MEMORANDUM

COMPANY: Toro Energy Limited
ATTENTION: Alan Tandy
CC:
FROM: Fiona Dixon/Alan Woodford
DATE: 9 December 2014
JOB NO: 1134N
DOC NO: 007a
SUBJECT: Water Supply Modelling Results - Lake Maitland Uranium Project

Alan,

Further to your request, we are pleased to present the following summary report on the groundwater modelling work we have undertaken for Toro Energy’s (Toro) proposed Lake Maitland uranium mining project.

1. BACKGROUND

RPS Aquaterra (2010) undertook extensive hydrogeological investigations on behalf of Mega Lake Maitland (Mega) to assess the water supply potential of the groundwater resources in a tributary catchment, located to the north of the Lake Maitland playa. Four aquifer units were identified, including: an upper alluvial sequence; intermediate sands and gravels; basal palaeochannel sands and weathered / fractured basement. Investigations to date suggest that of the four aquifers identified, the upper alluvial aquifer has the greatest potential to deliver a sustainable water supply.

Groundwater modelling was completed for Mega’s proposed Lake Maitland Water Supply Borefield (the Borefield) for a project life of 13 years (RPS Aquaterra 2010 (Original 13 Year Scenario)). This was based on a notional borefield of 10 bores installed in the upper alluvial aquifer. The modelling predicted that under average climatic conditions and after 13 years of borefield operation at an average rate of 3,600kL/d (1.3GL/a), a maximum water level drawdown of 5.5m or less than 25% of the original saturated thickness of the aquifer in the central borefield area. This modelling did not take into account any potential interference drawdown from the mine dewatering operations located approximately 13km to the south of the notional borefield.

Additional groundwater modelling to assess the cumulative impacts of mining operations, including dewatering and water supply pumping, on the groundwater systems was undertaken by Golder s (2010). This assessment predicted that, after 12 years of simultaneous mine dewatering and water supply pumping (as modelled by RPS Aquaterra in 2010) from the shallow aquifer systems, the water level drawdowns associated with each abstraction scheme coalesce and that the 0.5m drawdown contour would extend well outside the mining lease.

After acquiring the Lake Maitland Uranium Project from Mega, Toro wishes to investigate the feasibility of operating the Borefield at 1.3GL/a for a period of 20 years and further modelling has been requested to assess the water supply potential and drawdown impacts of the longer period of abstraction.

1.1 Scope of Work

The scope of work is:

- Extend the period of borefield operation at 1.3GL/a to 20 years, and compare with the previous model results (RPS Aquaterra 2010) in terms of reduction of aquifer saturated thickness and also the spatial extent of the predicted water level drawdown.
• Should the saturated thickness be dewatered by greater than 40% (i.e. exceeding environmental constraints) then run a similar scenario, applying an abstraction rate of 1GL/a and similarly assess.
• Complete uncertainty analyses for three sets of aquifer parameters for the preferred water supply abstraction scenario.

2. MODELLING

2.1 Model Set-up
The existing groundwater model set-up, developed and calibrated as part of the 2010 study was used for this work. The water supply scenarios modelled have used the same borefield configuration of 10 notional bores as used in the previous modelling study (RPS Aquaterra 2010). A copy of Lake Maitland Uranium Project – Water Supply Investigation, RPS Aquaterra 2010 is included in Appendix A.

2.2 Prediction Set-up
The calibrated model was used to predict drawdown resulting from 20 years of water supply abstraction at 1.3GL/a (Base Case prediction). No aquifer parameters and rates of abstraction were altered.

2.3 Prediction Results
The predicted water level drawdown contours after 20 years are shown in Figure 1. The 0.5m drawdown contour from the Original 13 Year Scenario has also been included in the figure. It can be seen that the drawdown extent has increased by approximately 1km and the predicted drawdown in the centre of the borefield has increased to 6.5m, 1m more than the Original 13 Year Scenario.

After 20 years of borefield operation, the 0.5m drawdown contour (which is assumed to represent the maximum drawdown extent) is predicted to extend a maximum distance of 8km to the north and 4.5km to the west and east of the proposed borefield. To the south, the 0.5m drawdown contour is predicted to extend 7.5km south of the proposed borefield area or 3.5km upstream of the northern extremity of the Lake Maitland deposit.

The predicted drawdown at each notional production bore for the Base Case and for all three uncertainty runs is shown in Table 1.

<table>
<thead>
<tr>
<th>Bore</th>
<th>Drawdown (m)</th>
<th>Base Case</th>
<th>Uncertainty Run 1</th>
<th>Uncertainty Run 2</th>
<th>Uncertainty Run 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7</td>
<td>10</td>
<td>11</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>7</td>
<td>10</td>
<td>10</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>8</td>
<td>11</td>
<td>12</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>8</td>
<td>11</td>
<td>12</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>7</td>
<td>10</td>
<td>11</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>7</td>
<td>10</td>
<td>10</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>7</td>
<td>10</td>
<td>11</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>5</td>
<td>7</td>
<td>7</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>9</td>
<td>12</td>
<td>15</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>8</td>
<td>11</td>
<td>12</td>
<td>8</td>
<td></td>
</tr>
</tbody>
</table>

The model predicts that the borefield can sustain a production rate of approximately 1.3 GL/a for 20 years, without breaching the 40% aquifer drawdown environmental constraint (Figure 5). Given the predicted water level drawdown magnitude and extent after 20 years of abstraction at 1.3GL/a, we have not run the second proposed borefield abstraction scenario (pumping at 1GL/a for 20 years).
2.4 Areas of Uncertainty

To assess the impacts of the following key hydrogeological uncertainties on the borefield supply potential over 20 years; zero recharge, significantly reduced aquifer storativity and permeability (as identified in the 2010 study), limited sensitivity analysis has been conducted on the Base Case model prediction to assess the uncertainty and risk.

Adjusting parameter values to be lower than those adopted in the Base Case prediction provides a more conservative (lower) prediction of the water supply potential of the proposed borefield. Details of the uncertainty runs, including a brief description of the results are outlined in Table 2.

Table 2: Summary of Uncertainty Runs

<table>
<thead>
<tr>
<th>Uncertainty Run</th>
<th>Description</th>
<th>Uncertainty Ranking</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Run 1</td>
<td>Specific yield of “undifferentiated” and “borefield area” alluvium reduced</td>
<td>Equal first</td>
<td>Maximum drawdown at centre of borefield of 8.5m</td>
</tr>
<tr>
<td></td>
<td>from 0.1 and 0.075 to 0.05 and 0.0375, respectively</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Run 2</td>
<td>Horizontal hydraulic conductivity of “undifferentiated” and “borefield area”</td>
<td>Equal first</td>
<td>Maximum drawdown at centre of borefield of 8.5m</td>
</tr>
<tr>
<td></td>
<td>alluvium reduced from 7.5m/d and 2.5m/d to 3.75m/d and 1.25m/d, respectively.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Vertical hydraulic conductivity of “undifferentiated” and “borefield area”</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>alluvium reduced from 0.75m/d and 0.25 m/d to 0.375m/d and 0.125m/d, respectively.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Run 3</td>
<td>Zero recharge applied over the 20 year prediction period.</td>
<td>Second</td>
<td>Maximum drawdown at centre of borefield of 6.5m</td>
</tr>
</tbody>
</table>

The maximum predicted drawdown in the centre of the notional borefield for each uncertainty run is shown in Figures 2, 3 and 4. Maximum predicted drawdown, at the centre of the notional borefield for all three uncertainty runs completed, as well as the Base Case, is shown in Figure 5, plotted against time. The predicted drawdowns at each production bore are shown in Table 1.

The model results suggest that the model is most sensitive to Runs 1 and 2:

- Run 1 – a decrease in the specific yield (Sy) of the alluvial aquifer and surrounding area with the maximum predicted drawdown at the centre of the borefield predicted at 8.5m or 2m greater than the Base Case. Figure 2 also shows that the drawdown is predicted to spread further away from the borefield than in the Base Case, as a larger area is required to supply the same volume of water.
- Run 2 – a reduction in the horizontal and vertical hydraulic conductivity of the alluvial aquifer and surrounding area is also predicted to result in a similar increase in drawdown at the centre of the borefield to Run 1 (to 8.5m or 2m greater than the Base Case). Figure 3 shows that the drawdown is predicted not to spread as far out as the Base Case, but extends further to the south.

A decrease in aquifer recharge has not significantly altered the predicted water level drawdown (Run 3) as the borefield abstraction is most reliant on aquifer storage and hydraulic connectivity between aquifers rather than rainfall recharge or throughflow.

Figure 5 clearly shows the similar predicted drawdown responses between the Base Case and Run 3 and Runs 1 and 2. The centre of the borefield has been referenced to bore 11, previously a different reference point was used and therefore the Base Case and Original 13 Year Scenario drawdown curves are similar, but are offset from one another. For Run 2 it can be seen that after 20 years the predicted drawdown marginally breaches the 40% aquifer drawdown constraint. However, this is related to the thickness of the aquifer at the reference location (bore 11) and can be avoided by optimising the position and abstraction rate of each bore, taking into account the aquifer thicknesses across the borefield.

2.5 Model Limitations

The groundwater flow model was developed in 2010 with data limitations in mind, i.e. no time series data for transient model calibration, and it is of a complexity that is consistent with the available data. The model was calibrated to the available data and it is fit for predicting the water level drawdown from borefield abstraction. The potential impacts of the development on the hydrological system are readily identified from the model output.
As with all models, there are limitations associated with the data availability, conceptualisation, and representation of dynamic flow processes. Although the model includes the known essential features of the hydrogeological system, and is calibrated to available data, the predictions are simulations based on the best available knowledge and techniques, and should not be regarded as matters of fact. Modelling has consistently adopted a conservative position with respect to the data limitations, with “worst-case” assumptions made in many instances where actual data is unavailable. The model should be refined as additional data becomes available (specifically water level and rainfall time series data) and dewatering predictions updated in the fullness of time.

The following list of limitations identifies areas where the model features and/or data availability could be improved during future work programmes:

- With additional field investigation programmes and construction phases of the project, further hydrogeological information will be available, and should be used to test and improve the reliability of the conceptual model. This detail should then be incorporated into the groundwater model.

- To date no long-term groundwater monitoring data are available to calibrate the model to transient or seasonally varying groundwater conditions. This data when available can be used to calibrate the model and provide greater confidence in model predictions.

- There is no substantial pumping stress on the system that could be used to calibrate the model. Water supply pumping (i.e. pumping from the target alluvial aquifer) is required, along with monitoring data, to assess the model validity for the purpose of predicting the long-term drawdown impacts. Recalibration of the model and re-simulation of drawdown predictions should be undertaken as operational borefield data is obtained.

- Additional groundwater modelling to assess the cumulative impacts of mining operations, including dewatering and water supply pumping, on the groundwater systems was undertaken by Golders (2010). This assessment predicted that, after 12 years of simultaneous mine dewatering and water supply pumping (as modelled by RPS Aquaterra 2010, Original 13 Year Scenario) from the shallow aquifer systems, the water level drawdowns associated with each abstraction scheme coalesce and that the 0.5m drawdown contour would extend well outside the mining lease.

  - This potential cumulative impact has not been included in the current model as it was not part of the required scope of work, however it is recommended that this is included in future modelling programmes.

  - Additionally, it is stated in the Golders report, that excess dewatering water will need to be discharged on site due to environmental considerations and for water management purposes. It is therefore recommended that the site water balance is reviewed to assess if some of the excess dewatering water can be used for water supply (as it is understood that there is no longer a salinity constraint on water used in the process plant), rather than pumping the borefield.

3. CONCLUSIONS AND RECOMMENDATIONS

The modelling predicts that under average climatic conditions the borefield can supply 1.3 GL/a for 20 years without breaching the 40% aquifer drawdown environmental constraint.

After 20 years of borefield operation, the 0.5m drawdown contour (which is assumed to represent the maximum drawdown extent) is predicted to extend a maximum distance of 8km to the north and 4.5km to the west and east of the proposed borefield. To the south, the 0.5m drawdown contour is predicted to extend 7.5km south of the proposed borefield area or 3.5km upstream of the northern extremity of the Lake Maitland deposit.

A maximum drawdown of 6.5m or 21% of the original saturated thickness of the aquifer is predicted in the central borefield area. Water level decline close to pumping bores will be greater; however, this will be a much-localised effect and none of the predicted water levels breaches the 40% aquifer water level drawdown constraint. This modelling did not take into account any potential interference drawdown from the mine dewatering operations located approximately 13km to the south of the notional borefield.
Uncertainty analysis shows that the sustainability of the borefield is more reliant on aquifer storage and hydraulic connectivity between aquifers rather than rainfall recharge or throughflow. If the specific yield of the aquifer is reduced by 50%, then the water level drawdown in the central borefield increases by around 2m to 8.5m (approx. 30% of saturated aquifer thickness). If the hydraulic conductivity is reduced by 50%, then drawdown in the central borefield increases by around 2m to 8.5m (approx. 30% of saturated aquifer thickness). The model is least sensitive to a change in recharge, under zero rainfall recharge conditions the predicted drawdown only increases slightly (0.5m) in the central borefield area.

It is recommended that future modelling predictions assess the potential impacts from both mine dewatering and water supply pumping. It is also recommended that the site water balance is reviewed to assess if some of the excess dewatering water can be used for water supply, rather than pumping the borefield.

4. REFERENCES


We trust this information is sufficient for your purposes; however should you require any further details or clarification, please do not hesitate to contact the undersigned.

Yours sincerely,
RPS Water Management

Fiona Dixon
Senior Hydrogeologist

Alan Woodford
Principal Hydrogeologist
LOCATION MAP

LEGEND

Predicted Drawdown (m)
Basecase (20 year) Scenario
(0.5m contour)
Tenement Boundary (L53/152)
Notional Production Bore

AUTHOR: FD
DRAWN: FD
REPORT NO: 007a
DATE: 01/12/2014
JOB NO: 1134N

Location: F:\Jobs\1134N\Mapinfo\Workspaces\Figure4.wor
FIGURE 5

PREDICTED DRAWDOWN AT CENTRE OF NOTIONAL BOREFIELD

Predicted Drawdown (m) vs Time (years)

- **Base Case**
- **Uncertainty Run 1 (Sy of Alluvium reduced by 50%)**
- **Uncertainty Run 2 (Kh / Kv of Alluvium reduced by 50%)**
- **Uncertainty Run 3 (Zero Recharge)**
- **40% Aquifer Drawdown (m) Limit**
- **Original 13yr Scenario**

Lake Maitland Water Supply Borefield - Predicted Drawdown vs Time

F:\Jobs\1134N6\00\Figures\Figure 5.xls\Fig 2