Environmental Impact Classification
Pursuant to Section 98 of the *Petroleum and Geothermal Energy Act 2000*

Beach Energy, Statement of Environmental Objectives (SEO) for Fracture Stimulation of Deep Shale Gas and Tight Gas Targets in the Nappamerri Trough (Cooper Basin), South Australia, dated July 2012

31 July 2012

INTRODUCTION

Pursuant to section 98 of the *Petroleum and Geothermal Energy Act 2000* (the Act) the Minister must classify the regulated activities covered by a prepared Environmental Impact Report (EIR) as either of low, medium or high environmental impact.

The classification must be made on the basis of:

- The prepared EIR;
- Criteria established for classifying the level of environmental impact of regulated activities, a copy of which is found on the Department for Manufacturing, Innovation, Trade, Resources and Energy (DMITRE) Energy Resources Division web page:

  http://www.pir.sa.gov.au/__data/assets/pdf_file/0008/27728/sigactv6.pdf; and
- Comment received from relevant Government departments in accordance with established administrative arrangements between these departments and DMITRE.

This document summarises the classification made by DMITRE on Beach Energy's SEO for Fracture Stimulation of Deep Shale Gas and Tight Gas Targets in the Nappamerri Trough (Cooper Basin), South Australia, dated July 2012. This classification is based on information provided in the EIR prepared by Beach Energy.

SUMMARY OF CLASSIFICATION

1) From an analysis of the environmental significance of the events and potential impacts associated with the proposed activities against the classification criteria referred to above (assessment provided as Attachment 1), these regulated activities have been classified as **medium environmental impact**.
2) The majority of events associated with the Beach Energy SEO for Fracture Stimulation of Deep Shale Gas and Tight Gas Targets in the Nappamerri Trough (Cooper Basin), South Australia, dated July 2012, were assessed to be of low environmental significance. This is due to the fact that appropriate management measures will be implemented by Beach Energy to avoid or mitigate any potential environmental consequences. However, DMITRE has classified these activities to be of medium environmental impact due to the uncertainty that exists as to the stakeholder concerns on the consequences of the proposed activities.
3) For a medium environmental impact classification, DMITRE is required to consult with the Department of Planning Transport and Infrastructure (DPTI) in accordance with the administrative arrangement dated 7 November 2000.Comments received from DPTI on 12 April 2012, agreed with the medium environmental impact classification.

Pursuant to delegated powers, I hereby classify this regulated activity as **medium environmental impact**.

Barry A Goldstein

BARRY A. GOLDSTEIN
Executive Director
Energy Resources Division
Department for Manufacturing, Innovation, Trade, Resources and Energy
Delegate of the Minister for Mineral Resources and Energy

ACTIVITY: Environmental Significance Assessment
PROJECT: Fracture Stimulation of Deep Shale Gas and Tight Gas Targets in the Cooper Basin, South Australia EIR
ASSESSOR: DMITRE

ABBREVIATIONS: H = High certainty; M = Medium certainty; L = Low certainty

REF	TYPE OF IMPACT	EVENT(S)	POTENTIAL CONSEQUENCES	PREDICTABILITY						MANAGEABILITY							COMMENTS	**Environmental significanc**
				SIZE	SCOPE	DURATION	FREQUENCY	STAKEHOLDERS	SIGNIFICANCE	AVOIDANCE	PROBABILITY	DURATION	SIZE AND SCOPE	CUMULATIVE EFFECTS	STAKEHOLDERS	SIGNIFICANCE		
	Natural Environment Impacts																	
	Soil Impacts																	
6.2, 6.3, Table 14		Spills or leaks from the storage and handling of fuel or chemicals associated with stimulation	Soil contamination	H	H	H	H	H	1	Yes						1	In order to minimise this risk, chemicals on site will be stored and handled in accordance with relevant standards and guidelines. Bulk fuel required for the pumping units will be stored in double lined containers. Chemicals will be stored with appropriate secondary containment as required. Any spills from chemical handling would be immediately cleaned up and contaminated material removed off-site for appropriate treatment or disposal. Several of the additives in the fracturing fluids (particularly biocides) have relatively high toxicity to aquatic organisms, particularly in fracturing fluids that have only just been mixed, where the additives have not been used and degraded. Although many of these additives are biodegradable and would be expected to break down over time, a release or spill to surface waters of large volumes of fluids containing these additives would require significant dilution to reduce levels of contaminants to below harmful levels and could result in impacts beyond the immediate area of operations. Many of the fracturing fluid additives are biodegradable and would be expected to break down over time if a spill or leak occurred. The rate of transport of any spilt contaminants to shallow groundwater (if present) is also likely to be limited by the low rainfall and high evaporation in the region. The relatively low permeability of the clay soils that are present at many of the potential exploration well locations would also limit the rate of transport of any spilt contaminants. Consequently, minor seepage from a pond, if it occurred, would be expected to have a low level, localised impact. A large release (e.g. due to pond failure) could affect a larger area and result in a moderate level consequence, but is considered unlikely given the construction, lining, operation and monitoring of the ponds that will be undertaken. Handling and storage in accordance with relevant International Standards Organisation standards, relevant MSDS and state regulatory requirements, as recommended by APPEA Code of Practice Guideline 4(2011). Fracturing additives contained in units with appropriate secondary containment. Emergency/spill response procedures in place with immediate clean up and remediation of spills. Personnel trained in correct procedures for use of materials, including refuelling and clean-up procedures. Bulk fuel storage in double lined containers. Refuelling undertaken with appropriate drip capture systems. Suitable facilities present to contain potential spills when handling fuel and chemicals. Clean-up materials and wastes appropriately contained for off-site disposal to a licensed waste management facility.	**Low**
6.2		Spills or leaks from the sourcing and storage of water in preparation for stimulation	Soil contamination	H	H	H	H	H	1	No	Low	Short				2	Temporary storage ponds, lined with suitable UV stabilised polyethylene material (or equivalent), will be used to contain the water for fracture stimulation and the fluids recovered during flowback. Quality control during construction of the ponds is important in preparing a suitable base for the lining material to minimise risk of liner breaches. Fencing prevents large fauna and livestock from entering the ponds and damaging the liners. Regular monitoring of the pond and fence condition, operating the ponds below maximum fill levels (allowing freeboard for rain events and wave action) and construction with above-ground bunding to prevent surface runoff into the ponds all minimise the risk of seepage or release from the pond. The water sourced for fracture stimulation from shallow bores (or other sources) may be brackish or saline. Chemicals are not added to the stored water, however it is desirable to prevent release of the water to soil and potentially to shallower groundwater systems. Should a pond leak develop while these ponds are being used to contain pre-stimulation water, the short term nature of utilisation, the absence of added chemicals and the remoteness from sensitive receptors or sensitive land uses indicate that there will be negligible to minor impacts on the soil and shallow groundwater and this risk is assessed to be low.	**Low**
6.2, Table 14		Spills or leaks from handling and storage of flowback fluids at the surface	Soil contamination	H	H	H	H	M	2	No	Low	Short				2	Temporary storage ponds, lined with suitable UV stabilised polyethylene material (or equivalent), will be used to contain the water for fracture stimulation and the fluids recovered during flowback. Quality control during construction of the ponds is important in preparing a suitable base for the lining material to minimise risk of liner breaches. Fencing prevents large fauna and livestock from entering the ponds and damaging the liners. Regular monitoring of the pond and fence condition, operating the ponds below maximum fill levels (allowing freeboard for rain events and wave action) and construction with above-ground bunding to prevent surface runoff into the ponds all minimise the risk of seepage or release from the pond. Routine inspections of flowback storage area and pipelines. Flowback lines from the wellhead rated and pressure tested to appropriate pressure Emergency shut-down system installed on well-head. Pond liners capable of withstanding expected operating conditions. On flowback ponds will be filled to significantly less than capacity as flowback is expected to be 30-40% of initial clean water storage volume. Pond operation monitored (e.g. pond wall integrity) and repair / remediation / decommissioning undertaken where appropriate (e.g. if leak evident, create drainage channel, recover fluid, repair or decommission pond) Spills / leaks cleaned up and remediated. Chemical utilisation during stimulation kept to the lowest possible to achieve necessary stimulation outcome. Lower toxicity chemicals investigated and used where practicable and suited to the stimulation design required. Well sites and pond locations selected to ensure that the consequences of a potential pond failure are minimised (e.g. ponds would not be located in close proximity to the Cooper Creek channel or other significant watercourses such that failure would result in direct release to these watercourses). Well leases located on higher ground as far as practicable. Where well leases have potential for infrequent flooding, measures will be undertaken to ensure ponds are not vulnerable to flooding (e.g. ponds on higher ground out, construction of higher pond walls, removal of flowback fluids off-site either during testing or at completion of operations) Monitoring of Cooper Creek levels at gauging stations upstream of the Nappamerri Trough to enable implementation of flood response procedures if flood fronts are identified that are likely to impact on well operability and pond integrity Implementation of additional management measures as identified by site-specific assessments against the stated environmental objective to avoid surface water impacts	**Low**
6.2		Separator upset resulting in small volumes of flowback fluid entering the flare pit	Soil contamination	H	H	H	H	M	2	No	Low	Short				2	Small volumes of flowback fluid could potentially enter the flare pit if a separator upset occurred during flaring. As equipment will be regularly inspected and maintained and flaring will be monitored, this would be very unlikely to occur, and if it did, volumes of fluid would be small and present a low level of risk. Flare pits will be rehabilitated following completion of operations.	**Low**
6.2, 6.3, Table 14		Storage and transport of waste	Soil contamination	H	H	H	H	H	1	Yes						1	Storage of waste and transport to licensed disposal facilities will be undertaken in accordance with relevant legislation and guidelines. Waste generation will be minimised where practicable, waste will be stored securely and licensed waste contractors will be used for waste transport. Hazardous wastes handled in accordance with relevant legislation and standards.	**Low**
6.3, Table 14		Flooding of well leases during fracture stimulation operations	Soil contamination	M	M	M	H	H	2	No	Low	Short				2	To mitigate the risk of fluid release due to flood inundation, well leases will not be located in areas where frequent flooding is likely. If well leases are to be located in areas where infrequent minor flooding may occur, measures will be undertaken to ensure that ponds are not vulnerable to flooding (e.g. ponds may be located on higher ground out of the floodplain and/or pond walls constructed higher above grade at these locations). If there is a risk posed by floodwaters, flowback fluids can be removed to ponds on other leases that are not at risk. This transfer can be instigated at the completion of flow back operations, during flowback operations to minimise the fluid volumes on the lease at any given time, or if flood fronts in the Cooper Creek catchment area are identified that will impact on well operability and pond security. Broad scale flooding in the region is associated with heavy rainfall in the Cooper Creek catchment hundreds of kilometres upstream of the Nappamerri Trough. Gauging stations at various locations upstream monitor the level of the creek and the potential for flooding is understood several weeks or more in advance. If necessary, decommissioning and demobilisation activities can be planned and executed to minimise the impact of creek flooding. Flooding of the well lease while fracture stimulation is being carried out could result in localised contamination from fuel and chemicals held on site. Short term (1-2 weeks), shallow and localised flooding due to localised high rainfall events is unlikely to result in significant risk as the stimulation activity is ceased in advance of storm weather and materials would be appropriately secured. Emergency spill response procedures in place with immediate clean up and remediation of spills.	**Low**

				ABBREVIATIONS: H = High certainty; M = Medium certainty; L = Low certainty														
							PREDICTABILITY					**MANAGEABILITY**						
REF	TYPE OF IMPACT	EVENT(S)	POTENTIAL CONSEQUENCES	SIZE	SCOPE	DURATION	FREQUENCY	STAKEHOLDERS	SIGNIFICANCE	AVOIDANCE	PROBABILITY	DURATION	SIZE AND SCOPE	CUMULATIVE EFFECTS	STAKEHOLDERS	SIGNIFICANCE	COMMENTS	**Environmental significanc**
	Groundwater Impacts																	
6.1.1, Table 14		Leakage to aquifers due to loss of well integrity	Groundwater contamination	M	M	M	H	L	4	No	Low	Short				2	A loss of well integrity could result in the leakage of fracturing fluids or hydrocarbons to aquifers or production of aquifer water when the well is flowed. The risk is reduced to as low as possible in the well design process and managed through operational monitoring during each step in the process. In particular: -The well design and construction provides the mechanical integrity that reduces this risk to as low as possible -Pressure testing confirms that production casing meets designed pressure specification -Cement bond logs confirm the integrity of cement that fills the casing-wellbore space and prevents migration -Pressure safety trip out systems during the fracture stimulation prevent pressure limits of the surface pipework and downhole casing equipment being exceeded -Pressure monitoring during the fracture stimulation provides confirmation that the stimulation has not resulted in a well integrity issue	**Med**
6.1.2, Table 14		Fracture propagation into overlying GAB aquifers	Groundwater contamination	H	M	M	H	L	4	No	Low	Short				2	If growth of fractures out of the target formations and into overlying fresh water aquifers occurred, it could result in contamination of these aquifers or establish a conduit from the aquifer to the wellbore such that, during production operations, water would be recovered to surface. Based on extensive fracture height growth monitoring in shale gas plays in the United States and the stress contrasts observed in the formations intersected in the Cooper Basin, it is considered improbable that this type of connection can be established. Monitoring of many fracture stimulation treatments in shale gas plays in the United States has shown that typical height growth of fractures is less than 200-300 metres (Fisher and Warpinski 2011). The Nappamerri Trough stratigraphic section and the location of the Great Artesian Basin aquifers and surface aquifers illustrate that a typical shale gas fracture treatment cannot reasonably be expected to have sufficient height growth to stimulate into the overlying aquifers. The Eagle Ford data shows no occurrence of height growth sufficient to intersect an aquifer located more than 400 metres above the fracture stimulation zone in at least 250 treatments, representing less than a 0.5% chance of occurrence. Further, the significant increase in stress in the rocks observed at the top of the Toolachee formation reduces the chance of fracture growth into the overlying aquifers to a negligible level. If it was considered that a fracture was able to grow 400 to 700 metres or more into the GAB, it is not expected that the resultant impact would be significant, for the following reasons: -Under production conditions, the flow will be from the aquifer to the well ensuring that further fluids do not cross flow into the aquifer -Flow from the aquifer production would be identified at the well by the elevated water production rates and analysis of the water chemistry -Any further fracture stimulation in the area would use micro-seismic monitoring equipment to ensure treatments are contained within the interval -When the well is shut-in or abandoned the aquifer will continue to flow to the lower gas zones until the pressure in the two zones equilibrates -Once equilibrated there is no pressure drive to enable gas or fluids to migrate towards the aquifer -Due to the low permeability of the GAB observed in the area and the very large distances to receptors, any contamination is likely to be significantly diluted over the many years that would be required before the water may come to surface. If required, due to risk of stimulation into GAB at specific well locations (thinning of geological strata or evidence of unsuitable geomechanical conditions), microseismic monitoring to be used to monitor height growth.	**Med**
6.1.3, Table 14		Leakage to GAB aquifers through geologic media	Groundwater contamination	H	M	M	M	L	4	No	Low	Short				2	Leakage of stimulation fluids to aquifers through the overlying strata could result in contamination of these aquifers. However, this is not considered to pose a credible risk for the project. The Permian target intervals are separated from the GAB by approximately 400 metres of limited permeability Nappamerri Group siltstone. The slightly overpressured Toolachee gas reservoirs in Kirby, relative to the GAB pressure regime, suggest that there is very poor hydraulic conductivity through the overlying Nappamerri Group siltstone in the Nappamerri Trough. It follows that if gas does not readily move through the Nappamerri Group siltstone, that a fracture stimulation fluid that is injected into the Permian Toolachee to Patchawarra sections is unlikely to migrate up to the GAB. The presence of inter formation faults may result in migration of fluids but there is very low probability of this threat in the Nappamerri Trough. In particular: the pressure differential between the GAB and the Permian Formations indicates that the intervals are not currently connected by faults. The seismic information has not detected large scale faults that connect the GAB to the Permian section.	**Med**
6.1.4, Table 14		Impact on Permian aquifer potential	Groundwater depletion	H	M	M	M	M	2	No	Low	Short				2	The impact of fracture stimulation operations on the aquifer potential of the Permian reservoirs themselves (i.e. the target formations for fracturing) is not considered to be significant. The sandstone units of the Toolachee, Daralingie, Epsilon and Patchawarra Formations may be considered aquifers in other parts of the Basin where they are filled with water. This is not the case in the Nappamerri Trough where the units are evidently gas saturated: water salinity is unknown due to the lack of recovery of formation water during drill stem tests conducted in exploration wells on structural highs in the Trough; and there is still some uncertainty but indications are that, due to the low permeability in the Trough, gas has been trapped in the sands regionally without the need for conventional structural trapping and there may not be water in these zones off structure. However, if it is considered that the Permian reservoirs are aquifers, the zones are not considered to be suitable for use for the following reasons: -if water is present, it is expected that the salinity will be sufficient to preclude use of the water -low permeability nature of the rocks results in insufficient yield for commercial use -depth of the zones requires expensive drilling and pumping equipment and is not commercially viable.	**Low**
6.1.5, Table 14		Lateral migration of injected fluid in the Permian section	Groundwater contamination	H	M	M	M	M	2	No	Low	Short				2	Migration of fracture stimulation fluid away from the stimulation treatment will not occur. Due to the low permeability, any fracture stimulation fluid that enters the Permian intervals is highly unlikely to migrate any significant distance beyond the stimulation treatment. Additionally, once the fracture stimulation treatment is performed the well is then flow tested. This creates a pressure sink at the wellbore. The pressure difference between the fluids in the rock pore space and the wellbore is the drive mechanism that results in gas and fluid production to the well. Once flow commences the pressure gradient underground will result in fluids moving towards the well rather than migrating either upwards or laterally away from the fracture stimulation.	**Low**
6.1.6, Table 14		Fracture propagation between Permian pressure cells that are normally isolated	Crossflow between aquifers	H	M	M	M	M	2	No	Low	Short				2	Fracture growth out of the immediate fracture stimulation zone and into adjacent strata within the Permian section may possibly occur, but will have negligible impact as it is unlikely to result in significant cross-flow between the Permian formations. Stress contrasts between layers in the Permian are likely to restrict growth between geological units. Evidence from pressure data in the area suggests that there are two pressure systems in the Permian section with the Toolachee formation appearing to be normally pressured (i.e. pressure in the formation reflects a head of water from surface to the depth of the reservoir) and the Epsilon and Patchawarra formation which is observed to be overpressured, as described in the discussion on the basin-centred gas accumulation (Section 3). The contrast in the stress above the Roseneath shale is expected to be sufficient to prevent growth of induced fractures from the over pressured system into the normally pressured system and vice-versa. However, should there be extension of induced fractures that connect these two systems there will be a brief cross flow of the higher pressured gas into the lower pressure gas system until the well is flow tested. During production testing the gas flow will be towards the wellbore as this will be lower pressure than the neighbouring strata. This is not likely to have significant environmental impact in these low permeability, gas-saturated formations, and rather than being detrimental, growth of fracture stimulation through the Permian interval can assist in improving recovery of gas from isolated sand pockets in the strata, maximising efficiency of drainage.	**Low**
6.1.7, Table 14		Water use	Groundwater depletion	M	M	M	H	L	4	No	High	Short				2	Water extraction for fracture stimulation will be undertaken within the regulatory framework of the Natural Resources Management Act. Beach will liaise with the Department for Water to ensure that appropriate authorisations are in place for drilling and extraction of groundwater. Landowners will be consulted regarding water well locations and water use and proposed water supply wells will be assessed to ensure that their use does not impact adversely on existing users of groundwater. There are relatively few water supply bores in the area and shallow aquifers are often unsuitable for stock or domestic use. The wells that will be fractured are expected to be geographically spread (several kilometres apart). They are also expected to be distant from existing water supply wells. A preliminary hydrogeological assessment was made to estimate an inferred zone of influence from extraction of water at fracturing locations. Where existing water wells are within approximately 1–5 km (dependent on aquifer properties) of an extraction point for a planned stimulation activity, there is potential for drawdown to be noticeable (e.g. greater than 5 m), if the fracturing water supply well is accessing the same aquifer or an aquifer in hydraulic connection to the existing well. At such locations, further assessment of potential drawdown, consultation with the well owner and monitoring would be carried out, to ensure that significant drawdown or impacts are avoided or mitigated. If impacts were detected by monitoring, alternative water supply options would be pursued and any impact to existing users would be made good. Extraction of large volumes of water from aquifers that provide baseflow to nearby waterholes (e.g. aquifers in sandy sequences underlying and adjacent to the Cooper Creek) could impact waterholes and the ecosystems that are dependent on them. Extraction of large volumes of water from aquifers such as these will be avoided (e.g. by assessing the location, depth, and aquifer properties of potential water supply wells to confirm they are not targeting such aquifers). Water use for fracture stimulation will be in accordance with the Far North Prescribed Wells Area Water Allocation Plan, and broadly applicable guidelines such as APPEA and API guidelines (APPEA 2011, API 2010). If the exploration and appraisal phase is successful and Beach is likely to progress to a development phase, alternative water sources are likely to be required. These may include recycling of recovered fracture stimulation fluids where practicable, recycling of produced formation water or extraction (under licence) of water from the Great Artesian Basin. In this case, detailed investigation and consultation regarding water sourcing would be carried out to ensure that significant impacts to water resources and other users are avoided.	**Med**

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				PREDICTABILITY						MANAGEABILITY								
REF	TYPE OF IMPACT	EVENT(S)	POTENTIAL CONSEQUENCES	SIZE	SCOPE	DURATION	FREQUENCY	STAKEHOLDERS	SIGNIFICANCE	AVOIDANCE	PROBABILITY	DURATION	SIZE AND SCOPE	CUMULATIVE EFFECTS	STAKEHOLDERS	SIGNIFICANCE	COMMENTS	**Environmental significanc**
	Surface Water Impacts																	
6.2, 6.3, Table 14		Spills or leaks from the storage and handling of fuel or chemicals associated with stimulation	Surface water contamination	H	H	H	H	H	1	Yes						1	In order to minimise this risk, chemicals on site will be stored and handled in accordance with relevant standards and guidelines. Bulk fuel required for the pumping units will be stored in double lined containers. Chemicals will be stored with appropriate secondary containment as required. Any spills from chemical handling would be immediately cleaned up and contaminated material removed off-site for appropriate treatment or disposal. Several of the additives in the fracturing fluids (particularly biocides) have relatively high toxicity to aquatic organisms, particularly in fracturing fluids that have only just been mixed, where the additives have not been used and degraded. Although many of these additives are biodegradable and would be expected to break down over time, a release or spill to surface waters of large volumes of fluids containing these additives would require significant dilution to reduce levels of contaminants to below harmful levels and could result in impacts beyond the immediate area of operations. Many of the fracturing fluid additives are biodegradable and would be expected to break down over time if a spill or leak occurred. The rate of transport of any spilt contaminants to shallow groundwater (if present) is also likely to be limited by the low rainfall and high evaporation in the region. The relatively low permeability of the clay soils that are present at many of the potential exploration well locations would also limit the rate of transport of any spilt contaminants. Consequently, minor seepage from a pond, if it occurred, would be expected to have a low level, localised impact. A large release (e.g. due to pond failure) could affect a larger area and result in a moderate level consequence, but is considered unlikely given the construction, lining, operation and monitoring of the ponds that will be undertaken. Handling and storage in accordance with relevant International Standards Organisation standards, relevant MSDS and state regulatory requirements, as recommended by APPEA Code of Practice Guideline 4(2011) Fracturing additives contained in units with appropriate secondary containment Emergency/spill response procedures in place with immediate clean up and remediation of spills Personnel trained in correct procedures for use of materials, including refuelling and clean-up procedures Bulk fuel storage in double lined containers Refuelling undertaken with appropriate drip capture systems Suitable facilities present to contain potential spills when handling fuel and chemicals Clean-up materials and wastes appropriately contained for off-site disposal to a licensed waste management facility	**Low**
6.2		Spills or leaks from the sourcing and storage of water in preparation for stimulation	Surface water contamination	H	H	H	H	H	1	No	Low	Short				2	Temporary storage ponds, lined with suitable UV stabilised polyethylene material (or equivalent), will be used to contain the water for fracture stimulation and the fluids recovered during flowback. Quality control during construction of the ponds is important in preparing a suitable base for the lining material to minimise risk of liner breaches. Fencing prevents large fauna and livestock from entering the ponds and damaging the liners. Regular monitoring of the pond and fence condition, operating the ponds below maximum fill levels (allowing freeboard for rain events and wave action) and construction with above-ground bunding to prevent surface runoff into the ponds all minimise the risk of seepage or release from the pond. The water sourced for fracture stimulation from shallow bores (or other sources) may be brackish or saline. Chemicals are not added to the stored water, however it is desirable to prevent release of the water to soil and potentially to shallower groundwater systems. Should a pond leak develop while these ponds are being used to contain pre-stimulation water, the short term nature of utilisation, the absence of added chemicals and the remoteness from sensitive receptors or sensitive land uses indicate that there will be negligible to minor impacts on the soil and shallow groundwater and this risk is assessed to be low.	**Low**
6.2, Table 14		Spills or leaks from handling and storage of flowback fluids at the surface	Surface water contamination	H	H	H	H	M	2	No	Low	Short				2	Temporary storage ponds, lined with suitable UV stabilised polyethylene material (or equivalent), will be used to contain the water for fracture stimulation and the fluids recovered during flowback. Quality control during construction of the ponds is important in preparing a suitable base for the lining material to minimise risk of liner breaches. Fencing prevents large fauna and livestock from entering the ponds and damaging the liners. Regular monitoring of the pond and fence condition, operating the ponds below maximum fill levels (allowing freeboard for rain events and wave action) and construction with above-ground bunding to prevent surface runoff into the ponds all minimise the risk of seepage or release from the pond. Routine inspections of flowback storage area and pipelines Flowback lines from the wellhead rated and pressure tested to appropriate pressure Emergency shut-down system installed on well-head Pond liners capable of withstanding expected operating conditions On flowback ponds will be filled to significantly less than capacity as flowback is expected to be 30-40% of initial clean water storage volume Pond operation monitored (e.g. pond wall integrity) and repair / remediation / decommissioning undertaken where appropriate (e.g. if leak evident, create drainage channel, recover fluid, repair or decommission pond) Spills / leaks cleaned up and remediated Chemical utilisation during stimulation kept to the lowest possible to achieve necessary stimulation outcome Lower toxicity chemicals investigated and used where practicable and suited to the stimulation design required Well sites and pond locations selected to ensure that the consequences of a potential pond failure are minimised (e.g. ponds would not be located in close proximity to the Cooper Creek channel or other significant watercourses such that failure would result in direct release to these watercourses) Well leases located on higher ground as far as practicable Where well leases have potential for infrequent flooding, measures will be undertaken to ensure ponds are not vulnerable to flooding (e.g. ponds on higher ground out, construction of higher pond walls, removal of flowback fluids off-site either during testing or at completion of operations) Monitoring of Cooper Creek levels at gauging stations upstream of the Nappamerri Trough to enable implementation of flood response procedures if flood fronts are identified that are likely to impact on well operability and pond integrity Implementation of additional management measures as identified by site-specific assessments against the stated environmental objective to avoid surface water impacts	**Low**
6.2		Separator upset resulting in small volumes of flowback fluid entering the flare pit	Surface water contamination	H	H	H	H	M	2	No	Low	Short				2	Small volumes of flowback fluid could potentially enter the flare pit if a separator upset occurred during flaring. As equipment will be regularly inspected and maintained and flaring will be monitored, this would be very unlikely to occur, and if it did, volumes of fluid would be small and present a low level of risk. Flare pits will be rehabilitated following completion of operations.	**Low**
6.2, 6.3, Table 14		Storage and transport of waste	Surface water contamination	H	H	H	H	H	1	Yes						1	Storage of waste and transport to licensed disposal facilities will be undertaken in accordance with relevant legislation and guidelines. Waste generation will be minimised where practicable, waste will be stored securely and licensed waste contractors will be used for waste transport. Hazardous wastes handled in accordance with relevant legislation and standards.	**Low**
6.3, Table 14		Flooding of well leases during fracture stimulation operations	Surface water contamination	M	M	H	H	M	2	No	Low	Short				2	To mitigate the risk of fluid release due to flood inundation, well leases will not be located in areas where frequent flooding is likely. If well leases are to be located in areas where infrequent minor flooding may occur, measures will be undertaken to ensure that ponds are not vulnerable to flooding (e.g. ponds may be located on higher ground out of the floodplain and/or pond walls constructed higher above grade at these locations). If there is a risk posed by floodwaters, flowback fluids can be removed to ponds on other leases that are not at risk. This transfer can be instigated at the completion of flow back operations, during flowback operations to minimise the fluid volumes on the lease at any given time, or if flood fronts in the Cooper Creek catchment area are identified that will impact on well operability and pond security. Broad scale flooding in the region is associated with heavy rainfall in the Cooper Creek catchment hundreds of kilometres upstream of the Nappamerri Trough. Gauging stations at various locations upstream monitor the level of the creek and the potential for flooding is understood several weeks or more in advance. If necessary, decommissioning and demobilisation activities can be planned and executed to minimise the impact of creek flooding. Flooding of the well lease while fracture stimulation is being carried out could result in localised contamination from fuel and chemicals held on site. Short term (1-2 weeks), shallow and localised flooding due to localised high rainfall events is unlikely to result in significant risk as the stimulation activity is ceased in advance of storm weather and materials would be appropriately secured. Emergency spill response procedures in place with immediate clean up and remediation of spills.	**Low**

				ABBREVIATIONS: H = High certainty; M = Medium certainty; L = Low certainty														
				PREDICTABILITY						MANAGEABILITY								
REF	TYPE OF IMPACT	EVENT(S)	POTENTIAL CONSEQUENCES	SIZE	SCOPE	DURATION	FREQUENCY	STAKEHOLDERS	SIGNIFICANCE	AVOIDANCE	PROBABILITY	DURATION	SIZE AND SCOPE	CUMULATIVE EFFECTS	STAKEHOLDERS	SIGNIFICANCE	COMMENTS	Environmental significanc
	Vegetation Impacts																	
6.4, Table 14		Activity outside designated/ approved areas	Damage to vegetation	H	H	H	H	H	1	Yes						1	Activities outside defined / approved areas have the potential to impact vegetation and fauna. All activities will be confined to the cleared well lease, with signage and fencing (where required) installed to delineate approved areas and any restricted areas. If flora of conservation significance is present in the vicinity it will be flagged and/or fenced off where necessary to prevent disturbance. Training and induction for all personnel to educate them on the importance of remaining within designated/ approved areas.	**Low**
6.2, 6.3, 6.4 Table 14		Spills or leaks from the storage and handling of fuel or chemicals associated with stimulation	Damage to vegetation	H	H	H	H	H	1	Yes						1	In order to minimise this risk, chemicals on site will be stored and handled in accordance with relevant standards and guidelines. Bulk fuel required for the pumping units will be stored in double lined containers. Chemicals will be stored with appropriate secondary containment as required. Any spills from chemical handling would be immediately cleaned up and contaminated material removed off-site for appropriate treatment or disposal. Several of the additives in the fracturing fluids (particularly biocides) have relatively high toxicity to aquatic organisms, particularly in fracturing fluids that have only just been mixed, where the additives have not been used and degraded. Although many of these additives are biodegradable and would be expected to break down over time, a release or spill to surface waters of large volumes of fluids containing these additives would require significant dilution to reduce levels of contaminants to below harmful levels and could result in impacts beyond the immediate area of operations. Many of the fracturing fluid additives are biodegradable and would be expected to break down over time if a spill or leak occurred. The rate of transport of any spilt contaminants to shallow groundwater (if present) is also likely to be limited by the low rainfall and high evaporation in the region. The relatively low permeability of the clay soils that are present at many of the potential exploration well locations would also limit the rate of transport of any spilt contaminants. Consequently, minor seepage from a pond, if it occurred, would be expected to have a low level, localised impact. A large release (e.g. due to pond failure) could affect a larger area and result in a moderate level consequence, but is considered unlikely given the construction, lining, operation and monitoring of the ponds that will be undertaken. Handling and storage in accordance with relevant International Standards Organisation standards, relevant MSDS and state regulatory requirements, as recommended by APPEA Code of Practice Guideline 4(2011). Fracturing additives contained in units with appropriate secondary containment Emergency/spill response procedures in place with immediate clean up and remediation of spills Personnel trained in correct procedures for use of materials, including refuelling and clean-up procedures Bulk fuel storage in double lined containers Refuelling undertaken with appropriate drip capture systems Suitable facilities present to contain potential spills when handling fuel and chemicals Clean-up materials and wastes appropriately contained for off-site disposal to a licensed waste management facility. A pond breach could result in a significant release of fluid. The construction, operation and monitoring of the ponds reduces the likelihood that this outcome will occur to a low level. In the event that a pond breach occurs before stimulation, the brackish (or saline) water may affect vegetation in the area of the spill (should it extend beyond the cleared lease area). During flowback, the returned fluid in the pond will consist of degraded fracture fluids and dissolved ions from the geological strata. As there is less returned fluid than injected water, pond operating levels can be significantly reduced and the risk of pond failure reduced further. A spill of flowback fluid associated with a pond breach may affect vegetation (should it extend beyond the lease area) and indirectly stock and fauna that may enter to feed. The spill area can be fenced to prevent stock and fauna entry. If, and as appropriate, drainage channels may be required to drain and gather spilt fluids and pump back to other holding ponds, and further assessment, rehabilitation and monitoring may be undertaken,	**Low**
	Fauna Impacts																	
6.4, Table 14		Use of roads and movement of vehicles and heavy machinery	Injury or death of stock or fauna	H	H	H	H	H	1	No	Low	Short				2	Fracture stimulation operations may result in a short term and localised increase in traffic volumes, which could increase the risk of collisions with stock and native fauna. Measures to mitigate the risks are part of standard operating procedures for Beach and include speed restrictions, monitoring of speeds in industry vehicles, driver education programs and restriction of transport movements to daylight hours as far as practicable.	**Low**
6.4		Storage and handling of fuel or chemicals	Access to contaminants by stock and native fauna	H	H	H	H	H	1	Yes						1	Access to fuel and chemicals and flowback fluids held in ponds presents a potential hazard to stock and to some native fauna. Stock access to chemicals and fuel will be prevented by storing and handling them in designated areas free from rubbish or waste that may attract fauna, manning of well sites while fracturing activities are being undertaken and immediate containment and clean-up if any spills occur. Stock-proof fencing will be erected around ponds to prevent stock from accessing flowback fluids. Drilling sumps will be fenced following drilling (which is standard practice). Regular inspections will be carried out to ensure the integrity of the fences.	**Low**
6.4		Storage and transport of waste	Access to contaminants by stock and native fauna	H	H	H	H	H	1	Yes						1	A high standard of waste management will be implemented to avoid impacts to flora and fauna. In particular, secure systems will be used for storage and transport (e.g. covered bins in a designated area) to prevent wind-blown litter or birds and dingoes accessing waste.	**Low**
6.4, Table 14		Activity outside designated/ approved areas	Damage to Habitat	H	H	H	H	H	1	Yes						1	Activities outside defined / approved areas have the potential to impact vegetation and fauna. All activities will be confined to the cleared well lease, with signage and fencing (where required) installed to delineate approved areas and any restricted areas. If flora of conservation significance is present in the vicinity it will be flagged and/or fenced off where necessary to prevent disturbance. Training and induction for all personnel to educate them on the importance of remaining within designated/ approved areas.	**Low**
6.4		Spills or leaks of flowback fluids	Access to contaminants by stock and native fauna	H	H	H	H	M	2	No	Low	Short				2	The presence of temporary ponds for holding flowback fluids has the potential to attract birds. Due to the nature of the ponds (relatively steep sided and lined with plastic, with no ‘beaches’, vegetation or food sources) visitation by birds is expected to be restricted to relatively small numbers for relatively short periods of time. Concentration data for fracturing fluids to be injected and available toxicity information (e.g. MSDS information provided by the stimulation service provider) indicate that the concentration of additives of highest concern for fauna (e.g. biocides) is expected to be below levels that pose a significant risk for birds coming into short term contact with flowback fluids. Many of the additives in the fracturing fluids are used or degraded in the process (including biocides) or remain in the formation and would return at a fraction of what was pumped down the well. The pH of the flowback fluids is expected to be relatively neutral, as acids are neutralised in the fracturing process. Water quality data from previous fracturing of the Holdfast-1 well supports this, with recorded pH in the range of 6.2 to 7.7. Ponds will be temporary and will be rehabilitated following removal of liner. As a consequence, the presence of the ponds is not expected have a significant impact on birds. Beach intends to conduct further investigation to confirm this, including ongoing testing of flowback fluid composition. The ongoing inspection and monitoring of the ponds would also detect bird mortality if it occurs. If necessary, additional measures to discourage bird use will be implemented, which may include installation of flagging or other devices to discourage bird presence. Access to fuel and chemicals and flowback fluids held in ponds presents a potential hazard to stock and to some native fauna. Stock access to chemicals and fuel will be prevented by storing and handling them in designated areas free from rubbish or waste that may attract fauna, manning of well sites while fracturing activities are being undertaken and immediate containment and clean-up if any spills occur. Stock-proof fencing will be erected around ponds to prevent stock from accessing flowback fluids. Drilling sumps will be fenced following drilling (which is standard practice). Regular inspections will be carried out to ensure the integrity of the fences.	**Low**
	Sensitive Area Impacts																	
6.3.1		Impact Coongie Lakes Ramsar Wetland Area	Loss of conservation values	H	H	M	H	M	2	No	Low	short				2	Well sites for fracture stimulation will not be established in locations that have significant wetland values , measures will be undertaken to ensure that surface water quality is not impacted, including appropriate siting of well sites and ponds. Consequently, it is not expected that fracture stimulation operations will trigger any of the criteria that would require EPBC Act approval . This will be confirmed on a site specific-basis. If individual wells appear likely to need approval, they would either be relocated or a referral submitted under the EPBC Act to determine whether approval is required.	**Low**
	Air impacts																	
6.5.3, Table 14		Noise and air emissions	Generation of greenhouse gas emissions	H	H	M	M	L	4	No	Low	Short				2	The volumes of gas flared will be recorded and estimates of vented gas volumes (dissolved in water stream or associated with initial flowback volumes) will be made. All greenhouse gas emissions will be reported in accordance with the requirements of the National Greenhouse and Energy Reporting Act (NGER Act). Fugitive emissions from the flow testing equipment will be minimised by pressure testing of lines prior to use to ensure integrity. Due to the depth of stimulation treatment, the relatively small volume of rock that receives induced fractures from the treatments and testing conditions that draws gas towards the well, fugitive emissions through migration through geological strata to surface is not considered a plausible pathway. Migration along the well bore is a potential source of fugitive emissions and this is mitigated by well design and construction methods particularly the presence of cemented casing strings, assessment of the cement quality with logging tools and monitoring the well and the lease during flowback. Equipment operated and maintained in accordance with manufacturer specifications. Flaring during production testing kept to minimum length of time necessary to establish resource and production parameters (consistent with APPEA Guideline 6 (2011)) Remote location of well sites Fracturing would not be carried out in close proximity to Innamincka or pastoral station residences	**Med**

				ABBREVIATIONS: H = High certainty; M = Medium certainty; L = Low certainty														
				PREDICTABILITY						MANAGEABILITY								
REF	TYPE OF IMPACT	EVENT(S)	POTENTIAL CONSEQUENCES	SIZE	SCOPE	DURATION	FREQUENCY	STAKEHOLDERS	SIGNIFICANCE	AVOIDANCE	PROBABILITY	DURATION	SIZE AND SCOPE	CUMULATIVE EFFECTS	STAKEHOLDERS	SIGNIFICANCE	COMMENTS	**Environmental significanc**
	Social Environment																	
	Community Resource Impacts																	
6.1.7, Table 14		Water use	Groundwater depletion	M	M	M	H	L	4	No	High	Short				2	Landowners will be consulted regarding water well locations and water use and proposed water supply wells will be assessed to ensure that their use does not impact adversely on existing users of groundwater. There are relatively few water supply bores in the area and shallow aquifers are often unsuitable for stock or domestic use. The wells that will be fractured are expected to be geographically spread (several kilometres apart). They are also expected to be distant from existing water supply wells. A preliminary hydrogeological assessment was made to estimate an inferred zone of influence from extraction of water at fracturing locations. Where existing water wells are within approximately 1–5 km (dependent on aquifer properties) of an extraction point for a planned stimulation activity, there is potential for drawdown to be noticeable (e.g. greater than 5 m), if the fracturing water supply well is accessing the same aquifer or an aquifer in hydraulic connection to the existing well. At such locations, further assessment of potential drawdown, consultation with the well owner and monitoring would be carried out, to ensure that significant drawdown or impacts are avoided or mitigated. If impacts were detected by monitoring, alternative water supply options would be pursued and any impact to existing users would be made good. Water use for fracture stimulation will be in accordance with the Far North Prescribed Wells Area Water Allocation Plan, and broadly applicable guidelines such as APPEA and API guidelines (APPEA 2011, API 2010). If the exploration and appraisal phase is successful and Beach is likely to progress to a development phase, alternative water sources are likely to be required. These may include recycling of recovered fracture stimulation fluids where practicable, recycling of produced formation water or extraction (under licence) of water from the Great Artesian Basin. In this case, detailed investigation and consultation regarding water sourcing would be carried out to ensure that significant impacts to water resources and other users are avoided.	**Med**
	Cultural & Heritage Impacts																	
6.5.2, Table 14		Impact on cultural heritage areas	Disturbance to Cultural Heritage	H	H	H	H	H	1	Yes						1	Potential impacts to cultural heritage arise mainly from activities occurring outside designated / approved areas. Work Area Clearances with the native title claimant groups are carried out prior to undertaking any exploration or production activities in the Cooper Basin. Fracture stimulation operations are undertaken on a prepared well lease, within the area cleared by the Work Area Clearance party. Signage and fencing (where required) is installed to delineate approved areas and any restricted areas. If sites of cultural heritage significance are present in the vicinity they may be flagged and/or fenced off where necessary to prevent disturbance. In addition, procedures are in place to deal with the incidental discovery of cultural heritage material. Training and induction for all personnel to educate them on the importance of remaining within designated/ approved areas.	**Low**
	Community Health & Safety																	
6.5.1, Table 14		Unauthorised access resulting in exposure to site hazards during operations	Public safety	H	H	H	H	H	1	No	Low	Short				2	Fracture stimulation activities will be carried out at established well leases where public access is restricted. Most sites are also expected to be relatively remote from public roads and accessed from roads with no public access. Measures such as signage and fencing will be in place at the well lease to warn of the hazards at the site and restrict access into the site. Potentially hazardous areas such as sumps and ponds will be securely fenced with warning signs in place. The population density in the area is very low. Fracture stimulation activities (and drilling activities in general) would not be carried out in close proximity to pastoral station residences, the Innamincka Township or campsites along the Cooper Creek. Sites will be attended by an operator during and after fracturing operations.	**Low**
6.5.1, Table 14		Bushfire as a result of activities	Public safety	M	H	H	M	H	2	No	Low	Short				2	Fires are generally not a frequent occurrence in the Cooper Basin, but heavy vegetation growth over 2010 and 2011 has resulted in an elevated fuel load and numerous grass fires have occurred from lightning strikes. In order to manage the risk of initiating fires, activities will be confined to the cleared well lease and combustible material will be cleared from around the flare pit. Fire fighting equipment will be maintained in the area as appropriate, and the requirements of the Fire and Emergency Services Act will be complied with (e.g. permits for 'hot work' on total fire ban days).	**Low**
6.5.1, Table 14		Use of roads and movement of vehicles and heavy machinery	Public safety	H	H	H	H	H	1	No	Low	Short				2	Fracture stimulation operations may result in a short term and localised increase in traffic volumes. The existing road and track network in the Cooper Basin is already heavily used by the oil and gas industry and the incremental change is not likely to be significant. Measures to mitigate the risks to the public are already in place including signage, speed restrictions, monitoring of speeds in industry vehicles, education programs and ongoing maintenance of roads and tracks.	**Low**
6.5.3, Table 14		Noise and air emissions	Reduction in local air quality	H	H	H	M	M	2	No	Low	Short				2	Noise and air emissions from the well sites during fracture stimulation will be localised and short term and are not likely to have a significant noise or air quality impact. The sites will not be in close proximity to residences (e.g. station homesteads or Innamincka). Equipment will be operated and maintained in accordance with specifications in order to minimise noise and air emissions. Flaring during production testing would be kept to minimum length of time necessary to establish resource and production parameters. Landowners notified of location of operations and appropriate consultation and mitigation measures implemented, if required, to ensure that no reasonable complaints are received.	**Low**
6.5.4		Flowback	Radioactivity	M	H	M	H	M	2	No	Low	Short				2	The potential for radioactivity resulting from Naturally Occurring Radioactive Materials (NORM) that are brought to the surface is perceived as a potential issue for fracture stimulation activities. Based on previous experience with Cooper Basin petroleum operations, levels of radioactivity associated with NORM in flowback of fracture stimulation fluids are not expected to be significant and are expected to be well below any levels of concern. NORM are usually only a potential issue when they are concentrated (e.g. by the formation of mineral scales or sludges over time in tanks, piping and facilities). Beach are undertaking monitoring at current well sites and fracturing operations to confirm the expectation that the levels of radioactivity will be well below any levels of concern. In the unlikely situation that NORM above the natural background levels were to occur, appropriate measures for handling and disposal of pond liners and contents remaining after evaporation would be implemented. Flowback ponds polyethylene lined to prevent soil and groundwater contamination.	**Low**
6.5.5, Table 14		Fracture stimulation	Seismic events	M	M	H	M	M	2	No	Med	Short	Confined			3	The induction of seismic events (i.e. micro-earthquakes) as a result of fracture stimulation is sometimes perceived as a potential issue. It is not considered that a credible risk is presented by fracture stimulation of deep shale gas and tight gas targets in the Nappamerri Trough. The region has low background seismic hazard and is mapped in the lowest category of earthquake hazard in Australia (McCue et al. 1993). There is a lack of major faulting in the central Nappamerri Trough. Fracture stimulation (using lower volumes of fluid) has been carried out in the Cooper Basin for over 40 years without any issues related to seismicity. Fracture stimulation of the Holdfast well in PEL 218 in 2011 did not register on the seismic monitoring equipment at Geodynamics' nearby Habanero site. In addition to the absence of significant risk posed by fracture stimulation operations, there is very low population density and little infrastructure that would be sensitive to small seismic events. Microseismic monitoring may be used at some well locations as part of the resource assessment and will be available to delineate seismic response.	**Low**
6.5.6		Fracture stimulation	Cumulative impacts	H	H	M	M	M	2	No	Med	Short	Confined			3	Cumulative impacts of fracture stimulation of scattered exploration and appraisal wells in the context of the Cooper Basin oil and gas province and the existing environment are not considered to be significant. Any impacts will generally be isolated, short term and will affect a very small proportion of the region.	**Low**
	Economic Environment																	
	Existing Land Use Impacts																	
6.4		Spills or leaks from handling and storage of fuels, chemicals and flowback fluids at the surface	Access to contaminants by stock	H	H	H	H	H	1	Yes						1	Access to fuel and chemicals and flowback fluids held in ponds presents a potential hazard to stock and to some native fauna. Stock access to chemicals and fuel will be prevented by storing and handling them in designated areas free from rubbish or waste that may attract fauna, manning of well sites while fracturing activities are being undertaken and immediate containment and clean-up if any spills occur. Stock-proof fencing will be erected around ponds to prevent stock from accessing flowback fluids. Drilling sumps will be fenced following drilling (which is standard practice). Regular inspections will be carried out to ensure the integrity of the fences.	**Low**