Boundary Conditions Between the City of Moscow and the City of Pullman

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Introduction

The city of Pullman, Washington and the city of Moscow, Idaho are located within the Palouse basin. The Columbia River Basalt Group is the underlying geology within the Palouse basin with a northern boundary of granite. The blue shading on the map represents the basalt and the pink shade represents the granite (Figure 1). The Washington Department of Ecology (DOE) observation well is located between Moscow and Pullman (Figure 1).

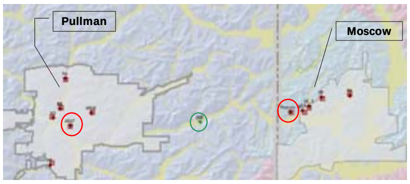


Figure 1: Screenshot of Modflow 2000. Red circles encompass the pumping wells used in the analysis. The green circle encompasses the DOE observation well

Boundary conditions can be created if two cones of depression intersect each other. A cone of depression is the area around the well where hydrologic head has been lowered (Figure 2). When the water is flowing in opposite directions at the same point the water cannot cross the line creating an impermeable boundary.

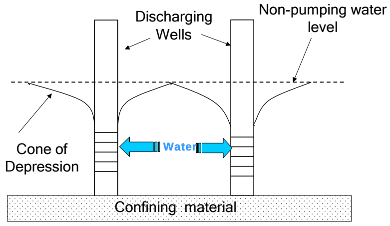


Figure 2: Example of intersecting cones of depression creating a boundary condition.

During a Moscow pump test, drawdown can be detected in the DOE well along the state boundary of Washington and Idaho. However, when a pump test of the similar nature was done in Pullman there was no detectable drawdown in the DOE well. This could be due to the presence of a boundary condition.

If the boundary is present and is detectable through out the year future development in the Palouse basin could affect the amount of water available to either city. The City of Pullman is able to draw water from the west. However if the boundary does exist between Moscow and Pullman the city of Moscow becomes enclosed. The presence of the boundary condition together with geologic boundaries would cause Moscow to have a limited basin to draw water from.

Objective

To modify a groundwater model of the Palouse basin to potentially show that the boundary condition between Pullman and Moscow moves at different times of the year and to analyze the results using Aqtesolv software.

Figure 3: Moscow #9 Pump Tests Screenshots of Modflow 2000 and Aqtesolv plots

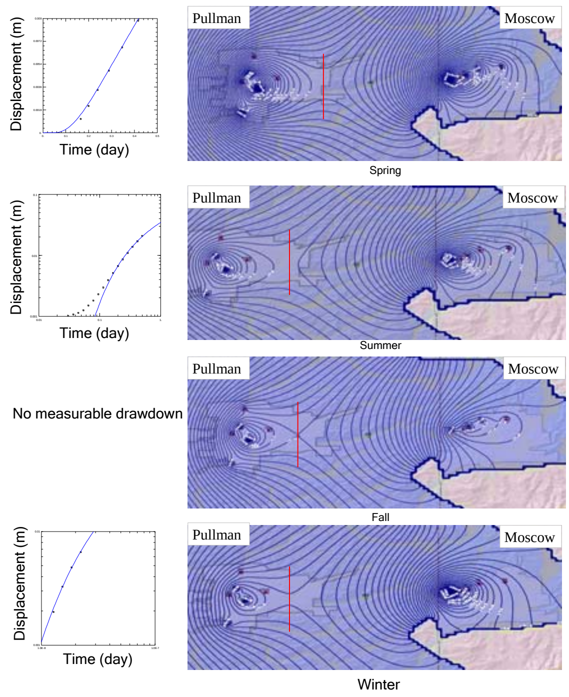
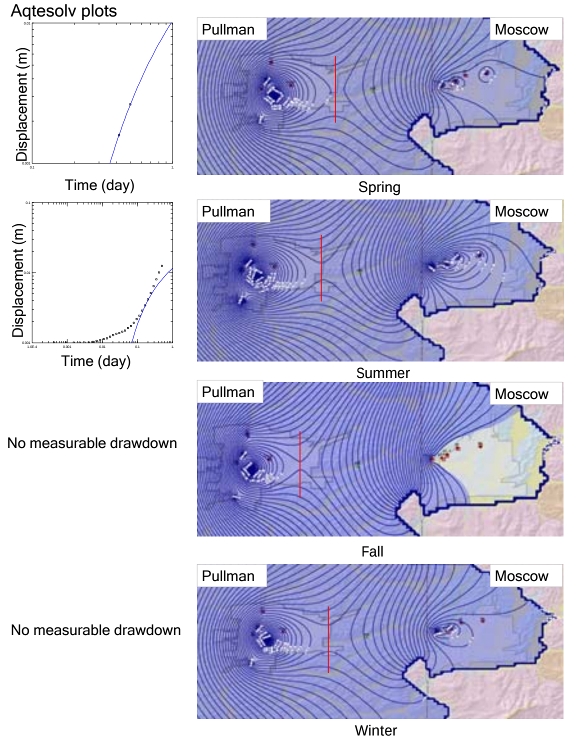


Figure 4: WSU #7 Pump Tests Screenshots of Modflow 2000 and Aqtesolv plots



Methods

Current Model

The model being employed was created by a previous graduate student at the University of Idaho. Displacement units in the model are days and meters. The current model of the Palouse basin is 400 meters thick with an impermeable bottom, homogenous, and isotropic. Included in the model are all the functional pumping wells in the city of Moscow and Pullman in addition to observation wells in the region. The pumping wells in the model are fully penetrating wells. The current model has one 360 day period divided into 30 day increments. The pumping rate for each month is an average calculated from the approximate daily pumping rates from 2005.

Boundary Conditions

To create the boundary condition within the Palouse basin a simulation of pump tests have been created in Modflow 2000. The wells that were used to simulate pump tests were Moscow #9 and WSU #7. The pump tests involving Moscow #9 and WSU #7 were conducted in the model during four different seasons in a year, representing spring, summer, fall, and winter.

To simulate the pump test each pump was turned off for 12 hours for the water level to return to a static water level. Static water level is the elevation or level of the water table in a well when the pump is not operating. Next the pumps where turned on for 12 hours to measure drawdown and to locate the potential boundary. The rate of pumping for both wells was 2200 gallons per minute. After the pumping was completed the pumps were once again turned off for 12 hours for recovery. After the completed pump test, including recovery time, the pumps turned back on and continued pumping at the monthly average. Once the eight different pump tests, four tests each well, were completed, the data was exported as a text file as head vs. time.

Aqtesolv

The data that was exported from Modflow 2000 was imported to Excel. Once in Excel the data was converted from elevations to drawdown during the time of the pump test. The drawdown data that was <0.001 meters was not used in the analysis.

After the data had been converted a new text file was create to import into Aqtesolv. The Theis method was used to evaluate the drawdown curves (Figures 3 and 4).

Results

The Modflow 2000 visuals in Figures 3 and 4 indicates that a boundary condition (red line) forms when both the cities are pumping. Drawdown interval shown in Figures 3 and 4 is 0.005 meters. During each of the pump tests the boundary location moves depending on which city is pumping more or less at the time. As can be seen from comparison to the boundary to the DOE well. None of the pump tests show that the boundary condition created between the two cities moves to the east of the DOE well.

The data from Moscow Fall, Pullman Fall, and Pullman Winter showed no visible drawdown. As a result the Theis curves were not generated.

Discussion

The Modflow visuals show the boundary condition (red line) for each season and pump test. The boundary does move back and forth depending on the city conducting the pump test and the season.

Although the Theis curve (Figures 3 and 4) is typically used to show boundary conditions, the Aqtesolv plots shown in Figures 3 and 4 show drawdown in the DOE well following the theoretical drawdown curve (blue line). Variations from the theoretical curve might be caused by the other pumps or boundary conditions. Showing the variations in drawdown during different seasons and pump tests so experimenters can account for the boundary conditions in their data.

In the Modflow 2000 visual for the Pullman fall test there are no drawdown interval lines east of Moscow because the drawdown is greater then the contour interval. Real pump tests need to be conducted to confirm the model results. Estimating transmissivity and storativity are not in the scope of this project.

References

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Acknowledgments

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