- No greater management input is required for site than that of surrounding areas consistent with designated land use; and
- Written agreement has been attained by the land owner / holder and the administering authority.

29.7.10 Rehabilitation Monitoring and Maintenance

29.7.10.1 Rehabilitation Monitoring

Potential monitoring locations (analogue sites) will be identified during the concept select phase of the Project and from ecological site assessments. Alternatively, pre–cleaned assessment sites may be used as analogue sites. Monitoring of the rehabilitated areas will be undertaken to identify whether the general objectives of the rehabilitation strategy are being met, and whether a sustainable and stable landform has been achieved. Monitoring will be conducted by suitably skilled and qualified persons at

representative locations. Annual reviews of monitoring data will be conducted during operations, and post closure, to assess trends and performance [B591]. The monitoring program will include:

- Monitoring for each major age class of the rehabilitation areas including replicate monitoring sites. Site selection will take into account the requirement to have monitoring points within the key disturbance areas.
- A standard monitoring plot design and transects will be used to determine statistical variance, and provide data for statistical analyses when comparing different rehabilitation treatments and changes over time.

Monitoring outcomes will determine whether rehabilitation is underperforming and additional maintenance is required. The following key aspects would be evaluated during monitoring:

- Soil erosion (and potential exposure of waste materials);
- Revegetation success;
- Weed infestation; and
- Integrity of diversion drains, waterways and erosion and sediment control structures.

Rehabilitation methods will be improved over time as additional knowledge is gained from the monitoring programs and research conducted into the different rehabilitation techniques.

A final rehabilitation report and a decommissioning plan, including a contaminated land assessment where required, landowner commitments and agreements, and rehabilitation status, will be prepared and submitted to the appropriate authorities for approval [B592].

29.7.10.2 Rehabilitation Maintenance

In the context of this strategy, maintenance constitutes the application of fertiliser or amendments, addition of erosion and sediment control, re-application of seed where required and the ongoing management of weeds as required. However, this management frequency would vary depending on the extent of rehabilitation success and necessary method for mitigating failing rehabilitation. There may also be a requirement to undertake minor remedial earthworks or soil conservation works and remediation of water management structures.

The full extent of maintenance works required may include activities such as:

- Infill and regrading of eroded areas and potential reapplication of erosion control techniques;
- De-silting or repair of drainage works and sedimentation dams;
- Reapplication of topsoil;
- Reseeding and/or replanting;
- Additional fertiliser application; and
- Weed management.

29.8 Post Closure Monitoring and Environmental Management

Following the cessation of CSG extraction, the environmental monitoring program established for the operations phase of the Project will be maintained until all decommissioning and rehabilitation works have been successfully completed.