The Challenge

a. For the initial boundary head values and recharge and ET rates:

   i. establish the flow across the boundary versus y-distance along the left (15 m) and right (5 m) boundaries.

   ii. Plot the equipotentials and flow vectors in plan view and outline (hand draw) the area that would be affected by recharge (i.e. if it were contaminated).

   iii. Also show a contour plot of the steady state ET flux in plan view.

In a confined aquifer, I'd think that we're likely looking at a constant depth to the water table. So, I think that a counter map of the ET flux would appear flat.

b. Change the extinction depth. What impacts does this have?

Reducing the extinction depth moves the head contours right and creates a local minimum. Increasing the extinction depth increases the gradient and shifts the contours left. (need to think about what is going on here). Higher values for extinction depths also relate with less flow out of the right side boundary. A deeper extinction depth would mean more water is lost to ET.

c. Explain, conceptually, how MODFLOW is representing ET. How does this compare to your intuitive understanding of ET in the real world?

I'm under the impression that MODflow is representing ET basically as negative recharge. In the real world we couldn't really just assign a flat number to multiply vs an area. Matric potentials, atmospheric vapor pressure, temperature, wind speed, plant growth and the soil would all effect the ET.

d. Now start the well pumping, extracting 20 m3/day.

   i. How does the well change the zone that is affected by the recharge area?

   It appears that pumping shrinks the zone affected by the recharge area. This makes sense because that recharge is being directed towards the well, away from other areas.

   ii. How does it affect the ET map? Write a mass balance for the well -

ET, applied to the whole map just reduces the amount of water in the system the farther you move from the higher constant head boundary.

   iii. how much water is coming from a boundary?

87.5 m^3/d? Into the system, at large; It seems that the capture zone of the well seems to cover from y values from 5 to about 17. When adding these fluxes up, it exceeds the pumping rate. It's possible that a portion of that is lost to ET but it does seem that I've overestimated the capture zone.

   iv. How much is originating as recharge?

$Q_{\Sigma}=Q_{capture}+P-ET \rightarrow (ET-P)=Q_{\Sigma}-Q_{capture}$. Since, Modflow treats ET and P more or less the same, these should probably be combined into a single net term that represents the net amount coming from recharge. In this model. ET is calculated over the entire capture area, P is only accounted for in the region where it is being applied.

   v. How do you account for the impact of ET on this mass balance?

My first guess is to apply the value for ET over the region of the capture zone and plug it into the water budget. I'm not quite sure how to go about finding the area

of the the capture zone.

vi. At steady state, what are the effects of 'capture' by the well?

The capture at the well subtracts from the flow reaching the right boundary. It shrinks the recharge zone. It alters the direction of the flow vectors within it’s range of influence.

The Socratic Method
This is going to be challenging ... but, I think that you will benefit from it! Worst case, we will only do it for one week!!

I am a strong believer in the idea that you only really learn something when you try to teach it to someone else. I'm also pretty sold on the idea that teaching is helping someone to learn something for themselves whenever possible, rather than just telling them the answer. So, I'd like you to give the Socratic Method a try. In your groups of 2 or 3, do the following:

a. Meet to discuss The Challenge. Try to identify what each of you feels like you know well and what you feel like you do not know as well.
b. Each of you should take charge of at least one thing that the other person doesn't know well. Study it to the point that you understand it. Ask me if you are stuck. Your goal is to advance the other person's knowledge of that topic!
c. Meet again. Each of you should teach the other the topic that you have investigated. Try, to the degree possible, to avoid telling the other person the answer ... rather, guide them to understand the topic by asking them questions.
d. Each of you should write an individual answer to The Challenge. Note who your partner(s) was(were) and let me know which topic you took the lead on explaining.

Due dates are the same. Sunday night: submit the key figures. Monday night: submit your initial responses to The Challenge. Tuesday night: submit your final responses to The Challenge.

Enjoy!