Memorandum

Date	27 October 2021
To	Kimberley Flowerdew
CC	
From	Iain Rea
Our ref	RE MAC 2021027 MEMO Yandi E8 Wetting Front

Subject	**Yandi E8 Creek Discharge Wetting Front**

Background

An option to manage surplus water at MAC is to transfer water from the existing A Deposit TN to the existing Yandi Downstream discharge point on Marillana Creek. This discharge point is located immediately downstream (east) of the rail bridge crossing adjacent to the E8 deposit (refer Figure 1 and 2).

The Department of Environmental Regulation Licence to Operate L6168/1991/10 for Yandi (Marillana Creek) Iron Ore Mine includes approval to discharge up to 15,000,000 tonnes of mine dewater per year (41.1ML/d). The majority of this allocation was historically utilised. However, since 2018 dewatering volumes have declined sharply as the remaining aquifer thickness has declined and the dewatering objective moves from drawing down water levels to maintaining water levels. The forecast FY23 surplus (discharge) is 10ML/d declining to 4ML/d in FY25.

The flow rate for the MAC to Yandi discharge scheme has been nominated at 30ML/d.

Approach to modelling Wetting Fronts

BHP has previously modelled wetting fronts using modelling techniques such as 2D hydraulic modelling or GoldSIM modelling. The use of 2D hydraulic modelling assumes unlimited storage under the wetting front which is appropriate where there is a large depth of storage. GoldSIM modelling requires establishment of a series of storages and assigning parameters such as volume and permeability to these sub storages.

All models are only as accurate as the underlying assumptions which results in a large degree of uncertainty.

The preferred method of estimating wetting fronts is to conduct trials.

As BHP have discharged water at this location for some 15 years at similar rates, the expected wetting front can be determined by using historical observations.

Available Observations

There are two available data points on the historical discharge, 2008 and 2013. These are analysed below.

2008 Wetting Front

The first observation is April 2008 when a discharge of 29.3ML/d was recorded by Rio Tinto as resulting in a wetting front length of 9km. Rio Tinto observed that the flow recedes to zero at MR17. It was also observed that downstream of this site (between MR17 and MR19), flow occurs between discontinuous pools at a rate of between 2 and 5ML/d. This is a result of water which is flowing through the gravels daylighting at local low points.

At the time of these observations Rio Tinto had not developed the CID deposits between the BHP discharge and site MR15.

The result are published on the EPA website *Rio Tinto: Yandicoogina Water Balance:pre and post mining hydraulics and hydrochemistry.*

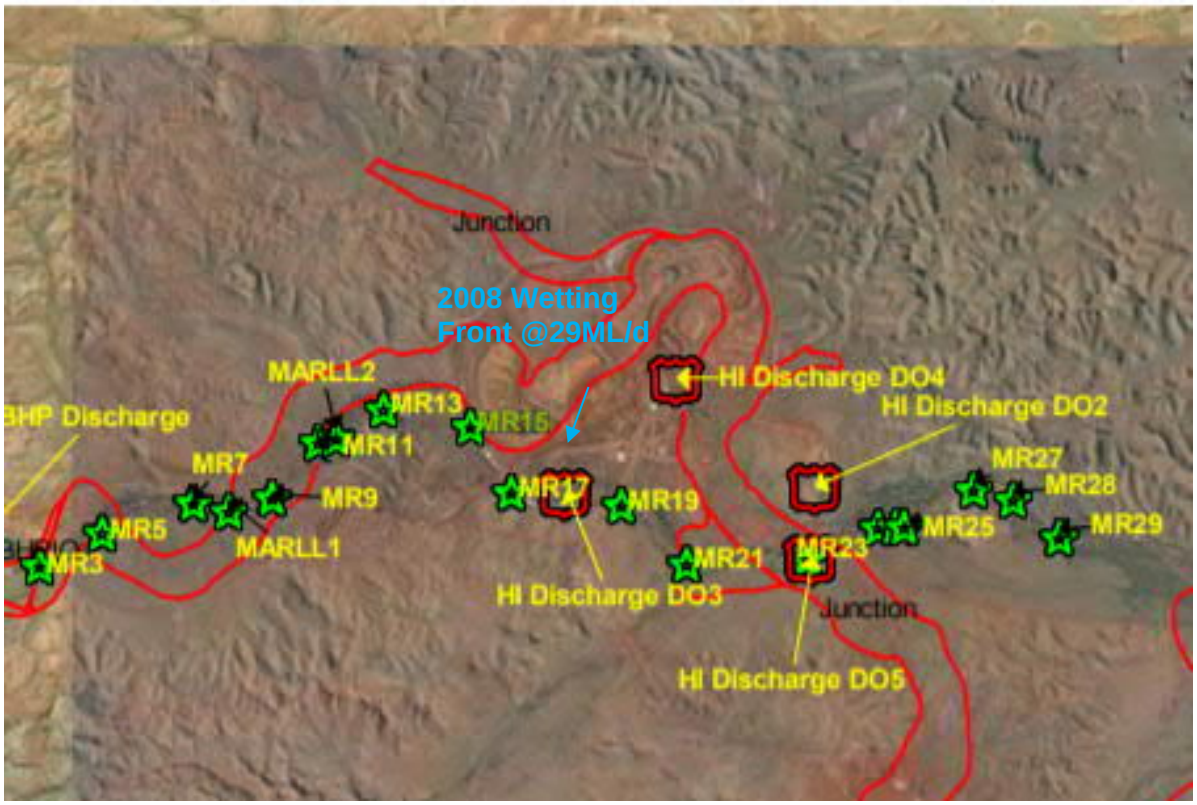
To confirm that the observations were not impacted by natural streamflow, the Flat Rocks stream gauging site located on Marillana Creek upstream of the BHP tenement was obtained and is shown in Table 1. The data shows that during

April 2008 there was only minor stream flow. These small volumes recorded at Flat Rocks are typical of seepage which occurs at the dolomite sill. They do not progress more than 1km downstream and would not impact flows near the .

Table 1: Streamflow conditions in 2008

Month	Recorded Streamflow (ML/d)	Average Streamflow (ML/d)
Jan-13	110	87
Feb-13	38	63
Mar-13	221	47
Apr-13	2	5
May-13	1	3

Figure 1: Wetting Front Limit 2008



2013 Wetting Front

The 2013 Wetting front limit is defined by aerial imagery taken 5 May 2013 by BHP over the Rio Tinto tenure. This imagery is shown in Figures 2 and 3.

Figure 2: Wetting Front Limit 2013

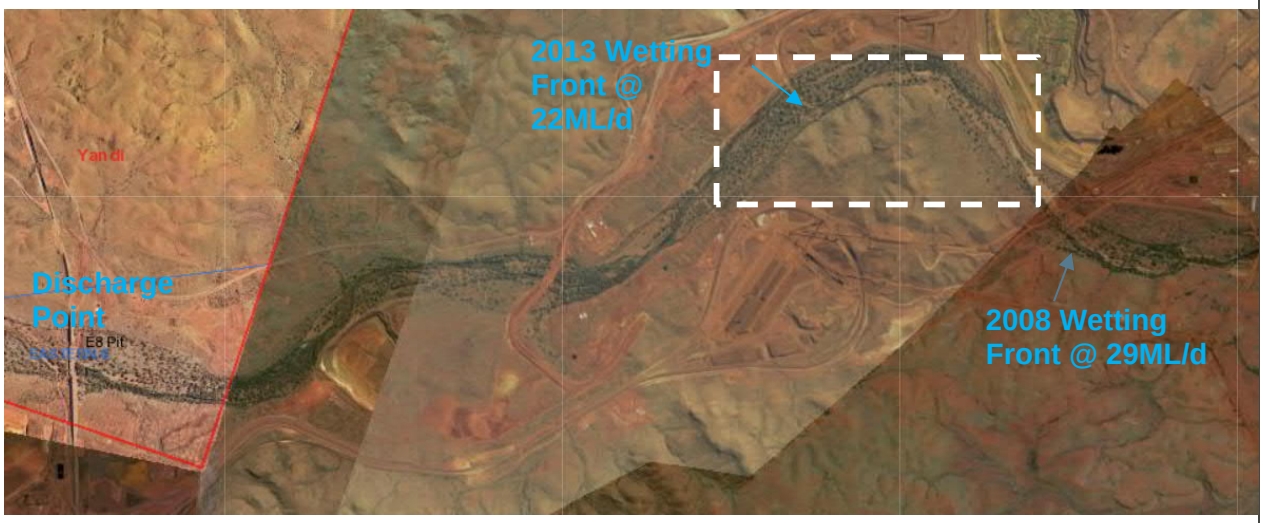
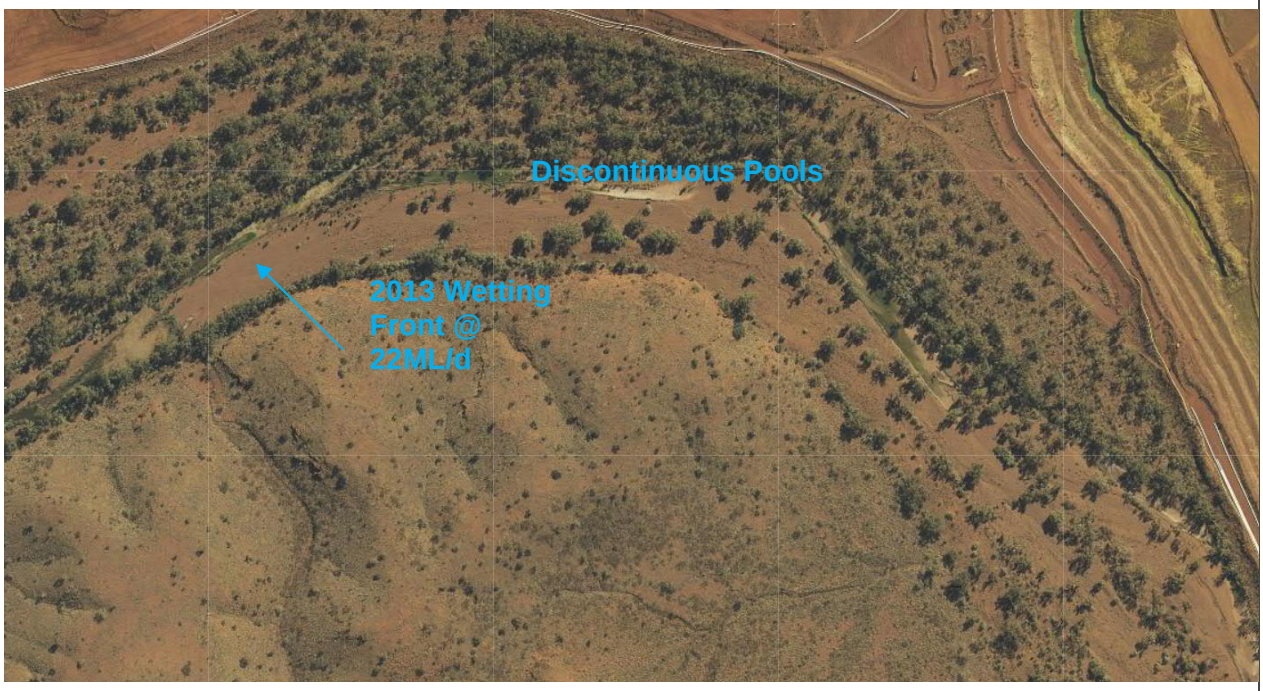


Figure 3: Wetting Front Limit 2013. Detailed Image



BHP Discharge through this period is detailed in Table 2. It can be seen that the discharge was steady at an average of 22.5ML/d. The wetting front length recorded in May 2013 was 6.5km.

Table 2: Discharge Volumes 2013

	Production ML/d	Consumption ML/d	Discharge ML/d
Mar-13	43.8	11.6	32.2
Apr-13	34.1	11.6	22.5
May-13	34.1	11.6	22.5

To ensure that there were no surface water flows at this time that would skew results, the stream gauging data was downloaded. This is contained in Table 3 and shows that during this time streamflow was below average and not a factor.

Table 3: Discharge Volumes 2013

Month	Recorded Streamflow (ML/d)	Average Streamflow (ML/d)
Jan-13	12	87
Feb-13	1	63
Mar-13	58	47
Apr-13	0	5
May-13	0	3

Conclusions

The wetting front recorded in 2008 with a discharge of 29.3ML/d was 9km.

In 2013 the wetting front with a discharge of 22.5ML/d was 6.5km.

This data is consistent and as it is based on observations is more reliable than what could be achieved via modelling. Since these observations, Rio Tinto have developed and dewatered the deposits between the discharge point and the observed wetting front limits. This will tend to increase the losses from the creek base and reduce the wetting front for a given discharge rate. Consequently, these historical observed limits can be considered an upper limit.

Please contact Water Engineering if further information is required.

Regards,
Iain Rea

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