Appendix B:
Mt Dromedary Underground Water Impact Report and Dewatering Assessment
(RLA 2018)
MT DROMEDARY UNDERGROUND WATER IMPACT REPORT
AND DEWATERING ASSESSMENT

NOVONIX LTD
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1 INTRODUCTION

Novonix Ltd (Novonix) requested that Rob Lait and Associates (RLA), in conjunction with Australasian Groundwater and Environmental Consultants (AGE), undertake an underground water impact report (UWIR), to support the development of an open-cut mine at the site of the Mount Dromedary Project (the Project) in North Queensland. RLA has prior involvement with hydrogeological assessments of the Mount Dromedary Project and this report builds upon existing knowledge of the groundwater conditions.

The UWIR is required by the Department of Environment and Science (DES; formerly the Department of Environment and Heritage Protection, DEHP) to meet the legislative requirements of the Environmental Protection (Underground Water Management) and Other Legislation Amendment Act 2016 (EPOLA Act), which amends the Environmental Protection Act 1994 (EP Act), and Chapter 3 of the Water Act 2000 (Water Act). The EPOLA Act details specific methods and information that DES considers necessary for provision to the administering authority, in accordance with section 126A of the EP Act.

1.1 Assumptions and limitations

The predictions of groundwater inflow to the proposed mine and associated drawdown presented in this UWIR are based on a numerical groundwater flow model that contains certain assumptions (Section 6). As no mining has yet occurred, there are no production bores currently used for dewatering the mine. Proposed mine development (to approximately 90 mbGL) is at approximately the same depth as the current monitoring bore suite. If this situation changes in the future, an alteration of the model may be required. The predictions are reliant on the current mine plan, and may change if operations vary significantly from planned development.

The groundwater model developed incorporates a steady state calibration that matches the modelled water levels with the observed levels in the four site monitoring bores and other surrounding private water bores. A transient calibration has not been carried out on the model due to a lack of response within the transient water level record. However, it should be noted that the groundwater levels from the four site monitoring bores have been collected over a relatively dry period in the context of the climate of the area. As recharge is modelled at 0.1% of rainfall, this is not expected to be a major limitation on the model outputs. The surface runoff at site would be expected to change with rainfall variability and this climatic input is not considered by the groundwater model. A site water balance incorporating surface runoff has been developed by ATC Williams.
2 LEGISLATIVE REQUIREMENTS OF A UWIR

2.1 Water Act 2000 (QLD)

2.1.1 Section 376

The statutory requirements for an UWIR, as detailed in section 376 of the Water Act, must be addressed in all cases. This section of the act is transcribed as boxed text below.

Section 376 of the Water Act (2000):

1) An underground water impact report must include each of the following—
   a) for the area to which the report relates—
      i) the quantity of water produced or taken from the area because of the exercise of any previous relevant underground water rights; and
      Example for paragraph (a)(i)—
      If the report is prepared by a mining tenure holder before it exercises its underground water rights, the quantity of water produced or taken from the area would be shown in the report as zero.
      ii) an estimate of the quantity of water to be produced or taken because of the exercise of the relevant underground water rights for a 3-year period starting on the consultation day for the report;
   b) for each aquifer affected, or likely to be affected, by the exercise of the relevant underground water rights—
      i) a description of the aquifer; and
      ii) an analysis of the movement of underground water to and from the aquifer, including how the aquifer interacts with other aquifers; and
      iii) an analysis of the trends in water level change for the aquifer because of the exercise of the rights mentioned in paragraph (a)(i); and
      iv) a map showing the area of the aquifer where the water level is predicted to decline, because of the taking of the quantities of water mentioned in paragraph (a), by more than the bore trigger threshold within 3 years after the consultation day for the report; and
   v) a map showing the area of the aquifer where the water level is predicted to decline, because of the exercise of relevant underground water rights, by more than the bore trigger threshold at any time;

Note—
If the underground water impact report or final report is approved, the mapped areas mentioned in subparagraphs (iv) and (v) establish immediately affected and long-term affected areas under section 387.
c) a description of the methods and techniques used to obtain the information and predictions under paragraph (b);

d) a summary of information about all water bores in the area shown on a map mentioned in paragraph (b)(iv), including the number of bores, and the location and authorised use or purpose of each bore;

da) a description of the impacts on environmental values that have occurred, or are likely to occur, because of any previous exercise of underground water rights;

db) an assessment of the likely impacts on environmental values that will occur, or are likely to occur, because of the exercise of underground water rights—

i) during the period mentioned in paragraph (a)(ii); and

ii) over the projected life of the resource tenure

e) a program for --

i) conducting an annual review of the accuracy of each map prepared under paragraph (b)(iv) and (v); and

ii) giving the chief executive a summary of the outcome of each review, including a statement of whether there has been a material change in the information or predictions used to prepare the maps;

f) a water monitoring strategy;

g) a spring impact management strategy;

h) if the responsible entity is the office—

i) a proposed responsible tenure holder for each report obligation mentioned in the report; and

ii) for each immediately affected area—the proposed responsible tenure holder or holders who must comply with any make good obligations for water bores within the immediately affected area;

i) other information or matters prescribed under a regulation.

2) However, if the underground water impact report does not show any predicted water level decline in any area of an affected aquifer by more than the bore trigger threshold during the period mentioned in subsection (1)(b)(iv) or at any time as mentioned in subsection (1)(b)(v), the report does not have to include the program mentioned in subsection (1)(e).

3) In this section—

environmental value see the Environmental Protection Act 1994, section 9.
2.2 EPOLA Act

There are two important amendments of the EPOLA Act that influence the implementation of a UWIR.

Amendment of s 87 (Amendment of s 376 (Content of underground water impact report))

Clause 33 of the EPOLA Act amends section 87 of the Water Reform and Other Legislation Amendment Act 2014, which in turn amends section 376 of the Water Act. The EPOLA Act states that UWIRs must include a description of impacts to environmental values, both past and future, that are anticipated from the exercise of underground water rights.

Amendment of s 215 (Other amendments)

Clause 7 of the EPOLA Act amends section 215 of the EP Act such that the regulator may deem impacts identified in a UWIR to be grounds for amendment of the environmental authority (EA) applicable to the resource activity. (Explanatory notes for EPOLA Act).

2.3 UWIR guideline

A guideline (DEHP, 2016a) was devised to provide additional information for proponents in responding to section 376 of the Water Act, including the changes made in accordance with the EPOLA Act. The guideline provides background on the methods appropriate for a UWIR and recommends the following outline:

Part A: Information about underground water extractions resulting from the exercise of underground water rights;

Part B: Information about aquifers affected, or likely to be affected;

Part C: Maps showing the area of the affected aquifer(s) where underground water levels are expected to decline;

Part D: An assessment of the impacts to the environmental values from the exercise of underground water rights;

Part E: A water monitoring strategy; and

Part F: A spring impact management strategy.

2.4 Report structure

In order to conform to the most recent recommendations of the regulators and to address the statutory requirements for UWIRs, this report is aligned with the structure derived from the UWIR guidelines (DEHP, 2016a) indicated above. Parts A through F are clearly identified within the heading titles of the report, and the relevant section of the Water Act is provided in the text.
3 PROJECT AREA

3.1 Project description

The Graphitecorp prospectus (Graphitecorp was the predecessor of Novonix) dated 10 November 2015 provides a good description of the Mount Dromedary Project as follows:

The Mount Dromedary Flake Graphite Project is located 125 km north-northwest of Cloncurry, Queensland, adjacent to a sealed highway. […]

The Project area was initially explored in the 1970’s and 1990’s. That work identified flake graphite mineralisation hosted in schist and slate. Although at an early stage of development, mineralisation is currently defined outcropping over a 3,000 m strike length and thicknesses from 30 m to 240 m. The limited drilling to date has focused on the southern and central areas. An initial 400 m reverse circulation (RC) drilling program was completed by Graphitecorp in September 2015 to confirm the presence of graphite schist at depth and complete the requirements of the relevant farm-in agreements.

The mineral resource has high and medium grade portions: the high grade portion being 2.7 Mt @ 20.4% C Graphitic and the medium grade portion being 1.6 Mt @ 5.7% C Graphitic. The mineral resource extends from surface to approximately 80 m depth.

The EA application for the Project, currently being developed by Novonix, is for two mine lease application (MLA) areas: MLA 100121 and MLA 100126. However, the proposed mining activities are planned for MLA 100121 only, and therefore, this report refers only to MLA100121. The location of the Project, as represented by the extent of MLA 100121 is shown in Figure 3.1. The groundwater bores relevant to the project are shown in Figure 3.2.
Mount Dronedary underground water impact report and dewatering assessment (G1904)

Location of MLA 100121

GDA94, Zone 54
1:500,000

Elevation (mAHD)

- 50
- 150
- 250
- 350
- 450

Elevation contour (10 m)

MLA 100121
Waterbody
Major road
Minor road
Major drainage
Minor drainage

Gauging station 9193004A
Gereta Station (BOM Station 029131)

©2018 Australian Geomatics and Environmental Consultants Pty Ltd (AGE) - www.agemundahaus.com.au

Source: 1 second UTM Derived DEMS © Commonwealth of Australia (Geoscience Australia) 2014; GDE02 DATA 7050 250K Series 3 © Geomatics NHQ of Australia (Geoscience Australia) 2006;

23/04/2018 Geospatial group Dronedary (G1904)/5_25/Workspaces/G1904_Dronedary Panel (MLA) Location of MLA 100121.jpg

DATE 25/01/2018 FIGURE No. 3.1
Mount Dronedary underground water impact report and dewatering assessment (G1904)

Monitoring bores and proximal registered bores
3.2 Climate

The semi-arid to arid Mt Isa region is described as having a tropical continental climate (Bureau of Meteorology, Australia - Köppen Australian climate classification scheme). Temperatures and evaporation rates are high, and rainfall is episodic.

Climate data for the Project area were assessed from Bureau of Meteorology (BOM) records. The nearest BOM meteorological station with relatively comprehensive rainfall and evaporation data to the Project is Mt Isa Airport (BOM Station 029127), more than 100 km southwest of the Project. Rainfall and evaporation data are key parameters for the assessment of groundwater recharge.

A statistical analysis of monthly rainfall and evaporation data from BOM Station 029127 for the years 1966 to 2012 is shown in Table 3.1 (considered by the author to be the most complete data set).

Table 3.1: Rainfall and evaporation for Mt Isa Airport (BOM Station 029127)

<table>
<thead>
<tr>
<th>Month</th>
<th>Mean rainfall (mm) for years 1966 to 2012</th>
<th>Mean monthly evaporation (mm) for years 1975 to 2012</th>
<th>Mean daily evaporation (mm) for years 1975 to 2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan</td>
<td>118.8</td>
<td>294.5</td>
<td>9.5</td>
</tr>
<tr>
<td>Feb</td>
<td>103.2</td>
<td>246.4</td>
<td>8.8</td>
</tr>
<tr>
<td>Mar</td>
<td>65.9</td>
<td>272.8</td>
<td>8.8</td>
</tr>
<tr>
<td>Apr</td>
<td>15.4</td>
<td>249</td>
<td>8.3</td>
</tr>
<tr>
<td>May</td>
<td>13.1</td>
<td>198.4</td>
<td>6.4</td>
</tr>
<tr>
<td>Jun</td>
<td>6</td>
<td>159</td>
<td>5.3</td>
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<tr>
<td>Jul</td>
<td>5.9</td>
<td>170.5</td>
<td>5.5</td>
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<td>Aug</td>
<td>3.7</td>
<td>213.9</td>
<td>6.9</td>
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<td>Sep</td>
<td>6.7</td>
<td>267</td>
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<td>Oct</td>
<td>19.2</td>
<td>322.4</td>
<td>10.4</td>
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<tr>
<td>Nov</td>
<td>39</td>
<td>327</td>
<td>10.9</td>
</tr>
<tr>
<td>Dec</td>
<td>72.5</td>
<td>328.6</td>
<td>10.6</td>
</tr>
<tr>
<td>Annual</td>
<td>469.4</td>
<td>3049.5</td>
<td>-</td>
</tr>
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</table>

Source: BOM (2017)
Precipitation in the semi-arid to arid climate of the Project area is dominated by summer storms and floods. Evaporation is greatest in summer, with average evaporation exceeding 250 mm/month from September to April. Even in the average wettest summer months of January and February, evaporation exceeds average monthly rainfall approximately threefold. The evaporation rate is primarily temperature-related, with the highest mean monthly evaporation (328.6 mm) occurring in November, and the lowest mean (159 mm) in June.

Although the Mt Isa Airport station has a long climate record, the nearest BOM meteorological station to the Project (about 58 km south west) with comprehensive rainfall data over the recent period from 2001 to 2017 is Gereta Station (Station 029131).

The complete monthly rainfall record for Gereta Station is provided in Figure 3.3, along with cumulative rainfall departure (CRD). The CRD method is a summation of the monthly departure of rainfall from the long-term average monthly rainfall. A rising trend in the CRD plot indicates periods of above average rainfall, whereas a falling slope indicates periods when rainfall is below average. It is evident that in the period from March 2013 until the end of 2017 rainfall in the region of the Project has been below average.

In general, groundwater level trends which do not correlate to a CRD trend (with or without a lag) suggest that a particular trend is not due to natural climatic variations.

Figure 3.4 shows the groundwater level trends in the Mount Dromedary groundwater monitoring bores over the period for which measurements have been recorded. It is clear that groundwater levels at Mount Dromedary from 2017 match well with the CRD when a short lag is incorporated (Figure 3.4), and that therefore groundwater level behaviour is a direct response to natural climatic variations.
Figure 3.3: Monthly rainfall and CRD at Gereta (029131) from 2001 to 2017
Figure 3.4: Groundwater Levels and CRD for Period of Measurement
3.3 Catchment hydrology

The Mount Dromedary Project area is situated in the Leichhardt River catchment and the Flinders River catchment. However, the mine extraction and processing activities will be in the Leichhardt River catchment only. The nearest semi-permanent to permanent river water to the Project is the Leichhardt River itself, about 20 km to the west of Mount Dromedary. The Leichhardt River is subject to a resource operation plan under the Gulf Rivers Water Resources Plan (GRWRP), and the surface water in the GRWRP is virtually fully committed. To the west of MLA 100121, the Leichhardt River flows north, to ultimately discharge to the Gulf of Carpentaria about 230 km to the north northwest.

The closest river gauge on the Leichhardt River to MLA 100121 is known as Leichhardt River at Miranda Creek (site number 913004A), which is situated about 58 km south southwest of the Mount Dromedary project (E 389185, N 7780130 MGA94 datum). Discontinuous gauge records exist for the Leichhardt River at Miranda Creek from January 1968 to May 2017, and discharge statistics are provided in Table 3.2. The water level and monthly discharge of the Leichhardt River at this location are plotted in Figure 3.5.

Discharge is ephemeral, with mean monthly discharge typically equal to or less than 10 m$^3$/s (cumecs) for two months of the year. The month of August is one of no mean flow. Typically, the months from June to September inclusive are within a dry period (Table 3.2).

Table 3.2: Discharge at Leichhardt River at Miranda Creek (913004A)

<table>
<thead>
<tr>
<th></th>
<th>Daily</th>
<th>Monthly</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Max</td>
<td>Min</td>
</tr>
<tr>
<td>Jan</td>
<td>195,424</td>
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<tr>
<td>Feb</td>
<td>150,327</td>
<td>0</td>
</tr>
<tr>
<td>Mar</td>
<td>188,194</td>
<td>0</td>
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<tr>
<td>Apr</td>
<td>29,649</td>
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<tr>
<td>May</td>
<td>1,592</td>
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<td>Jul</td>
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<td>29,117</td>
<td>0</td>
</tr>
<tr>
<td>All months</td>
<td>195,424</td>
<td>0</td>
</tr>
</tbody>
</table>

Source: Department of Natural Resources, Mines and Energy water monitoring information portal
3.4 Water plans

The Mount Dromedary area is within the Gulf Water Plan Area. The Resource Operations Plan of the Water (Gulf) Plan (2007) specifies water management areas, trading zones, and criteria for deciding water licence applications within the Leichhardt River catchment. The purpose of the plan is to regulate the taking of overland flow water and groundwater. The Leichhardt River is a prescribed watercourse under the Water Resources Act 1997.

3.5 Groundwater management areas

MLA 100121 lies within the Carpentaria management area of the Great Artesian Basin (GAB) groundwater management area (GMA). However, the aquifers present in the Mount Dromedary Project area are not GAB aquifers. The nearest GAB sediments are the Wallumbilla Formation of the Carpentaria Basin, which sub-crop to the east and west of the MLA. It is highly unlikely that groundwater at Mount Dromedary is connected to GAB aquifers, as it is hosted within the Corella Formation, a formation noted for its low groundwater storage and permeability. The regional hydrogeology is further detailed in Section 5.
4 UNDERGROUND WATER EXTRACTIONS (PART A)

This section of the report addresses section 376(a) of the Water Act.

4.1 Quantity of water already produced

No production of groundwater has been necessary other than small volumes to assist with exploration drilling programs. The Mount Dromedary project is a greenfield site.

4.2 Quantity of water to be produced in the next three years

4.2.1 Method of extraction

The volume of groundwater inflow to the proposed open-cut mine is expected to be small (refer to Section 4.2.3 below) and it will be catered for by in-pit pumping.

4.2.2 Estimate based on borefield capacity

No requirement for extraction bores are anticipated for the Mount Dromedary project.

4.2.3 Estimate based on 2018 numerical model

A numerical groundwater flow model for the proposed mine at the Mount Dromedary Project was developed for this UWIR using FEFLOW. The full details of this model are provided in Section 6. The FEFLOW model simulates groundwater flow in the aquifers around the Project and also simulates mine development based on the progressive deepening of the open-cut mine over the planned life of the mine. This includes simulation of the complete mining plan to a maximum depth of 90 mbGL over 25 years. The open-cut mine void is simulated within the model as drains, into which there is groundwater inflow. The model removes all water that enters the drains, and thus the open-cut mine void is simulated in the model as continuously dry, due to passive dewatering. Through this understanding, it is logical to use the predicted inflows to the open-cut pit as an estimate of the volume of water required for dewatering.

The predicted inflow to the pit is provided below as annual totals (Table 4.1; Figure 4.1), instantaneous rates (Figure 4.2), and cumulative volumes (Figure 4.3). The model predicts groundwater inflow volumes to the open-cut mine void of 5 ML, 26 ML and 58 ML for years, 1, 2, and 3 of the simulation, respectively (Figure 4.1). This gradual increase is a result of the mine development initially intersecting unsaturated material during the early years of the model simulation and progressively intersecting the groundwater table. The total inflow volume over the life of the mine is 1,463 ML (Table 4.1). As these volumes represent the expected groundwater inflow to the open-cut mine, they are the predicted volume required for the groundwater dewatering take at Mount Dromedary Project. These dewatering volumes are derived from a predictive model that incorporates recharge equal to 0.1% of rainfall. These volumes do not incorporate any incident rainfall or surface runoff that may enter the open-cut mine.
The assumptions inherent in these model predictions are summarised in Section 6. These dewatering rates are considered conservative and representative, and are a reasonable estimate of the anticipated volume of water that will be removed from the aquifers as a result of the proposed mine.

Table 4.1: Predicted annual groundwater dewatering volumes for life of mine

<table>
<thead>
<tr>
<th>Year</th>
<th>Annual dewatering volume (ML)</th>
<th>Cumulative dewatering volume (ML)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2019</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>2020</td>
<td>26</td>
<td>31</td>
</tr>
<tr>
<td>2021</td>
<td>58</td>
<td>89</td>
</tr>
<tr>
<td>2022</td>
<td>125</td>
<td>214</td>
</tr>
<tr>
<td>2023</td>
<td>171</td>
<td>385</td>
</tr>
<tr>
<td>2024</td>
<td>121</td>
<td>506</td>
</tr>
<tr>
<td>2025</td>
<td>83</td>
<td>588</td>
</tr>
<tr>
<td>2026</td>
<td>80</td>
<td>669</td>
</tr>
<tr>
<td>2027</td>
<td>85</td>
<td>753</td>
</tr>
<tr>
<td>2028</td>
<td>87</td>
<td>840</td>
</tr>
<tr>
<td>2029</td>
<td>72</td>
<td>912</td>
</tr>
<tr>
<td>2030</td>
<td>76</td>
<td>988</td>
</tr>
<tr>
<td>2031</td>
<td>77</td>
<td>1,066</td>
</tr>
<tr>
<td>2032</td>
<td>80</td>
<td>1,146</td>
</tr>
<tr>
<td>2033</td>
<td>83</td>
<td>1,229</td>
</tr>
<tr>
<td>2034</td>
<td>46</td>
<td>1,275</td>
</tr>
<tr>
<td>2035</td>
<td>39</td>
<td>1,314</td>
</tr>
<tr>
<td>2036</td>
<td>43</td>
<td>1,357</td>
</tr>
<tr>
<td>2037</td>
<td>46</td>
<td>1,404</td>
</tr>
<tr>
<td>2038</td>
<td>52</td>
<td>1,456</td>
</tr>
<tr>
<td>2039</td>
<td>7</td>
<td>1,463</td>
</tr>
<tr>
<td>2040</td>
<td>0</td>
<td>1,463</td>
</tr>
<tr>
<td>2041</td>
<td>0</td>
<td>1,463</td>
</tr>
<tr>
<td>2042</td>
<td>0</td>
<td>1,463</td>
</tr>
<tr>
<td>2043</td>
<td>0</td>
<td>1,463</td>
</tr>
<tr>
<td>2044</td>
<td>0</td>
<td>1,463</td>
</tr>
</tbody>
</table>
Figure 4.1: Predicted annual open-cut mine inflow volumes (ML)

Figure 4.2: Predicted instantaneous open-cut mine inflow volumes (ML)
Project No 1904 (Mount Dromedary UWIR)

Figure 4.3: Predicted cumulative open-cut mine inflow (ML)
5 AQUIFER INFORMATION AND UNDERGROUND WATER FLOW (PART B)

This section of the report addresses section 376(b)(i) to 376(b)(iii) of the Water Act.

5.1 Overview of aquifers

5.1.1 Geological Setting

A very comprehensive description of the geology of the Mount Dromedary Project is provided by Runge Pincock Minarco (RPM) in the November 2015 Mount Dromedary Graphite Flake project prospectus. As the geological sequence is the key to understanding the aquifers at the Project site, segments of the RPM description are paraphrased below.

- The Corella Formation (Table 5.1) is essentially a platform succession comprising thin-bedded calcareous sandstone, siltstone, impure limestone and dolomite, marble, carbonate breccias, minor quartzose sandstone, black shale, together with localised basalt pillow lavas and dolerite-amphibolite sills (Blake, 1987).
- The Black Mountain gabbro, dolerite sills and dykes intruded the Corella Formation about 1,685-1,640 Ma (Butera, 2008).
- Some of these mafic intrusions may have been syn-depositional or early diagenesis, but were probably emplaced before lithification of the host sediments.
- The rocks of the Corella Formation have subsequently been metamorphosed to amphibolite grade facies.
- The unit of economic interest is the graphitic schist which occurs within the Corella Formation. Graphite schist forms a distinct mappable unit at Mount Dromedary and can be traced over a strike length of at least 3,000 m with variable width up to 400 m.
- The Graphitic Schist is part of the Corella Formation package, a unit of the Proterozoic Mary Kathleen Group (Wilson & Grimes, 1986) which, in the Mount Dromedary area, lies within the Boomaarra Horst.
- The graphitic schist is underlain by grey siltstone and overlain by mica schist. The western margin of the graphitic schist is marked by a fault boundary contact with a dolerite sill.
- A coarse grained basic gabbro intrusion forms a prominent hill at Black Mountain.
- Major structural features of the area are the Boomaarra Horst: a north-south orientated elongate structure, situated in the northern sector of the Eastern Fold Belt. It is bounded by the north-south striking Coolullah Fault in the west and the subparallel Boomaarra Fault in the east (Figure 5.1; Figure 5.2).
The Mount Dromedary Graphitic Schist is interpreted to have originally formed in a narrow intra-horst graben rift within the Boomarra Horst. Growth faults on the basin margins opened up the sub-basin to shallow marine incursion and sediment influx. This is consistent with the thin discontinuous impure limestone and dolomite lenses, evaporite mud flats, algal mats and localised coarsening of the sequence to arenites and siltstones formed in a shallow marine-lagoonal depositional setting which is described above. It is possible the growth faults and wrench fault structures have not only controlled sedimentation but also the intrusion of the mafic gabbro.

West of the Coolullah Fault structure, the land surface is covered by transported gravels which merge with black soil plains.

There appears to be no on-lap of Mesozoic sediments over the Proterozoic basement rocks west of the Coolullah Fault, and the Proterozoic rocks are in fault contact with the Cretaceous Rolling Downs Group in that area (Figure 5.2).

Within the Boomarra Horst block, there may be some on-lapping of the Mesozoic Sediments from the east. The entire sequence is then truncated by the Boomarra Fault at the eastern margin of the horst (Figure 5.2).

The solid geology of the Mount Dromedary area is shown on Figure 5.1, with a cross section in Figure 5.2, and the recognised stratigraphy of the area is provided in Table 5.1.
Mount Dromedary underground water impact report and dewatering assessment (G1004)

Solid geology
Table 5.1: Stratigraphy and lithology of the Mount Dromedary region

<table>
<thead>
<tr>
<th>Age</th>
<th>Formation</th>
<th>Lithology</th>
<th>Map symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quaternary</td>
<td>Alluvium</td>
<td>Sand, silt, clay</td>
<td>Qa / Qhac</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Travertinous limestone</td>
<td>Qt</td>
</tr>
<tr>
<td>Tertiary-Quaternary</td>
<td></td>
<td>Sand, gravel, colluvial outwash deposits</td>
<td>TQr</td>
</tr>
<tr>
<td>Cretaceous</td>
<td>Toolebuc Formation</td>
<td>Calcareous bituminous shale and limestone</td>
<td>Ko/Klo</td>
</tr>
<tr>
<td></td>
<td>Wallumbilla Formation</td>
<td>Mudstone with calcareous concretions, labile sandstone and siltstone especially in lower part</td>
<td>Klu</td>
</tr>
<tr>
<td></td>
<td>Gilbert River Formation</td>
<td>Quartzose sandstone and conglomerate, minor siltstone and shale</td>
<td>Klg/JKg</td>
</tr>
<tr>
<td>Proterozoic</td>
<td>Corella Formation</td>
<td>Thin bedded calc-silicate rocks, quartzite schist; some granulite, gneiss and granofels. Graphitic schist</td>
<td>PLb/PLk/PLm/Plc</td>
</tr>
<tr>
<td>Proterozoic</td>
<td>Naraku Granite</td>
<td>Regional equivalent to local Black Mountain gabbro (?)</td>
<td>Pgu</td>
</tr>
</tbody>
</table>

Source: Dobbyn 1:250 000 Geological Series Map - Department of Mines and Energy, Queensland, 1972)
Figure 5.2: Cross section of the Boomarra Horst near Mount Dromedary (after Department of Mines and Energy, Queensland, 1972)
5.1.2 Aquifers

5.1.2.1 Calcite deposits

John Siemon Pty Ltd (2005) investigated several small calcite deposits in the area to the east of the Project, on the Cloncurry Road. The calcite lenses are located on Leased Land on Boorarra Station on Lot 3 on Plan LS18 and on Lot 1 on LS 14 covering Gleeson Station.

The calcite is encapsulated within hard calc-silicate rocks of the Corella Formation. The calcite deposits are therefore not continuous along the direction of strike (approximately north-northeast). Many of the exploration holes did not encounter groundwater either because they were too shallow (often <10 m depth) and did not encounter the watertable, or they penetrated the Corella Formation within the borehole. When groundwater was intersected its static water level was at about 11 m below ground level with small yields.

In view of the shallow and isolated nature of the ‘pods’ of calcite, this lithological unit is not considered to be a significant aquifer unit, and not considered hydraulically connected to the units at the Mount Dromedary Project.

5.1.2.2 Corella Formation

Four dedicated groundwater monitoring bores were installed at the Mount Dromedary project to assess aquifer types and permeability, primarily of the ore host rocks (i.e. the Corella Formation). Condensed details regarding the groundwater monitoring bores are shown in Table 5.2. The bore logs are provided in Appendix A.

Table 5.2: Condensed Details of the Groundwater Monitoring Bores at the Mount Dromedary Project

<table>
<thead>
<tr>
<th>Groundwater monitoring bore</th>
<th>Easting (MGA94)</th>
<th>Northing (MGA94)</th>
<th>Ground Surface Elevation (mAHD)</th>
<th>Depth Cased (m)</th>
<th>Perforations (m)</th>
<th>Airlift Yield (L/s)</th>
<th>Static water level when drilled (m bteo)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GWMB01</td>
<td>417908</td>
<td>7830392</td>
<td>131</td>
<td>90</td>
<td>78-90</td>
<td>7.5</td>
<td>6</td>
</tr>
<tr>
<td>GWMB02</td>
<td>418310</td>
<td>7831791</td>
<td>150.5</td>
<td>90</td>
<td>78-90</td>
<td>0.1</td>
<td>13.05</td>
</tr>
<tr>
<td>GWMB03</td>
<td>418502</td>
<td>7831217</td>
<td>147</td>
<td>90</td>
<td>78-90</td>
<td>0.1</td>
<td>13.54</td>
</tr>
<tr>
<td>GWMB04</td>
<td>418013</td>
<td>7831338</td>
<td>147</td>
<td>90</td>
<td>78-90</td>
<td>0.5</td>
<td>13.91</td>
</tr>
</tbody>
</table>
The main aquifer type that exists at the Mount Dromedary project occurs in fractured calc-silicates of the Corella Formation. The general depth at which the aquifers were encountered in the dedicated groundwater monitoring bores at the site is between 15 mBGL and 25 mBGL. There was no groundwater obtained at depths greater than this in the dedicated groundwater monitoring bores. With one exception, the airlift yield from the fractured calc-silicates is generally meagre (1 L/s or less). The airlift yield of GWMB01 (7.5 L/s) is derived from a fault zone recognised by a site geologist at the time of drilling and is expected to exhaust under sustained pumping.

Falling head permeability tests were undertaken on each of the four dedicated groundwater monitoring bores. The data were used to calculate the hydraulic conductivity (permeability) of the screened intervals in the groundwater monitoring bores using the Bouwer and Rice method (1976). The results are presented in Table 5.3.

Table 5.3: Calculated Hydraulic Conductivity at the Mount Dromedary Project

<table>
<thead>
<tr>
<th>Bore</th>
<th>Hydraulic Conductivity (m/d)</th>
<th>Hydraulic Conductivity (m/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GWMB01</td>
<td>$1.30 \times 10^{-1}$</td>
<td>$1.50 \times 10^{-6}$</td>
</tr>
<tr>
<td>GWMB02</td>
<td>$2.24 \times 10^{-1}$</td>
<td>$2.59 \times 10^{-6}$</td>
</tr>
<tr>
<td>GWMB03</td>
<td>$5.77 \times 10^{-2}$</td>
<td>$6.68 \times 10^{-7}$</td>
</tr>
<tr>
<td>GWMB04</td>
<td>$2.19 \times 10^{-2}$</td>
<td>$2.53 \times 10^{-7}$</td>
</tr>
</tbody>
</table>

Hydraulic conductivity values of $10^{-6}$ and $10^{-7}$ m/s are classed as very low and account for the low airlift yields and discharges of bores in the Corella Formation.

5.1.2.3 Mesozoic rocks

The Mesozoic sequence (the GAB aquifers) thins and pinches out over the Corella Formation from west of Mount Dromedary (where it is of the order of 60 to 100 m thick some 20 km away) to be absent over the Boomerarra Horst (Figure 5.2). To the west of the Coolullah Fault the Mesozoic sequence is relatively isolated from the rest of the GAB.

An isolated outcrop of the Toolebuc Formation occurs adjacent to the Coolullah Fault, about 6 km to the south of MLA 100121 (Figure 5.1). There are no reports of groundwater from the Toolebuc Formation in privately owned bores in the area. The Toolebuc Formation is not considered to be an aquifer unit in hydraulic connection to the Mount Dromedary Project.

The most productive aquifer unit in the Mesozoic sequence to the east and west of the Mount Dromedary Project is the Gilbert River Formation (shown as JKg; Figure 5.2). The Gilbert River Formation is one of the main aquifer units of the Carpentaria Basin (a sub-basin of the GAB). The Gilbert River Formation unconformably overlies granitic basement in this area. The Gilbert River Formation is overlain by the Wallumbilla Formation, which is a low permeability stratigraphic unit comprised mainly of pelitic rocks (e.g. mudstone and shale).
The Wallumbilla Formation is, to all intents and purposes, regarded as an aquitard and it is considered that there will be little hydraulic continuity between it and the Corella Formation at the Mount Dromedary project.

The Gilbert River Formation does not outcrop in the vicinity of the Mount Dromedary Project. It is interpreted that the nearest useful aquifer sequence of the Gilbert River Formation would be 20 km either to the east or west of Mount Dromedary. Given that the width of the Boomarra Horst is approximately 15 km to 20 km itself (Figure 5.1; Figure 5.2), and that the bounding faults (the Boomarra Fault and the Coolullah Fault) act as barriers to flow, such productive aquifers would be entirely separated from the hydrogeological units of the Project. This conceptual model is replicated in the numerical simulation, where the Boomarra Horst is modelled as a distinct zone (Section 6.3). The horst zone is separated from the Wallumbilla Formation and the Gilbert River Formation using a change in hydraulic conductivity parameters between the model zones. That is, the faults are not modelled as barriers, yet the material on either side of the faults represents the various geological units.

Therefore, neither the Wallumbilla Formation, nor the Gilbert River Formation are considered to be aquifer units of any significance to the Mount Dromedary Project.

5.1.3 Underground water flow and aquifer interactions

All of the groundwater bores at Mount Dromedary Project are completed in fractured calc-silicates of the Corella Formation. This unit is the host of the ore body for the proposed mine and all of the excavation will be within the Corella Formation.

The depth to groundwater trends in the four dedicated groundwater monitoring bores at the Mount Dromedary Project since records commenced are shown in Figure 5.3, along with the monthly rainfall at Gereta Station (BOM 029131). It is clear that all four groundwater monitoring bores at the Project respond to rainfall recharge, even though the groundwater level trend in bore GWMB02 is more subdued than the trends in the other three bores.

Seasonal fluctuations in groundwater levels of between one and four metres have been observed at Mount Dromedary to date. The depth to groundwater level in bore GWMB01, located close to an unnamed drainage line (Figure 5.4), is typically between 4 m to 7 m below the ground surface (Figure 5.3). This is not necessarily the watertable depth at that site, because the bore is screened from 78 m to 90 m, and therefore the water level in the bore is representative of the pore pressure at depth. The pressure closer to the surface (which would determine the elevation of the watertable) could be lower or higher that this water level. It was noted during drilling that water was first intersected in this hole at 7.5 m (a low flow rate of 0.1 L/s) and again at 17.5 m (with a substantial rate of 7 L/s) below surface (bore log is provided in Appendix A).
In the absence of a direct measurement of the watertable, it is reasonable to make a conservative assumption regarding its depth. Given the similarity of the depth of the first water intersection in the hole during drilling (7.5 m) with the typical depth to the water level in the bore (5 m to 7 m), it is likely that the watertable sits at a level similar to that of the water level in the bore. This conservative assumption is also supported by the presence of gravel packing in the annulus of the bore hole, which provides some degree of hydraulic connection between the deep screen interval and the high-flow interval at 17.5 mBGL.

For the purpose of assessing groundwater flow across the Mount Dromedary site the assumption was made that hydraulic connectivity exists across the site within the Corella Formation. Based on this assumption, the hypothetical surface formed by the water levels in the deeper bores - the potentiometric surface - was interpolated using the Surfer proprietary contouring software package and plotted in Figure 5.4. A blanking function was used to preclude extrapolation of contours outside the data domain. The kriging interpolation method was employed for all contouring.

The potentiometric surface represents the level to which the groundwater pressure rises within a borehole screened in the rock mass, related to a common datum (in this case Australian Height Datum - AHD). The potentiometric surface is, of course, disrupted by the solid material within the rock mass and only occurs within the free space (fractures or pores) within the rock material.

The potentiometric surface contours show that the local groundwater flow direction is from north to south, towards the central drainage line (that which is adjacent to GWMB01). The gradient of the potentiometric surface is 0.008 towards the south. Considering the complex geomorphology of the area, this local flow system is interpreted to sit within a heterogeneous regional system.
Figure 5.3: Groundwater level trends and rainfall at Mount Dromedary
Figure 5.4: Potentiometric surface contours and groundwater flow directions at Mount Dromedary
The conceptual model of inflow to the system includes rainfall recharge to the Corella Formation over the summer months. Given the presence of low permeability rocks to the east and west of the Mount Dromedary Project, it is unlikely that regional flow input from these directions will occur. The regional outflow is to the south. The watercourse toward the south of the MLA is ephemeral and, based on observational records for surface water monitoring in 2016 and 2017, has no remnant pools that persist even shortly after rainfall (S. Wetherall, pers.comm). Therefore, it experiences no baseflow from groundwater (groundwater levels in GWMB01 are generally greater than 5.5 m below the ground surface and are discussed above). In the regional sense, baseflow does not occur perennially or ubiquitously, as flow in the Leichhardt River is known to be ephemeral (Section 3.3).

Recharge to the groundwater system can be characterised from direct rainfall recharge through the soil zone to the watertable. Rainfall recharge through the soil zone will only be possible when soil moisture deficits are overcome and the soil profile reaches saturation (field capacity).

Groundwater hydrographs from the monitoring bores show that groundwater levels do rise slowly, in the order of 1 m to 4 m over a wet season, in response to significant climatic events. Groundwater levels to date also suggest that recharge episodes are infrequent, leading to long term declines in groundwater levels over prolonged dry periods between soaking rainfall events. As recent years have been relatively dry (Section 3.2), it may be assumed that recharge events could be more frequently spaced and decline in water level less severe during wetter years.

5.1.4 Underground water level trend analysis

From the limited groundwater level data set that is available, the peak in groundwater level is in April, lagging a few months behind peaks in rainfall in January to March (Section 3.2; Figure 3.3; Figure 3.4) and streamflow in February (Table 3.2; Figure 3.5).

Non-parametric tests of water level trends have not been conducted in this UWIR due to the limitations of the data that can cause bias in the results, including the limited groundwater level data set and the initially irregular frequency of measurement. Visual inspection indicates that there is a natural, gradual decline in groundwater level from the middle of 2017 to December 2017, corresponding to a decrease in CRD (Figure 3.4). This is confirmed by weakly correlative linear trends in bores with groundwater level records spanning from mid-2016 to the end of 2017.

The above trends may be considered the natural groundwater level reaction to background conditions, as Mount Dromedary is a greenfield site and there has been no exercise of underground water rights to date.
6 PREDICTIONS OF GROUNDWATER IMPACTS (PART C)

This section of the report addresses sections 376(b)(iv) to 376(e) of the Water Act.

6.1 Model setup

The model development has followed the general process outlined in the Australian Modelling Guidelines (Barnett et al., 2012). This process is outlined below:

- review data and develop conceptual model;
- constructing numerical flow model;
- calibrating the numerical flow model;
- scenario predictions; and
- reporting.

6.2 Model code / platform

The finite-element simulation package FEFLOW (Diersch, 2014), was used to simulate the impact of the mining operations on the groundwater regime. FEFLOW is a high-end groundwater flow package, capable of simulating two and three-dimensional density-coupled groundwater flow, mass and heat transport in saturated and unsaturated media. FEFLOW is used worldwide as a high-end groundwater modelling tool at universities, research institutes, government offices and engineering companies. It is often professionally applied for groundwater-related tasks within the mining sector.

6.3 Model domain

The general shape and extent of the model domain was developed to be of sufficient size and extent so as not to be influenced by physical boundary conditions. The full extent of the numerical model mesh is shown in Figure 6.1. The numerical model has been developed in the datum GDA94, with coordinates in Zone 54.

Mesh refinement was placed around the footprint of the proposed open-cut mine using the life of mine (LoM) plan as the basis for spatial extent (Figure 6.2). The LoM plan and schedule was provided by Novonix. The final model mesh consists of 3,027 mesh elements per layer and 1,547 nodes per slice.
Mount Doreen dairy underground water impact report and dewatering assessment (G1904)

Extent of model domain
Mount Doreen andy underground water impact report and desktop assessment (G1904)

Model mesh within mine area
6.3.1 Layers

The model was divided into three (3) layers in order to represent the geological layering and the depth of open cut mine development. Within FEFLOW, each model layer extends over the entire model domain.

Layer 1 and layer 2 within the Boomarra Horst (where the proposed mine is situated) represents highly weathered and slightly weathered Proterozoic lithology. The thickness of layer 1 representing the highly weathered Proterozoic rocks was set at a uniform 5 m, whereas layer 2 representing the slightly weathered Proterozoic was set at a uniform 20 m. Layer 3 throughout the model domain represents Proterozoic lithology to a depth of -10 mAHD.

As the model contains representations of regionally significant Mesozoic strata, there was a need to also characterise the major stratigraphic units within the Mesozoic sequence. The Wallumbilla Formation and the Gilbert River Formation comprise the major Mesozoic stratigraphic units present within the region and these are represented as layer 1 and layer 2, respectively, in areas outside of the Boomarra Horst. The thickness of layer 1 representing the Wallumbilla Formation was set at a uniform 50 m, whereas layer 2 representing the Gilbert River Formation was set at a uniform 20 m.

The natural topographic surface layer was used as the basis for the top of layer 1 in the model. The base of the model was represented at -10 mAHD. The surface topography was modelled through the use of a high resolution (cells 30 m by 30 m) digital elevation model (DEM).

Model layers were assigned as unconfined (phreatic), with “free and movable” assigned to layer 1 and “fixed” assigned to the remainder of the layers.

6.4 Model boundary conditions

6.4.1 Seepage faces

Time constant seepage faces were applied broadly to layer 1 to allow groundwater to be removed from the model domain. Seepage faces within FEFLOW behave as drains in the numerical model and have flow constraints that allow water to be removed from the model, not added. Therefore a simulated seepage face will not add groundwater to the model to maintain a constant head. The seepage faces were applied to help constrain groundwater elevations to topography.

6.4.2 Recharge

Areal recharge across the model domain from rainfall infiltration has been applied to the model.

A recharge rate (0.1% of rainfall) was applied to the predictive model. This boundary condition is considered conservative, as the recharge rate is relatively low (Section 5).
6.4.3 Mine development

The LoM open-cut mine development was obtained from data provided by Novonix in the form of 5-yearly progressive pit shell geometries. The depth of mine development was applied as time variant seepage faces to layer one (see above for discussion on the application of seepage faces within FEFLOW). The schedule for this development was based upon the series of five yearly proposed pit shells. The seepage faces allow groundwater to exit the model, and thus these open pit voids are simulated as effective drains from the time they are created, to the end of LoM.

6.5 Hydraulic parameters and model inputs

The hydraulic parameters used to initially represent the various model layers are summarised in Table 6.1.

Table 6.1: Summary of initial hydraulic parameters

<table>
<thead>
<tr>
<th>Model layer</th>
<th>Material</th>
<th>Horizontal hydraulic conductivity (m/d)</th>
<th>Vertical hydraulic conductivity (m/d)</th>
<th>Specific yield (%)</th>
<th>Specific storage (m$^3$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Highly weathered Proterozoic (5 m thickness)</td>
<td>0.05</td>
<td>0.005</td>
<td>5</td>
<td>$1 \times 10^{-5}$</td>
</tr>
<tr>
<td>1</td>
<td>Wallumbilla Formation (50 m thickness)</td>
<td>0.01</td>
<td>0.001</td>
<td>5</td>
<td>$1 \times 10^{-5}$</td>
</tr>
<tr>
<td>2</td>
<td>Weathered Proterozoic (20 m thickness)</td>
<td>0.005</td>
<td>0.0005</td>
<td>5</td>
<td>$1 \times 10^{-5}$</td>
</tr>
<tr>
<td>2</td>
<td>Gilbert River formation (20 m thickness)</td>
<td>1</td>
<td>0.1</td>
<td>5</td>
<td>$1 \times 10^{-5}$</td>
</tr>
<tr>
<td>3</td>
<td>Proterozoic</td>
<td>0.0005</td>
<td>0.00005</td>
<td>5</td>
<td>$1 \times 10^{-5}$</td>
</tr>
<tr>
<td>3</td>
<td>Proterozoic</td>
<td>0.0001</td>
<td>0.00001</td>
<td>5</td>
<td>$1 \times 10^{-5}$</td>
</tr>
</tbody>
</table>

The parameter zones used to define the Proterozoic and Mesozoic lithology are shown in Figure 6.3. The numerical model is divided into three major parameter zones, the western Mesozoic strata, the Boomarra Horst and the eastern Mesozoic strata. The basis for delineation between these three parameter zones are the Coolullah Fault, which separates the western Mesozoic strata and the Boomarra Horst, and the Boomarra Fault, which separates the eastern Mesozoic strata and the Boomarra Horst. These parameter zones are consistent with the mapped geology (Figure 5.1, Figure 5.2) and represent the simplified conceptual understanding presented in Section 5.1.
6.5.1 Observations

A series of observation points (total of 15) were provided by Novonix and derived from the Department of Natural Resources, Mines and Energy (DNRME, formerly Department of Natural Resources and Mines, DNRM) Groundwater Database (GWDB). These are consistent with the bores shown in Figure 6.6 and are summarised in Table 6.2.

Based on the location of the observation points (Figure 6.6) and the model layering, each bore location was assigned to a model layer commensurate with its screened depth.

Table 6.2: Groundwater level observations from regional bores

<table>
<thead>
<tr>
<th>Registered number</th>
<th>Bore name</th>
<th>Easting (GDA94 Z54)</th>
<th>Northing (GDA94 Z54)</th>
<th>Elevation (mAHD)</th>
<th>SWL (mBGL)</th>
<th>Groundwater elevation (mAHD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>7901</td>
<td>12 MILE</td>
<td>395676.2</td>
<td>7842980</td>
<td>97.1</td>
<td>19.2</td>
<td>77.9</td>
</tr>
<tr>
<td>13332</td>
<td>WHITEWOOD</td>
<td>411155.8</td>
<td>7858418</td>
<td>84</td>
<td>6.1</td>
<td>77.9</td>
</tr>
<tr>
<td>14094</td>
<td>BLACKALL BORE</td>
<td>441546.6</td>
<td>7822740</td>
<td>107.2</td>
<td>27.43</td>
<td>79.77</td>
</tr>
<tr>
<td>13235</td>
<td>LANDSBOROUGH BORE</td>
<td>411354.8</td>
<td>7816713</td>
<td>118.1</td>
<td>34.24</td>
<td>83.86</td>
</tr>
<tr>
<td>163343</td>
<td></td>
<td>397647</td>
<td>7834599</td>
<td>105.1</td>
<td>11</td>
<td>94.1</td>
</tr>
<tr>
<td>6430</td>
<td>NARDOO BORE</td>
<td>425121</td>
<td>7823878</td>
<td>127.6</td>
<td>20.12</td>
<td>107.48</td>
</tr>
<tr>
<td>163342</td>
<td></td>
<td>414738</td>
<td>7817306</td>
<td>124.6</td>
<td>13</td>
<td>111.6</td>
</tr>
<tr>
<td>93892</td>
<td>HOUSE BORE</td>
<td>412187.8</td>
<td>7807738</td>
<td>127.7</td>
<td>12</td>
<td>115.7</td>
</tr>
<tr>
<td>93949</td>
<td>SOUTH CAMEL WELL</td>
<td>421671.7</td>
<td>7831336</td>
<td>130.4</td>
<td>13</td>
<td>117.4</td>
</tr>
<tr>
<td>6137</td>
<td>ROSEGREEN NO. 4 BORE</td>
<td>428096.8</td>
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<td>GWMB04</td>
<td>418013</td>
<td>7831338</td>
<td>149.8</td>
<td>14.42</td>
<td>135.38</td>
</tr>
<tr>
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<td>GWMB03</td>
<td>418502</td>
<td>7831217</td>
<td>149.8</td>
<td>14.29</td>
<td>135.51</td>
</tr>
<tr>
<td>163715</td>
<td>GWMB02</td>
<td>418346</td>
<td>7831818</td>
<td>152</td>
<td>14.32</td>
<td>137.68</td>
</tr>
</tbody>
</table>
6.6 Calibration results

6.6.1 Objective

The objective of the calibration was to modify the model inputs such that the model reproduces the historical observed groundwater behaviour (heads) to a sufficient level. The calibration also provides the starting groundwater levels for the predictive model.

Due to necessary simplifications in creating the model, not every observation can be accurately simulated. However, it is necessary that the general groundwater level behaviour is captured across the model domain. A descriptor for assessment of the model-wide level of fit is the Scaled Root Mean Square (SRMS). This measure looks past individual bores and looks at the overall fit of the model. If the ratio of the RMS error to the total head loss in the system is small, the errors are only a small part of the overall model response (Anderson and Woessner, 1992). Barnett et al., (2012) suggest that a SRMS of under 10% indicates that a model is calibrated sufficiently.

The SRMS is just one measure and does not form the only metric for successful calibration. The calibrated model parameters need to be realistic and reflect the conceptual understanding and field data collected.

6.6.2 Methodology

The observations for the steady state calibration include groundwater levels (heads) only. This is not ideal, as calibrating to different observations types (i.e. heads and flows) helps to reduce the parameter non-uniqueness, as there is a smaller range of parameter combinations that can match all observation types, rather than heads alone. Unfortunately, there are no groundwater flow data (i.e. historical pit inflows) for the Project on which to base the calibration.

The steady state calibration involved manual techniques to understand how the model components perform with the likely ranges of parameters. However, it was assessed that the initial hydraulic parameters (horizontal and vertical hydraulic conductivity; Table 6.1) provided an acceptable match between observed and simulated groundwater levels. Figure 6.6 shows the monitoring sites used in the calibration process, which include the four dedicated monitoring bores in the MLA.

6.6.3 Results

The results of the calibration are presented as a comparison of the observed groundwater levels with the calculated water levels from the steady state model (Figure 6.4), and a statistical analysis derived from the calibration process (Table 6.3).
### Table 6.3: Calibration statistics

<table>
<thead>
<tr>
<th>Calibration performance measure</th>
<th>Weighted value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sum of residuals (SR) (m)</td>
<td>10.44</td>
</tr>
<tr>
<td>Mean sum of residuals (MSR) (m)</td>
<td>0.75</td>
</tr>
<tr>
<td>Scaled mean sum of residuals (SMSR) (%)</td>
<td>1.25</td>
</tr>
<tr>
<td>Sum of squares (SSQ) (m$^2$)</td>
<td>473.5</td>
</tr>
<tr>
<td>Mean sum of squares (MSSQ) (m$^2$)</td>
<td>33.82</td>
</tr>
<tr>
<td>Root mean square (RMS) (m)</td>
<td>5.82</td>
</tr>
<tr>
<td>Root mean fraction square (RMFS) (%)</td>
<td>0.39</td>
</tr>
<tr>
<td>Scaled RMFS (SRMFS) (%)</td>
<td>0.71</td>
</tr>
<tr>
<td>Scaled RMS (SRMS) (%)</td>
<td>9.73</td>
</tr>
</tbody>
</table>

**Figure 6.4: Calibration – modelled vs. observed groundwater levels**

The table above presents various calibration statistics used to assess the performance of a groundwater model. The figure illustrates the comparison between modelled and observed groundwater levels, showing a close alignment between the two datasets, indicating a good level of calibration.
The RMS error calculated for the calibrated model is 5.82 m. The total observed head loss within the model domain is 60 m; therefore, the ratio of RMS to the total head loss (SMRS) is 9.73%. This indicates a good calibration of the model, and is below the 10% SRMS specified in the Australian guidelines (Barnett et al., 2012).

The calibrated hydraulic parameters for each of the hydrostratigraphic units within the model domain are summarised in Table 6.4.

<table>
<thead>
<tr>
<th>Model layer</th>
<th>Material</th>
<th>Horizontal hydraulic conductivity (m/d)</th>
<th>Vertical hydraulic conductivity (m/d)</th>
<th>Specific yield (%)</th>
<th>Specific storage (m$^{-1}$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Highly weathered Proterozoic</td>
<td>0.05</td>
<td>0.005</td>
<td>5</td>
<td>1 x 10$^{-5}$</td>
</tr>
<tr>
<td>1</td>
<td>Wallumbilla Formation</td>
<td>0.01</td>
<td>0.001</td>
<td>5</td>
<td>1 x 10$^{-5}$</td>
</tr>
<tr>
<td>2</td>
<td>Weathered Proterozoic</td>
<td>0.005</td>
<td>0.0005</td>
<td>5</td>
<td>1 x 10$^{-5}$</td>
</tr>
<tr>
<td>2</td>
<td>Gilbert River formation</td>
<td>1</td>
<td>0.1</td>
<td>5</td>
<td>1 x 10$^{-5}$</td>
</tr>
<tr>
<td>3</td>
<td>Proterozoic</td>
<td>0.0005</td>
<td>0.00005</td>
<td>5</td>
<td>1 x 10$^{-5}$</td>
</tr>
<tr>
<td>3</td>
<td>Proterozoic</td>
<td>0.0001</td>
<td>0.00001</td>
<td>5</td>
<td>1 x 10$^{-5}$</td>
</tr>
</tbody>
</table>

### 6.7 Predictive model for impact assessment

#### 6.7.1 Model setup

The numerical model used to predict groundwater impact of the mine development was based on the calibrated model. The open-cut mine was simulated as a series of seepage faces (see Section 6.4.3) corresponding to the mined depth. These boundary conditions were temporally controlled to represent the development of the mine to the proposed depth (maximum development of 90 mBGL) over the whole LoM period. The seepage faces representing the open-cut mine were applied in quarterly time-steps and were based upon the five year progression of pit shells provided by Novonix.

The seepage faces representing the mine development are kept active all the way through the predictive simulation. However, based on the mine plan, it is understood that some partial backfilling of the open pit will occur during later stages of mine development. In this instance where backfilling is proposed, the seepage face has been represented at the elevation of the backfill.
The modelled extent of the Boomarra Horst is represented in Figure 6.3. The model provides a simplified representation of the Proterozoic geology within the region and does not include all the individual lithologies geologically mapped at the site (Figure 5.1, Figure 5.2, and Table 5.1). Given this simplified representation, the model assumes that the whole of the Proterozoic geology will act as one hydraulically connected unit in a horizontal and vertical sense.

6.7.2 Immediately affected area

6.7.2.1 Drawdown

The immediately affected area (IAA) is defined as the area where predicted drawdown exceeds the applicable bore trigger threshold (5 m in the case of consolidated formations at Mount Dromedary) within the first three years. As previously discussed in Section 4.2.3, the model predicts groundwater inflow volumes to the open pit void of 5 ML, 26 ML and 58 ML for years, 1, 2, and 3 of the simulation, respectively (Figure 4.3). This gradual increase is a result of the mine development initially intersecting unsaturated material during the early years of the model simulation and progressively intersecting the groundwater table.

The predicted groundwater drawdown in response to the mine development at Mount Dromedary Project is shown as contours in Figure 6.7 (for year 2) and in Figure 6.8 (for year 3). There is no drawdown due to the exercise of underground water rights for year one because most of the excavation is in unsaturated ground. The drawdown is predicted in a very localised area in the southern portion of the proposed mine, with a maximum predicted drawdown of 14 m. The 5 m contour represented in Figure 6.8 is assessed to be the IAA.

6.7.2.2 Impacted bores

The registered groundwater bores within 10 km of the proposed pit at Mount Dromedary Project are shown in Figure 6.6 and listed in Table 6.5. Not including the four bores dedicated to monitoring at the Project site, there are eleven bores that are or were once active bores. Most of these were likely used for stock watering (usually beef cattle). They are all situated in the county of Landsborough or Granada and are attributed to several owners. Assessment of the drilling completion dates for these bores indicates that all but a few are no longer used due to age. One bore that may be in current use within the 10 km zone around the Project is the South Camel Well (RN 93949, drilled in 2002). This bore is located 3,170 m to the east of bore GWMB03. Although there is no log available for this bore, its location indicates that it may be screened in the Corella Formation or the overlying Quaternary regolith or alluvium. Also close to the MLA is Daltons Bore (RN 33765), which is 2,270 m west of bore GWMB04. According to the bore log, this hole was drilled through sandstone and granite. As the bore is on the western side of the Colullah Fault from the Project, there is no expected hydraulic connection between with this site. Given the distance of these bores from the drawdown contours at any stage of the mine development, it is highly unlikely that they could be impacted by the exercise of underground water rights at the Mount Dromedary Project. Notwithstanding this, bore RN 93949 and RN 33765 are assessed for potential impact in Section 7.5.

There is no industrial use by nearby mines of groundwater (refer to Section 7.1.7).
6.7.2.3 **Groundwater inflow**

The predicted rates of seepage to the proposed mine are shown in Figure 6.5. For the first three years of mine development the predicted groundwater inflow is in the order of 0.1 ML/day (100 m$^3$/day) to 0.2 ML/day (200 m$^3$/day). The predictive model does not represent any pumping from dewatering bores during the simulation.

![Figure 6.5: Predicted open-cut mine inflow rates (ML/day)](image)

6.7.3 **Long term affected area**

The long-term affected area (LTAA) is defined as the area where predicted drawdown exceeds the applicable bore trigger threshold (5 m in the case of consolidated formations at Mount Dromedary Mine) at any time.

The predicted groundwater drawdown in response to the LOM mine development at Mount Dromedary is shown in Figure 6.9 for the LTAA. There are no private registered groundwater bores within the 5 m drawdown contour; there are only mine specific monitoring bores.

The drawdown contours (Figure 6.9) show that there is a maximum predicted drawdown of 80 m within the mine area. The 5 m drawdown contour (equivalent to the bore trigger threshold) is some 400 m to 500 m from the open pit. The 1 m drawdown contour is less than 1,000 m from the open-cut mine. There are no registered groundwater bores or known springs within the 1 m drawdown contour at the end of mining.
6.7.3.1 Groundwater inflow

The predicted rates of seepage to the mine are shown in Figure 6.5. After the first three years of mine development the predicted groundwater inflow peaks at a maximum of 0.9 ML/day (900 m$^3$/day) in year 5, but is generally around 0.2 ML/day (200 m$^3$/day) to 0.5 ML/day (500 m$^3$/day) during this period. Throughout the remaining LoM the inflows are predicted to be typically less than 0.3 ML/day (300 m$^3$/day), with a gradual reduction which reflects partial backfilling of the open pit void in the later stages of mining. The backfilling process reduces inflow in two ways. First, it is performed using relatively high storage material, slowing the effective recovery of groundwater within the backfilled void. Second, the backfilling effectively changes the geometry of the open-cute mine and, generally speaking, a smaller or shallower void will receive less inflow. The predictive model does not represent any pumping from dewatering bores during the simulation.
Mount Urondary underground water impact report and dewatering assessment (G1904)

Map showing the predicted impact in IAA in year 2 of operations

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Source: 1 second SRTM Derived DEMS - © Commonwealth of Australia (Geoscience Australia) 2011, GEOSTA TOPO 250K Series 2 - © Commonwealth of Australia (Geoscience Australia) 2006. @/Projects/CIW/Melbourne/1295_Dronedary/I9900/250K/North/1295_Dronedary/I9900/250K_H_.png showing the predicted impact in IAA in year 2 of operations

DATE 17/01/2018

FIGURE No. 6.7
Mount Drorday underground water impact report and dewatering assessment (G1904)

Map showing the predicted impact in IAA in year 3 of operations

GDA94, Zone 54
1:20,000
0.25 0 0.25 0.5 0.75 1 1.25 km

Legend:
- MLA 109121
- Model mesh
- Major road
- Minor road
- Major drainage
- Minor drainage

Drawdown contours (m)

©2018 Australian Groundwater and Environmental Consultants Pty Ltd (AGB) - www.agbconsultants.com.au

Source: 1 second draped DHKS - © Commonwealth of Australia (Geoscience Australia) 2011; GDA94 TOPO 250K Series R - © Commonwealth of Australia (Geoscience Australia) 2006;
C:\Projects\SWM\CoalmineCmpy.MF\Dewatering\0918\02_GIS\Workspaces\091_Dewatering\4858_GDA94Map showing the predicted impact in IAA in year 3 of operations.png

DATE 29/01/2018
FIGURE No: 6.8
Table 6.5: Registered bores within 10 km of the Mount Dromedary Project

<table>
<thead>
<tr>
<th>Bore name</th>
<th>Registered bore</th>
<th>Easting GDA z54</th>
<th>Northing GDA z54</th>
<th>Parish</th>
<th>Date drilled</th>
<th>Lot #</th>
<th>Plan #</th>
<th>Owner</th>
<th>County</th>
<th>Bore log avail.</th>
</tr>
</thead>
<tbody>
<tr>
<td>19 MILE BORE</td>
<td>2106</td>
<td>411562</td>
<td>7833622</td>
<td>2020</td>
<td>1/01/1916</td>
<td></td>
<td></td>
<td>P2</td>
<td>LANDSBOROUGH N</td>
<td></td>
</tr>
<tr>
<td>FIONAS BORE</td>
<td>8415</td>
<td>417511.6</td>
<td>7838600</td>
<td>4349</td>
<td>1/01/1930</td>
<td></td>
<td></td>
<td>STRATHEARN HOLDING</td>
<td>LANDSBOROUGH N</td>
<td></td>
</tr>
<tr>
<td>LIMESTONE BORE</td>
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<td>7838293</td>
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<td>1/01/1930</td>
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<td>418346</td>
<td>7831818</td>
<td>6000</td>
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<td>SP203578</td>
<td>Novonix</td>
<td>Y</td>
<td></td>
</tr>
<tr>
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<td>7830392</td>
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<td>SP203578</td>
<td>Novonix</td>
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<td></td>
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</tbody>
</table>

All these bores were marked as existing sub-artesian (not flowing) bores within the same shire code: 2450- Cloncurry.
Map showing the predicted maximum impact in ETAA over LoM
6.7.4 Predictive sensitivity

A sensitivity analysis was carried out to assess the response of the model to varying input parameters. The objective of the sensitivity analysis was to rank the input parameters in terms of their influence on the predicted results. The model parameters were adjusted to encompass the range of likely uncertainty in key parameters (invariably ± 1 order of magnitude from the calibrated value). Table 6.6 summarises the sensitivity analyses completed and the change in SRMS (calibration measure; Section 6.6) as a result of the parameter change.

The analysis shows that the cumulative groundwater inflow is relatively insensitive to specific storage (Ss), vertical hydraulic conductivity (Kv) and recharge, with changes in the order of ±10% to the cumulative inflow. Cumulative inflow volumes are most sensitive to changes in specific yield (Sy) and horizontal hydraulic conductivity (Kh), with changes up to ±80% in response to alteration of these parameters by one order of magnitude. It is important to note that the changes to the parameters of Kh (high and low) and recharge (high and low) significantly impact the steady state calibration of the model and suggest that these parameters are unlikely over the scale of the model domain. The respective changes to these parameters would cause the model to become uncalibrated, with the SRMS of these models being greater than the 10% suggested by Barnett et al. (2012). The parameter changes to Kv (high and low) do not substantially change the calibration of the model and these parameter extremes would be considered plausible in terms of likely ranges.

The sensitivity analysis was also assessed in terms of the long term (LTAA) maximum predicted drawdown. The 5 m contours for each of the sensitivity analyses are presented in Figure 6.10 along with the base-case 5 m predicted contour from the calibrated model. The drawdown predictions show that the majority of the 5 m contours from the sensitivity analyses are very similar in extent to the base-case predictive model.

There are two sensitivity analyses that provide modelled drawdown which are greater than the base-case predictive model, these are the low Sy and high Kh analyses. These analyses predict the 5 m drawdown contour in the order of 1,000 m from the open pit compared with 500 m in the base-case predictive model.

Table 6.6 summarises the change in SRMS (the calibration measure) as a result of the sensitivity analyses. The high Kh analysis results in an SRMS of 46%, this suggests that such parameters are highly unlikely based on the observed groundwater levels. The SRMS statistic cannot be provided for any changes in Sy. The model was calibrated in a steady state condition and therefore any changes to either specific yield or specific storage will not alter the calibration statistic. However, a reduction in the Sy parameter also has the effect of significantly reducing the cumulative inflow volume over the life of the project from 1,463 ML (in the base-case predictive model) to 360 ML. This is a reduction of 75%.
Table 6.6: Sensitivity scenarios

<table>
<thead>
<tr>
<th>Sensitivity analysis</th>
<th>Change</th>
<th>Cumulative inflow (ML)</th>
<th>SRMS (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Base-case is 1463 ML</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>High Ss (1 x 10^-4)</td>
<td>1586</td>
<td>n/a*</td>
</tr>
<tr>
<td>2</td>
<td>Low Ss (1 x 10^-6)</td>
<td>1443</td>
<td>n/a*</td>
</tr>
<tr>
<td>3</td>
<td>High Sy (10%)</td>
<td>2715</td>
<td>n/a*</td>
</tr>
<tr>
<td>4</td>
<td>Low Sy (0.5%)</td>
<td>360</td>
<td>n/a*</td>
</tr>
<tr>
<td>5</td>
<td>High Kh (x10)</td>
<td>2617</td>
<td>45.83%</td>
</tr>
<tr>
<td>6</td>
<td>Low Kh (x 0.1)</td>
<td>1318</td>
<td>47.74%</td>
</tr>
<tr>
<td>7</td>
<td>High Kv (x 10)</td>
<td>1564</td>
<td>9.66%</td>
</tr>
<tr>
<td>8</td>
<td>Low Kv (x 0.1)</td>
<td>1392</td>
<td>10.09%</td>
</tr>
<tr>
<td>9</td>
<td>High Recharge (1%)</td>
<td>1524</td>
<td>14.60%</td>
</tr>
<tr>
<td>10</td>
<td>Low Recharge (0.01%)</td>
<td>1455</td>
<td>46.80%</td>
</tr>
</tbody>
</table>

*The model was calibrated in a steady state condition and therefore any changes to either specific yield or specific storage will not alter the calibration statistics.*
Sensitivity of LoM drawdown to model parameters

Cumulative drawdown contour (5 m)
- High Ss (1 x 10^-4)
- Low Ss (1 x 10^-6)
- High Sy (10%)
- Low Sy (9.5%)
- High Ks (8 x 10^-10)
- Low Ks (8 x 10^-10)
- High Kv (x 10)
- Low Kv (x 10)
- High Recharge (1%)
- Low Recharge (0.01%)

Mount Dorendary underground water impact report and dewatering assessment (G1904)

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Source: 1st order UTM Derived DEMs © Commonwealth of Australia (Geoscience Australia) 2011; GEBIDATI TOPO 250K Series S © Commonwealth of Australia (Geoscience Australia) 2006;

©/Projects/51994/Complettmap_MtDorendary_HV/P1.02/Mapspace/P1_01/Delivered/1.10.10_02/51994_Sensitivity of LoM drawdown to model parameters.png

DATE 18/01/2018 FIGURE No 6.10
6.8  **Annual review of the predictions**

Annual review of model predictions and reporting is required if the predictions indicate the bore trigger threshold may be exceeded at any time. The results of this predictive model indicate that no bores will be impacted by exercise of underground water rights at Mount Dromedary. Notwithstanding this, it is recommended that a review of the model be undertaken on an annual basis, within the reporting associated with the UWIR (refer to Section 8.3.4 for details). This review will consist of comparison of predicted drawdown and inflow rates with observed drawdown and inflow rates, and comparison of the actual mine progression against that used within the predictive model. The review will assess the need, or otherwise, to update and/or recalibrate the model with newly available data.
7 IMPACTS TO THE ENVIRONMENTAL VALUES (PART D)

This section of the report addresses sections 376(da) and (db) of the Water Act.

7.1 Definition of EVs

An environmental value is defined in section 9 of the EP Act to be:

a) a quality or physical characteristic of the environment that is conducive to ecological health or public amenity or safety; or

b) another quality of the environment identified and declared to be an environmental value under an environmental protection policy or regulation.

The Environmental Protection (Water) Policy 2009 (Qld; EPP Water) provides a framework to protect and/or enhance the suitability of Queensland waters for various beneficial uses. Groundwater resources of the Mount Dromedary Project area are located within the Leichhardt River catchment (Sections 3.2 and 3.5). This area is not listed in Schedule 1 of the EPP Water, therefore, the environmental values listed in section 6(2) of the EPP Water may apply, which are:

(a) for high ecological value waters—the biological integrity of an aquatic ecosystem that is effectively unmodified or highly valued;

(b) for slightly disturbed waters—the biological integrity of an aquatic ecosystem that has effectively unmodified biological indicators, but slightly modified physical, chemical or other indicators;

(c) for moderately disturbed waters—the biological integrity of an aquatic ecosystem that is adversely affected by human activity to a relatively small but measurable degree;

(d) for highly disturbed waters—the biological integrity of an aquatic ecosystem that is measurably degraded and of lower ecological value than waters mentioned in paragraphs (a) to (c);

(e) for waters that may be used for producing aquatic foods for human consumption—the suitability of the water for producing the foods for human consumption;

(f) for waters that may be used for aquaculture—the suitability of the water for aquacultural use;

(g) for waters that may be used for agricultural purposes—the suitability of the water for agricultural purposes;

(h) for waters that may be used for recreation or aesthetic purposes, the suitability of the water for—

   (i) primary recreational use; or

   (ii) secondary recreational use; or

   (iii) visual recreational use;
(i) for waters that may be used for drinking water—the suitability of the water for supply as drinking water;

(j) for waters that may be used for industrial purposes—the suitability of the water for industrial use;

(k) the cultural and spiritual values of the water.

A description of each environmental value (EV) is provided below, and those that may be impacted by exercise of underground water rights at the Mount Dromedary Project are discussed further in Sections 7.4 through 7.6. Additionally, impacts to formation integrity and subsidence are assessed in Section 7.7.

7.1.1 Biological integrity of ecosystems

According to the Groundwater Dependent Ecosystems Atlas (GDE Atlas), there are ecological areas within 5 km of the boundary of MLA 100121 that have a low potential for interaction with groundwater. These areas include aquatic and terrestrial ecosystems that may be partially dependent on groundwater (Figure 7.1). There are no mapped areas of medium or high potential for ecosystem interaction with groundwater within 8 km of the MLA boundary.

The environment at the Mount Dromedary site is slightly disturbed, due to the history of beef cattle grazing in the region, and associated clearing in some areas, but in general, the vegetation communities are in good condition.

The ecosystems potentially relevant to groundwater EVs at Mount Dromedary Project are considered below.
Aquatic GDEs
- High potential for OW interaction
- Moderate potential for GW interaction
- Low potential for GW interaction

Terrestrial GDEs
- High potential for OW interaction
- Moderate potential for GW interaction
- Low potential for GW interaction

Registered bores and potential groundwater dependent ecosystems (GDEs)

Mount Dometary underground water impact report and dewatering assessment (G1904)

DATE 29/01/2018 7.1

Source: 1 second SRTM Derived DEMS © Commonwealth of Australia (Geoscience Australia) 2011; QRSRTM Topo 20m Series © Commonwealth of Australia (Geoscience Australia) 2006; C:/Projects/11546/Drilling/Lands/Lands/Lands/Lands/Lands/Drilling/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/Lands/La
7.1.1.1 **Terrestrial ecosystems**

Within MLA 100121 there are no specific areas mapped in the GDE Atlas as having potential for terrestrial ecosystem dependence on groundwater (Figure 7.1). However, during field surveys at the Project site, NRA (2017) identified mature trees and wetland indicator species (WIS) along a narrow strip (<5 m wide) of riparian vegetation along the drainage line that runs westward through the central part of the MLA. These species include: Black Tea-tree (*Melaleuca bracteata*, a WIS); a WIS sedge (*Fimbristylis* sp.) and mature *Corymbia terminalis* and *Eucalyptus leucophylla*. Wetland indicator species (WIS) rely on readily available sources of water, and mature trees have root systems that can penetrate to depths of 15 m or more (Eamus et al., 2006). Considering the drainage line is highly ephemeral, it is possible that this ecosystem is partly reliant on groundwater from the watertable for survival during dry periods, and may be considered a terrestrial GDE indicator (NRA, 2017). The degree of interaction between the WIS vegetation and the groundwater of the Corella Formation cannot be known from the available information (NRA, 2017). Therefore, a precautionary approach is taken, and this UWIR assumes that there is some degree of groundwater dependence in the riparian zone of this drainage line. An assessment of potential impacts on the biological integrity of this potential terrestrial GDE near GWMB01 is provided in Section 7.4.

7.1.1.2 **Aquatic ecosystems**

The definition of an aquatic GDE is an ecosystem (be it an aquatic, riparian or wetland ecosystem) that is dependent to some degree on the surface expression of groundwater. Therefore, for an aquatic GDE to be present at the Project site, a surface expression of groundwater must be suspected or identified.

As outlined in Section 3.3, the drainage lines that run through the MLA are highly ephemeral, and remnant ponds are not known to persist after rainfall. This indicates that all the discharge from these features is derived from overland flow and there is not a component of groundwater baseflow that contributes to the surface water features of the Project area. This is also in keeping with the fairly deep unsaturated zone in the area of the drainage line in the MLA (e.g. bore GWMB01 encountered water during drilling at 7.5 m and 17 m; Appendix A). Therefore, it is concluded that there are no aquatic GDEs present in or near the Project, and an assessment of potential impacts on the biological integrity of potential aquatic GDEs is not required.
7.1.1.3 **Subterranean ecosystems**

The definition of a subterranean GDE is an ecosystem (be it an aquatic, riparian or wetland ecosystem) that is dependent to some degree on the sub-surface expression of groundwater and exists within the subsurface. These types of GDEs include stygofauna and cave ecosystems.

As there are no caves within the vicinity of the Project, and the host rock type, the Corella Formation, does not comprise lithologies conducive to karstic dissolution (e.g. limestone), it is concluded that there are no subterranean GDEs present in or near the Project, and an assessment of potential impacts on the biological integrity of potential subterranean GDEs is not required.

7.1.2 **Beneficial use in production of foods**

Groundwater is not used for production of foods for human consumption in the vicinity of the Mount Dromedary Project area.

7.1.3 **Beneficial use in aquaculture**

Groundwater is not used for aquaculture purposes in the vicinity of the Mount Dromedary Project area.

7.1.4 **Beneficial use in agriculture**

Groundwater is not used for irrigation purposes in the vicinity of the Mount Dromedary Project area. No bores licensed specifically for irrigation purposes are located within a 10 km radius of the site.

Groundwater is commonly used for livestock (usually beef cattle) watering on properties in the region. This groundwater is sourced from a variety of aquifers in the region, some of which are not connected to the Project aquifers. The potential impact to this environmental value is assessed in Section 7.5.

7.1.5 **Suitability for primary, secondary or visual recreational use**

Groundwater is not used for primary, secondary, or visual, recreational use in the vicinity of the Mount Dromedary Project area.

7.1.6 **Suitability of the water for supply as drinking water**

Groundwater is not used as a drinking water supply in the vicinity of the Mount Dromedary Project area.

7.1.7 **Suitability of the water for industrial use**

The groundwater extraction at Mount Dromedary Project will be via passive in-pit dewatering, rather than from dedicated production or dewatering bores. The resultant water will be used for industrial purposes and mining activities on site. There are no other industrial users of any significance in area.
Industrial water quality requirements should be considered on a case-by-case basis (ANZECC/ARMCANZ, 2000). The groundwater at Mount Dromedary is of suitable quality for these local industrial processes and minor changes in quality would not have an impact on beneficial use. This environmental value will be maintained through protection of other values, such as the environmental value for livestock watering, which has well defined guideline values.

7.1.8 Cultural and spiritual values of the water

There are no known environmental values in relation to cultural and spiritual values of groundwater within the Mount Dromedary area.

7.2 Past impacts on EVs

As this is a greenfield site, environmental impacts that occurred within MLA 100121 in the past have not been reported. However, the slightly disturbed ecosystem that exists at the site based on the development of the area, with a significant grazing history of beef cattle, indicates that some moderate changes to the groundwater level and quality may have occurred in the last 200 years. As there is yet to be any mining at the site, the condition of the groundwater monitored from mid-2015 onwards is considered reliably representative of background conditions.

7.3 Predicted impacts on EVs

Those environmental values that are not impacted by exercise of water rights at the Mount Dromedary Project are identified and explained in Section 7.1 and are:

- biological integrity of aquatic and subterranean ecosystems;
- beneficial use in production of foods;
- beneficial use in aquaculture;
- suitability for primary, secondary or visual recreational use;
- suitability of the water for supply as drinking water;
- suitability of the water for industrial use; and
- cultural and spiritual values of the water.

The potential impacts on the remaining environmental values are explored below.
7.4 **Nature and extent of the impacts on a terrestrial GDE**

Potential impacts from the exercise of underground water rights on GDEs can include changes to both groundwater levels and groundwater quality; they may be permanent or temporary; and they must be considered in both spatial and temporal contexts (DEHP, 2016b). This section assesses potential impacts on a possible terrestrial GDE within the MLA. Aquatic and subterranean GDEs are not present in the Project area and are not assessed for impacts (Section 7.1.1). Potential impacts to springs (one type of aquatic GDE) are addressed in Sections 7.6 and 9.

The source aquifer of relevance for this UWIR for potential GDEs is the host unit, the Corella Formation (refer to geological map in Figure 5.1), as this is the outcropping unit in the area of the WIS vegetation.

It is considered appropriate that a precautionary approach to GDE impact assessment is used in this UWIR, due to the limited data available for this assessment. Therefore, it is assumed that ecological function of the WIS vegetation along the riparian zone of the central drainage line in MLA 100121 is in some way reliant on groundwater (see also NRA, 2017). As such, the model predictions of groundwater drawdown surrounding the proposed mine (Section 6.7) indicate that some area of these GDE indicators will be affected by reduced access to groundwater (Figure 6.7; Figure 6.8; and Figure 6.9). Part of the drainage line will be directly impacted by mine development through pit excavation and haul road construction. In addition, there are parts of the drainage line where the groundwater level is predicted to decline by tens of metres (e.g. Figure 6.8). These small areas would experience total loss of groundwater input to the tree roots. However, that is not to say that all water would be diverted from these communities. Surface runoff, infiltration and deep drainage would all remain unaltered by exercise of underground water rights. Because the drawdown predictions are conservative, it is possible that the reduction in groundwater access is overestimated, and flow-on impacts to ecosystem health may not be observed. Conversely, if some parts of the ecosystem have a high degree of reliance on groundwater, then there may be mortality of trees along this riparian zone in a worst case scenario.

As outlined in Section 7.1.1, potential terrestrial GDEs are limited to those mature trees whose roots can reach the watertable. The watertable is moderately deep at the Mount Dromedary Project (Figure 5.3) and could only be accessed by deep-rooted trees that exceed the depth of the unsaturated zone. For reference, the typical root depth expected for ecosystems in tropical savannah is approximately 15 m (Eamus *et al.*, 2006).

As there is potential impact predicted for a terrestrial GDE from the exercise of underground water rights at the Mount Dromedary Project, monitoring of the vegetation condition and the presence of the WIS vegetation is recommended, and could be incorporated into the Receiving Environment Monitoring Program (REMP), which is an anticipated requirement of the Project. This is outlined in Section 8.
7.5 Nature and extent of the impacts on stock watering

Groundwater is commonly used for livestock (beef cattle) watering on properties in the region of the Mount Dromedary Project. However, the bores are distal from operations by several kilometres and some are completed in other geological formations (Figure 6.6 and Table 6.5). As a result, there are no bores situated within the IAA or the LTAA (Section 6.7), and no impact is predicted for nearby groundwater users. The predicted drawdown for various years is shown in Figure 6.7, Figure 6.8, and Figure 6.9, and the model assumptions and uncertainty are discussed in Section 6.4. Sensitivity of the drawdown predictions to model inputs is discussed in Section 6.7.4.

The eleven registered groundwater bores within 10 km of the proposed pit at Mount Dromedary (Table 6.5) include a number of very old bores. Two bores within this list that are close to the MLA and may be completed in the Corella Formation are South Camel Well (RN 93949; drilled in 2002; 3,170 m to the east of bore GWMB03), and Daltons Bore (RN 33765; drilled in 1970; 2,270 m west of bore GWMB04). Given the distance of these bores from the drawdown contours at any stage of the mine development (e.g. maximum drawdown depicted in Figure 6.9), it is determined that they will not be impacted by the exercise of underground water rights at the Mount Dromedary Project.

As the groundwater in the region is used for stock watering, the water quality must be protected to maintain this value. Water quality objectives (WQOs) for livestock (beef cattle) watering may be adopted as appropriate for protecting the environmental value of groundwater use for agriculture near the site. In this case the ANZECC/ARMCANZ (2000) guidelines for stock watering are the most suitable parameters (Table 7.1). Maintenance of water quality at a level below the guideline values effectively preserves environmental values for groundwater used in agriculture.

As the groundwater salinity at Mount Dromedary is usually about 1,000 µS/cm and the exercise of underground water rights is not expected to change the groundwater quality in or around the site, there is no anticipated impact to the environmental value of stock watering from changes in water quality. A comparison of the complete record of groundwater quality at the site to date with the stock watering guideline values (Table 7.1) demonstrates this concept well. Almost all the parameter concentrations from groundwater samples obtained from the monitoring bores are below the guideline values (Table 7.1). The only exception to this is one instance of sulfate concentration in groundwater from GWMB01 being higher than the guideline value in May 2017, although levels had returned to normal by the following round in November (Table 7.1).
Table 7.1: Groundwater quality at Mount Dromedary compared to stock watering (beef cattle) guideline values

<table>
<thead>
<tr>
<th>Bore</th>
<th>Date</th>
<th>Aluminium - Total</th>
<th>Arsenic - Total</th>
<th>Cadmium - Total</th>
<th>Cobalt - Total</th>
<th>Copper - total</th>
<th>Electrical Conductivity</th>
<th>Fluoride</th>
<th>Calcium</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unit</td>
<td>mg/L</td>
<td>mg/L</td>
<td>mg/L</td>
<td>mg/L</td>
<td>mg/L</td>
<td>µS/cm</td>
<td>mg/L</td>
<td>mg/L</td>
</tr>
<tr>
<td>Guideline value</td>
<td></td>
<td>5</td>
<td>0.5</td>
<td>0.01</td>
<td>1</td>
<td>1</td>
<td>5,970¹#</td>
<td>2</td>
<td>1,000</td>
</tr>
<tr>
<td>GWMB01</td>
<td>1/11/2015</td>
<td>0.012</td>
<td>0.028</td>
<td>&lt;0.0002</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>1100</td>
<td>1.1</td>
<td>77</td>
</tr>
<tr>
<td>GWMB01</td>
<td>12/07/2016</td>
<td>1.8</td>
<td>0.013</td>
<td>&lt;0.0001</td>
<td>0.002</td>
<td>0.031</td>
<td>870</td>
<td>1.1</td>
<td>84</td>
</tr>
<tr>
<td>GWMB01</td>
<td>17/08/2016</td>
<td>0.036</td>
<td>0.008</td>
<td>0.0001</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>1100</td>
<td>0.95</td>
<td>100</td>
</tr>
<tr>
<td>GWMB01</td>
<td>10/05/2017</td>
<td>0.02</td>
<td>0.006</td>
<td>&lt;0.0001</td>
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<td>0.002</td>
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<td>0.5</td>
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<td>GWMB01 Duplicate</td>
<td>10/05/2017</td>
<td>0.02</td>
<td>0.006</td>
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<td>0.006</td>
<td>0.002</td>
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<td>0.007</td>
<td>&lt;0.0001</td>
<td>0.001</td>
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<td>1080</td>
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<tr>
<td>GWMB01 Duplicate</td>
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<td>&lt;0.01</td>
<td>0.007</td>
<td>&lt;0.0001</td>
<td>0.001</td>
<td>&lt;0.001</td>
<td>1070</td>
<td>1.1</td>
<td>104</td>
</tr>
<tr>
<td>GWMB02</td>
<td>16/08/2016</td>
<td>0.069</td>
<td>0.033</td>
<td>0.0002</td>
<td>0.002</td>
<td>&lt;0.001</td>
<td>970</td>
<td>1.1</td>
<td>67</td>
</tr>
<tr>
<td>GWMB02</td>
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<td>&lt;0.001</td>
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<td>&lt;0.001</td>
<td>&lt;0.001</td>
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</tr>
</tbody>
</table>

Notes: general – guideline values also exist for uranium, mercury, and chromium, but these analytes are not monitored
¹ – the value of 5,970 µS/cm is derived from a total dissolved solids guideline of 4,000 mg/L using a conversion factor 0.67
### Table 7.1 continued:

<table>
<thead>
<tr>
<th>Bore</th>
<th>Date</th>
<th>Lead - Total</th>
<th>Molybdenum - Total</th>
<th>Nickel - filtered</th>
<th>Nitrite + Nitrate (as N)</th>
<th>pH</th>
<th>Selenium - Total</th>
<th>Sulphate</th>
<th>Zinc - Total</th>
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<td>0.15</td>
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<td>0.077</td>
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<td>0.75</td>
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<td>&lt;0.001</td>
<td>0.03</td>
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<td>0.001</td>
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<td>&lt;0.01</td>
<td>8.02</td>
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<tr>
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<td>0.002</td>
<td>0.02</td>
<td>0.29</td>
<td>8</td>
<td>&lt;0.0002</td>
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<tr>
<td>GWMB04</td>
<td>14/11/2017</td>
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<td>7.91</td>
<td>&lt;0.0002</td>
<td>62</td>
<td>0.008</td>
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</tr>
</tbody>
</table>
7.6 **Nature and extent of the impacts on springs of interest**

There are no mapped springs within a 90 km radius of the Mount Dromedary Project (DSITI, 2015). Springs are discussed in more detail in Section 9, where it is established that there is no hydraulic connectivity between the Project aquifers and groundwater springs.

There is no anticipated impact on any spring or any environmental values associated with springs from the exercise of underground water rights at the Mount Dromedary Project.

7.7 **Impacts to formation integrity and surface subsidence**

As the Mount Dromedary Project is a proposed open-cut mine and the mining activities include no requirements for hydraulic fracturing or brine injection, the potential for structural instability or subsidence is considered inherently low. It is therefore determined that there is no significant risk of damage to formation integrity or surface subsidence at the Mount Dromedary Project, and a subsidence monitoring program is not necessary.
8 WATER MONITORING STRATEGY (PART E)

This section of the report addresses section 376(f) and section 378 of the Water Act.

8.1 Rationale and strategy

This underground water monitoring strategy is designed to monitor changes in the IAA and the LTAA. The monitoring program has two objectives, first, to observe groundwater level changes in order to measure drawdown as a result of exercise of underground water rights for comparison with predicted drawdown values, and second, to observe the changes in availability of groundwater for a potential terrestrial GDE. This second objective will also be supported by monitoring of the ecological condition of selected areas within the MLA identified as containing WIS vegetation (Section 7.1.1; NRA, 2017). This is outlined further below in Section 8.3.4.

There are no changes expected in water quality as a result of the exercise of underground water rights, and a moderate change in quality would not have a significant impact on environmental values or beneficial use (Section 7). Therefore, the compliance parameters expected to be placed on the groundwater through the conditions of the EA (discussed further below) are appropriate for groundwater quality monitoring and management. Novonix are currently in the process of obtaining the required record of background water quality, to enable any potential future deviations from baseline conditions to be discernible. Continued monitoring according to the program (as outlined below) is anticipated to be adequate in this regard.

The predicted drawdown is outlined in Section 6. The strategy behind the water level monitoring program is to assess the level of observed drawdown against predictions, ensuring that impacts do not exceed acceptable limits. The distribution of the current monitoring bores around the proposed open-cut mine provides good coverage with which to track the development of the drawdown. To this end, ongoing monthly monitoring at the four dedicated monitoring bores at the Project site is recommended as the prescribed EA compliance program (discussed further below).

8.2 Monitoring record

The monitoring at the Mount Dromedary Project to date provides baseline data that was collected regularly from 2015 to now in four bores (Section 5.1.4). Excluding the very initial readings after bore installation (which can be misleading in terms of static water level), groundwater level measurements have been obtained for each bore for 13 monitoring rounds since mid-2016, with recent frequency being monthly (Figure 5.3).

Groundwater quality has been monitored over five sampling rounds since bore installation in 2015 at the following dates:

- 1/11/2015;
- 12/07/2016;
- 16/08/2016;
- 10/05/2017; and
- 14/11/2017.
The groundwater samples for each location obtained across these monitoring rounds are:

- GWMB01: five samples plus two duplicates;
- GWMB02: three samples;
- GWMB03: four samples plus two duplicates;
- GWMB04: four samples; and
- Blanks: three samples.

### 8.3 Monitoring program and timetable

#### 8.3.1 Monitoring locations

Monitoring at the four existing groundwater bores will continue to enable the characterisation of groundwater at Mount Dromedary Project (locations shown in Figure 3.2). This monitoring suite is of suitable spatial extent and the bores are completed in the Corrella Formation, thereby appropriately placed to detect potential impacts of the proposed open pit development. Monthly collection of groundwater levels has been active since 2016, and should continue for at least another 12 months. Groundwater quality monitoring has been undertaken five times since 2015. It is desirable to increase this to a quarterly frequency for the collection of groundwater baseline data.

Novonix will continue to measure groundwater levels and groundwater quality in all four monitoring bores in accordance with the program outlined in this UWIR (Table 8.1).

#### 8.3.2 Water level monitoring

Groundwater level monitoring in the bores at Mount Dromedary Project listed in Table 8.1 shall be carried out monthly. Where possible, monthly monitoring of water levels will be synchronised with groundwater quality monitoring events, such that water levels are obtained immediately before purging and sampling of the bores.

<table>
<thead>
<tr>
<th>Bore ID</th>
<th>Recommended for EA as compliance bore</th>
<th>Monitoring frequency</th>
<th>Parameters</th>
</tr>
</thead>
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<td>Yes</td>
<td>Monthly for water level monitoring</td>
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</tr>
<tr>
<td>GWMB02</td>
<td>Yes</td>
<td>Quarterly for water quality monitoring</td>
<td></td>
</tr>
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<td>GWMB03</td>
<td>Yes</td>
<td>Water level and Water quality parameters listed in Table 8.2</td>
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<tr>
<td>GWMB04</td>
<td>Yes</td>
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<td></td>
</tr>
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</table>
8.3.3 Water quality monitoring

All samples for groundwater quality shall be collected after the bore is appropriately purged. The samples shall be preserved and forwarded to a NATA accredited water laboratory for analysis. The parameters to be analysed are provided in Table 8.2 and are similar to those historically reported from the previous five monitoring rounds. This parameter list is a preliminary recommendation for the conditions of the EA. Groundwater shall be sampled in accordance with the relevant guidelines and conventions (e.g. Sundaram et al., 2009; DEHP, 2010) and in compliance with Australian standards (AS/NZS 5667:11 1998).

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical Conductivity (µS/cm)</td>
<td>µS/cm</td>
</tr>
<tr>
<td>pH</td>
<td>pH units</td>
</tr>
<tr>
<td>Hardness (CaCO3)</td>
<td>mg/L</td>
</tr>
<tr>
<td>Major cations and anions</td>
<td>mg/L</td>
</tr>
<tr>
<td>Alkalinity species</td>
<td>mg/L</td>
</tr>
<tr>
<td>Sulphate</td>
<td>mg/L</td>
</tr>
<tr>
<td>Nitrate</td>
<td>mg/L</td>
</tr>
<tr>
<td>Ammonia (as N)</td>
<td>mg/L</td>
</tr>
<tr>
<td>Fluoride</td>
<td>mg/L</td>
</tr>
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<td>Aluminium – Diss</td>
<td>mg/L</td>
</tr>
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<td>Aluminium – Total</td>
<td>mg/L</td>
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<tr>
<td>Arsenic – Diss</td>
<td>mg/L</td>
</tr>
<tr>
<td>Arsenic – Total</td>
<td>mg/L</td>
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<tr>
<td>Cadmium – Diss</td>
<td>mg/L</td>
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<tr>
<td>Cadmium – Total</td>
<td>mg/L</td>
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<tr>
<td>Cobalt – Diss</td>
<td>mg/L</td>
</tr>
<tr>
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<td>mg/L</td>
</tr>
<tr>
<td>Copper – Diss</td>
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</tr>
<tr>
<td>Copper – Total</td>
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<td>Chromium – Diss</td>
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<tr>
<td>Lead – Diss</td>
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</table>
8.3.4 Reporting

The implementation of the groundwater monitoring strategy described above must be reported to the Office of Groundwater Impact Assessment (OGIA). It is anticipated that, if the Project is granted approval, the EA conditions for groundwater will also require Novonix to provide an annual review of the Groundwater Management Program to the regulators (DES). Therefore, the monitoring report made under the EA shall also be submitted to OGIA and, with some additions listed below, will fulfil the reporting requirements related to this monitoring strategy. In this report, the observed groundwater drawdown and inflows to the proposed mine will be compared to the predictions from the numerical model. Thus, a comparison of the observed impact to potential groundwater users and that predicted in the model simulation will be presented.

It is anticipated that, if the Project is granted approval, the EA conditions will also require Novonix to undertake annual reporting for a Receiving Environment Monitoring Program (REMP). In response to the presence of WIS vegetation in the vicinity of the Project site (Section 7.1.1), it is recommended that monitoring of the condition of the WIS vegetation be incorporated into the REMP. Where there are relevant findings, Novonix will incorporate information from the REMP into the groundwater report described above.
9 SPRING IMPACT MANAGEMENT STRATEGY (PART F)
This section of the report addresses section 376(g) and section 379 of the Water Act.

9.1 Springs of interest
The UWIR guidelines (DEHP, 2016a) define a spring as a spring of interest if:

“the water level in an underlying aquifer is predicted, in an UWIR or final report, to decline by more than the spring trigger threshold at the location of the spring at any time and the cause of the predicted decline is the exercise of underground water rights. The spring trigger threshold is a decline of water level of 0.2 metres in the source aquifer, unless an alternative spring trigger threshold has been defined by regulation.”

9.2 Spring inventory
There are no mapped springs within a 90 km radius of the Mount Dromedary Project (DSITI, 2015). The closest spring to the Project identified in the Queensland Government wetlands mapping is 97 km to the east of MLA 100121 (DSITI, 2015).

9.3 Connectivity between springs and Project aquifer
As there are no springs within the vicinity of the Project, and the host rock type, the Corella Formation, does not comprise lithologies conducive to karstic dissolution (e.g. limestone), it can be confidently inferred that there is no connection between the Project aquifers and any groundwater springs.

9.4 Spring values
In accordance with the UWIR guidelines (DEHP, 2016a), assessment of the risk to, and likely impact on, the ecosystem and cultural and spiritual values of springs are addressed under Part D (Section 7.6 of this UWIR).

9.5 Management strategy
There are no predicted impacts on springs from exercise of underground water rights at the Mount Dromedary Project (Section 7.6). Therefore, a management strategy for springs, including mitigation measures and reporting, is not required.
10 CONCLUSIONS

This UWIR has assessed the potential impact from the exercise of underground water rights from the proposed development of an open-cut mine at the Mount Dromedary Project (MLA 110121) to a total depth of 90 mBGL within the Corella Formation over 25 years.

In addition to characterisation of the aquifers, groundwater system and environmental values through research and data analysis, a numerical groundwater flow model was developed to simulate the proposed operations, and to predict the potential changes to the groundwater regime. The numerical model inherits a conservative approach and therefore provides model drawdown and pit inflow estimates that are likely to be overestimates. At the end of mining, the maximum predicted drawdown is 80 m within the immediate mine area. The LoM 5 m drawdown contour (equivalent to the bore trigger threshold) is some 400 m to 500 m from the open pit. There are no registered groundwater bores or known springs within the predicted drawdown extent at the end of mining. There is one potential terrestrial GDE within the drawdown zone that could be impacted by loss of access to groundwater.

An impact assessment was undertaken to identify potential risks to environmental values. Those environmental values that are not predicted to be impacted by exercise of water rights at Mount Dromedary Mine are:

- Biological integrity of aquatic, terrestrial and subterranean ecosystems outside of the MLA;
- Ecosystem and cultural and spiritual values of springs;
- Beneficial use in production of foods;
- Beneficial use in aquaculture;
- Beneficial use in agriculture (including use from nearby registered bores);
- Suitability for primary, secondary or visual recreational use;
- Suitability of the water for supply as drinking water;
- Suitability of the water for industrial use; and
- Cultural and spiritual values of the water.
Project No 1904 (Mount Dromedary UWIR)

There are potential impacts to the biological integrity of a terrestrial GDE within the zone of influence demarcated by the LoM 1 m drawdown contour. The degree of ecological dependence of the WIS vegetation along the drainage line in question is not directly quantified at this time. However, a conservative approach is adopted to inform the conclusion that some degree of impact could occur in the worst case scenario. Some individual trees within this potential GDE are closer to mine operations and would experience total loss of groundwater input, whereas others that are further downstream may experience only a minor reduction in groundwater availability. This reduction will be monitored in the form of groundwater level monitoring and vegetation condition observations outlined in Section 8, and will be compared to predictions of drawdown annually.

No spring management strategy is required for the Mount Dromedary Project. The recommended groundwater monitoring, vegetation monitoring, and reporting programs outlined in this UWIR are adequate to quantify acceptable impacts and detect unacceptable impacts; and are rationalised against the anticipated conditions of an EA pending project approval.
11 CERTIFICATION OF UWIR

We certify that this underground water impact report has been prepared by Rob Lait and Associates Pty Ltd and Australasian Groundwater and Environmental Consultants Pty Ltd, as independent practising hydrogeologists, at the request of Novonix Resources Ltd.

Rob Lait  
Principal Hydrogeologist

Angela Bush  
Senior Hydrogeologist

Daniel Barclay  
Principal Hydrogeologist

Rob Lait and
Associates Pty Ltd

Australasian Groundwater and
Environmental Consultants
12 REFERENCES

12.1 Legislation and policy
Environmental Protection Act 1994 (Qld)

Water Act 2000 (Qld)

Environmental Protection (Water) Policy 2009 (Qld)

Queensland Heritage Act 1992

Aboriginal Cultural Heritage Act 2003

Torres Strait Islander Cultural Heritage Act 2003

The Environmental Protection Regulation 2008

Environmental Protection (Underground Water Management) and Other Legislation Amendment Bill 2016

Explanatory notes for the Environmental Protection (Underground Water Management) and Other Legislation Amendment Bill 2016

Water Plan (Gulf) 2007 (Policy under the Water Act 2000)

12.2 Publications and reports


Bouwer, Herman and Rice, R.C., (1976), A slug test for determining hydraulic conductivity of unconfined aquifers with completely or partially penetrating wells, Water Resources Research 12(3) 423–428.


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13 APPENDIX A – BORE LOGS
Borehole No: GWMB01
Location: Mt Dromedary
Date Drilled: 24/7/2015
Easting: 417568
Northing: 7636392
Method: Rotary Air Blast
Driller: J Riddell
Drilling Rig:

Client: Graphite Corp
Project No: 252
Elevation (m):

Depth (m) Strata Description
0 Brown topsoil
5 Sandstone - clay altered
10 Calcite/Slate (altered sandstone) - chloritic, pyrite and chlorite epidote + hematite + calcite, patchy
15 Water intercept at 7.5m - sand (0.1L)
20 Water intercept at 17.5m - adit lift yield 7Ls, EC 600, micro-seismometer, pH 7.2
25 Meta arenite mineral CS alteration
30 Blended talc mica altered sandstone - chloritic, pyrite and chlorite epidote + hematite + calcite alteration, patchy
35
40
45
50
55
60
65
70
75
80
85
90
95
100

Notes:
Datum: GDA94 (54K)
Borehole No: GWMB02  
Location: Mt Dromedary  
Date Drilled: 10/7/2016  
Easting: 418502  
Northing: 7831217  
Method: Rotary Air Blast  
Driller: J Riddell  

Client: Graphite Corp  
Project No: 252  
Elevation (m):  
Drilling Rig:  

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### Strata Description

- **Depth (m):**  
- **Symbol:**  
- **Strata Description:**  
  - Brown soil  
  - Brown foliated meta-granite  
  - Black graphite schist  
  - Fault zone, quartz and pink-cream-white siltstone  
  - Pink-cream-white siltstone  
  - Fine grained grey dolerite, dolerite schist  
  - Water intercept, 20-5m depth, seal (0.1m)  
  - Grey, massive  
  - Black bands of graphite schist and siltstone  
  - Massive white limestone

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### Well Construction Details

- **Elevation (m):**  
- **Infos and SYA:**  
- **Well Construction Details:**  
  - Surface to 6m cement annular grout  
  - Drill cuttings  
  - 15.5m to 12.5m, bentonite seal  
  - 0 to 80m 105mm borehole  
  - Surface to 90m, 100mm ID PN12 PVC casing  
  - 15.5m to 50m, 5-7mm gravel pack envelope  
  - 75 to 50m, 2.5mm aperture slotted PVC casing  
  - Bottom tap  

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**Datum:** GDA94 (54K)
Borehole No: GWMB04  
Location: Mt Dromedary  
Date Drilled: 24/7/2016  
Easting: 418346  
Northing: 7631818  
Method: Rotary Air Blast  
Driller: J Riddell

Client: Graphite Corp  
Project No: 252  
Elevation (m):  
Drilling Rig:

Depth (m)  Symbol  Strata Description  Info's and SYM.  Well Construction Details

0  White, calcite altered sandstone - calcareous and chloritic hard

12  Water intercept, 12 to 15m depth, airlift yield 0.5L/s

15  Biotite schist, Green-grey, abundant biotite, a lumpy feel

45  Biotite schist, Green-grey, abundant biotite, very weathered Zone, soft, crumbly

64  Muscovite-biotite schist, Green-grey hard, both mica minerals very abundant (85% of rock)

77  Muscovite-biotite schist as for 64 to 77 but very weathered, soft and crumbly

90  Muscovite-biotite schist, Green-grey hard, both mica minerals very abundant (85% of rock)

7 7 to 10m, bentonite seal

0 to 50m 105mm borehole  
Surface to 50m, 50mm ID PN12 PVC casing

10 to 50m, 5.7mm gravel pack envelope

50 to 50m, 2.5mm aperture slotted PVC casing

Bottom cap

Datum: GDA94 (54K)