Montana
Water Policy Interim Committee
(October 24, 2007)

Panel Discussion #1

Costs to develop and provide water in subdivisions exempt wells versus one large one

"Science of one well versus many"

John Metesh
Montana Bureau of Mines and Geology

One well versus many

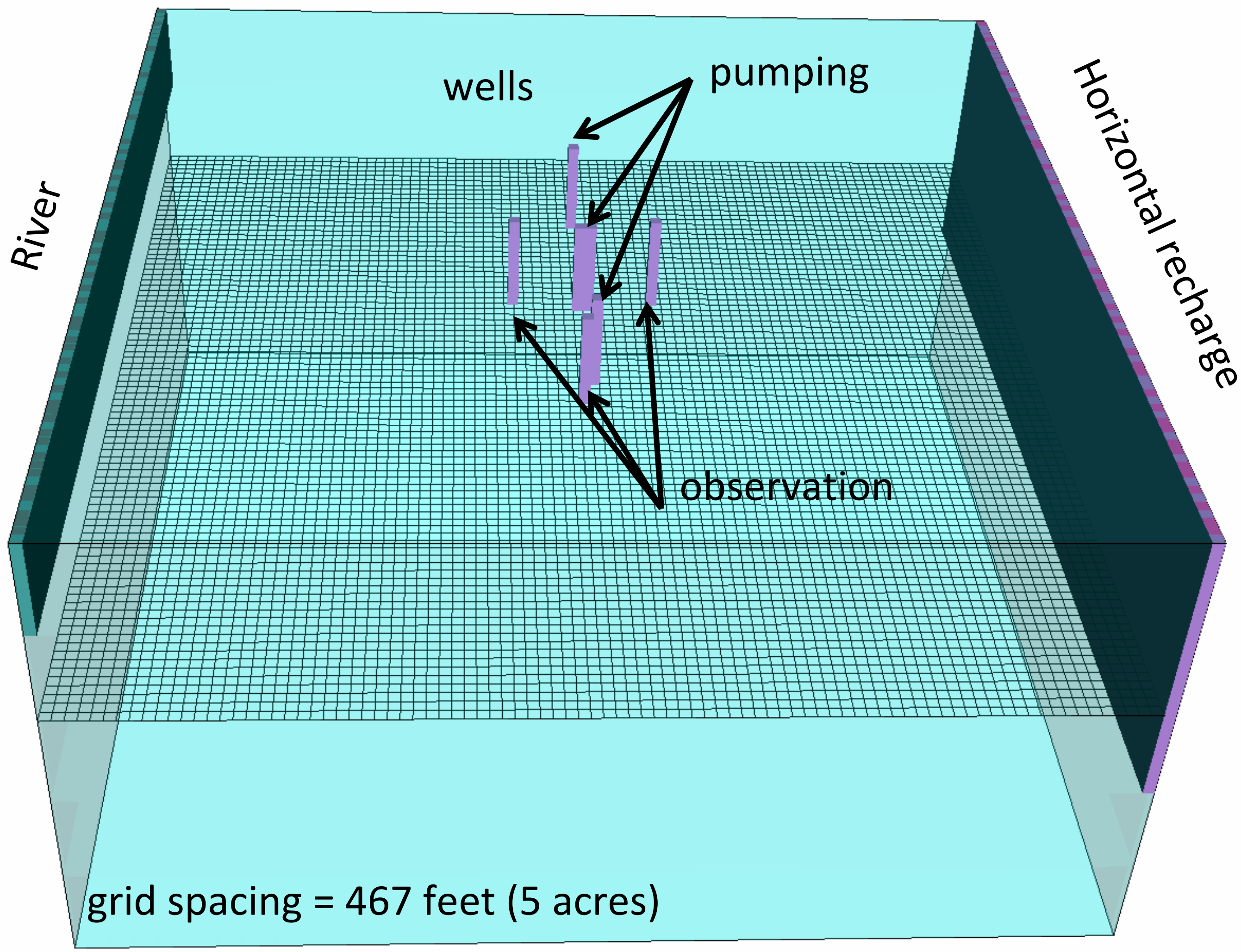
A mathematician says:

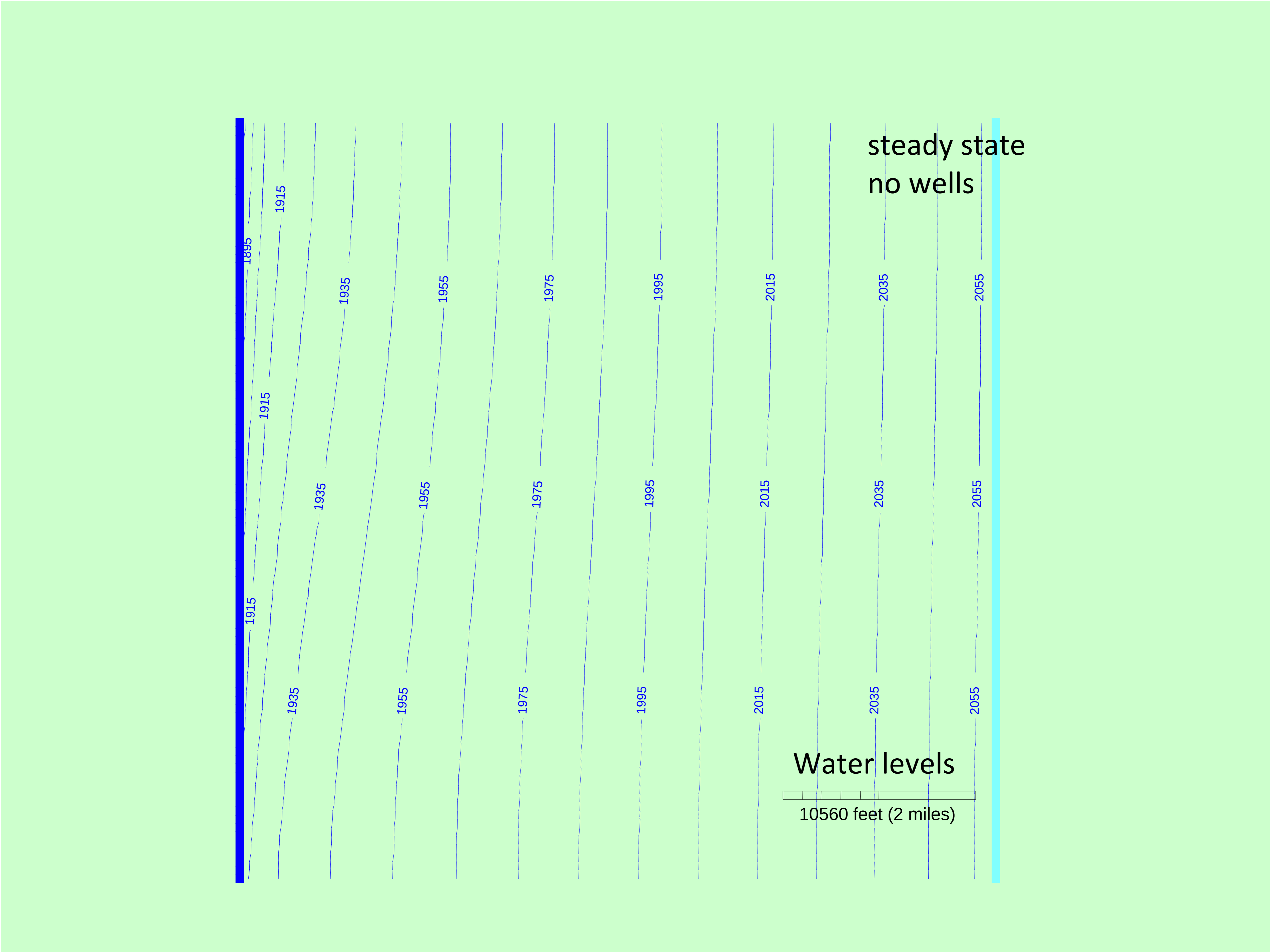
1*1,000 = 10*100 = 100*10 = 1,000*1   there's no difference

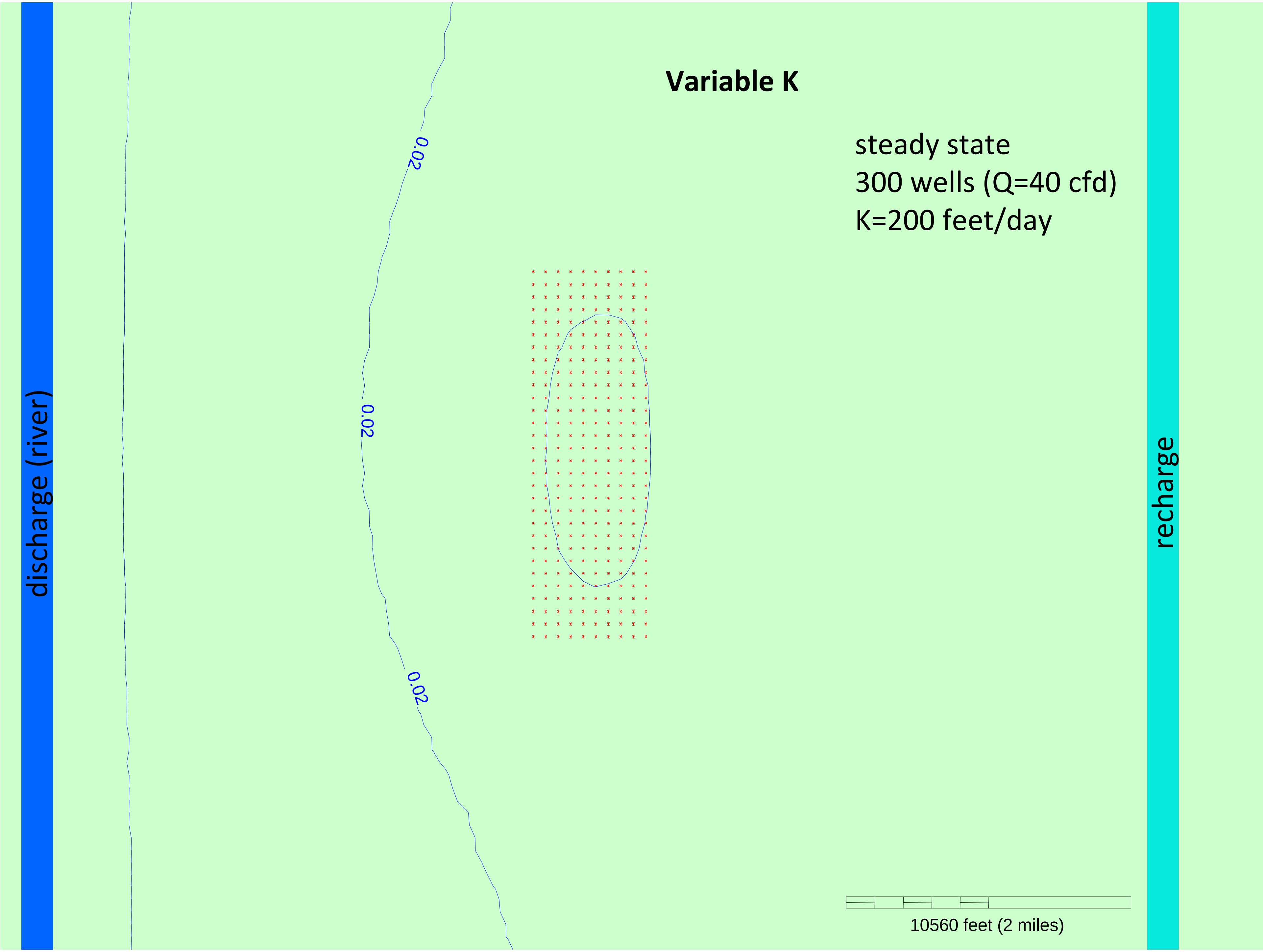
A hydrogeologist says:

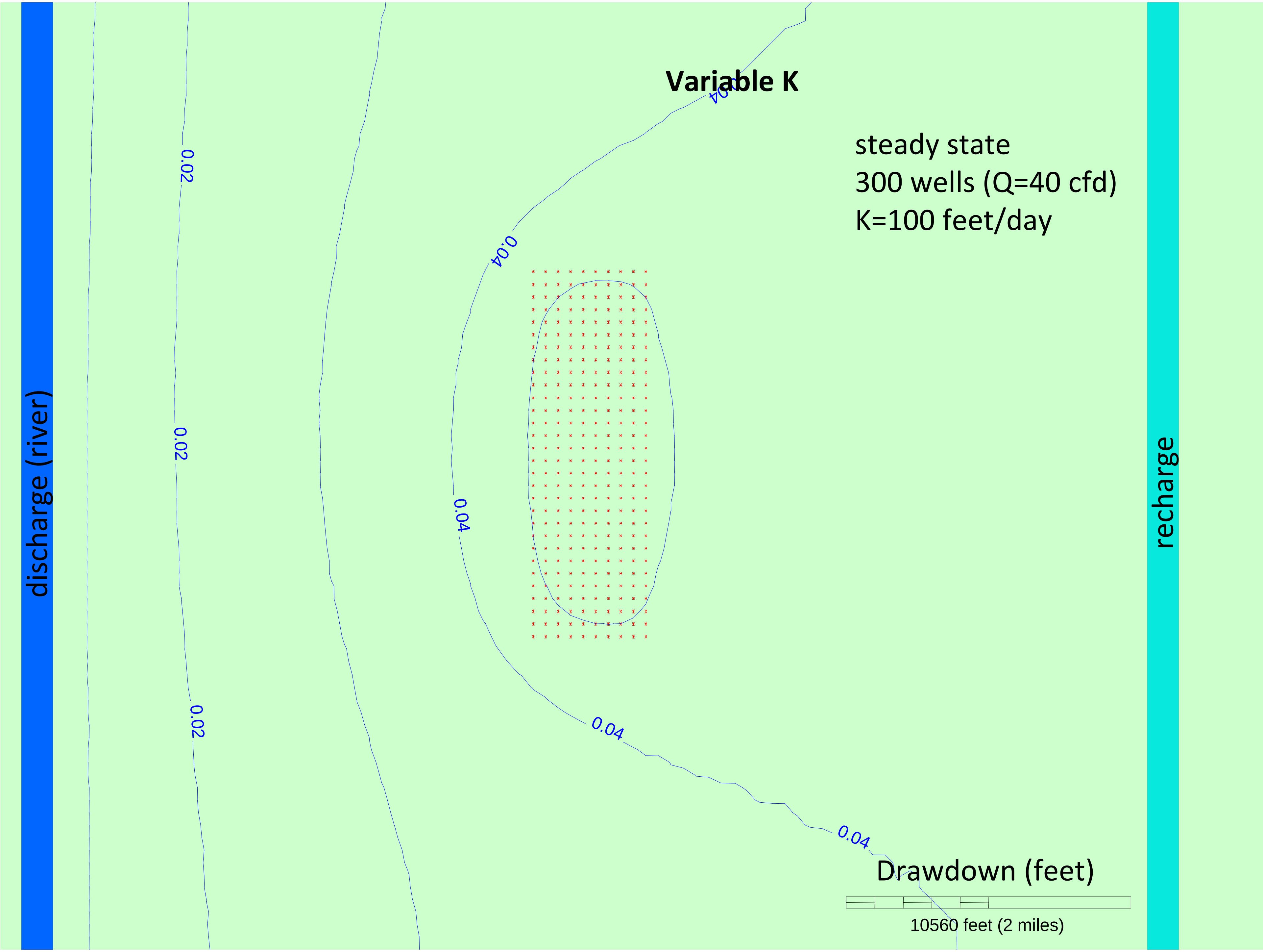
in depends…

8 miles from river to “recharge”

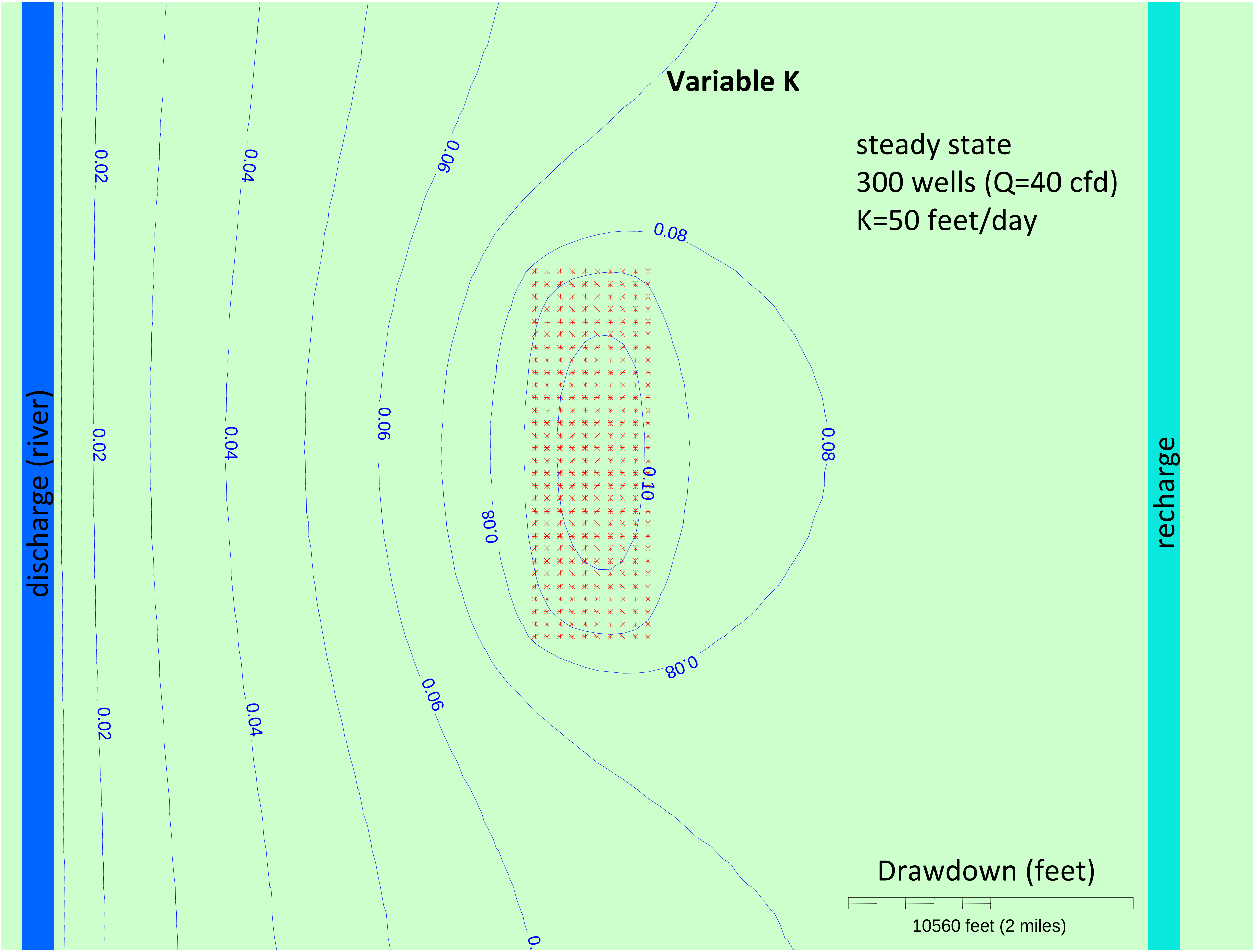



steady state
no wells
Water levels
10560 feet (2 miles)
1895
1915
1935
1955
1975
1995
2015
2035
2055


Variable K
steady state
300 wells (Q=40 cfd)
K=200 feet/day
discharge (river)
recharge
0.02
0.02
0.02
10560 feet (2 miles)

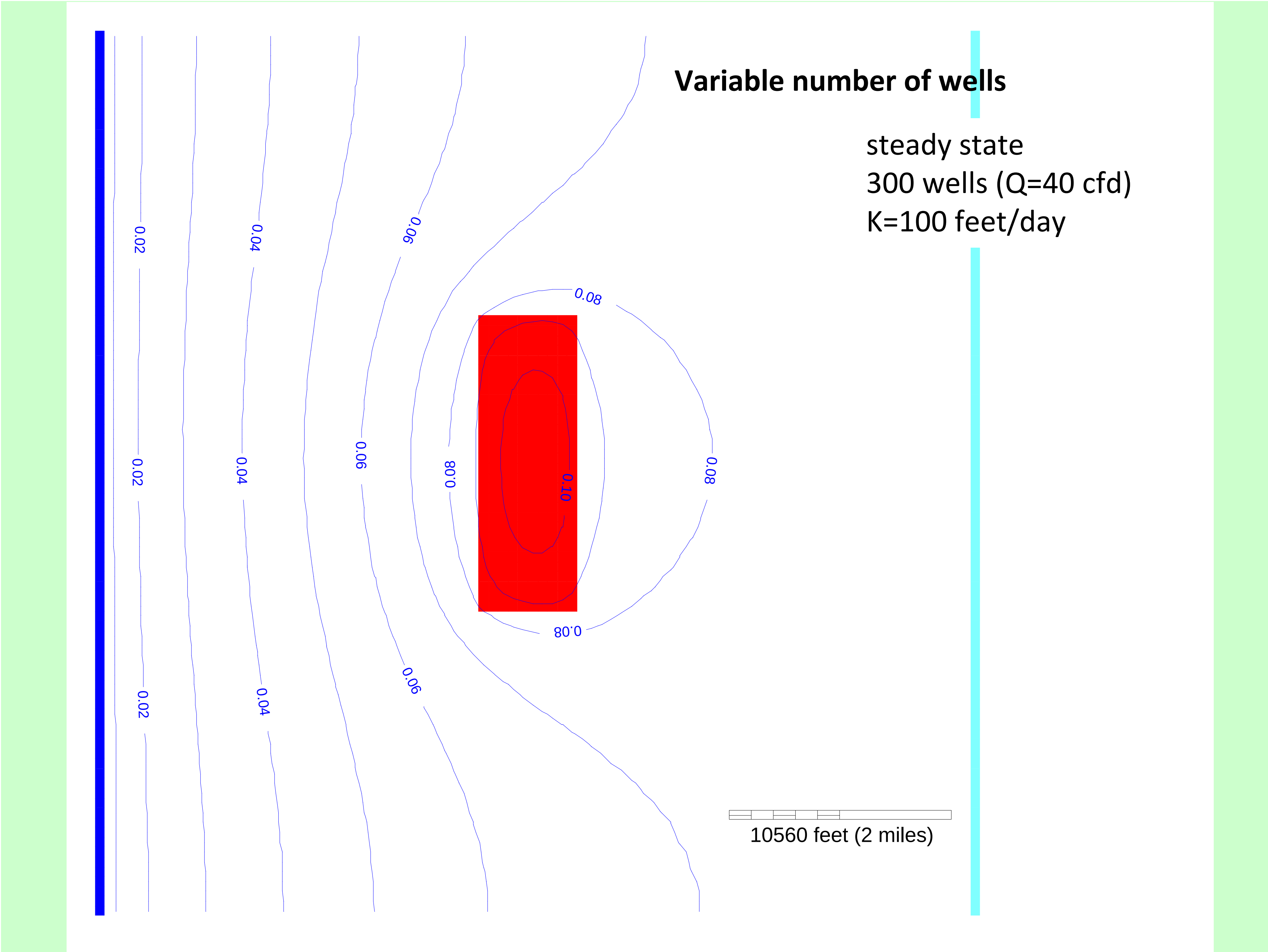


Variable K
steady state
300 wells (Q=40 cfd)
K=100 feet/day
discharge (river)
recharge
0.02
0.02
0.02
0.04
0.04
0.04
0.04
0.04
Drawdown (feet)
10560 feet (2 miles)


Variable K
steady state
300 wells (Q=40 cfd)
K=50 feet/day
discharge (river)
recharge
0.02
0.02
0.02
0.04
0.04
0.04
0.06
0.06
0.06
0.08
0.08
0.08
0.08
0.10
Drawdown (feet)
10560 feet (2 miles)

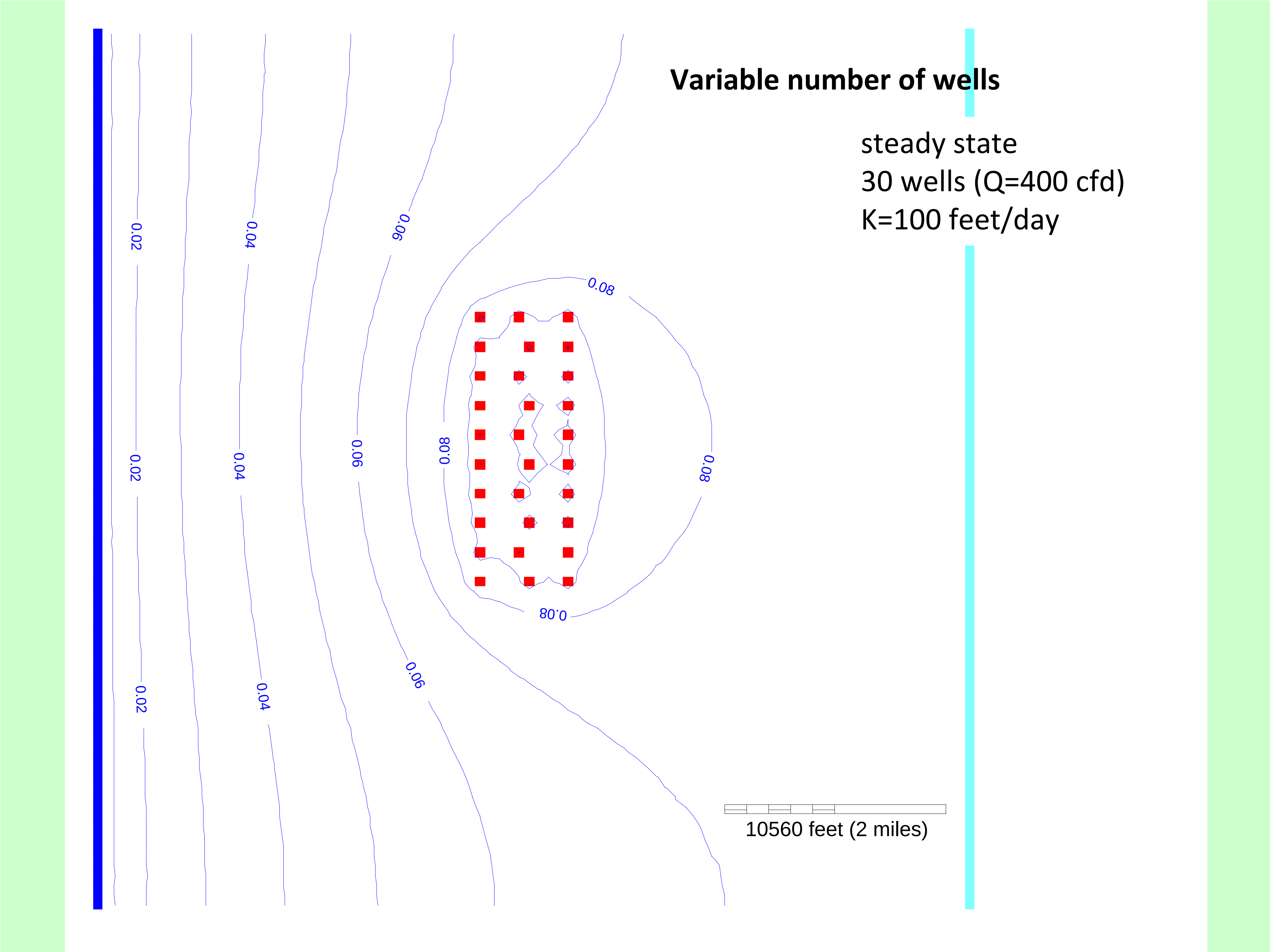
Variable number of wells

steady state
300 wells (Q=40 cfd)
K=100 feet/day



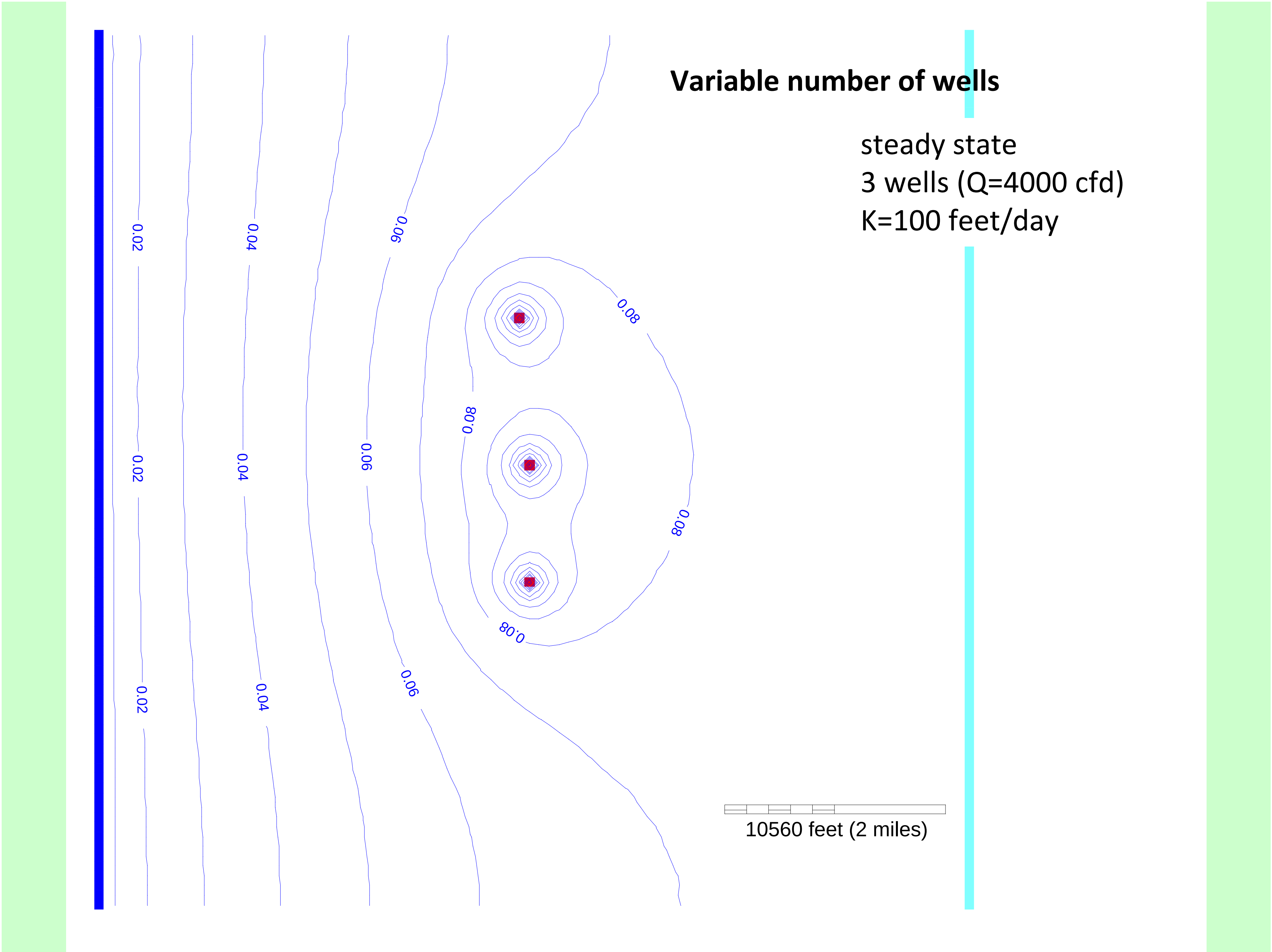
Variable number of wells

steady state
30 wells (Q=400 cfd)
K=100 feet/day



Variable number of wells

steady state
3 wells (Q=4000 cfd)
K=100 feet/day



Problems with steady state analysis:

Assumption of pumping rate (300 gpd) translates to ~0.21gpm

Steady State assumes a constant discharge rate (24/7/365)

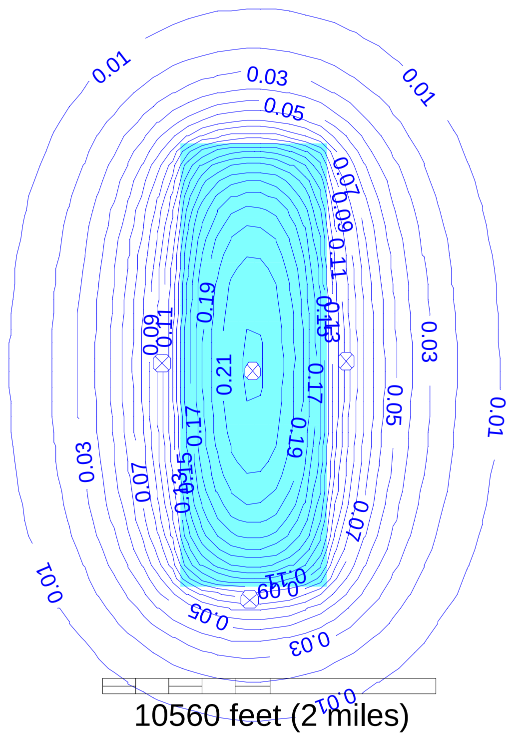
Real wells pump at 5 to 15 gpm for shorter periods

To maintain water balance, **all** water must come from the river

Real wells get at least some water from aquifer storage

Variable number of wells **and rate**

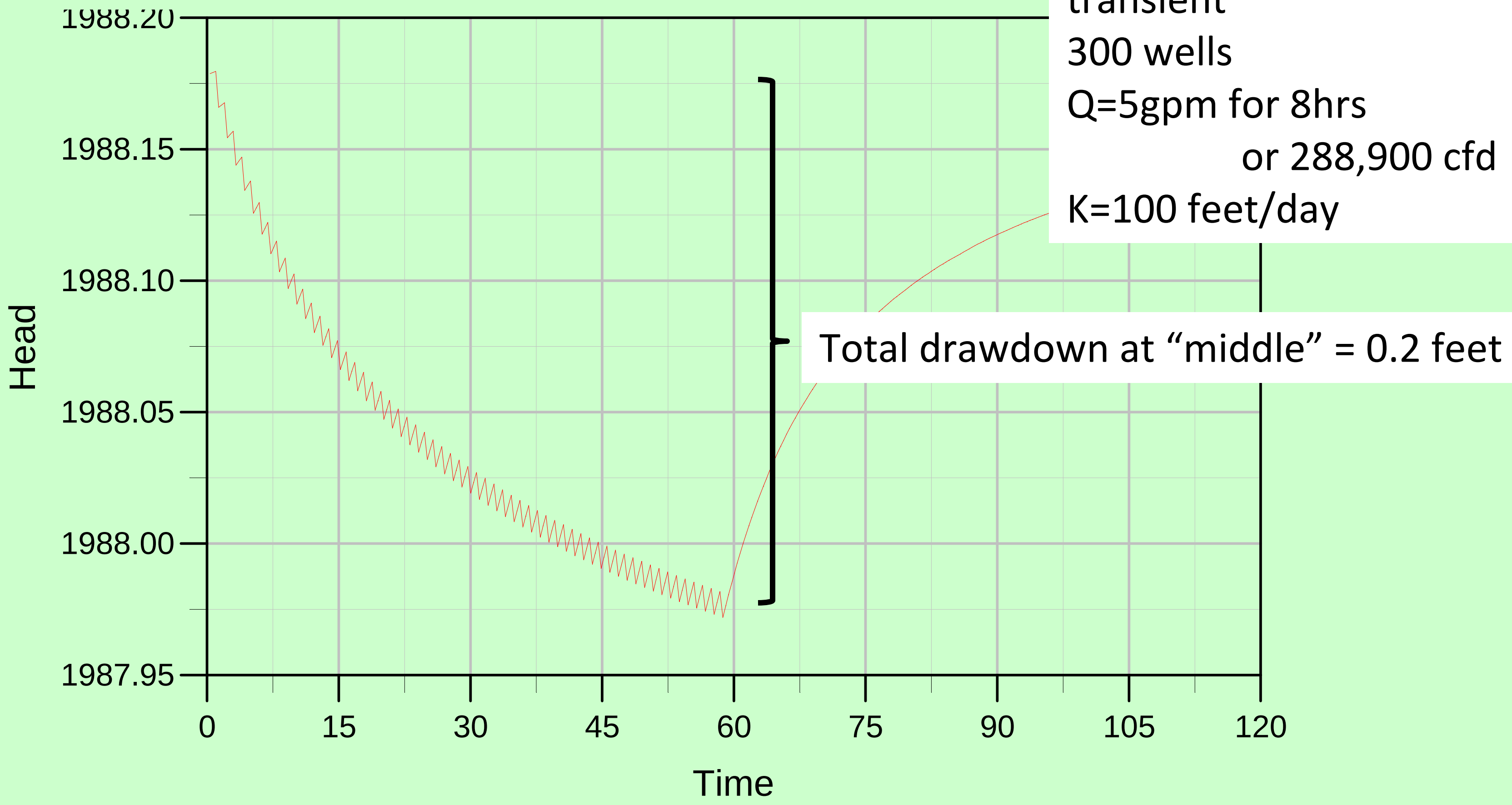
transient
300 wells
Q=5gpm for 8hrs (**then off for 16**)
or 288,900 cfd
K=100 feet/day



maximum drawdown = 0.22 feet

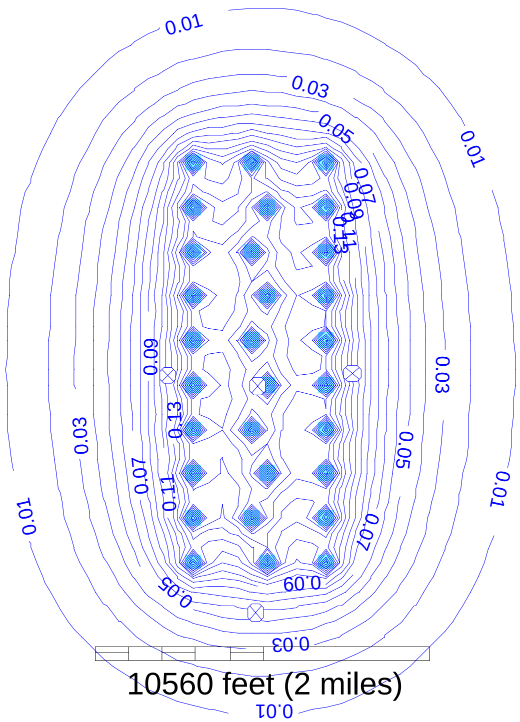
Variable number of wells <u>and rate</u>

transient
300 wells
Q=5gpm for 8hrs
or 288,900 cfd
K=100 feet/day



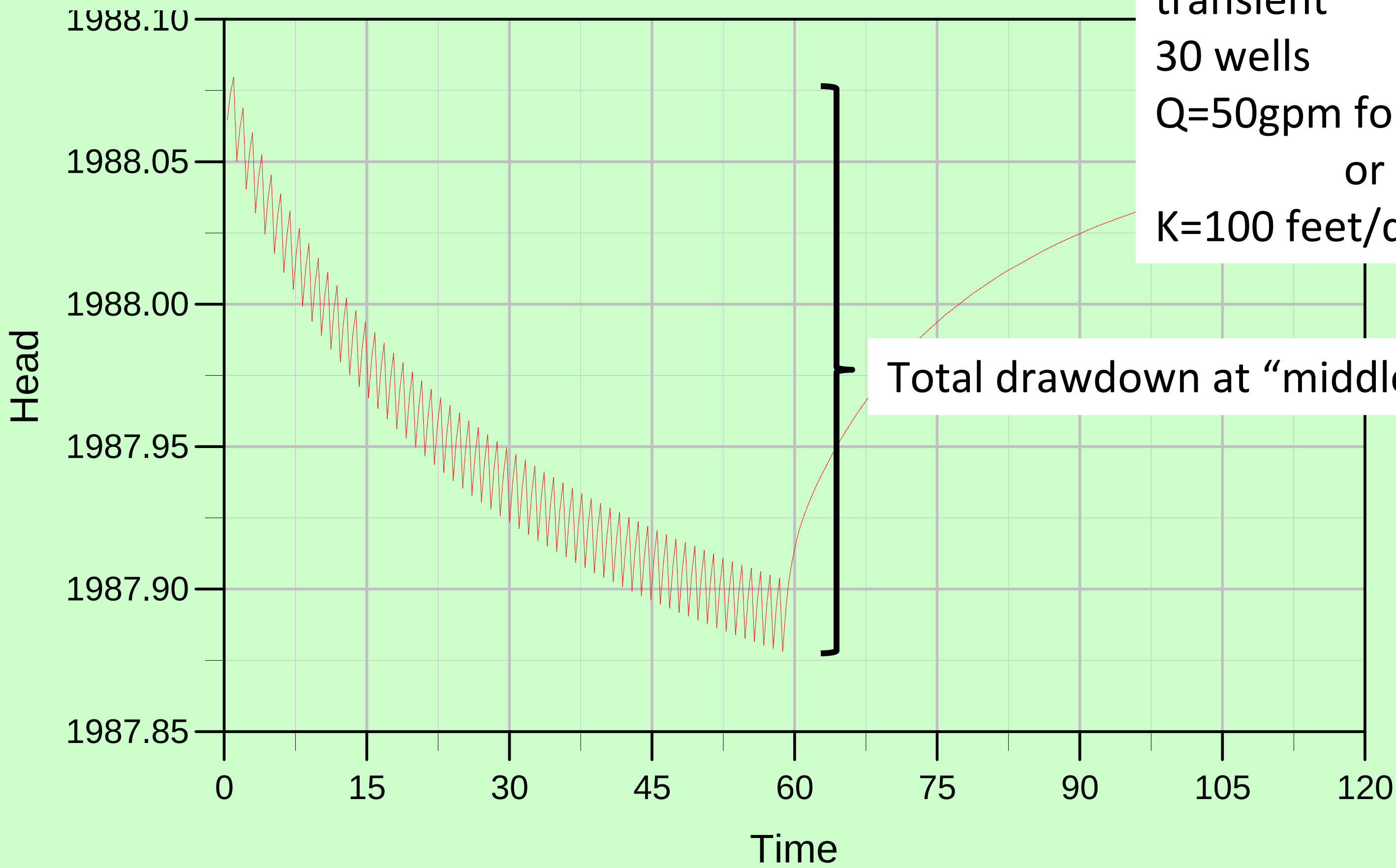
Variable number of wells and rate

transient
30 wells
Q=50gpm for 8hrs
or 288,900 cfd
K=100 feet/day



maximum drawdown = 0.27 feet

Variable number of wells <u>and rate</u>



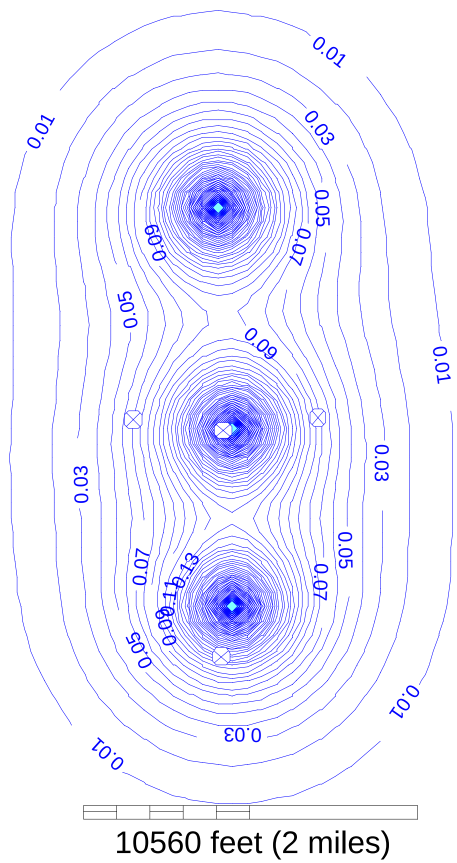
transient
30 wells
Q=50gpm for 8hrs
or 288,900 cfd
K=100 feet/day

Total drawdown at “middle” = 0.2 feet

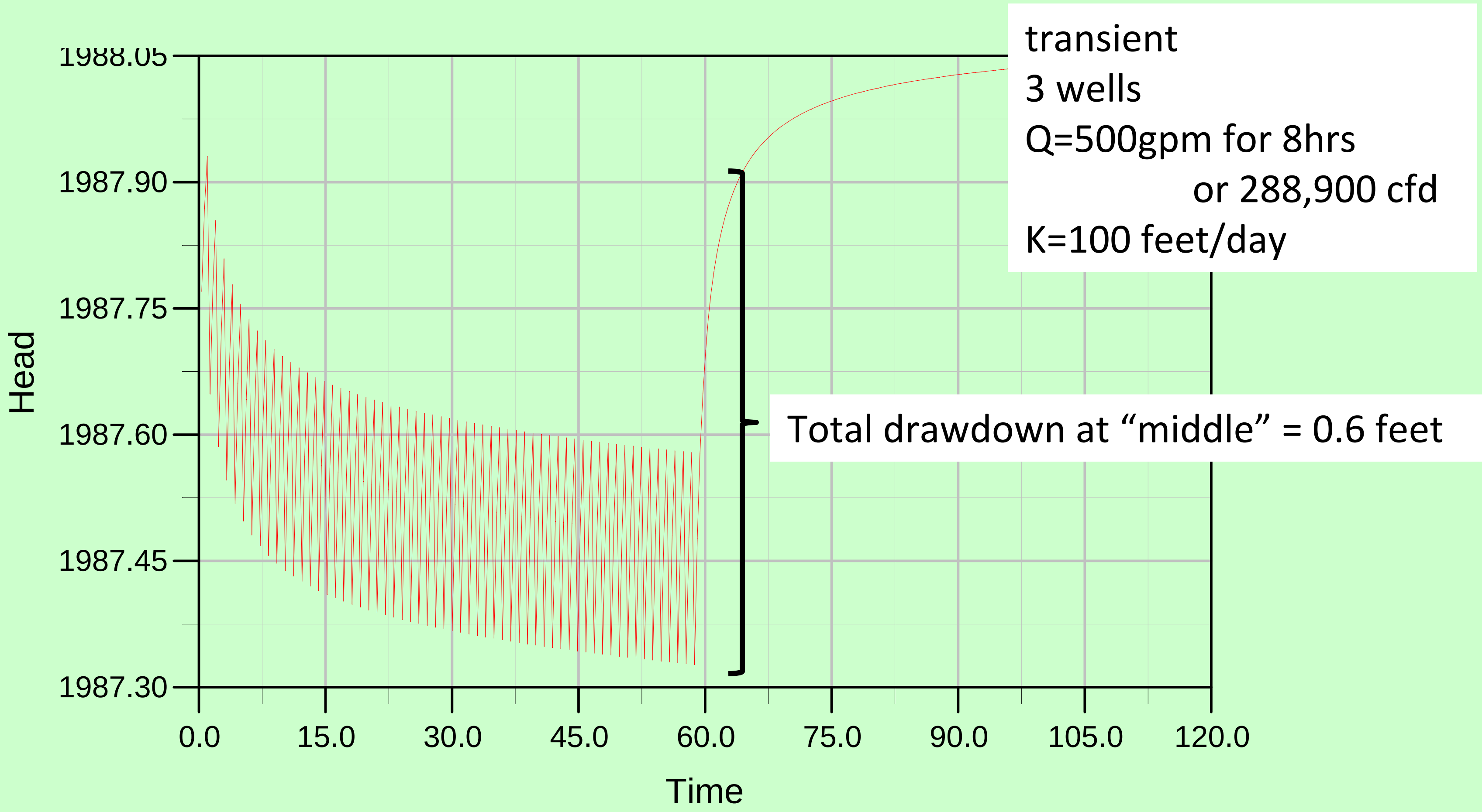
Variable number of wells <u>and rate</u>

transient
3 wells
Q=500gpm for 8hrs
or 288,900 cfd
K=100 feet/day

maximum drawdown = 1.3 feet

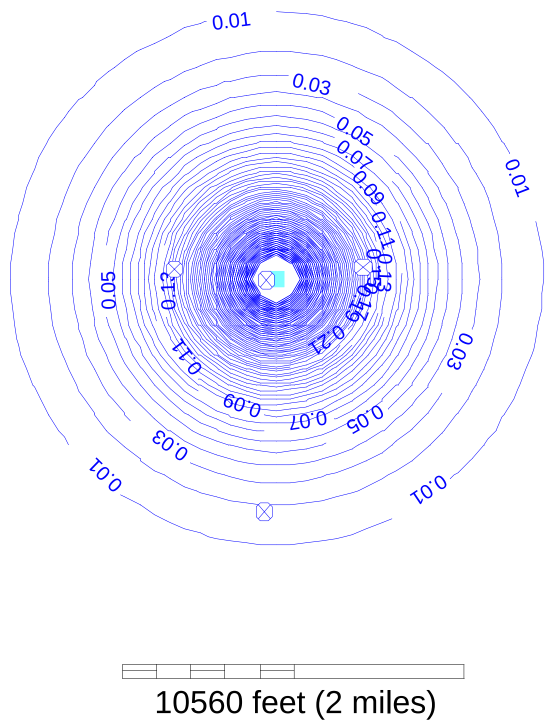


Variable number of wells and rate

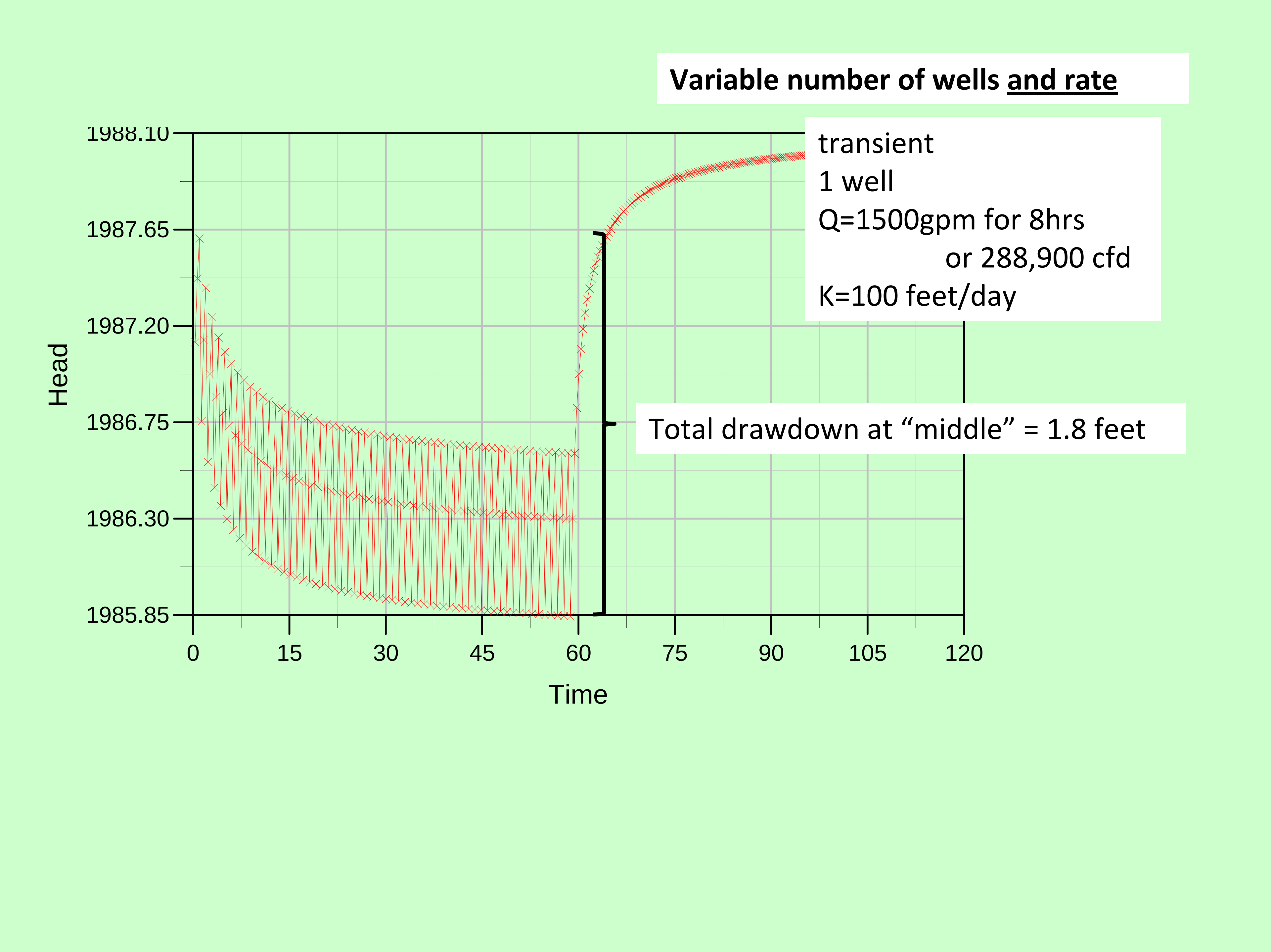


Variable number of wells and rate

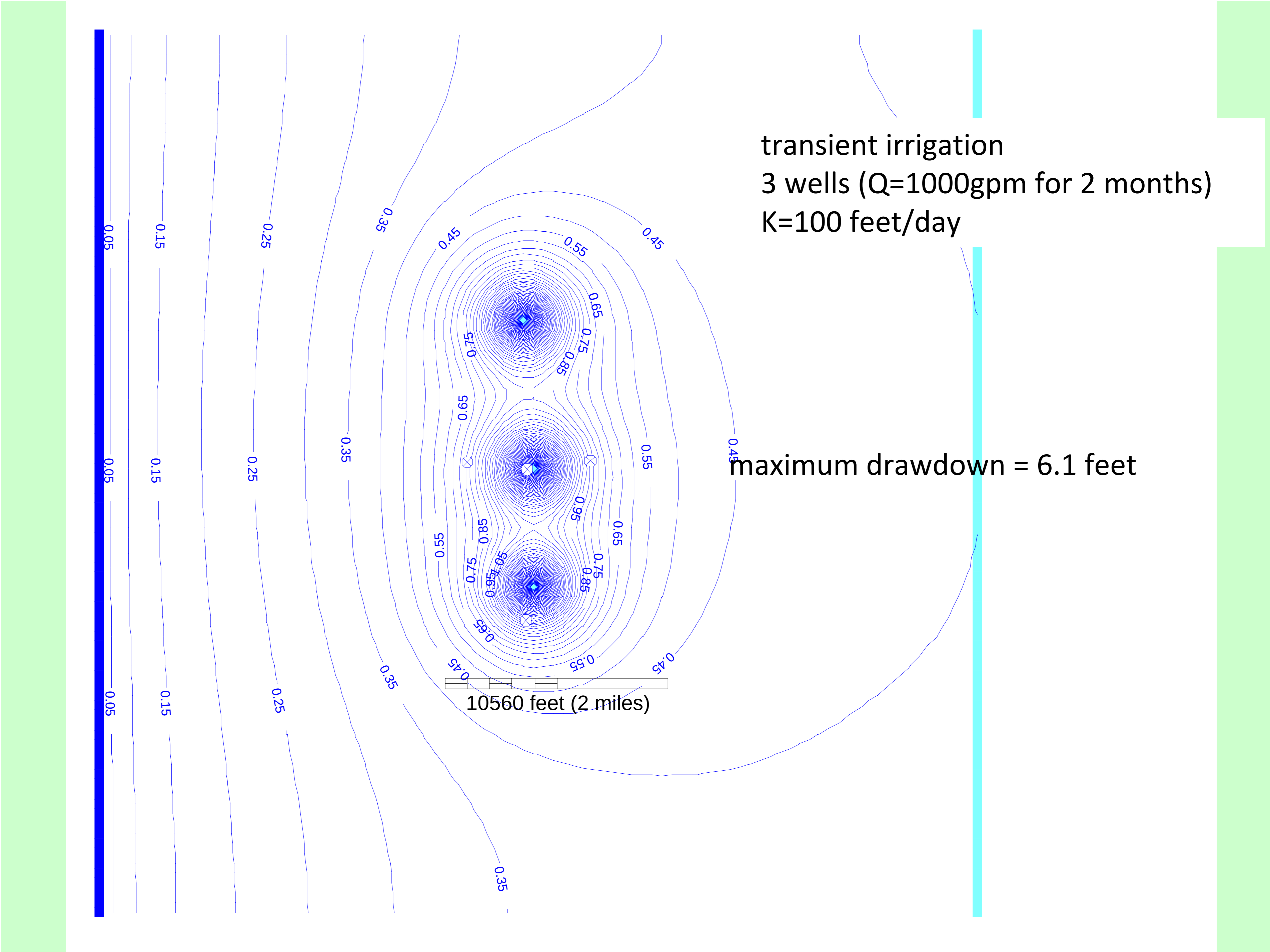
transient
1 well
Q=1500gpm for 8hrs
or 288,900 cfd
K=100 feet/day



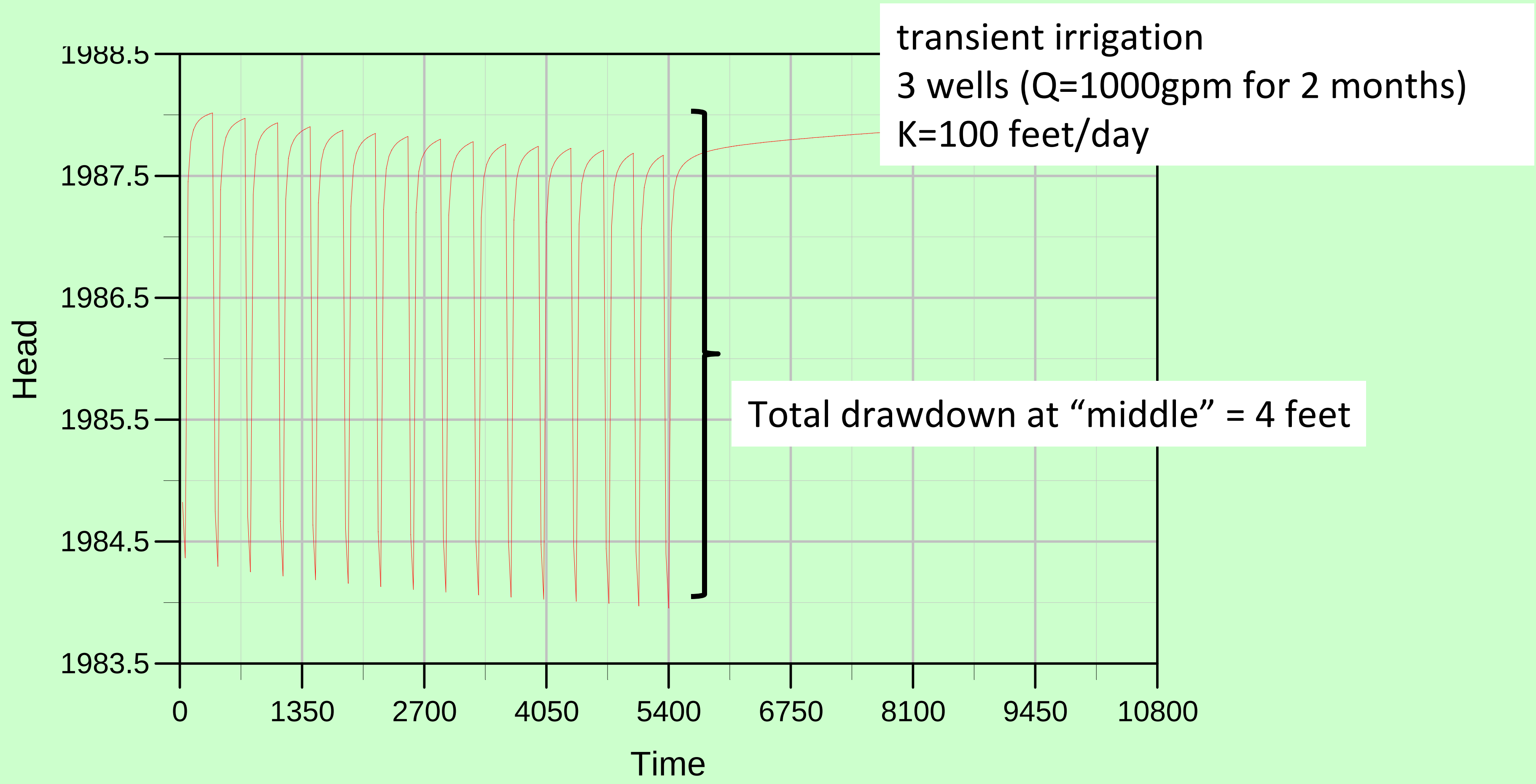
maximum drawdown = 1.9 feet


Variable number of wells and rate
transient
1 well
Q=1500gpm for 8hrs
or 288,900 cfd
K=100 feet/day
Total drawdown at “middle” = 1.8 feet
1988.10
1987.65
1987.20
1986.75
1986.30
1985.85
Head
0
15
30
45
60
75
90
105
120
Time

transient irrigation
3 wells (Q=1000gpm for 2 months)
K=100 feet/day



maximum drawdown = 6.1 feet



transient irrigation
3 wells (Q=1000gpm for 2 months)
K=100 feet/day
Total drawdown at "middle" = 4 feet
1988.5
1987.5
1986.5
1985.5
1984.5
1983.5
Head
0
1350
2700
4050
5400
6750
8100
9450
10800
Time

The longer you stretch out the effect (with respect to both time and space), the more likely it will be affected (mitigated?) by other stresses (recharge, seasonal variation…)

Higher pumping rates in fewer wells:

- Smaller footprint (modeled “volume of influence”)
- Fewer wells mean less well interference
- May be easier to mitigate (natural or artificial)
- Non-hydrogologic advantages…lower risk, economics (installation and long term)

Transient over Steady State Analysis:

- Rates and periodicity are more realistic
- Water truly comes from storage in the short term – not the river
- Analyses of natural changes and (mitigation) are better

Modeling over Analytical Methods:

- Inhomogeneous, anisotropic – not a problem
- well interference – not a problem
- Variation of recharge both long and short term – not a problem
- Non fully penetrating wells, streams

…need more data

- HB324, HB831 – pumping test data
- sub basin analyses from multiple applications
- New geologic and hydrogeologic mapping

One experiment is worth a thousand expert opinions

One picture is worth a thousand words

One model will start a thousand arguments