SEL26/2005

Annual Report Year 2

July 2008

APPENDIX 3

Report by Hot Dry Rocks Pty Ltd on aquifer quality and distribution in SEL26/2005

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REVIEW OF AQUIFER DISTRIBUTION AND CHARACTERISTICS WITHIN SEL 26/2005 TASMANIA

Report prepared for KUTh Energy Ltd

July 2007

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EXECUTIVE SUMMARY

Hot Dry Rocks Pty Ltd was commissioned by KUTh Energy Ltd to provide a report on the known aquifers within special exploration licence SEL 26/2005, and how these aquifers might affect KUTh's planned geothermal exploration drilling program. This report investigates the risk of intersecting groundwater within SEL 26/2005, and ways of managing the risk. HDRPL carried out a desktop study as follows:

- Review available information
- Identify locations of aquifers within SEL 26/2005
- Characterize aquifers
- Suggest management options

Specific findings and recommendations include:

- Approximately 85–95% of Tasmania is underlain by fractured rock aquifers. The hydrogeological nature of most aquifers in Tasmania is not well understood, except in areas where detailed study has been carried out.
- Tasmanian aquifers can be classified into nine groups, some of which are low–moderately prospective for groundwater, with the remainder moderate–highly prospective.
- Moderate–highly prospective aquifers present a greater risk of intercepting significant quantities of groundwater, and wells drilled in these areas will require careful management to avoid compromising aquifer integrity and disturbing the temperature profile.
- Wherever possible, boreholes should be drilled in areas of low–moderate groundwater prospectivity to reduce risk (and potential cost) of intercepting significant quantities of groundwater.
- Sealing of aquifers requires pumping grout into the annulus between the casing and edge of the drill hole. Grouting of wells is a common practice in the groundwater industry.
- All drilling activities should be undertaken by contractors experienced in groundwater bore installation in Tasmania and familiar with protocols and procedures for dealing with intersected aquifers.

Table of Contents

1.0 Introduction and Scope

Hot Dry Rocks Pty Ltd (HDRPL) was commissioned by KUTh Energy Ltd (KUTh) to provide a report on the known aquifers within special exploration licence SEL 26/2005, and how these aquifers might affect KUTh's planned drilling program. HDRPL understands that Mineral Resources Tasmania (MRT) and KUTh have jointly recognised that aquifers within SEL 26/2005, and the groundwater therein, might be at risk of contamination by drilling, and that this risk must be addressed and managed.

Through the process of exploring for geothermal energy it is expected that the drilling carried out will intercept groundwater within aquifers. An aquifer can be described as a body of rock or sediment that is sufficiently porous and permeable to store, transmit, and yield significant or economic quantities of groundwater to wells and springs.

HDRPL carried out a desktop study as follows:

- Review available information
- Identify locations of aquifers within SEL 26/2005
- Characterize aquifers
- Suggest management options.

2.0 Information Review

A search was carried out of open file information on groundwater in Tasmania, primarily through the MRT and Geoscience Australia websites. Results of this search can be found in Section 7 of this report. The search revealed one document in particular[1] which provided a comprehensive review of groundwater occurrence in Tasmania. Other documents found were specific to certain study areas such as Coal River, Longford, Devonport–Port Sorrell–Sassafras, Greens Beach, and may be of local use when planning drill locations in these areas.

This report draws primarily on the Tasmanian groundwater review by Bacon and Latinovic (2003)[1].

3.0 Groundwater Occurrence in Tasmania

3.1 Extract from Bacon and Latinovic (2003)[1]

> "In Tasmania, groundwater occurs in a number of aquifer types. It is estimated that approximately 85–95% of Tasmania is underlain by fractured rock aquifers, in which water storage and transportation occurs through the fractures in the rock mass. The lithological properties of a number of these aquifers are believed to be causing them to operate as dual porosity aquifers, with a degree of storage occurring within pores in the rock mass and water movement occurring along the fractures.
>
> The remainder of the aquifers (underlying some 10–15% of Tasmania) are those in which water storage and flow occurs through the pores within the aquifer material. These intergranular aquifers are typified by Tertiary and Quaternary sedimentary rocks which occur as localized deposits in certain

[1] **Bacon, C.A. and Latinovic, M.** (2003). A review of groundwater in Tasmania. *Tasmanian Geological Survey Record* 2003/01.

basins (e.g. Longford).

The hydrogeological setting of the aquifers varies according to their location and variations in geology. In certain areas, the aquifers behave as confined aquifers, in which the water stored is under pressure. In others…the water is stored under unconfined conditions.

The exact nature of the hydrogeological conditions in all aquifers in Tasmania is not completely understood, except in certain areas where detailed study work has been carried out..."

3.2 Groundwater Prospectivity

In their study, Bacon and Latinovic (2003)[1] categorised aquifers based on geological and hydrogeological characteristics. Aquifers are described in terms of prospectivity. Prospectivity, in this context, is the chance of a borehole encountering groundwater with a yield greater than 0.05 l/s. Boreholes reported as dry holes usually have small, unreported yields; nominally less than 0.05 l/s.

4.0 Aquifers Types and their Distribution

Aquifers are classified into nine groups: Quaternary coastal deposits (Groups 1 & 2), Quaternary alluvial deposits (Group 3), Tertiary sedimentary deposits (Group 4), Triassic and Permian fractured rocks (Group 5), Paleozoic and neoproterozoic fractured rocks (Group 6), Tertiary basalt fractured rocks (Group 7), Jurassic dolerite fractured rocks (Group 8), and Devonian granite fractured rocks (Group 9). A brief description along with thumbnail picture to show distribution in the SEL is provided below for each group.

4.1 Groups 1 & 2: Quaternary coastal aquifers

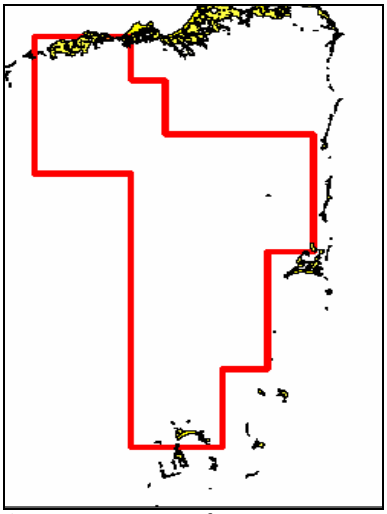

Figure 1. Location of Quaternary coastal aquifers

- Aeolian sand deposits marginal to the coast and coastal plain deposits.
- The aquifers are unconfined to semi-confined.
- Prospectivity: Moderate to High

4.2 Group 3: Quaternary alluvial aquifers

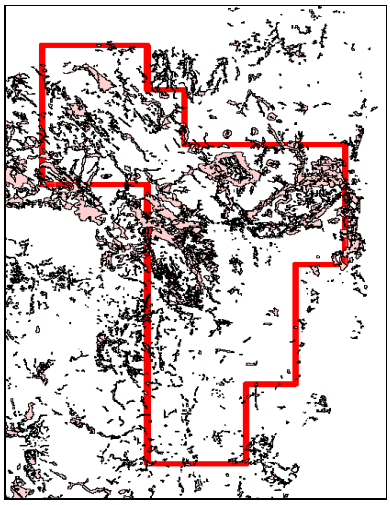

Figure 2. Location of Alluvium aquifers

- Alluvium deposits of limited thickness including talus and till deposits.
- Yields are variable and often low due to high clay content.
- Yields can be appreciable where sediments are coarse grained.
- Prospectivity: Low to Moderate

4.3 Group 4: Tertiary sedimentary aquifers

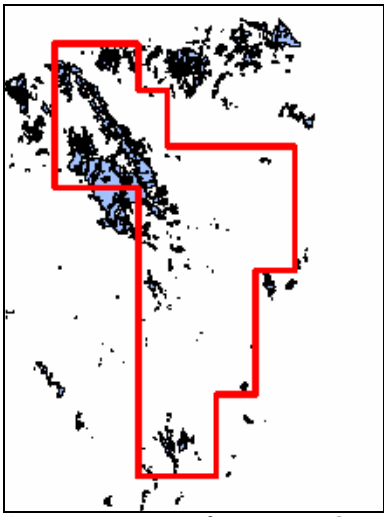

Figure 3. Location of Tertiary Sedimentary aquifers

- Clay, sand and gravel of non-marine origin (lacustrine deposits); variable thickness up to several hundred meters.
- These aquifers are found in the Longford, Tamar and Coal River and are of high prospectivity for groundwater.
- These aquifers are often confined as is the case in the Longford Area. Detailed studies of Longford and Coal River Basins would be of benefit for review prior to drilling holes in these areas.
- Prospectivity: Moderate to High

4.4 Group 5: Triassic and Permian aquifers

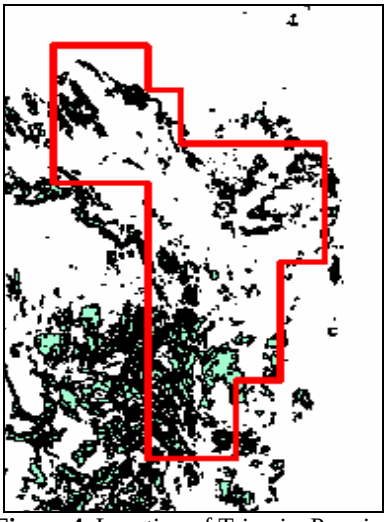

Figure 4. Location of Triassic–Permian fractured rock aquifers

- Consisting of fractured mudstones, sandstones and other sedimentary rocks these aquifers can be high yielding.
- Prospectivity: High

4.5 Group 6: Paleozoic and Neoproterozoic fractured rock aquifers

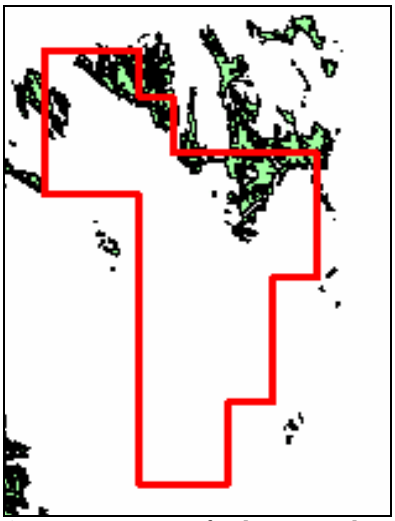

Figure 5. Location of Paleozoic and Neoproterozoic fractured rock aquifers

- Ordovician, Devonian and Cambrian turbidite sequences including Cambrian volcanics are included in this group and water prospectivity is high. This group includes the Mathinna beds which are one of the more prospective units for groundwater in Tasmania.
- Prospectivity: Moderate to High

4.6 Group 7: Tertiary basalt fractured rock aquifers

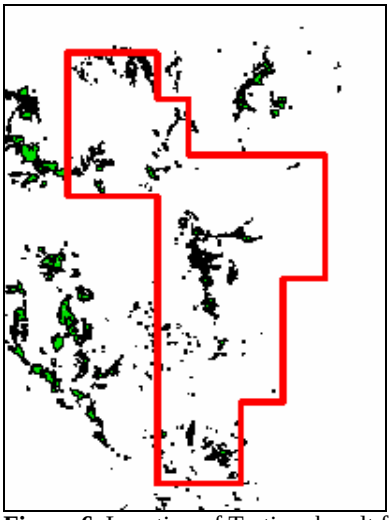

Figure 6. Location of Tertiary basalt fractured rock aquifers

- Predominately a fractured rock aquifer, the basalt may contain vesicles which increase water storage. Where the basalt occurs around Campbell Town is noted to be particularly prospective.
- Prospectivity: High

4.7 Group 8: Jurassic dolerite and lower prospectivity basalt

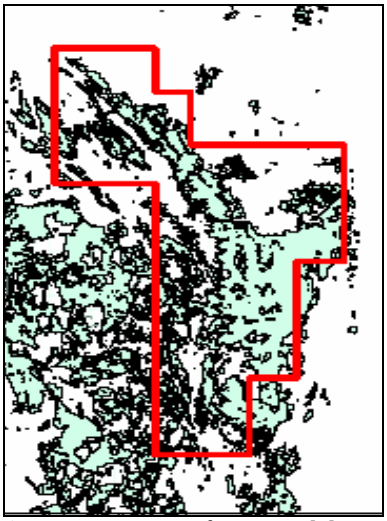

Figure 7. Location of Jurassic dolerite fractured rock aquifers

- These unconfined to semi-confined fractured rock aquifers have fewer fractures and fractures are less open than other fractured rocks, leading to low groundwater prospectivity.
- Prospectivity: Moderate

4.8 Group 9: Devonian granite aquifers

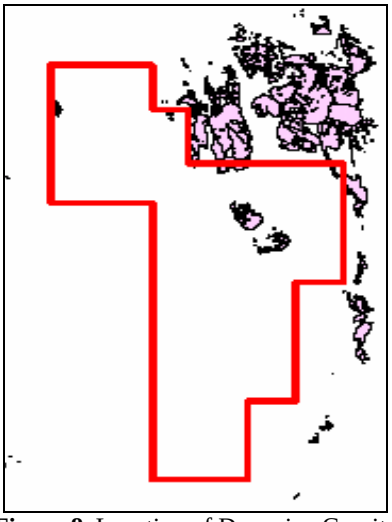

Figure 8. Location of Devonian Granite fractured rock aquifers

- Sparse jointing in the granite make these rocks low to moderately prospective for groundwater.
- The aquifers range from confined to unconfined.
- Prospectivity: low to moderate

4.9 Overview of aquifer prospectivity

By combining groups of moderate to high prospectivity aquifers (1, 2, 4, 5, 6 & 7) and the low to moderate prospectivity groups (3, 8 & 9) we can identify areas where there is a greater risk of intercepting significant quantities of groundwater (Figure 9).

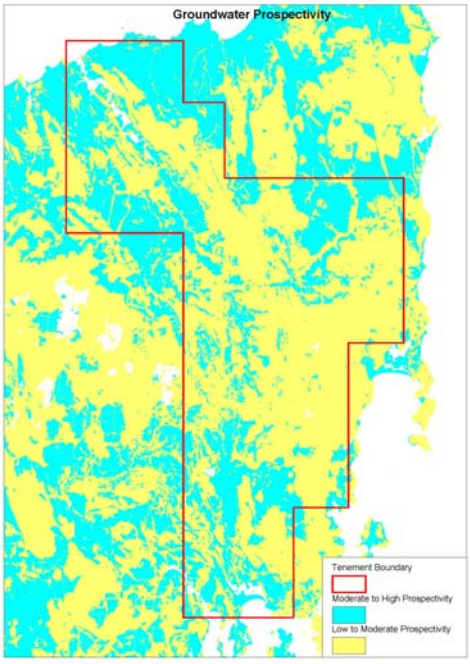

Figure 9. Moderate–high (blue) and low–moderate (beige) groundwater prospectivity map.

5.0 Management of aquifer intersection risk

During the course of the planned drilling program it is reasonable to expect that groundwater will be intercepted. Depending upon the characteristics (permeability and porosity) of the aquifer hosting the groundwater, flow rates may be significant (greater then 0.05 l/s) and require the aquifer to be sealed. Sealing of aquifers avoids compromising aquifer integrity and, in the context of geothermal gradient measurements, reduces disturbance to the equilibrium temperature profile. The process requires pumping grout into the annulus between the casing and the side of the hole at the level of the aquifer, and is a common practice in the groundwater industry.

HDRPL recommends, wherever possible, locating boreholes in areas of low–moderate groundwater prospectivity (see Figure 9). This will reduce the risk of intercepting significant quantities of groundwater, and thus minimise the cost of sealing aquifers through grouting techniques. Note, however, that there will still be potential for intersecting significant groundwater in the lower risk areas, so the drilling contractor should be prepared for such an event.

It is very likely that in a program of regularly spaced boreholes in SEL 26/2005, at least some of those bores will be drilled in areas of moderate–high groundwater prospectivity (see Figure 9). The groundwater risk in these areas can be managed by the drilling contractor applying appropriate grouting procedures whenever aquifers are intercepted. Note, however, that even in areas of high prospectivity, some bores may not intersect aquifers with significant flow.

There will always be a finite risk of intersecting aquifers with significant flow wherever drilling takes place. The risk, and therefore potential cost, of drilling operations will be minimised by drilling in areas of low–medium groundwater prospectivity wherever possible. Drilling contractors, however, should be aware of groundwater risk and constantly prepared to act to avoid contamination of groundwater and disturbance of the temperature profile.

5.1 Selecting drilling contractor

The document "Minimum construction requirements for water bores in Australia[1]" discusses grouting techniques used to seal aquifers. The document notes that "…positive placement of grout by tremie pipe or pressure cementing is to be used for all bores where the grout is to be placed under water." In all cases where significant water is intercepted and sealing of an aquifer is required in the geothermal drilling program, the grout will be required to be placed under water. HDRPL therefore recommends that drilling contractors enlisted to drill geothermal bores should be familiar with this protocol, and demonstrate previous positive experience of groundwater bore installation in Tasmania.

[1] Edition 2. Federal Land, Water and Biodiversity Committee, 2003.

6.0 Conclusions

A search for references on Tasmanian groundwater resources revealed one document in particular[1] that provided a comprehensive review of groundwater occurrence in Tasmania. Other documents specific to certain areas (Coal River, Longford, Devonport–Port Sorrell–Sassafras, Greens Beach) may be of use when planning drilling activities in these areas. Specific findings include:

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7.0 Reference list for groundwater in Tasmania

Bacon, C.A. and Latinovic, M. (2003). A review of groundwater in Tasmania. *Mineral Resources Tasmania, Tasmanian Geological Survey Record* 2003/01.
(File: UR2003_01.pdf)

Cromer, W.C. (1979). Groundwater from coastal sands at Greens Beach, Northern Tasmania. *Tasmanian Department of Mines, Geological Survey Bulletin* 57.
(File: GSB57.pdf)

Cromer, W.C. (1993). Geology and groundwater resources of the Devonport–Port Sorrell–Sassafras Tertiary Basin. *Tasmanian Department of Mines, Geological Survey Bulletin* 67.
(File: GSB67.pdf)

Land, Water and Biodiversity Committee (2003). Minimum construction requirements for water bores in Australia, Edition 2.
(File: mcrwba.pdf)

Latinovic, M. (2002). Tasmanian Groundwater Flow Systems for Dryland Salinity Planning. Mineral Resources Tasmania Tasmanian Geological Survey Record 2003/02.
(File: UR2003_02.pdf)

Leaman, D.E. (1971). The geology and groundwater resources of the Coal River Basin. *Tasmanian Department of Mines, Underground Water Supply Paper* No.7.
(File: UGWSP7.pdf)

Moore, W.R. (1977). The groundwater potential of north-eastern Tasmania. *Mineral Resources Tasmania*, TR20_249_251
(File: TR20_249_251)

Taylor, K. (2000). Groundwater resources of the Northern Midlands and Fingal Valley regions. *Mineral Resources Tasmania, Tasmanian Geological Survey Record* 2000/04.
(File: UR2000_04.pdf)