6

IMPACT ASSESSMENT METHOD

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6 Impact Assessment Method

This chapter outlines the methods employed within the EIS specialist technical studies to undertake an assessment of potential impacts on the environmental, social and economic values associated with the Project, from proposed construction, operation and decommissioning activities. Potential cumulative impacts associated with this Project and other existing projects within the region are outlined within each technical study impact assessment (Sections 8 to 29), where appropriate, and summarised and discussed specifically within the Cumulative Impacts chapter (Section 31) of this EIS.

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).

The impact assessment methodology outlined in this chapter has also been previously developed and used in Arrow's Surat Gas Project EIS (Arrow, 2011).

The nature of CSG resources are that they are extensive and spatially variable, requiring a geographically widespread development of infrastructure locations to recover the resource. As a result, the precise location for production wells, gathering lines and other associated infrastructure required to transport and process the gas and treat the associated water, remains uncertain until exploration results inform the optimum well spacing and detailed design confirms the gas field layout.

Arrow uses an environmental framework to reduce the uncertainty about potential impacts of CSG development. This is done by identifying environmental constraints and proposing environmental management controls that will apply to development in a particular area. The environmental framework ensures planning and development of CSG fields will occur with consideration of environmental, social and cultural constraints commencing at the outset, during the planning and preliminary design phase.

In order to establish an environmental framework for the Project, it is first necessary to identify the environmental and social values associated with the Project area. Environmental values are identified during a number of technical specialist assessments of the potential impacts associated with the design, construction, operation and maintenance and rehabilitation of the proposed Project.

6.1 Environmental and Social Values

6.1.1 Environmental Values

Environmental values encompass the qualities, characteristics and conditions of the physical, biological, social, cultural and economic environments. For this Project, technical specialists undertook detailed desktop studies and targeted field surveys to identify environmental values in accordance with the definition of 'environmental values' as set out by the *Environmental Protection Act 1994* (EP Act). The EP Act defines an environmental value as:

a) *a quality or physical characteristic of the environment that is conducive to ecological health or public amenity or safety; or*
b) *another quality of the environment identified and declared to be an environmental value under an environmental protection policy or regulation.*

The technical specialists undertaking the assessment of environmental values for the EIS adopted assessment criteria set out in statutory guidelines or policy, and where not provided, they defined values based on their standard accepted practice and their own knowledge base within their specific field of study.

A particular environmental value's sensitivity or vulnerability to change, as indicated by its conservation status and other criteria, provides an indication of the level of constraint it poses to the development of Project infrastructure. For this EIS, technical specialists made an assessment on the sensitivity of the identified environmental values and the associated constraint, based on a number of criteria.

Where an environmental value is defined by a feature (such as an 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 emissions modelling will indicate the distance at which the applicable air emission limits will be achieved, providing an indication of the separation required between CSG facilities and sensitive receptors.

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

6.1.2 Social Values

Social values are qualities of the social environment that are conducive to the well-being of the population, and the maintenance of public amenity and safety. These qualities may be affected adversely should they be subject to changes, either attributable directly to, or induced by, the Project's activities. Some values may be able to be defined in a spatial sense, enabling an assessment of change directly related to their proximity to a Project activity (for example, a residential area close to a proposed storage depot). Other values may be defined in terms of the qualitative characteristics of a group of people, where changes would tend to be induced indirectly by the Project (for example, increased school enrolments due to population increase in the Project area).

The baseline identification and assessment of social values drew on secondary information (such as census data, mapping, examination of regional planning reports etc.) as well as a program of field investigation and consultation with key stakeholders to establish qualitative characteristics of the social environment and the sensitivity of the social values likely to be affected by the Project.

6.2 Impact Assessment Method

This section describes the methods used by technical specialists to undertake the assessment of impacts associated with the activities undertaken during the Project's life-cycle. It briefly outlines the structure of subsequent impact assessment sections, which present a summary of the technical study report findings appended to this EIS.

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Sections 8 to 29 of this EIS present the potential impacts associated with the proposed development. The Cumulative Impacts chapter (Section 31) of this EIS provides an overall assessment of the cumulative impacts of the Project in combination with other planned developments or sources of contamination.

The potential impacts of the proposed development on environmental values have been assessed for each environmental aspect using one of three methods:

- Significance assessment;
- Risk assessment; and
- Compliance assessment.

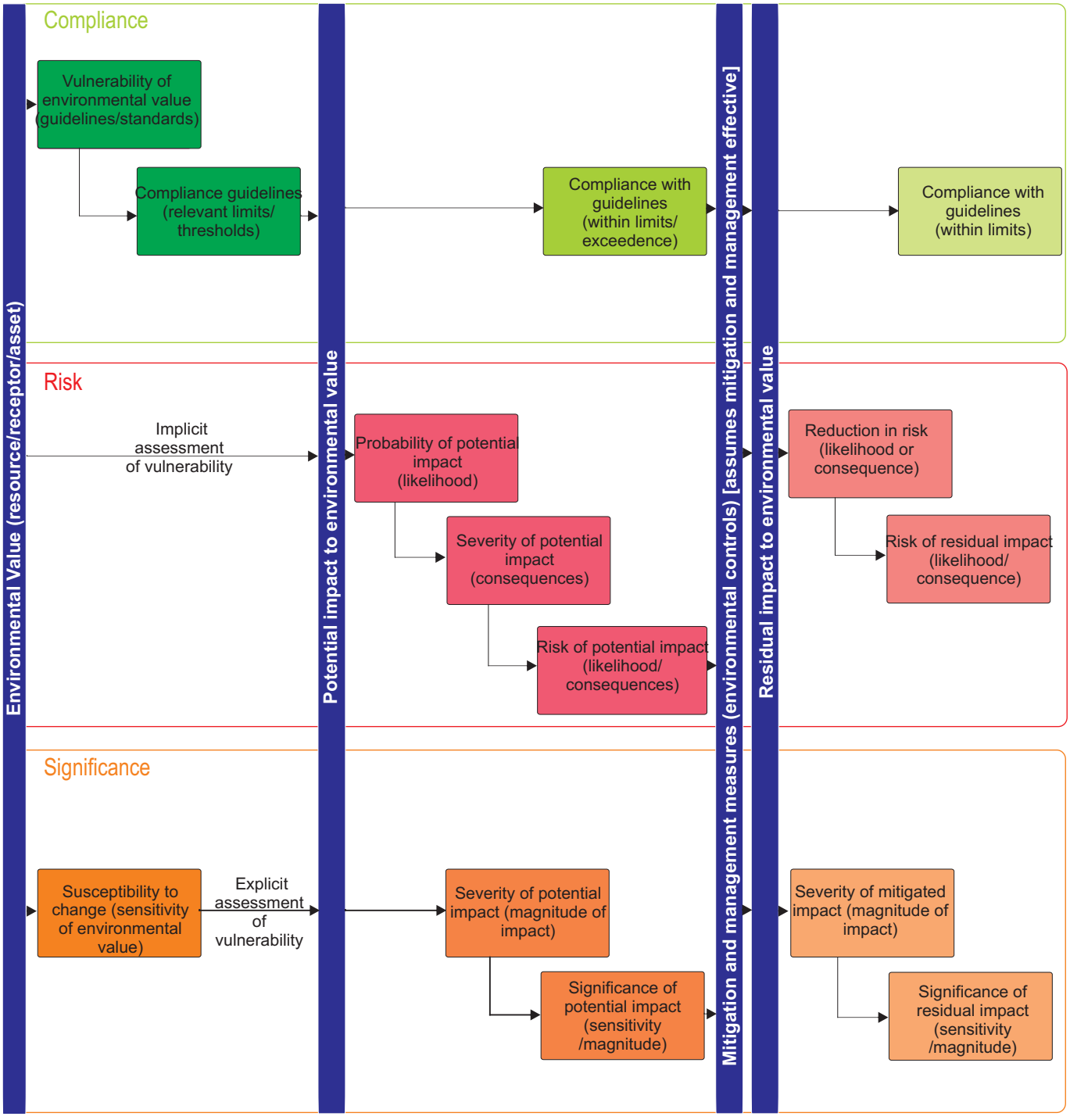
Figure 6-1 shows how each method was applied to the impact assessment process. This is reflected in the structure of this chapter.

Significance assessment was adopted for technical studies where an understanding of the vulnerability of the environmental asset or resource was important to the assessment. For example, an understanding of the sensitivity of ecosystems in their current state provides a sound basis for determining the severity of potential impacts.

Risk assessment was utilised for potential impacts that arise through the management of materials and substances (such as waste).

A compliance assessment was adopted for environmental aspects regulated by statutory guidelines, including air quality and noise and vibration.

Application of these methods requires an understanding of the affected environmental values (discussed in Section 6.1.1) and a description of each impact assessment method is set out below.



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ENVIRONMENTAL IMPACT ASSESSMENT METHODS

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IMPACT ASSESSMENT METHOD

Figure: **6-1**

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6.2.1 Assessment Methods

6.2.1.1 Significance Assessment Method

The significance of an impact is assessed by considering the vulnerability or sensitivity of the environmental value and the magnitude of the impact, before and after the application of mitigation and management measures. It assumes the impact will occur and that the worst case will be identified and assessed. The significance of the residual impact is assessed assuming successful implementation of proposed mitigation and management measures.

Sensitivity of an Environmental Value

An environmental value's sensitivity is determined by its susceptibility or vulnerability to threatening processes, and consequently, its intrinsic value. Model attributes that define sensitivity were revised by the technical specialists to reflect the specific focus of the technical study. The model attributes of sensitivity are:

- **Conservation status**: assigned by governments (including statutory and regulatory authorities) or recognised international organisations through legislation, regulations and international conventions.
- **Intactness**: an assessment of how intact an environmental value is. It is a measure (with respect to its characteristics or properties) of its existing condition, and particularly its representativeness.
- **Uniqueness or rarity**: an assessment of its occurrence, abundance and distribution within and beyond its reference area, e.g., bioregion/ biosphere.
- **Resilience to change**: an assessment of the ability of an environmental value to adapt to change without adversely affecting its conservation status, intactness, uniqueness or rarity.
- **Replacement potential**: an assessment of the potential for a representative or equivalent example of the environmental value to be found to replace any losses.

Applying these attributes enables the sensitivity of an environmental value to be ranked as high, moderate or low. Table 6-1 lists the model criteria adopted for sensitivity.

Table 6-1 Criteria for Sensitivity

Sensitivity	Description
High	• The environmental value is listed on a recognised or statutory state, national or international register as being of conservation significance. • The environmental value is intact and retains its intrinsic value. • The environmental value is unique to the environment in which it occurs. It is isolated to the affected system/area which is poorly represented in the region, territory, country or the world. • It has not been exposed to threatening processes, or they have not had a noticeable impact on the integrity of the environmental value. Project activities would have an adverse effect on the value.
Moderate	• The environmental value is recorded as being important at a regional level, and may have been nominated for listing on recognised or statutory registers. • The environmental value is in a moderate to good condition despite it being exposed to threatening processes. It retains many of its intrinsic characteristics and structural

Sensitivity	Description
	elements. • It is relatively well represented in the systems/areas in which it occurs but its abundance and distribution are limited by threatening processes. • Threatening processes have reduced its resilience to change. Consequently, changes resulting from Project activities may lead to degradation of the prescribed value. • Replacement of unavoidable losses is possible due to its abundance and distribution.
Low	• The environmental value is not listed on any recognised or statutory register. It might be recognised locally by relevant suitably qualified experts or organisations e.g., historical societies. • It is in a poor to moderate condition as a result of threatening processes which have degraded its intrinsic value. • It is not unique or rare and numerous representative examples exist throughout the system / area. • It is abundant and widely distributed throughout the host systems / areas. • There is no detectable response to change or change does not result in further degradation of the environmental value. • The abundance and wide distribution of the environmental value ensures replacement of unavoidable losses is achievable.

The Sensitivity assessment undertaken by technical specialists has informed the constraints analysis and mapping (Appendix BB of this EIS) that has, and will continue to be used by Arrow for infrastructure location and route selection, and the management of potential impacts of construction, operation and maintenance and decommissioning activities.

Magnitude of Impact

The magnitude of an impact on an environmental value is an assessment of the geographical extent, duration and severity of the impact. These attributes are defined as follows:

- Geographical extent: an assessment of the spatial extent of the impact where the extent of impact is defined as site, local, regional or widespread (i.e. state-wide, national or international).
- Duration: the timescale of the effect (i.e. if it is short, medium or long term).
- Severity: an assessment of the scale or degree of change from the existing condition, as a result of the impact. This could be positive or negative.

Applying these attributes enables the magnitude of an impact to be ranked as high, moderate or low. Table 6-2 lists the model criteria adopted for magnitude.

Table 6-2 Criteria for Magnitude

Magnitude	Description
High	An impact that is widespread, long lasting and results in substantial and possibly irreversible change to the environmental value. Avoidance through appropriate design responses or the implementation of site-specific environmental management controls are required to address the impact.

Magnitude	Description
Moderate	An impact that extends beyond the area of disturbance to the surrounding area but is contained within the region where the project is being developed. The impacts are short term and result in changes that can be ameliorated with specific environmental management controls.
Low	A localised impact that is temporary or short term and either unlikely to be detectable or could be effectively mitigated through standard environmental management controls.

Significance of an Impact

The significance of an impact on an environmental value is determined by the sensitivity of the value itself and the magnitude of the impact it experiences. The significance assessment matrix below (Table 6-3) shows how, using the criteria above, the significance of an impact is determined.

Table 6-3 Significance Assessment Matrix

	Sensitivity of Environmental Value		
Magnitude of Impact	High	Moderate	Low
High	Major	High	Moderate
Moderate	High	Moderate	Low
Low	Moderate	Low	Negligible

The classifications (major, high, moderate, low or negligible) for significance of an impact are as follows:

Major Significance of Impact - arises when an impact will potentially cause irreversible or widespread harm to an environmental value that is irreplaceable because of its uniqueness or rarity. Avoidance through appropriate design responses is the only effective mitigation.

- **High** Significance of Impact - occurs when the proposed activities are likely to exacerbate threatening processes affecting the intrinsic characteristics and structural elements of the environmental value. While replacement of unavoidable losses is possible, avoidance through appropriate design responses is preferred to preserve its intactness or conservation status.
- **Moderate** Significance of Impact - although reasonably resilient to change, the environmental value would be further degraded due to the scale of the impact or its susceptibility to further change. The abundance of the environmental value ensures it is adequately represented in the region, and that replacement, if required, is achievable.
- **Low** Significance of Impact - occurs where an environmental value is of local importance and temporary and transient changes will not adversely affect its viability provided standard environmental management controls are implemented.
- **Negligible** Significance of Impact - impact on the environmental value will not result in any noticeable change in its intrinsic value and hence the proposed activities will have negligible effect on its viability. This typically occurs where the activities occur in industrial or highly disturbed areas.

Application of the criteria for sensitivity and magnitude may produce inconsistent designations. For example, the magnitude of impacts might be assessed as widespread (large geographical extent) but readily reversible (short-term duration and low severity). In these instances, technical specialists used their professional judgement and the precautionary principle to determine the overall sensitivity of the environmental value or magnitude of impact.

The significance assessment matrix and relative criteria for sensitivity and magnitude were refined by the technical specialists to reflect the specific focus of each technical study that used this assessment method. This included adding additional classifications (e.g. a five by five matrix) and revising the criteria to reflect the focus of the study. Where sensitivity and magnitude criteria have been refined for a specific technical study the refined matrix is provided within the specific technical report for the assessment.

Application of Significance Assessment Method

Once determined, the sensitivity of an environmental value does not change unless proposed actions or activities reduce the value's vulnerability to adverse effects. For example, programmed road upgrade works that occur or are scheduled to occur prior to the commencement of a project (possibly as a result of forecast growth in traffic or a road reaching its design life) would improve the road condition making it more resilient to the impacts of traffic generated during construction and operation of the proposed development.

The impact magnitude is assessed prior to and after the application of mitigation measures. Combining this assessment with the sensitivity of the environmental value enables the significance of the impact to be determined and, following the application of mitigation, the significance of the residual impact. The change in significance is a measure of the effectiveness of the proposed mitigation.

Technical specialists assessed the significance of impacts and presented them in the technical reports. In reporting the findings of the technical studies in this EIS, individual assessments made by the technical specialists have, where appropriate, been consolidated to provide an overall assessment of significance for each of the key impacts.

6.2.1.2 Risk Assessment Method

The principles of risk management described in AS / NZS 31000:2009 *Risk Management – Principles and Guidelines*, and its companion documents: HB 436:2004 Risk Management Guidelines Companion to AS / NZS 4360:2004 and HB 203:2012 *Environmental Risk Management – Principles and* Process, were adopted in the risk assessment method.

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Qualitative risk assessment was used to assess the likelihood and consequence of impacts to the environment from the proposed Project activities. Quantitative risk assessment was used to evaluate aspects of the hazards and risks associated with the proposed development. Qualitative criteria developed to rank the likelihood and consequences of potential impacts are set out in Table 6-4 and Table 6-5 respectively.

Table 6-4 Qualitative Criteria for Likelihood

Descriptor	Description
Common Almost certain or common	Will occur, or is of a continuous nature, or the likelihood is unknown. There is likely to be an event at least once a year or greater (up to 10 times per year). It often occurs in similar environments. The event is expected to occur in most circumstances.
Has happened Likely, has occurred in recent history	There is likely to be an event on average every one to five years. Likely to have been a similar incident occurring in similar environments. The event will probably occur in most circumstances.
Could happen Possible, has occurred in the past, but not common	The event could occur. There is likely to be an event on average every 5 to 20 years.
Not likely Unlikely or uncommon	The event could occur but is not expected. May have heard it discussed as a possibility but an extremely unusual one. A rare occurrence (once per 100 years).
Practically Impossible Rare or practically impossible	The event may occur only in exceptional circumstances. Very rare occurrence (once per 1,000 years). Unlikely that it has occurred elsewhere; and, if it has occurred, it is regarded as extremely unique.

Table 6-5 Qualitative Criteria for Consequence

Descriptor	Description
Severe Widespread serious long-term effect	Extreme permanent changes to the environment, major public outrage, or the consequences are unknown. Serious environmental harm that causes actual or potential environmental impacts that are irreversible or of high impact or widespread. Likely prosecution by regulatory authorities.
Major Wider spread, moderate to long-term effect	Substantial and significant changes that will attract public concern; are only partially able to be rehabilitated or uncertain whether it can be successfully rehabilitated. Actual or potential environmental harm either temporary or permanent, requiring immediate attention. Possible prosecution by regulatory authorities.
Moderate Localised, short-term to moderate effect	Significant changes that may be rehabilitated with difficulty. Direct or indirect environmental impacts beyond location (onsite or offsite). Repeated public concern. Reportable to the government.
Minor Localised short-term effect	Some limited consequence but no significant long-term changes, may be easily rehabilitated.
Negligible No impact or no lasting effect	Possible impacts but without noticeable consequence. Temporary or short-term reversible environmental impact, localised event, location of little environmental value.

The level of risk of each environmental impact is determined by combining likelihood and consequence in a matrix. Table 6-6 was derived from the environmental impact aspect of Arrow's risk matrix.

Consistent with the requirements of AS / NZS 31000:2009 *Risk Management – Principles and Guidelines* and its companion documents, the technical specialists, in some instances, revised the descriptors, descriptions and categories to reflect the needs and specific objectives of the studies. Proposed changes were reviewed to ensure that the revised criteria were consistent with the model criteria, (i.e. the descriptors and descriptions adequately differentiated the levels of risk). The likelihood and consequence criteria, and risk matrix used by the technical specialists are described in the relevant technical study reports.

Table 6-6 Qualitative Risk Assessment Matrix

		Likelihood				
		Rare or practically impossible	**Unlikely or uncommon**	**Possible, has occurred in the past, but not common**	**Likely, has occurred in recent history**	**Almost certain or common**
Consequence		**Rare**	**Unlikely**	**Possible**	**Likely**	**Almost certain**
Widespread serious long-term effect	**Severe**	Medium	High	High	Very High	Very High
Wider spread moderate to long-term effect	**Major**	Medium	Medium	High	High	Very High
Localised, short-term to moderate effect	**Moderate**	Low	Medium	Medium	Medium	High
Localised short-term effect	**Minor**	Very Low	Low	Low	Medium	Medium
No impact or no lasting effect	**Negligible**	Very Low	Very Low	Low	Low	Medium

Where appropriate, risk assessments undertaken by the technical specialists for individual impacts have been consolidated to provide an overall assessment of the risk of key environmental impacts. In these instances Table 6-4, Table 6-5 and Table 6-6 were used for the overall assessment of risk of environmental harm.

6.2.1.3 Compliance Assessment Method

A number of statutory guidelines are set out in environmental protection policies and other regulatory documents to protect the relevant environmental values. These guidelines include an implicit assessment of the vulnerability of the environmental value. This is done by setting limits or thresholds, or providing the framework for determining the vulnerability of an environmental value. For example, a Cultural Heritage Management Plan or agreement can be established under the *Aboriginal Cultural Heritage Act 2003* (ACH Act).

The limits and thresholds set out in the guidelines are generally based on established scientific knowledge and general societal aspirations typically relating to quality of life.

The application of the compliance assessment method typically uses modelling to predict emissions or discharges from proposed Project activities. This enables compliance with published limits or thresholds, which are to be determined before, and also if necessary, after the application of mitigation and management measures. In the case of Indigenous cultural heritage, assessments are based on the retained knowledge of Indigenous people and the guidance of archaeological and anthropological experts. Compliance in this case is demonstrated through implementation of the duty of care provisions of the ACH Act, and the cultural heritage management plan or agreement.

6.2.2 EIS Impact Assessment Section Structure

The impact assessment studies (Sections 8 through 29) of the EIS generally address the following aspects:

Legislative Context and Standards - This describes the applicable policy, legislation, regulations, standards and guidelines for the protection of the environmental values, management of impacts and, in some instances, the conduct of technical investigations, such as noise measurement standards.

Assessment Methods - The study methods that were used to understand, describe and assess potential impacts on the environmental values are detailed, along with any assumptions and/or limitations. Methods include desktop studies, field investigations, modelling and stakeholder consultation.

Where relevant, information is provided on the ranking criteria and assessment matrix used, particularly if they vary significantly from the model criteria and matrix described. Where the compliance method was adopted, the limits or thresholds set out in applicable standards or guidelines are detailed.

Existing Environment and Environmental Values - The existing environment, including applicable baseline or background information, and the identified environmental values are described. The geographic extent of the area potentially affected by the Project is described, along with the physical, biological, cultural and social environments. If the significance approach to impact assessment was adopted, the sensitivity of the environmental values is described. Where compliance assessment was adopted, the baseline or background limits determined through field measurement and sampling are listed.

Issues and Potential Impacts - Project activities that may have an impact on the identified environmental values are detailed, along with the assessment of the potential impacts of those activities. There is a focus on the key impacts of the proposed development, with the comprehensive assessment of all impacts detailed in the relevant technical study.

The significance of a potential impact or risk of environmental harm is described through discussion of the findings of the assessment carried out by the technical specialist. Where significance assessment was adopted, the magnitude of the impact is described, along with the results of application of the significance assessment matrix. Where risk assessment was used, the likelihood and consequence of environmental harm from Project activities are described and the assessed risk from application of the risk matrix presented. Compliance with statutory guidelines is reported where that method was adopted.

Environmental Protection Objectives - The environmental protection objectives that describe the commitment to protect the identified environmental values from potential impacts are outlined. The environmental protection objectives are measurable and auditable, so that achievement of the desired outcomes can be demonstrated by a comparison against proposed performance indicators.

Avoidance, Mitigation and Management Measures - This describes the avoidance, mitigation and management measures that will be implemented to avoid or reduce potential impacts to as low as reasonably practicable, based on the hierarchy of avoid, minimise, manage and offset. The aim of these measures is to protect identified values and achieve the environmental protection objectives. Measures will be implemented through Project design, construction methods, operating and maintenance procedures, and decommissioning methods.

Many measures to avoid, mitigate and manage potential impacts have been built into Arrow's processes as part of its core business systems. The core business aspects of environmental management constitute the base case prior to the implementation of the identified mitigation measures.

Mitigation and management measures proposed will be incorporated in, and implemented through, Arrow's Environmental Management System. This will be the case whether the measures are generic and applicable to a range of Project activities, wherever they occur, or are measures that are specific to a location, area, or activity. The mitigation and management measures set out in this EIS are Arrow's commitments to the effective management of the potential environmental and social impacts of the Project.

The mitigation and management measures that are applicable to the protection of environmental values are included in the EM Plan (Appendix Z of this EIS) and those that are applicable to the protection of social values in the Social Impact Management Plan (Appendix V of this EIS).

Residual Impacts - The residual impacts to the identified environmental values assuming the effective implementation of the proposed avoidance, mitigation and management measures are described.

Where significance assessment has been adopted, the magnitude of the residual impact is assessed and used in the significance matrix to determine the significance of the residual impact, which reflects the effectiveness of the proposed mitigation.

Evaluation of the likelihood and consequence of the residual impact and application of the adopted risk assessment matrix provides a measure of the effectiveness of mitigation and resultant risk of environmental harm where that method was adopted.

Modelling of emissions and discharges with proposed mitigations in place will determine whether those potential sources of pollutants or contaminants comply with the applicable guidelines, thereby satisfying regulatory requirements and demonstrating the protection of relevant environmental values.

Inspection and Monitoring - Proposed inspection and monitoring that will demonstrate achievement of the environmental protection objectives is outlined. The programs will observe and report on the performance of the proposed mitigation and management measures, with a focus on facilitating early intervention and remediation of identified non-conformances or the implementation of adaptive management when trigger levels are reached.

The proposed methods, parameters, locations, frequency and performance indicators are described in the EM Plan (Appendix Z) and Social Impact Management Plan (Appendix V) of this EIS.

6.3 Conclusions

Impact assessment methodologies have been used in Sections 8 to 29 of this EIS to assess the Project's potential impact on local environmental and social values as a result of activities undertaken throughout the Project's life-cycle (as defined in government policies and regulations or as an attribute of the environment that is conducive to ecological health, public amenity or safety).