Southdown Magnetite Project
Groundwater monitoring and management plan
Prepared for
Grange Resources Limited
November 2018
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1 Purpose and scope of Groundwater Monitoring and Management Plan

Grange Resources Limited (Grange Resources), on behalf of Southdown Joint Venture, proposes to develop a magnetite mine (Southdown Magnetite Project) as part of the Albany Iron Ore Project in the Wellstead area east of Albany. Development of the mine will involve dewatering to enable safe mining of the identified magnetite deposit, a portion of which is located below the regional watertable, and possible groundwater abstraction for water supply from separate aquifers to the north and south of the Project area.

This Groundwater Monitoring and Management Plan describes the adaptive management approach to groundwater abstraction for both dewatering and water supply to address any unexpected and adverse damage to the ecosystems of the region that might result from groundwater abstraction. This Plan has been prepared to support the assessment of impacts to Matters of National Environmental Significance under the Environmental Protection and Biodiversity Conservation Act 1999. This process would be based on monitoring groundwater responses to abstraction in the deeper aquifers and monitoring shallow groundwater levels to determine if there are any responses to the abstraction. If an unexpected groundwater level drawdown occurs, then vegetation health monitoring will be conducted to determine if there is a response in comparison to a control site. This information can then be used to inform adaptive management of the Project.

The purpose of the monitoring program is to assess aquifer response to expected modelled rates of drawdown and to trigger the implementation of contingencies where necessary. The monitoring plan will also validate, provide new information and improve the current understanding of the conceptual and numerical hydrogeological model.

2 Summary of predicted outcomes and residual risk

Groundwater abstraction will be undertaken for mine dewatering and for water supply as part of the Southdown Magnetite Project, creating spatially and temporally distinct areas of drawdown. There is no overlap between the areas of drawdown associated with the abstraction areas and the groundwater response to abstraction has been modelled separately for each activity.

Figure 1 shows the location of the proposed mine pit and the Palaeovalleys where the proposed water supply borefields may be located. The exact location of the borefields are unknown but will be within one or both of the Palaeovalleys shown within Figure 1.

Groundwater abstraction from the proposed water supply borefield is expected to result in up to 25 m of drawdown in the potentiometric surface (i.e. pressure) in the lower Werillup aquifer. Groundwater investigations and the model developed by Rockwater (2017) indicate that no measurable drawdown will occur in the shallow Pallinup aquifer as a result of water supply abstraction from the Werillup aquifers as shown in the cross section in Figure 2. This is due to the confining layer between the shallow Pallinup aquifer and the deeper Werillup aquifers. However, as a precautionary measure, an adaptive
management process will be implemented to address any uncertainty regarding hydraulic connection between the aquifers and potential transfer of drawdown into the shallow aquifer.

The average depth to water in the Pallinup Formation is about 15 m with an annual variation of up to 1 m (based on review of quarterly monitoring dataset from March 2006 to June 2018 provided by Rockwater). Shallower depths to water occur beneath sump-like surface depressions, which, where not cleared for agriculture, form ephemeral wetlands such as Mettler Lake which is about 7.5 km south east of the proposed mine (Figure 3). Mettler Lake is one of the most significant wetlands in the vicinity of the project area and is protected within the Mettler Lake Reserve. The current depth to water in the Pallinup Formation beneath the deepest part of the Mettler Lake basin floor is estimated to be approximately 5 m (Figure 3). The depth to watertable below Springwell Lake is approximately 8 m. Any surface water in these lakes is derived from rainfall and perched watertables. Shallow groundwater levels are also associated with the coastal creek lines that discharge to the sea south of the proposed mine and water supply borefield. The most significant of these are Wilyun Creek and Eyre River which intersect the shallow groundwater table and have permanent groundwater inflows as illustrated in the cross-section in Figure 2.

The mine pit dewatering was modelled by Golder (2006) as part of a Public Environmental Review (PER) for the Southdown Project. The model was based on progressive mining of a 300 m deep pit in an easterly direction for a 20 year period. Modelled drawdowns for the end of mining, shown in Figure 4, are highest for the western margin of the pit, where they extend up to 1 km from the pit margin. Most of the cone of depression is predicted to lie under the waste dump and other components of the mine infrastructure. Therefore, potential impacts to the environment are considered unlikely. If more extensive groundwater drawdown did occur, the areas most at risk from drawdown would be the vegetation associated with surface depressions such as Springwell Lake (Figure 3) down gradient (south east) of the mine pit. Therefore, groundwater levels beneath Springwell Lake and near Mettler Lake will be monitored.

The water quality of the regional aquifer is brackish to saline and as such, is unlikely to provide a preferred water supply source to any vegetation, as the species present within the mine locality do not represent salt tolerant species (Ecologia 2007) and are unlikely to utilise groundwater, even in areas where depth to groundwater is shallow. Therefore, this adaptive management plan is conservative as it monitors groundwater levels adjacent to low lying areas (such as Springwell Lake) even though the risk of impact is considered low.
BORES, PALAEOVALLEYS AND WERILLUP AQUIFERS

- Water bore or exploration hole
- Cross-section
- Upper Werillup aquifer
- Wellstead Sub-basin
- Southdown magnetite deposit

FIGURE 1

Southdown Joint Venture
Water Supply Investigation
July 2018

Rockwater Pty Ltd
FIGURE 16

CONCEPTUAL GROUNDWATER FLOW SYSTEM

Client: Southdown Joint Venture
Project: Water Supply Investigation
Date: Sept. 2017
Dwg No: 216-1-1/17/2-16
3 Monitoring plan

The Southdown Magnetite Project will implement a monitoring program in the areas potentially affected by the proposed groundwater abstraction for dewatering and water supply. This monitoring program will also include control sites so that the effect of the project can be separated from other variables. These control sites will be chosen once the proposed abstraction regime has been finalised and the groundwater model updated to ensure they are appropriate controls and outside of the area of potential impact.

The monitoring program is outlined in Table 1 and Figure 5. Figure 5 indicates the existing network of nested monitoring bores and the areas within which new bores are proposed. At least eight new nested monitoring bores will be installed in the northern palaeovalley and at least eight new nested monitoring bores within and adjacent to the southern palaeovalley. The exact location of new monitoring bores is subject to landholder discussion and consent and therefore only general locations are shown in Figure 5.

3.1 Werillup Aquifer

The monitoring program for the Werillup Formation will be based on the following:
- Groundwater abstraction will occur from this formation. Drawdown levels in this aquifer will be monitored to validate the modelled aquifer response by Golder (2006) for mine dewatering and by Rockwater (2017) for water supply abstraction.

3.2 Pallinup Aquifer

The monitoring program for the Pallinup Formation will be based on the following:
- The shallow aquifer in the Pallinup Formation will be monitored for any pressure changes due to groundwater abstraction from the underlying Werillup Formation or from mine dewatering.
- Groundwater levels of this formation will be monitored in areas with shallow depth to groundwater to identify any impacts on the groundwater system that may potentially affect native vegetation.

3.3 Vegetation monitoring

The vegetation monitoring program will be based on the following:
- Baseline vegetation monitoring in areas of interest and in control areas will be undertaken. Additional monitoring will be triggered in response to unexpected changes to shallow groundwater levels.

The monitoring plan outlined below will identify any impacts on vegetation due to groundwater abstraction from mine dewatering or water supply abstraction.

Monitoring results will be reviewed (annually) against baseline data and will be used to determine whether any changes need to be made to the management of the project.
<table>
<thead>
<tr>
<th>Parameter</th>
<th>What?</th>
<th>Purpose</th>
<th>Location</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groundwater levels</td>
<td>Monitor groundwater levels in Pallinup and Werillup Formations.</td>
<td>To determine whether the aquifer response is as predicted.</td>
<td>Adjacent to the borefield, around the mine site, in Springwell Lake, adjacent to Mettler Lake, headwaters of Wilyun Creek and Eyre River. Indicative locations are provided in Figure 5.</td>
<td>Monthly for the first three years of abstraction, then every three months. After five years, the monitoring will continue annually for the duration of the groundwater abstraction.</td>
</tr>
<tr>
<td>Groundwater quality</td>
<td>Monitor groundwater quality in Pallinup and Werillup Formations</td>
<td>To determine whether the hydrological response to abstraction is affecting groundwater quality.</td>
<td>Adjacent to the borefield, around the mine site, in Springwell Lake, adjacent to Mettler Lake, headwaters of Wilyun Creek and Eyre River. Indicative locations are provided in Figure 5.</td>
<td>Monthly for the first three years of abstraction, then every three months thereafter – Salinity, EC or TDS, pH and temperature. After five years, the monitoring will continue annually for the duration of the groundwater abstraction.</td>
</tr>
<tr>
<td>Vegetation health</td>
<td>Monitor vegetation health in permanent quadrats according to the Keighery condition rating system</td>
<td>To identify any change in vegetation health that may result from groundwater drawdown.</td>
<td>Springwell Lake, Mettler Lake, Wilyun Creek, at the mine site boundary and control sites.</td>
<td>Baseline vegetation health survey in early autumn (end of dry season) prior to the commencement of dewatering. Further monitoring only conducted if triggered by unexpected changes in the shallow groundwater levels.</td>
</tr>
</tbody>
</table>
Potential borefield area (approx. 1 km-spaced prod. bores, nested mon. bores between, subject to land owner discussion)

Nested environmental monitoring bores, subject to land owner discussion
4 Adaptive management

If monitoring indicates that unexpected and significant impacts are likely, Grange Resources will implement appropriate contingency actions within an adaptive management framework. The proposed approach to adaptive management will ensure that no unexpected impacts occur.

The key elements of the adaptive management approach that will be applied in the operation of the Southdown Magnetite Project are:

- Tiered monitoring approach will verify model predictions and ensure early warning of unexpected changes
- Clear decision-making framework
- Hydrological model, triggers and contingencies will be refined based on results of monitoring
- Monitoring results, triggers and contingencies will be regularly reviewed (annually) and where necessary, revised in agreement with the regulatory agencies.

4.1 Adaptive management process

The process for determining the need for triggering contingency actions is set out in Figure 6.

The groundwater modelling used to provide the basis for assessment of environmental impacts has predicted rates of groundwater level change in both the deep aquifer (Werillup Formation) and shallow aquifer (Pallinup). Comparison of the observed and modelled response will be evaluated in accordance with the processes in Figure 6 and set out in Table 2. The model will be updated prior to the commencement of dewatering to incorporate more recent hydrogeological information and groundwater abstraction plans. The model will then be periodically reviewed (nominally every five years or as project plans change or triggered by an unexpected monitoring response) during the life of the project.

The specific contingency action and triggering process for each of these potential risk areas is set out in Table 2, to be read in conjunction with Figure 6.
MONITORING AND RESPONSE PROCESS

Groundwater level monitoring in shallow aquifer indicates a change not attributable to rainfall trends

Compare groundwater level response to pressure changes in the Werillup Formation and determine whether change in groundwater level is attributable to the project.

Yes

If yes, undertake vegetation monitoring in the area of the response and in a control site

Are vegetation monitoring results consistent with baseline data and control area

Review monitoring program to ensure that it is effectively monitoring pressure changes in the deep aquifer and shallow groundwater levels. No further action required.

NO

If no, investigate prognosis for groundwater and environmental outcomes and implement contingency actions if considered necessary

MONITORING AND RESPONSE PROCESS

Figure 6: Flow chart showing process for responding to groundwater monitoring triggers

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4.2 Triggers and contingencies

The following contingencies will be implemented, if required:

- Advise regulators of trigger event or unexpected hydrological responses within one month.
- Investigate reasons for the hydrological response
- Review numerical model with the new data and determine whether environmental impacts are like to occur as a result of dewatering
- Implement vegetation and surface water monitoring in risk areas, if needed
- Implement appropriate contingency actions as agreed with regulators.
- Amend the abstraction regime, if required and monitor response.

The triggers and contingencies are outlined in Table 2.

Table 2: Triggers and contingency actions

<table>
<thead>
<tr>
<th>Feature</th>
<th>Response Trigger Level</th>
<th>Contingency action</th>
</tr>
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<tbody>
<tr>
<td>Deep borehole monitoring (Werillup Formation)</td>
<td>Drawdown exceeds the modelled rate of decline by greater than 20%.</td>
<td>Investigate reasons for hydrological response by looking at drawdowns in surrounding bores. Review the model(s) with new information and determine whether environmental impacts are likely. Assess whether contingencies are required.</td>
</tr>
<tr>
<td>Shallow borehole monitoring (Pallinup Formation)</td>
<td>Groundwater level drawdown in the shallow Pallinup Formation indicate groundwater level change due to abstraction from Werillup Formation</td>
<td>Advise regulators of trigger event. Review modelling with new information and determine whether environmental impacts are likely. Implement vegetation monitoring program in areas of risk (i.e. if drawdown is near areas with groundwater levels &lt;10 m). Implement surface water monitoring program in areas of risk (i.e. if drawdown is near/within 1 km of areas with perennial groundwater discharge such as Wilyun Creek or Eyre River).</td>
</tr>
<tr>
<td>Feature</td>
<td>Response Trigger Level</td>
<td>Contingency action</td>
</tr>
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<td>------------------</td>
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<td></td>
<td>Groundwater levels indicate unacceptable change in water table (&gt;1 m drawdown in comparison to reference sites and/or expected water levels) at key monitoring sites that may potentially affect native vegetation or surface water discharge.</td>
<td>Investigate monitoring results from deeper aquifer, rainfall and control sites to determine whether response from shallow aquifer is due to dewatering or over-abstraction from deep aquifer. If a correlation between the aquifers is determined, advise regulators of exceedance and planned response. Implement appropriate contingency actions as agreed with regulators. Likely to include amending the abstraction regime.</td>
</tr>
<tr>
<td>Vegetation health</td>
<td>Monitoring of vegetation health outside the Development Envelope indicate water-stress related to change in groundwater levels</td>
<td>Advise regulators Reduce groundwater abstraction from deep aquifer and increase monitoring of vegetation health and observe response.</td>
</tr>
</tbody>
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5 Review and revision

The monitoring plan will be reviewed annually for the first two years of abstraction to determine whether changes need to be made to the adaptive management of the project. The monitoring program should then be reviewed every five years and modifications made where necessary.
References


