

Environment & Community Superintendent
Peabody Energy – Metropolitan Coal
Parkes Street
Helensburgh NSW 2508
Attention: Stephen Love

Stephen,

Re: Assessment of Performance Measure for Negligible Environmental Consequences on the Waratah Rivulet

1. INTRODUCTION

In accordance with the Metropolitan Coal Longwall 304 Water Management Plan, Metropolitan Coal is required to undertake an analysis against the subsidence impact performance measure for the Waratah Rivulet downstream of the maingate of Longwall 23. The relevant performance measure relating to environmental consequences on the Waratah Rivulet downstream of the maingate of Longwall 23 is as follows (**emphasis added**):

*Negligible environmental consequences (that is, **no diversion of flows, no change in the natural drainage behaviour of pools**, minimal iron staining, and minimal gas releases) on the Waratah Rivulet between the full supply level of the Woronora Reservoir and the maingate of Longwall 23 (upstream of Pool P).*

In order to assess the potential exceedance of the performance measure, an analysis of pool water levels against the Longwall 304 Water Management Plan significance levels is periodically undertaken. The significance levels / triggers for Pools P, T, U, V and W on Waratah Rivulet are as follows:

Negligible Environmental Consequences on Waratah Rivulet: No Diversion of Flows, No Change in the Natural Drainage Behaviour		
Performance Indicator	Significance Levels/Triggers	
Analysis of water level data for Pools P, T, U, V and W indicates the water level is at or above the pool's previous minimum.	Level 1	The water level in Pools P, T, U, V or W has not been below the pool's previous minimum.
	Level 2	The water level in Pools P, T, U, V or W has been below the pool's previous minimum, however, is considered to be due to an error type.
	Level 3	The water level in Pools P, T, U, V or W has been below the pool's previous minimum and does not appear to be due to an error type; and the same is not occurring in control pool(s).

In the quarterly analysis for July to September 2019¹, the recorded water level in Pool U fell below the pool's previous minimum and the same behaviour was not observed at the control pools on Woronora River. In accordance with the above significance levels / triggers, this equates to a Level 3 significance level and therefore requires further investigation.

¹ HEC (2019). "Metropolitan Coal LW 304 Extraction Plan Triggers – Water Quality and Pool Water Level Analysis 3rd Quarter 2019". Hydro Engineering & Consulting Pty Ltd letter: J0604-76.l8b.

In order to assess whether there has been an exceedance of the performance measure and the possible cause of the reduction in Pool U water level, Hydro Engineering & Consulting Pty Ltd (HEC) has been commissioned to undertake detailed investigation of the climatic conditions and hydrological characteristics of the Waratah Rivulet and control pools. Specifically, the works undertaken and detailed in this letter report comprise:

- Consideration of rainfall and the rainfall residual mass curve leading up to the recorded low water level in Pool U (for at least the preceding five years to adequately capture any trends);
- Detailed consideration of the water level data at Pool U and the control pools, as well as pools upstream and downstream of Pool U;
- A conclusion as to whether the performance measure above is considered to have not been met as a result of the recorded low water level in Pool U; and
- Recommendations as to any further follow-up actions.

2. POOL U CHARACTERISTICS

Pool U is located on Waratah Rivulet approximately 460 metres (m) upstream of the future Longwall (LW) 309 and approximately 620 m from the western boundary of LW 27 (refer Figure 1). LW 27 was mined between September 2016 and March 2017, while mining of LW 309 has not yet commenced. During the review period, Metropolitan Coal was mining LW 304 which is approximately 1,000 m to the north-east of Pool U.

Figure 2 presents a conceptual figure of Pool U developed by Mine Subsidence Engineering Consultants (MSEC)² during a stream mapping exercise undertaken in 2008. Photographs of Pool U (Photos 1 to 4), collected during the stream mapping exercise, are also presented below.

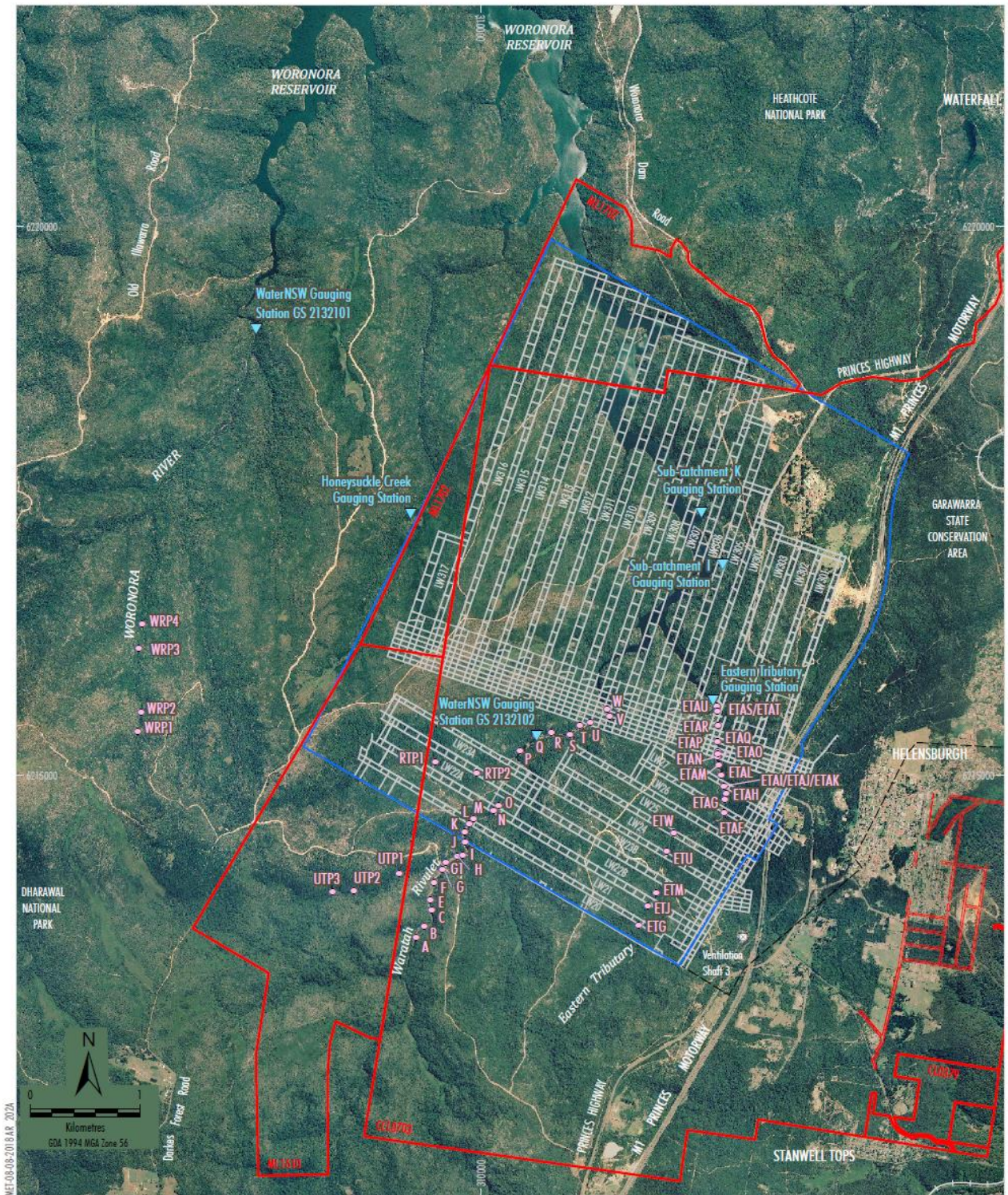
The following characteristics of Pool U were documented by MSEC during the stream mapping exercise in 2008:

- The base of Pool U is comprised of sandstone with boulders and large detached blocks up to 4 m in size and alluvial deposits mainly on the south east bank;
- Flow is restricted by boulders towards the middle of the pool;
- Aquatic vegetation was present at the upstream end of the pool and at the alluvial deposits; and
- Pool U is controlled by a boulder field comprised of vegetation and boulders up to approximately 5 m in size.

The pools directly upstream (Pools P, Q, R, S and T) and downstream (Pool V) of Pool U are rock bar controlled and have different geomorphological characteristics to Pool U. Pool W, downstream of Pool U, is controlled by a boulder field overlying a rock bar and also has different geomorphological characteristics to Pool U. The pools upstream (Pools P, Q, R, S and T) and downstream of Pool U (Pool W and Pool V) have not been previously impacted by mine subsidence³.

² MSEC (2008). "MSEC Stream Mapping – Waratah Rivulet". Prepared for Metropolitan Coal, RES00264102.

³ No diversion of flows, no change in the natural drainage behaviour of pools, minimal iron staining and minimal gas releases.



- LEGEND**
- Mining Lease Boundary
 - Railway
 - Project Underground Mining Area
Longwalls 20-27 and 301-317
 - Existing Underground Access Drive (Main Drift)
 - ▼ Gauging Station
 - Pool Water Level Site

Source: Land and Property Information (2015); Date of Aerial Photography 1998; Department of Industry (2015); Metropolitan Coal (2019); MSEC (2019)

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Surface Water Quantity Sites

Figure 1 Surface Water Quantity Sites



Photo 1 Upstream end of Pool U looking Downstream (MSEC, 2008)



Photo 2 Downstream end of Pool U looking Upstream (MSEC, 2008)



Photo 3 Pool U Potholes and Emerging Flow (MSEC, 2008)

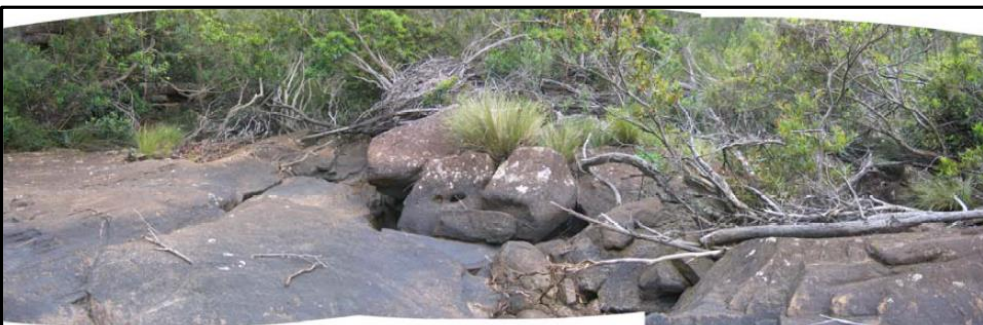
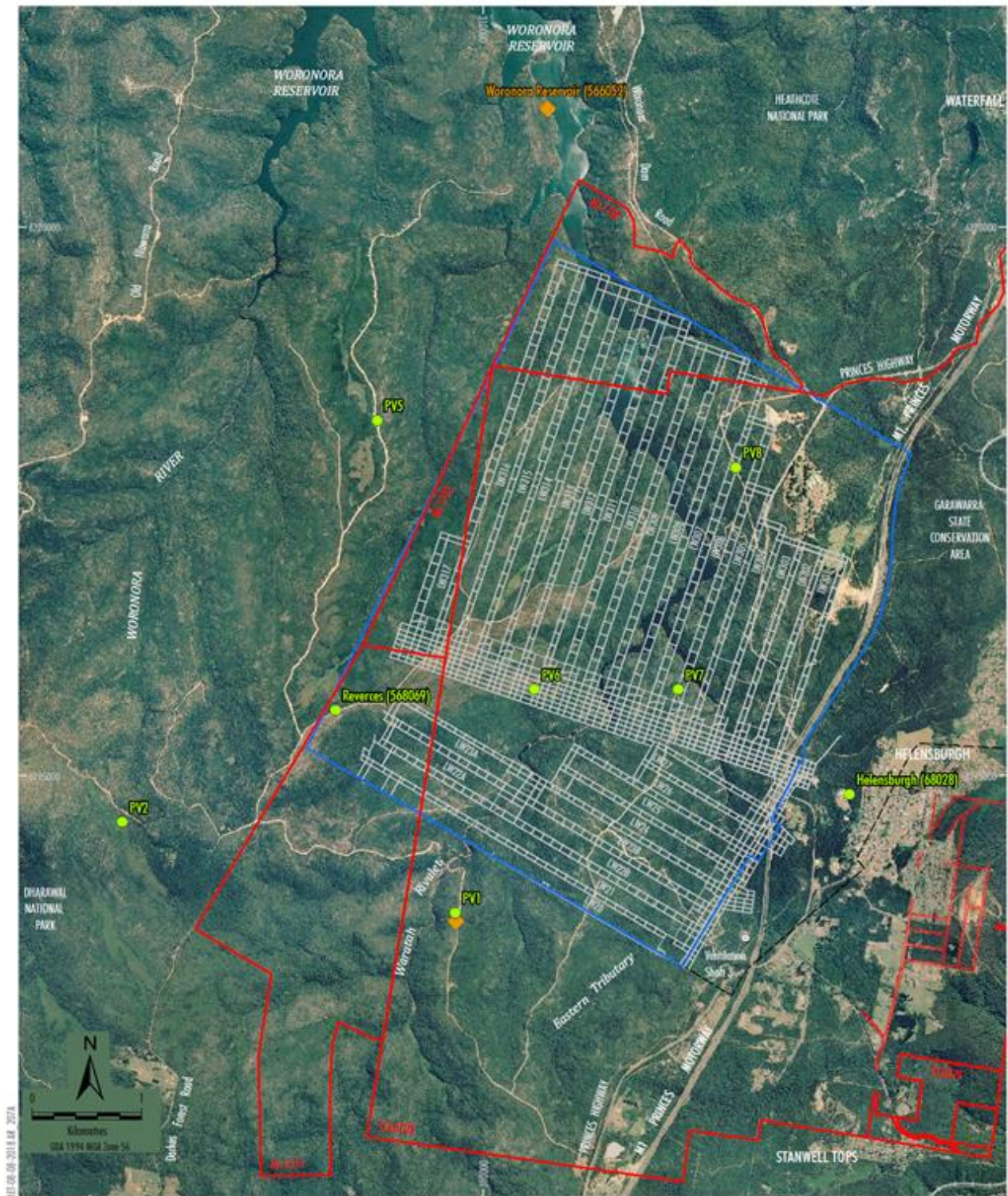


Photo 4 Downstream end of Pool U looking Downstream (MSEC, 2008)

3. CATCHMENT CLIMATIC CONDITIONS

Rainfall data are available for a number of sites within the vicinity of Pool U, with the locations shown on Figure 3. Rainfall station PV6 is located in close proximity to Pool U and has been monitored by Metropolitan Coal since July 2010. The PV6 daily rainfall data for the period January 2011 to December 2019, equivalent to the period of water level record, was used to calculate the rainfall residual mass, as presented in Figure 4. The residual mass is calculated as the cumulative deviation from the mean daily rainfall. Positive (upward) residual mass slopes indicate periods of above average rainfall whereas negative (downward) slopes indicate periods of below average rainfall.



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- LEGEND**
- Mining Lease Boundary
 - Railway
 - Project Underground Mining Area Longwalls 20-27 and 301-317
 - Existing Underground Access Drive (Main Drift)
 - ◆ Evaporimeter
 - Pluviometer

- Notes:**
1. The Bureau of Meteorology pluviometer at Deiras Forest (65024) is not shown. It is located approximately 3.75 km south of the Metropolitan Coal pluviometer (PV2).
 2. The Bureau of Meteorology pluviometer at Lucas Heights (66078) is not shown. It is located approximately 12.5 km north of the Metropolitan Coal pluviometer (PV8).

Source: Land and Property Information (2015); Data of Aerial Photography 1998; Department of Industry (2015); Metropolitan Coal (2019); MSEC (2019)

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 Meteorological Sites

Figure 3 Meteorological Sites

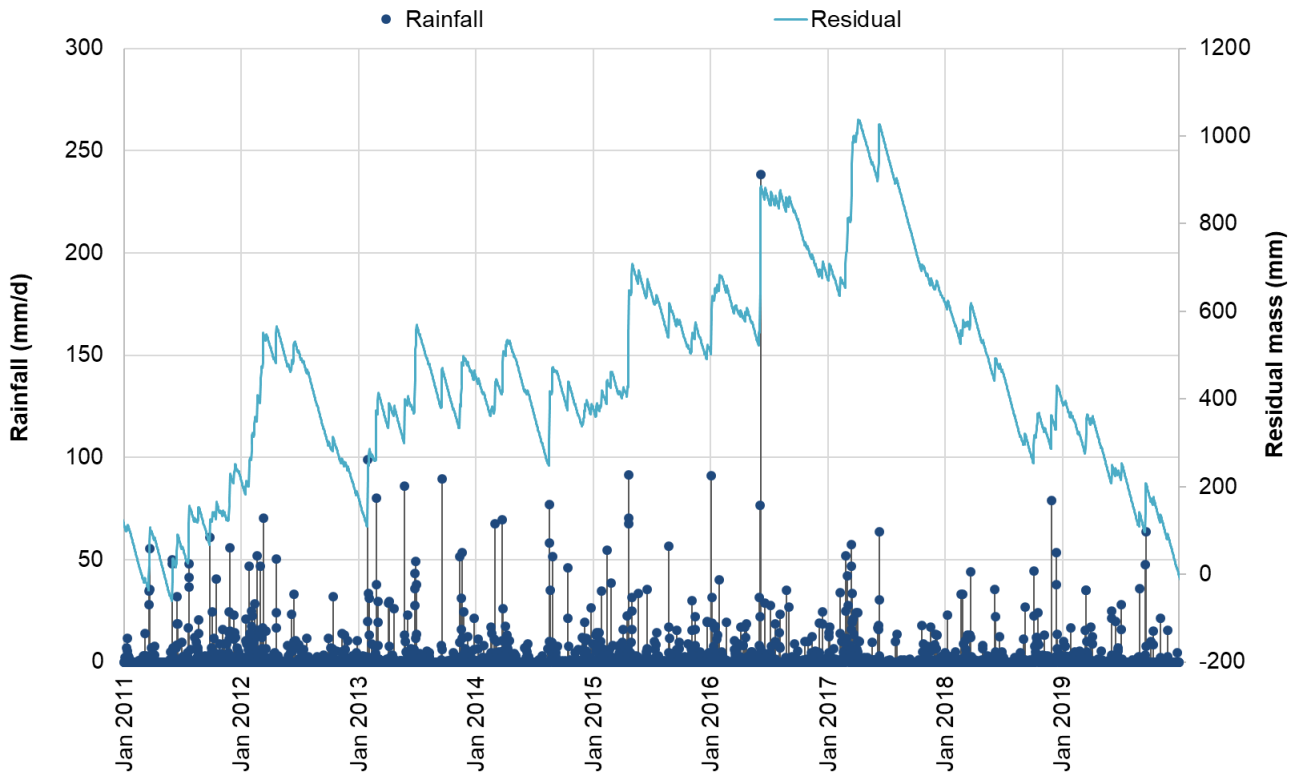


Figure 4 PV6 Rainfall Residual

As illustrated in Figure 4, an overall positive slope of rainfall residual mass occurred between mid-2011 to mid-2017 indicating that above average rainfall occurred during this period. From mid-2017 to December 2019, a negative rainfall residual slope occurred indicating below average rainfall during this period.

Table 1 presents the total annual rainfall recorded at PV6 from 2011 to 2019 inclusive.

Table 1 PV6 Annual Rainfall

Year	Rainfall (mm)
2011	1130.5
2012	992.0
2013	1305.5
2014	958.5
2015	1158.0
2016	1196.5
2017	973.5
2018	806.5
2019	630.0

Table 1 shows a substantial decline in annual rainfall from 2017 to 2019, consistent with Figure 4, with the lowest annual rainfall volumes in the nine years recorded in 2018 and 2019.

The declining rainfall between mid-2017 and December 2019 is also clearly evidenced in the long-term rainfall residual curve presented in Figure 5. The rainfall residual has been calculated for the period of January 1900 to December 2019 from daily rainfall records for Helensburgh (Bureau of Meteorology Station 68028)⁴. The steep negative slope in rainfall residual between mid-2017 and December 2019 is indicative of drought conditions.

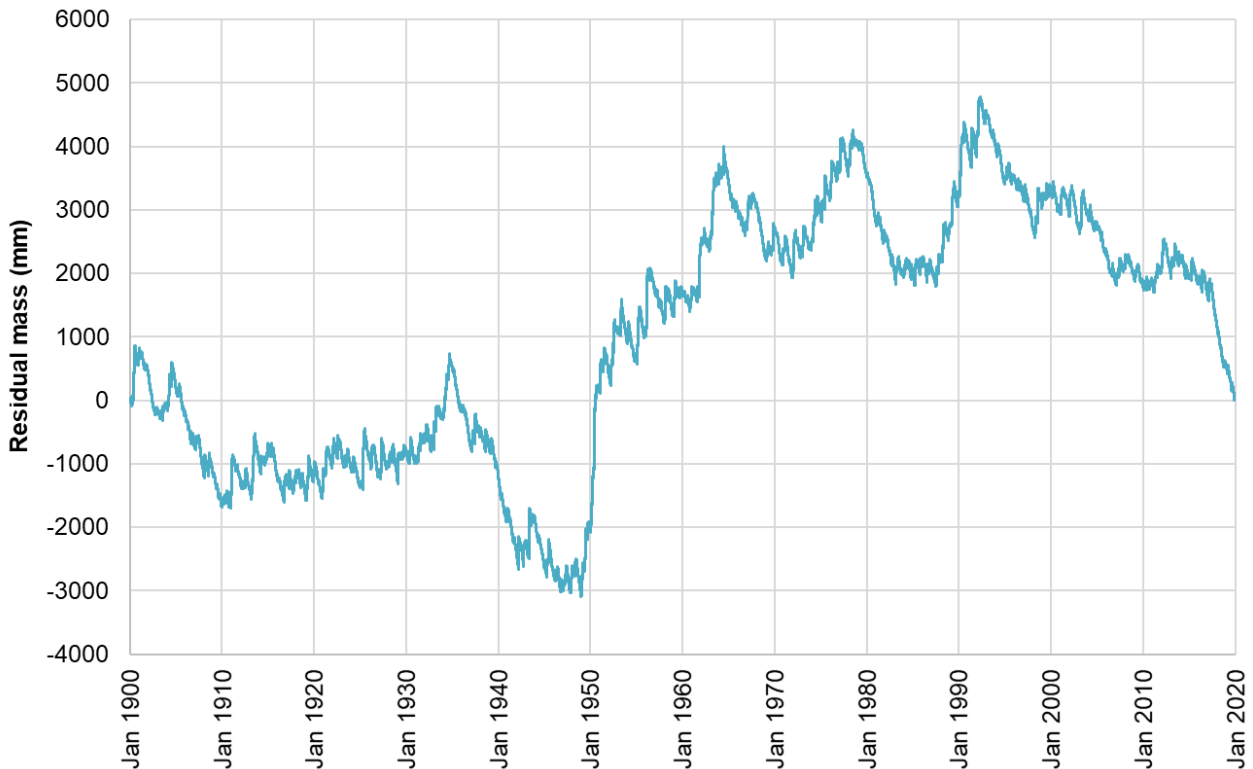


Figure 5 Helensburgh (68028) Rainfall Residual

4. POOL U WATER LEVEL RECORDS

Automated water level monitoring of Pool U commenced in January 2011, with recorded data shown in Figure 6. Water level measurements have been recorded hourly except for periods in which the sensor malfunctioned and required replacement.

⁴ Patched point data obtained from <https://www.longpaddock.qld.gov.au/silo/point-data/>.

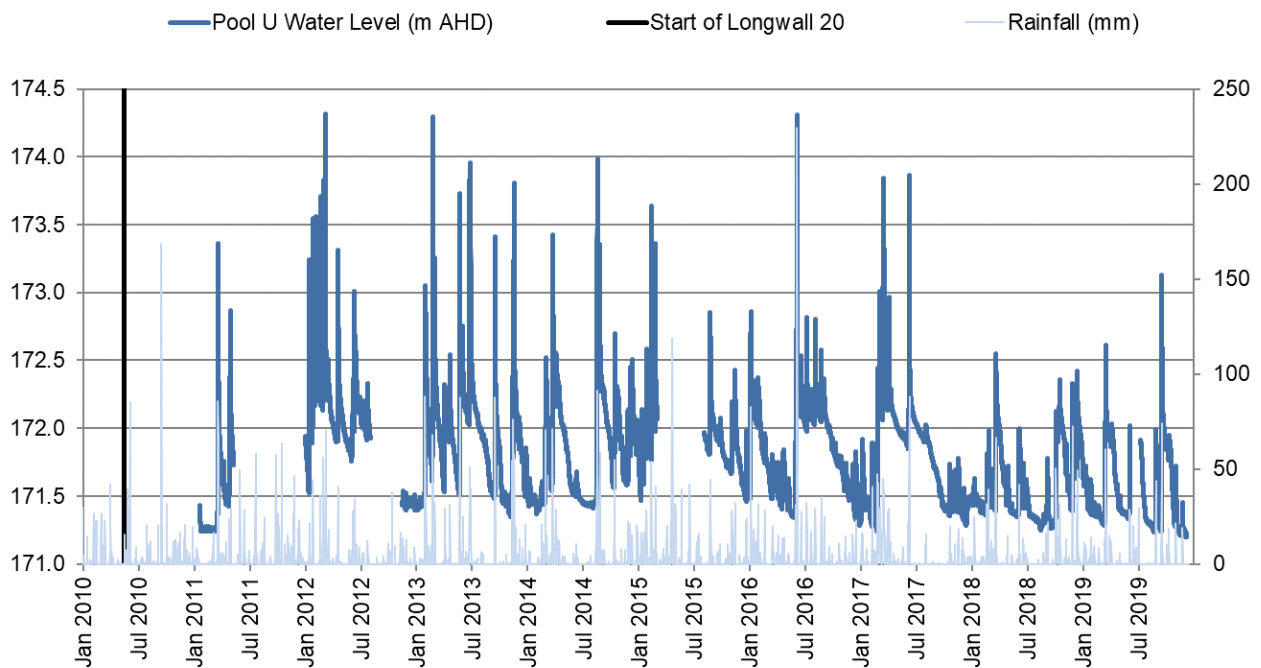


Figure 6 Pool U Water Level

The minimum water level recorded in Pool U between January 2011 and July 2019 was 171.241 m AHD. Between July and September 2019 (the review period), the minimum water level recorded in Pool U was 171.237 m AHD. The water level of Pool U declined below the previous minimum for periods during 24th and 25th August 2019. The minimum water level recorded during the review period was 4 mm less than that of the previous minimum and is within the range of accuracy of the water level sensor and natural fluctuations associated with hot and dry climatic conditions. Following the review period, the water declined further below the previous minimum in November and December 2019, reaching 171.198 m AHD in early December 2019.

The records presented in Figure 6 show lower peak water levels in Pool U from approximately mid-July 2017 in comparison with peak water levels recorded between 2011 and 2017. The lower water level in Pool U is consistent with the substantial decline in rainfall occurring since mid-2017.

The general hydrograph trend has remained consistent over the monitoring period with a sharp peak in water level at the onset of rainfall events, followed by an initial steep recession in water level and then a more gradual recession over a period of months.

5. WATER LEVEL COMPARISON WITH UPSTREAM AND DOWNSTREAM POOLS

The water level records for pools directly upstream (Pool S and T) and downstream of Pool U (Pool V and W) have been reviewed to assess if the water level in these pools fell below their respective previous minimums during the review period (July to September 2019) and if similar behaviour to Pool U was evident at the upstream and downstream pools.

Figure 7 presents the variance of the minimum water level recorded in each month to December 2019 from the minimum water level recorded between January 2012 and September 2019.

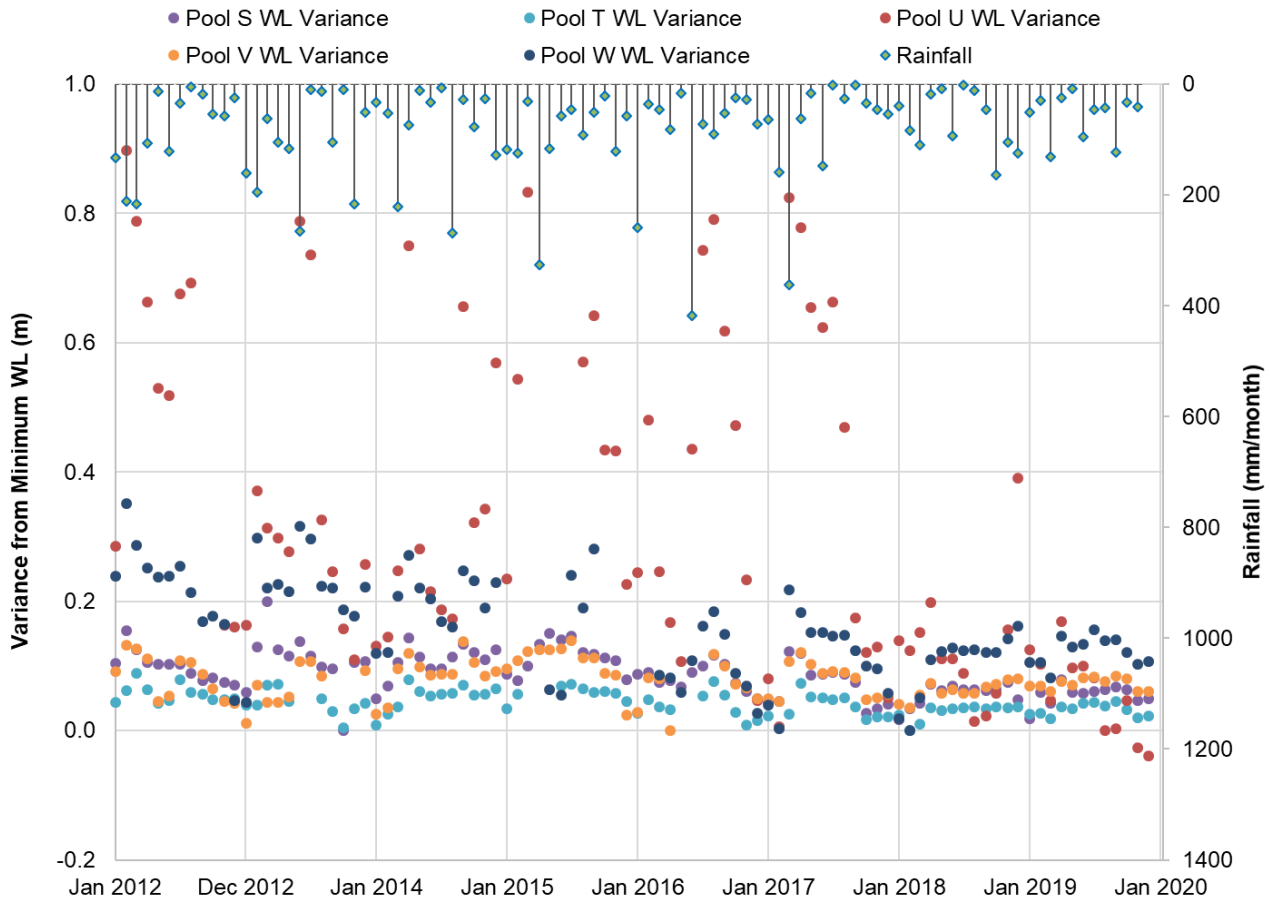


Figure 7 Monthly Minimum Waratah Rivulet Pool Water Level Variance from Minimum Water Level Recorded Between January 2012 and September 2019

Figure 7 illustrates that, during the review period, the water level in Pool S, T, V and W did not fall below the previous minimum. The minimum water level was recorded in October 2013 for Pool S, in February 2018 for Pool T and W, in April 2016 for Pool V and in August 2019 for Pool U. As evidenced in Figure 7, the water level records for Pool U are substantially more variable than the upstream and downstream pools.

Pool U is controlled by a partially vegetated boulder field, as shown in Photo 4. During low flow periods, water would flow through the voids in the boulder field which are likely to be partially blocked by sediment, leaves and other organic matter which build up over time. There is potential for increased seepage and evapotranspiration to occur at the Pool U control due to the presence of sedimentation and vegetation. As such, the Pool U water level is likely to be more susceptible to changes in the control than that of the upstream and downstream pools which are controlled by rock bars (Pools P, Q, R, S, T and V) or than that of Pool W which is controlled by a boulder field overlying a rock bar. Changes in the control for Pool U are likely to account for changes in the water level which are not observed to such an extent at the upstream and downstream pools.

Figure 7 illustrates that the water level of Pool S, T and V appears to be less susceptible to changes in climatic conditions than that of Pool U and Pool W. Prior to 2017, water levels above 0.2 m variance from the minimum water level were regularly recorded at Pool W in comparison with a maximum variance of 0.18 m above the previous minimum water level recorded from February 2017 to December 2019. For Pool U, prior to mid-2017, water levels above 0.4 m variance from the minimum water level were regularly recorded at Pool W in comparison with a maximum variance of 0.39 m above the previous minimum water level recorded from August 2017 to December 2019.

6. WATER LEVEL COMPARISON WITH CONTROL POOLS

The water level records for the control pools on Woronora River (WRP1, WRP2, WRP3 and WRP4) have been reviewed to assess if the water level declined below the previous minimum during the review period (July to September 2019) and if similar behaviour to Pool U was evident at the control pools.

WRP1 is a relatively short pool with inflow via a small, steep cascade and is controlled by a short boulder field / permeable rock bar. Inflow to WRP2 is via a small waterfall and is controlled by an impermeable rock bar in the form of a wide, flat section (i.e. low low-flow sensitivity). WRP3 is controlled by an impermeable rock bar with a narrow low flow section (i.e. high low-flow sensitivity). From photographs of WRP4 collected in 2014, the control for WRP4 appears to be a boulder field however the control section was substantially 'drowned' in water at the time and the exact nature of the control could not be ascertained. In terms of comparison with Pool U, WRP1 and WRP4 are likely the most representative pools although the boulder field control on these pools are relatively short in comparison with the Pool U control and are more likely to have open 'free' flowing pathways between boulder rock fragments.

Figure 8 presents the variance of the minimum water level recorded in each month from the minimum water level recorded between January 2016 and September 2019 for WRP1, WRP2, WRP3 and WRP4 in comparison with Pool U.

Figure 8 illustrates that, during the review period (July to September 2019), the water level in WRP1, WRP2, WRP3 and WRP4 did not fall below the previous minimum. Prior to the end of the review period (September 2019), the minimum water level was recorded in March 2019 for WRP1 and WRP2 and in February 2018 for WRP3 and WRP4. However, the water level of WRP1 fell below the previously recorded minimum in October, November and December 2019. The Pool U water level also fell below the previously recorded minimum in November and December 2019. Although not declining below the previously recorded minimum, the water level of WRP2, WRP3 and WRP4 fell substantially between October and December 2019.

A decline in water level in all control pools on the Woronora River was recorded for the period from mid-2017 to December 2019 in comparison with the period from January 2016 to mid-2017. The decline in water level is consistent with a substantial decline in rainfall during the corresponding period.

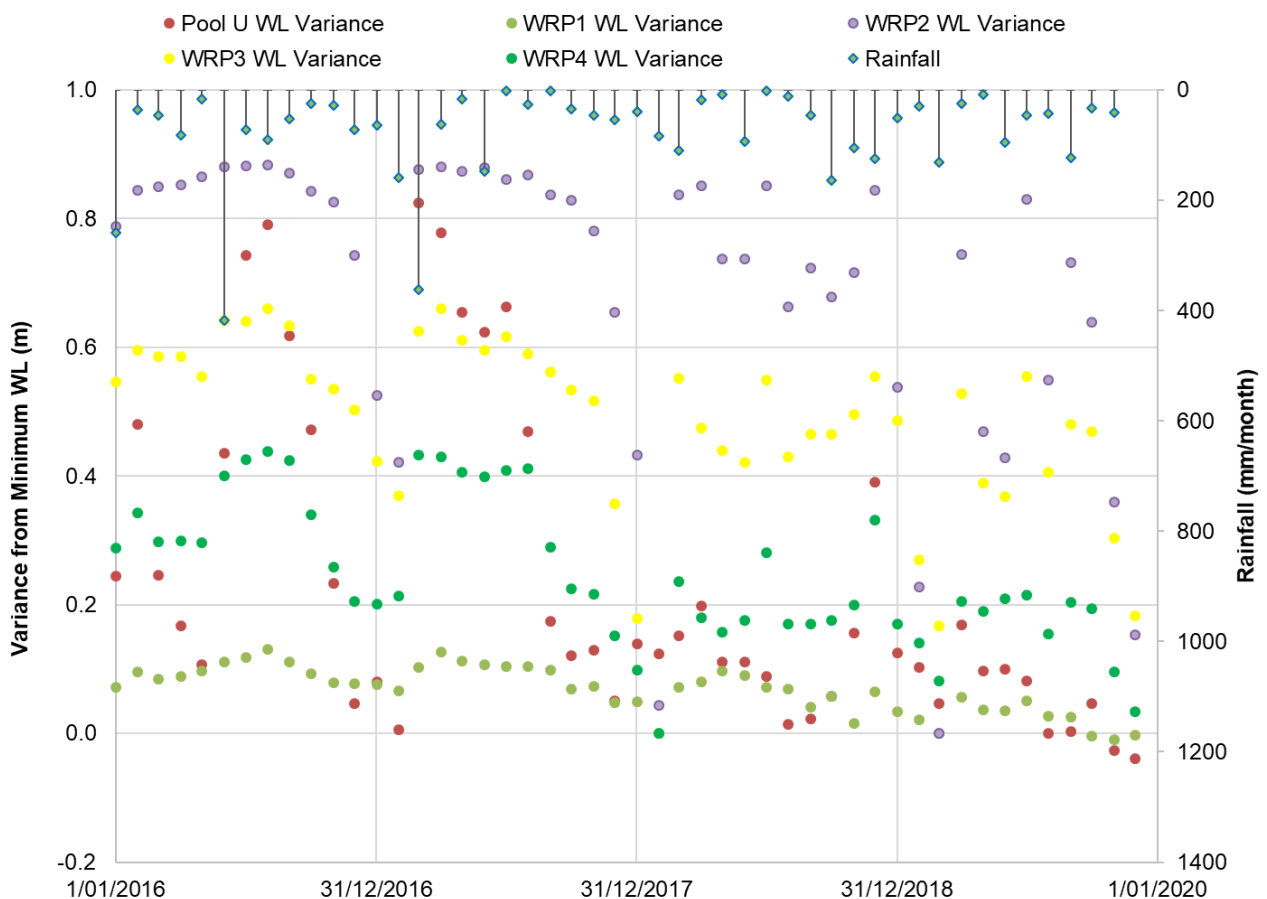


Figure 8 Monthly Minimum Woronora River Pools and Pool U Water Level Variance from Minimum Water Level Recorded Between January 2012 and September 2019

7. ASSESSMENT OF PERFORMANCE MEASURE

Based on the above assessment of climatic conditions and pool water levels in Waratah Rivulet and Woronora River, the performance measure relating to negligible environmental consequences on the Waratah Rivulet between the full supply level of the Woronora Reservoir and the maingate of Longwall 23 (upstream of Pool P) is considered to have not been exceeded.

Although the Pool U water level fell below the previously recorded minimum during the review period (July to September 2019) and the same was not observed at the control pools or the pools directly upstream and downstream of Pool U, it is considered that the decline in water level is a result of climatic conditions and potentially due to changes in the Pool U control as opposed to mine related subsidence impacts. This conclusion has been drawn from the following insights:

- During the review period, Metropolitan Coal was mining LW 304 which is approximately 1,000 m to the north-east of Pool U. Longwall mining within the vicinity of Pool U has not occurred since March 2017 when mining of LW 27, approximately 620 m from Pool U, was completed.
- The decline in water level in Pool U is consistent with the substantial decline in rainfall occurring between mid-2017 and December 2019.


- The minimum water level recorded during the review period was 4 mm less than that of the previous minimum and is within the range of accuracy of the water level sensor and natural fluctuations associated with hot and dry climatic conditions.
- The control and geomorphological characteristics of Pool U are different to that of the pools directly upstream and downstream of Pool U and as such changes in the control for Pool U are likely to account for changes in the water level which are not observed to such an extent at the upstream and downstream pools.
- A decline in recorded water level for all control pools on Woronora River occurred for the period from mid-2017 to December 2019 in comparison with the period from January 2016 to mid-2017. The decline in water level is consistent with a substantial decline in rainfall during the corresponding period.
- The water level of control pool WRP1 fell below the previously recorded minimum in October, November and December 2019.

8. RECOMMENDATIONS FOR FURTHER ANALYSIS

Should drought conditions in the catchment continue, the Pool U water level, and potentially the water level of other pools, may fall below the previously recorded minimum. It is recommended that regular analysis of the pool water level data continues, as is undertaken at present (i.e. quarterly until a Level 2 or Level 3 trigger is identified, and then monthly until data indicates a return to Level 1). Should the Pool U water level continue to decline in the absence of a corresponding decline in rainfall, further investigation should be initiated.

Please contact the undersigned if you have any queries or require further information.

Yours faithfully,



Camilla West
Senior Water Resources Scientist



Tony Marszalek
Director