Summary of considerations and recommendations on the
Environmental Evaluations of Carbon Energy

24 January 2011

Report of the Independent Scientific Panel on Underground Coal Gasification to
the Department of Employment, Economic Development and Innovation (DEEDI) in
response to a request from the Department of Environment and Resource
Management (DERM)

This report is supported by a range of individual reports previously delivered to
DERM and DEEDI by members of the Independent Scientific Panel on numerous
occasions following various stages of the Environmental Evaluation Process. All
reports have been provided in confidence. This report has been extracted so as to
provide a document from the ISP that can be communicated into the public domain
should DEEDI choose to do so.

Independent Scientific Panel:
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ISP Summary Report on DERM Environmental Evaluations – Carbon Energy

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1. OVERVIEW

The report summarises a number of pieces of advice previously delivered to the Department of Environment and Resource Management (DERM) and the Department of Employment, Economic Development and Innovation (DEEDI).

This report summarises the ISP’s advice on environmental issues, the quantity and quality of information provided to the ISP by Carbon Energy, infrastructure failures and operating compromises to the trial and the scale, scope and nature of the pilot. These topics were considered on the basis of a specific request by DERM.

The ISP proposes to continue to follow its established roadmap for the trial. The ISP will send in the next weeks the proposed reporting risk assessment approach to the company for feedback. This will be followed by finalisation of the reporting risk assessment format and the minimum data set required to support reporting. The ISP’s report to government is to provide government with the considerations of the ISP of the success or otherwise of each of the technologies based on the pilot trial. Assessment of the Carbon Energy technology will be on the same basis as the other companies.
2. CONSIDERATIONS

2.1. Environmental issues

Commentary on environmental aspects (including air, water, land and waste) of the three pilots with respect to the underground gasification process and any gas treatment

The ISP has found some difficulty in assessing the implications of the Environmental Evaluations in some aspects of environment because of a lack of sufficient base line information. More systematic monitoring should have been required and undertaken at the outset. All trials should have had the same initial baseline and monitoring requirements and minimum conditions for Environmental Authorities (EAs) should have been in place and been as consistent as possible across the trials.

Carbon Energy appears to have potentially compromised water and land. Around the time of ignition, the gas outflow pipe appears to have become clogged with a slurry of ash and water. This produced additional pressure in the chamber, which eventually forced water up the pipe and out of the vent chimney. Bunding to contain the water was insufficient and water escaped to a nearby ephemeral waterway (Bloodwood Creek). At the time the water contained hydrocarbons and BTEX greater than drinking water limits but less than stock water limits. Later soil sampling detected no residual contaminants. No concerning emissions to air are believed to have occurred. However, it is unknown if any gas escaped and, if so, what its constituents may have been.

In all three pilots more attention should have been given to obtaining appropriate base line data (see section 3.3 – monitoring). Carbon Energy base line information is considered reasonable in terms of the scale and nature of the incident under investigation via the Environmental Evaluations.

For valid environmental comparisons, all three trials should have had similar compliance conditions within their EAs.
2.2. Quality and quantity of information provided to the ISP

All companies provided the ISP initially with background information that described their technologies and also general information on the benefits to society and the Queensland economy of underground coal gasification. The latter material, in particular, was clearly articulated. The case made was obviously aimed at advocacy for the UCG industry but that was explicit and not otherwise represented. The former material was supported by interviews with each company at their offices in Brisbane. Carbon Energy was well prepared and a great deal of information was communicated. The company proved to be open and willing to engage with the ISP to ensure good understanding of its technologies, operational protocols, modelling capabilities and data from monitoring. Carbon Energy willingly communicated challenges with its operating environment. Carbon Energy also has good technical capacity but is perhaps a little too dependent on a single modelling expert from CSIRO who appears to be consulting to Carbon Energy outside his core research program. The documentation for the Environmental Evaluations and monitoring information provided by Carbon Energy is forthright in level of detail. The report describes and specifies events leading to contravention of guidelines, including responses taken and results of subsequent environmental monitoring. In general, the scope and level of detail is thorough, with all pertinent information included.

2.3. Infrastructure failures or operating compromises in the trials

This section considers any malfunctions that may have occurred at any of the sites, the risk to the environment from these and corrective measures put in place, or proposed, to prevent a recurrence during the remainder of the trial.

The current situation is that Carbon Energy has had a failure of infrastructure. Understanding the causes for this failure is vital, and obtaining this understanding is an essential part of any pilot study.
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At Carbon Energy, soon after ignition, pressure build up appears to be the best explanation of the forcing of water up the outflow and through the chimney. No further escape of liquids or gasses appears to have occurred after the initial incident. The ISP recommends improvement of containment bunding.

As part of the interview with the ISP, Carbon Energy indicated that the inflow channel collapsed, which compromised the ability of the pilot to operate as planned. An alternative operating scheme was then implemented. There is no evidence of escape of liquids or gas into the surrounding environment. A monitoring point was in place between the inflow and outflow channels to detect leakages. However, the collapse somewhat compromises the trial of operating conditions because the panel is not operable in the expected normal mode. Carbon Energy has suggested an improved method for installation of the inflow pipe to ensure the collapse does not reoccur. The Carbon Energy start-up infrastructure malfunction (see section 2.1) that resulted in release of waters has been outlined in detail in the Environmental Evaluation response documentation provided by Carbon Energy. The resulting corrective measures have also been outlined in the two reports submitted by Carbon Energy to DERM in July 2010. These measures look to be adequate to prevent a similar malfunction from reoccurring.

2.4. Scale, scope and nature of each pilot

The scale, nature and scope of these pilot programmes are in line with their purpose as technological trials, and are appropriate for this function. The Carbon Energy trial has been compromised by partial collapse of the inflow pipe that has changed the nature of the technological testing. It is the understanding of the ISP that Carbon Energy’s preference would be to commence a new panel with improved infrastructure to better prove up their technology as originally planned.

2.5. Site specific considerations

This section considers any matters relevant to the location of each of the sites and environmental values at each location.
ISP Summary Report on DERM Environmental Evaluations – Carbon Energy

The area surrounding the Carbon Energy trial site at Chinchilla is appropriate assuming groundwater pressures are assured. An important site consideration is the maintenance of sufficient groundwater pressure surrounding the chamber to contain and control the burn. One potential change to the current operating environment is the regional development of the coal seam gas (CSG) industry. To extract coal seam gas, groundwater pressure must be reduced to allow the gas to desorb from the coal. Origin Energy presented their estimates of pressure reduction across the CSG production region to the ISP and the State government interdepartmental working group. Their proposition was that a significant pressure decrease would occur and they contend that this is likely to impact UCG. The details of the Origin groundwater modelling (calibration, validation and simulation results) have not yet been received by the ISP. It is unknown from the presentation whether modelling was only undertaken in the Walloon coal measures (from where CSG is extracted in the Surat Basin) or whether pressure changes in other connected aquifers was also modelled. If the former, then the Origin information is only relevant for assessment of pressure effects where UCG is being undertaken in the same measures as the CSG extraction. If modelling was extended to other connected aquifer systems then the information may be of assistance in assessing pressure impacts on UCG in those connected systems.

Without the Origin modelled data it is difficult for the ISP to assess the impact of pressure decrease from CSG on UCG. It is important that DERM access the modelling outputs and assess the details. The ISP is prepared to assist in this activity. Given uncertainty over the time course of development of CSG and that the assumptions regarding this in the Origin Energy modelling are unknown, the ISP does not feel it appropriate to make recommendations regarding responses by government. If however, pressure is expected to be reduced to below the chamber operating pressure in the UCG pilot trial within the next 6-12 months then a discussion between government, the CSG and UCG companies should occur to determine the best course of action with respect to spatial development of CSG. If however, the drawdown is to occur after the pilot trials are concluded then the issue would be
more appropriately dealt with in the ISP considerations of impacts of UCG industry scale up.

3. RECOMMENDATIONS

3.1. Alteration in scope, scale or nature of each trial

The scale, nature and scope of the Carbon Energy pilot programme are appropriate for a trial programme. There is no need to alter these factors.

3.2. Alterations in any regulatory controls

Recommendation 1. It is recommended that the Government moves to place all three trials under the same minimum Environmental Authority conditions without delay.

3.3. Monitoring

Recommendation 2. It is recommended that improved groundwater monitoring be initiated at all pilot sites and that pressure and gas monitoring be examined for adequacy.

A critical factor concerning environmental monitoring, to assist in regulatory and operational control, is the implementation of a comprehensive monitoring scheme to establish background levels of the water chemistry and soil properties. This factor relates to the issue faced by the three companies that have run UCG trials, which is the lack of initial regulatory oversight and structure within which to operate.

In all three pilots more attention should have been given to obtaining better baseline data. This could have been facilitated by implementing more systematic monitoring. It is not too late to improve the water monitoring and it is recommended that this be done forthwith at all three sites.

It is recommended that concentric arrays of boreholes into all aquifers above the coal aquifer, the coal aquifer itself, and the aquifer below the burn chamber should be installed. Distances for these arrays should be logarithmic away from the burn
ISP Summary Report on DERM Environmental Evaluations – Carbon Energy

chamber. Some bores close to the chamber may have to be sacrificed as the chamber expands. This should be seen as a reasonable and necessary cost of the trials because it is critical to have early warning of any changes to the groundwater as this is a signal that unexpected changes may be occurring in the chamber. Risk management protocols should be in place to ensure such signals trigger appropriate actions. These actions should have been agreed with the approving government agencies before the trials commenced. Triggers should be put in place for all known possible risks at all trial sites. Triggers for temperature, gas, pressure and water quality and flow should be included. Carbon Energy demonstrated to the ISP that taking this approach at their site allowed them to learn how to best control the chamber conditions to manage the movement of water and its constituents in balance with the operating conditions required to produce the necessary syngas composition. The ISP was shown very convincing information to support this approach (see section 2.1).

For Western Queensland base line monitoring must include seasonal variations in groundwater compositions.

Recommendation 3. Monitoring at entry and exit points from the chamber should be standard for all trials to ensure that any leaks are immediately detected.

Recommendation 4. Soil testing in all pilots should be undertaken as close to the chamber as practical (safe) as the chamber expands. This will provide information on the possible release of contaminants from the chamber. It is considered unlikely that this will occur during normal operations of the chamber as groundwater flow is always into the chamber. However, deviations from normal operating conditions can occur and monitoring should be in place to detect any contamination as a result.

Carbon Energy would like to shutdown the current panel and commence a new panel using the lessons from the latest panel to improve their system. If the Government determines that this is acceptable, improved monitoring of the new panel should be implemented as described above. A proposed monitoring plan should be submitted by Carbon Energy for approval by DERM. This plan will have to
be designed to demonstrate that the decommissioned panel is safe to environment, stock and humans. As part of its roadmap process as agreed with DEEDI and communicated to industry, the ISP will provide guidance in the form of a risk assessment outline to assist Carbon Energy with this design process. This assumes the ISP has sufficient time to develop the risk approach in time for any decision DERM might take in relation to the Carbon Energy site.

3.4. Information

*Recommendation 5.* It is recommended that the Government put together a succinct summary of cause of each of the UCG incidents, the environmental compromises that occurred (including site and DERM monitoring information) and consequent actions and put this into the public domain as soon as possible.

3.5. Continuance of the trials

*Recommendation 6.* It is recommended that the Carbon Energy panel 1 be decommissioned but not immediately. Carbon Energy should present a plan to government for decommissioning. The Plan should provide detail on the decommissioning and panel cleaning processes. In particular, the monitoring process to provide assurance that the panel contains no substances deleterious to people, stock or the environment. The ISP would be content to see this plan as a response to the DEEDI roadmap process as previously communicated to industry. However, if DERM sees a need to move more rapidly then the recommendation could be enacted immediately. The trial should continue as planned for additional panels.
Summary of considerations and recommendations on the Environmental Evaluations of Cougar Energy

24 January 2011

Report of the Independent Scientific Panel on Underground Coal Gasification to the Department of Employment, Economic Development and Innovation (DEEDI) in response to a request from the Department of Environment and Resource Management (DERM)

This report is supported by a range of individual reports previously delivered to DERM and DEEDI by members of the Independent Scientific Panel on numerous occasions following various stages of the Environmental Evaluation Process. All reports have been provided in confidence. This report has been extracted so as to provide a document from the ISP that can be communicated into the public domain should DEEDI choose to do so.

Independent Scientific Panel:
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1. OVERVIEW

The report summarises a number of pieces of advice previously delivered to the Department of Environment and Resource Management (DERM) and the Department of Employment, Economic Development and Innovation (DEEDI).

This report summarises the ISP’s advice on environmental issues, the quantity and quality of information provided to the ISP by Cougar Energy, infrastructure failures and operating compromises to the trial and the scale, scope and nature of the pilot. These topics were considered on the basis of a specific request by DERM.

The ISP proposes to continue to follow its established roadmap for the trial. The ISP will send in the next weeks the proposed reporting risk assessment approach to the company for feedback. This will be followed by finalisation of the reporting risk assessment format and the minimum data set required to support reporting. The ISP expects Cougar Energy to participate because the decommissioning process for that site once completed, should form part of their complete report to the ISP. The ISP’s report to government is to provide government with the considerations of the ISP of the success or otherwise of each of the technology based on the pilot trial. Assessment of the Cougar Energy technology should be on the same basis as the other companies.
2. CONSIDERATIONS

2.1. Environmental issues

Commentary on environmental aspects (including air, water, land and waste) of the three pilots with respect to the underground gasification process and any gas treatment

The ISP has found some difficulty in assessing the implications of the Environmental Evaluations in some aspects of environment because of a lack of sufficient base line information. More systematic monitoring should have been required and undertaken at the outset. All trials should have had the same initial baseline and monitoring requirements and minimum conditions for Environmental Authorities (EAs) should have been in place and been as consistent as possible across the trials.

Environmental Evaluations implications have been observed for water and land in relation to the Cougar Energy trial where benzene and toluene were each detected. Detection occurred in adjacent bores, i.e., benzene in one bore and toluene in another in a different stratum/horizon. Each bore recorded one reading less than stock water limits but greater than drinking water limits. Both were detected in bores at some distance (approx. 250m) from the chamber, which is a concern as it indicates high likelihood of transport from the chamber. It is not possible to be certain of this because no isotopic signatures of the benzene or toluene were reported. However, gas composition that was measured at the same locations is consistent with the gas source being the chamber. Therefore, water quality was compromised. It is unknown whether pollution of the soil/regolith on the path between the chamber inlet and the bores occurred. No benzene or toluene was detected in surrounding bores and water systems following extensive survey conducted by DERM. However, in a sample submitted by Cougar on the 28 October, a benzene concentration of 45 micrograms per litre was found in borehole T5058. This is above the trigger level of 1 microgram per litre.
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In all three pilots more attention should have been given to obtaining appropriate base line data (see section 3.3 – monitoring). The information disclosed by Cougar Energy is inadequate. Acquisition of better data beforehand would have revealed the complexities of the hydrological situation at Kingaroy before the burn. The complexity at this site may have indicated a precautionary approach.

For valid environmental comparisons, all three trials should have had similar compliance conditions within their EAs.

2.2. Quality and quantity of information provided to the ISP

All companies provided the ISP initially with background information that described their technologies and also general information on the benefits to society and the Queensland economy of underground coal gasification. The latter material, in particular, was clearly articulated. The case made was obviously aimed at advocacy for the UCG industry but that was explicit and not otherwise represented.

Cougar Energy have a stated position that they are not engaged in running a pilot trial of a new technology but a small-scale facility of a well-tested technology. Consequently, they assert, they do not need a lot of in-house technical capability and can rely on consultants as required. Consistent with this view, when the ISP interviewed Cougar Energy at their offices a consultant explained, via use of a whiteboard alone, their underground design and operational approach. The ISP prefers the approach adopted by another company of building strong internal technical capacity.

The documentation for the Environmental Evaluations and monitoring information provided by Cougar Energy has generally lacked detail and been less-than-clear in explanation with some self-contradictory comments and other comments that were difficult to interpret. In some cases, specific requests were made and either overlooked or misinterpreted.
2.3. Infrastructure failures or operating compromises in the trials

This section considers any malfunctions that may have occurred at any of the sites, the risk to the environment from these and corrective measures put in place, or proposed, to prevent a recurrence during the remainder of the trial.

The current situation is that Cougar Energy has had a failure of infrastructure. Understanding the causes of this failure is important, and obtaining this understanding should be an essential part of the pilot study.

At Cougar Energy, backpressure soon after ignition appears to be the best explanation for the pushing of water and ash up the inflow bore/pipe. Pressure and temperature have been proposed as explanation for the compromise to the bore casing at a point where, during construction, a join was made. Water and gas then escaped through the compromised infrastructure and were detected in bore down the gradient of groundwater flows. It is possible that the flow was along a preferential pathway at the interface between two horizons/strata. Gas continued to appear in one of the bores for some time after the event indicating the compromise did not self anneal. The Cougar Energy situation is concerning, with at least a casing breach of the bores, and the additional potential of an underground explosion, having released contaminated waters into the groundwater. The fact that the possible existence of an explosion has yet to be confirmed or ruled out, means that corrective measures have not been put in place to prevent the reoccurrence of this type of malfunction. Finally, the compromised infrastructure remains in the condition it was when the incident occurred (assuming no further deterioration, which may have occurred). Whilst infrastructure compromise is the most convincing explanation, detection of benzene and toluene in separate bores in different aquifers remains unexplained. Even though various hypotheses have been put forward none are very convincing. Other transport mechanisms and pathways, therefore, cannot be entirely ruled out.
2.4. Scale, scope and nature of each pilot

The scale, nature and scope of these pilot programmes are in line with their purpose as technological trials, and are appropriate for this function.

2.5. Site specific considerations

This section considers any matters relevant to the location of each of the sites and environmental values at each location.

The ISP’s view is that the location of the Cougar Energy trial in the Kingaroy region was not optimal. The local hydrogeology indicates considerable underground complexity and potential for preferential flow of groundwater. This information was contained in the consultant’s report that was available to Cougar Energy (and therefore potentially to government) at the time of approval. It is unclear why the trial was not located in a more simple hydrogeological setting, which was available not too distant from the existing site. The complexity of the aquifers and strata surrounding the test chamber are not competent to contain potential, and as it turns out actual, fluid flows potentially containing contaminants. Regardless of the hydrogeological setting, the ISP does not accept that the surrounding land use provides an optimal site setting for UCG. In particular, agricultural reliance on the groundwater of the region is not a circumstance prudent for trialling UCG production, given the environmental, anthropogenic and political consequences of a malfunction such as happened. The location for testing of this type of technology should be carried out in as close to controlled circumstances as possible.

An important site consideration is the maintenance of sufficient groundwater pressure surrounding the chamber to contain and control the burn. One potential change to the current operating environment is the regional development of the coal seam gas (CSG) industry. To extract coal seam gas, groundwater pressure must be reduced to allow the gas to desorb from the coal. Origin Energy presented their estimates of pressure reduction across the CSG production region to the ISP and the State government interdepartmental working group. Their proposition was that a significant pressure decrease would occur and they contend that this is likely to
ISP Summary Report on DERIM Environmental Evaluations – Cougar Energy

impact UCG. The details of the Origin groundwater modelling (calibration, validation and simulation results) have not yet been received by the ISP. It is unknown from the presentation whether modelling was only undertaken in the Walloon coal measures (from where CSG is extracted in the Surat Basin) or whether pressure changes in other connected aquifers was also modelled. If the former, then the Origin information is only relevant for assessment of pressure effects where UCG is being undertaken in the same measures as the CSG extraction. If modelling was extended to other connected aquifer systems then the information may be of assistance in assessing pressure impacts on UCG in those connected systems.

Without the Origin modelled data it is difficult for the ISP to assess the impact of pressure decrease from CSG on UCG. It is important that DERIM access the modelling outputs and assess the details. The ISP is prepared to assist in this activity. Given uncertainty over the time course of development of CSG and that the assumptions regarding this in the Origin Energy modelling are unknown, the ISP does not feel it appropriate to make recommendations regarding responses by government. If however, pressure is expected to be reduced to below the chamber operating pressure in the UCG pilot trial within the next 6-12 months then a discussion between government, the CSG and UCG companies should occur to determine the best course of action with respect to spatial development of CSG. If however, the drawdown is to occur after the pilot trials are concluded then the issue would be more appropriately dealt with in the ISP considerations of impacts of UCG industry scale up. The Cougar Energy Kingaroy trial has the least exposure to this potential impact.

3. RECOMMENDATIONS

3.1. Alteration in scope, scale or nature of each trial

The scale, nature and scope of the pilot programmes are appropriate for a trial programme. There is no need to alter these factors. However, alteration of regulatory controls may include measures to dictate factors including the scope, scale and nature of future trials, especially with regards to monitoring requirements.
Recommendation 1. Given the incident at the Cougar Energy site, it is recommended that the nature of the Cougar Energy trial be changed to short circuit the operational phase and move under a planned regime to decommissioning of the chamber.

3.2. Alterations in any regulatory controls

Recommendation 2. It is recommended that the Government moves to place all three trials under the same minimum Environmental Authority conditions without delay.

3.3. Monitoring

Recommendation 3. It is recommended that improved groundwater monitoring be initiated at all pilot sites and that pressure and gas monitoring be examined for adequacy.

A critical factor concerning environmental monitoring, to assist in regulatory and operational control, is the implementation of a comprehensive monitoring scheme to establish background levels of the water chemistry and soil properties. This factor relates to the issue faced by the three companies that have run UCG trials, which is the lack of initial regulatory oversight and structure within which to operate.

In all three pilots more attention should have been given to obtaining better baseline data. This could have been facilitated by implementing more systematic monitoring. It is not too late to improve the water monitoring and it is recommended that this be done forthwith at all three sites.

It is recommended that concentric arrays of boreholes into all aquifers above the coal aquifer, the coal aquifer itself, and the aquifer below the burn chamber should be installed. Distances for these arrays should be logarithmic away from the burn chamber. Some bores close to the chamber may have to be sacrificed as the chamber expands. This should be seen as a reasonable and necessary cost of the trials because it is critical to have early warning of any changes to the groundwater as this is a signal that unexpected changes may be occurring in the chamber. Risk management protocols should be in place to ensure such signals trigger appropriate
actions. These actions should have been agreed with the approving government agencies before the trials commenced. Triggers should be put in place for all known possible risks at all trial sites. Triggers for temperature, gas, pressure and water quality and flow should be included.

For Western Queensland baseline monitoring must include seasonal variations in groundwater compositions.

**Recommendation 4.** Monitoring at entry and exit points from the chamber should be standard for all trials to ensure that any leaks are immediately detected.

**Recommendation 5.** Soil testing in all pilots should be undertaken as close to the chamber as practical (safe) as the chamber expands. This will provide information on the possible release of contaminants from the chamber. It is considered unlikely that this will occur during normal operations of the chamber as groundwater flow is always into the chamber. However, deviations from normal operating conditions can occur and monitoring should be in place to detect any contamination as a result.

**Recommendation 6.** Given that the incident at the Cougar Energy site has resulted in a halt to gasification activities, the ISP recommends that additional monitoring be put in place immediately. This should consist of regular monitoring of water levels in the chamber (at least weekly). Further, the chamber should be surrounded by a ring of bores into the coal seam and into the aquifers above and below it. These bores should be sampled at least fortnightly for all the analytes specified in the Environmental Authority for the site. If no exceedance occurs after 6 weeks monitoring could be reduced to monthly. Further, should rainfall exceed 100mm in any 24 hour period, sampling should be conducted as soon as the site can be safely accessed.

### 3.4. Information

**Recommendation 7.** It is recommended that the Government put together a succinct summary of cause of each of the UCG incidents, the environmental
ISP Summary Report on DERM Environmental Evaluations – Cougar Energy

compromises that occurred (including site and DERM monitoring information) and consequent actions and put this into the public domain as soon as possible.

3.5. Continuance of the trials

Recommendation 8. The ISP recommends that the Cougar Energy trial not be reignited. The basis for this recommendation is that it is very likely that the incident resulted in a compromise to infrastructure allowing gas and water to escape from the chamber into the surrounding environment. Further, the Environmental Evaluation report indicated that Cougar Energy did not act sufficiently rapidly to shut down the facility when the changes to infrastructure were first observed. This indicates insufficient risk management protocols for the site and/or insufficient sensitivity of controls. It is unknown but possible that the escape of water and gas may have been avoided if the facility had have been shutdown more rapidly. Further, operating in such a hydrogeologically complex site should only proceed after it is shown to be acceptable on the basis of significantly better base line information. It should be noted that this will not change the edaphic and socio-political suitability of the site.

It is recommended that Cougar Energy move to decommission the cavity. First, a plan should be submitted for government approval and action taken immediately thereafter. It is an important (critical) part of all of the pilot trials that effective decommissioning can be undertaken and demonstrated not to leave unacceptable legacies in the environment. It is not recommended that a “clean up” approach be adopted. That is, the site should be treated as a pilot trial moving into orderly and planned decommissioning following an unscheduled permanent shutdown.
Summary of considerations and recommendations on the Environmental Evaluations of Linc Energy

24 January 2011

Report of the Independent Scientific Panel on Underground Coal Gasification to the Department of Employment, Economic Development and Innovation (DEEDI) in response to a request from the Department of Environment and Resource Management (DERM)

This report is supported by a range of individual reports previously delivered to DERM and DEEDI by members of the Independent Scientific Panel on numerous occasions following various stages of the Environmental Evaluation Process. All reports have been provided in confidence. This report has been extracted so as to provide a document from the ISP that can be communicated into the public domain should DEEDI choose to do so.

Independent Scientific Panel:
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1. OVERVIEW

The report summarises a number of pieces of advice previously delivered to the Department of Environment and Resource Management (DERM) and the Department of Employment, Economic Development and Innovation (DEEDI).

This report summarises the ISP’s advice on environmental issues, the quantity and quality of information provided to the ISP by Line Energy, infrastructure failures and operating compromises to the trial and the scale, scope and nature of the pilot. These topics were considered on the basis of a specific request by DERM.

The ISP proposes to continue to follow its established roadmap for the trial. The ISP will send in the next weeks the proposed reporting risk assessment approach to the company for feedback. This will be followed by finalisation of the reporting risk assessment format and the minimum data set required to support reporting. The ISP’s report to government is to provide government with the considerations of the ISP of the success or otherwise of each of the technologies based on the pilot trial. Assessment of the Line Energy technology will be on the same basis as the other companies.
2. CONSIDERATIONS

2.1. Environmental issues

Commentary on environmental aspects (including air, water, land and waste) of the three pilots with respect to the underground gasification process and any gas treatment

The ISP has found some difficulty in assessing the implications of the Environmental Evaluations in some aspects of environment because of a lack of sufficient base line information. More systematic monitoring should have been required and undertaken at the outset. All trials should have had the same initial baseline and monitoring requirements and minimum conditions for Environmental Authorities (EAs) should have been in place and been as consistent as possible across the trials.

Across the three trials Environmental Evaluations implications have been observed for water and land. In all three pilots more attention should have been given to obtaining appropriate base line data (see section 3.3 – monitoring). Linc Energy base line information is considered reasonable in terms of the scale and nature of the incident under investigation via the Environmental Evaluations.

For valid environmental comparisons, all three trials should have had similar compliance conditions within their EAs.

2.2. Quality and quantity of information provided to the ISP

All companies provided the ISP initially with background information that described their technologies and also general information on the benefits to society and the Queensland economy of underground coal gasification. The latter material, in particular, was clearly articulated. The case made was obviously aimed at advocacy for the UCG industry but that was explicit and not otherwise represented. The former material was supported by interviews with each company at their offices in Brisbane. In the office interview, Linc Energy was well prepared and a great deal of information was communicated. The company proved to be open and willing to
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engage with the ISP to ensure good understanding of its technologies, operational protocols, modelling capabilities and data from monitoring. Linc Energy also willingly communicated challenges with its operating environment. Linc Energy demonstrated a database with a considerable quantity of information and with associated QA/QC protocols. Linc Energy was able to demonstrate a significant build up of technical capacity in the company.

The documentation for the Environmental Evaluations and monitoring information provided by Linc Energy is forthright in level of detail. The report describes and specifies events leading to contravention of guidelines including responses taken and results of subsequent environmental monitoring. In general, the scope and level of detail is thorough, with all pertinent information included.

2.3. Scale, scope and nature of each pilot

The scale, nature and scope of these pilot programmes are in line with their purpose as technological trials, and are appropriate for this function. The Linc Energy trial is regarded as world’s leading practice.

2.4. Site specific considerations

The area surrounding the Linc Energy trial site at Chinchilla is appropriate assuming groundwater pressures are assured. An important site consideration is the maintenance of sufficient groundwater pressure surrounding the chamber to contain and control the burn. One potential change to the current operating environment is the regional development of the coal seam gas (CSG) industry. To extract coal seam gas, groundwater pressure must be reduced to allow the gas to desorb from the coal. Origin Energy presented their estimates of pressure reduction across the CSG production region to the ISP and the State government interdepartmental working group. Their proposition was that a significant pressure decrease would occur and they contend that this is likely to impact UCG. The details of the Origin groundwater modelling (calibration, validation and simulation results) have not yet been received by the ISP. It is unknown from the presentation whether modelling was only undertaken in the Walloon coal measures (from where CSG is extracted in the Surat
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Basin) or whether pressure changes in other connected aquifers was also modelled. If the former, then the Origin information is only relevant for assessment of pressure effects where UCG is being undertaken in the same measures as the CSG extraction. If modelling was extended to other connected aquifer systems then the information may be of assistance in assessing pressure impacts on UCG in those connected systems.

Without the Origin modelled data it is difficult for the ISP to assess the impact of pressure decrease from CSG on UCG. It is important that DERM access the modelling outputs and assess the details. The ISP is prepared to assist in this activity. Given uncertainty over the time course of development of CSG and that the assumptions regarding this in the Origin Energy modelling are unknown, the ISP does not feel it appropriate to make recommendations regarding responses by government. If however, pressure is expected to be reduced to below the chamber operating pressure in the UCG pilot trial within the next 6-12 months then a discussion between government, the CSG and UCG companies should occur to determine the best course of action with respect to spatial development of CSG. If however, the drawdown is to occur after the pilot trials are concluded then the issue would be more appropriately dealt with in the ISP considerations of impacts of UCG industry scale up.

3. RECOMMENDATIONS

3.1. Alteration in scope, scale or nature of each trial

The scale, nature and scope of the pilot programmes are appropriate for a trial programme. There is no need to alter these factors.

3.2. Alterations in any regulatory controls

Recommendation 1. It is recommended that the Government moves to place all three trials under the same minimum Environmental Authority conditions without delay.
3.3. Monitoring

Recommendation 2. It is recommended that improved groundwater monitoring be initiated at all pilot sites and that pressure and gas monitoring be examined for adequacy.

A critical factor concerning environmental monitoring, to assist in regulatory and operational control, is the implementation of a comprehensive monitoring scheme to establish background levels of the water chemistry and soil properties. This factor relates to the issue faced by the three companies that have run UCG trials, which is the lack of initial regulatory oversight and structure within which to operate. Linc Energy implemented their own background level survey before initiation of their trial, however this was to standards that they designed, not ones set by a regulatory authority. The ISP makes no general assessment of the Linc Energy approach given this lack of a regulatory backdrop.

In all three pilots more attention should have been given to obtaining better baseline data. This could have been facilitated by implementing more systematic monitoring. It is not too late to improve the water monitoring and it is recommended that this be done forthwith at all three sites.

It is recommended that concentric arrays of boreholes into all aquifers above the coal aquifer, the coal aquifer itself, and the aquifer below the burn chamber should be installed. Distances for these arrays should be logarithmic away from the burn chamber. Some bores close to the chamber may have to be sacrificed as the chamber expands. This should be seen as a reasonable and necessary cost of the trials because it is critical to have early warning of any changes to the groundwater as this is a signal that unexpected changes may be occurring in the chamber. Risk management protocols should be in place to ensure such signals trigger appropriate actions. These actions should have been agreed with the approving government agencies before the trials commenced. Triggers should be put in place for all known possible risks at all trial sites. Triggers for temperature, gas, pressure and water quality and flow should be included.
For Western Queensland base line monitoring must include seasonal variations in groundwater compositions.

**Recommendation 3.** Monitoring at entry and exit points from the chamber should be standard for all trials to ensure that any leaks are immediately detected.

**Recommendation 4.** Soil testing in all pilots should be undertaken as close to the chamber as practical (safe) as the chamber expands. This will provide information on the possible release of contaminants from the chamber. It is considered unlikely that this will occur during normal operations of the chamber as groundwater flow is always into the chamber. However, deviations from normal operating conditions can occur and monitoring should be in place to detect any contamination as a result.

### 3.4. Information

**Recommendation 5.** It is recommended that the Government put together a succinct summary of cause of each of the UCG incidents, the environmental compromises that occurred (including site and DERM monitoring information) and consequent actions and put this into the public domain as soon as possible.

### 3.5. Continuance of the trials

**Recommendation 6.** It is recommended that the Linc Energy pilot continue as planned.