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DgS
Ditton Geotechnical Services

25 November, 2014

Dennis Zines
Kadenz Pty Limited
1 Fairweather Street
Bellevue Hill NSW 2023

Report No. DEN-003/1

Dear Dennis,

Subject: Subsidence Impact Management Compliance Assessment for the 4th Triennial Independent Audit of Dendrobium Mine, Mount Kembla

1.0 Introduction

This report provides an independent review by Ditton Geotechnical Services Pty Ltd (DgS) on the environmental performance of the Dendrobium Mine in regards to subsidence impact management within Areas 3A and 3B at the Dendrobium Mine, Mount Kembla.

This report forms part of the 4th Triennial Independent Audit Report by Kadenz Pty Ltd, which is required by the NSW Department of Planning & Environment's Consent Condition 8.6 *Independent Environmental Audit* in the Modified Development Approval (DA-60-03-2001) dated 8/12/2008 for the Dendrobium Mine.

This audit has included the outcomes of mining impacts for the period from September, 2011 to September, 2014. Mining activities resulting in the development of subsidence and associated impacts during this period include the extraction of longwalls LWs 7 and 8 in Area 3A (April, 2011 - December, 2012) and LW 9 & 10 in Area 3B (February, 2013 to September, 2014). LW9 was completed in June, 2014 and LW10 is currently being extracted.

Separate Subsidence Management Plans (SMPs) were developed for Areas 3A and 3B before mine subsidence impact occurred in accordance with Consent Condition 3.7 of the Modified DA. Monitoring and reporting of the impacts and consulting with the relevant stakeholders in regards to these have been on-going through the audit period.

2.0 Abbreviations

The abbreviations used in this report are as follows:

CMA - Corrective Management Action

DCCC - Dendrobium Community Consultative Committee

DP&E - Department of Planning and Environment (*formerly Planning & Infrastructure*)

DRE - Department of Resources & Energy *(an agency of T&I)*

DSC - Dams Safety Committee

T&I - Department of Trade and Investment

IC - Illawarra Coal

ICEFT - Illawarra Coal Environmental Field Team

NOW - NSW Office of Water *(an agency of T&I)*

OEH - Office of Environment and Heritage

SCA - Sydney Catchment Authority

SIMMCP - Swamp Impact Monitoring, Management and Contingency Plan

TARP - Trigger Action Response Plan

WIMMCP - Watercourse Impact Monitoring, Management and Contingency Plan

3.0 Scope of Work

The requirements of the Schedule 8.6 of the Modified DA are provided below:

6. By 31 December 2011, and every 3 years thereafter, unless the Director-General directs otherwise, the Applicant shall commission and pay the full cost of an Independent Environmental Audit of the development. This audit must:

(a) be conducted by suitably qualified, experienced and independent team of experts whose appointment has been endorsed by the Director-General;

(b) include consultation with the relevant agencies;

(c) assess the environmental performance of the development and assess whether it is complying with the relevant requirements in this approval and any relevant EPL or mining lease (including any strategy, plan or program required under these approvals);

(d) review the adequacy of strategies, plans or programs required under these approvals; and, if appropriate,

(e) recommend measures or actions to improve the environmental performance of the development, and/or any strategy, plan or program required under these approvals.

Note: This audit team must be led by a suitably qualified auditor and include experts in the fields of a) mine subsidence impacts and remediation and b) stream hydrology and water quality.

The work completed by DgS for the review period included:

(i) A desktop review of the relevant subsidence impact prediction, monitoring and management documentation for Areas 3A and 3B:

- Dendrobium Mine's Modified Development Approval Conditions of Consent and Statement of Commitments (DA 60-03-2001, dated 8/12/2008)
- Environmental Assessment for Area 3 (dated November, 2007)
- Subsidence Management Plans (SMPs) for Areas 3A (April, 2010) and 3B (Feb, 2013)
- Swamp Impact Monitoring, Management & Contingency Plans (SIMMCP)
- Watercourse Impact Monitoring, Management & Contingency Plans (WIMMCP)
- Revised Swamp and Watercourse TARPS (Oct 2013 and Dec 2013)
- Annual Environmental Management Reports (AEMRs) for 2011/2012, 2012/2013 and 2013/2014.
- End of Panel Reports (EoPRs) for LWs 7, 8 and 9 (LW10 is still being extracted)
- Relevant Government Agency Correspondence (DRE, SCA and OEH)
- Bio-diversity Offset Strategy for Area 3B (approval pending from OEH & SCA)
- Swamp Rehabilitation and Research Program (04/06/2014)
- Independent Hydrological Model reviews by SCA (Mr Grantley Smith of the Water Research Laboratory UNSW) and DCCC (Professor McMahon of Melbourne University).
- OEH submission to Ministers Department (Martin Krogh, 2012)
- OEH submission to DP&E (13/12/2012)
- OEH submission to T&I (30/09/2013)
- OEH submission to BHPB (21/10/2013)
- OEH submission to DP&E (13/12/2012)
- OEH submission to BHPB (17/01/2014)
- OEH submission to DP&E (09/07/2014)
- OEH submission to DP&E (31/07/2014)
- OEH submission to DP&E (06/08/2014)
- SCA submission to Kadenz (Sep, 2014)
- T&I/DRE submission to Kadenz (Sep, 2014)
- OEH submission to Kadenz (Aug, 2014)

- Dendrobium response to OEH Submission to Kadenz (Sep, 2014)
- DSC submission to Kadenz (12/11/2014)
- Dendrobium response to DSC submission to Kadenz (Nov, 2014)

(ii) A walkover inspection of Area 3A (LW 7 & 8) and Area 3B (LW 9) on 3/9/2014 with Garry Brassington (Dendrobium Mine's Approvals Manager) and Josh Carlon (ICEFT) to view surface impacts and identify possible inconsistencies in the application of the SMP/SIMMCP/WIMMCPs.

(iii) Provide an assessment of the effectiveness of the SMP/SIMMCP/WIMMCPs and possible avoidance of remediation measures or strategies.

(iv) Provide recommendations on any changes to the SMP/SIMMCP/WIMMCPs and or the overall reporting process such that it may improve the effectiveness of above plans in future mining areas.

4.0 Desktop Review

4.1 Conditions of Consent and Subsidence Management Plan (SMP) Overview

The DA's Conditions of Consent and SMPs for Areas 3A and 3B provides a framework for addressing monitoring and impact management strategies / requirements for the following features within the area of longwall mining influence:

- Sandy Creek, Wongawilli Creek and Donalds Castle Creek and their tributaries (1st, 2nd and 3rd Order Watercourses according to the Strahler System)
- Steep slopes (up to 2V:1H) and rock face features < 10 m high.
- Sandy Creek Waterfall
- Upland Swamps (12, 15b, 16, 1a, 1b, 5 and 8)
- Shallow and deep groundwater aquifers.
- Terrestrial and aquatic flora and fauna.
- Aboriginal Heritage Sites (rock shelters/overhangs with art or artefacts)
- Lake Cordeaux and Avon storage areas.
- 330 kV Transgrid Powerline easement.
- 33 kV Powerline easement.
- Fire trails.

The conditions require that subsidence predictions and impact management plans (with TARPs) are to be developed for each feature in consultation with the relevant stakeholders.

Baseline studies of pre-mining conditions for natural features such as swamps and watercourses should be completed for a minimum period of two years to allow a reasonable assessment of post-mining impacts. The monitoring program must be carefully designed to capture the relevant data and environmental response to mine subsidence effects and impacts. The measured impacts are compared to predicted impacts, TARPs and Performance Measures

to ascertain if the project complies with the approval conditions and/or whether remediation works or CMAs are necessary to restore functionality.

The Performance Measures provided in the DA generally allow for a 'minor' or temporary impact to sensitive natural, culturally significant and man-made features. In some cases, the impacts will naturally recover within a reasonable time frame or be able to be remediated to the satisfaction of Stakeholders if necessary. Overall, the intended outcome is to satisfy both Schedule 2.1 of the DA:

1. The Applicant shall implement all reasonable and feasible measures to prevent and/or minimise any harm to the environment that may result from the construction, operation, or rehabilitation of the development.

and 1.3 of the Statement of Commitments in Appendix 4 of the DA:

Minimise volume of sterilised coal which could be efficiently extracted within the mining and environmental constraints of the area.

The mine must therefore (i) develop mining layouts that seek to meet the required Performance Measures for each recognised feature and minimise the loss of coal resource, (ii) predict and measure the impacts due to subsidence movements against relevant performance measures defined in the SMP, and (iii) determine if impacts are within predictions or if exceedances have occurred, what CMAs (if any) should be considered in consultation with the relevant Stakeholders.

The mine was also required by Schedule 3.14 of the DA to provide Environmental Offsets for "losses to water quality and flows to SCA storages" and measures to have a "beneficial effect on water quality, water quantity, aquatic ecosystems and/or ecological integrity of SCA's special areas or water catchments".

It is of note that the mine has considered requests by various departments and stakeholders to adjust proposed mining layouts if the uncertainties and consequences of possible subsidence impacts are considered too great a risk to the environment and the mine operations. Examples of this include the re-orientation and shortening of Area 3 longwalls to avoid undermining Wongawilli Creek, Sandy Creek and geological structure.

IC established a "technical committee" of subsidence and geotechnical experts (as requested in the DA) to prepare a TARP to monitor and manage mining impacts at Sandy Creek Water Fall. The longwalls were stopped 50 m short of some of the approved locations, based on the stringent valley closure and horizontal strain limits applied to avoid cracking and rock fall impacts occurring within 30 m of the overhang.

Several changes to the swamp and watercourse impact management plans are noted for the audit period:

- The development of the SIMMCP and WIMMCP for Area 3B resulted in the revision of Trigger Action Response Plans (previously referenced in Table 24.2 in the SMP -

Part B for Area 3A) in consultation with OEH and SCA to reduce impact assessment ambiguity and objectively ascertain the impacts of mining on upland swamps and watercourses due to measured subsidence effects. The TARPs for the Landscape Features (cliffs, steep slopes, fire trails and aboriginal archaeological sites) have remained unchanged in Area 3. OEH claims that the mine is in breach of its consent conditions in regards to the development of and measured swamp impacts (refer to **Section 4.4.3**).

- A Bio-diversity offset strategy was also required in the SMP Approval to "compensate for the impacts of Longwalls 9 to 13 on Upland Swamps". The mine submitted its Draft Bio-offset Strategy to OEH for review. OEH has subsequently requested further details on the proposed bio-banking scheme and claim that the strategy has not been completed to their satisfaction in recent correspondence (refer to **Section 4.4.3**).

Comparison between predicted v. observed subsidence effects and impacts have been assessed in End of Panel (EoP) and Annual Environmental Monitoring Reports (AEMRs).

The performance of the SMP/SIMMCP/WIMMCPs during and after mining of LWs 7 to 9 has been assessed in the EoPs and AEMRs for 2011 to 2014. The outcomes are summarised in **Section 4.2**.

A Swamp Rehabilitation Research Program (SRRP) is also being undertaken in Area 3 that will attempt to restore shallow groundwater levels and surface water diversions that have occurred along watercourses and beneath swamps due to the surface and subsurface fracture network caused by subsidence. A program to improve our understanding of sub-surface interaction of the fracture network in the Constrained Zone (between the surface cracking zone and base of Bulgo Sandstone) has also been undertaken during LW9 extraction. Further details are provided in **Section 4.3**.

4.2 Annual Environmental Management Reports (AEMRs) and EoP Reports

Three AEMRs and three EoPRs have been submitted to DP&E/DRE during the audit period.

As previously mentioned, the TARP trigger levels for Landscape Management Plans (LMPs) were originally defined using the subjective terms of 'minor', 'moderate' and 'severe' impact. Consideration of CMAs were invoked when mine subsidence damage was assessed by mining representatives as being 'moderate' or 'severe'.

Subsequent review of observed impacts and consequences above LW7 in Area 3A resulted in the modification of the TARPs in the SIMMCP, WIMMCP and LMPs to a Level 1 to 3 Impact-based system. The new TARP system was developed in consultation with OEH and linked observed impact magnitudes with associated environmental consequences and appropriate CMA responses.

No Corrective Management Action (CMA) were invoked during the current audit period by the Dendrobium SIMMCP, WIMMCP Trigger Levels except for back filling of surface cracks across fire trails to make the roads safe and serviceable. Swamp and watercourse

rehabilitation trials are going to be assessed in Areas 3A and 3B over the next 5 years however.

According to the SMP/SIMMCP and WIMMCPs, monitoring of all significant features will continue for a period of 2 years after mining is completed. Periodic inspections (i.e. annual) by ICEFT of the subsided areas will be undertaken to identify any impacts that may require CMAs to be implemented in consultation with the relevant Stakeholders.

A summary of the predicted subsidence effects and associated impacts within the completed mining areas (as described in the EoPRs) are presented below:

Area 3A - LWs 6, 7 and 8

- Subsidence predictions (p) along SCW North and South Centrelines above LWs 6 & 7 were higher than measured (m) values (1.55 m (p) v. 1.525 m (m) and 1.775 m (p) v. 1.416 m (m) respectively) with minor exceedances of the predicted tilts and compressive strains due to "irregular" subsidence profile movements of the overburden.

  Note: It is the author's experience over the past 20 years that differential subsidence predictions based on continuous or 'smooth' subsidence profiles are likely to be exceeded occasionally as the surface profile of subsiding, jointed rock mass is invariably 'smooth' or regular. Provided the predicted impacts that are based on the 'smooth' subsidence model are reasonably conservative, the occasional tilt and strain exceedances are not usually significant in terms of environmental impact management.

- Valley closure measurements due to LWs 6 to 8 across the Sandy Creek arm of Lake Cordeaux and Wongawilli Creek were within predicted values. No surface impacts were observed.

- IC established a "technical committee" of subsidence and geotechnical experts to prepare an appropriate TARP to monitor and manage mining impacts at Sandy Creek Water Fall as LWs 6 to 8 approached their finishing points. The longwalls were stopped up to 50 m short of the approved locations, based on the stringent valley closure and horizontal strain limits applied to avoid cracking impact. Measured closure on High Resolution Survey Lines were found to provide sufficient sensitivity in controlling horizontal rock mass stress induced by the differential displacements associated with regional stress relief above the extracted longwall panels.

- Minor surface cracks and soil/rock displacements were expected to occur along water courses with rock bars, beneath the upland swamps, across fire trails and on ridges and steep slopes due to the predicted subsidence effects. The surface cracks were assessed to be within Level 1 or 2 Impact ranges, which refer to cracking along watercourses without and with surface flow diversion and pond losses respectively. No CMAs have been invoked at this stage in watercourses and swamps. CMAs have been taken for infilling of several fire trail cracks to maintain public safety requirements.

- One moderate sized rock fall (240 m^3) occurred along WC17 and just outside the extraction limits of LW7. An underlying section of a 1.2 m deep rock ledge or step along WC17 collapsed after fracturing was first noted 3 weeks earlier.

- Level 1 and 2 fracturing occurred in rock bars along two intermittent watercourses with pond drainage recorded at three locations (Pools 7, 8 & 10) along creeks WC12 and SC10C. Loss of aquatic habitat was recognised with no flora or fauna 'kills' detected. No CMAs have been attempted at this stage, however, a proposal by the mine to remediate SC10C pond with low pressure grouting has been submitted to DP&E for approval.

- Level 2 Stream flow diversion and loss of pond water occurred downstream of Swamp 12 and 15b with no gas emissions, change to catchment yields or water quality detected.

- Iron oxide / hydroxide deposits and rock bar staining occurred along WC17 and SC10C due to exposure of groundwater to fresh rock mass surfaces. Iron oxide staining/deposits were noted along the flowing creek beds. *Note: It is understood that an independent water chemistry consultant has assessed that the effects of iron oxide staining and precipitation is temporary and unlikely to become a serious issue for aquatic biota.*

- The water quality monitoring included Fe, Mn, Ni, pH, Electrical Conductivity, Oxidation-Reduction Potential readings that did not exceed TARP limits or any other geomechanical effects of aquatic ecological concern.

- There were no discernible consequences to the vegetation within Swamps 12 and 15b in the sub-catchments of Wongawilli and Sandy Creeks. There have been shallow groundwater declines due to near surface cracking of the rock mass below the swamps however, which have Triggered Level 1, 2 and 3 TARPs.

- The Swamp TARP Impact levels indicate an increasing area of groundwater level impact beneath the swamps and Dendrobium Mine will continue to monitor for any changes to swamp extent, bio-diversity and soil moisture. It is considered that die-back of Pouched Coral Fern within the lower reaches of Swamp 15b (Level 1 Trigger) may be a natural life-cycle response and therefore an inconclusive indicator of mining impact at this stage. Further monitoring of the development or extent of this phenomenon will be on-going to ascertain its significance.

- Minor fracturing with no flow diversions were predicted along reaches of Wongawilli and Sandy Creeks within 250 m of the longwalls. No cracking or water quality impacts have been reported to-date and were not expected, due to the intention of the mine to provide adequate set-back distances from the longwall panels.

- There have been losses of aquatic biota habitat where Pools 7, 8 & 10 on WC17 and SC10C were drained as a consequence of surface cracking above LW7. There have generally been no detectable changes to aquatic and terrestrial plant communities and fauna habitats (or threatened species), except for a lack of breeding and decline in population of Littlejohn's Tree Frog, according to specialist environmental consultants.

- Groundwater level drawdowns in deep piezos after LW7 and 8 typically ranged from 4 to 20 m in the Wongawilli Seam, 10 m to 20 m in the Bulli Seam with < 5 m drawdowns as in the Scarborough and Bulgo Sandstone. The groundwater heads were in general agreement with the predicted responses with < 10 m of additional drawdown in the Coal Seams and < 5 m of additional draw down in the Scarborough and Bulgo Sandstones after LW 8. Drawdown extents in the seams continued to expand into Area 3B and south of Area 3A as expected.

- Groundwater level recovery of a few metres has been measured above Area 2 between May 2011 and January 2012. The recovery response after mining was predicted by the groundwater modelling.

- A regional approach has now been adopted for groundwater monitoring in Areas 1, 2, 3A and 3B. A local 3D numerical model has been developed recently for the longwalls in Area 3b (**HydroSimulations, 2014**) to give more quantitative groundwater predictions than has been possible in the past. Measured groundwater inflows into the workings were also lower than predicted flows.

- Surface cracking and soil displacement developed along the Fire Trails in Area 3A. Several cracks observed along the Fire Trail were within the predicted values, with no CMA required at this stage.

- The impacts of subsidence, tilt and strain on the Transgrid 330 KV power line towers have been controlled through the installation of cruciform footings on the towers. Cracking was observed around two towers (No.s 14 and 15) but did not affect the structures.

Area 3B - LW9

- Subsidence predictions above LW9 were higher and lower than measured values by up to 30%. The predicted (p) values for Swamp 1a and 1b were lower than measured (m) values (e.g. 1.30 m (p) v. 1.70 m (m); and 1.55 m (p) v. 1.7 m (m)) and approximately equal to or higher than the measured values for Swamps 5 and 8 (1.30 m (p) v 1.31 m (m); and 1.95 m (m) v. 1.44 m (m)).

  Note: It is assessed that the explanation for the subsidence exceedance by MSEC is not related to the accuracy of the LIDAR surveys, based on similar exceedances measured by the conventional surveys. It is also misleading to apply the LIDAR accuracy limits to the predicted subsidence profile along the panel (it should have been applied to the measured LIDAR profile). It is considered more likely that the exceedance may be related to starting end of the panel, where higher subsidence can occur due to first goafing effects.

- No tilt and strain data have been provided or discussed in the EoP Report for LW9, although reference has been made to the relevant MSEC report for these.

- Maximum valley closure measurements of 56 mm to 313 mm due to LW9 across Donalds Castle Creek and Tributary and Wongawilli Creek were all within predicted values. Level 1 and 2 Impacts such as rock bar buckling (resulting in uplift), cracking and flow diversion were observed and also within the predicted ranges.

- The first and second order streams associated with Wongawilli and Donalds Castle Creeks were impacted by Level 1 to Level 2 cracking of rock bars, changes in water colour (iron staining or turbidity), flow diversion and pond water level losses. The observed impacts were considered by the mine to be within the predicted ranges presented in the SMP/SIMMCP/WIMMCPs for Area 3B.

- Level 1 surface cracks between 10 mm and 80 mm wide occurred on steep slopes and rock faces, with occasional rock falls up to 1.2 m^3 in size and effecting up to 2 m^2 in face area. The impacts were assessed to be within the predicted range. No CMAs have been required at this stage.

- There were no discernible consequences to Swamps 1a, 1b, 5 and 8 in regards to bio-diversity, erosion, soil moisture and surface water flow in the sub-catchments of Wongawilli and Donalds Castle Creeks due to LW9. However, there have been shallow groundwater declines and recession rate increases due to near surface cracking of the rock mass below the swamps, which have Triggered Level 1 and 2 TARPs. Shallow groundwater levels have not recovered since LW9 was completed.

- The increasing area of groundwater level impact beneath the swamps in Area 3B will be continued to be monitored. Hydrologic modelling indicates that the diverted surface waters have not been lost from the catchments at this stage.

- The water quality monitoring included Fe, Mn, Ni, pH, Ec, Oxidation-Reduction Potential readings that did not exceed TARP limits or any other geomechanical effects of aquatic ecological concern in watercourses and reservoirs (Avon and Cordeaux).

- Seven Level 1 triggers were reached in accordance with low pool water levels in WC21, DDC and DC13 and there have been losses of aquatic biota habitat as a consequence of surface cracking above LW9. There have generally been no detectable changes to aquatic and terrestrial plant communities and fauna habitats (or threatened species).

- Groundwater level drawdowns in deep piezos after LW9 were 40 m in the Wongawilli and Bulli Seams, with increased drawdowns up to 107 m in the Scarborough Sandstone and between 1 m and 82 m in the Bulgo Sandstone. Lower Hawkesbury Sandstone drawdowns ranged from 0 m to 40 m with 1 m to 5 m in the Upper Hawkesbury Sandstone.

  The groundwater heads were in general agreement with the predicted responses in Area 3B, however it was noted by **HydroSimulations, 2014** that higher drawdowns occurred beneath the swamps due to the lack of surface cracking effects adopted in the model and should be reviewed.

- One of the four Aboriginal Heritage rock shelter sites (with art) was impacted slightly by LW9. The shelter was impacted by the cracking and opening of an existing joint. The art was not impacted.

- Level 1 and 2 surface cracking and heaving (uplift) between 10 mm and 50 mm across access tracks or fire trails have generally in-filled naturally or required remediation as per the CMAs in the TARP.

- Level 1 cracking along the Maldon - Dombarton Railway Corridor has not caused any impact to the feature.

4.3 Swamp Rehabilitation Research Program

The purpose of the SRRP is to provide the framework of BHPBIC's swamp research program and comply with Condition 15 of the Area 3B SMP Approval. Rehabilitation and research activities described in the SRRP will be undertaken in accordance with the DP&E Area 3B SMP Approval.

The objectives of the SRRP are to:

- Investigate methods to rehabilitate swamps subject to subsidence impacts and environmental consequences within Areas 3A and 3B, with the aim of restoring groundwater;

- levels and groundwater recharge response behaviour to pre-mining levels;

- Establish a field trial (for a 5 year duration or longer) for rehabilitation techniques at a swamp or swamps that have been impacted by subsidence;

- Provide for the expenditure of at least $3.5 million over this period; and

- Include a schedule for subsequent trials, development of work plans and ongoing reporting.

There are two broad mechanisms by which subsidence could cause changes in swamp hydrology:

- The bedrock below the swamp cracks as a consequence of strains and water drains into the fracture zone. The extent and permanence of these changes relate to the size of the fracture zone (increase in porosity/storage) and whether the fractures are connected to a deeper aquifer, the mine workings or bedding shear pathway to the surface lower in the catchment.

- Tilting, cracking, desiccation and/or changes in vegetation health result in concentration of runoff and erosion which alters water distribution in the swamp.

Changes to swamp hydrology can result in environmental consequences. The likelihood and timing of these consequences relate to the size and duration of the effect. The environmental consequences which could relate to changes in hydrology include:

- Increased rates or frequency of erosion events;
- Increased frequency and extent of the organic components of the swamp soil burning during intense bushfires;
- Increased rates of species composition change and/or changes in vegetation communities.

It is understood the mine will be applying their experience gained during crack sealing rehabilitation works along the Georges River above four West Cliff longwalls. The following remediation techniques will be assessed at Swamp 15b (Area 3A) and Swamps 1a/1b and 5 (Area 3B):

- grout type and injection methods;
- erosion and knick point control methods;
- water spreading.

The above techniques will be assessed on their ability to restore shallow groundwater levels, soil erosion and moisture losses, surface flows and pond levels during low-flow periods within an impacted catchment.

The mine intends to consult with key stakeholders (OEH/SCA/DCCC) and published the research findings and outcomes.

4.4 Correspondence with Stakeholders

4.4.1 SCA Issues with Further Surface Flow Monitoring and Hydrological Modelling in Area 3

It is understood that the outstanding issue from the previous 2011 Audit of establishing stream flow monitoring points at two locations along Wongawilli Creek has been resolved between the Mine and SCA.

However, the SCA currently considers the hydrological model used by the Dendrobium Mine (**Ecoengineers, 2014**) to be "inadequate, inappropriate and unproven for its intended use" (e-mail from SCA representative to Dennis Zines dated 27/08/14).

The SCA commissioned an independent review of the RUNOFF2005 Hydrological Model by UNSW Water Research laboratory and submitted a report in December 2012 to the DP&E. The review heavily criticised the use of the model, but did not provide any suggested alternatives. No action could therefore be taken by DP&E or the mine.

4.4.2 DCCC Issue with Hydrological Modelling in Area 3B

A further review of the RUNOFF 2005 model by Professor Thomas MacMahon of University of Melbourne was commissioned by the DCCC and submitted to DP&E in June, 2014.

Overall, the reviewer was satisfied with the use of the model to-date and provided several suggestions / recommendations to improve its performance. It is noted that the recommendations provided in the McMahon review were considered and where appropriate adopted by modelling consultants. The additional requirements were addressed in a report submitted to DP&E in March, 2014.

4.4.3 OEH Issues with SIMMCP and WIMMCP for Area 3b

OEH has raised ten issues concerning the interpretation and implementation of the Modified Development and SMP Approval Conditions of Consent in their recent letter to Kadenz (28/08/2014).

The issues raised relate to the following Conditions of Consent:

1. Area 3B SMP Condition 6.3 - Bio-Diversity Offset Strategy in DRAFT but not yet satisfied.
2. Area 3B SMP Condition 9.3 - Claimed breach of Performance Measures for Swamp Ecology (Swamp 1a, 1b & 5).
3. Area 3 SMP Condition 11.3 - Watercourse Impact Monitoring, Management and Contingency Plan not yet satisfied.
4. Area 3 SMP Condition 12.3 + DA Condition 6.3 - Swamp Impact Monitoring, Management and Contingency Plan not yet satisfied.
5. Area 3 SMP Condition 11 & 12.3 + DA Condition 6.3 - Swamp Impact Monitoring, Management and Contingency Plan not yet satisfied.
6. Area 3 SMP Condition 13.3 - Groundwater model status unknown.
7. Area 3 SMP Condition 15.3 - Swamp rehabilitation research not yet satisfied.
8. DA Condition 14.3 - Environmental Offsets status unknown.
9. DA Condition 12.8 - Claimed breach of access to information requirement.
10. A number of conditions in Development Consent and SMP Approval - lack of meaningful consultation and lengthy delays in full filling approval requirements.

A detailed response from Gary Brassington, Dendrobium Approvals Manager is attached that has addressed the claims made by OEH. Reference to these and previous OEH correspondences between 13/12/2012 and 6/08/2014 has highlighted several differences of opinion and objections put to DP&E and BHPB on how the Dendrobium Mine has not consulted with them during the development of the Area 3B TARPs and how the impacts to watercourses and swamps have been incorrectly interpreted.

It is however, considered that the majority of issues raised by OEH appear to be related mainly to their perceived lack of opportunity to contribute to the development of the Swamp and Watercourse TARPs and SRRP program. The main issue appears to be is that whilst they were invited to several workshops during the development of these documents, they were not

given any opportunity to contribute to the TARPs until after the draft report was submitted to DP&E. Subsequent requests to amend them have apparently not been responded to. OEH have subsequently claimed that the TARPs are deficient in their capability to identify significant impact to swamps and watercourses and groundwater losses and that the claims of 'minor' impact are actually more significant than this.

In regards to the SRRP, OEH were critical of the first component of sub-surface cracking research undertaken above LW9. OEH acknowledges that the research fulfils the deep groundwater modelling aspects of the project, but has done little to address our understanding of the shallow subsurface fracturing networks and whether grouting would be an effective swamp rehabilitation method of helping to restore pre-mining groundwater levels and recession rates. OEH claim that the external review of the SRRP would ensure scientific rigour and allow beneficial dissemination of swamp rehabilitation knowledge to other projects.

A request was also made by OEH (17/01/2014) that the Dendrobium Mine should acknowledge that subsidence impacts may be reduced by consideration of mining geometry changes in the SMP Documentation is also a valid CMA in future mining areas. OEH note that the Giant Dragonfly is also not included in the Fauna Impact TARP.

The lack of accessibility to raw swamp and watercourse impact data is still a significant issue to OEH/SCA, as it has not been provided on the Dendrobium website or at least made available to stakeholders as was requested of the mine in the previous audit report.

Further discussion on these issues in the context of SMP Compliance is provided in **Section 6.0**.

4.4.4 DSC Issues with Groundwater Level and Chemistry Monitoring

DSC has raised two issues concerning deep aquifer groundwater level and water chemistry monitoring in the Scarborough and Bulgo Sandstone in their recent letter to Kadenz (12/11/2014). The issues raised include:

- incorrect groundwater pressure heads calculated from vibrating piezometer data caused by the assumption applied to early spreadsheets that 1 m head of water = ~10kPa has been replaced with the conversion 1m head of water = 9.8041kPa.; and

- Some of the water chemistry anolytes have been contaminated by leachate from cementitious grout plugs that were installed to seal off the rock mass sections. DSC note that this issue has not been acknowledged or resolved at this stage.

DSC consider that the above issues represent a non-compliance with the required monitoring and reporting conditions within the Notification Areas.

It is considered by the auditors that the above issues have now been responded to adequately by IC in their letter to Kadenz (dated November 2014).

5.0 Site Inspection Results

Several impacted sites in Areas 3A and 3B were visited on 3/09/2014. The attached photos show typical subsidence impacts at the creeks, swamps and landscape sites visited above LWs 7 to 9. It was noted that the observed impacts were consistent with the documentation provided by the mine to government agencies and stakeholders.

6.0 Discussion and Recommendations

6.1 Predicted v. Measured Subsidence Effects

Measured subsidence effects at surface features within the area of influence of mining have generally been less than or consistent with the EA and SMP predictions for the Dendrobium Project Area. It is noted however that the observed subsidence exceedance above the starting end of LW9 has not been addressed adequately, and further review of the possible reasons for the increased subsidence magnitude should be reviewed by MSEC and an independent expert if necessary.

6.2 Effectiveness of SMP/SIMMCP/WIMMCP/SRRP

Overall, the SMP/SIMMCP/WIMMCPs appear to be performing reasonably well in regards to the predicted subsidence and management of impacts. The auditors note that the proposed SRRP and on-going monitoring of impacted features is occurring and that it also includes the potential for grouting and remediation of impacted pools to restore their function as aquatic biota habitats.

Measured impacts have been previously assessed as ranging from ‘negligible’ or no impact to ‘minor’ and ‘moderate’ impact, based on the trigger level definitions provided in the SMP. Several of the Stakeholders have had issues with the mine deciding on whether an impact is ‘minor’ or ‘moderate’ or greater. The mine has subsequently revised the TARPs at least twice in good faith by removing any subjective references to impact.

The previous amendment to the TARPs were applied to Area 3A after LW7 and referred to Impacts that were ‘Normal’, ‘Within Predictions’ or ‘Exceeding Predicted Impact Criteria’.

The TARPs for Area 3B have subsequently removed the references to the predicted impact values and now refer to Level 1, 2 or 3 impact magnitudes (i.e. crack size, erosion, gas release, iron staining, lowering or loss of pond and ground water level and recharge rate decline, water quality, etc) and the observed consequences or effects on the measured performance indicators (eg. changes to swamp size, declining richness and diversity of species, fauna habitat loss, surface water flow paths etc). The new approach allows measured impacts to be linked directly to the effects on the features (swamps and watercourses, cliffs etc) and is a direct response by the mine to an OEH request for this to be adopted (**Krogh, 2012**).

The overall performance of the TARPs to assign an appropriate CMA to the observed impacts and consequences to natural and man-made features are also considered to have been adequately defined by the TARPs.

Whilst the long-term consequences of mine subsidence on the Endangered Environmental Community are not clear at this stage, any deterioration of the swamps and water courses in Areas 3a and 3b are not apparent from the environmental monitoring results and lack of performance criteria exceedances to-date. It is also considered that the groundwater modelling work being undertaken by the mine and its consultants will continue to improve our understanding of longwall impacts to these areas.

Indeed, the ability of the EECs to survive years of drought and bush fire impacts indicates a high resilience to surface and groundwater level variation. However, the resilience of the swamps and watercourse ecologies might well have been reduced by the current mining layout impacts in the medium to long-term.

The proposed SRRP is therefore likely to contribute to our understanding of the effectiveness of crack sealing rehabilitation works to restore hydrogeological conditions to watercourses and swamps over the next 5 years.

6.3 SMP Compliance with Consent Conditions

The Southern Coalfields Inquiry (DP&E, 2008) defined the meaning of the terms *effects, impacts*, and environmental *consequences* as they pertain to subsidence of natural features:

- The term *effect* describes subsidence itself;
- Any physical change to the fabric of the ground, its surface, or man-made features is described as an *impact;*
- The environmental *consequence* is used to describe any change in the amenity or function of a feature that arises from an impact.

It is considered that the current TARPs applied at Dendrobium appear to have reasonably categorised and linked measured/observed *impacts* and their *consequences* in the appropriate Trigger Level Category for a particular feature or key performance indicator.

Based on the EoPRs and AEMRs, the TARPs have identified several Level 2 and 3 Impacts that are within the predicted ranges of the SMP Report, but are being considered for CMAs in consultation with SCA, T&I, DP&E and OEH. These impacts include the remediation of several drained pools 7 and 8 along WC17 and Pool 10 on SC10C watercourses.

The lowering of the shallow groundwater levels beneath all undermined swamps to-date are a concern in regards to swamp health and function to support EECs; however, as it was recognised as a potential impact in the SMP reports, they do not appear to represent a breach, based on the apparent lack of change to the swamps as required by the Performance Measures.

The lack of accessibility to raw swamp and watercourse impact data is still also a significant issue to stakeholders. It is considered by the auditors that the information required to be reported by the mine has been done so in accordance with the approval conditions of consent. It is not appropriate that the mine should have to provide unprocessed environmental monitoring data to Stakeholders. The raw data is first interpreted by experts in their field, peer reviewed and then subject to independent audit.

It is considered that the proposed SRRP for Area 3A and 3B watercourses and swamps will probably alleviate and address the majority of the OEH *et al* concerns if groundwater and surface water levels can be restored. However, if this SRRP does not achieve the desired levels, then independent input into the Dendrobium TARPs may be considered as part of the SMP Approval process for Area 3C.

For and on behalf of
Ditton Geotechnical Services Pty Ltd

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Attachments:

Photos

Dendrobium Mine's Response to OEH Issues (dated August, 2014)

References:

Ecoengineers, 2014. **End of Panel Surface and Groundwater Impacts Assessment-Dendrobium Mine Area 3B - LW9**. Ecoengineers Pty Ltd Report No. 2014/01 (01/06/2014).

HydroSimulations, 2014. **End of Panel Groundwater Assessment for LW9 (Area 3B)**. HydroSimulations Pty Ltd Report No. HC2014/015. (19/08/2014).

Krogh, 2012. **Assessment of Impacts over Dendrobium Mine**. Martin Krogh. Office of Environment and Heritage, Department of Premiers and Cabinet (31/08/12).

McMahon, 2014. **Independent Review of Surface Water Study for Dendrobium Community Consultative Committee**. Emeritus Professor T.A. McMahon, University of Melbourne (04/06/2014).

Photo 1 - Down stream Rock Bar Cracking and Iron staining along 1st Order Creek No. SC10C, Area 3A (>2 years since mining of LW 7)

Photo 2 - Cracked Pond Rock Bar after recent rains along 1st Order Creek No. SC10C, Area 3A (>2 years since mining of LW 7)

Photo 3 - Drained Pond No. 10 after recent rains along 1st Order Creek No. SC10C, Area 3A (>2 years since mining of LW 7)

Photo 4 - Uncracked creek bed upstream of Impacted Sections of 1st Order Creek No. SC10C, Area 3A (>2 years since mining of LW 7)

Photo 5 - Downstream of Sandy Creek Bridge after LWs 6 to 8 completed in Area 3A

Photo 6 - Immediately Upstream of the Sandy Creek Waterfall after LWs 6 to 8 completed in Area 3A

Photo 7 - Swamp No. 1b along Donalds Castle Creek in Area 3B above LW9

Photo 8 - Surface water and saturated peat within Swamp 1b along Donalds Castle Creek in Area 3B after LW9 Complete

Photo 9 - Shallow Ground Water Level & Soil Moisture Monitoring in Swamp 1b along Donalds Castle Creek in Area 3B

Photo 10 - Water Flowing Downstream of Swamp 1b along Donalds Castle Creek in Area 3B after LW9 Complete

Photo 11 - V-Notch Weir Constructed by OEH Contractors to Independently Measure Surface Water Discharge Variation over a Rock Bar Down Stream of Swamp No. 1b above LW9

Photo 12 - Location of IC Subsurface Fracturing Research Boreholes to Test Impact of LW9 on the Bald Hill Claystone