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Company:	The Bloomfield Group		
Attention:	Christopher Knight		
Cc:			
From:	Damien Janssen		
Date:	29/11/2018	**Job No:**	EWP72644.005
Subject:	Rix's Creek North Pit Void Assessment		

Hi Christopher,

Further to our recent discussions, we present the following report discussing the anticipated hydrological function of the backfilled North Void, to be utilised as a clean water dam.

1 Background

Rix's Creek Mine of Rix's Creek Pty Ltd, is owned and operated by Bloomfield Collieries Pty Ltd (Bloomfield). The mine is an open cut coal mine approximately 5km northwest of Singleton in the Hunter Valley Coalfields of NSW. Bloomfield is seeking approval for the Rix's Creek Continuation of Mining Project which relates to the continued operation of the existing open cut coal mine – seeking to extend the life of the existing mining operation until approximately 2037. The continuation of mining operations will extend in a north-westerly direction. RPS have completed the Groundwater Impact Assessment (RPS, 2014)[1] for the Continuation of Mining Project, including the assessment of drawdown during operational dewatering, along with the predicted groundwater recovery and salinity trends for the mine site in a post mine closure state.

To facilitate the ongoing public consultation during the approval phase, and in response to an Independent Planning Commission (IPCN) recommendation "that the applicant investigate water impacts related to any interaction with backfilled North Pit Void consistent with those undertaken for the West Pit Void". This report, like the previous West Pit Void assessment (RPS, 2018)[2], provides additional information and discussion on the dynamic hydrogeological conditions associated with the North Void - a partial pit void, backfilled above water table, and how the resulting hydraulic dynamics will operate after mine closure.

The discussion includes two components:

- General Concepts - key generic concepts underpinning the backfilled pit void and clean water dam, in recovery/development and in equilibrium; and
- Specific Concepts - application and discussion in the context of the Rix's Creek Continuation of Mining Project.

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[1] RPS 2014, Rix's Creek Continuation of Mining Project Groundwater Impact Assessment, prepared for Bloomfield Collieries Pty Ltd, September 2014

[2] RPS 2018, Rix's Creek West Pit Void Assessment, prepared for Bloomfield Collieries Pty Ltd, June 2018

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2 Pit Void Dynamics - General Concepts

The pit void dynamics in this instance can be considered in two parts:

- The backfilled pit void, with material placed to elevations higher than predicted groundwater level recovery; and
- The above water table remnant pit void, to be utilised as a clean water dam.

2.1 Below Water Table Backfilled North Void

With the spoil material from the site backfilled into the North Void to a level above anticipated groundwater levels, the main process in play is the slow regional groundwater level recovery (at same salinity/quality as the regional system) saturating the backfill material and surrounding basement formations. There will also be enhanced local groundwater recharge from ponded fresh water in the remaining depression (direct rainfall and up-catchment runoff) that will locally accelerate groundwater recovery to equilibrium levels (with a slight freshening of the overall saline groundwater resource in the area). However, the degree to which vertical infiltration can occur though the base of the dam will be inhibited by the preferential placement and compaction of finer grained materials such as claystones, siltstones and mudstones with clay subsoil where available.

Considering that the backfilled material landform has been placed to an elevation approximately 5m above the recovered regional groundwater level, the effects of evaporation on groundwater levels/quality can be discounted, not able to contribute to the dynamics of the groundwater system recovery.

The ultimate groundwater levels and associated gradients are also driven by the below water table permeability characteristics and contrasts between backfill material (0.1 to 1 m/d) and basement units (0.01 to 0.001m/d). This will lead to slightly elevated groundwater levels and flat hydraulic gradients in the higher permeability backfill material; and slightly lower groundwater levels and steeper hydraulic gradients moving into the surrounding lower permeability basement rock units, and tying in to regional groundwater gradient trends in the area. These dynamics are outlined in Figure 1 below.

2.2 Above Water Table Remnant Pit Void

The remnant pit void, to be utilised as a fresh water dam, will have a water balance driven by a number of factors, including:

- Direct rainfall and runoff volumes from up-catchment areas;
- Evaporative losses from the dam water surface; and
- Infiltration losses from the dam vertically into the deeper regional groundwater system (this will be reduced by the placement and compaction of available lower permeability materials – claystones, siltstones, mudstones and clay subsoils).

As with the groundwater system discussed above, there will be a development stage and an equilibrium stage for the clean water dam. The development stage will occur when the dam is undergoing its initial filling, which will take a number of rainfall events over several years to fill the clean water dam to its equilibrium level (which will ultimately be controlled by the elevation of the dam outflow point). After this dam equilibrium level is reached, each subsequent up-catchment significant rainfall/runoff event will induce an associated overtopping event which will flow into the down-catchment creek line.

Between runoff (and overtopping) events, the water balance drivers of evaporation and infiltration will slowly reduce the volume of fresh water in the dam. Evaporation processes will also have a slight influence on the overall salt concentrations (building up over time) within the clean water dam. However, as rainfall events are relatively consistent on a seasonal basis, there is continual fresh water diluting and flushing to control and reset any minor evapo-concentration salt build-up effects. Figure 1 presents these dynamics and interactions below.

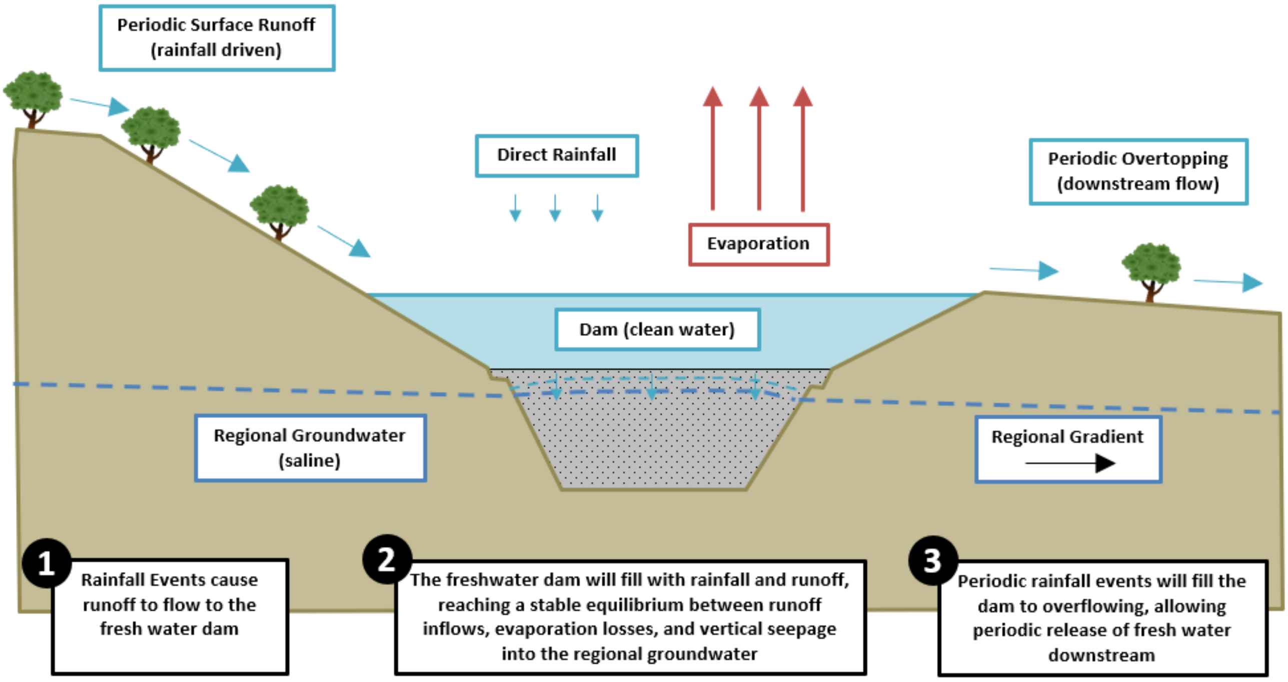

Figure 1 – Water Balance Drivers in Clean Water Dam in backfilled Pit Void (Note: schematic illustration only)

In terms of possible interactions between the clean water dam and the underlying regional groundwater system, the following are identified:

- Localised groundwater mounding beneath the clean water dam, controlled initially by the ability of water to infiltrate through the base of the dam into the groundwater system, controlled ultimately by the ability of groundwater to flow away from this recharge (regional permeability), as mounding will "back-up" and ultimately stabilise;
- Localised groundwater freshening beneath the clean water dam which will mix and diffuse within the regional saline groundwater resource over time. This slightly "fresher" saline water will move in accordance with the regional groundwater gradient

3 Pit Void Dynamics – Rix's Creek Specific

3.1 Fresh Water Dam Dynamics

In applying the key hydrological processes for the clean water dam to the site-specific setting of the Rix's Creek North Void the following inputs were considered:

- Direct rainfall (on the surface area of the water dam) and runoff volumes (on the up-catchment surface area, and adopting a conservatively low run-off co-efficient of 10%);
- Evaporative losses from the dam water surface; and

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- Infiltration losses from the dam vertically into the deeper regional groundwater system (adopting an infiltration rate aligned to the selective placement of claystone, siltstone, mudstone in the base of the dam).

On this basis, it was observed that in the vast majority of years – average rainfall (650mm); wet year (2015 / 899mm); the inflows of direct rainfall and surface run-off were greater than the losses of evaporation and infiltration. However, in the driest years (ie. 2006 / 424mm) on an annual basis, more water evaporated/infiltrated than entered the dam, meaning there could be infrequent years when overtopping events do not occur.

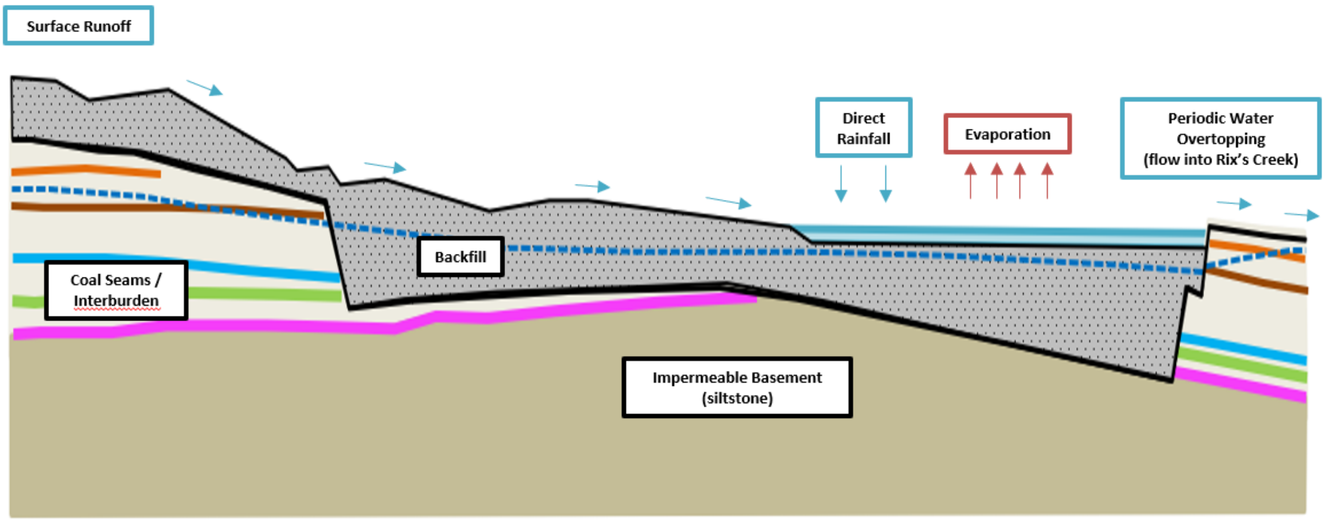

Figure 2 – Rix's Creek North Pit Void (Note: long-section with vertical exaggeration)

There will effectively be two key stages to the clean water dam development – the "filling" stage; and the "equilibrium" stage. The filling stage will be characterised by all the inflow volumes from rainfall and runoff accumulating within the dam as it fills. Based on the volume of the clean water dam, which is nine metres deep in the deepest areas, it may take a number of years (dictated by actual rainfall events and associated volumes) for the clean water dam to approach its equilibrium stage – where subsequent inflow volumes would result in a commensurate outflow pulse, which will contribute to periodic creek flow events within Rix's Creek.

As mentioned previously, when the clean water dam reaches its equilibrium state, the water balance indicates that in all except the driest of years, more water flows into the dam than evaporates or infiltrates – so the dam will push outflow volumes into the Rix's Creek drainage line. Another important implication of this water balance dynamic is that the clean water dam will maintain its fresh water quality – with fresh inflow volumes from local rainfall events continually mixing and flushing through the clean water dam. Even in a drying climate scenario (where low rainfall years might move towards an inflow/outflow balance), the regularity of average and above average events will ensure that the clean water dam is overtopping often, with creek flow events most years, and often numerous times per year.

3.2 Surface Water – Groundwater Interaction

In terms of possible interactions between the clean water dam and the underlying regional groundwater system, specifically at the North Void / fresh water dam area, the following are identified:

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- Localised groundwater mounding beneath the clean water dam, inhibited initially by the presence of the selectively placed lower permeability materials, and the ability of water to infiltrate through this into the groundwater system; and controlled ultimately by the ability of groundwater to flow away (via regional permeability) from this local continual recharge, so mounding and recharge will “back-up” and ultimately stabilise;
- Localised groundwater freshening beneath the clean water dam, although this will likely mix and diffuse within the regional saline groundwater resource over time. This slightly “fresher” saline water will move in accordance with the regional groundwater gradient – which in the case of Rix’s Creek, will be to drain towards the West Pit hydraulic sink associated with the pit lake left there (RPS, 2018).

Based on the above key findings, it is concluded that the above water table North Void (and clean water dam) at the Rix’s Creek project, will sustainably operate as intended (ie. a clean water dam, with periodic fresh water releases into the Rix’s Creek drainage line). It is also confirmed that such a dam in the above water table backfilled void will not impact upon future water quality of the regional groundwater resource.

Yours Sincerely,
RPS Water

Damien Janssen
Principal Hydrogeologist