Farm Challenge Report

Homework 7

HWRS 482

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*Introduction*

This report details the results of a MODFLOW model examining how the introduction of ACME Farming Corp. will impact the groundwater supply to Wildcat Farm. The farms cultivate alfalfa and cotton. Located in southern Arizona, crop consumptive use and evapotranspiration losses can significantly draw down regional aquifers to the detriment of multiple users.

*Conceptual Model*

Chart, bar chart

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The conceptual model of the system shows four observation wells at the edges of the domain. Data from these well provide the framework for determining plausible constant head boundaries and hydraulic conductivities (K). The system contains three zones of gradient hydraulic conductivities, representing the distribution of measured K at four observation wells. Grid resolution is 100 square meters, which is great enough to generate a representative scale without a prohibitive computational draw.

*Model Parameters*

* Hydraulic conductivity, zone 1: 1 m/d

Chosen as a conservative representation of the measured K at observation wells one and three.

Kobs1 = 1.5 m/d

Kobs2 = 1 m/d

* Hydraulic conductivity, zone 2: 6 m/d

A median value between the zones of greatest and lowest hydraulic conductivities

* Hydraulic conductivity, zone 3: 11 m/d

Chosen as a representative value between the measured K at observation wells two and four.

Kobs2 = 13 m/d

Kobs4 = 8 m/d

* Coordinates, areas, and crops for each farm were given in the provided materials.
  + Wildcat Farm: 30 acres of cotton, approximately square, southwest corner latitude and longitude: (1500,125)
  + ACME Farming Corp: 500 acres of alfalfa, approximately rectangular, southwest corner latitude and longitude (0,700)

*Pumping Rates*

Wildcat Farm pumps 348 m3/d

Cotton consumptive use \* farm area = (.003 m/d \* 121,410 m2)

ACME Faming Corp pumps 10,462 m3/d between two wells

Alfalfa consumptive use \* farm area = (.0052 m/d \* 2,023,500 m2)

*Evapotranspiration*

Background ET:

Cultivated ET:

Table

Description automatically generated

Base case in southwest is 10 in/yr <https://geochange.er.usgs.gov/sw/changes/natural/et/#:~:text=Estimates%20of%20the%20mean%20annual,year%20in%20the%20humid%20Southeast>.

*Recharge*

Net recharge in non-irrigated areas in this domain is 1e-4 m/d

* Wildcat Farm: 0.001 m/d

Total irrigation \* (1 – efficiencycotton) = .003 m/d \* (1 – 0.80)

* ACME Farming Corp: 0.0008 m/d

Total irrigation \* (1 – efficiencyalfalfa) = .0052 m/d \* (1 - 0.85)

*Boundary Conditions*

Constant head boundaries were derived from provided water table depth (WTD) at each observation well.

Obs1 WTD = 4.8 m

Obs2 WTD = 5.4 m

Obs3 WTD = 50.2 m

Obs4 WTD = 51.6 m

WTDleft boundary = 5 m

WTDright boundary = 50 m

Constant head boundaries = Thickness of domain – WTD

*Assumptions*

*Scenario 1 – Reasonable Guess*

In the first case, hydraulic conductivities are represented in three horizontal layers. This is the simplest distribution of the ranges measured at the observation wells. Wildcat farm pumps from a single well located in its center; this location remains constant among all three cases. This instance places one ACME will in the moderate-K zone and one in the high-K zone.

Ztop = 800 m

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Text

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Chart

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Chart, table

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*Scenario 2 – Worst Case*

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Graphical user interface, chart

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Chart, radar chart

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*Scenario 3 – Best Case*

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Chart, surface chart

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Diagram

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Chart

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