Souhegan River Protected Instream Flow Study and Water Management Plan

Technical Review Committee Meeting 7 January 2005

University of New Hampshire
University of Massachusetts
Normandeau Associates, Inc.

Assessment of Well Withdrawal Impacts on Surface Water

Do groundwater withdrawals reduce streamflow?

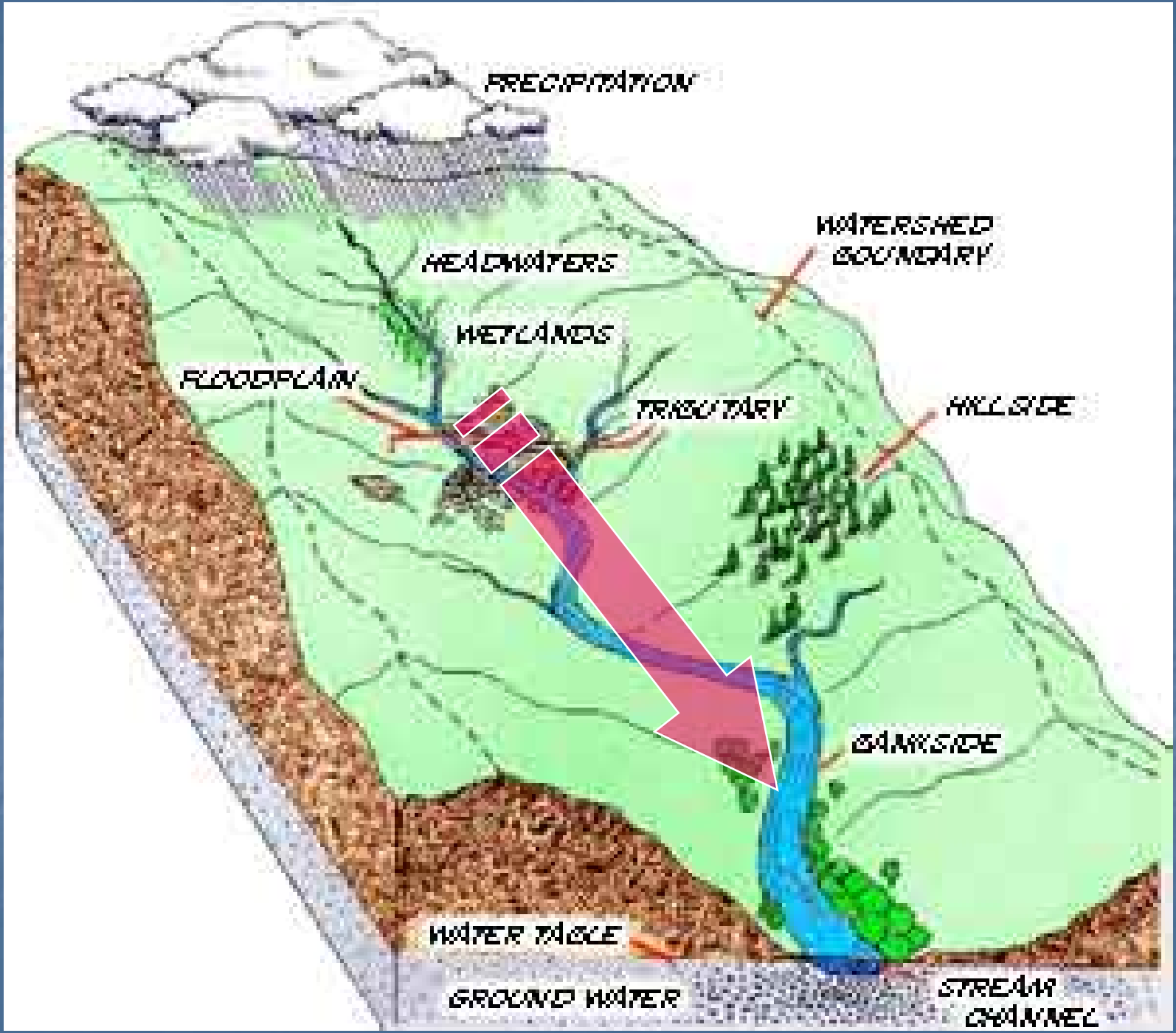
If so, can reductions to groundwater pumping be used at low flow times as one type of management strategy to meet instream flow needs?

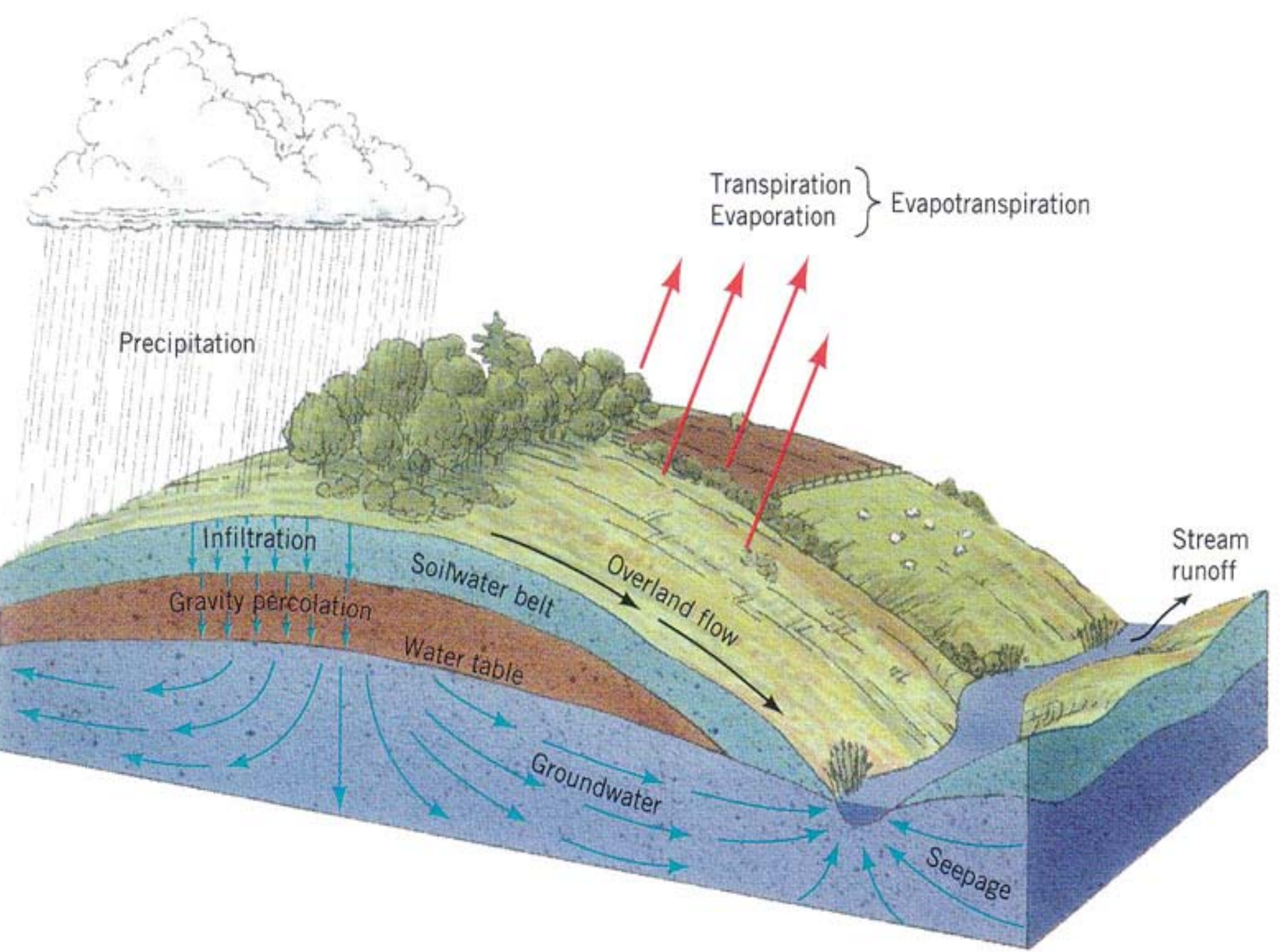
How effective are such strategies in comparison to other withdrawal reduction strategies?

Do groundwater withdrawals reduce streamflow?

If the groundwater had not been pumped, where was it going?

- Discharge to river, tributaries, or other surface waters
- Continued groundwater movement
- Deeper groundwater circulation

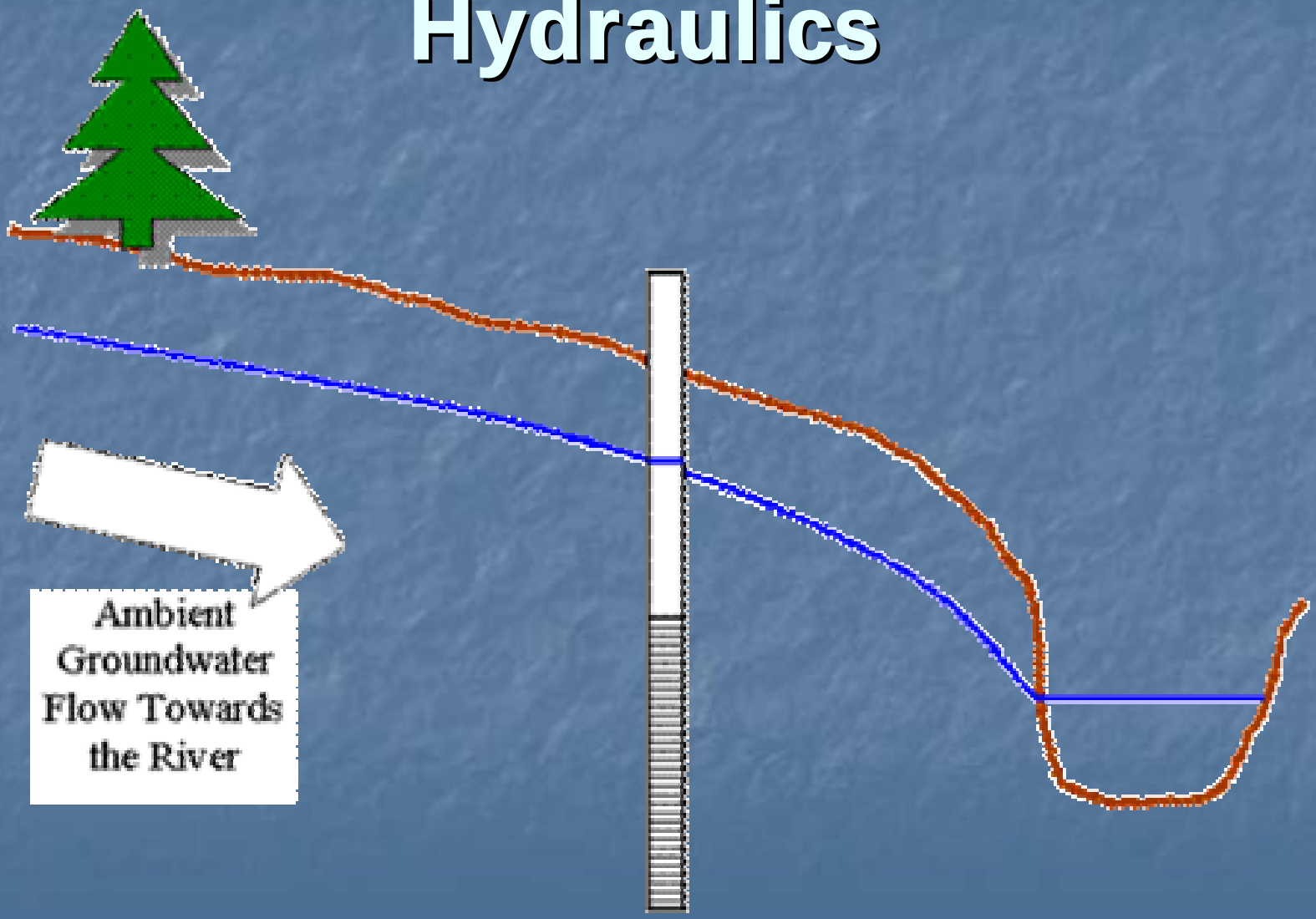

PRECIPITATION
WATERSHED BOUNDARY
HEADWATERS
WETLANDS
FLOODPLAIN
TRIBUTARY
HILLSIDE
BANKSIDE
WATER TABLE
GROUND WATER
STREAM CHANNEL


Transpiration
Evaporation
Evapotranspiration
Precipitation
Infiltration
Gravity percolation
Soilwater belt
Overland flow
Water table
Groundwater
Seepage
Stream
runoff

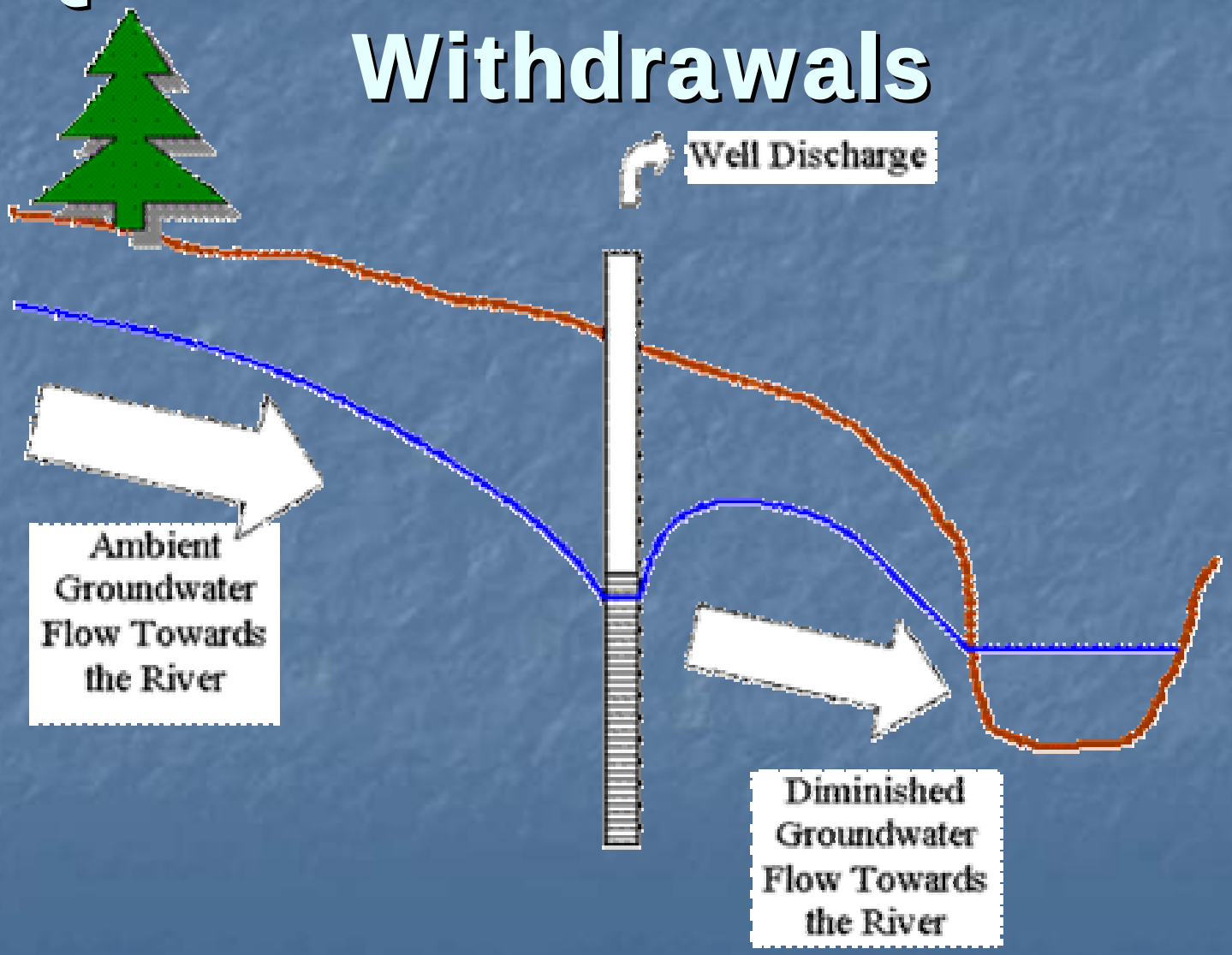
Can reductions to groundwater pumping be used at low flow times as one type of management strategy to meet instream flow needs?

Are individual wells inducing river water recharge?

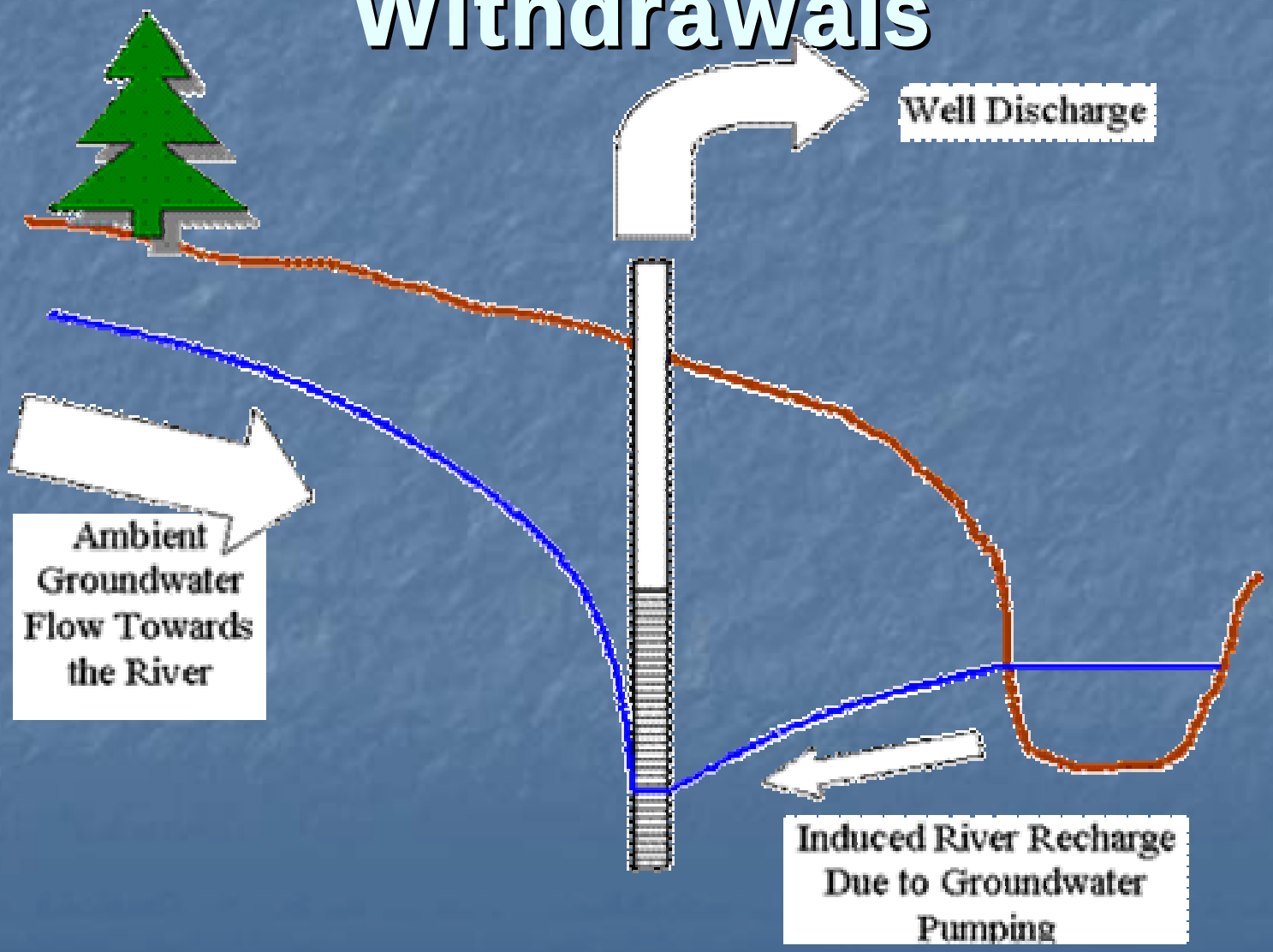
Ambient Groundwater Hydraulics



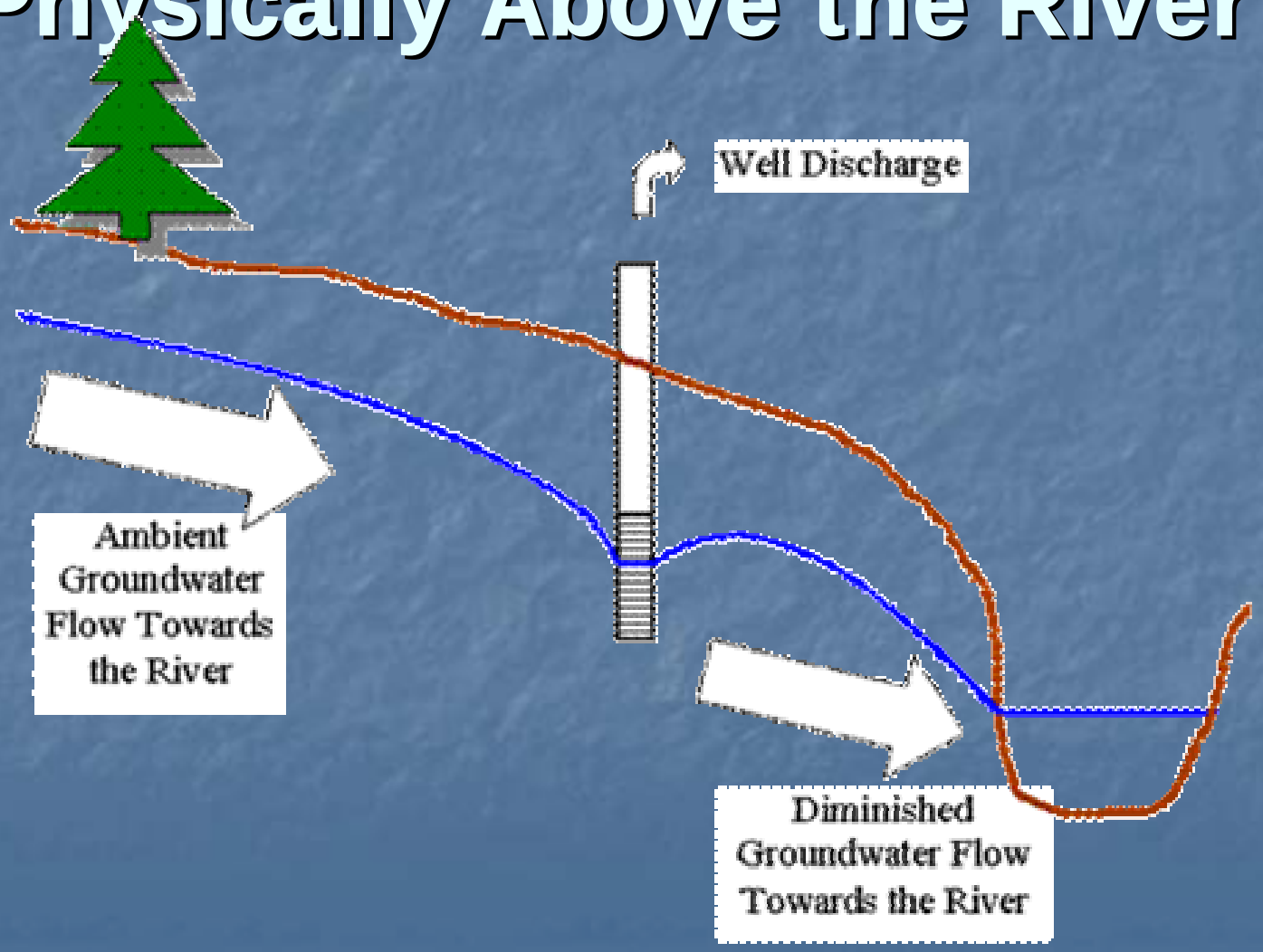
Effect of Relatively Small Quantities of Groundwater Withdrawals



Effect of Increasing the Quantity of Groundwater Withdrawals



Effect of Groundwater Pumping Even When Well is Physically Above the River



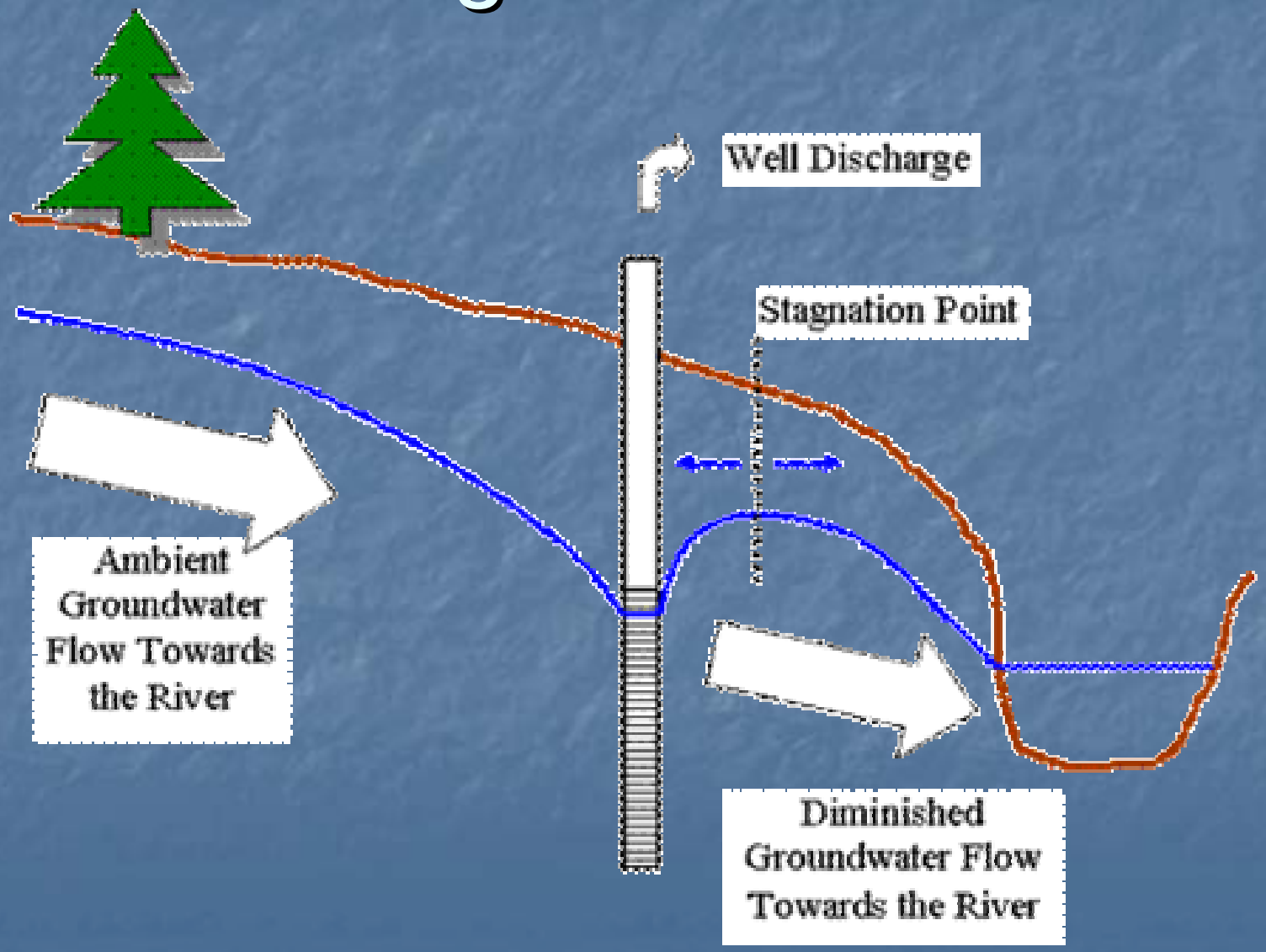
Induced Recharge

Since water resources operate on the watershed scale, in general, if the slope of the groundwater table is towards the river, then groundwater pumping has the likelihood of removing water that ultimately would have flowed in the river.

Induced recharge is surface water directly captured by groundwater pumping.

If the river discharge falls below the recommended ISF values, the most immediate flow control management strategy for groundwater is to halt induced recharge.

Stagnation Point



Short Term Groundwater Management

When the stagnation point reaches the river, the well induces recharge from the river. Therefore a short term management strategy to improve (increase) river flow is to halt induced recharge. This would be accomplished by reducing the well pumping rate.

Methodology for Well Pumping

Distance from well to stagnation point = x_s (feet)

$$x_s = \frac{Q}{2\pi T i}$$

Q = well pumping rate (cubic feet per day)
T = aquifer transmissivity (feet per day)
i = the slope to the groundwater table (dimensionless)

Groundwater ISF Strategy

Compute well pumping rate to achieve x_s (this is Q_s)

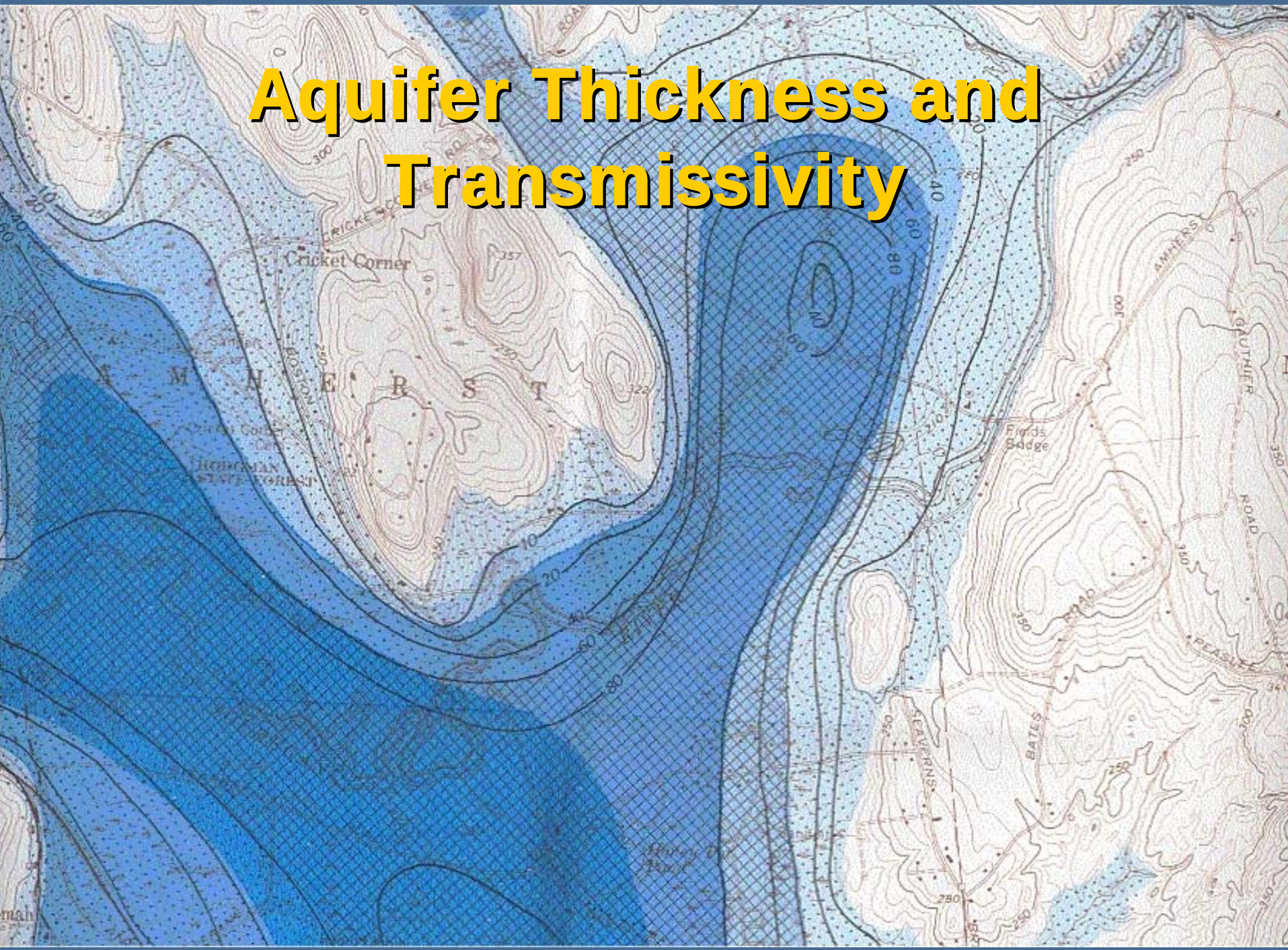
Compare Q_s to actual well pumping (Q_p)

If :

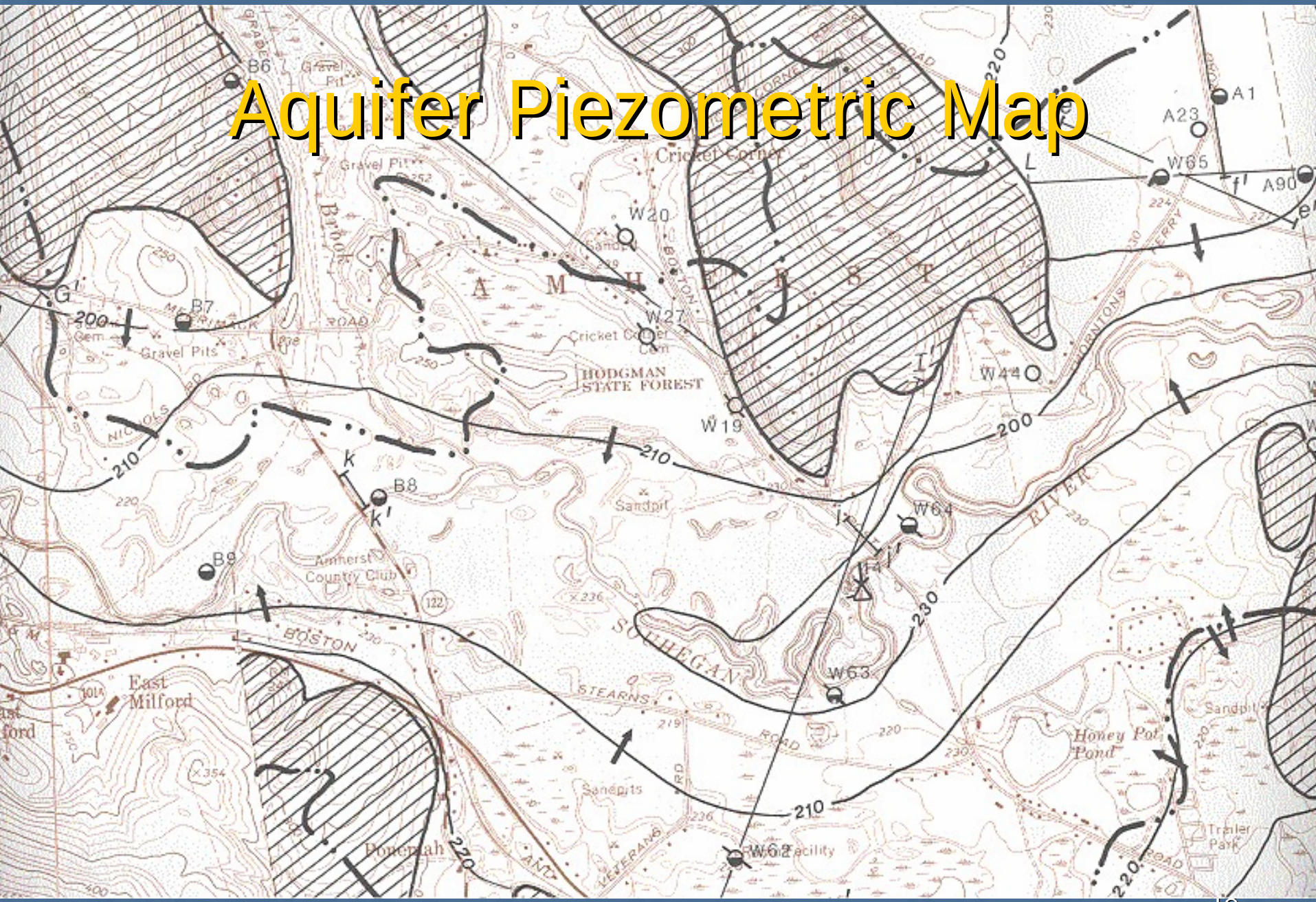
$Q_p \leq Q_s$ continue pumping

$Q_p > Q_s$ reduce pumping to Q_s

Aquifer Thickness and Transmissivity



Aquifer Piezometric Map



Methods for Evaluating Induced Recharge

1. **Existing Study**

2. **Analytical Estimation**

3. **Field Measurements - Office**

4. **Field Measurements**
   - **Miniature Piezometers or Wells**
   - **Seepage Meters**
   - **Tracers**
   - **Pumping Tests**

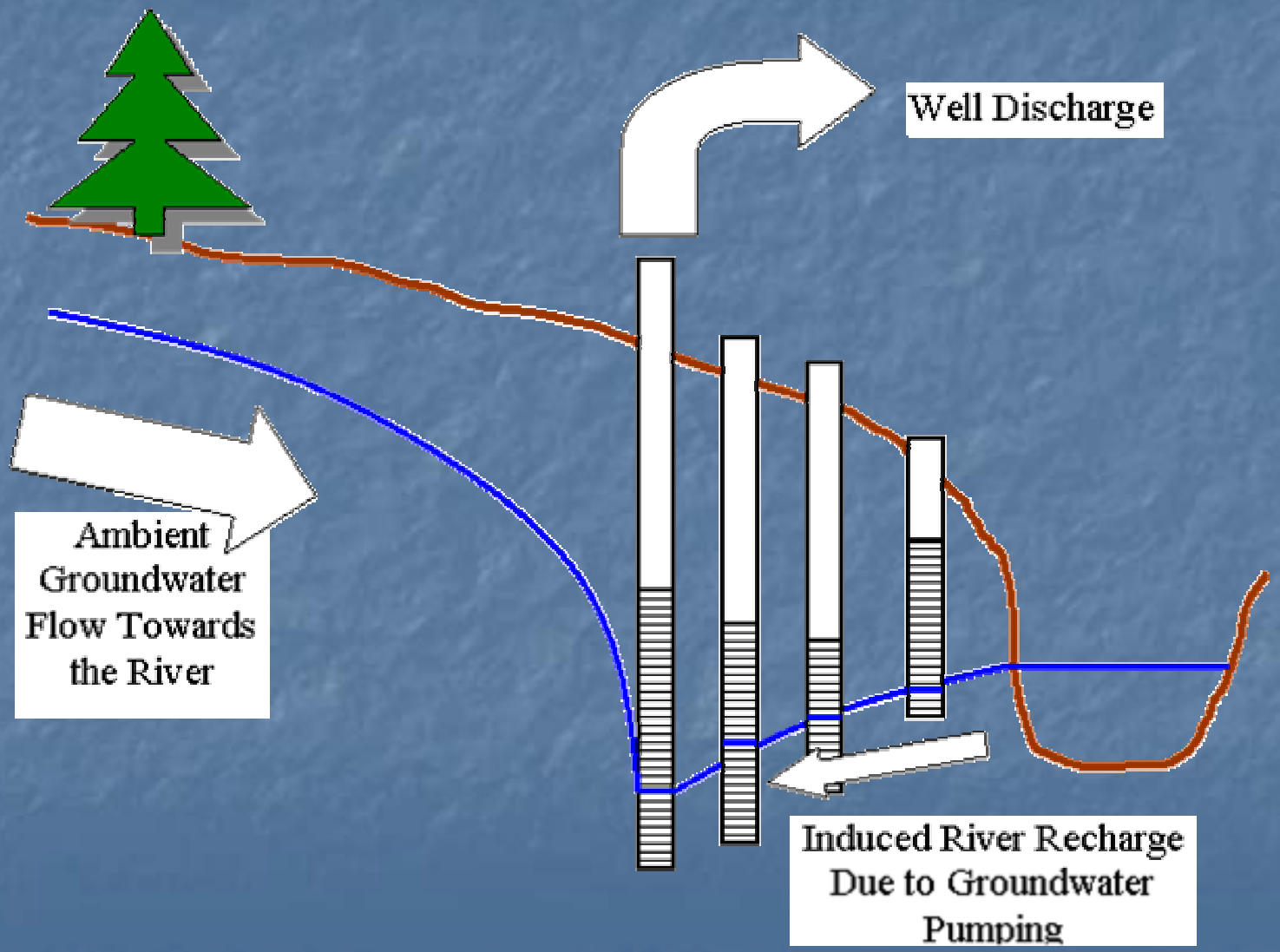
Existing Study

Reports submitted for large groundwater permit

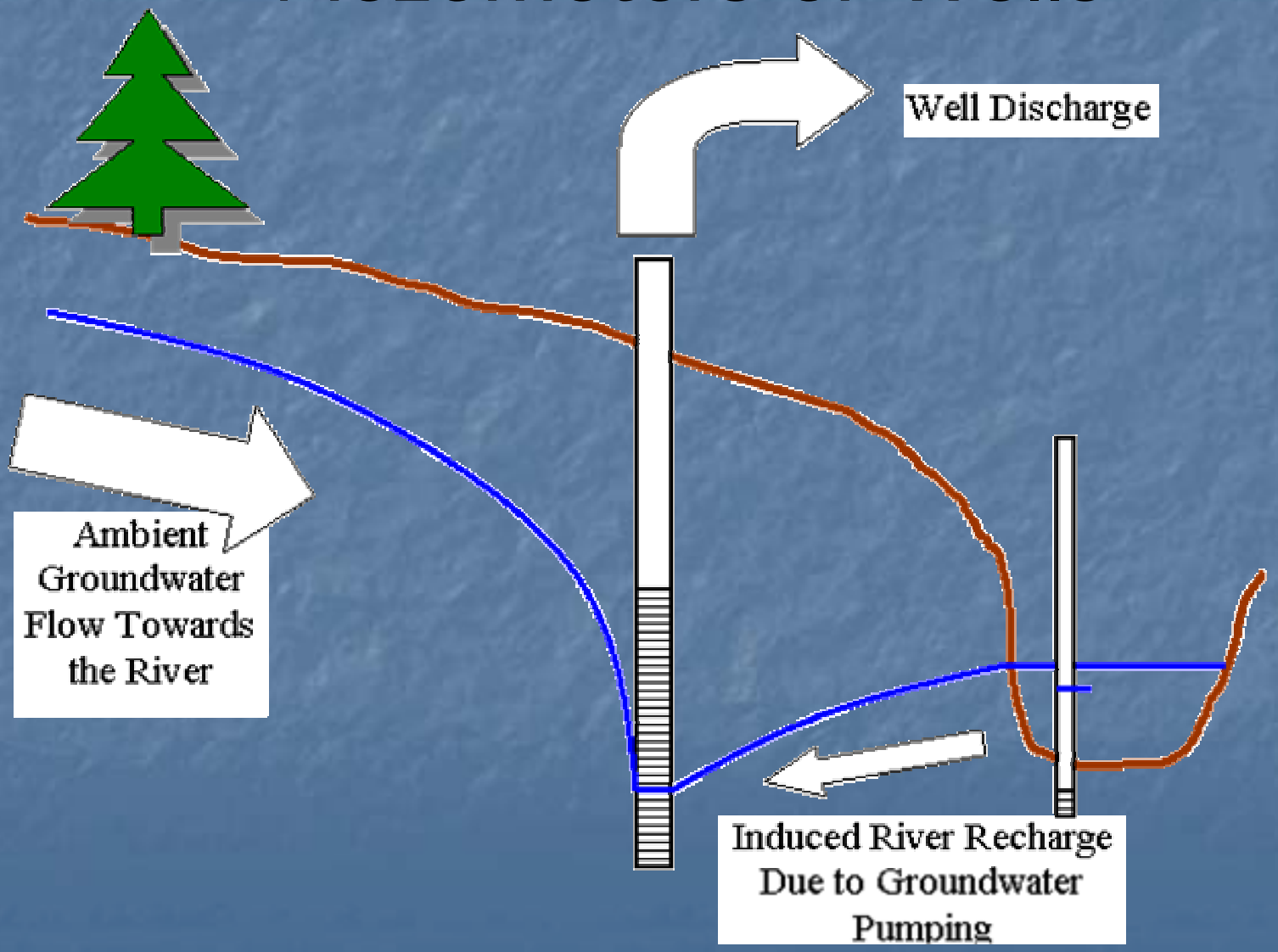
Analytical Estimates

Use map or other existing aquifer information along with pumping information to estimate x_s and Q_s

Field Measurements - Office



Field Measurements – Miniature Piezometers or Wells



Case Study

Water supply well (Town of Pembroke, NH) along the Soucook River

Site Data

- Well construction – summer 1993
- Pumping Test – November, 1993
  - 650 gpm
  - T = 3800 ft^2/day
  - S = 0.1
  - i = 0.03
- Permitted Yield – 505 gpm

Explanation

- ⊙ Municipal Water Supply Well
- ▣ Private Well
- ⊗ Registered known or potential contamination source
- aquifer boundary
- watershed boundary

Scale 1:24000

0 1000 2000 ft

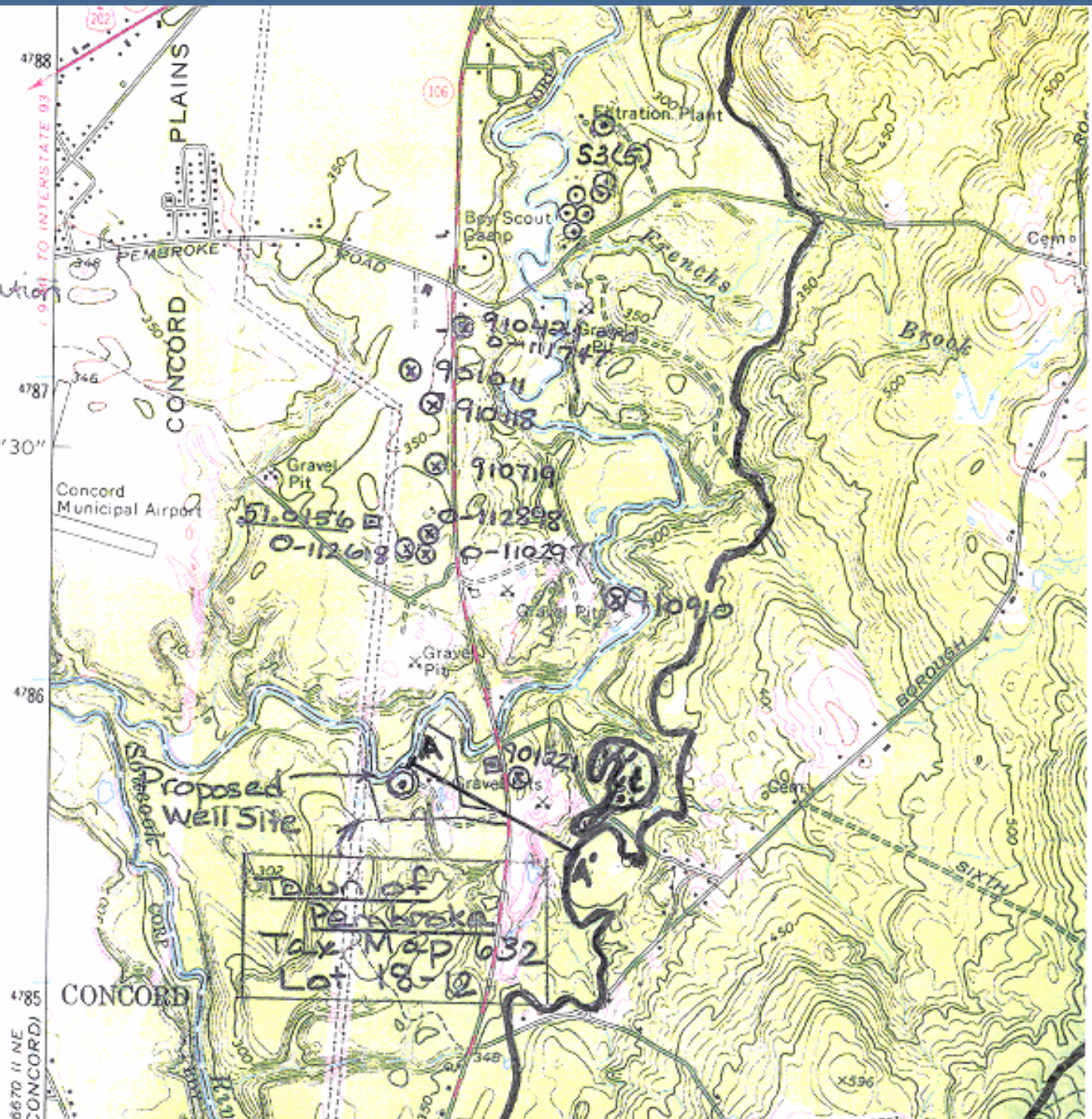


Figure 1:
Site Location and Hydrologic Boundaries

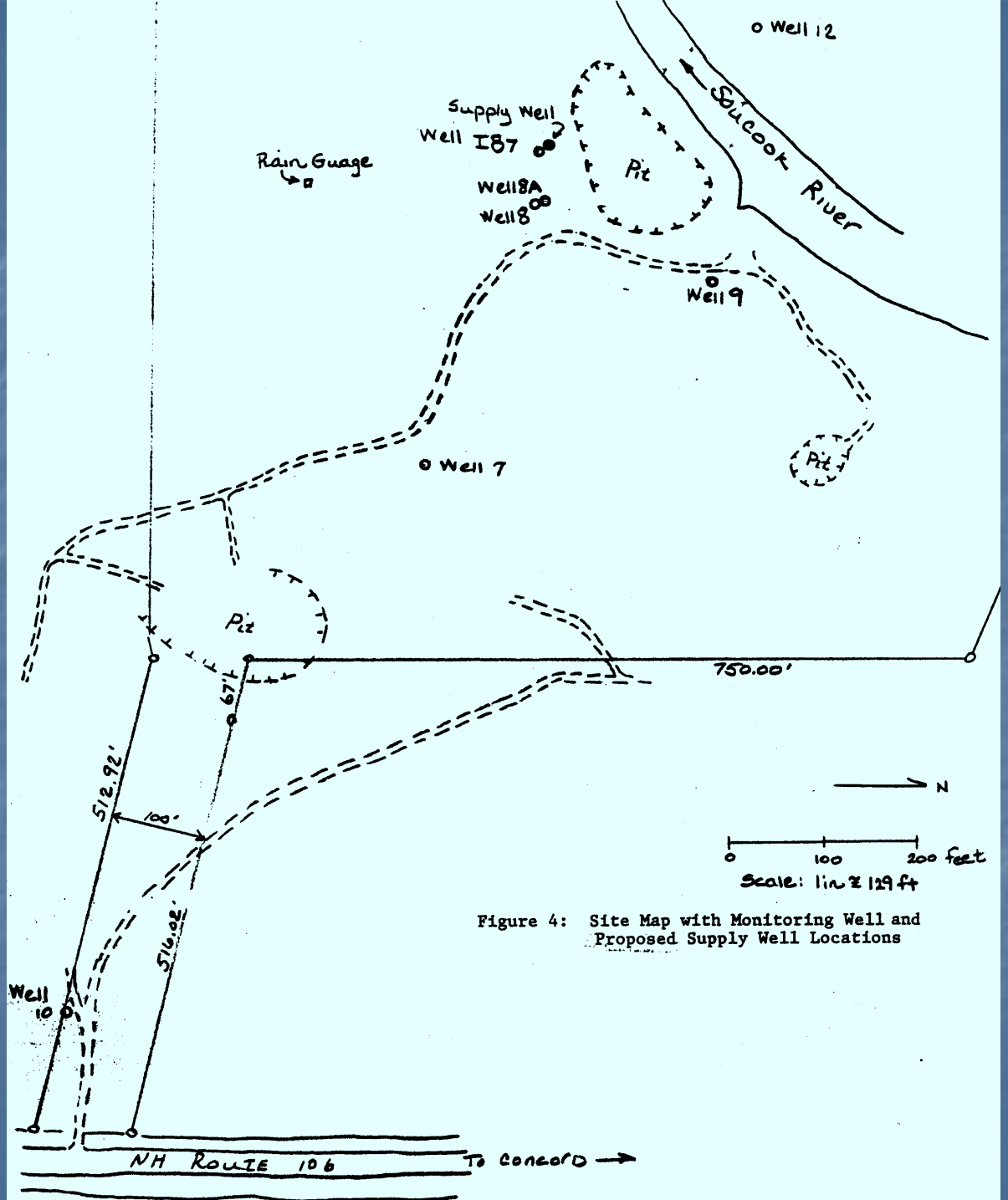
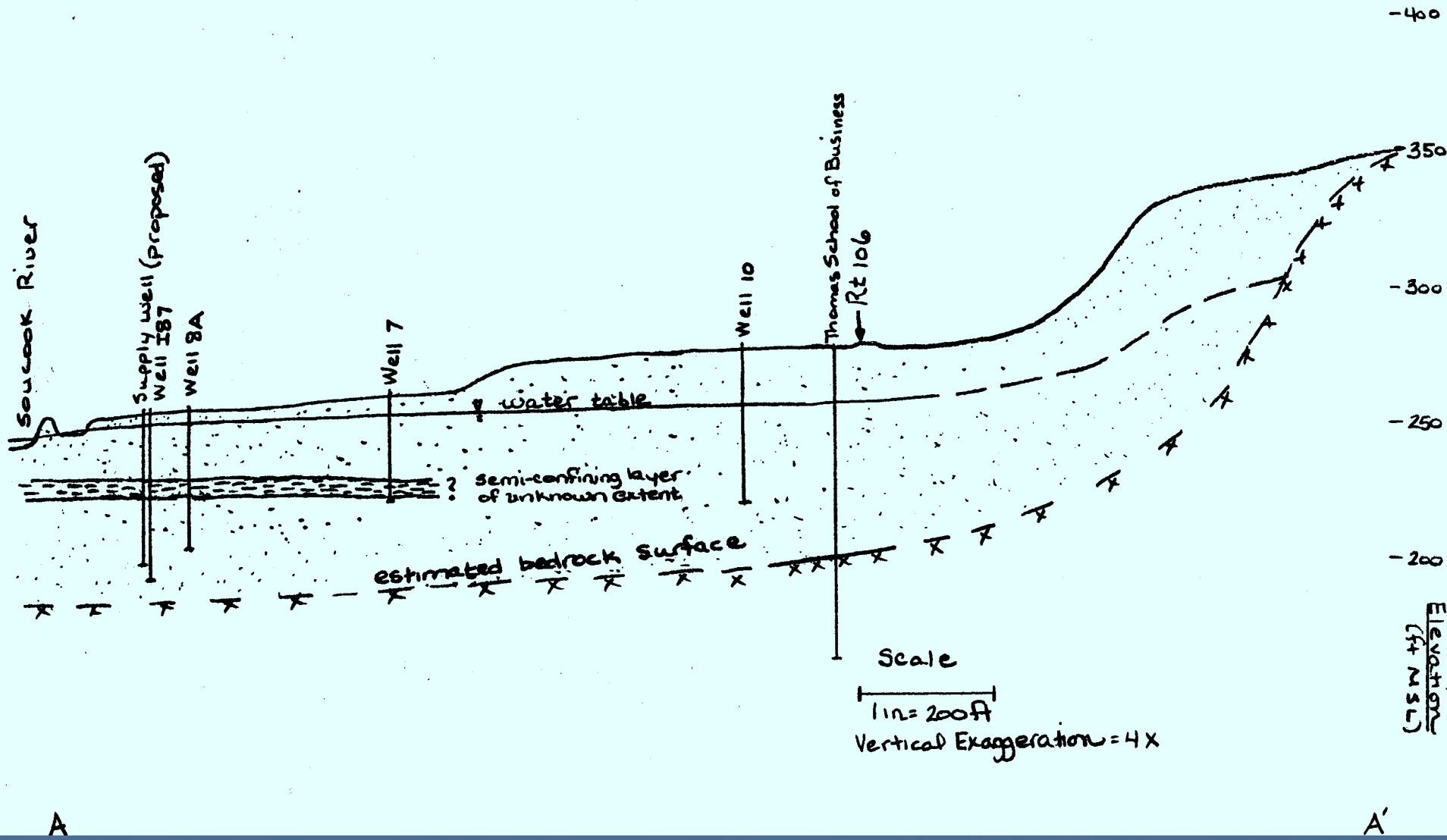
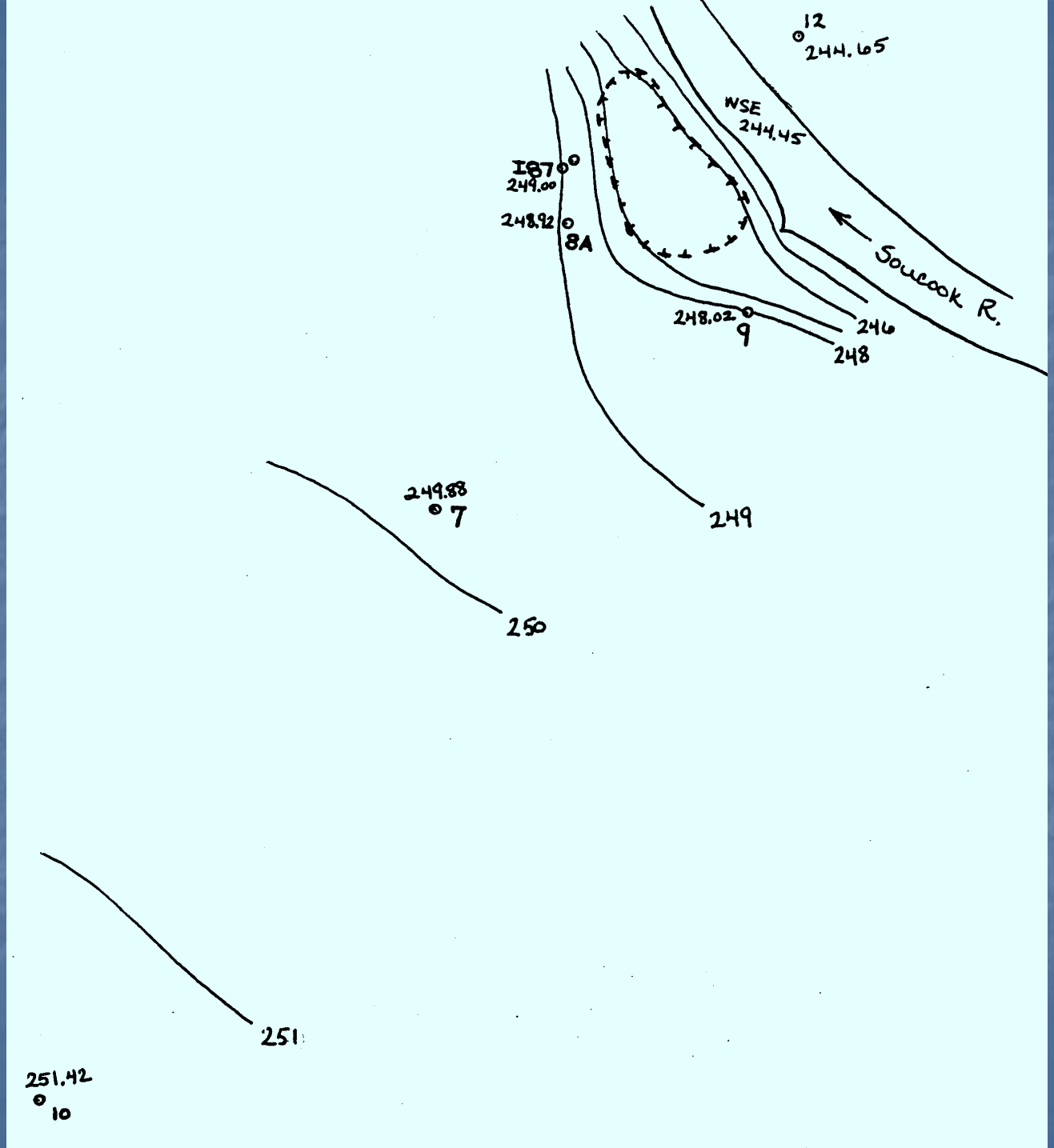


Figure 4: Site Map with Monitoring Well and Proposed Supply Well Locations

Figure 3: Estimated Geologic Cross-Section of the Stratified Drift Aquifer in the Vicinity of the Proposed Well Site, Pembroke, NH




12
244.65
WSE
244.45
I87
249.00
248.92
8A
Souncook R.
248.02
9
246
248
249
249.88
7
250
251
251.42
10

Analytical Method

- Q = 650 gpm
- T = 3800 ft^2/day
- S = 0.1
- i = 0.03
- Distance from well to river = 140 ft.

- x_s = 175 ft
- Q_s = 520 gpm

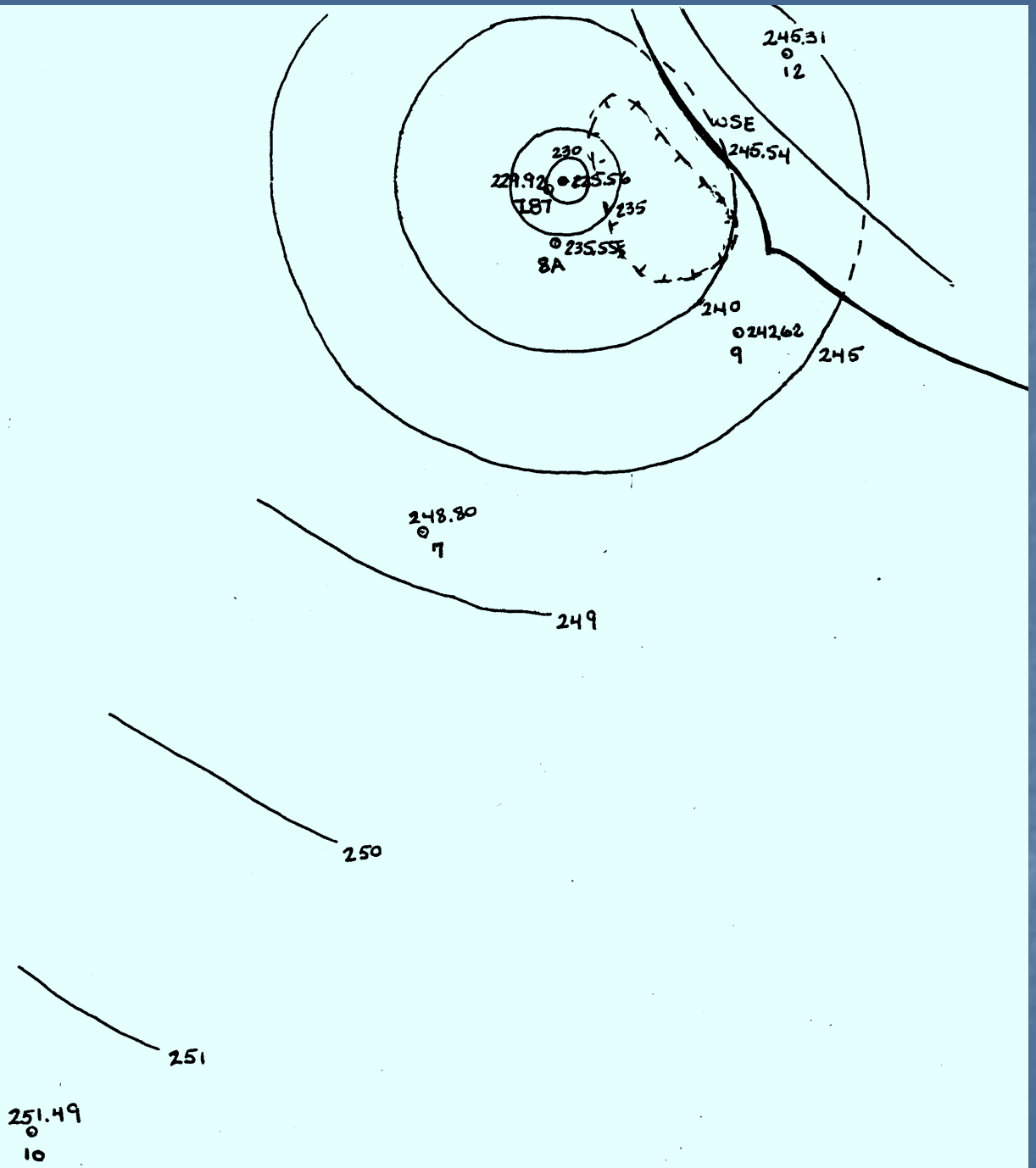


Figure 9b: Piezometric Contours after 100.5 hours of pumping

NH
SOUHEGAN RIVER