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Hunterston No. 1 Drilling Project
Hazard Evaluation and Risk Assessment

Prepared for Great South Land Minerals

July 2001

e-systems
Pty Limited

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Hunterston No 1 Drilling Project - Hazard Evaluation and Risk Assessment - SEL13/1998
E-Systems Proprietary Limited; Great South Land Min
Anon SEL13/1998

e-systems
Pty Limited
205 Davey Street
Hobart Tasmania 7000
AUSTRALIA

Telephone (03) 6224 8870
Facsimile (03) 6224 8871
e-systems@trump.net.au

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HUNTERSTON NO. 1 DRILLING PROJECT

HAZARD EVALUATION AND RISK ASSESSMENT

Introduction and scope

E-Systems Pty Limited was engaged by Great South Land Minerals (GSLM), Hobart to assist in the identification of hazards associated with the proposed Hunterston No. 1 Drilling Project, planned for the third quarter of 2001. This health, safety and environmental risk assessment is undertaken to address the conditional approval of the drilling project, in accordance with the advice of the Department of Infrastructure, Energy and Resources (DIER). Preliminary approval was granted in correspondence from Dr Geoffrey Green, Acting Director of Mines, to Mr David Tanner of Great South Land Minerals Limited, dated 7 June 2001, subject to conditions which include:

> *A health safety and environment risk assessment must be carried out by an independent assessor. The initial assessment can be made during preparations to extend the hole, but must be completed before drilling commences. If any defects in the well plan are identified it must be revised accordingly.*

The drilling project is a stratigraphic well to be drilled to a target depth of 900 to 1,200 metres in the Hunterston area of the Central Highlands. A slim hole mineral drilling machine is to be used to obtain a stratigraphic core as described in the Hunterston No. 1 Well Plan (prepared by GSLM, May 2001), which was submitted to DIER to obtain preliminary approval.

The purpose of this hazard evaluation was to identify the health, safety and environmental hazards that might eventuate during the project. A team of technical specialists systematically reviewed the planned activities and identified the key hazards that must be managed to reduce project risk to acceptable levels.

Approach

The process of identifying hazards, assessing and managing risk was undertaken in accordance with AS/NZS 4360 for risk management. The method selected to identify hazards was the preliminary hazard analysis (PHA) technique.[1] This method was chosen on the basis of its:

- Applicability to the planning process for the stratigraphic well drilling program;
- Wide acceptance as a proven hazard evaluation tool;
- Reliance on the expertise of available drilling, engineering and geology specialists on the hazard evaluation team; and
- Public availability (not requiring proprietary licenses for use).

[1] Center for Chemical Process Safety, *Guidelines for Hazard Evaluation Procedures*, Second Edition, American Institute of Chemical Engineers, 1992.

During the team meeting, elements of the "What-if?" and checklist hazard evaluation techniques were also used by the facilitator to assist in the identification of possible hazards for discussion by the team.

The PHA method relies on a team of specialists to review the proposed activities to be undertaken during the drilling project, as described in the GSLM Well Plan. The persons involved in the PHA team meeting were:

Name	Company	Area of expertise	Qualifications/experience
Shane Bartel	GSLM	Environmental assessment	5 years experience
Rod Tabor	GSLM	Well testing, logging and perforating	BEng, FIEE(UK), CEng 21 years oilfield experience
David Tanner	GSLM	Drilling project management	Professional engineer
Andy Horbach	OME Drilling Group	OME Drilling Group Director	30 years experience
James Polson	OME Drilling Group	Drilling, rig mobilisation and set-up, mud logging	7 years experience
Ross Smith	OME Drilling Group	Drilling, subsea engineering well control	20 years experience, mostly in drilling
Richard Stoklosa	E-Systems	Risk assessment	MSc Chemical Engr, FIEAust, CPEng, NPER

Preparation for the team meeting identified the following project activities for detailed discussion:

1. Site preparation;
2. Rig mobilisation;
3. Rig up (equipment set up, equipment test);
4. Test well head, casing and plug (including blow out preventer, or BOP);
5. Drill out cement plug;
6. Core well to depth (drilling run, retrieving core, tripping pipe, changing drill bit);
7. Maintenance of drilling equipment;
8. Well testing;
9. Plug and abandon;
10. Rig down;
11. Rig demobilisation; and
12. Site remediation.

The PHA was organised to address each of these activities, and to record potential hazards, their primary causes, their major consequences, and a hazard category ranking. Following the hazard category ranking, suggestions were made by the PHA team for any corrective/preventive measures that could be applied to control risk (eg to reduce the likelihood, or to reduce the severity of the consequences). This information is presented in Attachment 1, which contains the PHA worksheets developed during the team meeting and the definitions used by the team to select an appropriate hazard category. The PHA worksheets were distributed to the participants at the conclusion of the meeting for review and comment to preserve the accuracy and quality of the hazard identification process.

Following the PHA meeting and endorsement of the information contained PHA worksheets, potential risk was managed by the adoption of appropriate corrective/preventive control measures.

For purposes of the PHA and risk assessment, the requirements of the Mineral Resources Tasmania *Mineral Exploration Code of Practice*, and the APPEA *Environmental Code of Practice* were considered guiding principles for the health, safety and environmental risk assessment. Assumptions adopted by the hazard evaluation team, to avoid unproductive speculation during the hazard evaluation meeting include:

- All applicable Australian Standards and relevant industry codes of practice are used by designers, equipment and material suppliers, transporters, construction crews and GSLM and contractor personnel;
- Equipment selected for the project is fit for purpose, structurally competent, constructed of appropriate materials and independently verified by a qualified inspector; and
- All materials supplied for project activities is on specification and appropriate for their intended use.

It should be noted that although previous drilling activity in Tasmania has not reported the presence of hydrogen sulphide (H_2S) gas, the hazard evaluation team assumed that toxic gas is a potential hazard that must be accounted for in the consideration of drilling and well testing activities.

Results of the preliminary hazard analysis

The results of the PHA hazard evaluation were recorded on the PHA worksheets presented in Attachment 1. The information is presented for each of the 12 project activities described above. In the worksheets, each identified hazard has a unique number for reference (the activity number, followed by a sequential number for each hazard identified under that activity).

Four of the hazards identified in the team meeting were classified as hazard category "4" events, which are described as having potentially catastrophic impacts:

1.1 Injury or fatality to personnel due to flammable/toxic gas, or radiant heat hazard, caused by the proximity of the flare to a private access road and rig site.

3.1 Injury or fatality to personnel, or damage to equipment as a result of moving equipment and heavy lifts during rig up (same hazard during rig down activity no. 11).

6.1 Potential formation or well blowout as a result of coring operations where drilling personnel do not recognise signs of abnormal pressure and do not react to regain pressure control.

8.1 Injury or fatality to personnel, or damage to equipment as a result of an explosion of produced gas during well testing activities.

Corrective/preventive risk control measures were discussed at length for each of these hazard category 4 events and the most appropriate measures were recorded by the team in the PHA worksheets (Attachment 1). The level of risk represented by category 4 events is considered unacceptable without the adoption of corrective/preventive measures. Appropriate risk management measures must be adopted to reduce the likelihood of the potential event, or to reduce the severity of the potential consequences so that the level of risk is reduced to acceptable levels.

Nine of the hazards were classified as hazard category "3" events, considered to have potentially serious impacts. Several recommended corrective/preventive risk control measures were recorded on the PHA worksheets to reduce risk to levels "as low as reasonably practicable" (ALARP).

Six other hazards were classified as hazard category "2" events, meaning that these hazards could potentially result in only minor impacts. The PHA team identified further risk control measures for these category 2 events to reduce risk in accordance with the ALARP principle.

Risk management

A Risk Register/Risk Treatment Schedule and Action Plan has been developed to capture the results of the hazard evaluation and to detail specific risk management commitments. The Risk Register/Risk Treatment Schedule and Action Plan is presented in Attachment 2 for reference. Each hazard identified by the PHA team is recorded on the Plan for follow up.

The Risk Register is used to qualitatively estimate the likelihood of a hazard occurring, and the severity of the potential consequences. Definitions of likelihood and consequences (adapted from AS/NZS 4360) are the same as those used in the PHA hazard category ranking, as defined in Attachment 1. Based on the estimated likelihood and consequences of a hazard, risk can be classified in one of four categories using the approach shown in Attachment 1 and listed on the Risk Register. In the case of the PHA method of hazard evaluation, the risk category is taken to be the hazard category assigned during the PHA team meeting. Each level of risk has a corresponding level of risk management objectives:

Risk Level 1	Negligible risk.	Incorporate cost effective risk reduction strategies within the scope of long term planning.
Risk Level 2	Moderate risk.	Implement cost effective measures for risk reduction and formalise routine procedures for reducing risk.
Risk Level 3	Significant risk.	Implement cost effective measures for risk reduction and assign senior management responsibility.
Risk Level 4	Intolerable risk.	Cannot be justified under any circumstances. Implement risk reduction measures to reduce risk to a lower level.

The planned implementation of risk reduction/control measures listed on the Risk Register/Risk Treatment Schedule and Action Plan allow a re-assessment of the level of risk following 'treatment' to reduce the likelihood of an event occurring, or the severity of the potential consequences. Recommendations to reduce risk according to the ALARP principle were made in every case. In some instances, additional risk reduction/control measures were adopted in consultation with GSLM, which were identified as appropriate risk management actions subsequent to the PHA team meeting.

The re-assessment of the level of risk is recorded in the Risk Register/Risk Treatment Schedule and Action Plan as the "treated risk level". In the case of the four hazards which were initially assigned a hazard category of "4" (for potentially catastrophic impacts), the adoption of the risk management actions listed on the Risk Register/Risk Treatment Schedule and Action Plan has resulted in a treated risk level of "3", which is acceptable under AS/NZS 4360 as long as risk is reduced to a level "as low as reasonably practicable", and senior management responsibility is assigned to ensure that risk reduction/control measures are implemented.

The hazards identified by the PHA team and the risk management actions adopted by GSLM are discussed below (by treated risk level). It should be noted that GSLM is commits to implement all of the risk reduction measures listed in the column titled "Preferred risk treatment options" on the Risk Register/Risk Treatment Schedule and Action Plan in Attachment 2.

Intolerable risk

None of the identified hazards, when appropriate risk treatment options were adopted, were considered 'intolerable' risks. Specifically, risks associated with hazards 3.1, 6.1 and 9.1 are reduced from 'intolerable' to 'significant' risks with the risk reduction/control measures listed in the Risk Register/Risk Treatment Schedule and Action Plan.

Significant risk

Under AS/NZS4360, it must be demonstrated that any significant risks (Risk Level 3) are reduced to a level "as low as reasonably practicable" (ALARP). The objective of the ALARP approach is to apply risk control measures to reduce risks of drilling activities to an achievable level, where the cost and feasibility of further measures become unreasonably disproportionate to additional risk reduction obtained.

Following the adoption of appropriate risk reduction measures, thirteen significant (Level 3) risks are noted in the Risk Register/Risk Treatment Schedule and Action Plan, listed below by number:

1.1. Human exposure to flammable gas, radiant heat hazards, and possibly toxic gas (hydrogen sulphide, or H_2S) due to the proximity of the flare to the existing access road and the rig site.

3.1. Injury or fatality to personnel, or damage to equipment as a result of moving equipment and heavy lifts during rig up (same hazard during rig down activity number 11).

3.2. Injury to personnel, or damage to equipment as a result of equipment failure during hydraulic pressure testing of rig equipment.

4.1 Injury to personnel, or damage to equipment as a result of equipment failure during hydraulic pressure testing of the well head, casing and plug.

6.1 Potential formation or well blowout as a result of coring operations, where drilling personnel do not recognise signs of abnormal pressure and do not react to regain pressure control.

6.2 Loss of pressure control as a result of a very large well kick during coring operations, jamming the drill string and losing the ability to circulate.

7.2 Loss of pressure control as a result of a loss of drilling mud during temporary maintenance shut down, caused by a lost circulation zone or gas incursion into the drill hole from a formation.

8.1 Injury or fatality to personnel, or damage to equipment as a result of an explosion of produced gas during well testing activities.

8.2 Equipment damage caused by erosion of well testing equipment during a flow test.

8.3 Environmental contamination as a result of waste hazardous material produced during well testing.

8.4 Potential blowout of the well as a result of a loss of pressure control during well testing.

12.1 Potentially contaminated drill cuttings buried on site, as a result of disposal in pits remaining after the demobilisation of the drilling rig.

12.2 Lack of site remediation, caused by inadequate remediation strategy or inadequate implementation.

Significant level risks require senior management responsibility to ensure that risk reduction measures and safeguards are implemented to reduce risk to acceptable levels.

Moderate risk

Moderate risks (Risk Level 2) are managed by implementing cost effective measures for risk reduction, and formalising procedures to work safely and preserve the integrity of process equipment.

Following the adoption of appropriate risk reduction measures, six moderate (Level 2) risks are noted in the Risk Register/Risk Treatment Schedule and Action Plan, listed below by number:

1.2 Equipment damage as a result of a bush fire on surrounding land.

2.1 Equipment damage or potential electric shock during rig mobilisation activities, caused by inadequate roadways or inadequate clearance to overhead power lines.

3.3 Injury to personnel or equipment damage due to a lightning strike.

5.1 Potential well kick while drilling out the cement plug, caused by an accumulation of gas in the formation just below the plug.

6.3 Loss of pressure control during coring operations, due to increasing formation pressure requiring increasing mud weight.

7.1 Delays in drilling operations or loss of pipe due to stuck pipe following temporary maintenance shut downs.

Moderate level risks require management responsibility to ensure that risk reduction measures and safeguards are implemented to reduce risk to acceptable levels.

Negligible risk

None of the hazards identified in the PHA team meeting, or re-assessed following the adoption of appropriate risk reduction/control measures represent negligible risk (Risk Level 1).

Conclusions and recommendations

The hazard evaluation was an opportunity for a team of experienced specialists in a variety of drilling, engineering, geology and management disciplines to discuss the types of concerns and potential hazards of the Hunterston No. 1 Drilling Project. The outcome of the hazard evaluation is the Risk Register/Risk Treatment Schedule and Action Plan presented here (Attachment 2). The project team has identified the recommendations that will be adopted for each hazard to reduce risk to acceptable levels in accordance with the ALARP principle. The project team must monitor these risks to ensure that control measures remain effective during the project lifecycle.

The key hazards identified in this hazard evaluation and risk assessment are associated with the "hazard category 4" (potentially catastrophic impact) items noted by the PHA team:

1. The potential exposure to radiant heat hazards (and possibly toxic gas) at the flare pit, and the siting of the flare pit to mitigate the exposure (PHA item 1.1);

2. Potential injuries and equipment damage during rig up activities, when heavy lifts are necessary (PHA item 3.1);

3. Loss of pressure control during coring operations (PHA item 6.1); and

4. Potential explosion hazards involving produced gas during well testing activities (PHA item 8.1).

Each of these hazards has been reviewed in detail, and GSLM commits to all of the "preferred risk treatment options" listed in the Risk Register/Risk Treatment Schedule and Action Plan. Adoption of these risk control strategies reduces the likelihood of these types of hazardous events, and/or the severity of the potential consequences. Corrective/preventive actions will be implemented by GSLM to reduce risk to a level "as low as reasonably practicable".

There is substantial reliance placed on the procedures of experienced and qualified contractors to manage and control hazards that have been identified, subject to GSLM's own Well Plan and Blowout Prevention and Well Control procedures. It is recommended that GSLM formally verify that all necessary contractor procedures have been developed, and that a "Bridging Document" is developed to indicate how the drilling and well testing contractors address GSLM's safety requirements, as contained in the GSLM Well Plan and Blowout Prevention and Well Control document, with reference to the requirements of the *Mineral Exploration Code of Practice, Schedule C.* Implementation of contractor procedures should be audited by GSLM to ensure that all risk treatment measures are in place during project activities. An audit requires sufficient documentation of all procedures and test results, which should be specified in the contractor's "Bridging Document".

Respectfully submitted,
E-SYSTEMS PTY LIMITED

Richard Stoklosa

Richard Stoklosa FIEAust, CPEng, NPER-3
Managing Director

Attachment 1

Preliminary Hazard Analysis Worksheet

e-systems Pty Limited
environment
health & safety
risk management
major projects
205 Davey Street
Hobart Tasmania 7000
Telephone (03) 6224 8870
Facsimile (03) 6224 8871
e-systems@trump.net.au
ACN 065 135 051

Hazard Evaluation — Preliminary Hazard Analysis

GREAT SOUTH LAND MINERALS
HUNTERSTON NO. 1 DRILLING PROJECT

Results of Team Meeting, 13 July 2001

Hazard	Cause	Major Effects	Hazard Category	Corrective / Preventive Measures Suggested
1. Site Preparation Mineral Resources Tasmania—Mineral Exploration Code of Practice, Schedule C; and APPEA Code of Environmental Practice. Land clearance, stockpiling topsoil separately from subsoil. Tree removal and for flare stack safety, flare pit, fire protection access. Flare pit to be separated from the collection dam. Drilling pad to be drained to a sump designed to contain fluids used in drilling operations. All chemicals and fuel to be bunded. Waste drilling mud to be removed by truck for off site disposal. Oil spill sorbent material and other materials to be available on site. Natural drainage allows additional dams to prevent discharge to Hunterston Rivulet. Site plan and specifications to be developed prior to rig up. Civil works to prepare site prior to rig mobilisation to site.				
1.1 Flammable gas, toxic gas, radiant heat hazard from flare location to access road and to rig site.	Proximity of flare to existing access road (potentially downwind) and to rig site. Ordovician limestone known to contain sulphur, potential accumulation of hydrogen sulphide.	Potential human exposure, resulting in worker injury or fatality. Lack of site access by emergency vehicles.	4	Loop access road to site to allow alternative access. OME Drilling to develop a detailed site plan, including flare location. Toxic gas detection on the rig floor, over the cutting shakers, and in mud pits. Shut down of drilling operations to assess situation.
1.2 Fire hazard on surrounding land.	Bush fire.	Damage to equipment.	2	Emergency response plan and liaison with fire brigade, posting of emergency numbers. Fire break around the drilling rig and fuel storage.
2. Rig mobilisation Transport company to deliver equipment to site on public and private roads. Liaison with land owners.				
2.1 Failure of roadway during transport. Electrical hazards.	Inadequate access road. Overhead power lines.	Damage to equipment. Electric shock.	2	Liaison with land owner, road inspection, location of overhead power lines.

Hazard	Cause	Major Effects	Hazard Category	Corrective / Preventive Measures Suggested
3. Rig up (equipment set up, equipment test) Soil stability to be adequate. Concrete pad to be constructed if necessary. Cranes to be used to rig up, with qualified operators. Specifications for contractors to be audited. Set up and testing of equipment to be one week duration.				
3.1 Moving equipment and heavy lifts.	People or equipment struck.	Injury to personnel. Damage to equipment.	4	Equipment operated by qualified and trained persons. No unauthorised persons on site. Perimeter control and sign posting. Site office in "safe zone", upwind of rig.
3.2 Hydraulic pressure test failure (water lines, seals, swivels, etc).	Equipment failure.	Potential worker injury. Equipment damage.	3	Persons testing from safe location.
3.3 Lightning strike.	Storm conditions.	Potential worker injury. Equipment damage.	2	Shut down operations during electrical storm.
4. Test well head, casing and plug (including BOP) Equipment tested and certified prior to installation on site.				
4.1 Hydraulic pressure test failure.	Equipment failure.	Potential worker injury. Equipment damage.	3	BOP and other pressure control equipment tested and certified prior to installation on site. Persons testing from safe location.
5. Drill out cement plug Rotating pipe on drill rig. Escape lines to be installed on rig for persons working at height. Standard operating procedures and trained personnel.				
5.1 High pressure in casing.	Pressure accumulated below cement plug.	Potential well kick.	2	Choke manifold lined up to divert immediately, accumulator charged ready to shut in, mud system prepared, and circulate for a period and monitor pressure.

Hazard	Cause	Major Effects	Hazard Category	Corrective / Preventive Measures Suggested
6. Coring well to depth (drilling run, retrieving core, tripping pipe, changing drill bit) Standard operating procedures and training of operators. Previous drilling activity in Tasmania has not detected hydrogen sulphide.				
6.1 High pressure in well during drilling, coring, core retrieval and tripping, and not recognising indicators.	Pressurised formation encountered. Swabbing well while tripping pipe. Swabbing well while retrieving core.	Loss of pressure control and potential formation/well blowout.	4	Monitoring of drilling conditions. All personnel will be trained to recognise and detect 'kicks' and know how to respond. Discontinue drilling operations and plug and abandon well.
6.2 Drill rod stuck, unable to circulate.	A very large well kick jams rod and prevents mud circulation.	Instant, hard shut in of well, making it impossible to circulate and control pressure.	3	Divert to flare line and attempt to keep flare lit. Allow to burn out. Evacuation procedure.
6.3 Increasing mud weight to control pressure.	Increasing formation pressure.	Inability to control increasing pressure. Use of barite may plug off circulation and create difficulties in recovering the drill string.	2	Establish criteria for drilling operations to discontinue drilling based on maximum mud weight required to maintain pressure control. Shut down of drilling operations to assess situation and revise the well plan.
7. Maintenance of drilling equipment Periodic shut down of rig (at about 300 hours) for one half day to maintain equipment. Blind rams must be tested each time rod/pipe is tripped from the hole. BOP function test daily. Weekly pressure test. Testing procedures to be conducted as specified in the well plan.				
7.1 Inability to rotate pipe after temporary pause in drilling.	Stuck pipe in hole.	Delays in drilling operations, loss of pipe.	2	Drilling procedures to avoid problem.
7.2 Loss of drilling mud during shut down.	Lost circulation zone. Gas incursion into drill hole from formation.	Loss of pressure control, potential blowout.	3	Continuous monitoring by drilling personnel.
8. Well testing Basic flow testing will be available on site, only if it is safe to do so. Wireline logging and drill stem testing may be feasible, mobilised from other sources.				
8.1 Explosion hazard.	Gas disposal.	Potential worker injury. Equipment damage.	4	Testing to be conducted within equipment limits. Procedures to be developed to avoid ignition of gas except at the flare.
8.2 Washouts.	Erosion of equipment during flow test.	Equipment damage.	3	Short term testing.

Hazard	Cause	Major Effects	Hazard Category	Corrective / Preventive Measures Suggested
8. Well testing (continued)				
8.3 Hazardous material disposal.	Produced fluids.	Environmental contamination.	3	Direct fluids to flare pit and ignite petroleum. If fluids cannot be ignited, the well will be shut down and fluids collected for off-site disposal.
8.4 Loss of well control during testing.	Inability to control flow rate and pressure at end of flow test. Burst pipe.	Loss of pressure control, potential blowout.	3	Kill the well through the annulus with very heavy brine or barite. Develop criteria to allow testing only below a prescribed mud weight.
9. Plug and abandon No one on the rig floor when pumping cement at high pressure. Schedule C stipulates plug and abandon requirements.				
10. Rig down Same hazards and controls as rig up.				
11. Rig demobilisation Same hazards and controls as mobilisation. Wash down of equipment prior to leaving the site.				
12. Site remediation Baseline environmental monitoring prior to site disturbance will be used to guide site remediation activities. Consider impacts, if any, of the oil seep reportedly associated with an earthquake in 1962. Remediation of spills, removal of concrete. Rehabilitation (reseeding and fertilisation) of areas that may be impacted by flaring. Shallow soils and mudstone bedrock. Replace topsoil on cleared areas and reseed with fertiliser, subject to consultation with land owner. Consult with land owner regarding changes in drainage and any land rehabilitation.				
12.1 About thirty tonnes of diamond drill cuttings.	Burial on site in pits used for drilling.	Potentially contaminated cuttings buried on site.	3	Obtain safety and environmental data for mud chemicals and take appropriate disposal action.
12.2 Site remediation does not return land to previous condition.	Land owner accepts responsibility for land remediation, but does not implement plan.	Soil erosion, slow recovery of vegetation. Land does not recover to pre-disturbance conditions.	3	Develop a Site Remediation Plan to detail appropriate strategy, and provide to contractor/landowner for implementation.

Hazard Evaluation – Preliminary Hazard Analysis (PHA)

A PHA requires the categorisation of hazards in several broad categories:

Hazard Category 1	Negligible Adverse Impacts
Hazard Category 2	Potentially Minor Impacts
Hazard Category 3	Potentially Serious Impacts
Hazard Category 4	Potentially Catastrophic Impacts

Hazards are categorised in terms of its potential severity and the potential likelihood of occurrence, according to the definitions shown in Table 1. Designation of the four hazard categories, based on these definitions, is presented in Figure 1.

Table 1. Explanation of Terms Used to Assess Hazards

FREQUENCY OF OCCURRENCE		
CATEGORY	APPROXIMATE FREQUENCY	DESCRIPTION
Virtually Impossible	$<10^{-4}$/year, or only once in more than 1,000,000 years	This type of event has almost never occurred, but conceivably could.
Rare	$>10^{-4}$/year and $<10^{-3}$/year, or once in 10,000 to 1,000,000 years	Such events have occurred on a worldwide basis but only a few times.
Unlikely	$>10^{-3}$/year and $<10^{-2}$/year, or once in 100 to 10,000 years	Event occurs, but it is not likely here within project life.
Likely	$>10^{-2}$/year and <1/year, or once in one to 100 years	Event likely to occur during the project lifetime.
Virtually Certain	>1/year, or more than once per year	Event can be expected to occur more than once a year, on the average.

POTENTIAL SEVERITY OF CONSEQUENCES	
CATEGORY	DESCRIPTION
Negligible	No injuries. No effect to the environment or public health. No impact to business operations or cash flow.
Minor	First aid treatment. No serious impacts to the environment or public health. Incidental impacts to business operations or cash flow.
Major	Medical treatment necessary. Possible serious impacts to the environment or public health. Possible impacts to business performance or financial targets.
Severe	Extensive injuries requiring lengthy rehabilitation. Substantial impacts to the environment or public health. Substantial impacts to the performance of one or more business units, and/or temporary loss of cash flow.
Disastrous	Fatality. Extreme, irreversible, and unmitigable environmental damage, or hazard to public health. Sustained loss of production/cash flow in one or more business units.

Figure 1. Hazard Categories for PHA Risk Assessment (Refer to Table 1 for definitions)

FREQUENCY OF OCCURRENCE	POTENTIAL SEVERITY OF CONSEQUENCE				
	NEGLIGIBLE	MINOR	MAJOR	SEVERE	DISASTROUS
VIRTUALLY CERTAIN	3	3	4	4	4
LIKELY	2	3	3	4	4
UNLIKELY	1	2	3	4	4
RARE	1	1	2	3	4
VIRTUALLY IMPOSSIBLE	1	1	2	3	3

Note:

1	Hazard Category 1	Negligible adverse impacts. Manage risk using existing procedures.
2	Hazard Category 2	Potentially minor impacts. Management responsibility must be specified and assigned.
3	Hazard Category 3	Potentially serious impacts. Senior management attention needed.
4	Hazard Category 4	Potentially catastrophic impacts. Detailed analysis and management planning required at senior levels.

Attachment 2

Risk Register/Risk Treatment Schedule and Action Plan

HUNTERSTON NO. 1 DRILLING PROJECT
Risk Register / Risk Treatment Schedule and Action Plan

Reference number	Causes	Consequences	Hazard		Existing controls and safeguards	Level of risk	Possible risk treatment options	Preferred risk treatment options	Cost / benefit analysis	Treated risk level	Person assigned	Implementation timetable
			Likelihood	Consequence								
PHA 1.1 *Site preparation*	Flammable/toxic gas, radiant heat hazard, caused by proximity of flare to private access road and rig site.	▪ Potential human exposure, resulting in injury or fatality. ▪ Lack of site access by emergency vehicles.	Unlikely	Disastrous	▪ GSLM Well Plan. ▪ Compliance with Mineral Resources Tasmania *Mineral Exploration Code of Practice (Schedule C).* ▪ Flat topography allows simply access/egress to/from the rig site.	Hazard Cat 4	▪ Loop access road to site to allow alternative access. ▪ OME Drilling Group to develop a detailed site plan, including flare location. ▪ Toxic gas (H_2S) detection on the rig floor, over the cutting shakers, and in the mud pits. Procedure for alarm to shut down drilling operations to assess situation.	▪ OME Drilling Group to develop a detailed site plan, including flare location. ▪ Toxic gas (H_2S) detection on the rig floor, over the cutting shakers, and in the mud pits. Procedure for alarm to shut down drilling operations to assess situation.		3 Conseq reduced to major		▪ Detailed site plan prior to rig up and testing. ▪ Toxic gas detection calibrated and operational prior to drilling out cement plug.
PHA 1.2 *Site preparation*	Fire hazard to rig from bush fire on surrounding land.	▪ Equipment damage	Unlikely	Minor	▪ Compliance with Mineral Resources Tasmania *Mineral Exploration Code of Practice (Schedule C).*	Hazard Cat 2	▪ Emergency response plan. ▪ Liaison with fire brigade, posting of emergency numbers. ▪ Fire break around the drilling rig and fuel storage.	▪ Emergency response plan. ▪ Liaison with fire brigade, posting of emergency numbers. ▪ Fire break around the drilling rig and fuel storage.		2		▪ To be completed prior to rig up.
PHA 2.1 *Rig mobilisation*	Failure of roadway during transport of equipment. Electrical hazards from overhead power lines.	▪ Damage to equipment. ▪ Electric shock.	Rare	Major	▪ Compliance with Mineral Resources Tasmania *Mineral Exploration Code of Practice (Schedule C).* ▪ Compliance with the *Workplace Health and Safety Act.*	Hazard Cat 2	▪ Liaison with land owner. ▪ Road inspection and locating overhead power lines along access route.	▪ Liaison with land owner. ▪ Road inspection and locating overhead power lines along access route.		2		▪ To be completed prior to rig up.
PHA 3.1 *Rig up*	People or equipment struck by moving equipment and heavy lifts.	▪ Injust to personnd. ▪ Damage to equipment.	Unlikely	Severe	▪ Compliance with Mineral Resources Tasmania *Mineral Exploration Code of Practice (Schedule C).* ▪ Equipment operated by qualified and trained persons, as required by *Workplace Health and Safety Act.*	Hazard Cat 4	▪ Verification of qualifications and training of equipment operators. ▪ Prevent access to unauthorised persons on the site, using perimeter control and sign posting. ▪ Locate a site office at a safe location, upwind of rig site.	▪ Verification of qualifications and training of equipment operators. ▪ Prevent access to unauthorised persons on the site, using perimeter control and sign posting. ▪ Locate a site office at a safe location, upwind of rig site.		3 Likelihood reduced to rare.		▪ To be completed prior to rig up.
PHA 3.2 *Rig up*	Equipment failure during hydraulic pressure testing.	▪ Potential worker injury. ▪ Equipment damage.	Rare	Severe	▪ Compliance with Mineral Resources Tasmania *Mineral Exploration Code of Practice (Schedule C).* ▪ Compliance with the *Workplace Health and Safety Act.*	Hazard Cat 3	▪ Personnel to conduct pressure testing from a safe location.	▪ Personnel to conduct pressure testing from a safe location. ▪ Testing procedures to include guidance on abnormal conditions, to allow workers to recognise hazardous situations.		3		▪ To be completed prior to rig up.
PHA 3.3 *Rig up*	Lightning strike during storm conditions.	▪ Potential worker injury. ▪ Equipment damage.	Rare	Major	▪ Standard industry procedure to shut down operations and clear the rig site during electrical storm conditions.	Hazard Cat 2		▪ Include severe weather contingency in the emergency response plan for the project, or formalise severe weather procedures in a separate shut down plan for rig operations.		2		▪ To be completed prior to rig up.
PHA 4.1 *Test well head, casing and plug*	Equipment failure during hydraulic pressure testing.	▪ Potential worker injury. ▪ Equipment damage.	Rare	Severe	▪ Compliance with Mineral Resources Tasmania *Mineral Exploration Code of Practice (Schedule C).* ▪ Compliance with the *Workplace Health and Safety Act.* ▪ BOP and other pressure control equipment to be tested and certified prior to installation on site.	Hazard Cat 3	▪ Personnel to conduct pressure testing from a safe location.	▪ Personnel to conduct pressure testing from a safe location. ▪ Testing procedures to include guidance on abnormal conditions, to allow workers to recognise hazardous situations.		3		▪ To be completed prior to testing of well head.
PHA 5.1 *Drill out cement plug*	Pressure accumulation at the base of the cement plug, resulting in high pressure in casing during drill out.	▪ Potential well kick.	Rare	Major	▪ GSLM Well Plan. ▪ GSLM Blowout Prevention and Well Control procedures. ▪ Drilling contractor procedures.	Hazard Cat 2	▪ Choke manifold to be lined up to divert immediately, accumulator charged and ready to shut in, mud system prepared in advance. ▪ Procedure to circulate for a period of time and to monitor pressure.	▪ Choke manifold to be lined up to divert immediately, accumulator charged and ready to shut in, mud system prepared in advance. ▪ Procedure to circulate for a period of time and to monitor pressure. Develop an oil spill contingency plan, with procedures for containing and recovering produced liquid spills.		2		▪ To be completed prior to drilling out cement plug.

HUNTERSTON NO. 1 DRILLING PROJECT
Risk Register / Risk Treatment Schedule and Action Plan

Reference number	Causes	Consequences	Hazard		Existing controls and safeguards	Level of risk	Possible risk treatment options	Preferred risk treatment options	Cost / benefit analysis	Treated risk level	Person assigned	Implementation timetable
			Likelihood	Consequence								
PHA 6.1 *Coring well to depth*	High pressure in well during drilling/coring, caused by pressurised formation, swabbing well while tripping pipe, or swabbing well while retrieving core. Personnel fail to recognise indicators of abnormal pressure conditions.	▪ Loss of pressure control. ▪ Potential formation or well blowout.	Unlikely	Severe	▪ GSLM Well Plan. ▪ GSLM Blowout Prevention and Well Control procedures. ▪ Drilling contractor procedures.	Hazard Cat 4	▪ Monitoring of drilling conditions. ▪ All rig personnel will be trained to recognise and detect 'kicks' and know how to respond. ▪ Discontinue drilling operations and plug and abandon well.	▪ Procedures to monitor drilling conditions, with guidance on abnormal conditions, to allow workers to recognise hazardous situations and know how to respond. ▪ All rig personnel will be trained to recognise and detect 'kicks' and know how to respond. ▪ Procedure to discontinue drilling operations and plug and abandon well. ▪ Develop an oil spill contingency plan, with procedures for containing and recovering produced liquid spills.		3 Likelihood reduced to rare		▪ To be completed prior to drilling out cement plug.
PHA 6.2 *Coring well to depth*	A very large well kick could jam the drilling rod and prevent mud circulation in the hole.	▪ Instant, hard shut in of well, making it impossible to circulate and control pressure.	Rare	Severe	▪ GSLM Well Plan. ▪ GSLM Blowout Prevention and Well Control procedures. ▪ Drilling contractor procedures.	Hazard Cat 3	▪ Divert to flare line and attempt to keep flare lit. Allow produced gas to burn out. ▪ Establish evacuation procedure for the rig.	▪ Procedure to recognise this type of situation, and to divert to flare line and attempt to keep flare lit. ▪ Establish evacuation procedure for the rig in the emergency response plan.		3		▪ To be completed prior to drilling out cement plug.
PHA 6.3 *Coring well to depth*	Increase in formation pressure, requiring increasing mud weight to control pressure.	▪ Inability to control increasing pressure. ▪ Use of barite may plug off circulation in and create difficulties in recovering the drill string.	Rare	Major	▪ GSLM Well Plan. ▪ GSLM Blowout Prevention and Well Control procedures. ▪ Drilling contractor procedures.	Hazard Cat 2	▪ Establish criteria for drilling operations to discontinue drilling based on a maximum mud weight required to maintain pressure control. ▪ Shut down drilling operations to assess the situation and revise the well plan.	▪ Establish criteria for drilling operations to discontinue drilling based on a maximum mud weight required to maintain pressure control. ▪ Procedure to shut down drilling operations to assess the situation and revise the well plan.		2		▪ To be completed prior to drilling out cement plug.
PHA 7.1 *Maintenance*	Inability to rotate pipe after a temporary pause in drilling operations.	▪ Delays in drilling operations. ▪ Loss of pipe.	Unlikely	Minor	▪ Drilling contractor procedures.	Hazard Cat 2	▪ Establish specific procedures to avoid stuck pipe during temporary suspension of drilling operations.	▪ Establish specific procedures to avoid stuck pipe during temporary suspension of drilling operations.		2		▪ To be completed prior to drilling out cement plug.
PHA 7.2 *Maintenance*	Loss of drilling mud during shut down, caused by lost circulation zone or gas incursion into the drill hole from a formation.	▪ Loss of pressure control. ▪ Potential blowout..	Rare	Severe	▪ GSLM Blowout Prevention and Well Control procedures. Blind rams must be tested each time rod/pipe is tripped from the hole. BOP function tested daily. Weekly pressure test of equipment. ▪ Drilling contractor procedures.	Hazard Cat 3	▪ Continuous monitoring by drilling personnel.	▪ Establish specific procedures for continuous monitoring during maintenance activities and other temporary shut downs. ▪ Perform maintenance activities in a manner that allows rapid recovery of drilling operations and well control.		3		▪ To be completed prior to drilling out cement plug.
PHA 8.1 *Well testing*	Explosion of produced gas during well testing.	▪ Potential worker injury or fatality. ▪ Equipment damage.	Unlikely	Disastrous	▪ GSLM Well Plan. ▪ GSLM Blowout Prevention and Well Control procedures. ▪ Drilling contractor procedures. ▪ Testing contractor procedures.	Hazard Cat 4	▪ Testing to be conducted within equipment limits. ▪ Procedures to be developed to avoid ignition of gas except at the flare.	▪ Specify safe work limits for test equipment to be used. ▪ Procedures for well testing, including precautions to monitor explosive gas atmospheres and avoid gas ignition on the drilling rig.		3 Likelihood reduced to rare Conseq reduced to severe		▪ To be completed prior to well testing.
PHA 8.2 *Well testing*	Erosion of equipment during flow test.	▪ Equipment damage.	Unlikely	Major	▪ Drilling contractor procedures. ▪ Testing contractor procedures.	Hazard Cat 3	▪ Short term testing should not make equipment vulnerable to erosion.	▪ Establish preventative maintenance procedure to inspect well test equipment for signs of erosion.		3		▪ To be completed prior to well testing.
PHA 8.3 *Well testing*	Production of well fluids (petroleum liquids and condensate).	▪ Hazardous material disposal. ▪ Potential land and surface water contamination.	Unlikely	Major	▪ Drilling contractor procedures. ▪ Testing contractor procedures.	Hazard Cat 3	▪ Direct produced fluids to the flare pit and ignite ▪ If fluids cannot be ignited, establish procedure to shut down the well. ▪ Collect any remaining fluids for off site disposal.	▪ Develop an oil spill contingency plan, with procedures for containing and recovering produced liquid spills. ▪ Procedures for handling produced fluids during well testing.		3		▪ To be completed prior to well testing.
PHA 8.4 *Well testing*	Loss of well control, due to inability to control flow rate and pressure at the end of a flow test, or burst pipe..	▪ Loss of pressure control. ▪ Potential blowout.	Rare	Severe	▪ GSLM Blowout Prevention and Well Control procedures. ▪ Drilling contractor procedures. ▪ Testing contractor procedures.	Hazard Cat 3	▪ Kill the well through the annulus with very heavy brine or barite. ▪ Develop criteria to allow testing only below a prescribed mud weight.	▪ Procedures to kill the well through the annulus with very heavy brine or barite. ▪ Specify criteria to allow testing only below a prescribed mud weight.		3		▪ To be completed prior to well testing.

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Reference number	Causes	Consequences	Hazard		Existing controls and safeguards	Level of risk	Possible risk treatment options	Preferred risk treatment options	Cost / benefit analysis	Treated risk level	Person assigned	Implementation timetable
			Likelihood	Consequence								
PHA 12.1 *Site remediation*	Disposal of about 30 tonnes of drill cuttings, to be buried on site in pits used for drilling.	▪ Potential for contaminated material buried on site.	Virtually certain	Minor	▪ GSLM Well Plan. ▪ Drilling contractor procedures.	Hazard Cat 3	▪ Obtain safety and environmental data for mud chemicals, and take appropriate disposal action.	▪ Obtain safety and environmental data for mud chemicals, and take appropriate disposal action. ▪ Dispose of drill cuttings in accordance with all applicable laws and regulations.		3 (potential for future liability or account-ability)		▪ Prior to rig demobilisation.
PHA 12.2 *Site remediation*	Site remediation does not return land to previous condition. Land owner may accept responsibility and receive compensation for land remediation, but may not implement remediation.	▪ Soil erosion. ▪ Slow recovery of vegetation. ▪ Land does not recover to pre-disturbance conditions.	Likely	Minor	▪ GSLM Well Plan.	Hazard Cat 3	▪ Develop a Site Remediation Plan to detail appropriate strategy, and provide to contractor/landowner for implementation.	▪ Develop a Site Remediation Plan to detail appropriate strategy, and provide to contractor/landowner for implementation. ▪ If landowner is to be compensated directly, provide Site Remediation Plan and obtain the landowner's agreement to implement it as a condition of payment.		3 (potential for future liability or account-ability)		▪ Prior to rig demobilisation.