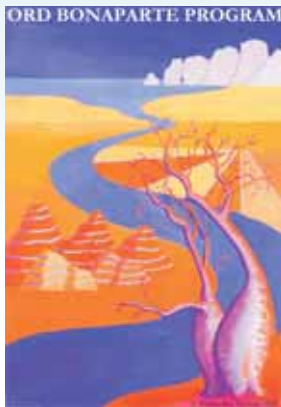




Construction of a monitoring system to study the effectiveness of dewatering boreholes to manage rising groundwater levels in the Ivanhoe Plain, Ord River

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CSIRO Land and Water, Perth
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**CONSTRUCTION OF A MONITORING SYSTEM TO STUDY THE
EFFECTIVENESS OF DEWATERING BOREHOLES TO MANAGE RISING
GROUNDWATER LEVELS IN THE IVANHOE PLAIN, ORD RIVER**

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ABSTRACT/SUMMARY

A groundwater model was developed to simulate the proposed dewatering from two production bores (P10 and P11) in the Ivanhoe Plain; the model was used as an aid for the selection of monitoring well sites for two dewatering production bores. Twenty-four sites were selected and monitoring wells were installed at each site in May 2003. Each well was installed with an automatic logger recording fluctuations of water levels every 30 minutes. A water sampling and monitoring regime was established, and the data collected will be used to refine the groundwater model.

Preliminary results from the modelling indicate that an area of 47 ha will have drawdown exceeding 1 m as a result of pumping the two production bores. The amount of channel leakage induced by continuous pumping at a rate of 10000 m³/d (i.e. 5000 m³/d from each production bore) is in the order of 3000 m³/d. These results are subject to further calibration of the model as data from the monitoring becomes available.

INTRODUCTION

The Ord River Irrigation Area (ORIA) is located in the East Kimberly region of Western Australia. The northern part of the irrigation area, known as the Ivanhoe Plain, has been flood irrigated since 1963, and as a result groundwater levels have been rising steadily and in some areas is approaching the ground surface. Based on detailed hydrogeological studies and water level monitoring, the Water and Rivers Commission have made recommendations on the number of dewatering bores required and rates of abstraction to reduce the rising water levels. Two dewatering bores (P10 and P11) were drilled in June 2000 (Water Corporation, 2000) (Figure 1). Pumps were installed in the bores in May 2003, but there was a need to establish a monitoring network to test the effectiveness of these dewatering bores.

A groundwater model was developed to simulate the proposed dewatering; the model was used as an aid in the selection of monitoring well sites. Twenty-four sites were selected and monitoring wells were constructed at each site in May 2003. A water sampling and monitoring regime was put in place, and the data collected will be used to refine the groundwater model as it becomes available.

The efficiency of the production bores will be gauged on the extent and degree to which they drawdown groundwater levels. The study will determine the extent of the cone of depression caused by the proposed groundwater pumping, and the extent of channel leakage induced by dewatering the paleochannel. The ultimate goal is to design the most effective pumping regime, which minimises channel leakage while maximising groundwater extraction.

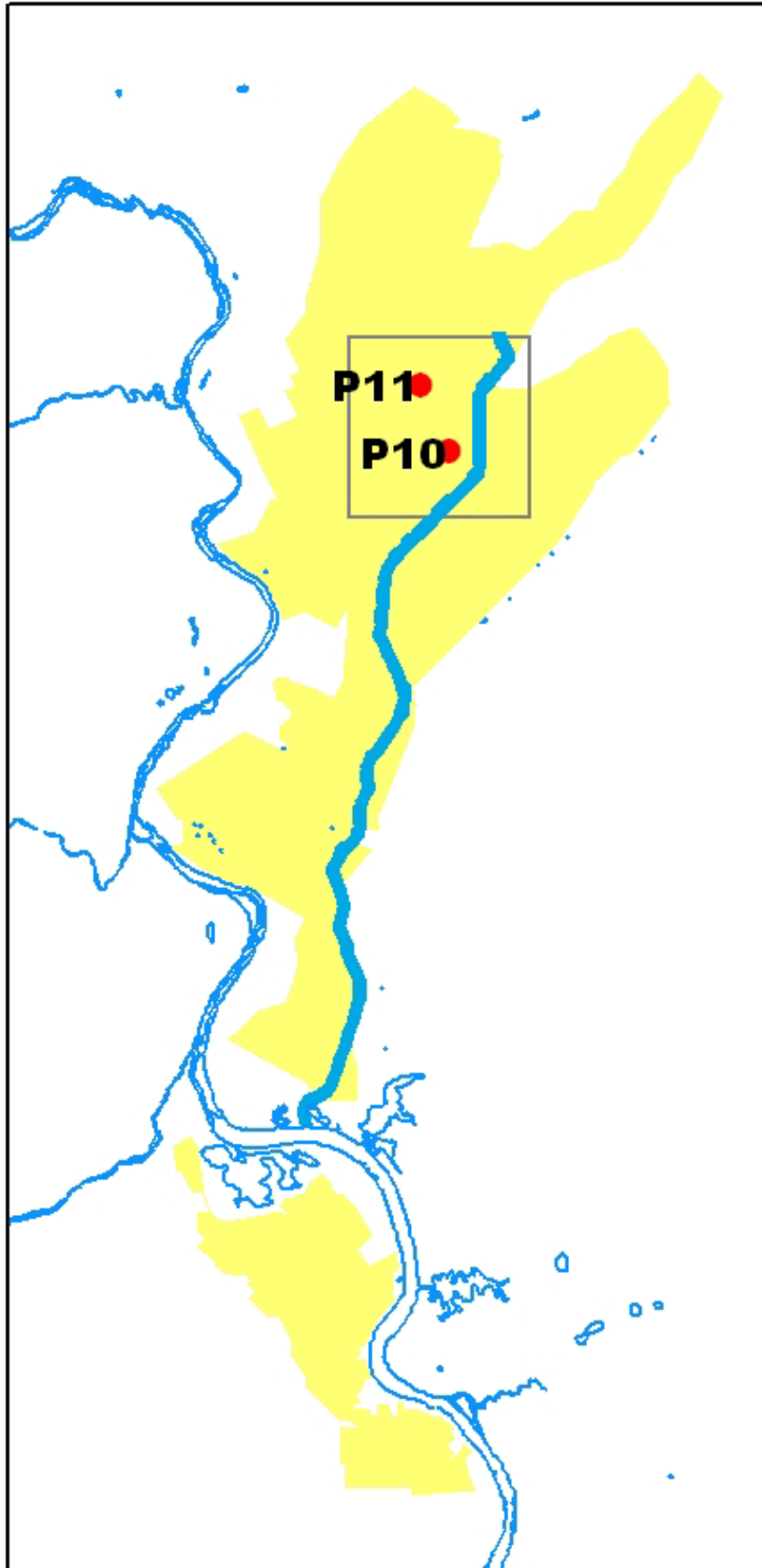


Figure 1: Location of the two dewatering bores in the Ivanhoe Plain

BACKGROUND

This study focuses on two production bores (P10 and P11 [Figure 2]) near the northern end of the main supply channel (M1) which feeds the Ivanhoe Plain irrigation system. The two production bores were constructed for the Water Corporation in May 2000 (Water Corporation, 2000). P10 was drilled to a depth of 31 m, with a 6 m screen; P11 was drilled to a depth of 34 m with an 8 m screen. Pump tests were carried out on the production bores at the time of construction, with groundwater being extracted at a rate of 3000 m³/d for a period of 24 hours. Drawdown was 5.5 m in P10, and 4 m in P11. At the time of these initial pump tests there were no monitoring wells in the area, so the extent of drawdown was not determined.

In May 2003, new pumps were installed in P10 and P11, and pumping trials began on the 19 May 2003. The pumps will be activated on 26 June 2003.

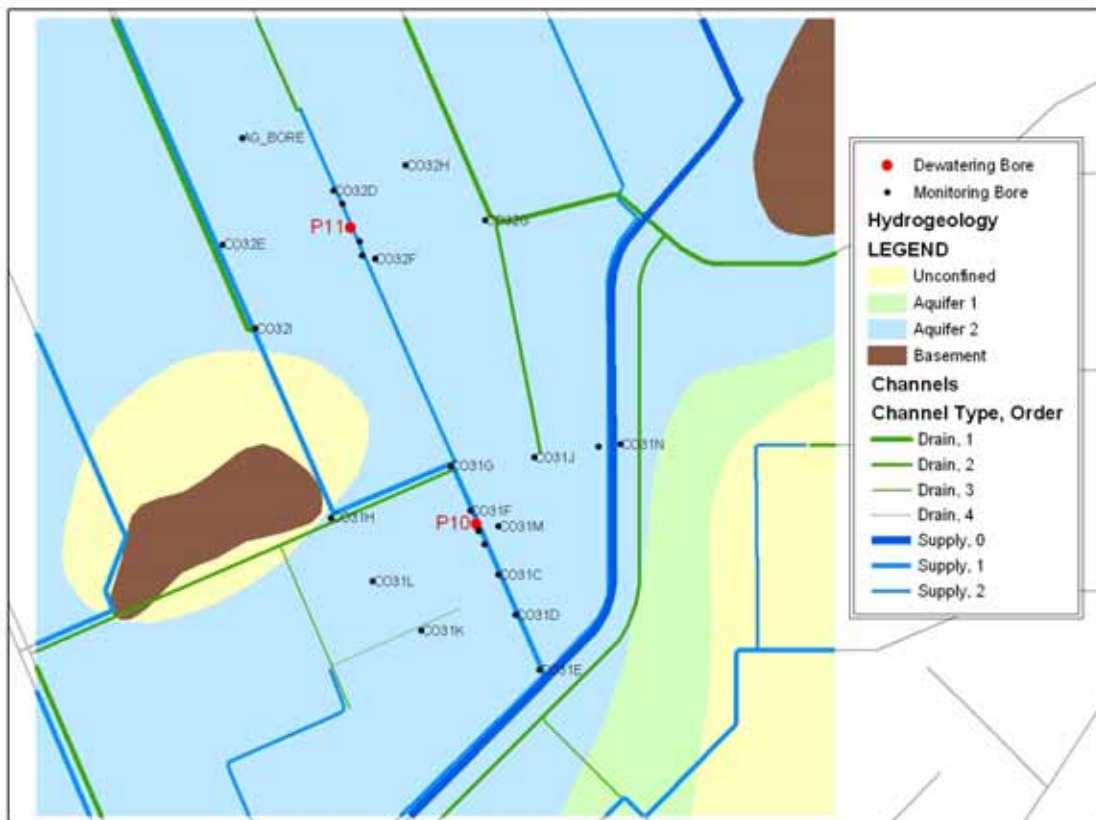


Figure 2: Boundary of study area and model layers

METHODS

A series of monitoring wells will be required to assess the effectiveness of the pumping trial which commenced in June 2003, and will enable the determination of both the extent and degree of drawdown due to pumping P10 and P11. Without knowing *a priori* the area of influence of the production bores it is difficult to know where to place the monitoring wells (e.g. minimum and maximum distance of the monitoring wells from the production bores). To assist in this regard, a groundwater model of the pumping trial was developed to simulate the groundwater response to pumping. The results from the model were used to aid in the selection of sites for the monitoring wells.

The groundwater model was based on information from various sources, such as Water and Rivers Commission (WRC) hydrogeological logs, the production bore construction logs and the May 2000 pump tests. The model was implemented in MODFLOW with three aquifer layers (Figure 3): unconfined silt layer, a semi-confined low conductivity aquifer, and a highly conductive semi-confined paleochannel. Supply and drainage channels were implemented in the model as river boundary conditions, with properties reflecting the size of the channel. The recharge applied in the model was the combined recharge from rainfall and irrigation. The main crop in the study area is sugar cane, and therefore evapotranspiration in the model is quite high. All model inputs were considered uniform over time.

The model parameters were derived from a variety of sources, and the model will require calibration when the necessary data is available. At this stage the model is effectively uncalibrated, due to the absence of monitoring data from the initial pump tests in May 2000. This is unavoidable, as the whole purpose of this exercise is to establish the monitoring network.

The groundwater model was first used to determine the steady state hydraulic head surface for the case where the production bores remain inactive. This steady state head surface was used as the initial head surface in subsequent transient modelling (including abstraction from the dewatering bores) to enable the calculation of drawdown due to pumping over time. The pumps were each set to extract 5000 m³/d (i.e. a total extraction of 10000 m³/d). Pumping was continuous over a ten-year simulation period.

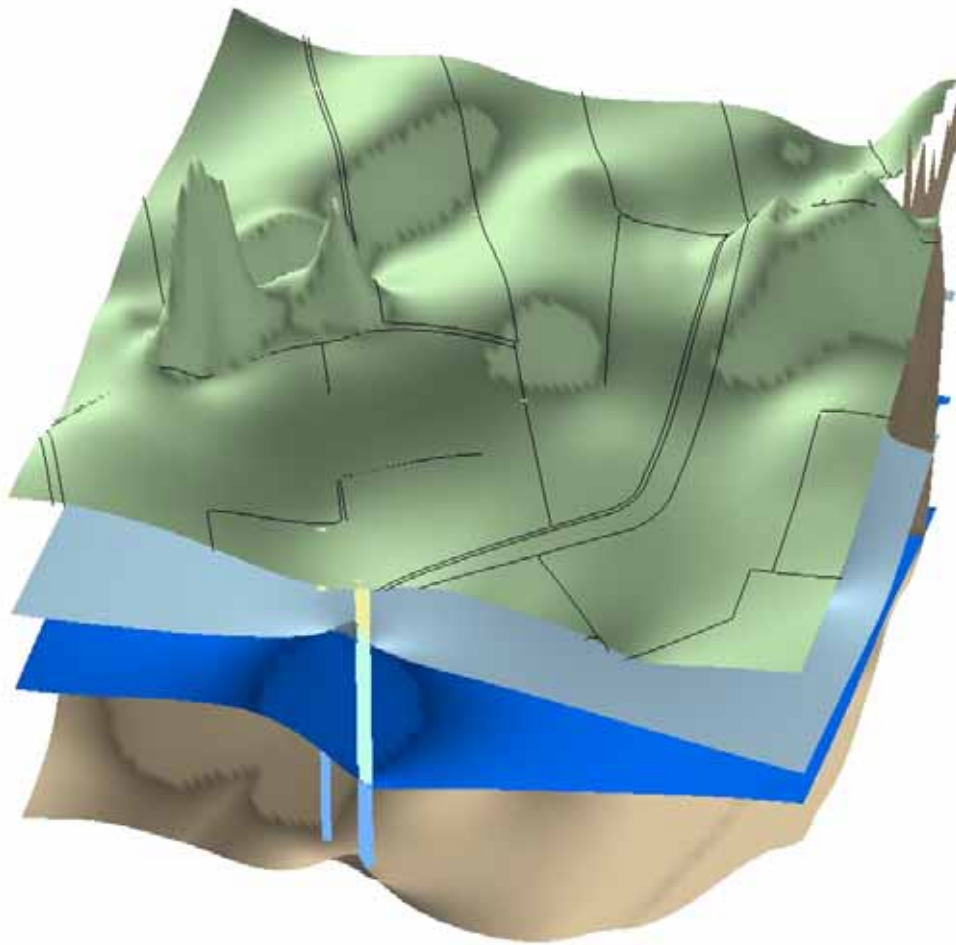


Figure 3: Model Layers: light blue - bottom of unconfined silt layer, dark blue - bottom of low conductivity second layer; and brown - bottom of third palaeochannel layer

The location of the monitoring wells will be based on the results of the groundwater model and the available hydrogeological data (O'Boy *et al.*, 2001). Once the sites for the monitoring wells have been selected and the wells installed, a regime of water level measurements and water sampling will be put in place to determine the degree of surface water leakage from the channels induced by pumping, the extent of drawdown due to pumping, and the degree of drawdown due to pumping.

RESULTS

The initial steady state model (with no pumping) resulted in a fairly flat groundwater surface. The general flow of groundwater in the study area is from the M1 to the north-west.

The water levels in the transient model (with the two pumps extracting a total of 10000 m³/d) stabilised after 5-6 years; however, there was minimal change after the first year. After ten years of continuous pumping the model predicted 1.5 m of drawdown at a distance of 150 m from either production bore. There was approximately 0.5 m of drawdown between 500 and 570 m from the production bores. The area where drawdown exceeded 1 m was 22 ha around P11, and 25 ha around P10. The model also predicted 3000 m³/d of leakage from the supply and drainage channels were induced by pumping groundwater from the paleochannel.

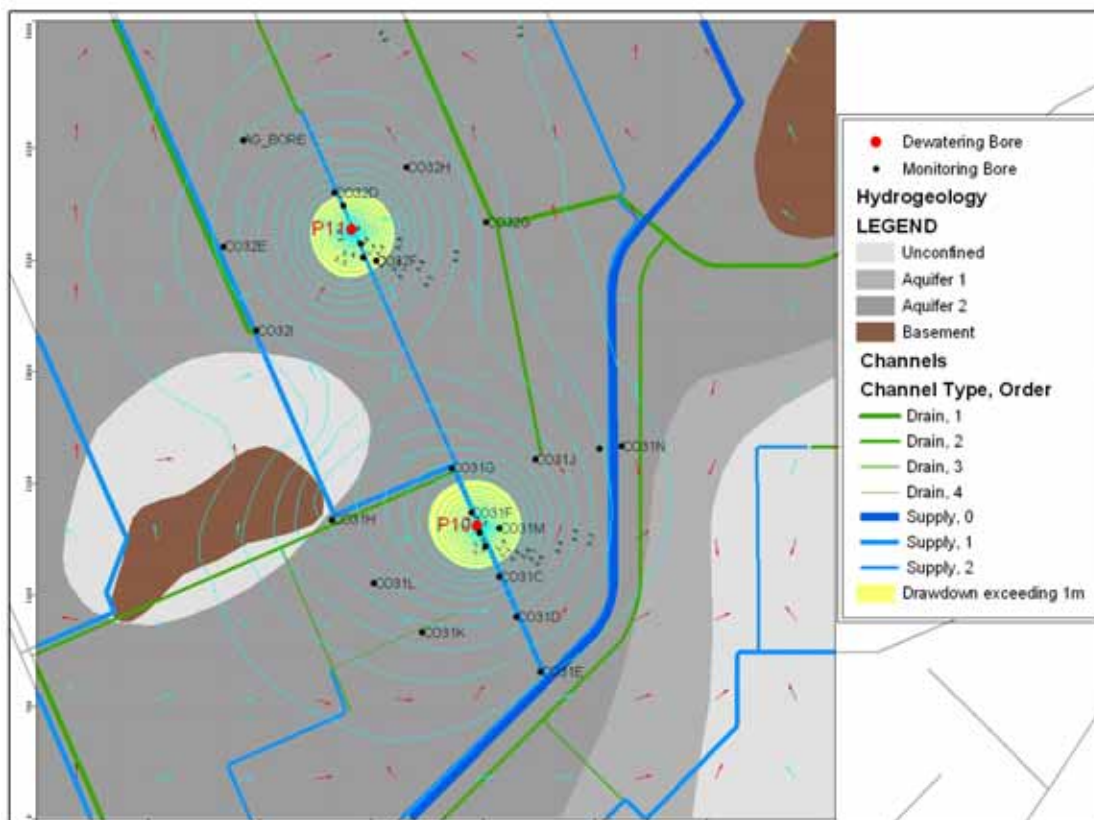


Figure 4: Extent of cone of depression after 5 years and location of monitoring wells

The extent of the cone of depression was used as a guide in the positioning of the monitoring wells (Figures 4 and 5). Decisions on the exact site of the monitoring wells were made in the field. Twenty-four monitoring wells were drilled between 7 – 9 May 2003. An automatic logger was installed in each of these wells, taking groundwater level measurements at 30-minute intervals. Groundwater samples from all wells for chemical and isotope analysis were collected after drilling and development of the wells was completed. Regular monthly samples will also be collected for isotope analysis, to determine the extent of surface water leakage over time.

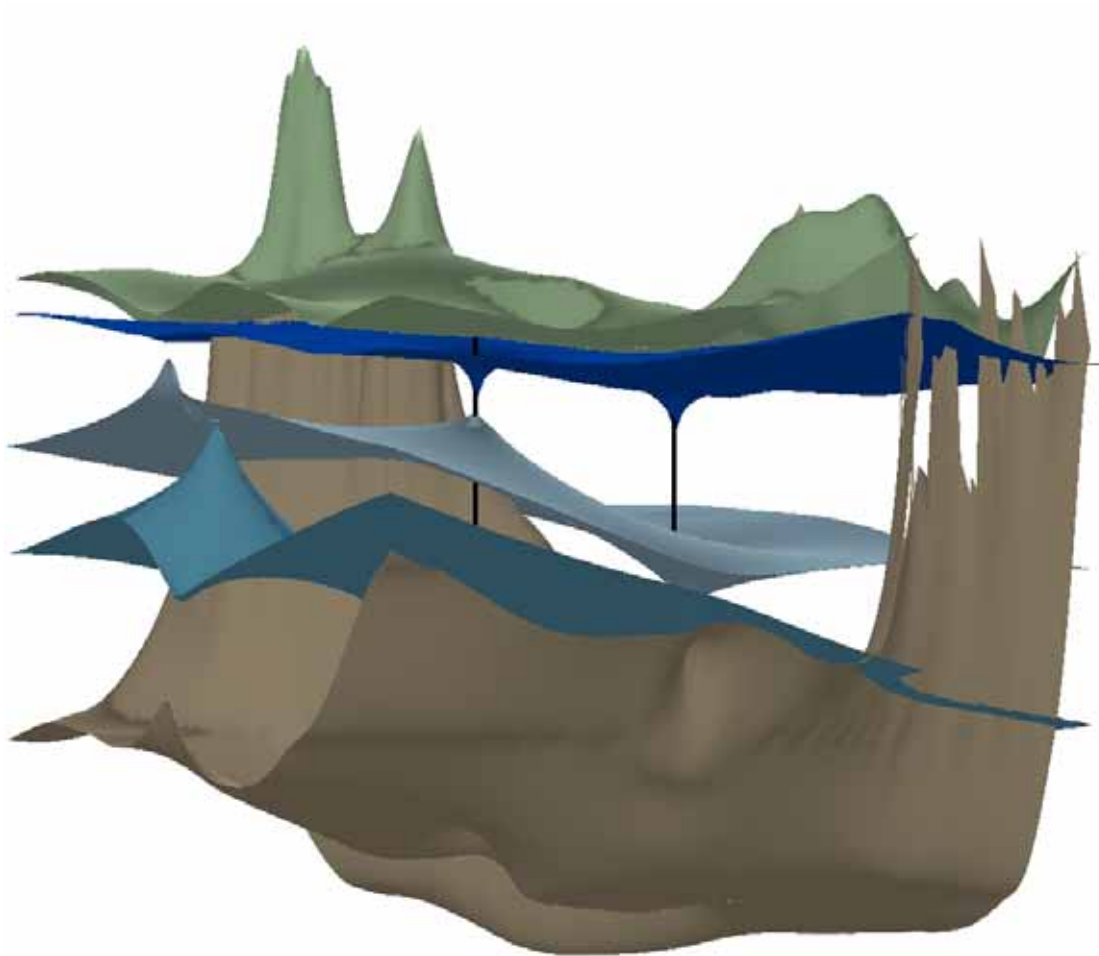


Figure 5: Extent of cone of depression after 5 years

DISCUSSION AND CONCLUSIONS

The preliminary model was parameterised using all available hydrogeological data; however, without a pre-existing set of monitoring wells, it was not possible to properly calibrate the model. Therefore the model could only be matched to represent similar hydrogeological conditions. With the set of monitoring wells in place, it will be possible to properly calibrate the model to the drawdown observed in the monitoring wells. In addition to this, the results from the water sample analysis will provide information of the extent of channel leakage, which can also be incorporated in the model. The combination of the monitoring wells, the water sampling regime and the refined groundwater model will provide a much clearer picture of the extent of drawdown due to the pumping of P10 and P11, and the quantity of leakage from the nearby supply channels and drains. This greater understanding, combined with the calibrated model, will make it possible to design a pumping strategy that minimises channel leakage while maximising the extent of drawdown.

Preliminary results from the modelling indicate that an area of 47 ha will have drawdown exceeding 1 m as a result of pumping the two production bores. The amount of channel leakage induced by continuous pumping at a rate of 10000 m³/d (i.e. 5000 m³/d from each production bore) is in the order of 3000 m³/d. These results are subject to further calibration of the model as data from the monitoring becomes available.

ACKNOWLEDGEMENTS

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