

# **GEOHERMAL RESOURCES PTY LTD**

## **Environmental Impact Report**

### **Geothermal Exploration Drillhole Rehabilitation and Decommissioning Program**

**October 2021**

## CONTENTS

1. INTRODUCTION .....	3
1.1. Scope.....	3
1.2. Location.....	3
BACKGROUND .....	4
1.3. Frome Project Area .....	4
1.4. Geothermal Resources/Havilah Resources.....	5
2. LEGISLATIVE FRAMEWORK .....	6
2.1. Petroleum and Geothermal Energy Act 2000 and Regulations 2013 .....	6
2.1.1. Environmental Impact Report.....	7
2.1.2. Statement of Environmental Objectives.....	9
2.1.3. Entry to and use of land .....	9
2.1.4. Activity Notification/Approval Process .....	9
2.2. Other Legislation.....	9
3. DESCRIPTION OF ACTIVITIES .....	10
3.1. Previous Drilling and Access.....	10
3.2. Well Abandonment and Decommissioning .....	10
3.3. Rehabilitation.....	11
4. SUMMARY OF EXISTING ENVIRONMENT .....	12
4.1. Climate .....	12
4.2. Biophysical Environment .....	12
4.2.1. Landforms, soils, geology, vegetation and habitat .....	12
4.2.2. Threatened Species.....	13
4.3. Groundwater.....	13
4.4. Surface Water .....	13
4.5. Aboriginal Cultural Heritage .....	13
4.6. Non-indigenous Heritage .....	14
4.7. Land Use.....	14
5. CONSULTATION.....	14
6. RISK ASSESSMENT .....	15
6.1 Potential Hazards and Consequences.....	15
6.2 Risk Assessment.....	15

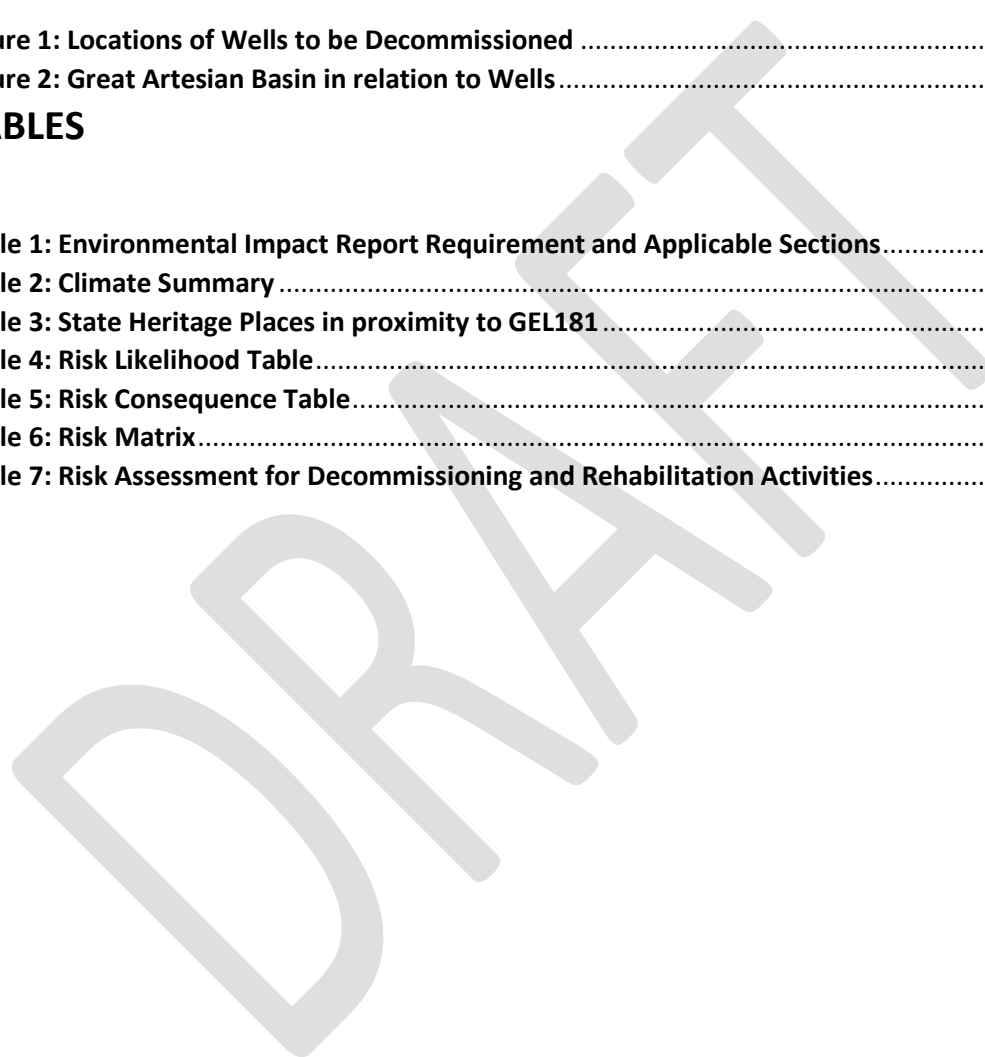
7. RISK MANAGEMENT.....	23
7.1. Standards .....	23
7.2. Training, Inductions and Responsibilities .....	23
7.3. Emergency Response .....	23
7.4. Reporting.....	23
8. REFERENCES.....	24

**FIGURES**

Figure 1: Locations of Wells to be Decommissioned .....	4
Figure 2: Great Artesian Basin in relation to Wells.....	5

**TABLES**

Table 1: Environmental Impact Report Requirement and Applicable Sections.....	8
Table 2: Climate Summary .....	12
Table 3: State Heritage Places in proximity to GEL181 .....	14
Table 4: Risk Likelihood Table.....	15
Table 5: Risk Consequence Table.....	17
Table 6: Risk Matrix.....	18
Table 7: Risk Assessment for Decommissioning and Rehabilitation Activities.....	20



## 1. INTRODUCTION

This Environmental Impact Report (EIR) has been prepared in accordance with requirements under the *Petroleum and Geothermal Energy Act 2000* and the *Petroleum and Geothermal Energy Regulations 2013*. It has been prepared by Geothermal Resources Pty Ltd (Geothermal Resources), which is a wholly owned subsidiary of Havilah Resources Limited, in conjunction with a Statement of Environmental Objectives (SEO).

The decommissioning work will be undertaken in accordance with Mineral Exploration Drillholes guideline M21 such that the groundwater integrity is maintained, which can involve back-filling and/or placing of cement plugs. New ground disturbance at the drill collar is expected to be minimal.

This EIR has utilised some information contained in publicly available environmental reports prepared for other relevant activities, namely the *South Australian Cooper Basin Operators Environmental Impact Report: Drilling, Completions and Well Operations* (Santos 2015) and *Frome Geothermal Energy Project: Proposed eight-hole geothermal gradient drilling programme* (Geothermal Resources Limited 2006).

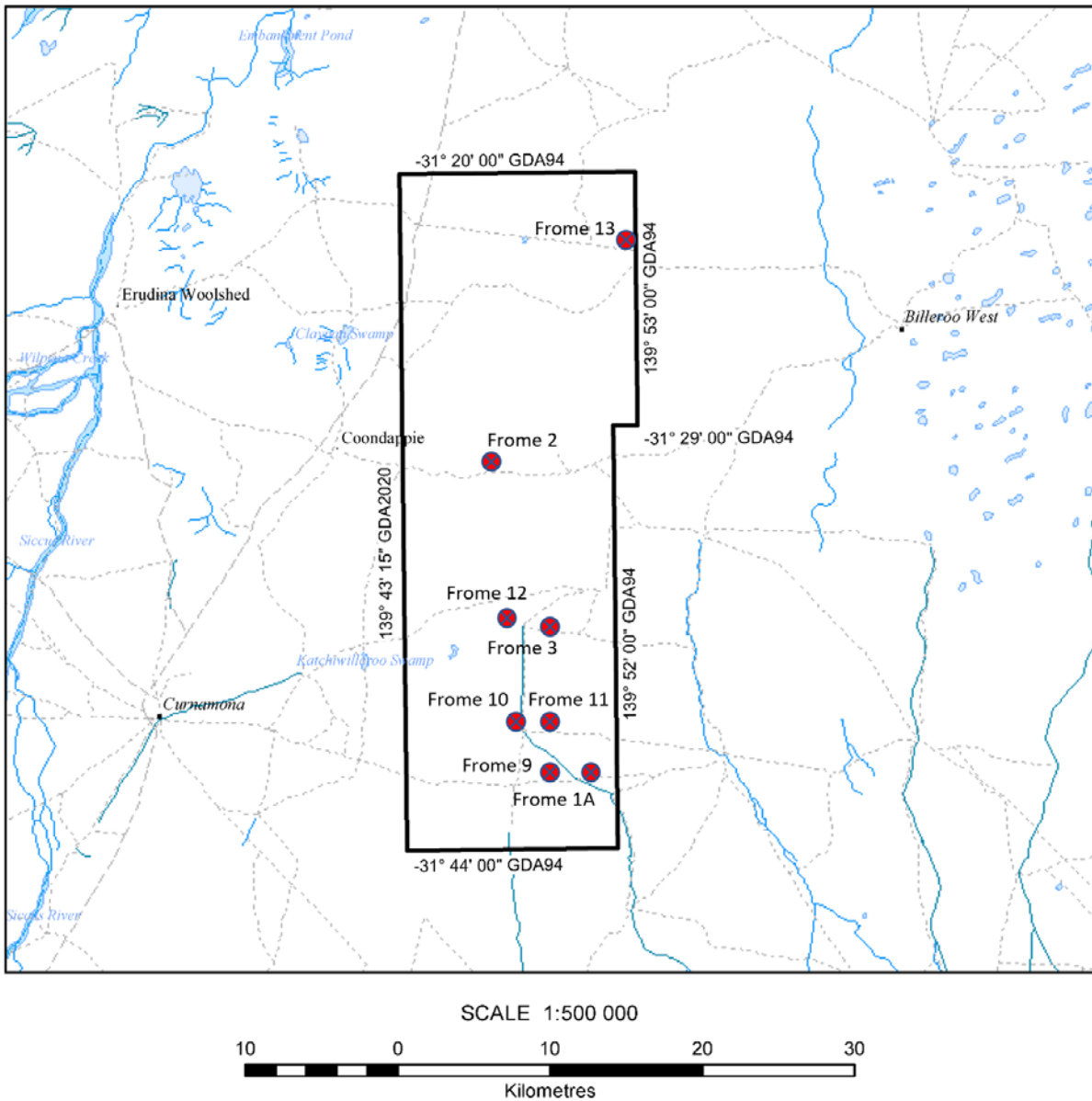
### 1.1. Scope

This EIR and the SEO have been prepared to support decommissioning activities on previously drilled geothermal holes at the Frome Geothermal Project. They provide a risk assessment and basis for compliance for decommissioning and environmental rehabilitation. The decommissioning will be undertaken in accordance with *Mineral Exploration Drillholes guideline M2* such that the groundwater integrity is maintained, which can involve back-filling and/or placing of cement plugs in a manner to be approved by the Department for Energy and Mining (DEM). As part of the decommissioning, all exposed PVC drill collars will be cut off below surface.

Note that complete clean up and surface contouring and scarifying of each drill site took place immediately after completion of drilling and temperature logging (refer to pictures of drillhole locations in Appendix 1). It is aimed to keep disturbance of the drill sites to a minimum in order to avoid any detrimental effects on re-vegetation.

### 1.2. Location

Frome Geothermal Project drill hole sites to be decommissioned and rehabilitated lie east of the main Yunta-Arkaroola road approximately 410km north-east (direct) of Adelaide and approximately 120km north (direct) of Yunta. They are situated in the North East Pastoral district on pastoral stations Kalabity, Curnamona, and Frome Downs. Well locations are shown on Figure 1. All wells are located on GEL 181 that covers approximately 641 km<sup>2</sup>. They were designed to test the geothermal gradient over a large buried granite body that is marked by a regional gravity low. The wells were drilled to depths ranging from 200 metres to 1809 metres.



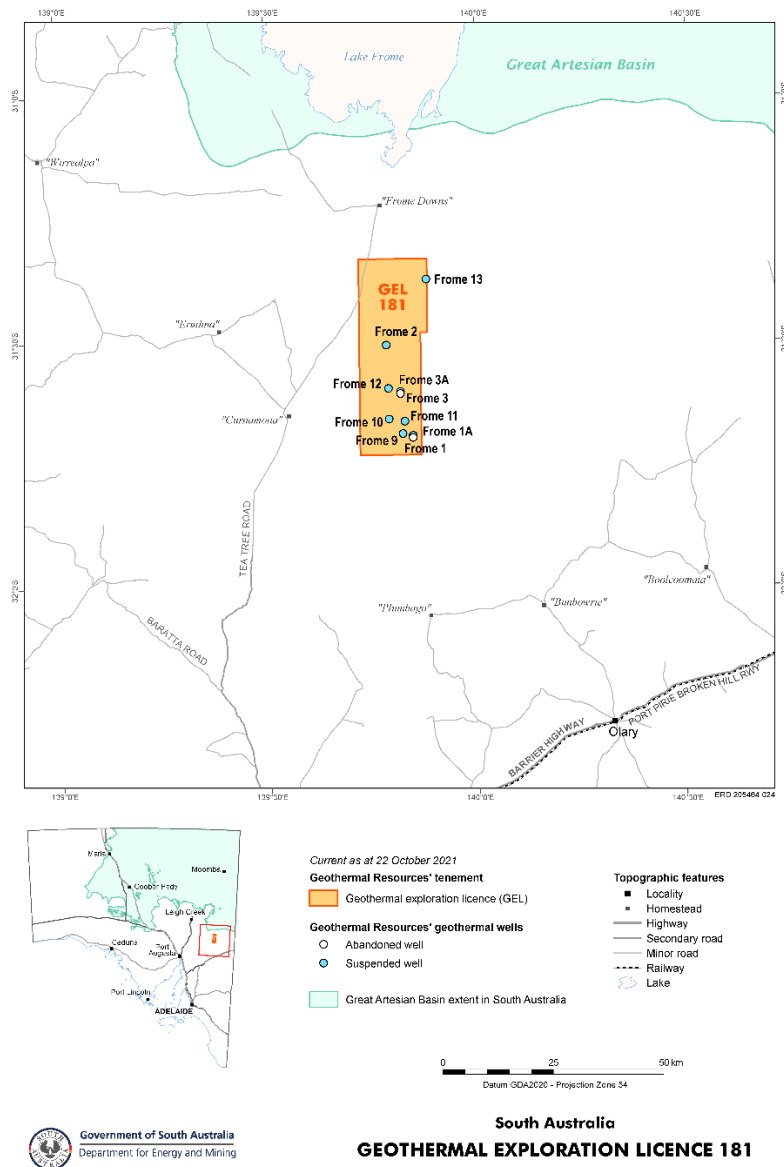
**Figure 1** Locations of wells to be decommissioned

## BACKGROUND

### 1.3. Frome Project Area

The Frome Project area was identified as a prospective geothermal resource target due to the likelihood of highly radiogenic Mesoproterozoic granites buried at depths of more than 2 km beneath the Arrowie Basin. This interpretation is based on the coincidence of a regional gravity low and non-reflective seismic responses. The Arrowie Basin covers an area in regional South Australia of approximately 43,000 km<sup>2</sup> aged between the early to mid Late Cambrian.

The Frome Project area lies just south of the Great Artesian Basin (Figure 2). This is confirmed by the absence of any Mesozoic age Great Artesian Basin sediments intersected in any Frome Project drillholes.



**Figure 2** The southern boundary of the Great Artesian Basin lies north of the Frome wellholes, consistent with the lack of any Mesozoic sediments encountered in the Frome wellholes.

#### 1.4. Geothermal Resources/Havilah Resources

Geothermal Resources Limited listed on the ASX in 2006 and conducted geothermal exploration drilling in the Arrowie Basin between 2007 and 2009, with the assistance of a REDI grant. The target was a large area of granite beneath the Arrowie Basin that was marked by a large gravity low feature. High geothermal gradients were discovered in all holes drilled in the area, including two deep diamond drillholes, namely Frome 12 and Frome 13 (Table 1).

Funding for geothermal exploration work dried up suddenly, preventing drilling of planned development wells. Geothermal Resources was taken over by Havilah Resources Limited (“Havilah”) in 2011 and became a wholly owned subsidiary.

Havilah holds more than 16,000 km<sup>2</sup> of mineral exploration licences in the Curnamona Craton on which it has discovered JORC resources of more than 1.3 million tonnes of copper and 3.3 million ounces of gold. It owns Kalkaroo station where its exploration base is located. It carries out its own mineral drilling operations and has an experienced exploration and drilling team. In particular it has successfully rehabilitated thousands of drillholes in the region, some over 500 metres deep.

## **2. LEGISLATIVE FRAMEWORK**

This chapter provides a brief overview of the legislative framework applicable to geothermal and petroleum licensing in South Australia.

### **2.1. Petroleum and Geothermal Energy Act 2000 and Regulations 2013**

The legislation which governs petroleum and geothermal exploration in South Australia is the *Petroleum and Geothermal Energy Act 2000* (the Act) and the *Petroleum and Geothermal Energy Regulations 2013* (the Regulations).

Key objectives of this legislation include:

- creating an effective, efficient and flexible regulatory system for the industries involving exploration for, and the recovery or commercial utilisation of, petroleum and other resources (including geothermal resources and natural reservoirs suitable for storage or production purposes) to which this Act applies.
- encouraging and maintaining an appropriate level of competition in exploration for and production of petroleum and other resources to which this Act applies.
- minimising environmental damage from the activities involved in
  - exploration for, or the recovery or commercial utilisation of, petroleum and other resources to which this Act applies.
  - the construction or operation of transmission pipelines for transporting petroleum and other substances to which this Act applies
- establishing appropriate consultative processes involving people directly affected by regulated activities and public generally.
- ensuring as far as reasonably practicable, security of supply for users of natural gas.
- protecting the public from risks inherent in regulated activities.

Environmental objectives, as defined in Part 12 of the Act are:

- to ensure that regulated activities that have (actually or potentially) adverse effects on the environment are properly managed to reduce environmental damage as far as reasonably practicable.
- to eliminate as far as reasonably practicable risk of significant long-term environmental damage.
- to ensure that land adversely affected by regulated activities is properly rehabilitated.

Regulated resources, as defined in Part 1 of the Act, are:

- a naturally occurring underground accumulation of a regulated substance;
- a source of geothermal energy; or

- a natural reservoir.

Regulated substances as defined in Part 1 of the Act are:

- petroleum;
- hydrogen sulphide;
- nitrogen;
- helium;
- carbon dioxide;
- any other substance that naturally occurs in association with petroleum; or any substance declared by regulation to be a substance to which the Act applies.

Regulated activities, as defined in Section 10 of the Act, are:

- exploration for petroleum or another regulated resource;
- operations to establish the nature and extent of a discovery of petroleum or another regulated resource, and to establish the commercial feasibility of production and the appropriate production techniques;
- production of petroleum or another regulated substance;
- utilisation of a natural reservoir to store petroleum or another regulated substance;
- production of geothermal energy;
- construction of a transmission pipeline for carrying petroleum or another regulated substance; or
- operation of a transmission pipeline for carrying petroleum or another regulated substance.

Regulated activities also include all operations and activities reasonably necessary for, or incidental to, exploration for and production of petroleum or another regulated substance, such as:

- physical and geophysical surveys of land;
- drilling of wells;
- the injection of water or some substance into a natural reservoir in order to enhance production of petroleum or another regulated substance;
- forcing water or some other substance through a source of geothermal energy in order to absorb thermal energy and enable its recovery or utilisation at the surface;
- the processing of substances recovered from a well;
- the construction of borrow pits;
- the installation of plant and equipment;
- the use of a natural reservoir to store a regulated substance;
- water disposal;
- the construction of roads, camps, airport, buildings and other infrastructure.

### **2.1.1. Environmental Impact Report**

An Environmental Impact Report (EIR) provides an assessment of the potential impacts of regulated activities on the environment and provide the basis of information for development of the Statement for Environmental objectives (SEO) (unless activities are classified as 'high impact' and an environmental impact assessment under the *Development Act 1993* is required).

In accordance with Section 97 of the Act, the EIR must:



- take into account cultural, amenity and other values of Aboriginal and other Australians in so far as those values are relevant to the assessment
- take into account risks inherent in the regulated activities to the health and safety of the public
- contain sufficient information to make possible an informed assessment of the likely impact of the activities on the environment.

Regulation 10 outlines the content required to be included in an EIR, which are outlined in Table 2 below.

**Table 1: Environmental Impact Report Requirement and Applicable Sections**

Requirement	Section
a) a description of the regulated activities to be carried out under the licence (including their location)	Section 4
b)	
(i) a description of the specific features of the environment that can reasonably be expected to be affected by the activities, with particular reference to the physical and biological aspects of the environment and existing land uses	Section 5
(ii) an assessment of the cultural values of Aboriginal and other Australians which could reasonably be foreseen to be affected by the activities in the area of the licence, and public health and safety risks inherent in those activities (insofar as these matters are relevant in the particular circumstances)	Section 5.5
(iii) if required by the Minister – a prudential assessment of the security of natural gas supply	N/A
c) a description of the reasonably foreseeable events associated with the activities that could pose a threat to the relevant environment, including:	Section 7
(i) information on	
A- events during the construction stage (if any), the operational stage and the abandonment stage	
B- events due to atypical circumstances (including human error, equipment failure or emissions, or discharges above operating levels)	
(ii) information on the estimated frequency of these events	
(iii) an explanation of the basis on which these events and frequencies have been predicted	
d) an assessment of the potential consequences of these events on the environment, including:	Section 7
(i) information on	
i. the extent to which these consequences can be managed or addressed	
ii. the action proposed to be taken to manage or address these consequences	
iii. the anticipated duration of these consequences	
iv. the size and scope of these consequences	
v. the cumulative affects (if any) of these circumstances when considered in conjunction with the consequences of other events that may occur on the relevant land (insofar as this is reasonably practicable)	
(ii) an explanation of the basis on which these consequences have been predicted	
e) a list of relevant land owners	Section 6
f) information on any consultation that has occurred with the owner of the relevant land, any Aboriginal groups or representative, any agency or instrumentality of the Crown, or any other interest person or parties, including specific detail about relevant issues	Section 6

---

that have been raised and any response to those issues, but not including confidential information.

---

### **2.1.2. Statement of Environmental Objectives**

Section 96 of the Act states that “A licence must not carry out regulated activities unless a statement of environmental objectives (SEO) is in force for the relevant activities under this Part”. The accompanying SEO outlines the environmental objects that the regulated activity is to achieve and the criteria upon which the objective are to be assessed and is developed on the information provided in this EIR.

Division 4 of the Act and Part 3 of the Regulations describe the requirements for an SEO and how it is assessed and approved. The SEO must be reviewed at least once every 5 years.

### **2.1.3. Entry to and use of land**

Under Part 10, Section 60 of the Act a licensee may enter land to carry out authorised activities on the land; or enter land for the purpose of gaining access to adjacent land on which the licensee proposes to carry out authorised activities.

Under Part 10, Section 61 of the Act a licensee must, at least 21 days before entering land, give written notice to each owner of the land, in the form required by the regulations that describes the licensee’s intention to enter the land; and if the licensee proposes to carry out regulated activities on the land.

The relevant parties who must be provided with a notice of entry prior to conducting the operations described in this EIR are:

- Representatives of Native Title Claimants
- Landholder’s whose properties will be entered and/or travelled through

### **2.1.4. Activity Notification/Approval Process**

Prior to commencing a regulated activity (e.g. drillhole decommissioning), Section 74(3) of the Act requires that:

- The Minister’s prior written approval is required for activities requiring high level supervision (as per Regulation 19), and
- Notice of activities requiring low level supervision is to be given at least 21 days in advance (as per Regulation 18).

The application for the Minister’s approval and notification of activities must provide specific technical and environmental information on the proposed activity and include an assessment to demonstrate that it is covered by an existing SEO.

Consequently, the activity notification process provides an additional opportunity for DEM to ensure that the proposed activities and their impacts can be effectively managed and are consistent with the approvals obtained in the EIR and SEO approval process.

## **2.2. Other Legislation**

A number of other Acts apply to petroleum and geothermal activities, these are listed below:

- *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)

- *Native Title Act 1993*
- *Aboriginal and Torres Strait Islander Heritage Protection Act 1984*
- *Aboriginal Heritage Act 1988*
- *Crown Lands Act 1929*
- *Environment Protection Act 1993*
- *Fire and Emergency Services Act 2005*
- *Heritage Places Act 1993*
- *Landscapes South Australia Act 2019 (previously Natural Resources Management Act 2004)*
- *National Parks and Wildlife Act 1972*
- *Native Title (South Australia) Act 1994*
- *Native Vegetation Act 1991*
- *Pastoral Land Management and Conservation Act 1989*
- *South Australian Public Health Act 2011*
- *South Australian Radiation Protection and Control Act 1982*
- *Work Health and Safety Act 2012.*

### **3. DESCRIPTION OF ACTIVITIES**

This chapter identifies and provides an overview of the proposed activities of the EIR and the accompanying SEO. It should be noted that this EIR does not include a description of activities for drilling but does give a brief history of operations.

#### **3.1. Previous Drilling and Access**

Geothermal Resources undertook drilling activities in the region between March 2007 and May 2009. The wells ranged from 200 to 1,809 metres in depth and currently lie in GEL 181 (Figure 1).

The wells were carefully sited along existing well maintained station tracks. This avoided the need for construction of new tracks and any cross-country travel that could have resulted in unnecessary damage to vegetation and the surface environment. These station tracks are associated with local pastoral operations and are therefore well developed and did not require any significant upgrades. These same tracks will be used by Havilah's vehicle access for the de-commissioning work.

In addition, the drill sites were chosen in locally poorly vegetated areas, that in some cases were hollows caused by wind erosion (see photos in Appendix 1).

All drill sites were cleared during a cultural heritage survey conducted by four senior representatives of the Adnyamathanha native title claimant group on 10 and 11 of August 2006 prior to commencement of any drilling work in the area.

Station owners are known to Havilah Resources personnel and will be contacted prior to decommissioning activities taking place and once they have been completed.

#### **3.2. Well Abandonment and Decommissioning**

The wells were drilled to enable downhole temperature logging in order to calculate geothermal gradients across the region. When not in use the holes were capped at surface.

Surface rehabilitation, including removal of all drill cuttings and rubbish, and levelling and scarifying with a backhoe to promote regeneration of vegetation was completed soon after drilling ceased (see photos in Appendix 1).

Minor saline groundwater was cut in the bedrock and there is no aquifer as such in any bedrock formations, due to the very weak water flows. In general the rocks were very tight and unfractured as recorded in drill logs. No Cenozoic palaeochannels nor Mesozoic Great Artesian Basin sediments were encountered in any holes (Figure 2).

It is apparent that multiple aquifer layers do not occur and hence mixing of different aquifers is not an issue in this region. Accordingly, it is considered that measures such as concreting to isolate and confine aquifers and prevent cross-flow should not be required for the Frome drillholes.

### **3.3. Rehabilitation**

Surface rehabilitation resulting in native vegetation regeneration to its pre-drilling (grazed) state has already taken place. This work, plus removal of drill cuttings spoil, took place using a backhoe shortly after the drilling was completed.

Well decommissioning programs will be submitted to DEM for prior approval as part of the Activity Notification Stage. The decommissioning details will be agreed with DEM having regard to the *Mineral Exploration Drillholes guideline M21*.

It is expected that key rehabilitation tasks will include:

1. Cutting any projecting PVC drill casing below the surface and capping it with a solid PVC cap in order to:
  - To remove any surface safety hazard caused by PVC casing projecting above the ground.
  - To prevent surface material being washed into the open holes and causing a surface cratering effect.
2. Backfilling and/or placing concrete plugs in the holes as approved by DEM having regard to the *Mineral Exploration Drillholes guideline M2*.

All work will be done as far as possible with light vehicles rather than heavy drilling equipment in order to minimise further disturbance to the already re-vegetated drilling sites. Material for backfilling would need to be sourced from external locations by agreement with local station owners and may require use of heavy trucks. Such sources have not yet been determined.

It is proposed that this work will be undertaken by Havilah field staff who are well experienced in this work, having rehabilitated thousands of deep mineral exploration holes. Havilah's work has been inspected and approved by DEM Mineral Resources Division on a number of occasions.

Personnel will be accommodated at Havilah Resources exploration base camp at Kalkaroo station to the east. Public roads and private station tracks run from Kalkaroo through Kalabity, Curnamona and Frome Downs stations and will provide necessary vehicle access. Access will be avoided immediately after heavy rain to avoid unnecessary track damage.

Station owners are well known to Havilah Resources personnel and will be contacted prior to decommissioning activities taking place and once they have been completed.

As noted above, all drill sites were cleared during a cultural heritage survey conducted by four senior representatives of the Adnyamathanha native title claimant group on 10 and 11 of August 2006 prior to commencement of any drilling work in the area. The proposed decommissioning activities will be completely confined to areas cleared by this previous heritage survey.

## 4. SUMMARY OF EXISTING ENVIRONMENT

This section provides a summary of the existing environment in which Geothermal Resources wishes to undertake decommissioning and rehabilitation activities. It includes biophysical environments, social environments, climate, Aboriginal Heritage and land use.

### 4.1. Climate

Meteorological data has been sourced from the Bureau of Meteorology (BOM). The closest weather station to the decommissioning sites are Yunta located approximately 120 km to the south. A summary of the average monthly climate data for Yunta is presented in Table 3 below.

Table 2: Climate Summary

Month	Average Monthly Rainfall (mm)	Maximum Monthly Rainfall (mm)	Average Daily Maximum Temperature (°C)	Average 9am Wind Speed (km/h)
January	21.1	176.5	32.6	11.4
February	20.8	146.9	32.1	10.8
March	15.6	146.0	29.3	11.3
April	15.9	116.0	24.2	10.0
May	22.5	123.0	19.1	9.0
June	21.7	70.9	15.9	9.5
July	16.8	71.9	15.4	10.9
August	19.0	58.3	17.3	12.4
September	18.3	97.4	20.8	14.7
October	22.5	99.0	24.3	15.9
November	19.7	113.5	28.3	12.9
December	21.7	154.2	31.1	12.4

The Frome Downs project area is generally arid with an annual average rainfall of approximately 200mm and a temperature variation of between 0°C and 45°C. Rainfall is extremely variable, with drought seasons common.

### 4.2. Biophysical Environment

#### 4.2.1. Landforms, soils, geology, vegetation and habitat

The Frome Downs project area is mostly flat open country vegetated with species of saltbush, bluebush and small shrubby trees (predominately Acacia species) and occasional groves of larger trees such as black oak and mulga. There are wide flood plains occupying the low areas that may become temporarily inundated after extreme rain storms. Well defined water courses are generally lacking. Interspersed sand sheets that form slightly higher ridges are mostly covered with thicker low scrubby vegetation.

The area is marked by a thin veneer of wind blown sand and hardpan comprised of ferruginous and gypsum cemented sandy to gravelly material. Variable thicknesses of Cenozoic sands and clays (eg Namba Formation) up to 90 metres thick rest unconformably on either Cambrian or Neoproterozoic gently dipping shelf sediments of the Arrowie Basin. This sequence rests unconformably on either Mesoproterozoic granitic rocks or Palaeoproterozoic metasediments and granitic gneisses.

#### **4.2.2. Threatened Species**

Reviews of DEW and EPBC databases and published material indicate that there are no records of threatened plants or animals near the decommissioning sites or within GEL 181. Although this area has not been intensely surveyed, there have been no long-term observations of rare or endangered species indicating there is little likelihood of encountering such.

Confinement of all vehicles to existing station tracks and selection of open sparsely vegetated areas for the drilling sites means that the likelihood of the drilling work having impacted any unrecognised threatened species was exceptionally low. Likewise, the likelihood of impacting any of these species as a result of the decommissioning work will be extremely low.

#### **4.3. Groundwater**

Groundwater in the region is almost exclusively sub-artesian and occurs in Cenozoic Eyre Formation palaeochannel sands and gravels (eg Goulds Dam palaeochannel). It is of high-salinity and is not suitable for stock (mostly >10,000 TDS). Hence all stock water is derived from natural surface catchments in dams.

No Cenozoic palaeochannels, which are typically marked by freely flowing pressurised sands, were intersected during the drilling. Eyre Formation brown sands were logged in Frome 2 and 3, but no water flows were recorded. No Eyre Formation was logged in the other wells.

No Mesozoic sedimentary formations were encountered in any of the wells, hence there is no groundwater connection to the better quality water of the Great Artesian Basin that lies to the north of GEL 181 (Figure 2).

None of the wells recorded water flows of any significance from the Cambrian, Neoproterozoic and Mesoproterozoic age bedrock formations. Drillcore shows that these rocks were uniformly tight and unfractured, with no evidence for more permeable faulted or fractured zones.

The lack of well defined aquifers and the general absence of groundwater in any of the wells drilled indicates that the possibility of undesirable cross-contamination between aquifers is minimal. The only known groundwater in the region is from Eyre Formation palaeochannels, and it is too saline for stock use. Contamination of (non-existent) bedrock aquifers from the Eyre Formation is not feasible because of the extremely low permeability of the bedrock and the lack of any significant permeability enhancing fracturing or faulting.

#### **4.4. Surface Water**

Local ephemeral water holes and clay pans are generally absent in the area. Lake Frome lays to the north of the Frome project area and is the largest drainage feature in the region. The lake is fed by a large catchment, including the Flinders Ranges to the west, the Olary Ranges to the south, and the Barrier Ranges to the east.

#### **4.5. Aboriginal Cultural Heritage**

The Frome Downs project area lies within two Native Title determined areas, those being; the Adnyamathanha People No. 1 (Stage 1) determination to the north, and Adnyamathanha No.1 (Stage 2) determination in the south.

On 10 and 11 August 2006, prior to drilling, a heritage survey was conducted by four senior Adnyamathanha people who were familiar with the area. They were taken to each of the proposed drilling sites and in each case did not identify any culturally significant features as recorded in a signed statement clearing the sites for drilling activities. The proposed decommissioning activities will be completely confined to the areas subject to this previous heritage survey thereby mitigating the risk of disturbance to any cultural sites, objects or remains.

All drill sites were chosen adjacent to station tracks and in areas of naturally sparser vegetation, usually shallow wind blow-outs, to minimise any environmental impacts (refer to photos of drill collar areas in Appendix 1). No new tracks were created to access any of the drill sites.

#### 4.6. Non-indigenous Heritage

Non-indigenous heritage in the region dates back to the 1840s when European exploration of the area was occurring. Rapid pastoral development followed with all pastoral leases being taken up by the mid 1880s. Sheep and cattle grazing continues to this day in the region with some conservation work being undertaken on stations such as Bimbowrie and Boolcoomatta.

There are three Heritage Places listed on the SA Heritage Register in relatively close proximity to the Frome project area (Table 4). None are affected by the current well sites or proposed decommissioning activities.

**Table 3: State Heritage Places in proximity to GEL181**

State Heritage Code	Description
10310	Original Curnamona Station Homestead
12601	Mount Victoria Well Historic Site, including boiler, tank, trough and wind pump
10311	Antro Woolshed and shearers quarters

#### 4.7. Land Use

The project area lies within the pastoral leases of Curnamona, Kalabity and Frome Downs that have been used for sheep grazing for over 100 years. There are no other land uses. The country is flat and mostly featureless with rainfall unpredictable and drought periods common.

The nearest settlement is Yunta, approximately 120 km to the south, which lies on the main Barrier Highway.

### 5. CONSULTATION

Relevant stakeholders are:

- The Adnyamathanha Native Title Claimant group (ATLA)
- Pastoral leaseholders/managers affect by activities including:
  - Curnamona Station
  - Frome Downs Station
  - Kalabity Station
- Relevant government agencies

In each case it is proposed to provide the relevant stakeholders with draft copies of the Environmental Impact Report and Statement of Environmental Objectives that outline the nature of the

decommissioning activities to be undertaken, a description of possible disturbance and mitigation measures and invite any feedback. Contact will be via email initially and any feedback will be followed up with telephone calls and meetings if required.

## 6. RISK ASSESSMENT

This chapter identifies and assesses the potential hazards and risks to the environment as outlined in Section 5. It also provides a matrix by which these risks can be measured and a risk assessment table outlining the activity, event, type of impact, consequences, control measures and residual risk.

### 6.1 Potential Hazards and Consequences

A hazard is considered to be a source of potential environmental harm or impact. Hazards are likely to be minimal in view of the non-ground disturbing rehabilitation work proposed, but could include:

- Fire
- Vehicle movement on access tracks and roads (chiefly dust)
- Litter and rubbish
- Hydrocarbon and contaminated water spills

Potential consequences associated with the above hazards could include but are not limited to:

- Impact to visual amenity
- Loss/damage to native vegetation
- Soil erosion and compaction
- Disturbance/injury to native fauna
- Damage to sites of cultural heritage
- Injury to company personnel or members of the public
- Injury/loss of stock
- Disturbance to land uses
- Dust and noise
- Introduction/spread of pest plant species
- Contamination of soil

### 6.2 Risk Assessment

An environmental risk assessment has been carried out by Geothermal Resources to ascertain minor acceptable risks, and major risks in relation to proposed activities in this EIR. This has been achieved by comparing the likelihood and consequence of environmental harm that may occur due to each activity. Table 4 outlines the measurement of likelihood of a threat occurring while Table 5 outlines the criteria for judging the severity of the potential consequence. Table 6 shows the overall risk rating when likelihood and consequence are combined.

Table 4: Risk Likelihood Table

Rating	Descriptor	Description	Frequency
A	Almost certain	The threat is expected to occur in most circumstances	Recurring threat during the lifetime of the project or operation (e.g. more than once a month)
B	Likely	The threat will probably occur in most circumstances	Threat that may occur frequently during the lifetime of the project or operation (e.g. at least once per year)



<b>C</b>	Possible	The threat could occur	Threat that may occur during the lifetime of the project or operation (e.g. once in 3 years)
<b>D</b>	Unlikely	The threat could occur but not expected	Threat that is unlikely to occur during the lifetime of the project or operation (e.g. once in 10 years)
<b>E</b>	Rare	The threat may occur in exceptional circumstances	Threat that is very unlikely to occur during the lifetime of the project or operation (e.g. once in 15 years)

DRAFT

**Table 5: Risk Consequence Table**

Rating	Safety	Health	Environment	Equipment and Assets	Business Continuity	Community and Reputation	Liability
<b>1 Minor</b>	Single minor injury to one person. First aid or no treatment required. No lost time.	Reversible health effects of minor concern requiring first aid treatment at most.	Issues of non-continuous nature with promptly reversible impact or consequence (e.g. within shift). Low-level incident, site contained.	Below \$5,000 (or 0.1% of operational budget based at \$50,000,000).	Loss of operations for > ½ day. Reduction in capacity, < 10% for up to one month.	Unsubstantiated, low profile or no media attention. One-off complaint which is resolved via existing procedures.	Below \$50,000 (or 0.1% of operational budget based at 50,000,000). Financial or accounting issue with ability to resolve with existing resources.
<b>2 Moderate</b>	Medically treated injury. Reversible injury. Requires treatment but does not lead to restricted duties.	Reversible health effects of concern that result in medical treatment but not restricted duties.	Issues of a non-continuous nature and minor impact and consequence. Low-level incident, site contained. Short term reversible (e.g. within days).	Between \$5,000-\$50,000 (or 0.1%- 0.5% of operational budget)	Loss of operations for > ½ day. Reduction in capacity, < per 20% for up to one month. Minor disruption to supply of services or technical support.	Substantiated, low impact, low media profile. Unresolved, low level community dissatisfaction, Repeated community complaints.	Between \$50,000 - \$100,000 (or 0.1% - 0.5% of operational budget). Financial or accounting issue requiring CFO resolution.
<b>3 Serious</b>	Reversible injury or moderate irreversible impairment. Less than 10 days lost time.	Severe but reversible health effects. Results in a lost time illness of less than 10 days.	Issues of a continuous nature - limited impact and consequence. Incident resulting in some site contamination. Medium term recovery impact.	Between \$50,000 - \$200,000 (or 0.5% - 3.5% of operational budget). Threat to property by known extreme organisations.	Loss of operations for one day to one-week Reduction in capacity, < 30% for up to one month. Increased government interest.	Substantiated, public embarrassment, moderate media profile (front page, one day). Repeated community complaint. Community demonstration. Impact on share price.	Between \$100,000 - \$250,000 (or 0.5% - 3.5% of operational budget).
<b>4 Major</b>	Severe irreversible damage to one or more persons. Lost Time Injury greater than 10 days.	Severe and irreversible health effects or disabling illness.	Compliance issue with large fine, media attention. Serious harm not immediately recovered. Significant site contamination or off-site impact. Long term recovery.	Between \$200,000 - \$500,000 (or 3.5 -10% of operational budget). Confirmed threats, without actions.	Loss of operations for one week to one month. Reduction in capacity, < 50% for up to one month. Regulatory enquiry.	Substantiated, public embarrassment, high impact, major media attention. Local or state media interest. Severe community dissent. Criticism from NGO and / or government.	Between \$250,000 - \$1,000,000 (or 3.5 - 10% of operational budget). Financial or accounting issue requiring General Manager finance resolution.
<b>5 Catastrophic</b>	Single fatality. Permanent disabling injuries.	Life threatening or permanently disabling illness.	Issues of a continuous nature with major long-term impact and potentially serious consequences.	Above \$1,000,000 (or more than 10% of operational budget). Escalating threats or actions.	Loss of operations for > 1-3 months. Loss of permit to operate. Total loss of production for more than one month.	Substantiated, public embarrassment, multiple impacts, long lasting widespread media coverage. Severe, prolonged community dissent.	Above \$1,000,000 (or more than 10% of operational budget).

Table 6: Risk Matrix (red= very high risk, orange= high risk, yellow=medium risk, green=low risk)

		Consequence				
		1 Minor	2 Moderate	3 Serious	4 Major	5 Catastrophic
Likelihood	A Almost Certain	10	16	20	23	29
	B Likely	7	12	17	21	24
	C Possible	4	8	13	19	22
	D Unlikely	2	5	9	14	18
	E Rare	1	3	6	11	15

Table 7 below details the hazards and threats, potential consequences, management strategies and residual risks associated with decommissioning and rehabilitation activities outlined in this EIR.

The following activities and/or events associated with well decommissioning have been identified that have the potential to impact on the environment as defined under the Petroleum and Geothermal Energy Act 2000:

#### **Movement of vehicles to, from and within well site locations**

Potential threats are mainly to the native vegetation and fauna, soil and the introduction/spread of pest plant species. These can be mitigated to a large degree by ensuring vehicles use only existing tracks during dry weather. Introduction of pest plant species can be avoided by regular inspection and washing down of vehicles.

#### **Fire (resulting from rehabilitation and decommissioning activities)**

While wild fires are almost unknown in this area due to the sparse vegetation, risk will be mitigated by ensuring firefighting equipment is carried on all vehicles, avoiding working on high fire danger days and not driving off-road over dry vegetation that could come in contact with hot exhausts.

#### **Storage and Handling of Fuel and Oil**

Spillage of fuel and oil can contaminate soil and potentially kill native vegetation and fauna. This will be mitigated by not handling any hydrocarbons on site and carrying spill kits.

#### **Storage and transport of waste**

All waste material resulting from the de-commissioning work will be removed from site and disposed of in accordance with accepted methods.

#### **Subsurface decommissioning**

Groundwater cross-contamination and collapse of the hole collar are outcomes that can be avoided by adherence to the well decommissioning guidelines as described in *Mineral Exploration Drillholes guideline M2*.

All risk consequences that were identified returned a residual risk rating of “Low” or “Medium” when control measures were put into place. This is consistent with the proposed activities in this EIR being decommissioning and rehabilitation only with no drilling or site preparation required.

The highest consequence activities involved with decommissioning and rehabilitation include the movement of vehicles to and from site potentially introducing pest plant species, along with the risk of fire caused by operations. Geothermal Resources will ensure that all appropriate management strategies are in place prior to operations to further minimise the likelihood of these occurring, including relevant personnel induction.

DRAFT

**Table 7: Risk Assessment for Decommissioning and Rehabilitation Activities**

Activity/Event	Type of Impact	Potential Hazard/Threat	Control/Management Strategy	Consequence	Likelihood	Residual Risk
Movement of vehicles to, from and within well site locations	Soil	Soil erosion and compaction	<ul style="list-style-type: none"> <li>- Vehicles to travel at reduced speeds to minimise rutting</li> <li>- Travel to be prohibited during wet weather events</li> <li>- Personnel to use only existing pastoral tracks</li> <li>- Ripping and rehabilitation to be undertaken if compaction occurs</li> </ul>	1	E	Low
	Vegetation	Damage to native vegetation and fauna habitat	<ul style="list-style-type: none"> <li>- Personnel to use only existing pastoral tracks</li> <li>- No off-road driving will be undertaken</li> </ul>	2	E	Low
	Native fauna	Disturbance to rare, endangered species and loss due to collision	<ul style="list-style-type: none"> <li>- Personnel to use only existing pastoral tracks</li> <li>- No off-road driving or excessive speed</li> <li>- Operations to take place in areas known to be absent of species</li> </ul>	2	E	Low
	Existing landuse / stakeholder activities	Damage to stakeholder infrastructure or stock	<ul style="list-style-type: none"> <li>- Vehicles to travel at reduced speeds to minimise chances of collision</li> <li>- Personnel to use only existing tracks</li> <li>- Station managers to be contacted prior to any work being undertaken</li> </ul>	2	E	Low
	Surface water impacts	Alteration of surface water drainage	<ul style="list-style-type: none"> <li>- Drainage lines to be avoided when driving to and from sites</li> <li>- Travel to be prohibited during wet weather events</li> <li>- Unavoidable damage to be repaired as soon as practicable</li> </ul>	2	E	Low
	Existing landuse / stakeholder activities	Generation of dust resulting in reduction in local air quality	<ul style="list-style-type: none"> <li>- Vehicles to travel at reduced speeds to avoid generating excess dust</li> <li>- Vehicles to further reduce speed when in close proximity to infrastructure</li> </ul>	1	A	Medium
	Existing landuse / stakeholder activities and native vegetation	Introduction/spread of pest plant species	<ul style="list-style-type: none"> <li>- Vehicles to be washed down prior to entering work area</li> <li>- Inspections of vehicles to be undertaken prior to entering work area</li> </ul>	3	E	Medium

	Cultural heritage	Disturbance or damage to sites of cultural heritage significance	<ul style="list-style-type: none"> <li>- Drill sites have already been cleared by heritage survey.</li> <li>- Personnel to use only existing tracks</li> <li>- Personnel to be trained to identify areas or objects of significance</li> </ul>	3	E	Medium
	Public safety	Vehicle collision	<ul style="list-style-type: none"> <li>- Vehicles to travel at reduced speeds to minimise chances of collision</li> <li>- Personnel to use only existing tracks</li> </ul>	2	E	Low
Fire (resulting from rehabilitation and decommissioning activities)	Native flora and fauna	Damage to vegetation and habitat, loss of native fauna	<ul style="list-style-type: none"> <li>- Firefighting equipment will be available in all vehicles</li> <li>- Fire safety induction for all personnel</li> <li>- Fire danger season restrictions applied when operating</li> <li>- Driving over dry vegetation litter and foliage prohibited</li> </ul>	2	E	Low
	Existing landuse / stakeholder activities	Damage to stakeholder infrastructure or stock	<ul style="list-style-type: none"> <li>- Firefighting equipment will be available in all vehicles</li> <li>- Fire safety induction for all personnel</li> <li>- Fire danger season restrictions applied when operating</li> <li>- Driving over dry vegetation litter and foliage prohibited</li> <li>- Activities not to take place in close proximity to infrastructure</li> </ul>	3	E	Medium
	Public safety	Impacts to public safety and reduction in air quality	<ul style="list-style-type: none"> <li>- Firefighting equipment will be available in all vehicles</li> <li>- Fire safety induction for all personnel</li> <li>- Fire danger season restrictions applied when operating</li> <li>- Emergency response plan in place</li> <li>- Activities not to take place in any communities or near dwellings</li> </ul>	3	E	Medium
Storage and handling of fuel and oil	Soil	Spill/leak resulting in contamination of soil	<ul style="list-style-type: none"> <li>- All vehicle refuelling to be undertaken offsite</li> <li>- Spill kits to be available at each site</li> <li>- Emergency response plan in place</li> </ul>	2	E	Low
	Surface and groundwater	Spill/leak resulting in contamination of surface or groundwater	<ul style="list-style-type: none"> <li>- All vehicle refuelling to be undertaken offsite</li> <li>- Spill kits to be available at each site</li> <li>- Emergency response plan in place</li> </ul>	2	E	Low
	Public safety	Spill/leak resulting in impacts to public safety	<ul style="list-style-type: none"> <li>- All vehicle refuelling to be undertaken offsite</li> <li>- Spill kits to be available at each site</li> <li>- Emergency response plan in place</li> </ul>	2	E	Low
	Existing landuse / stakeholder activities	Spill/leak resulting in impacts on stock	<ul style="list-style-type: none"> <li>- All vehicle refuelling to be undertaken offsite</li> <li>- Spill kits to be available at each site</li> <li>- Impacted soil to be immediately contained and removed</li> <li>- Any affected areas will be fenced off to exclude stock</li> </ul>	2	E	Low

	Native flora and fauna	Spill/leak resulting in damage to vegetation and habitat, loss of native fauna	<ul style="list-style-type: none"> <li>- All vehicle refuelling to be undertaken offsite</li> <li>- Spill kits to be available at each site</li> <li>- Impacted soil to be immediately contained and removed</li> <li>- Any affected areas will be fenced off to exclude native fauna</li> </ul>	2	E	<b>Low</b>
Storage and transport of waste	Fauna and flora	Scavenging of native species	<ul style="list-style-type: none"> <li>- All litter and waste will be removed from site post operations</li> <li>- Litter and waste will be contained during operations</li> </ul>	1	E	<b>Low</b>
	Local stakeholder safety	Litter and reduced visual amenity	<ul style="list-style-type: none"> <li>- All litter and waste will be removed from site post operations</li> </ul>	1	E	<b>Low</b>
Subsurface well decommissioning	Groundwater	Cross flow of groundwater	<ul style="list-style-type: none"> <li>-Decommissioning of wells undertaken in accordance with Mineral Exploration Drillholes guideline M21</li> <li>-Decommissioning program developed and approved by DEM through Activity Notification process</li> </ul>	3	E	<b>Medium</b>
	Soil	Collapse and subsidence of hole collar	<ul style="list-style-type: none"> <li>-Decommissioning of wells undertaken in accordance with Mineral Exploration Drillholes guideline M21</li> <li>-Decommissioning program developed and approved by DEM through Activity Notification process</li> </ul>	3	E	<b>Medium</b>

## **7. RISK MANAGEMENT**

To manage the risks outlined in Section 7, Havilah adopts a number of strategies in risk management. This chapter outlines the standards by which Geothermal Resources personnel abide, training and inductions which on site personnel will be required to complete, the emergency response plan, and reporting criteria in the event of an incident.

### **7.1 Standards**

Geothermal Resources operate in full compliance with applicable Australian and international standards, including but not limited to:

- AS/NZS ISO 31000:2009 Risk Management
- AS/NZS ISO 45001:2018 Occupational Health and Safety Management Systems – Specification with Guidance for Use
- AS/NZS ISO 14001:2016 Environmental Management Systems – Requirements with Guidance for Use
- AS 1940:2017 The Storage and Handling of Flammable and Combustible Liquids

Havilah’s policies and procedures manuals, which its personnel are familiar with, cover these aspects.

### **7.2 Training, Inductions and Responsibilities**

As noted above Geothermal Resources will use internal staff and its own equipment to undertake decommissioning and rehabilitation of wells. All employees will undertake relevant inductions and training for all aspects of operations, including but not limited to:

- Havilah Resources Operating Light Vehicles SOP
- Havilah Resources Fire Awareness SOP
- Havilah Resources Waste Management SOP

For general environmental aspects, a Geothermal Resources nominated representative will be responsible for cleanliness of the site and access tracks, supervision of decommissioning works, and general documentation of operations. An on-site induction will be carried out which refers to these environmental outcomes.

### **7.3 Emergency Response**

An Emergency Response Plan has been developed for all of Havilah’s projects and will be applied to Geothermal Resources decommissioning activities. The conditions at the various well sites are no different to those that Havilah encounters on a daily basis at its current drilling sites.

### **7.4 Reporting**

External reporting (e.g. Serious or Reportable incidents, annual reports) is carried out in accordance with the requirements of the *Petroleum and Geothermal Energy Act 2000* and the applicable SEO.

All serious incident and reportable incidents will be reported on to the relevant official governing body by Geothermal Resources personnel.



## 8 REFERENCES

Department for Energy and Mining (website), *Arrowie Basin information page*, [http://energymining.sa.gov.au/petroleum/prospectivity/arrowie\\_basin](http://energymining.sa.gov.au/petroleum/prospectivity/arrowie_basin), viewed 1 April 2020

Geothermal Resources Limited, *Proposed eight-hole geothermal gradient drilling programme*, 2006

Santos, *Australian Cooper Basin Operators Environmental Impact Report, Drilling, Completions and Well Operations*, 2015

South Australian Resources Information Gateway (SARIG), *SA Heritage Places (map)*, viewed 3 April 2020

DRAFT

# Appendix 1

## Photographs of Frome drill sites

DRAFT



Frome 1A



Frome 2



Frome 3



Frome 5



From 9



From 10



Frome 11



Frome 12