



Our Ref: 3251\_06012017\_PJ

6 January 2017

Murray Townrow  
Project Manager  
Williamtown Sand Syndicate  
PO Box 898  
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Dear Murray

**Re: Bores Used in Calibration of Groundwater Model for Proposed Cabbage Tree Road Sand Quarry**

Further to your email request for additional information from Hydrosimulations in regard to the use of groundwater levels at HWC groundwater bores SK5992 and SK4942 in calibration of the groundwater model we provide the following.

HWC bores SK5992 and SK4942 are located approximately 1 km to the west and 800 m to the north of Williamtown Sand Syndicate's proposed sand extraction areas respectively and as shown on Figure 3.2 of the Groundwater Assessment (Umwelt November 2015). These bores form part of or are located in close proximity to HWC's Tomago groundwater production bore network.

As can be seen from **Plate 1** and **Plate 2**, recorded groundwater levels at these bores vary dramatically and are significantly influenced by drawdown during periods of pumping. We also understand there was an issue with pumps on these bore lines in the past, however do not have all the details in regard to this at present or know what changes may have been made to these bores as a result of these issues.

Our past experience working with HWC groundwater database for the area is that at times changes such as relocation of bores or adjustments to collar height are made to HWC bores and not necessarily updated in the HWC database.

As shown on **Plates 1** and **2** groundwater levels at bores SK5992 and SK4942 were influenced by pumping activities on several occasions between 1997 and 2007 and from the recorded data again on occasions in June 2010, August 2011 and September 2015.

It is apparent from **Plates 1** and **2** that a significant long term change in recorded groundwater levels occurred after mid 2007. For this series of reasons bores SK 5992 and SK 4942 were not used to calibrate the groundwater model developed for the proposed Cabbage Tree Road Sand Quarry.

To explore the potential viability of using bores SK5992 and SK 4942 to assist in calibration of the model, we compared results from the groundwater model that was calibrated using monitoring bores down gradient of the proposed extraction area (i.e.

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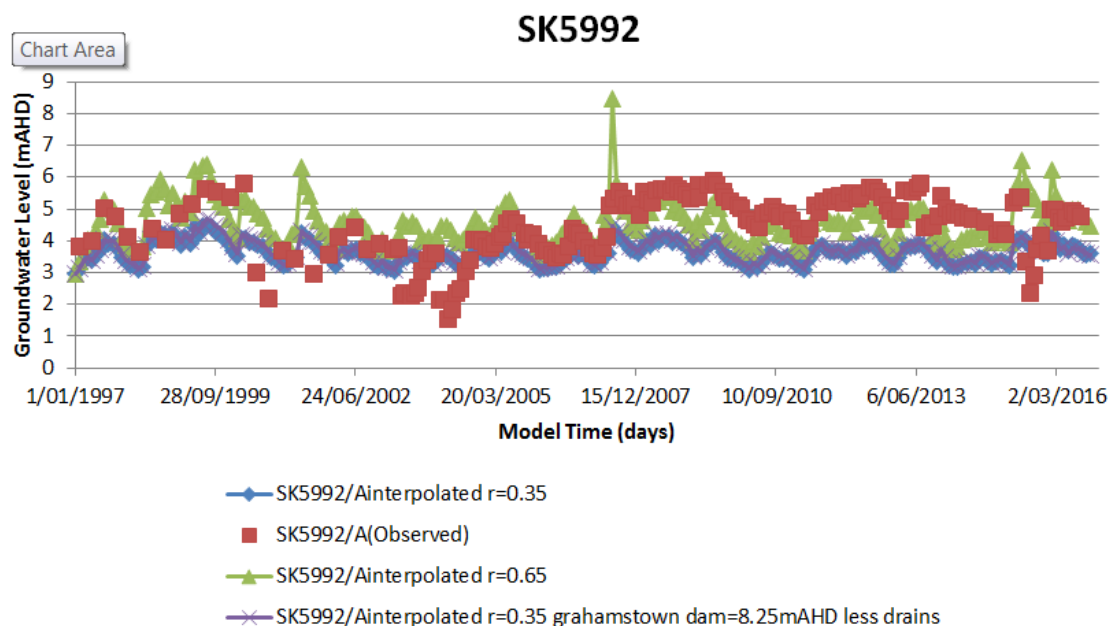
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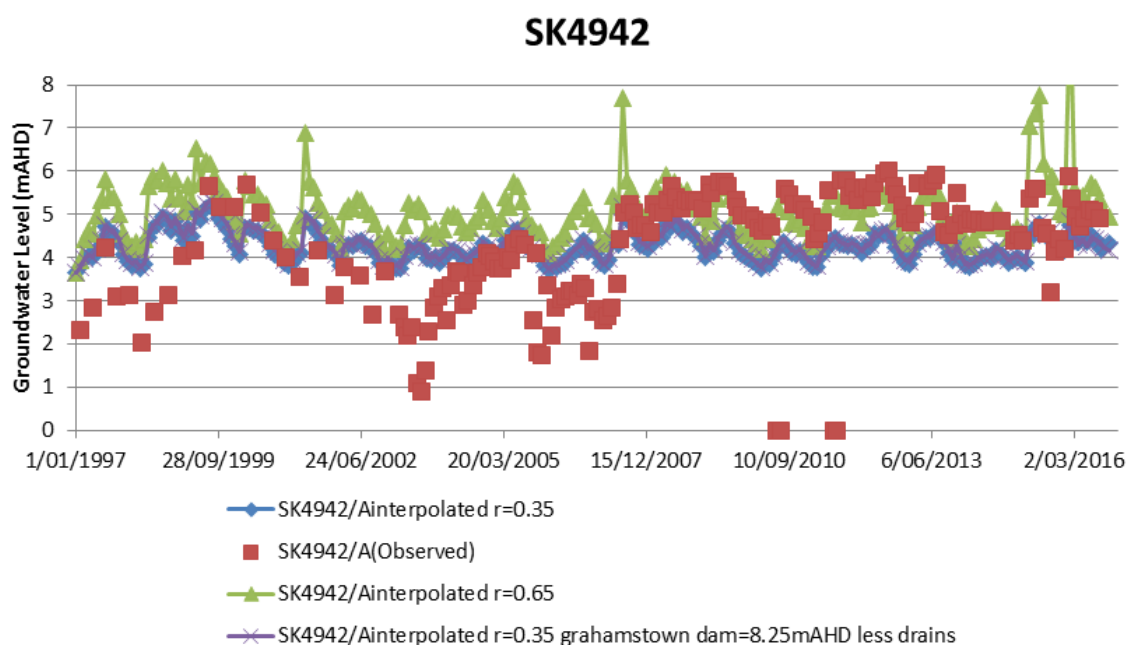
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bores SK 3508, SK3509 and F8) with recorded groundwater levels at bores SK5992 and SK 4942.



**Plate 1 – HWC Monitoring Bore SK5592**

At bore SK5992 as shown on **Plate 1**, up to October 2004 groundwater levels vary significantly in response to pumping and rainfall. For the period October 2004 to May 2007 there is a reasonable correlation between predicted levels and recorded levels. After June 2007 when there was a significant rainfall event, recorded groundwater levels have remained approximately 1 m to 2 m above predicted levels except for a periods of apparent pumping in approximately August 2015.



**Plate 2 - HWC Monitoring Bore SK4942**

Similarly at bore SK4942 as shown on **Plate 2**, prior to June 2007 groundwater levels at SK4942 were significantly influenced by pumping activities and after this time recorded groundwater levels have been approximately 1 m to 1.5 m higher than predicted levels.

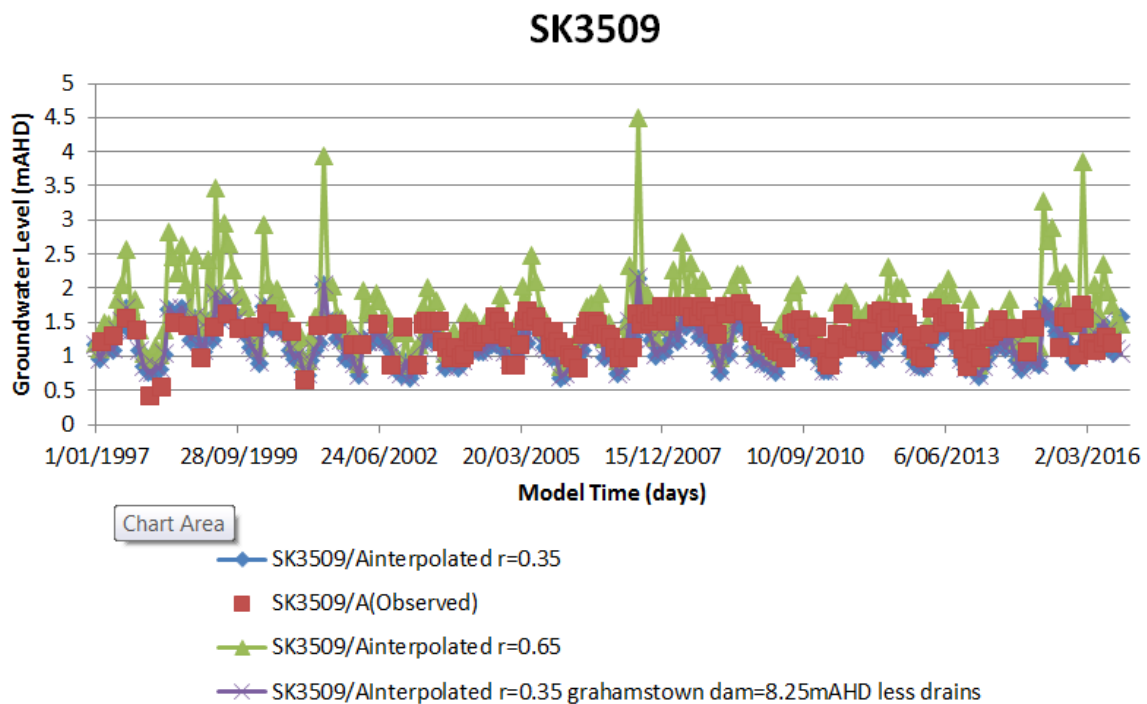
To explore further potential recalibration of the groundwater model using recorded data from bores SK 5992 and SK 4942, a series of additional simulations were undertaken.

This included increasing the recharge rate to monitoring the impact on predicted groundwater levels. Calibration of the groundwater model to recorded groundwater levels at SK 3508, SK3509 and F8 was achieved using a groundwater recharge rate of 0.35 times rainfall which is considered realistic and is shown in blue on **Plates 1 and 2**.

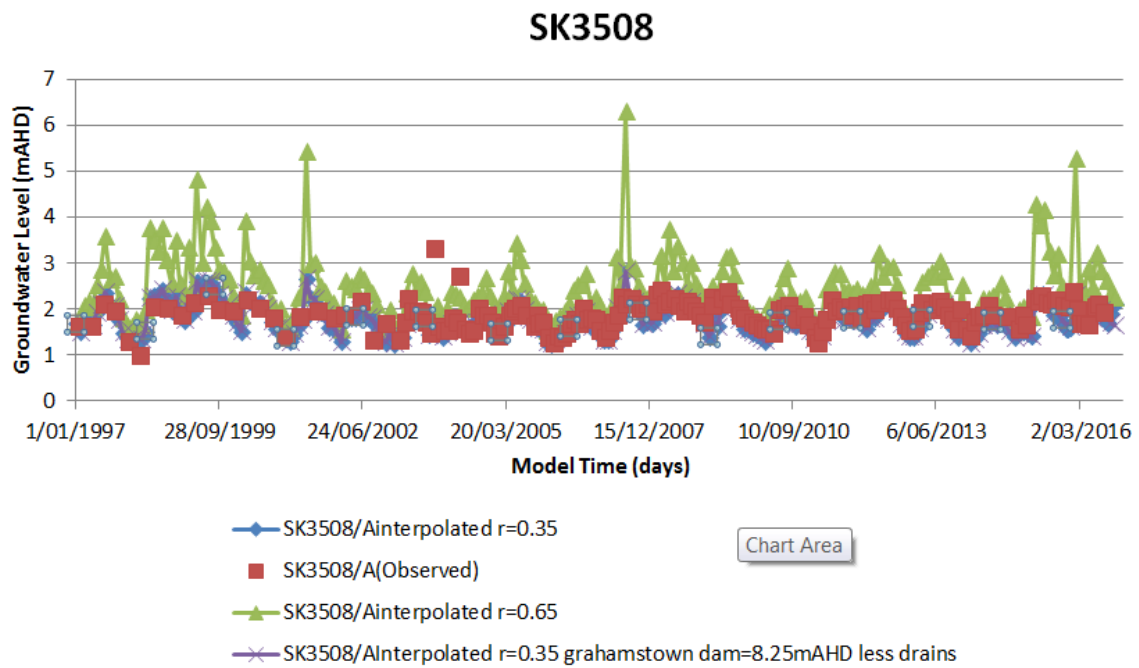
As can be seen from **Plates 1 and 2** even increasing the recharge to 0.65 times rainfall which is considered unrealistic, still results in predicted groundwater levels that are typically lower than those recorded after July 2007 at bores SK5992 and SK 4942.

As shown on **Plates 3, 4 and 5**, increasing recharge to 0.65 to times rainfall results in predicted groundwater levels at the down gradient bores used to calibrate the model (SK 3508, SK3509 and F8) being up to 4 metres above recorded groundwater levels at these bores. It is apparent from this analysis that increasing the recharge rate above 0.35 times rainfall is unlikely to result in calibration of the model upslope and downslope of the proposed extraction area.

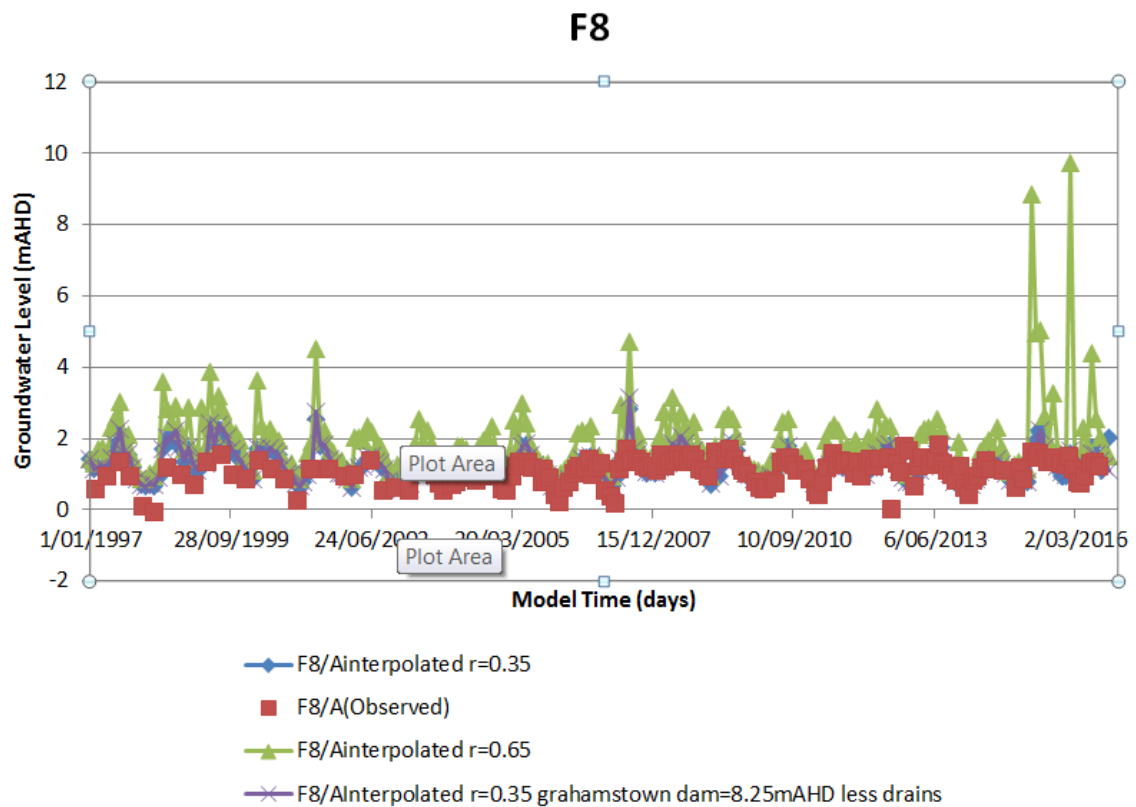
To explore further potential calibration with groundwater bores SK5992 and SK 4942, the model layout was modified to remove all drains and increase upstream groundwater level at the boundary of the model to 8.25 mAHD which is approximately ground level. The changes, even though they are not representative of actual conditions, should potentially result in higher groundwater levels at bores SK5992 and SK 4942. As shown on **Plates 1 to 5**, removing the drains and increasing the upstream boundary condition level has negligible impact on predicted groundwater levels at any of the bores and does not result in predicted levels increasing to those recorded at bores SK5992 and SK4942.



**Plate 3 – HWC Monitoring Bore SK3509**



**Plate 4 – HWC Monitoring Bore SK3508**

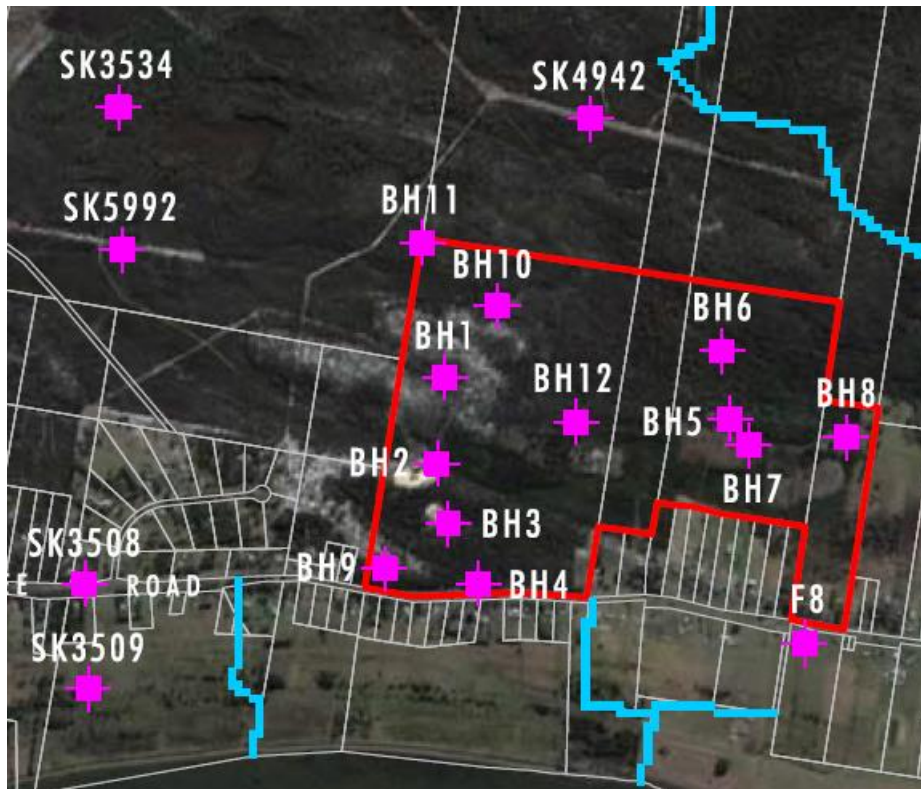


**Plate 5 – HWC Monitoring Bore F8**

It is concluded based on this analysis, realistic calibration using recorded groundwater levels at bores SK 5992 and SK4942 is not achievable and that further investigation of these bores, changes that may have occurred at these bores and impacts of pumping would be required.

As quarrying will commence in the southern down gradient section of the proposed quarry in proximity to bores SK3509, SK3508 and F8 where good calibration has been achieved, it is proposed that extraction levels in this area be determined based on the predicted highest groundwater levels in this area as set out in Groundwater Assessment (Umwelt November 2015) and that further calibration of the model be undertaken prior to quarrying in the northern section of the proposed quarry area.

It is proposed that to achieve this, further investigation of potential changes that may have occurred at HWC bores SK5992 and SK4942 since July 2007 be undertaken. It is also proposed that prior to the commencement of quarrying within the northern section of the proposed extraction area, additional monthly groundwater level monitoring be undertaken at bores BH1 to BH12 as shown on **Plate 6** over the next 2 years with the results of this monitoring being used to review and if required refine the groundwater model predictions for the proposed northern extraction area.



**Plate 6 –Groundwater Monitoring Bore Locations**

Please do not hesitate to contact me if you would like to discuss this further.

Yours sincerely

Peter Jamieson  
Director