6 Risk assessment methodology

6 RISK ASSESSMENT METHODOLOGY

6.1 Introduction

INPEX has committed to a systematic risk assessment process as a means of achieving best practice in environmental management for its Ichthys Gas Field Development Project (the Project). The company believes that considerable advantages can be gained by communicating environmental impacts through a risk-ranking process to stakeholders and decision-makers. Understanding the risks to the environment that a development of this type can pose and the factors that govern whether such risks are likely to emerge is essential to a proactive approach to environmental management.

This chapter of the draft environmental impact statement (Draft EIS) describes the methodology used to identify and categorise environmental risks resulting from planned activities associated with the Project. The purpose of this methodology is to identify the activities and the environmental aspects associated with these activities that have the potential to result in environmental impacts. By developing management measures and controls to avoid or reduce the risks identified, the "residual risks" can be reduced to an acceptable level.

The risk assessment process used has been developed to align with Australian Standard *AS/NZS 4360:2004, Risk management* together with its associated document *Risk management guidelines—Companion to AS/NZS 4360:2004* (Handbook HB 4360:2004).

The assessment of environmental risk is an essential component of INPEX's approach to the environmental impact assessment process. It also forms the basis for ongoing management and review of significant environmental risks throughout the life of the Project. The outcomes from the risk assessment will be used in the design, construction, commissioning, operations and decommissioning phases to ensure that all risks identified will be managed appropriately, with suitable additional controls being incorporated into the design of the Project as it progresses.

Management controls identified through the risk assessment process are included in the provisional environmental management plans (EMPs) provided in this Draft EIS as annexes to Chapter 11 *Environmental management program* and documented in Chapter 7 *Marine impacts and management*, Chapter 8 *Terrestrial impacts and management* and Chapter 10 *Socio-economic impacts and management*.

The assessment of public safety was conducted through a quantitative risk assessment which is also described in Chapter 10.

6.2 Methodology

Risk-based environmental assessment is recognised as an iterative process that is subject to an inherent degree of uncertainty. In order to reduce the levels of uncertainty, this methodology allows for ongoing research, monitoring and review as part of the environmental review process outlined in Chapter 11.

The risk assessment methodology adopted for the Draft EIS ensures that a systematic approach is applied to the assessment and management of environmental risk. The methodology can be divided into three main steps:

1. risk scoping and preliminary risk assessment
2. detailed risk assessment
3. communication of residual risk.

The methodology is summarised in the flow diagram in Figure 6-1.

6.2.1 Risk scoping and preliminary risk assessment

The risk scoping and preliminary risk assessment was undertaken through two main mechanisms:

- by holding preliminary high-level environmental risk workshops
- by soliciting input from government, specialists and stakeholders.

These are described in more detail below.

Preliminary environmental risk workshops

A series of preliminary environmental risk workshops were conducted through the scoping and preliminary risk assessment stage.

The objective of the workshops was to identify and categorise the significant activities during the Project's construction, commissioning and operations phases that could have environmental aspects and impacts. Once identified, each activity with an associated impact was then ranked according to its environmental risk. The purpose of the workshop was to identify the high-level risks and uncertainties, and any gaps in knowledge, in order to direct the development of the environmental studies and surveys and to influence Project design from an early stage.

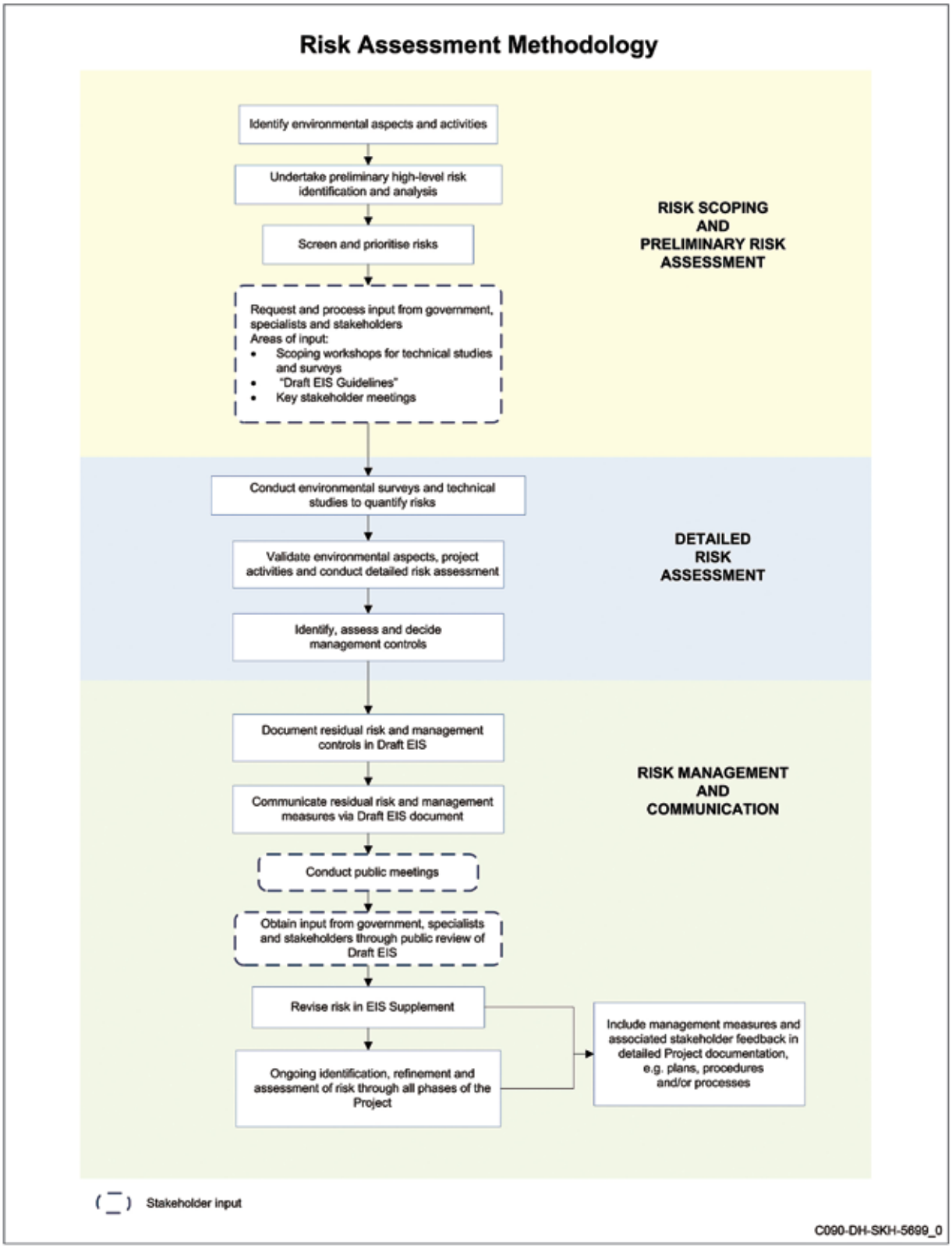

Figure 6-1: Risk assessment methodology

The workshops involved participants from a number of Project disciplines and groups, including the following:

- environmental engineers and scientists
- civil engineers
- process engineers
- onshore facilities personnel
- offshore facilities personnel
- marine operations personnel
- pipeline engineers
- operations personnel
- quality, health and safety personnel.

The outcomes of the preliminary risk workshops formed the basis of the Project's environmental risk and aspect register. This was then built upon in the subsequent detailed risk workshops.

The methods used in the workshops are summarised below.

Identification of environmental aspects

An environmental aspect is defined as follows:

> *An environmental aspect is a feature or characteristic of a project activity that has the potential to affect the environment.*[1]

Each aspect brainstormed with the workshop participants yielded a list of activities that could lead to the occurrence of that particular aspect.

The key aspects identified during the workshops are as follows:

- land and sea use (activities associated with access to Project areas and the physical presence of infrastructure)
- physical disturbance to plant and animal life as a result of Project activities, for example through dredging and clearing operations
- physical disturbance to heritage sites
- acid drainage and acid sulfate soil disposal
- drainage and runoff (stormwater, erosion, possible contaminants)
- noise and vibration
- visual impact
- accidental spills
- dredge discharges and dredge spoil disposal
- waste disposal
- air emissions
- greenhouse gas emissions
- hydrotest water disposal
- wastewater discharges
- quarantine breaches
- marine blasting.

Identification of environmental impacts

Once identification of the activities which could result in a particular environmental aspect was complete, the likely impacts of each were identified.

An environmental impact has been defined as follows:

> *any change to the environment, whether adverse or beneficial, wholly or partly resulting from an organization's environmental aspects.*[1]

Each environmental aspect has been considered in turn against each sensitive receptor in the surrounding environment for a potential pathway or interaction. Where pathways exist, each potential environmental impact has been recorded in the aspect register.

Greenhouse gases constitute a significant environmental risk. However, the standard risk assessment processes (assessing consequence versus likelihood) is not an appropriate tool for evaluating global pollutants. Greenhouse gas management is discussed in detail in Chapter 9 *Greenhouse gas management*.

Preliminary environmental risk ranking

The preliminary risk assessment required each activity that had an associated impact to be qualitatively ranked by risk categories, with severities ranging from "critical" through to "high", "medium" and "low". This method involved the identification of a high-level likelihood and consequence for each impact and, based on this, the determination of the level of risk through the application of an environmental risk matrix (see Figure 6-2 and Table 6-1 below). In addition, where standard management controls were known to exist, these were documented.

When critical risks were identified, these were addressed either by avoiding the activity or by adopting an alternative process with a lower associated risk to the environment. This qualitative ranking of the risks assisted INPEX both to prioritise the environmental risks and to identify what technical studies needed to be undertaken where risk allocation had been based on uncertainties or scanty or inadequate knowledge.

1 Adapted from *AS/NZS ISO 14001:2004, Environmental management systems—Requirements with guidance for use*

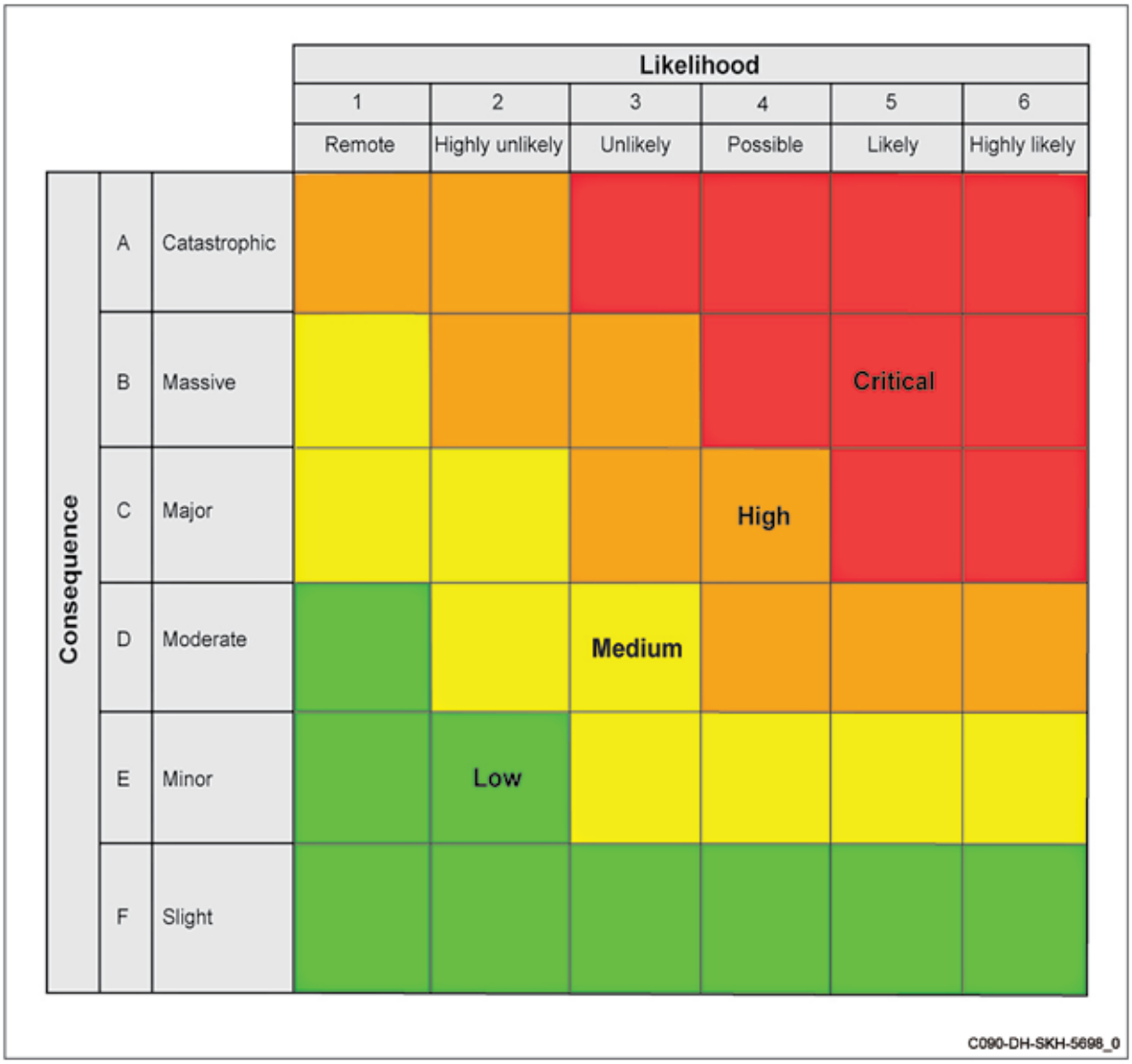

Figure 6-2: INPEX environmental risk matrix

Table 6-1: Management of corresponding risk category

	Management
Critical	Undertake an ALARP ("as low as reasonably practicable") assessment and consider risk-sharing, transfer and avoidance options.
High	Assess risk and manage to an ALARP level.
Medium	Review to ensure that appropriate barriers and controls are in place.
Low	Manage by operational documentation.

Input from government, specialists and stakeholders

Environmental impact statement guidelines

The environmental impact statement guidelines prepared for the Project by the Commonwealth's Department of the Environment, Water, Heritage and the Arts (DEWHA) and the Northern Territory's Department of Natural Resources, Environment, the Arts and Sport (NRETAS), issued in September 2008[2], identified the key matters of concern and established the scope for the environmental, social and economic studies required to assess the potential impacts of the Project.

These EIS guidelines were presented for public review in draft form in June 2008 to provide an opportunity for stakeholders to comment on issues relating to the Project. The DEWHA and NRETAS took the feedback from the review period into consideration when finalising the guidelines for publication in September 2008.

Scoping of technical studies and surveys

INPEX had earlier engaged in a workshop with various Northern Territory government departments, in April 2008, to discuss the range of baseline and impact assessment studies required for the onshore and nearshore development areas. Participants in the workshop included government experts from various divisions of NRETAS and the Department of Planning and Infrastructure[3], members of the INPEX environmental team, INPEX engineers, and environmental specialists. This process enabled the participants to identify significant environmental values within the Project area, to carry out a high-level assessment of relevant existing knowledge, and to reach agreement on the scope and methods of further investigations to be carried out by INPEX.

Stakeholder consultation

In order to identify the environmental and socio-economic aspects that could be affected by the Project, and to investigate these potential impacts with appropriate rigour, INPEX initiated stakeholder consultation following submission of the initial referrals. This process has continued through the Draft EIS preparation phase and will continue as the Project moves through its successive phases. More details on the stakeholder consultation process and its outcomes are provided in Chapter 2 *Stakeholder consultation*.

2 *Guidelines for preparation of a draft environmental impact statement: Ichthys Gas Field Development Project, Blaydin Point, Darwin, NT* (September 2008), available online at <http://www.nt.gov.au/nreta/environment/assessment/register/inpex/pdf/eisguidelinesinpex.pdf> (last accessed 1 March 2010).

3 The Northern Territory's Department of Planning and Infrastructure was restructured in December 2009 and its functions were transferred to two new departments, the Department of Lands and Planning and the Department of Construction and Infrastructure.

6.2.2 Detailed risk assessment

Conducting technical studies and surveys

In order to inform the detailed risk assessment and address the uncertainties or knowledge gaps that were identified at the risk scoping and preliminary risk assessment stage, a range of environmental surveys and modelling studies were undertaken.
These included the following:

- marine water and sediment quality studies
- marine ecology and benthic community studies
- terrestrial ecology studies
- hydrology and hydrogeology studies
- oil-spill trajectory modelling for the nearshore and offshore development areas
- dredge-plume modelling for the nearshore development areas
- plume modelling for wastewater discharges in the nearshore and offshore development areas
- air-quality modelling for the onshore and nearshore development areas
- noise modelling, both underwater and terrestrial.

A comprehensive list of the studies and modelling programs undertaken is provided in Chapter 1 *Introduction*.

Validate environmental aspects, Project activities and risks

Following the preliminary environmental risk workshops and using input from the technical studies, the modelling, and the stakeholder engagement exercise, it was possible to assess the risks to the environment in more detail. This was undertaken in a series of workshops by specialists in the various fields.

The workshop methodology and evaluation process consisted of the following steps:

- the validation of environmental aspects
- the validation of actual and potential environmental impacts
- the validation and identification of additional management measures and controls
- the determination of likelihood and consequence
- the assessment of the residual risk
- a determination of whether any additional controls would be required to reduce residual risk to ALARP.

These steps are described below.

Validation of environmental aspects and impacts

The information gathered both from the technical studies and modelling and from government agencies and stakeholders assisted the workshop team members to assess and validate the environmental aspects and impacts previously identified during the preliminary environmental risk workshops.

Determination of likelihood and consequence

The risk assessment required a more detailed approach to determining the likelihood and consequence of each impact. The definitions used for likelihood and consequence during this detailed assessment are described below and shown in tables 6-2 and 6-3, the environmental risk matrix is shown in Figure 6-2, and the categories are explained in Table 6-1.

Where relevant data were available to permit a quantitative evaluation of the likelihood and consequence of an impact, this approach was applied, as was the case with the assessment of oil-spill scenarios. Where a quantitative assessment was not possible, a qualitative evaluation was made which relied on the knowledge and experience of team members and specialists.

Likelihood can be described as the level of probability that, or the frequency with which, an aspect of an activity will impact upon the environment.
The likelihood levels applied in this detailed risk assessment have been quantified using six categories, ranging from "remote" (1) to "highly likely" (6) and is based on past experience and on frequency or probability depending on the nature of the aspect, the type of activity and the availability of data as shown in Table 6-2.

A consequence can be defined as an outcome or impact from an event occurring. Six categories, ranging from "catastrophic" (A) to "slight" (F), have been used to describe the type and severity of a consequence of an impact on the environment resulting from a planned or accidental activity of the Project. As multiple consequences may apply for a single hazard or aspect, the approach used was to take the worst credible risk (in terms of consequence versus likelihood).

Consequence columns are coded (e.g. B1, S3) to allow the user to demonstrate which consequence drove the risk score. The consequence categories are as follows:

- biodiversity and ecological processes
  - protected species (B1)
  - marine primary producers (B2)
  - ecological diversity (B3)

Table 6-2: Definitions of "likelihood" for detailed environmental risk assessment

	Likelihood →					
Historical	Unheard of in the industry	Has occurred once or twice in the industry	Has occurred many times in the industry, but not in the Company	Has occurred once or twice in the Company	Has occurred frequently in the Company	Has occurred frequently at the location
Frequency (continuous operation)	Once every 10 000–100 000 years at the location	Once every 1000–10 000 years at the location	Once every 100–1000 years at the location	Once every 10–100 years at the location	Once every 1–10 years at the location	More than once a year at the location or continuously
Probability (single activity)	1 in 100 000–1 000 000	1 in 10 000–100 000	1 in 1000–10 000	1 in 100–1000	1 in 10–100	>1 in 10
	1	**2**	**3**	**4**	**5**	**6**
	Remote	**Highly unlikely**	**Unlikely**	**Possible**	**Likely**	**Highly likely**

Table 6-3: Definitions of consequences of environmental risk assessments

Consequences	Biodiversity and ecological processes			Environmental quality				Societal considerations		
	Protected species	Marine primary producers	Ecological diversity	Water quality	Marine sediment quality	Air quality	Soil and groundwater contamination	Protected areas	Cultural matters	Compliance
	B1	B2	B3	E1	E2	E3	E4	S1	S2	S3
A	Eradication of local population. Loss of critical habitats or activities.	Permanent loss of primary producers on large or regional scale.	Significant and permanent effects on ecological diversity on a regional scale.	Continuous or regular contamination of water quality above background and/or national or international standards and/or known biological effect concentrations on a regional scale.	Permanent to long-term contamination above background and/or national or international quality standards and/or known biological effect concentrations on a regional scale.	Continuous exceedance over national or international air-quality standards. Human fatalities possible.	Extensive off-site contamination of groundwater and/or soil on a regional scale. Cost of effective treatment not possible. Sustained damage to the environment; human health risks likely.	Significant permanent effect on one or more of protected-areas values.	Significant permanent impact on aesthetic, heritage, economic or recreational values. Overall societal benefits do not outweigh impacts.	Significant and continuous licence or regulatory or internal target exceedances. Fines and/or prosecutions incurred or expected.
B	Extensive impact on population(s). Significant impact on critical habitats or activities.	Recoverable loss of primary producers on a large scale.	Significant and permanent effects on ecological diversity on a large scale.	Continuous or regular contamination of water quality above background and/or national or international standards and/or known biological effect concentrations on a large scale.	Permanent to long-term contamination above background and/or national or international quality standards and/or known biological effect concentrations on a large scale.	Frequent and sustained exceedance over national or international air quality standards. Human fatalities possible.	Extensive off-site contamination of groundwater and/or soil at a medium scale. Treatment difficult and/ or expensive. Damage to the environment and risk to human health possible.	Significant long-term effect on one or more of protected-areas values.	Significant long-term impact on aesthetic, heritage, economic or recreational values. Overall societal benefits do not outweigh impacts.	Frequent and significant licence or regulatory or internal target exceedances. Fines or prosecutions likely.
C	Minor disruptions to a significant portion of the population. Minor impacts on critical habitats or activities. No threat to overall population viability.	Permanent loss of primary producers on a medium scale.	Significant and permanent effects on ecological diversity on a medium scale.	Continuous or regular discharge with contamination above background and/or national or international quality standards and/or known biological effect concentrations on a medium scale.	Permanent to long-term contamination above background and/or national or international quality standards and/or known biological effect concentrations on a medium scale.	Frequent, short-term exceedances over national or international air-quality standards. Human illness and effects on the environment possible.	Extensive contamination of groundwater and/ or soil, off-site contamination probable and treatment difficult and/or expensive. Limited threat to the environment or human health.	Moderate long-term or permanent effect on one or more of protected-areas values.	Moderate impact on aesthetic, economic, heritage or recreational values. Overall societal benefits do not outweigh impacts.	Frequent, minor to moderate licence or regulatory or internal target exceedances. Fines or prosecutions possible.
D	Minor disruptions or impact on a small portion of the population. Minor and temporary impact on critical habitat or activity. No threat to overall population viability.	Recoverable loss of primary producers on a medium scale.	Loss of ecological diversity on a medium scale. Community or habitat maintains ecological integrity though some change in species composition or abundance may occur. Community, habitats and species well represented regionally.	Continuous or regular discharge with contamination above background and/or national or international quality standards and/or known biological effect concentrations on a local to medium scale.	Short- to medium-term contamination above background and/or national or international quality standards and/or known biological effect concentrations on a medium scale.	Frequent temporary exceedances over national or international air quality standards. Human illness and effects on the environment possible.	Moderate contamination to groundwater or soil, contained within site boundary and readily treated. No significant threat to the environment or human health.	Moderate medium-term effect on one or more of protected-areas values. Full recovery expected.	Moderate impact on aesthetic, heritage, economic or recreational values. Overall societal benefits outweigh impacts.	Occasional significant licence or regulatory or internal target exceedances. Fines or prosecutions possible.
E	Minor and temporary disruption to small portion of the population. No impact on critical habitat or activity.	Permanent loss of small proportion of primary producers on a localised scale.	Loss of ecological diversity on a localised scale. Community or habitat maintains ecological integrity though some change in species composition or abundance may occur. Community, habitats and species well represented regionally.	Continuous or regular discharge, with contaminants reduced to below background and/or national or international quality standards and/or known biological effect concentrations within a small mixing zone.	Short- to medium-term contamination above background and/or national or international quality standards and/or known biological effect concentrations on a localised scale.	Occasional and temporary exceedance over national or international air quality standards. No effect on human health or the environment.	Minor contamination of soil and/or groundwater, contained within site boundary and readily treated. No threat to the environment or human health.	Minor medium-term effect on one or more of protected-areas values. Full recovery expected.	Minor impact on aesthetic, heritage, economic or recreational values.	Occasional minor licence or regulatory or internal target exceedances. No fines or prosecutions.
F	Behavioural responses of inconsequential ecological significance.	Recoverable loss of small portion of primary producers on a localised scale.	Minor loss of ecological diversity on a localised scale. Communities, habitats and species well represented on a medium scale.	Occasional discharge with contaminants reduced to below background and/or national or international quality standards and/or known biological effect concentrations within a small mixing zone.	Short-term contamination above background and/or national or international quality standards and/or known biological effect concentrations over a very small area (<1 km^2).	Very infrequent and temporary exceedance over national or international air-quality standards. No effect on human health or the environment.	Minor contamination of soil within site boundary and readily treated. No effect on groundwater. No threat to the environment or human health.	Negligible impact on protected-areas values.	Negligible impact on aesthetic, heritage, economic or recreational values.	Very infrequent minor licence or regulatory or internal target exceedances.

- environmental quality
  - water quality (E1)
  - marine sediment quality (E2)
  - air quality (E3)
  - soil and groundwater contamination (E4)
- societal considerations
  - protected areas (S1)
  - cultural matters (S2)
  - compliance (S3).

The consequence of an impact on the environment has to be considered in both spatial and temporal terms: is it localised or regional in its effect, is it affecting a small area or a large area, is it temporary or permanent, is it reversible or irreversible, or is it short term or long term?

This is the purpose of Table 6-3 where the definitions of each level of consequence have been tabulated.

Validation and identification of additional management measures and controls

A key component of the preliminary risk workshops and detailed risk assessment was the identification of the range of management measures and controls necessary to reduce the risks identified.

The level of management for each identified risk depended on its assigned risk-ranking category as shown in Figure 6-2 and Table 6-1.

Management controls for treating risk have been assessed in terms of the following considerations:

- their potential benefits
- their effectiveness in reducing risk
- the cost to implement the option(s)
- the impact of controls on personnel safety and other stakeholder objectives, including the introduction of new risks or issues.

The management measures and controls identified in chapters 7, 8 and 10 form the basis of the provisional EMPs in Chapter 11.

6.2.3 Communication of residual risk

Outcomes of the risk assessment process have been documented in this Draft EIS and will be communicated to stakeholders through the submission of the document for public review.

Summaries showing the outcomes of the risk assessment process have been presented in tables in chapters 7, 8 and 10.

Key aspects are listed with a summary of the associated activities, their potential impacts, management measures and controls, and residual risk. Residual risk is ranked using the INPEX environmental risk matrix in Figure 6-2 above. Table 6-4 provides an example of how risk is presented in the relevant chapters.

Table 6-4: Example of risk assessment summary table

Aspect	Activity	Potential impacts	Management controls, mitigating factors	Residual risk		
				C*	L†	RR‡
Soil erosion	Large-scale earthworks for construction of onshore processing facility. Clearing of vegetation during site preparation.	Sedimentation of mangrove areas around the onshore development area, leading to smothering of pneumatophores, which will lead to plant mortality and a reduction in plant growth.	Large-scale vegetation clearing will be undertaken preferentially in dry-season conditions to avoid the erosion risks associated with monsoon rains in the wet season. Erosion protection infrastructure (e.g. silt fencing, spoon drains, contouring and sediment ponds) will be installed to ensure that sediment is contained within the site boundaries as far as possible. If soil erosion is evident, exposed surfaces at the affected area will be stabilised with mulched vegetation, dust suppressants or slope stabilisation products. Provisional Vegetation Clearing, Earthworks and Rehabilitation Management Plan. Provisional Liquid Discharges, Surface Water Runoff and Drainage Management Plan.	F (B2)§	3	Low

* C = consequence.

† L = likelihood.

‡ RR = risk rating.

§ F – describes the level of consequence; B2 – describes the category of consequence.

It is important to note that the socio-economic aspects of the Project's operating environment are complex, and are influenced by many factors that are additional to the direct effects of the Project. For example, the local labour market will vary according to national and international economic conditions, making the consequences of the Project (which would be a relatively large employer in the Darwin region) difficult to predict at any point in time.

In addition, the consequences of certain socio-economic impacts are sometimes subjective and would be rated differently by different people. For example, the consequences of the Project employing large numbers of workers in the Darwin region could be seen as a positive opportunity for the employees joining INPEX, but a negative impact by other businesses seeking to attract or retain workers.

For these reasons, risk-ranking was not undertaken for some of the socio-economic aspects. Potential impacts have been identified for all socio-economic aspects of the Project that could affect the community, and management commitments have been developed to mitigate negative impacts and maximise benefits.

Once approved and published, the Draft EIS will be exhibited for public review and comment. During this public review period, any member of the public or government may submit comments or concerns on the environmental impacts of the Project to the DEWHA or to NRETAS through INPEX.

6.2.4 Ongoing monitoring and review

Environmental risk assessment is an iterative process. The aspect register generated as a result of the risk assessment workshop will be reviewed and updated as required. These reviews will be informed by ongoing environmental monitoring conducted as part of the environmental management system. This is critical for achieving continual improvement. The framework for environmental monitoring is outlined in Chapter 11.

In addition, as the Project progresses through the front-end engineering design phase to the construction and operations phases there will be a continuous process of identification, refinement and assessment of risk.