1.72 Groundwater Hydrology
Problem Set #3

DAVIS BASIN — Due Oct. 19

The goal of this lab is to characterize and evaluate the hydrogeology of the Stanley N. Davis Basin. You have a rough map of the basin (rivers and outcrop boundaries) and some data gathered by your consulting firm. The map represents a portion of the basin which is filled with unconsolidated sediments. Impermeable granitic bedrock outcrops above the 1300 foot contour in the southwestern and northeastern parts of the map. This hot and arid region had an annual rainfall of less than six inches last year. The only continually flowing stream (perennial stream) is shown as a solid black line on the map; the dashed lines represent dry desert washes (ephemeral streams). With the data that the consultants have provided, you will characterize the aquifer(s) and map the groundwater flow pattern in the basin.

The following areas are irrigated by groundwater (refer to Appendix C for an explanation of coordinates):

5-4-24 through 5-4-36
5-5-1 through 5-5-36
5-6-7, 5-6-8, 5-6-9, 5-6-16, and 5-6-36
6-4-1 through 6-4-36
6-5-1 through 6-5-36
6-6-1 through 6-6-36

Irrigated fields and meadows are more or less uniformly distributed throughout this area. Only about one percent of the total irrigated area is actually irrigated during a particular year. All irrigation water comes from gravel-packed, large-diameter irrigation wells, which are pumped continuously through the six-month growing season and shut down for the other six months (April - Sept). You may neglect precipitation and evaporation from the map area.

THE DATA

The consultants took data from wells, test holes, bench marks, and river surface stations. There is a lot of information, so familiarize yourself with the data before starting the mapping.

<u>Wells</u>: Data are provided for domestic, stock, and irrigation wells. For each well you have the ground surface elevation (relative to msl) for the well, the depth of the well (depth below ground surface), and the water elevation (msl). You should make the following assumptions when analyzing the well data:

1) The irrigation wells are screened (i.e., open) over their entire length.
2) Domestic and stock wells are screened near their bottoms.
3) Water levels in all wells represent non-pumping conditions.

The location of all wells is marked on your map. There are a total of 23 domestic wells, 25 stock wells, and 5 irrigation wells. Look carefully at the irrigation well data before you decide to use it in constructing your hydrologic maps. The table of well data has been appended to this lab (Appendix A).

Streams: You have data from three stream gauge stations in the Davis Basin (Table 1). At these locations (also marked on your map) the flow rate in the stream (in cfs) has been measured monthly throughout the year. You also have a measurement of the average water level (msl) at each gauging station. These data should be useful in your interpretation of the groundwater regime. Remember that a stream (or portions of a stream) may be perennial or ephemeral. Use your interpretation of the stream/groundwater interaction to change the designation of the streams on the map, if necessary.

Station	location	Surface Elevation (ft)	J	F	M	A	M	J	J	A	S	O	N	D
R1	4-3-18a	1,400	20	15	10	10	5	2	1	-	-	-	3	15
R2	5-4-16d	1,095	15	8	2	1	-	-	-	-	-	-	-	5
R3	6-6-30a	980	17	10	3	6	7	6	4	3	8	6	5	8

- indicates no stream flow in that month

Table 1: Stream Discharge (cfs)

Bench Marks: There are seven bench mark stations in the Davis Basin (Table 2). At these locations the USGS has kindly measured the ground surface elevation (relative to msl).

Station	Location	surface elevation (ft)
BM1	4-3-6b	1565
BM2	4-6-1a	1610
BM3	4-6-7c	1100
BM4	4-6-24a	1750
BM5	6-3-6c	1750
BM6	6-3-30d	2103
BM7	6-6-36a	985

Table 2: Bench Marks

Driller's Logs of Test Holes: Five test holes were bored in the Davis Basin to map the lithology of the area. For each hole, the driller has provided you with a boring log showing the type of unconsolidated deposit encountered with depth (also by elevation). The driller also measured the ground surface elevation at test hole locations. See Appendix B.

MAPPING

Your first task is to map the Davis Basin area. You will contour the ground surface elevation in the basin as well as the piezometric surface. Do not agonize over the contours! They should roughly (not precisely) show the surfaces.

1) Hand draw 100 foot contour lines of the ground surface elevation.
2) Use the stream discharge data provided to determine which streams on the map are perennial and which are ephemeral. Alter the symbols on the map to comply with your assessment.
3) Map the piezometric surface of the aquifer(s) by drawing 10 foot contours. Use different colors to contour the ground surface, the water table, and any other piezometric surface(s). Remember to indicate the meaning of your color choices in the map legend.
4) Label areas of natural recharge and discharge in the basin (i.e., recharge to and discharge from groundwater).
5) Indicate the direction of groundwater flow in the basin with arrows.

CROSS SECTION

Thus far you have examined the basin as a two-dimensional system. However, the driller's test logs provide some vertical information about the basin. Use the driller's logs information to create a geologic cross-section or **fence diagram.**

1) Draw a vertical cross-section of the basin lithology from the driller's logs.
2) Preserve the relative distances between adjacent holes.
3) Use the same symbols for each material as in the attached sample boring log.
4) Remember to show the trace of the cross-section on your map, and label the end points A-A'.
5) Draw both the water table and any other piezometric surface(s) on your cross-section.

QUESTIONS

1) Describe the aquifer(s) – number, distribution, thickness, lithology.
2) Where does the groundwater flow **out of** the map area?
3) How is the lithology of T1 different from that of the other boring logs?
4) Is the stream recharging or discharging the aquifers(s)?
5) Is the granite discharging water to the basin or is it being recharged by the basin?
6) Why are the water level data from the irrigation wells inconsistent with both the piezometric surface of the lower aquifer <u>and</u> the water table surface of the upper aquifer?
7) Describe the temporal nature of recharge to and discharge from the aquifer(s).
8) Does the present irrigated acreage appear to suffer from a shortage of water? Support your answer.
9) Describe future aquifer conditions in the basin if irrigation practices continue unchanged.

Appendix A: Well Data

(a) (msl, from datum) ↑ (b) (from surface) ↓ (c) (from sea level) ↑

Well	Location	Surface Elevation (ft)	Depth of Well (ft)	Water Elevation (ft)
S1	4-3-1d	1195	950	700
S2	4-3-4c	1410	1100	745
D1	4-3-5c	1500	1190	750
S3	4-3-18c	1520	1105	760
D2	4-3-21d	1395	1000	755
S4	4-3-28b	1305	1300	755
S5	4-3-30b	1390	1000	740
S6	4-3-35a	1205	890	750
D3	4-4-21c	1165	810	690
S7	4-4-23a	1140	820	705
S8	4-5-2b	1120	760	[illegible]
D4	4-5-8b	1115	920	695
D5	4-6-19c	1095	705	[illegible]
S9	4-6-28c	1087	750	710
D6	4-6-35a	1405	100	695
S10	5-3-11c	1190	840	715
S11	5-3-30d	1190	950	725
D7	5-4-4d	1150	820	740
S12	5-4-30c	1115	910	740
S13	5-5-3b	1100	870	685
S14	5-5-7b	1100	790	725
D8	5-5-14b	1070	40	1050
I1	5-5-17d	1070	1000	845
D9	5-5-25b	1020	55	1005
D10	5-5-27c	1030	840	690
S15	5-5-29c	1050	40	1045
I2	5-6-17a	1055	1020	690
D11	5-6-27d	1030	35	1020
I3	5-6-32b	998	900	755
S16	6-3-1b	1105	790	705
S17	6-3-8c	1580	90	[illegible]
D12	6-3-10b	1150	1000	720
S18	6-3-11c	1097	800	715
S19	6-3-14d	1130	850	715
S20	6-3-35c	1350	400	[illegible]
D13	6-3-36a	1098	750	710
S21	6-4-8b	1070	50	1060
S22	6-4-11b	1065	45	1040
I4	6-4-15b	1070	1020	890
S23	6-4-23a	1030	105	1020
D14	6-4-27b	1040	165	1025
D15	6-4-35d	1005	30	998
D16	6-5-4c	1010	35	1005
D17	6-5-11c	1000	40	995
D18	6-5-10b	1015	30	1000
D19	6-5-21c	1000	55	996
S24	6-5-31d	995	780	690
D20	6-5-36a	990	30	985
D21	6-6-3d	998	25	995
S25	6-6-10c	990	785	685
D22	6-6-13c	990	30	985
D23	6-6-27b	990	40	980
I5	6-6-33a	975	790	665

Appendix B: Driller's Logs of Test Holes

	Surface elevation (ft)	Depth of hole (ft)
TH1	1350	1200
TH2	1190	950
TH3	1150	1000
TH4	995	1000
TH5	985	800

TH1

0-10	top soil
10-150	gravel and sand
150-400	gravel
400-850	sand and fine gravel
850-900	sand
900-1200	gravel and sand

TH2

0-5	top soil
5-280	fine sand
280-295	clay
295-390	sand
390-630	clay
630-950	sand and fine gravel

TH3

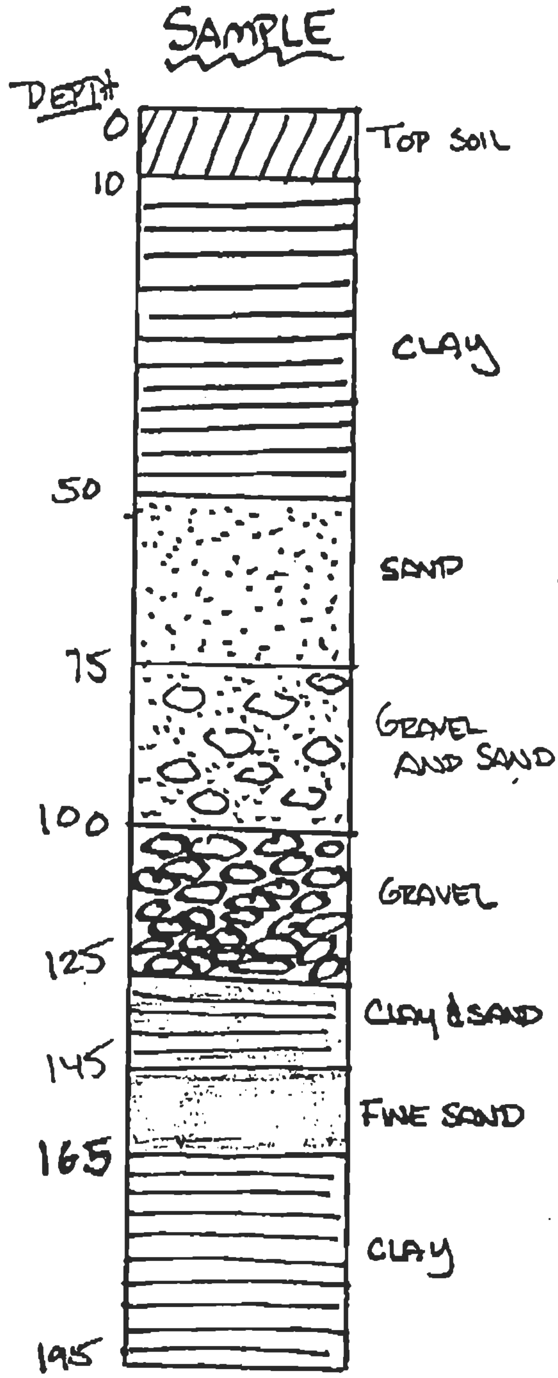
0-5	top soil
5-25	fine sand
25-150	sandy clay
150-790	clay
790-1000	fine sand

TH4

0-5	top soil
5-40	sand
40-125	clay
125-130	sand
130-650	clay
650-900	fine sand
900-1000	clay and sand

TH5

0-10	top soil
10-50	sand and gravel
50-90	clay
90-120	fine sand
120-690	clay
690-800	fine sand



Appendix C: Map Locations

example: 4-3-21a

There are 12 Township designations in the basin

3	4	5	6
4-3	4-4	4-5	4-6
5-3	5-4	5-5	5-6
6-3	6-4	6-5	6-6

BASIN MAP

Each Township is divided into 36 sections

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

TOWNSHIP

Each section is further divided into 4 quarters

b	a
c	d

SECTION