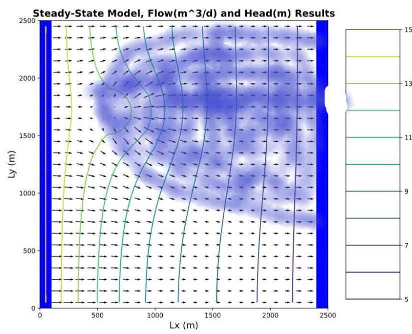
Under the initial conditions, the flow coming through y=5 was 87.4 m^3/d and 87.1 through y=15. In those 10 meters the model seemed to show 0.3 m^3/d in net losses to the surface. ET and recharge seem to be roughly equal. (this calculation was actually done using the flow that was calculating along the x axis. Attempts to transpose this list in python haven't been successful. The loops written to transpose this seem to have a problem in dealing with the frf array.

Initial recharge area



Reducing the extinction depth moves the head contours right and creates a local minimum. Increasing the extinction depth increases the head gradient and shifts the contours left. (need to think about what is going on here). Lowering the extinction depth increased ET and the extra volume lost to the atmposhere lowered the head faster. The system Higher values for extinction depths also relate with less flow out of the right side boundary.

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. I also doubt that the extinction depth would actually be a constant and the effect of ET would not decrease linearly.

After the pumping rate is turned on in Modflow;

When pumping at 20 m^3/d, 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.

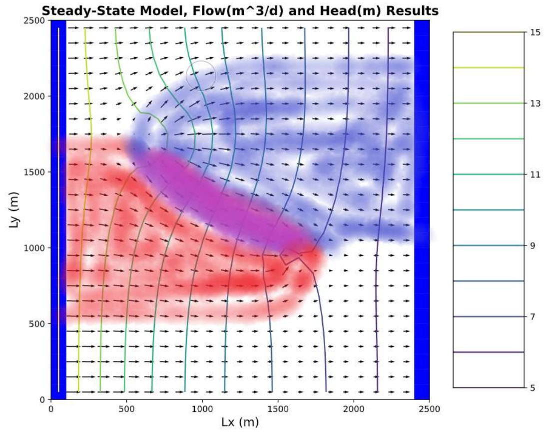
$$\mathbf{Q_{pump}=Q_{capture\text{-}boundary}+R_{capture}-ET_{capture}}$$

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. It does not effect the pumping rate directly but it does mean that other inputs have to compensate for the losses due to ET.

87.5 m^3/d seems to be coming from the left boundary system, at large; This isn't much more than before the pumping started. With the boundary capture and the recharge capture all remaining more or less constant, and an additional 20 m^3/d being pumped out, the ET would have to be decreasing to accommodate the pumping.

iv. How much is originating as recharge?

Each cell has an area of 10,000 m^2 and the recharge is defined as 5e-4 m/d. Let's say that the number of recharge cells is 4ish(eyeballing it). Of those it looks like a quarter falls within the capture zone . An area of 40,000 m^2 multiplied by your recharge gives us about 200 m^3/d.



Using the water budget equation above: I'd expect to see about 135 cells lose to ET over the capture area. To check if this is reasonable let's divide that volume by the area of the capture zone to find the average ET depth over the capture zone. It looks like this would amount to an average of about a twentieth of an inch. Given that a quarter inch can be expected to be lost on the surface, this doesn't really seem too outlandish. A better way of doing this would be to do a mass balance for the entire system. We can quantify the boundary flows using FloPy. The pumping rates are defined as 0 and 20. Recharge is going to be constant for both cases. So, we can take a look at the change in ET by using a water budget. The same issue that came up with summing the flow across the boundaries earlier on still haven't solved. Not wanting to pick out the values manually, trying to get the python extraction loop working seems like the best bet.

$Q_{right}=Q_{left}+R-ET-Q_{pump}$

At steady state, 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 its range of influence.