

8. ENVIRONMENTAL FRAMEWORK

A key premise of environmental impact assessment is that the location, type, scale and duration of development is known; thus enabling the impacts of the proposed construction, operation and maintenance activities on the environmental values at that place, at the nominated time, to be assessed.

For this project, the type of development, and construction, operation and maintenance activities are known, as is the duration for installing individual items of project infrastructure e.g., the drilling of a production well or construction of an integrated processing facility. The typical operating life of coal seam gas infrastructure is also known. The potential impacts associated with the project activities are known, as Arrow has been developing coal seam gas resources for over 10 years. What is not known is where future development will occur, and at what time.

Unlike conventional gas resources, coal seam gas resources are extensive requiring widespread development to recover the resource. The yield from target coal seams is variable across the resource. This leads to uncertainty about the number, timing and location of wells required to dewater the coal seams and extract the gas. Prior to considering environmental and social constraints, selection of the ideal location of infrastructure required to treat the coal seam gas water and process the gas is also uncertain, being driven by exploration results and optimisation of well placement and water and gas gathering systems.

The lack of certainty about the preferred location of infrastructure is an issue for environmental impact assessment because the impacts at a specific location cannot be fully understood. However, they can be described based on the typical impacts of project activities. With that knowledge, greater certainty about potential impacts can be achieved by identifying those areas that are not amenable to certain types of development and if they were developed, how development should proceed. This is achieved through the identification of constraints to development and the establishment of environmental management controls that should apply to project activities in constrained areas.

This chapter explains the application of the framework approach to the Surat Gas Project environmental impact statement (EIS). It also explains how the environmental framework will integrate with Arrow's health, safety and environmental management system (HSEMS).

8.1 Objective of the Environmental Framework

The principal objective of the environmental framework is to protect the environmental values of the project development area (as defined in government policies and regulations or as an attribute of the environment that is conducive to ecological health, public amenity or safety), and to identify appropriate environmental management controls for project activities having regard to the constraints imposed by the environmental values.

Implementation of the environmental framework will allow Arrow to:

- Address uncertainty about potential impacts of the location and timing of coal seam gas infrastructure development.
- Identify constraints to coal seam gas development in the project development area having regard to the sensitivity of identified environmental values.

- Document the constraints through mapping or the establishment of guidelines (including buffers, thresholds and trigger levels) to inform site and route selection for coal seam gas infrastructure.
- Develop environmental management controls to address the identified constraints.
- Integrate the environmental framework with their HSEMS.

The framework approach ensures planning and development of coal seam gas fields will occur in an orderly manner through the application of environmental management controls (avoidance, mitigation and management) that are reflective of the level of sensitivity of environmental values.

8.2 Environmental Values

The sensitivity or vulnerability of an environmental value to change provides an indication of the level of constraint it poses to the development of coal seam gas infrastructure. Environmental values were identified by technical specialists who made an assessment of the sensitivity of the identified values and proposed environmental management controls to address the potential impacts on the values. The assessment was informed by detailed desktop studies and targeted field surveys.

Where an environmental value is defined by a feature (e.g., ecological community) the constraint can be expressed spatially and shown in maps. The output of a model can also be expressed in a spatial context. For example, air modelling will indicate the distance at which the applicable air emission limits will be achieved providing an indication of the separation required between coal seam gas facilities and sensitive receptors.

Modelling and subsequent impact assessment can provide an indication of the degree of change that can be tolerated before intervention is required e.g., facilitate the nomination of trigger levels for the volumes of traffic that can be accommodated before road upgrades are required.

The level of constraint is derived from the sensitivity of the environmental value, and the proposed environmental management controls, particularly those that recommend avoidance, separation distances or buffers or site specific management.

8.3 Constraints to Development

The level of environmental constraint provides an indication of the project activities that could occur in a particular area, subject to the application of appropriate environmental management controls. They also provide an indication of the project activities that should not occur in certain areas. Table 8.1 lists the project activities that are permissible in areas that have been categorised as 'no go' or as a high, moderate or low constraint.

The appropriate level of environmental management control for construction, operation and maintenance, and decommissioning activities undertaken in the constrained areas is also listed in Table 8.1. The controls apply cumulatively i.e., controls applicable to project activities in highly constrained areas incorporate the controls applying to project activities in moderate and least constrained areas.

Table 8.1 Permissible project activities based on level of constraint

Level of Environmental Constraint	Environmental Management Control	Project Activity		
		Wells	Gathering Systems	Production Facilities
No go	Not applicable	No	No	No
High	Site-specific environmental management measures	Yes	Yes	No
Moderate	Specific environmental management measures	Yes	Yes	Yes
Low	Standard environmental management measures	Yes	Yes	Yes

Environmental management controls will be developed and incorporated in Arrow's HSEMS, which will provide the policy, management and audit framework for construction and operation environmental management plans.

8.4 Constraints Analysis

The method for undertaking constraints analysis is described in the following section, after which the preliminary and future constraints analyses are described.

8.4.1 Method

The analysis of constraints is done using a Geographic Information System (GIS). Datasets or layers for each relevant environmental aspect are compiled in the project GIS, and spatial analysis undertaken to determine the level of constraint.

Two analyses are performed. The first involves determining the level of constraint posed by each environmental aspect. The second evaluates the cumulative effect of combining certain layers e.g., all nature conservation related environmental aspects.

The output of the individual and cumulative constraints analyses are GIS layers which can be presented in maps at any scale. This enables maps showing constraints at the scale of an allotment (or even part of an allotment) to be prepared. Planning for coal seam gas development will use large and small scale maps to ensure decisions about the location of infrastructure at the allotment scale do not adversely affect gas field design and vice versa.

The only limitation on scale is the accuracy of the base information. Queensland and Australian government GIS data is typically collated at 1:100,000 or 1:250,000 scale. In some instances, it is available at 1:25,000 or 1:50,000 scale. Detailed mapping compiled through field surveys is more accurate but limited by the method and accuracy of the equipment used to acquire the data.

Information produced in the constraints analysis is evaluated and interpreted to understand what is driving the constraint, particularly where cumulative constraint analysis has been conducted. This is done to determine whether coincident constraints warrant elevation of the common area to a higher level of constraint e.g., several coincident highly constrained areas might warrant the common area being designated a 'no go' area. In this instance, the common area would be included in a separate GIS layer containing constraints determined by interpretation.

Typical cumulative constraints analyses include environmental aspects that fall into the following groups:

- Physical environment e.g., landform, soils and slope.
- Natural environment e.g., terrestrial and aquatic ecology, and surface water.
- Social environment e.g., air quality, noise and safety buffers from risk assessment.
- Cultural environment e.g., Indigenous and non-Indigenous cultural heritage.
- Land tenure e.g., freehold, leases, reserves and easements.
- Land use e.g., built infrastructure, roads etc.

Planning policies and associated guidelines that seek to protect good quality agricultural land and potential strategic cropping land require the spatial extent of the land to be defined and mapped at a property scale. Adopting indicative state-wide trigger mapping is not appropriate for identifying constraints at a property scale and consequently did not form part of the constraints analysis.

Notwithstanding the exclusion of those values in the analysis, constraints imposed by good quality agricultural land and potential strategic cropping land are important considerations in coal seam gas field development planning. When mapped at the property scale they will be incorporated in constraints mapping and will be a key input to the planning process. Arrow has committed to working with landowners to integrate coal seam gas infrastructure and project activities with farm infrastructure and operations. This will, by necessity, require the constraints of each property and agricultural enterprise, including those posed by good quality agricultural land and potential strategic cropping land, to be considered in field development planning.

8.4.2 Preliminary Constraints Analysis

To facilitate conceptual design of the coal seam gas fields, Arrow undertook preliminary constraints analyses based on available Queensland and Australian government GIS data and preliminary advice and information from the technical specialists. Constraints were identified for:

- Terrestrial ecology.
- Aquatic ecology.
- Non-Indigenous cultural heritage.
- Indigenous cultural heritage.
- Surface water hydrology.
- Land tenure.
- Land use encompassing engineering and road network constraints.
- Landscape.
- Public safety.

The criteria that defined the constraints for each of the above environmental aspects are described in the following sections.

Terrestrial Ecology

'No Go' Areas

Category A Environmentally Sensitive Areas have been identified as 'no go' areas. The project development area encompasses the following areas:

- Bendidee National Park.
- Wondul Range National Park.
- Lake Broadwater Conservation Park.
- Chinchilla Rifle Range (Chinchilla Sands Local Fossil Fauna Site).
- Binkey State Forest (Scientific area near Gurulmundi).
- Barakula State Forest (Waaaje wildflower area).

Highly Constrained Areas

The following areas are deemed to be highly constrained:

- The declared buffer zones (that preclude project activities) to the Category A Environmentally Sensitive Areas listed above.
- The declared buffer zone (that precludes project activities) to the Chinchilla Rifle Range and Bendidee State Forest.
- *Environmental Protection and Biodiversity Conservation Act 1999* (Cwlth) (EPBC Act) listed endangered and critically endangered communities.
- Essential habitat for endangered, vulnerable and rare flora and fauna.
- Core habitat for highly sensitive (non-resilient) fauna.
- Category B Environmentally Sensitive Areas.
- Regional ecosystems classified as endangered and 'of concern'.
- The following areas:
 - Barakula State Forest.
 - Kurumbarilla State Forest.
 - Wyagu State Forest.

Moderately Constrained Areas

Areas determined to be moderately constrained include:

- Category C Environmentally Sensitive Areas.
- The declared buffer zones (that preclude project activities) to Category B Environmentally Sensitive Areas.
- Core habitat (possible) for endangered, vulnerable and rare flora and fauna.
- Core habitat for resilient fauna.
- General habitat for endangered, vulnerable and rare flora and fauna.
- Regional ecosystems classified as 'not of concern' and 'least concern'.
- Derived grasslands.
- State forests (other than those identified as highly constrained).

Least Constrained Areas

Non-remnant vegetation was determined to be least constrained.

Aquatic Ecology

Aquatic ecology assets in the project development area are variable due to the ephemeral nature of many of the watercourses. The assets identified as posing a constraint on development are the more intact streams, water bodies and wetlands.

'No Go' Areas

Category A Environmentally Sensitive Areas associated with watercourses were identified as 'no go' areas, particularly the Lake Broadwater Conservation Park.

Highly Constrained Areas

The declared buffer zones (that preclude project activities) around Category A Environmentally Sensitive Areas were identified as highly constrained areas, particularly the buffer zone surrounding Lake Broadwater Conservation Park.

Oakey Creek between Cecil Plains Road and the project development area boundary was identified as a highly constrained area due to potential habitat for the *Mogurnda adspersa* (purple spotted gudgeon) and *Gadopsis marmoratus* (freshwater blackfish).

Non-Indigenous Cultural Heritage

Known non-Indigenous cultural heritage is recorded in state and national registers. Consequently, the constraint is posed by registered historic sites and places, which have been identified as 'no go' areas.

'No Go' Areas

Sites listed on the Australian Heritage Database which incorporates the National Heritage List, Commonwealth Heritage List and the Register of the National Estate, including:

- Chinchilla Sands Local Fossil Fauna Site (Chinchilla Rifle Range).
- Boonarga Cactoblastis Memorial Hall (Warrego Highway, Chinchilla).

Sites listed on the Queensland Heritage Register, including:

- Wyaga Homestead, Wyaga.
- Nandef Precinct Dalby. Dalby Milling Company.

Locally significant sites identified as 'no go' areas are cemeteries and isolated graves.

Sites within towns and built-up areas are 'no go' areas based on the restriction on coal seam gas development within those areas. These sites include the Dalby War Memorial and Memorial Park listed in the Australian Heritage Database and the following sites listed in the Queensland Heritage Register: Dalby Swimming Complex; Dalby Town Council Chambers; St Johns Anglican Church, Dalby; Chinchilla War Memorial; Former CBC Bank, Dalby; and St Columba's Convent School, Dalby.

Indigenous Cultural Heritage

Cultural heritage management plans prepared in accordance with the requirements of the *Aboriginal Cultural Heritage Act 2003* (Qld) and sites listed on state and national heritage registers define the level of constraint posed by Indigenous cultural heritage on project activities. At the planning stage, registered sites and prospective sites provide an indication of the level of constraint posed by the non-Indigenous cultural heritage values. Sites of prospective cultural heritage (material and places) can be inferred from landforms. Analysis of landforms, informed by advice from archaeologists/anthropologists, was used to identify areas of potential constraint.

'No Go' Areas

Sites listed in the Australian Heritage Database, including:

- Chinchilla Sands Local Fossil Fauna Site (Chinchilla Rifle Range).
- Lake Broadwater Environmental Park (referred to as Lake Broadwater Conservation Park in Queensland legislation).

Moderately Constrained Areas

The Barakula State Forest Area, an Indicative Place on the Register of the National Estate has been identified as a moderately constrained area.

Areas identified as being prospective for Indigenous cultural material and places were determined to be moderately constrained and include:

- Watercourse and waterway beds, banks and adjacent land.
- High terraces below 300 m above sea level (ASL) on duplex/sandy loam soils.
- High plains above 300 m ASL away from hydrological features.
- Ridges and escarpments.
- Ridges and rocky uplands.

Surface Water Hydrology

'No Go' Areas

Declared buffer zones to watercourses that preclude project activities were identified as 'no go' areas.

Highly Constrained Areas

Highly constrained areas are declared buffer zones to watercourses that limit the type of project activities.

Moderately Constrained Areas

Watercourses classified into the following geomorphic categories were identified as moderately constrained areas:

- Anabranching fine-grained.
- Chain of ponds.
- Flood-out.
- Valley fill.
- Low-moderate sinuosity fine grained.
- Low-moderate sinuosity gravel bed.
- Meandering fine grained.
- Meandering gravel bed.
- Multiple-channel sand belt.

Long Swamp, a wetland that is not listed was also identified as a moderately constrained area.

Least Constrained Areas

Watercourses classified into the following geomorphic categories were identified as least constrained areas:

- Confined and partly confined.
- Partly confined meandering.
- Headwater.
- Flood channel.

Land Tenure

Petroleum activities are not permitted in some land tenures and it is undesirable to develop such infrastructure in other tenures for various reasons such as constructability.

'No Go' Areas

The following tenures were identified as 'no go' areas for the reasons nominated:

- National Parks including Wondul Range National Park and Bendidee National Park, as petroleum activities are prohibited in these reserves.
- Lake Broadwater Conservation Area because of its biodiversity, palaeontology and cultural significance.
- Third-party petroleum pipeline easements including a 100 m buffer for operation and safety reasons. This does not preclude pipelines or gathering systems crossing other pipelines, or being co-located within the easement if approved by the party benefitting from the right. Its purpose is to alert gas field designers to the presence of other infrastructure.
- Railway reserves including a 100 m buffer for operation and safety reasons. As with third-party pipeline easements this does not preclude pipelines or gathering systems crossing railways, or being co-located within the reserve if approved by the railway owner and/or operator. Its purpose is to alert gas field designers to the presence of other infrastructure.

Highly Constrained Areas

Mining leases are deemed highly constrained because of the potential for conflicting land use and because leaseholder agreement is required to enable development of petroleum resources.

Land Use

Built infrastructure poses a constraint on coal seam gas development due to its footprint and as a consequence of any associated safety buffers e.g., flight path approaches to airports and airfields.

'No Go' Areas

The following built infrastructure was identified as 'no go' areas:

- Residences and sensitive receptors (e.g., schools, hospitals and churches) and all land within 200 m of those sites.
- Built-up areas, particularly towns including Wandoan, Chinchilla, Dalby, Cecil Plains, Millmerran, Goondiwindi.
- Airports and airfields as defined by security fencing, and approach flight paths as endorsed by the Civil Aviation Safety Authority.
- Mines and quarries.

Highly Constrained Areas

Third-party licensed petroleum pipelines were identified as posing a high constraint on project activities, as specific procedures are required to cross or work adjacent to such infrastructure.

Moderately Constrained Areas

Other infrastructure, particularly the following assets was identified as posing a moderate constraint on project activities, as there are established protocols for the construction and operation of petroleum infrastructure across or adjacent to these assets.

- Water pipelines.
- High voltage transmission lines.
- Distribution power lines.
- Roads and road reserves.

- Stock routes.

Landscape

Landscape is characterised as units based on their sensitivity to modification. The units were used to identify areas that are more constrained than others to coal seam gas development.

Highly Constrained Areas

Landscape units Type A Wooded River Valley which occurs along the Condamine River and Type I Forested Steep Hills (Captain's Mountain) were identified as areas sensitive to landscape modification.

Moderately Constrained Areas

The following landscape units were identified as moderately constrained:

- Type E Elevated Native Forest.
- Type F Foothills Plains and Valleys.
- Type H Terraced Brigalow Farmland which is the terraced farmland associated with Captain's Mountain, south of Millmerran.

Least constrained areas

The landscape units identified as posing the least constraint are those where extensive modification has occurred or the features screen views to varying degrees. They are:

- Type B Settled Arable Plains.
- Type C Sodic Transitional Pastures.
- Type D Lowland Native Forest.
- Type G Lowland Brigalow Plains.
- Type J Cromosol Undulating Lowlands.

Results of Preliminary Constraints Analyses

The results of the preliminary constraints analysis were presented as a series of GIS layers that were used to produce maps at a scale of 1:25,000 to inform conceptual design. Maps at the project development area scale and other scales were also produced to provide an overview of the level of constraint and to address specific gas field planning issues. The layers produced for conceptual design purposes were principally the product of cumulative constraints analysis of related environmental aspects, and included:

- Natural environment incorporating terrestrial flora and fauna and nature conservation resources.
- Aquatic ecology.
- Heritage incorporating registered Indigenous and non-Indigenous sites and places.
- Surface water hydrology which is based on stream order.
- Land tenure.
- Engineering incorporating built infrastructure, roads and existing (third party) petroleum developments.
- Roads.

- Landscape which is based on landscape units.
- Environmental constraints incorporating the natural environment, aquatic ecology, surface water hydrology, heritage and land tenure analyses.

Figure A10.1 in Attachment 10, Preliminary Constraints Analysis shows the results of the preliminary environmental constraints analysis at the project development area scale (1:800,000). Attachment 10 also includes a map series at 1:200,000 (Figures A10.2 to A10.10) that provides a greater level of detail of the preliminary environmental constraints analysis presented in Figure A10.1. This map series also shows the nominal separation distance (200 m) from sensitive receptors (houses, schools and hospitals etc) which were identified from available GIS data and satellite imagery, and ground truthed from the public road network where they were located in areas adjacent to Arrow's existing operations. This information is useful as it provides an indication of the density of settlement and assists Arrow identify those areas less likely to raise amenity issues associated with the siting, construction and operation of production facilities.

Once prospective production facility sites have been identified, public health and safety from exposure to noise and air emissions, and hazardous facilities respectively, is evaluated. This was achieved by application of a nominal separation distance of 2,000 m to sensitive receptors. The separation distance is the greater of preliminary buffer distances proposed by the technical specialists for public health from the effects of noise (2,000 m) and air emissions (1,000 m), and public safety from hazardous facilities (500 m).

Modelling carried out as part of the technical studies (Appendix C – Air Quality Impact Assessment, Appendix N - Noise and Vibration Impact Assessment and Appendix S – Preliminary Hazard and Risk Assessment) commissioned to inform preparation of this EIS indicates that the preliminary buffer distances are conservative and reduced separation distances will ensure public health and safety is protected. The buffer distances proposed by Arrow are a planning tool. The ultimate separation distances required to protect public health and safety will depend on the effectiveness of design responses, environmental management controls and operating procedures developed to ensure the relevant criteria are met at the sensitive receptors.

The information presented in this EIS, in the maps in Attachment 10, Preliminary Constraints Analysis, is based on mapping compiled from various sources at various scales. The accuracy of the preliminary environmental constraints mapping reflects the accuracy of the base mapping which was generally supplied at 1:100,000 or 1:250,000 scale. Consequently, it is indicative and needs to be used in conjunction with other information to provide a meaningful understanding of the type and level of constraint.

8.4.3 Future Constraints Analyses

The preliminary constraints analysis is based on Queensland and Australian government mapping and preliminary advice from technical specialists. It will be updated to incorporate the findings of the EIS including the results of field surveys, sensitivity analyses performed by the technical specialists, and proposed mitigation measures. Negotiations with regulatory authorities and ongoing community consultation will also inform update of the constraints mapping and environmental management controls.

The project GIS, a live system, will be periodically updated to include updates to Australian and Queensland government GIS data, the results of ecological and preconstruction clearance surveys, and any subsequent environmental impact assessment processes.

Modelling undertaken in the technical studies (Appendix C – Air Quality Impact Assessment, Appendix N – Noise and Vibration Impact Assessment and Appendix S – Preliminary Hazard and Risk Assessment) has refined separation distances required to ensure public health and safety. Noise remains the more dominant determinant. Separation distances between sensitive receptors and project-related noise sources have been provided in Appendix N – Noise and Vibration Impact Assessment, and they vary considerably dependant on the level of attenuation used. An appropriate buffer distance, to be used for planning purposes, will be selected on the basis of attenuation options being considered in detailed design.

The technical specialists have proposed mitigation measures that are presented in the impact assessment Chapters 9 to 29 of this EIS. The measures or environmental management controls reflect the significance of potential impacts of the proposed development, and hence respond to the level of constraint posed by the environmental values. The mitigation measures will be incorporated in documents comprising Arrow's HSEMS, enabling implementation of the environmental framework.

8.5 Environmental Management Framework

The environmental framework comprising constraints and environmental management controls will be incorporated in, and implemented through, Arrow's HSEMS. Mitigation measures presented as commitments in this EIS will be incorporated in standard operating procedures. The standard operating procedures will incorporate procedural environmental management controls that will apply to all project activities, specific procedures that respond to a particular issue (e.g., rehabilitation of Vertosol or black soils) and site specific management measures where project activities occur in a highly constrained area (e.g., in or adjacent to cultivation areas). Arrow has already developed and implemented a standard operating procedure for site and route selection, which uses the output of constraints analysis.

Work plans set out the procedures to be followed by Arrow staff and contractors in carrying out construction, operation and maintenance and decommissioning activities. The plans dictate the work methods and safety requirements for the particular activity. Currently, these plans operate separate to environmental management plans (standard operating procedures). To improve environmental management, Arrow is investigating the integration of environmental management procedures in work plans to provide staff and contractors with a single point of reference, and to ensure environmental management measures are implemented at the appropriate time and in the correct manner.

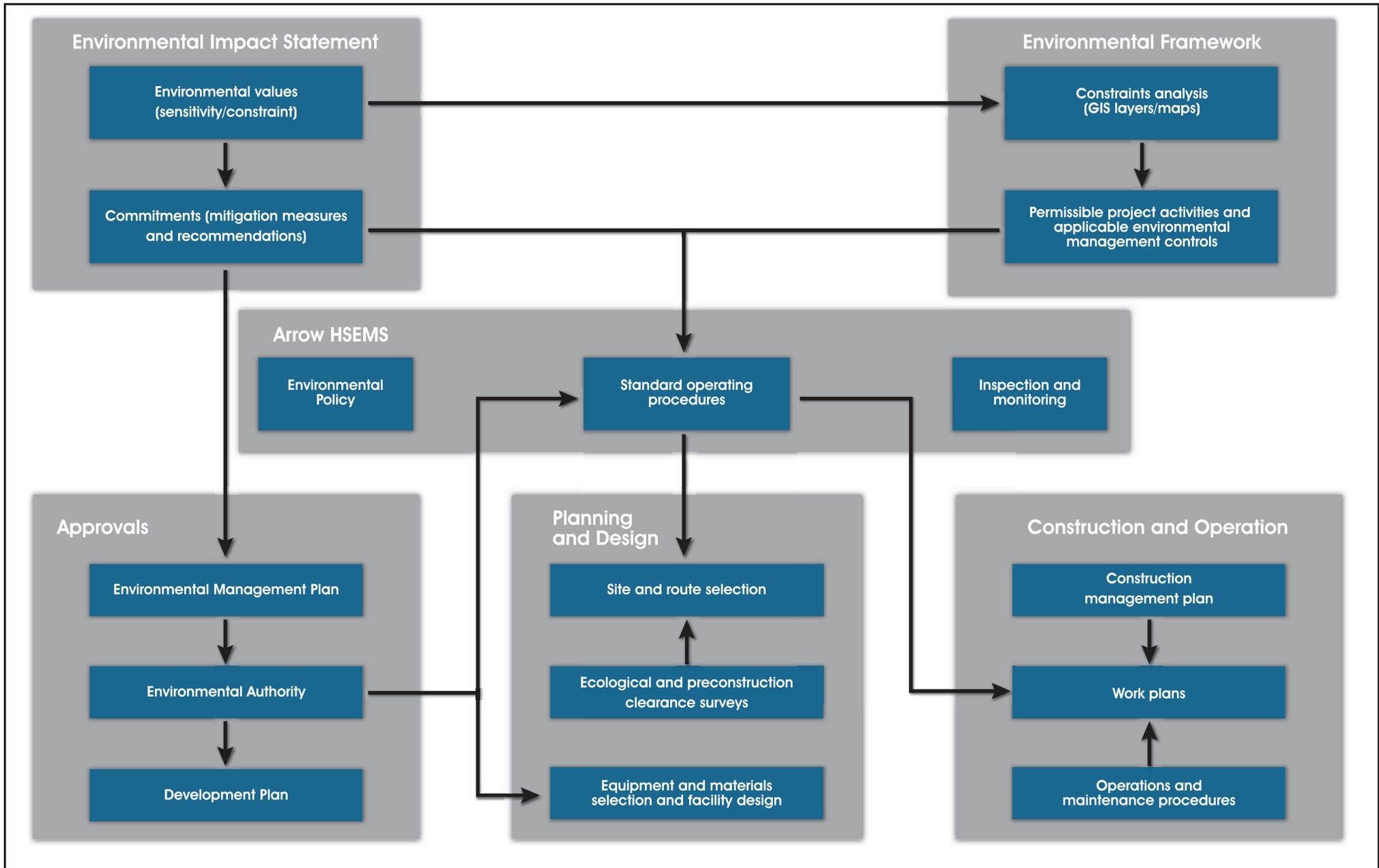
The relationship between the environmental framework and Arrow's HSEMS and the key information flows are shown in Figure 8.1. Implementation of the environmental framework as an integrated component of Arrow's HSEMS and field development process is shown in Figure 8.2 and described below.

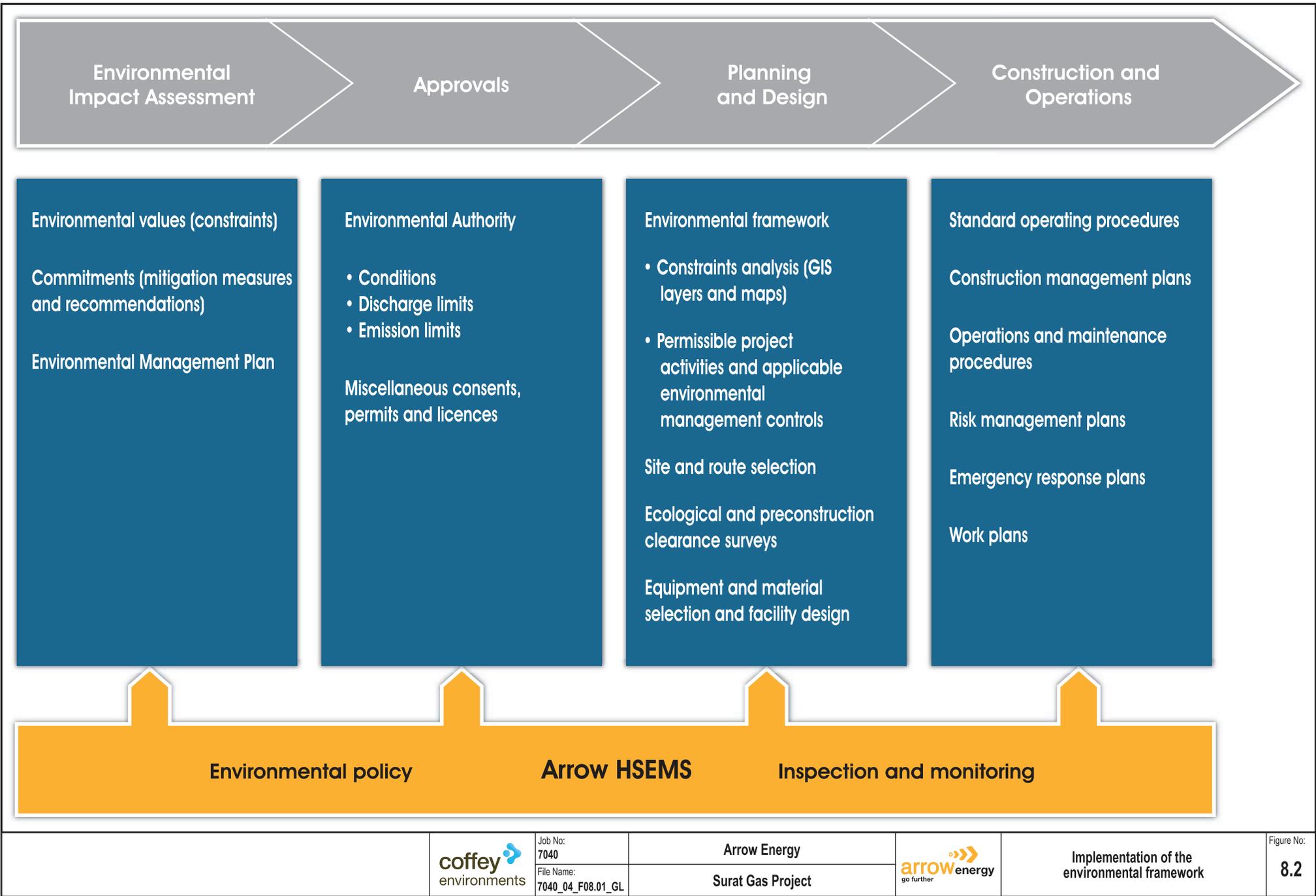
8.5.1 Integration of Environmental Framework with Arrow's HSEMS

The environmental framework – constraints maps and environmental management controls – will be incorporated in Arrow's HSEMS, as standard operating procedures.

A standard operating procedure will be developed to describe the process and frequency of updates to the constraints maps. The procedure will incorporate the following requirements:

- Periodic review of the constraints criteria to ensure they reflect state and federal government policy, guidelines and listings, and the results of any environmental impact assessment undertaken by Arrow.





- Periodic update of the project GIS to incorporate updated government datasets and the results of any ecological surveys and any environmental impact assessment processes undertaken by Arrow.
- Constraints analyses, as required, to ensure constraints mapping is up to date.

Development and implementation of this procedure will ensure the findings of this EIS are incorporated in the constraints mapping including updating the constraints criteria to reflect the sensitivities assigned to the environmental values identified by the technical specialists.

Arrow has prepared a site and route selection standard operating procedure that is being used to inform the identification and evaluation of sites for coal seam gas infrastructure including facilities. The procedure requires the constraints mapping to be used in identifying sites and routes, and evaluating the feasibility.

Mitigation and management measures proposed in this EIS will be incorporated in standard operating procedures of the Arrow HSEMS. Standard or procedural controls that apply to all project activities regardless of the level of constraint will be incorporated in thematically-based procedures e.g., air quality. Controls for the management of activities in moderately constrained areas will be incorporated in procedures that are specific to the identified impact e.g., rehabilitation of black soils (Vertosols and Dermosols). Site-specific management plans that address identified impacts in highly constrained areas will be developed on an as-needed basis, as they will respond to the site conditions and environmental management requirements at the site. The standard operating procedures will be subject to the review and audit requirements of the Arrow HSEMS.

Work plans developed for construction, and operation and maintenance activities will be revised to incorporate relevant aspects of the standard operating procedures or reference the applicable standard operating procedures. This will ensure environmental management is integrated with management and supervision of coal seam gas development activities.

8.5.2 Integration of Environmental Framework with Gas Field Planning

Gas field planning commences with the analysis of exploration and pilot well data to enhance Arrow's knowledge of the coal seam gas reservoirs and their potential yield. Geologists and reservoir engineers highlight the most prospective reserves which are passed onto the field development planning and concept engineers who prepare a conceptual gas field layout. The well density and infrastructure required to transport and process the gas and coal seam gas water is conceptualised and optimised. Technical feasibility of the resource recovery is the primary consideration at this stage in the development process.

Field development engineers use the constraints maps to determine the feasibility of constructing the conceptual gas field layout having regard to the environmental, social and cultural constraints. The conceptual layout is refined to produce a preliminary design to facilitate landowner and stakeholder consultation, and field surveys of the potential sites and routes. Key considerations in this phase are technical feasibility (including constructability) and cost. Cost encompasses capital and operating costs, and the cost of mitigation including rehabilitation, which is primarily informed by the constraints and associated environmental management controls.

Ecological and cultural heritage clearance surveys, along with geotechnical investigations inform any further refinement of the conceptual gas field layout, particularly the location and arrangement of production facilities and routes for medium pressure gas pipelines. Road access and interfaces with municipal infrastructure are discussed with relevant authorities and local government to

determine any additional controls or measures that should apply to development at the nominated sites and along the nominated routes. Landowner consultation will explore options for realignment of medium pressure gas gathering pipelines and configuring the production wells and associated gathering systems to reduce impacts on farming operations or business activities.

The outcome of consultation, field surveys and geotechnical investigations informs the detailed design of the gas field and selection of equipment and construction methods that address the technical and environmental constraints. The environmental management controls (standard operating procedures) applicable to the proposed activities at the selected sites or routes are identified and incorporated in the work plans.

Whilst field development and optimisation continues throughout the field life, the first phase of the Surat and Bowen development, up to the point of commencement of production drilling and start of construction of infrastructure, stretches roughly a 4 to 5 year period, covering the following main steps:

Step 1: Analysis of geological and geophysical data to inform exploration program including location of exploration wells. Exploration drilling program.

Step 2: Analysis of exploration data. Installation of pilot wells to prove coal seam gas yields and coal seam gas water production.

Step 3: Conceptual and preliminary design of gas field. Land access negotiations with landowners initiated. Consultation with landowners and key stakeholders on gas field development. Ecological and cultural heritage clearance surveys, and geotechnical investigations.

Step 4: Detailed design of gas field and production facilities. Ongoing land access negotiations.

Step 5: Detailed design of gas field and production facilities, revision and/or development of work plans, preparation of site specific environmental management plans. Land access arrangements finalised.

Environmental Impact Statement
Surat Gas Project