Estimating Ground-Water Discharge and Nitrogen Loading into Hood Canal

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Preliminary results, subject to revision

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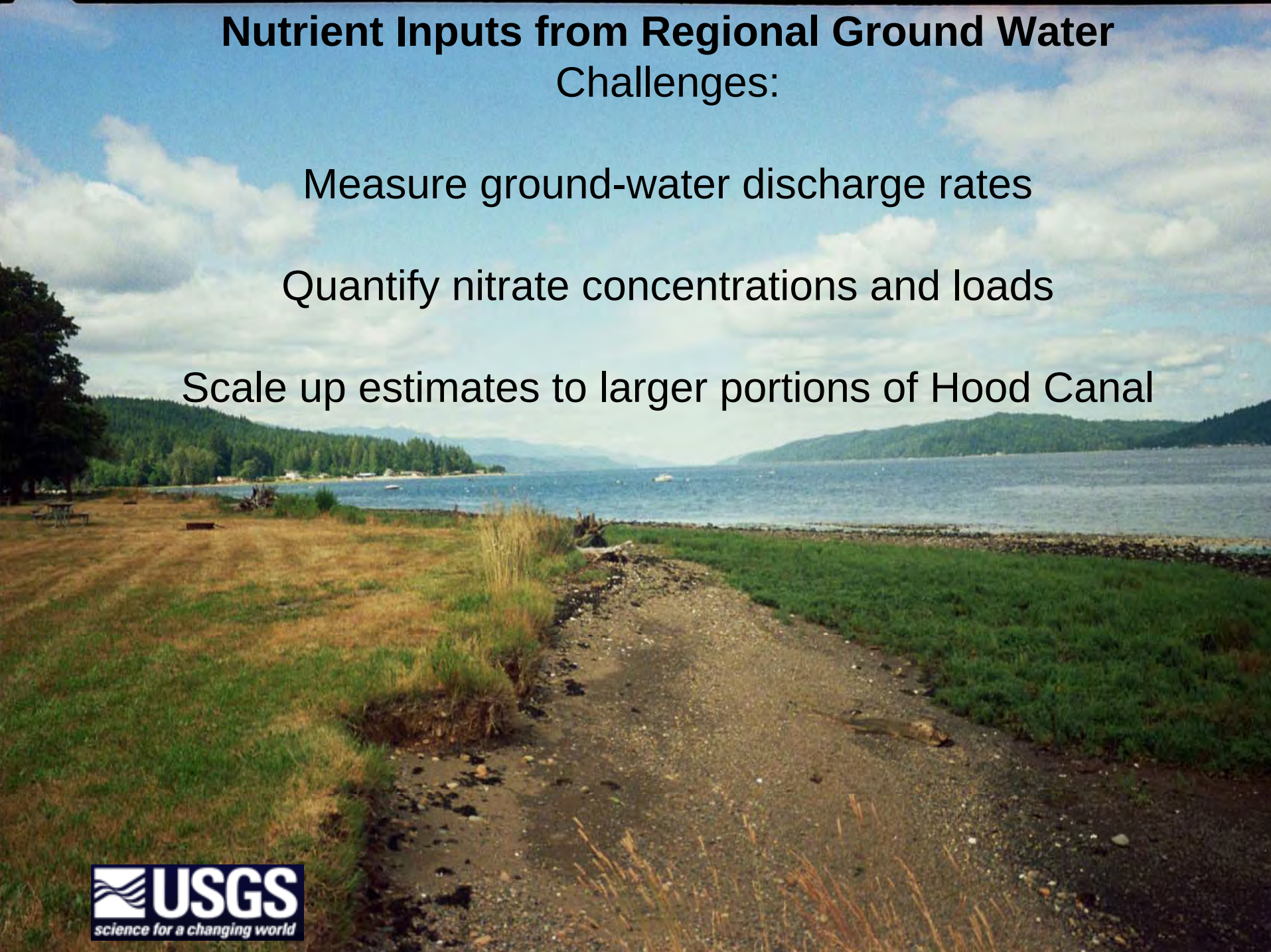

Nutrient Inputs from Regional Ground Water

Challenges:

Measure ground-water discharge rates

Quantify nitrate concentrations and loads

Scale up estimates to larger portions of Hood Canal

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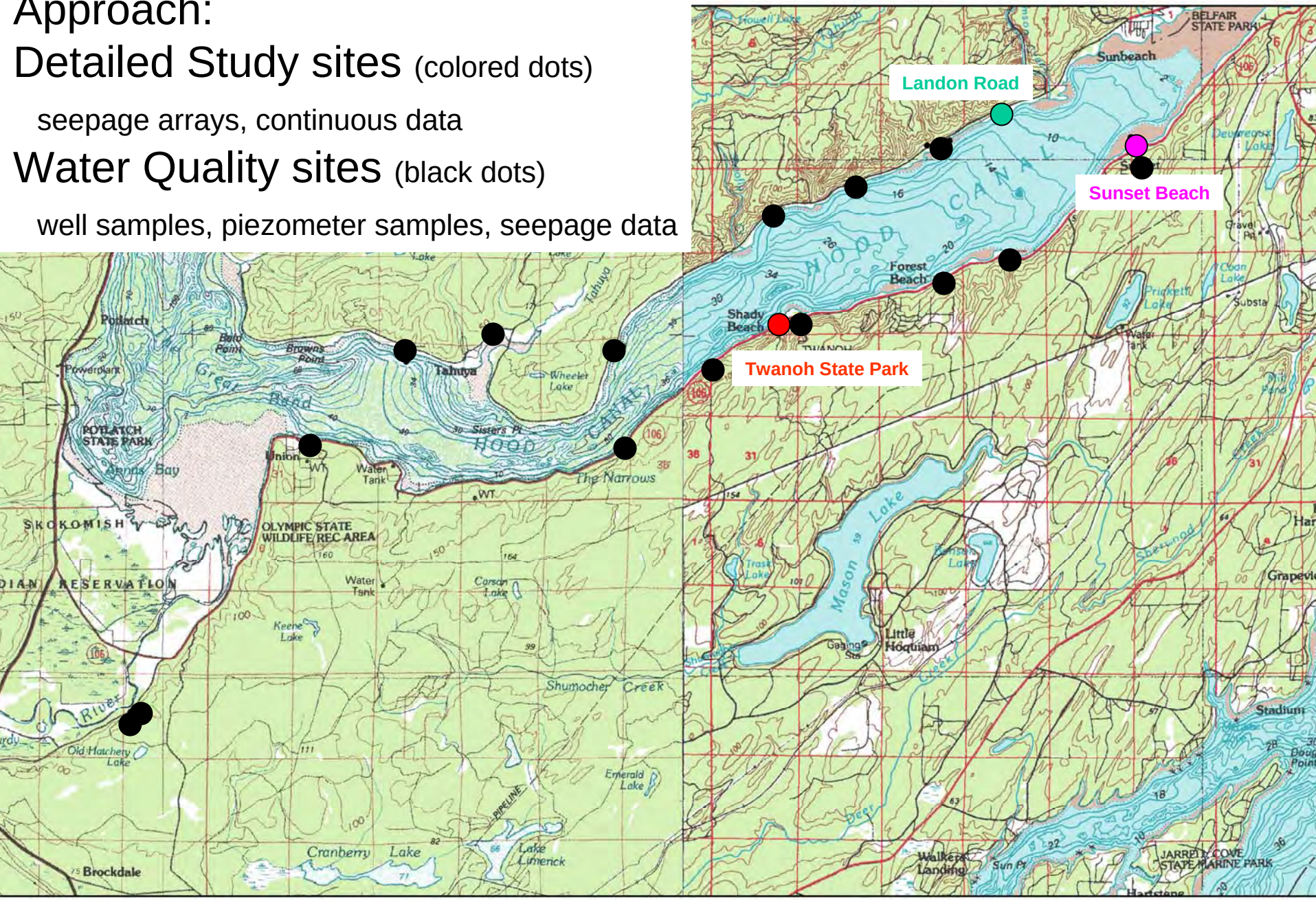
Approach:

Detailed Study sites (colored dots)

seepage arrays, continuous data

Water Quality sites (black dots)

well samples, piezometer samples, seepage data



Measuring water levels: in shallow piezometers;

Using a manometer board; and

by direct measurement

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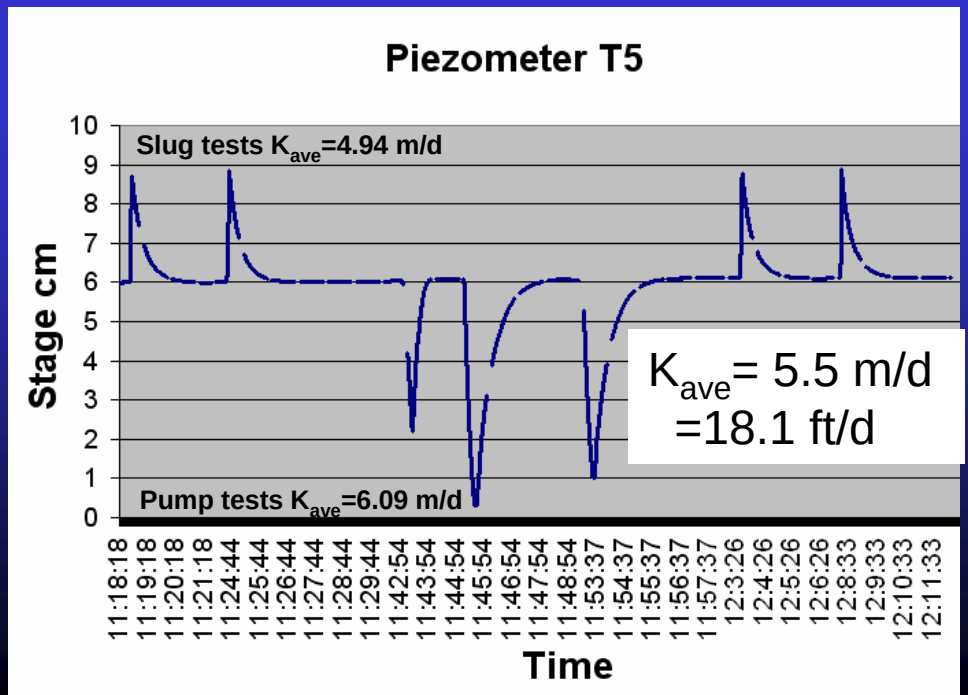
Conducting slug/pump tests in shallow piezometers to determine aquifer hydraulic conductivity



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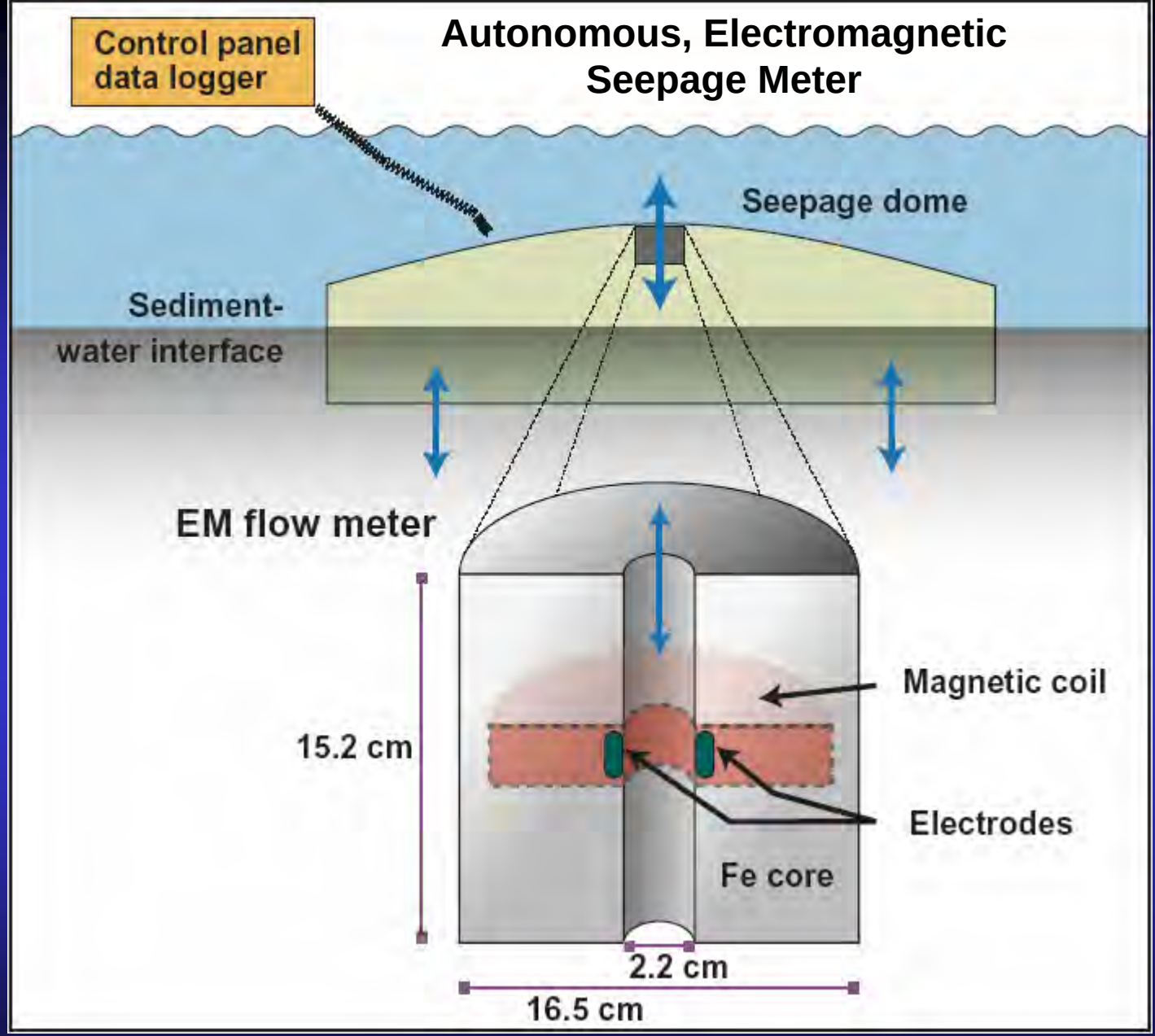

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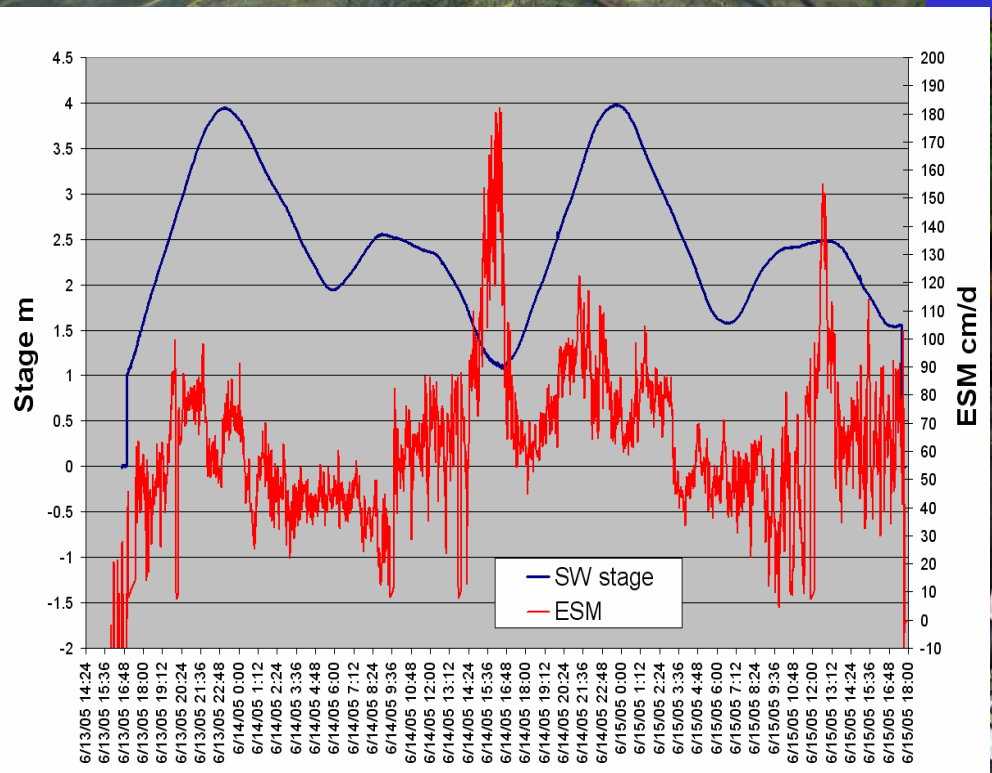
Continuous measurement of seepage using an Electromagnetic Seepage Meter (ESM)

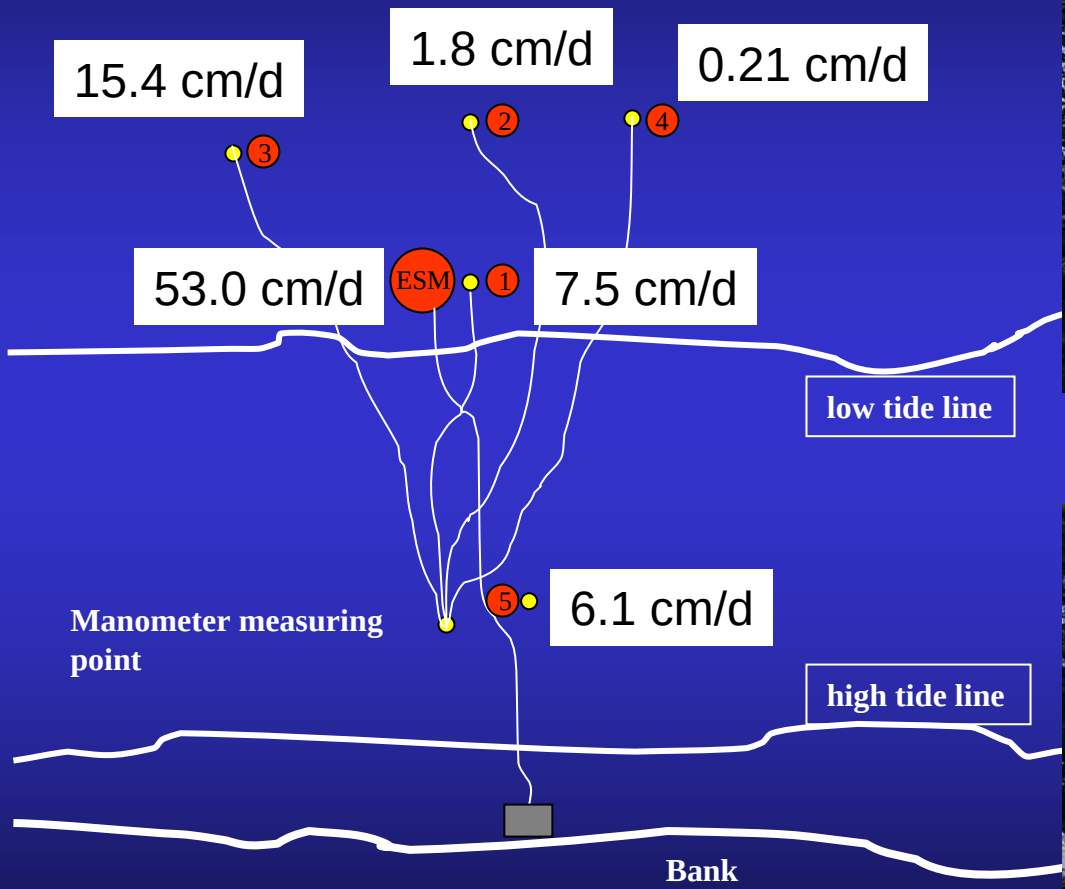
Measures flow through an electromagnetic coil

Records continuous data



Twanoh State Park

Twanoh State Park
Average Seepage Rates



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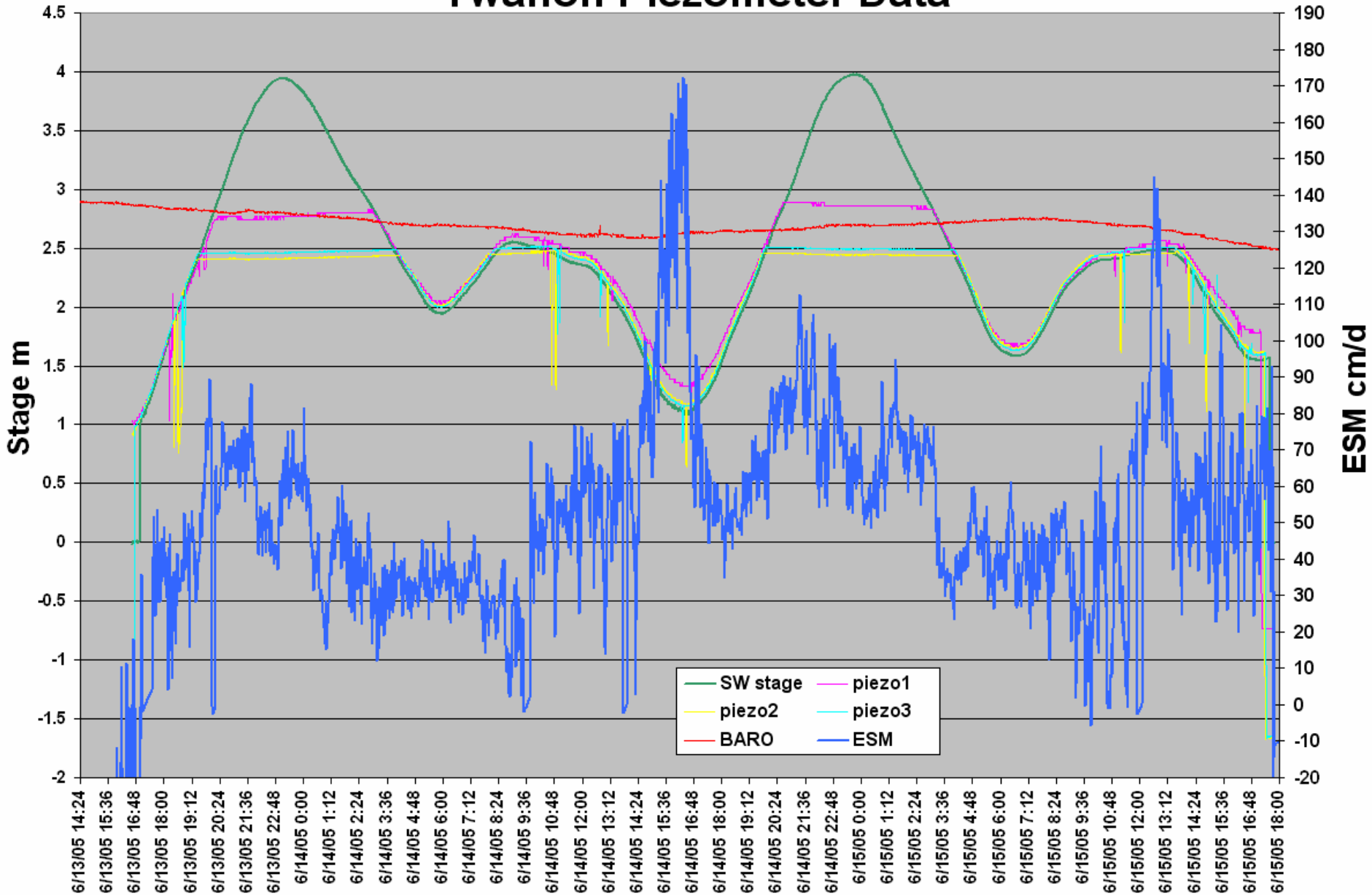
Twanoh Piezometer Data



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Water Quality Samples

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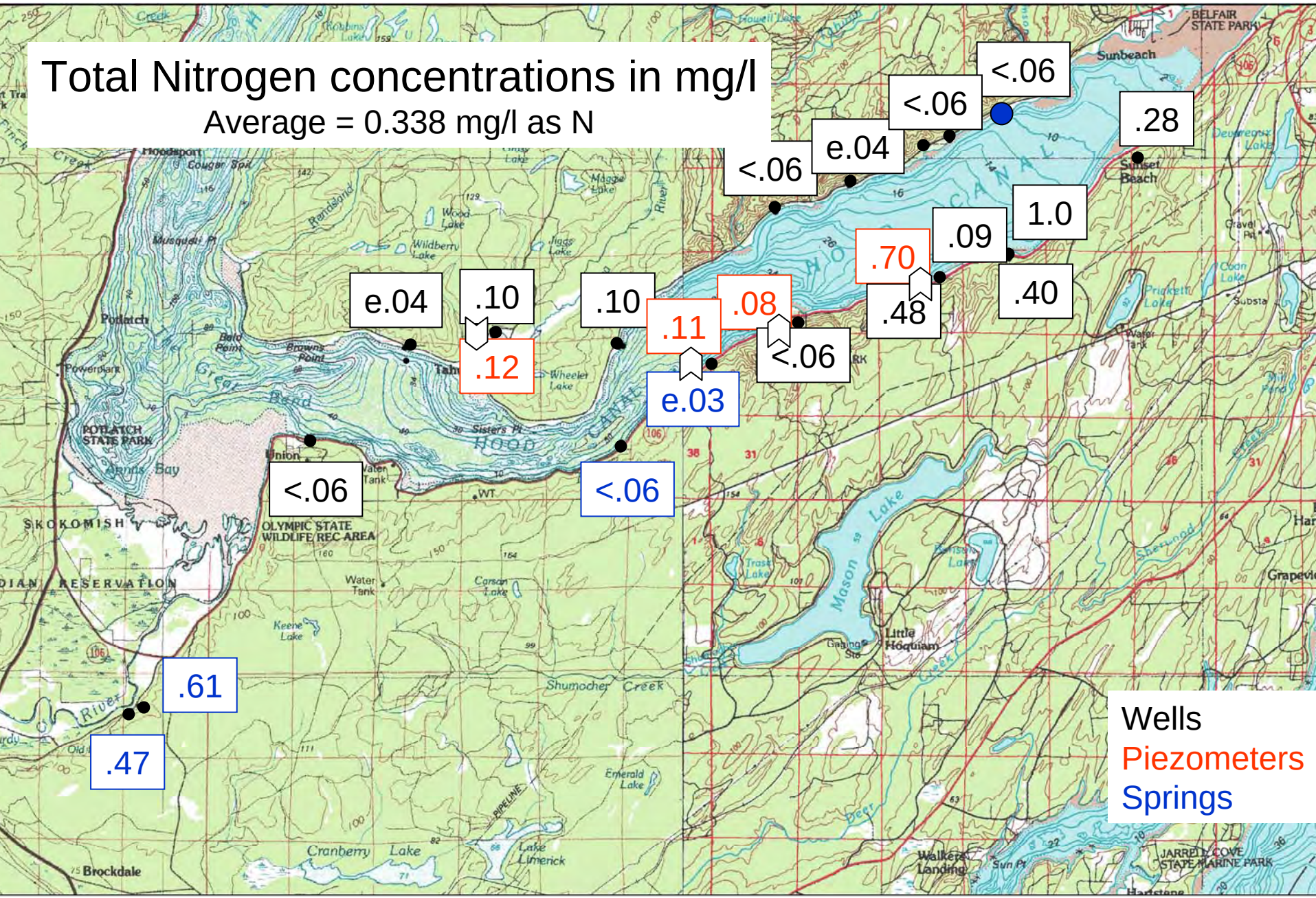
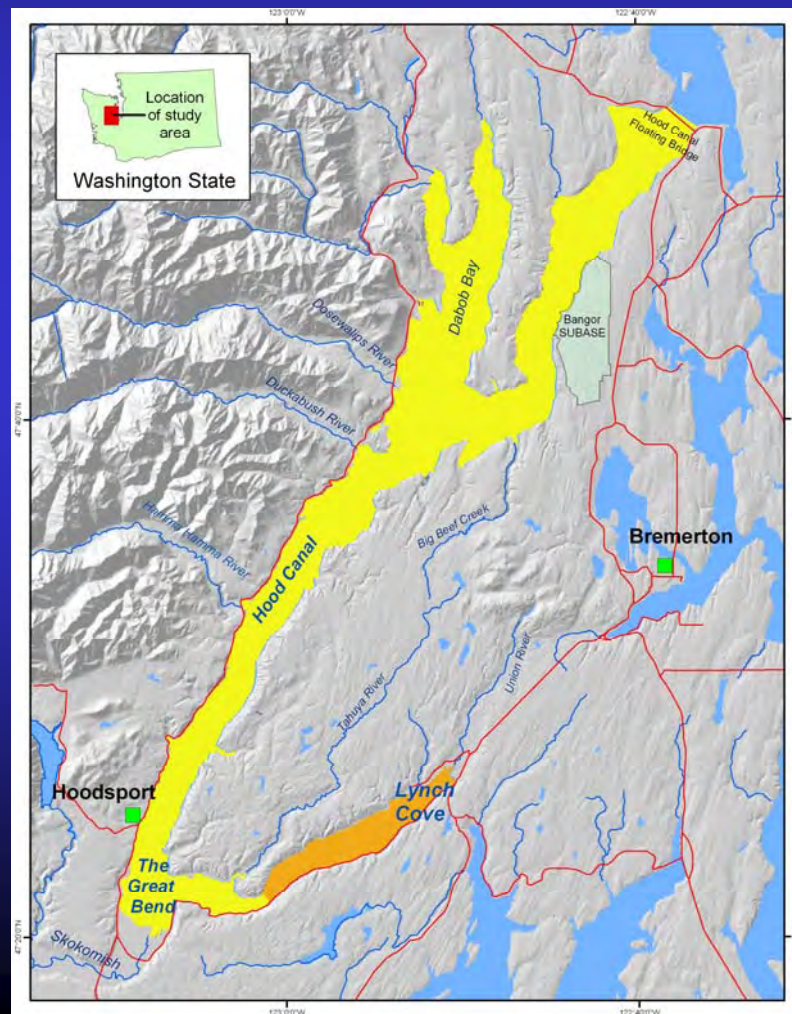

Total Nitrogen concentrations in mg/l
Average = 0.338 mg/l as N
<.06
<.06
.28
e.04
<.06
1.0
.09
.70
.40
.48
.08
<.06
.11
.10
e.04
.10
.12
e.03
<.06
<.06
.61
.47
Wells
Piezometers
Springs

Estimating Nutrient Loading for Lynch Cove

Load = Concentration x Seepage rate x Area

Average Total Nitrogen concentration in ground water = 0.338 mg/L
Average Seepage rate = 10.2 cm/d
Approximate ground-water discharge
Area = 2,888,109 m^2
Ground water Discharge =
294,587 m^3/d or 3.4 m^3/s
Regional Ground Water
Discharge using mass balance
= 7.3 m^3/s

Total Nitrogen
Load = 35.4 metric tons per year
Regional Ground Water
Load using mass balance
= 28.4 metric tons per year



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Some Remaining Questions

- Do nutrients actually make it into the canal? (Is nitrate reduced through geochemical processes?)
- Are sewage inputs significant?
- What are the processes that control spatial and temporal distribution of ground-water discharge?

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Proposed On-Site Sewage and Ground-Water Loading Study

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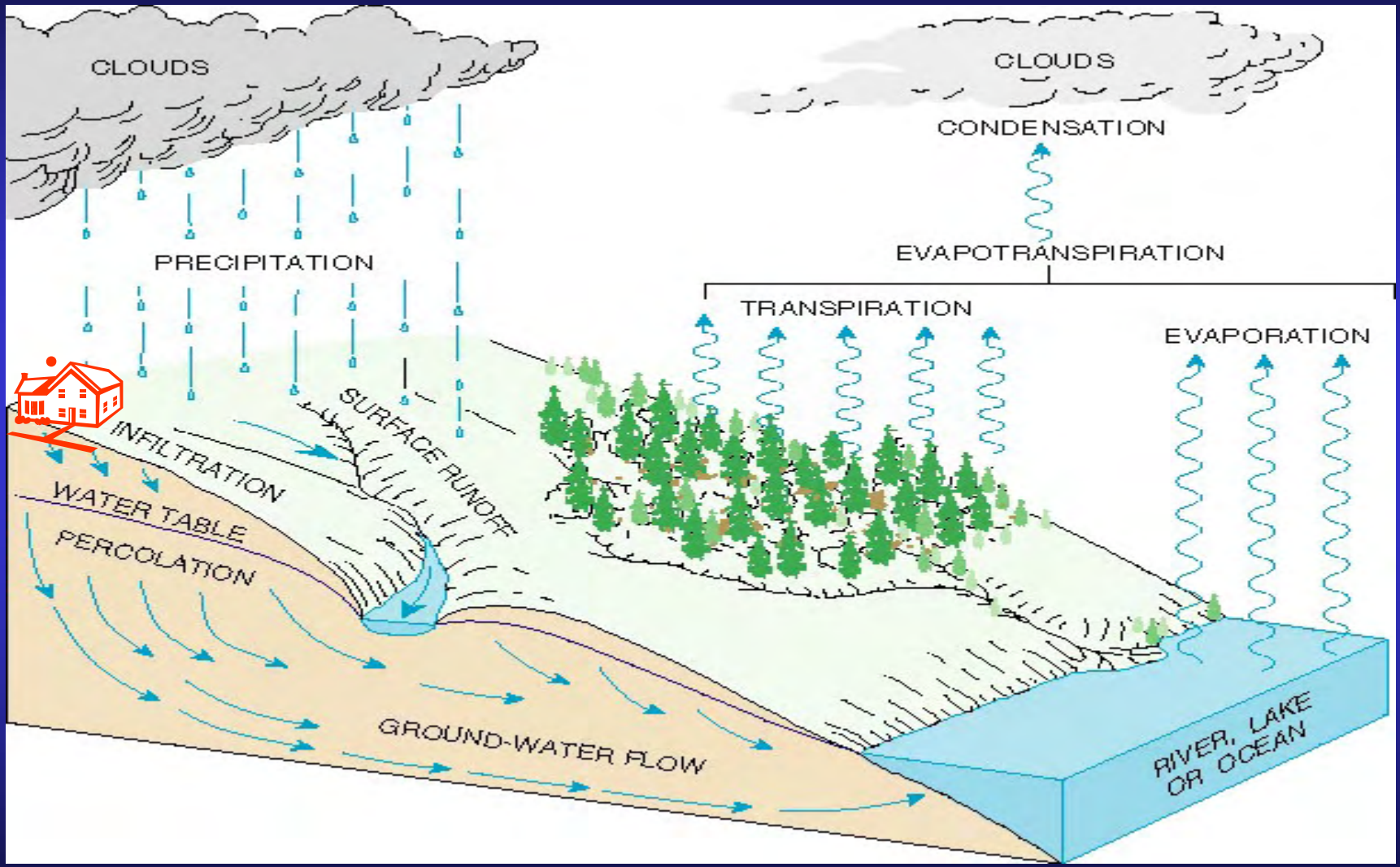
The Hydrologic Cycle



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Questions for Study

- How much nitrogen do on-site sewage systems contribute to the ground-water system? (OSS loading)
- What is the efficiency of OSS in various geohydrologic settings?
- How much nitrogen enters Hood Canal through the ground-water system? (ground-water loading)

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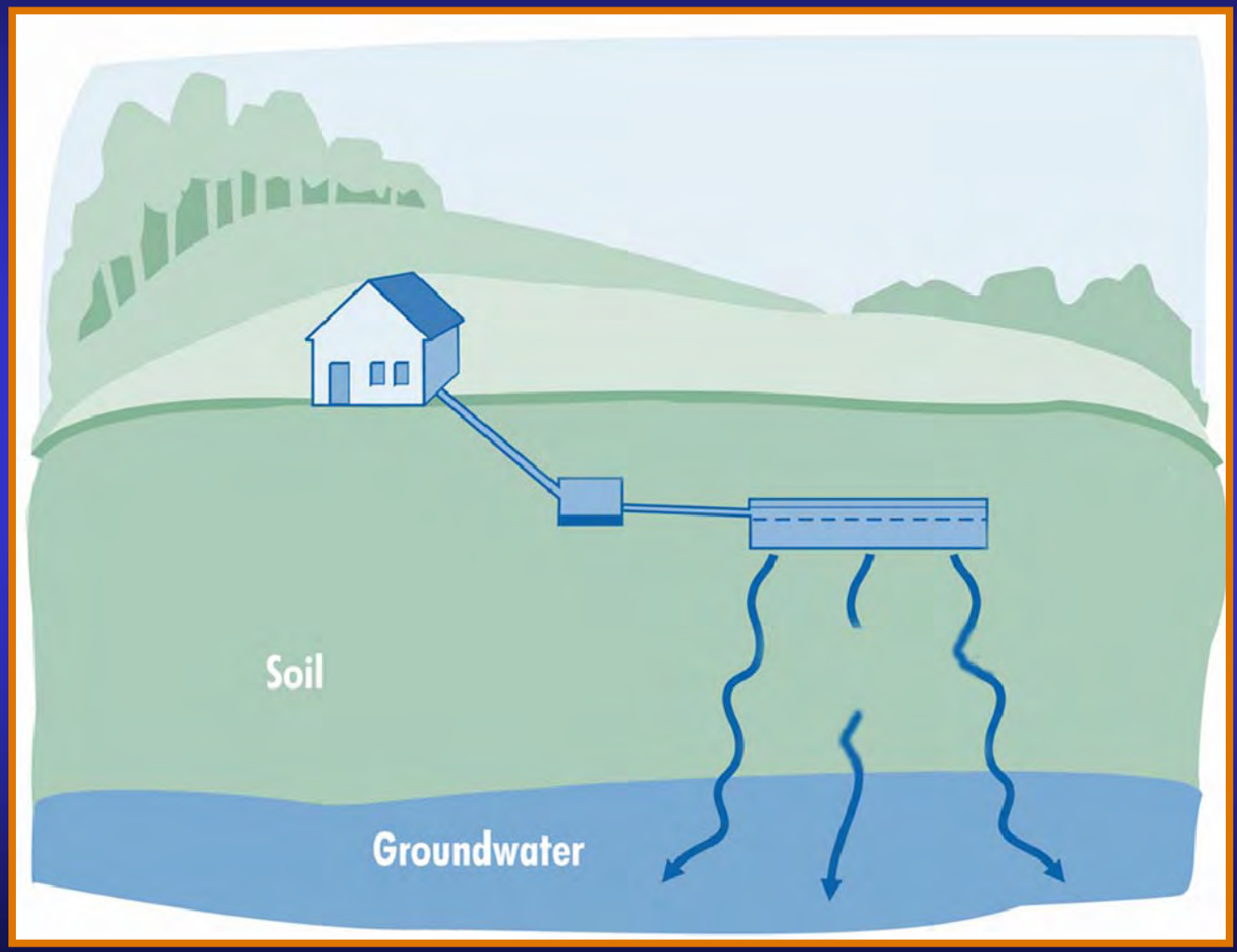
On-Site Sewage Loading



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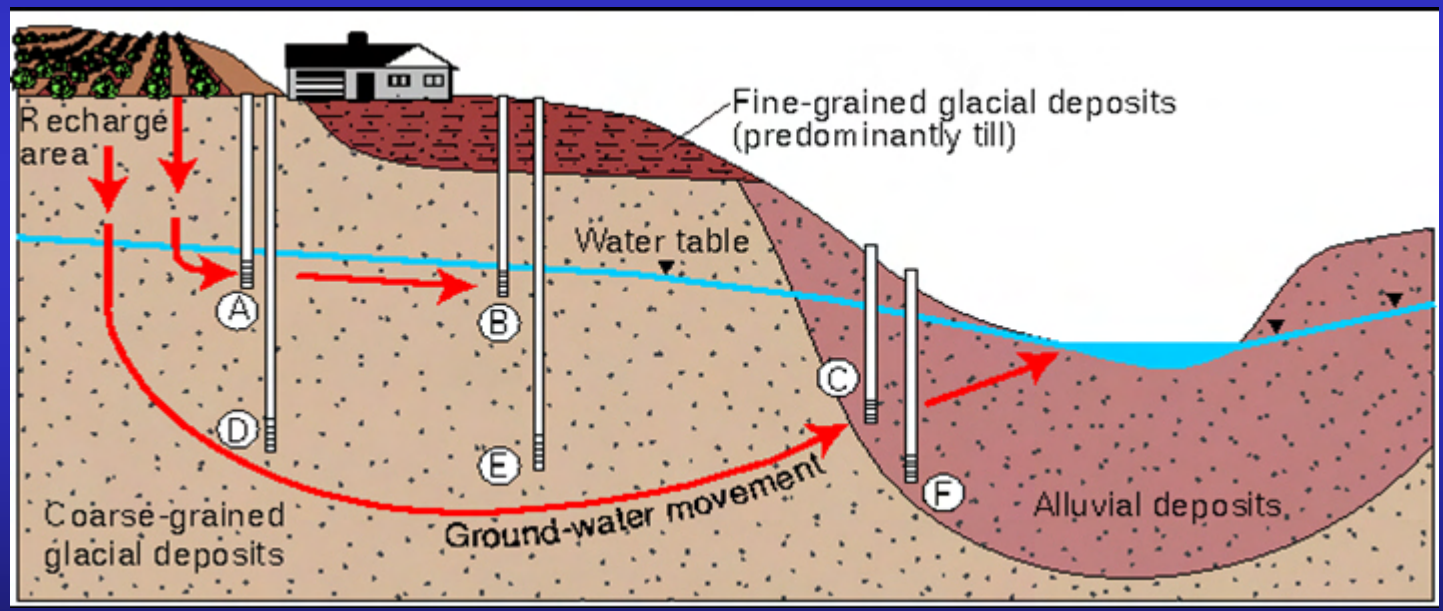
On-Site Sewage Loading (cont.)

Monitor water levels and chemistry at specific sites with OSS, under various geohydrologic settings. Measure at the water table downgradient from the drainfield.



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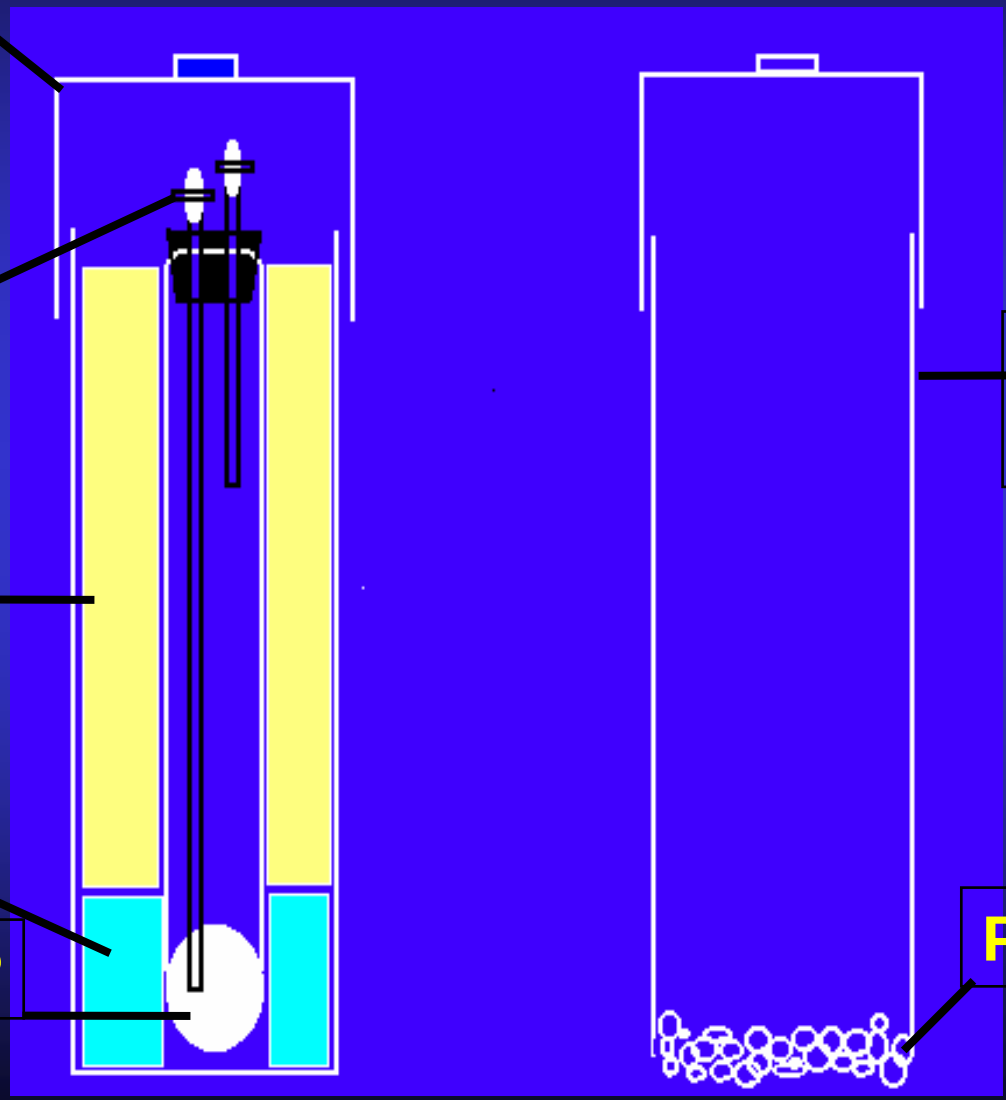

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On-Site Sewage Loading (cont.)

Suction
Lysimeter

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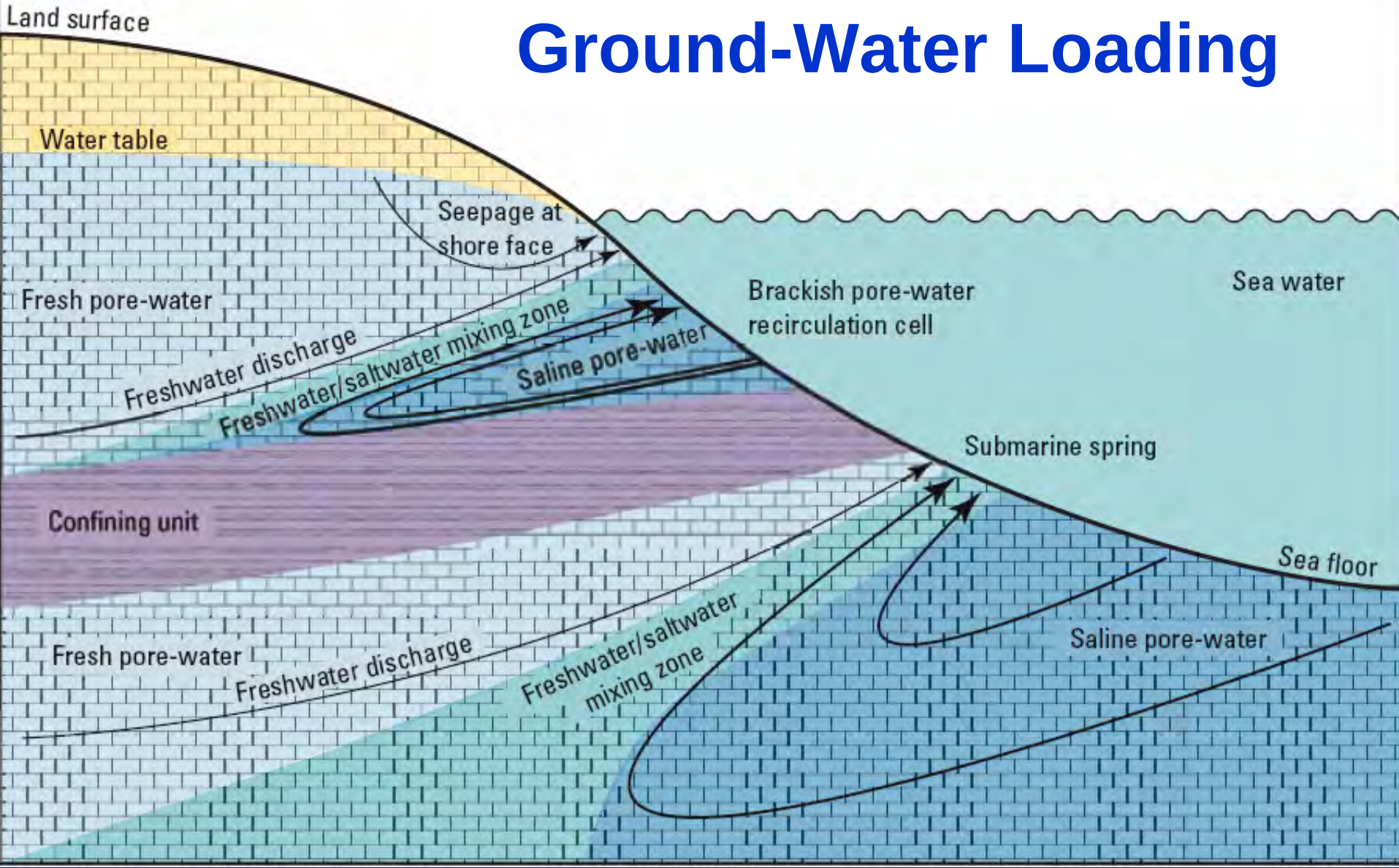
Ground-Water Loading



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Ground-Water Loading (cont.)

Measure seepage and flow at more areas and at different times of year to understand variability in different settings

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Ground-Water Loading (cont.)

Sample near-shore shallow wells to determine nitrogen concentrations and the geochemistry of ground water system, especially processes that remove nitrate from the ground water system.

Sample upland production (domestic) wells to determine variability in nitrate concentrations.

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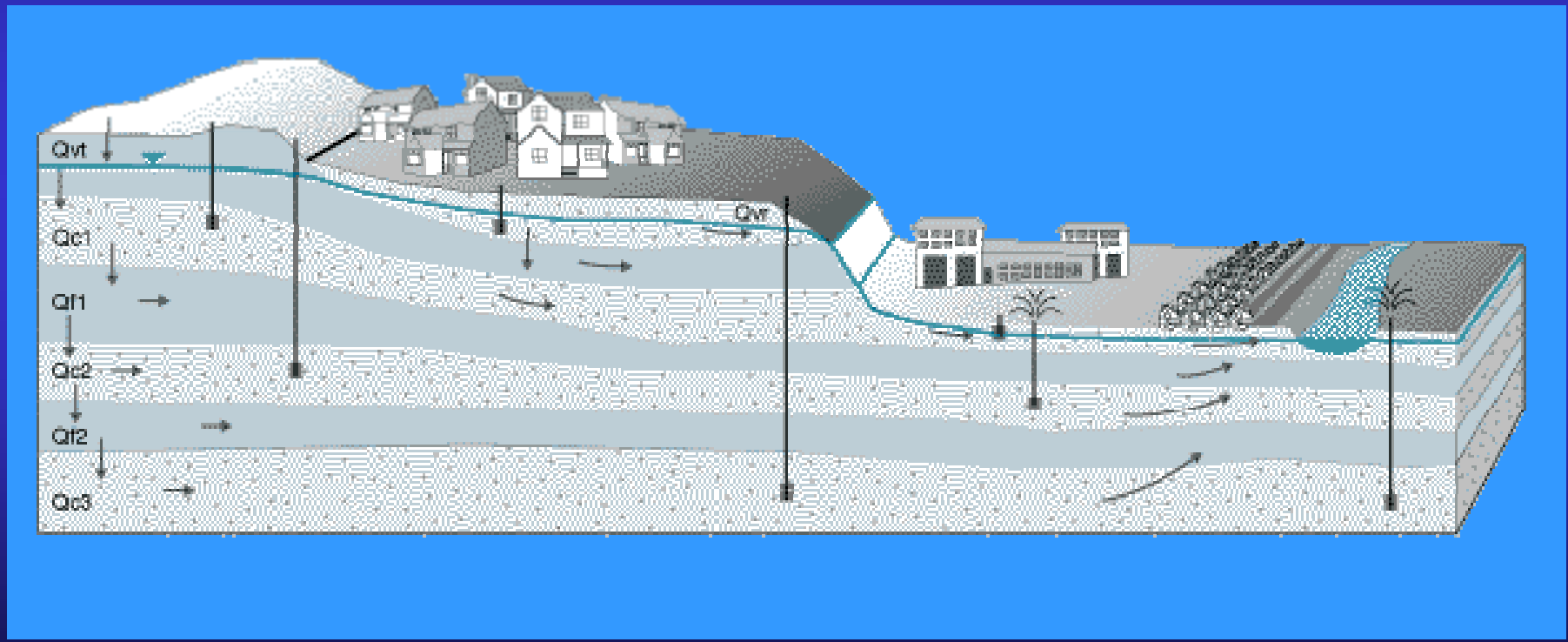
Ground-Water Loading (cont.)

Construct simple cross-sectional computer models and use GIS to upscale the results throughout the greater Hood Canal area.



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