Sequim-Dungeness Hydrogeology

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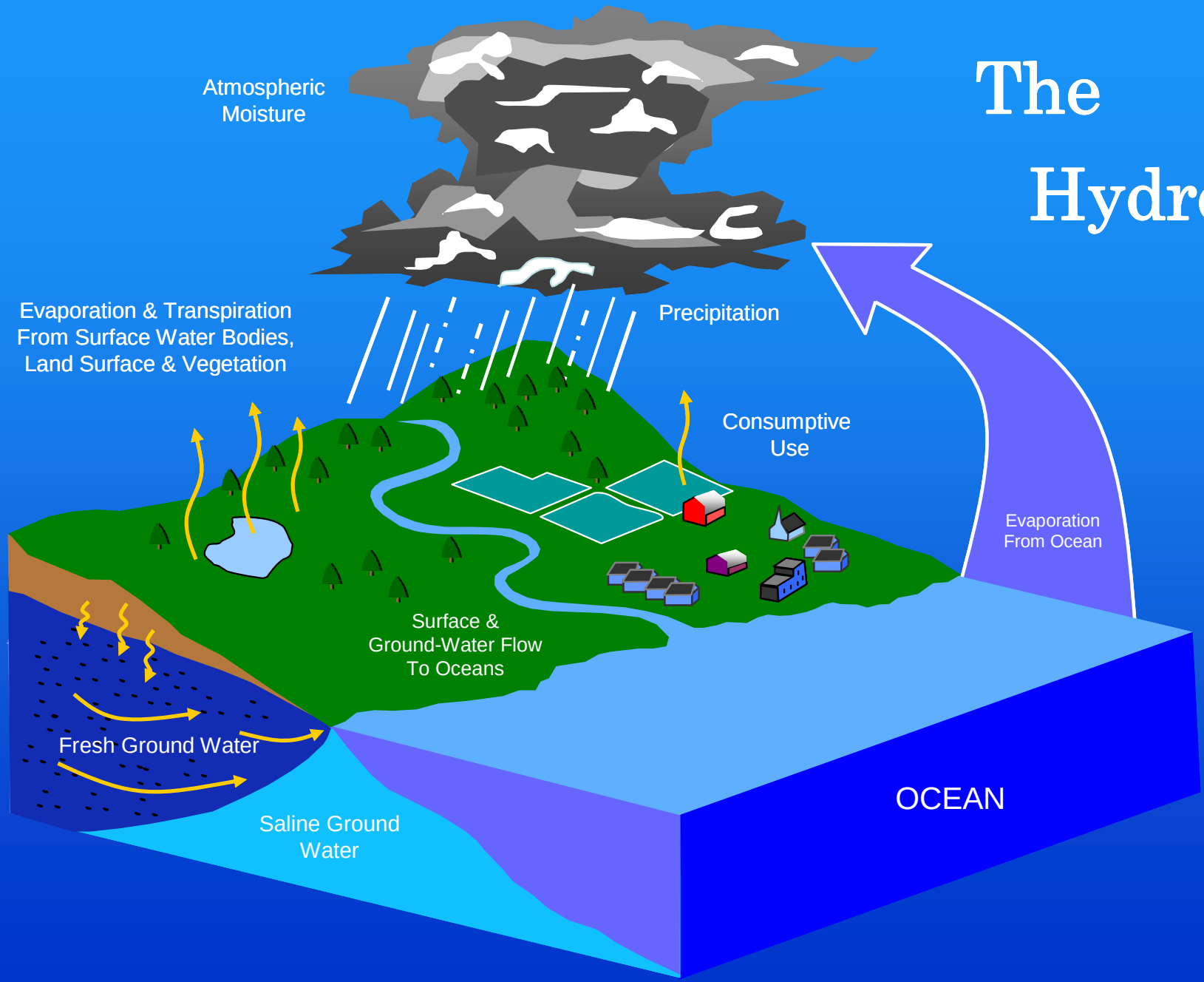
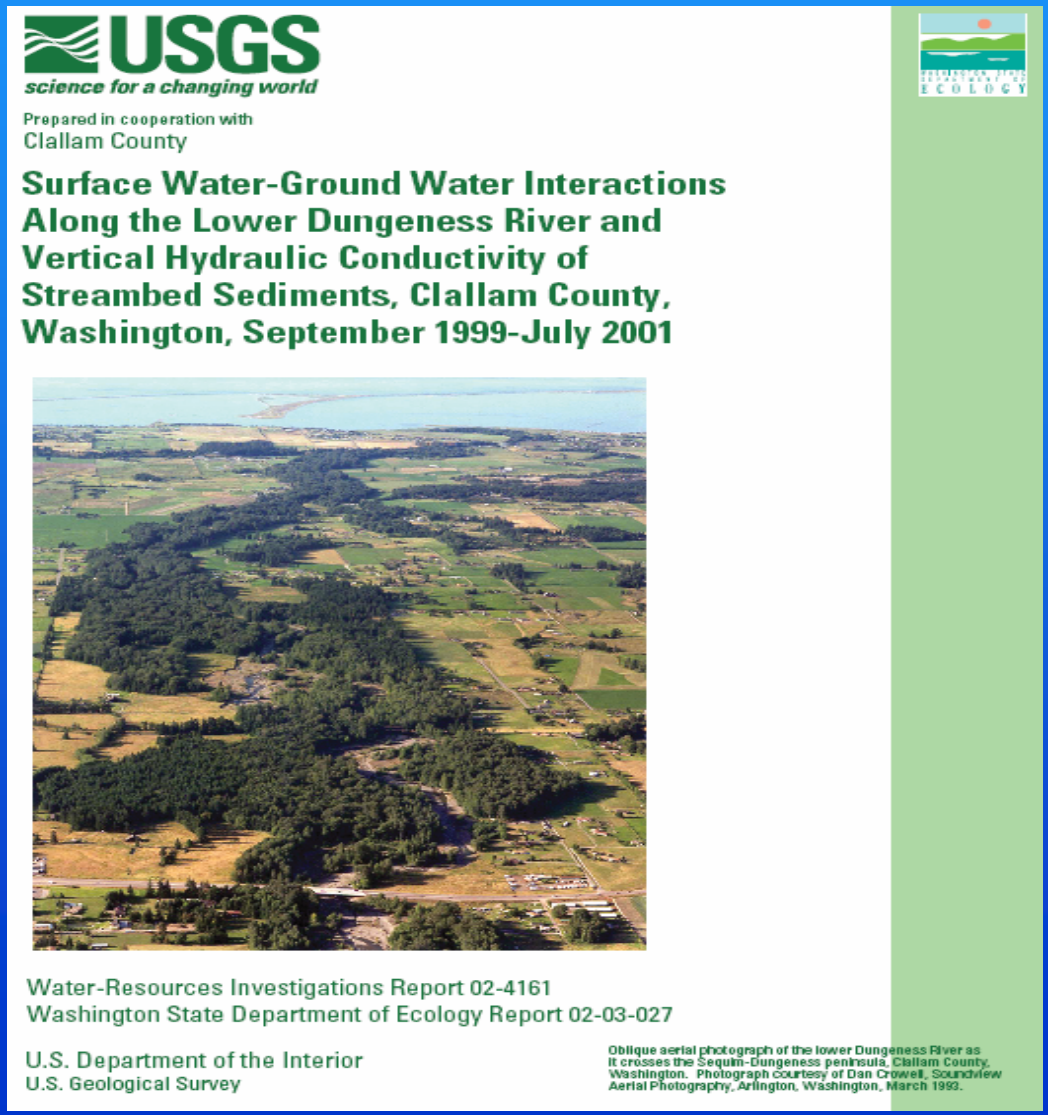
Hydrogeologist

Department of Ecology

The Hydrologic Cycle



Existing Studies



Soil Conservation Service, 1941

USGS, 1983, 1996, 1999

Ecology, 1999, 2001, 2003

Ecology & USGS, 2002

Pacific Groundwater Group, 2002

Bureau of Reclamation, 2002

Private landowner data

Local government data

Water rights records

Well logs

On-going monitoring

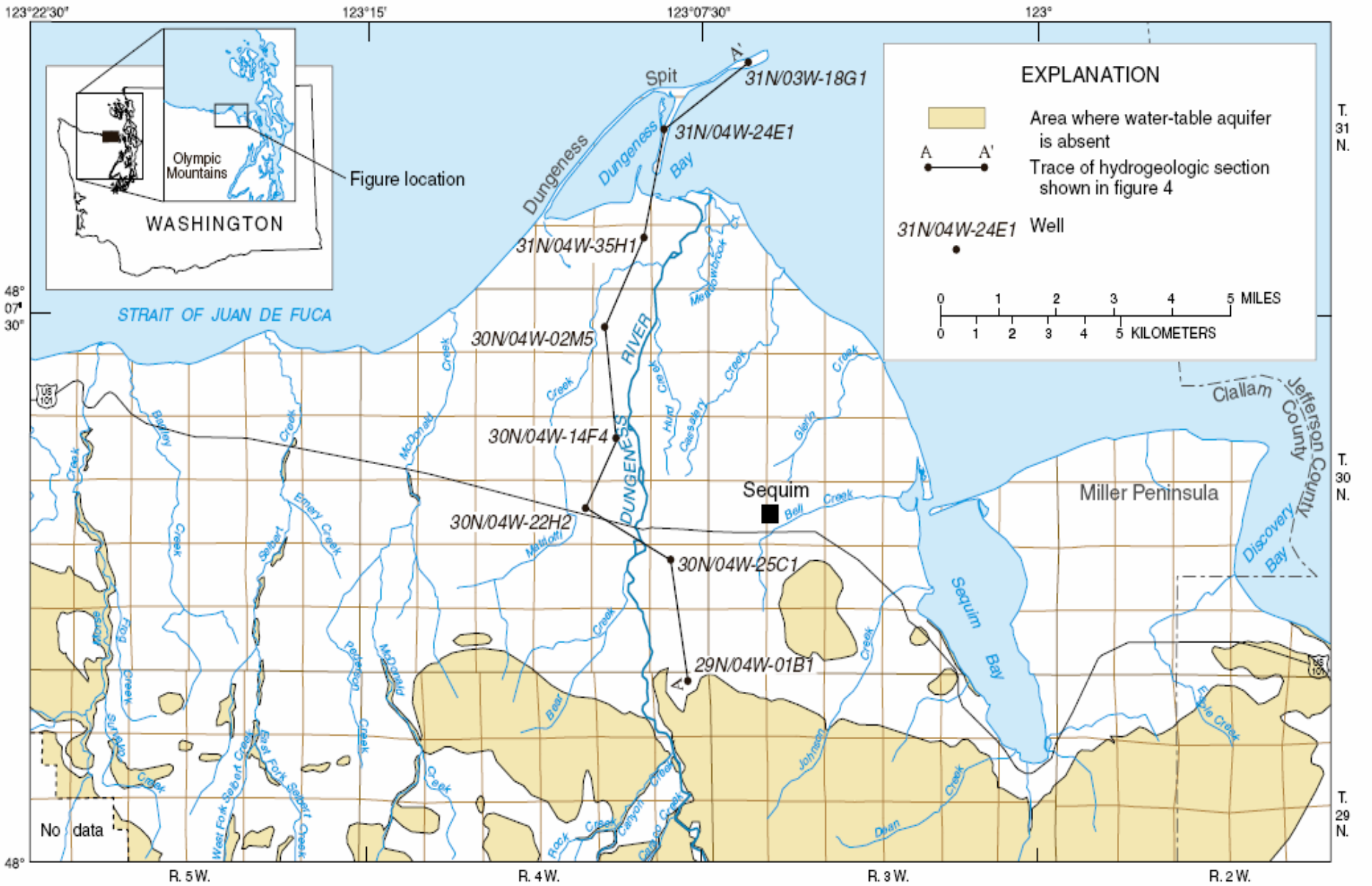
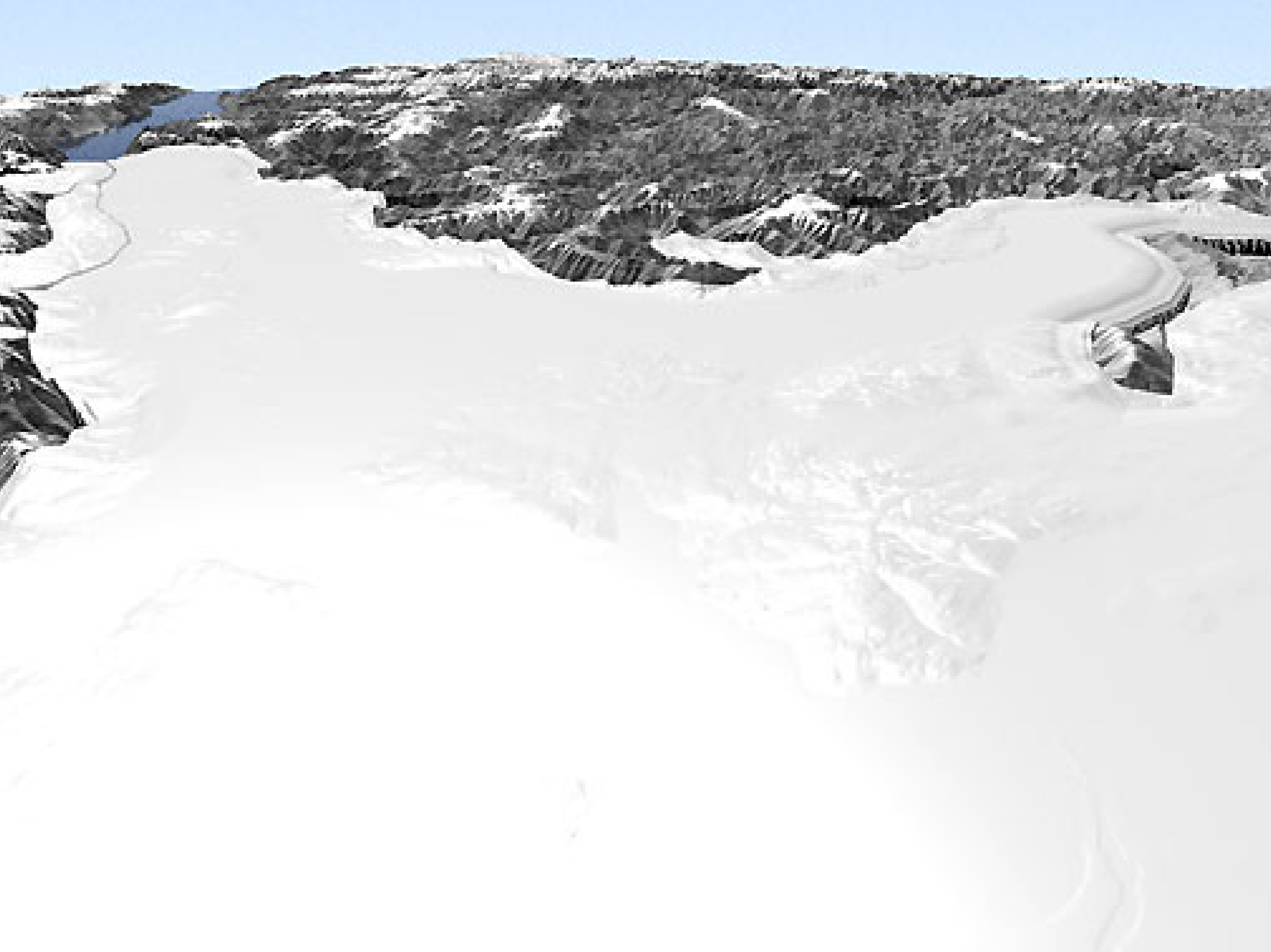
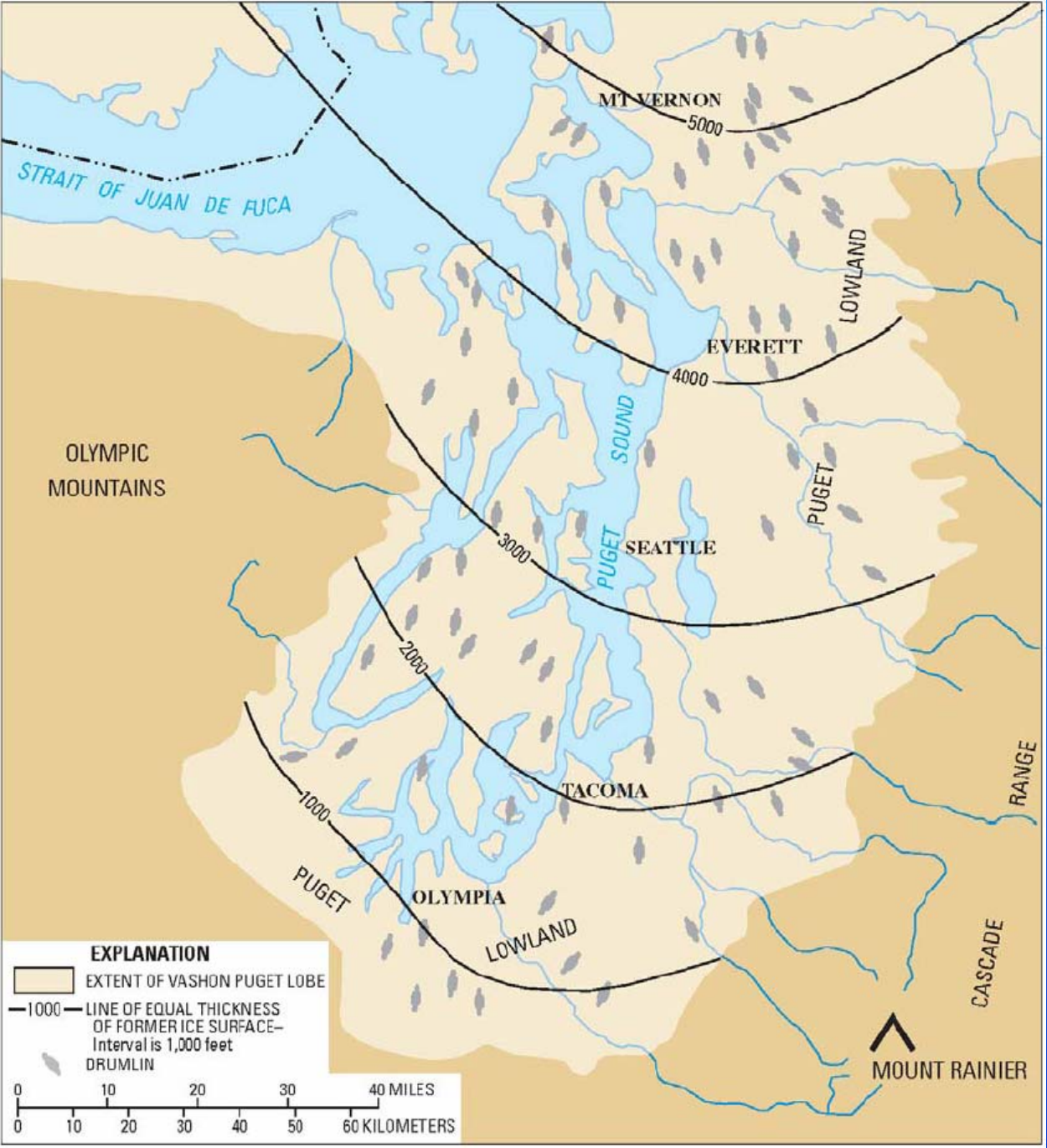


Figure 1. Location of the study area, the Dungeness River, and the trace of the hydrogeologic section on the Sequim-Dungeness peninsula, Clallam County, Washington.

The hydrogeologic section is shown in figure 4. (Modified from Thomas and others, 1999).





B. Extent of Vashon Puget lobe of the Fraser Cordilleran glaciation (from Easterbrook. 1979).

Thickness and extent of Vashon Glaciation

Dungeness Surficial Geology

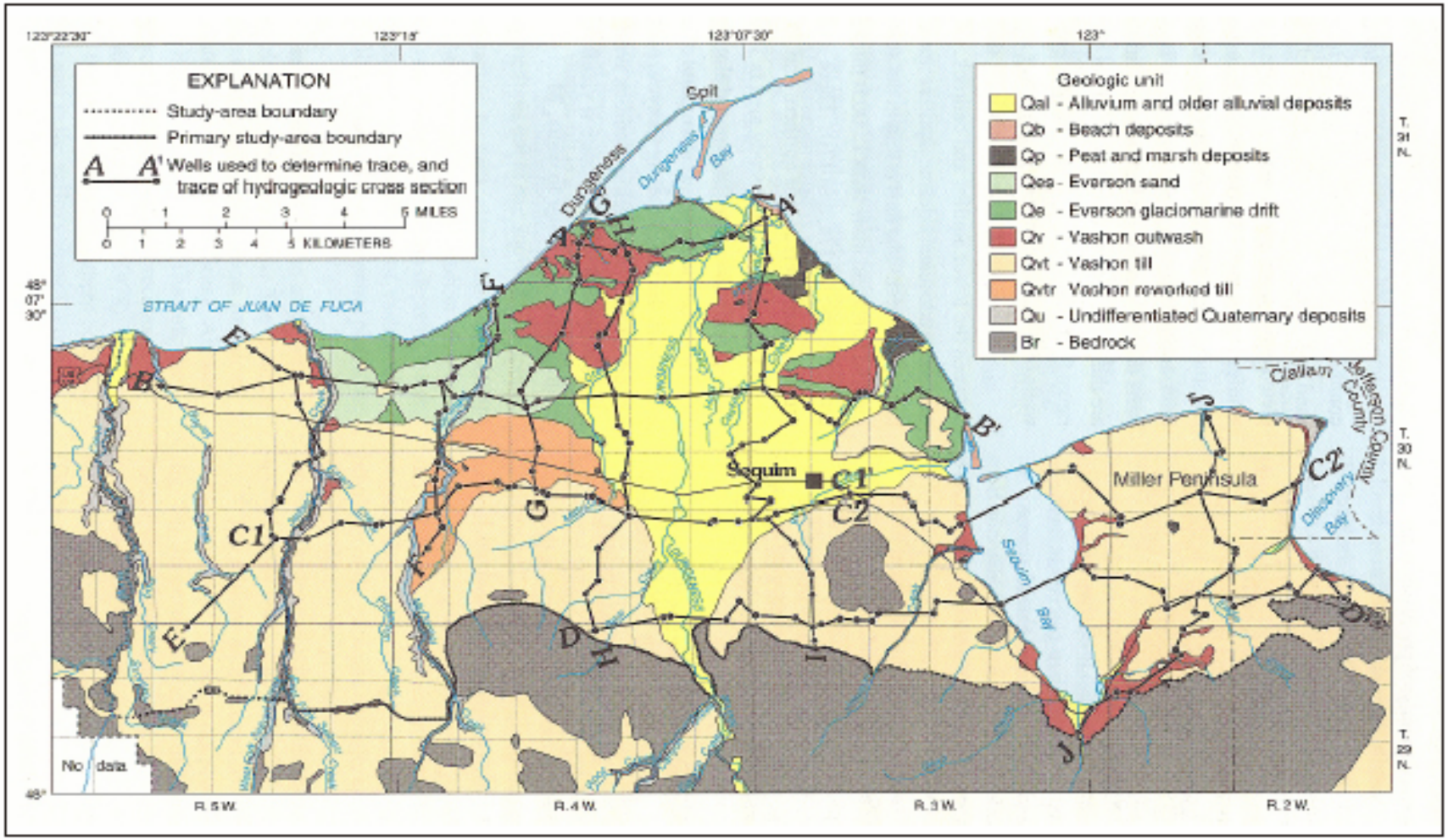


Figure 2.1-1. Generalized surficial geology and locations of hydrogeologic sections (Thomas et al. 1999).

Ground Water Flow in the Dungeness

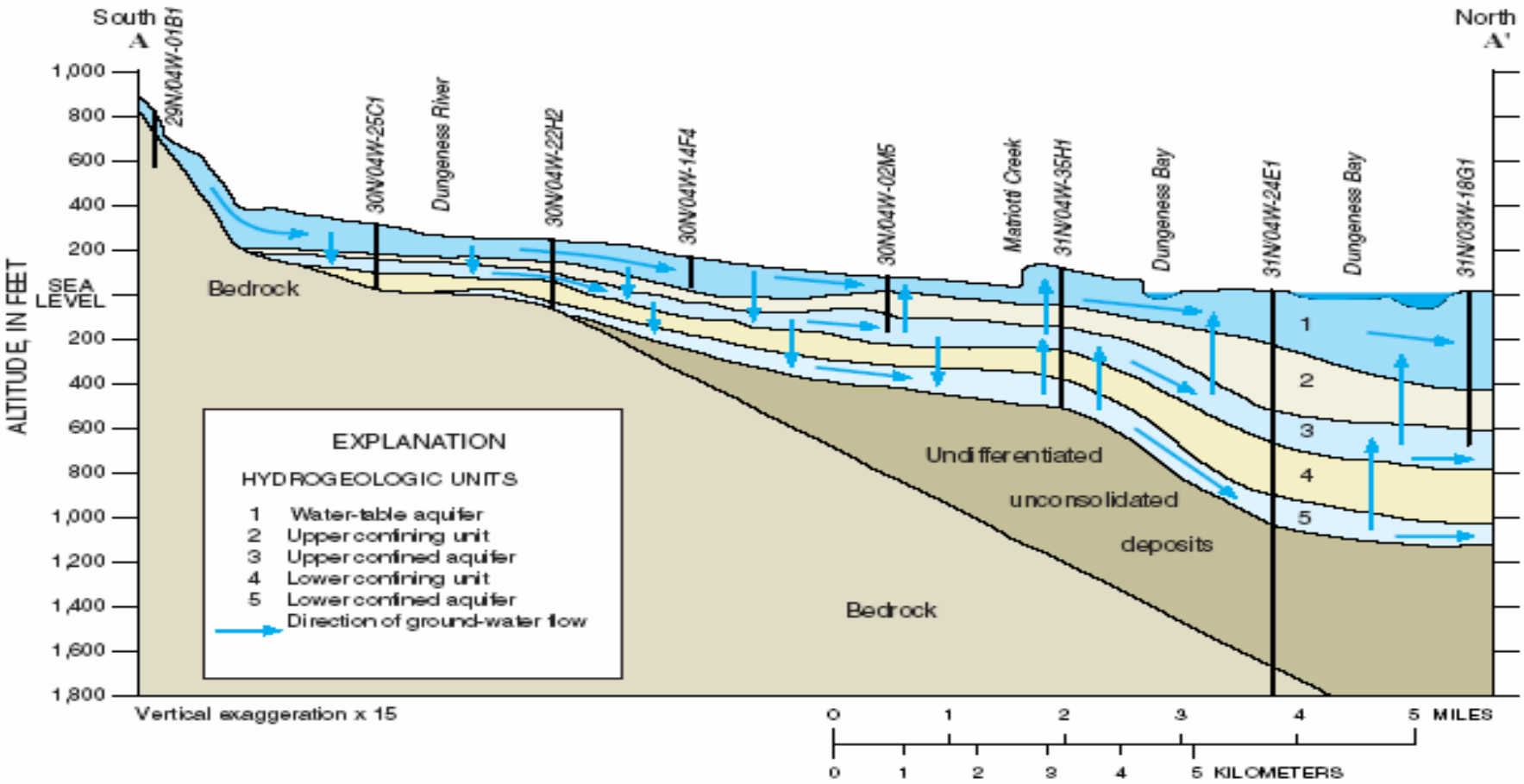
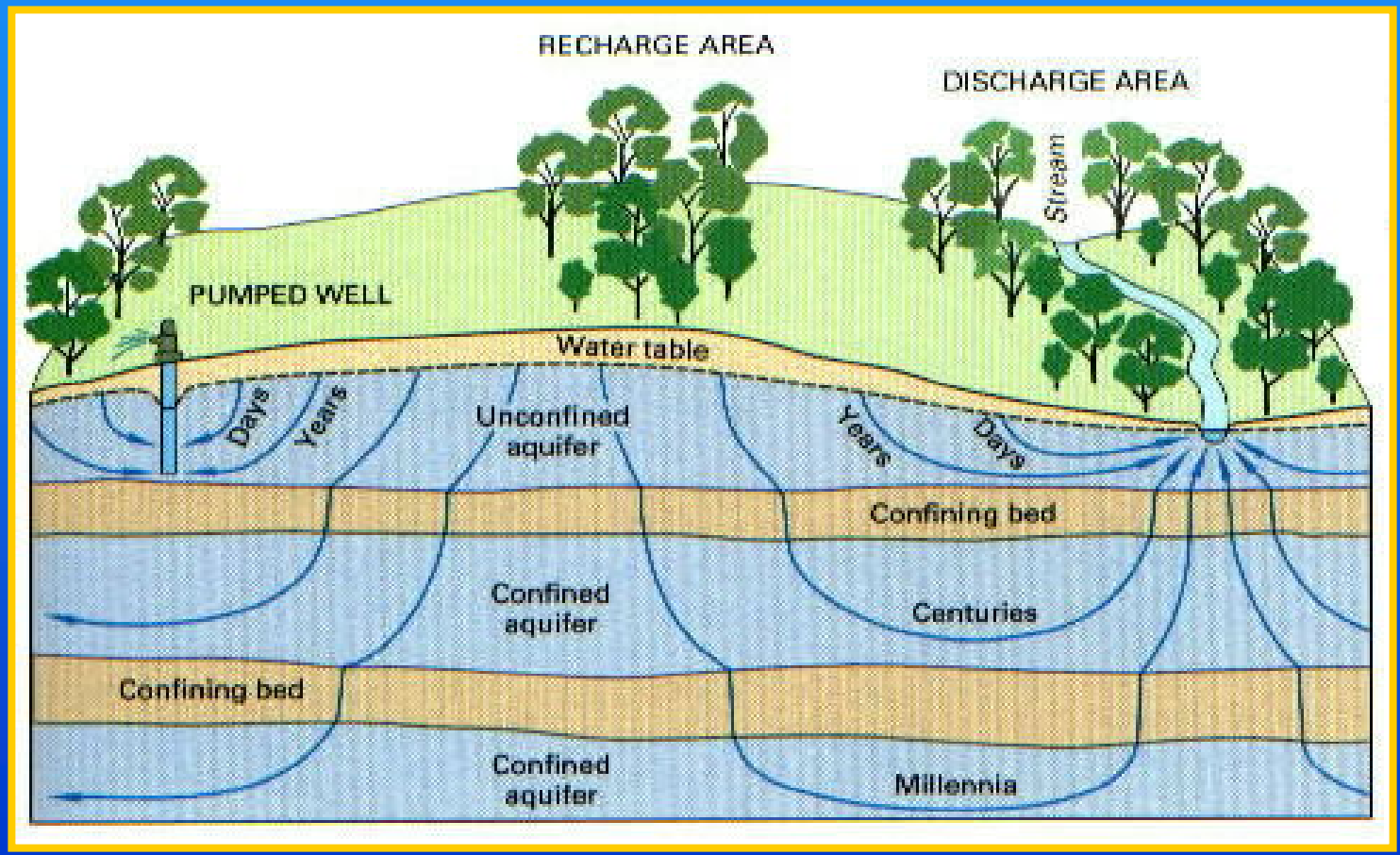


Figure 4. Hydrogeologic section showing the principal aquifer and confining units and directions of ground-water flow on the Sequim-Dungeness peninsula, Clallam County, Washington.
(Modified from Drost, 1983) See figure 1 for the trace of the section.

How Groundwater Moves



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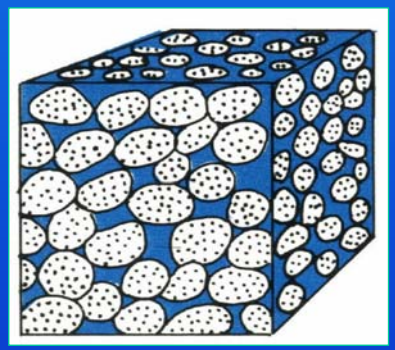
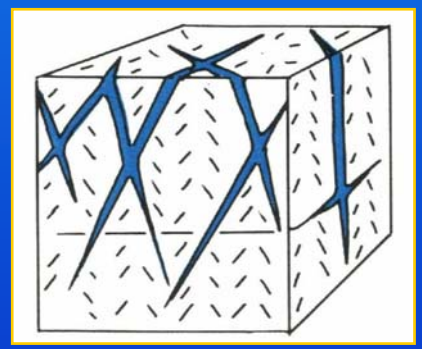
How Ground Water Moves

- Water passes through different types of geologic material with varying degrees of ease
- Hydrogeologists refer to this property as “Hydraulic Conductivity”

How Ground Water Moves

- Hydraulic Conductivity is related to the “Porosity” of a geologic material. Porosity is related to the sizes of pores or fractures in the material





Hydraulic Conductivity Varies by Material Types

- Gravel
- Vesicular Basalt (Primarily flow tops and bottoms)
- Sand
- Sandstone
- Silty Sand
- Silt
- Silt-Clay Rich Sedimentary Interbed
- Clay
- Shale, Mudstone
- Basalt Dense Interior, Granite, etc

High Hydraulic Conductivity

Low Hydraulic Conductivity

How Ground Water Moves

- Ground water flow occurs based on Darcey's Law:

$$Q = K\ i\ a$$

- Q = Discharge (Gallons per minute)
- K = Hydraulic Conductivity (cm/sec)
- i = Hydraulic Gradient (ft/ft or unit-less)
- a = Cross-sectional area (square feet)

Source of Water for Wells

- Water Balance (inflow = outflow)

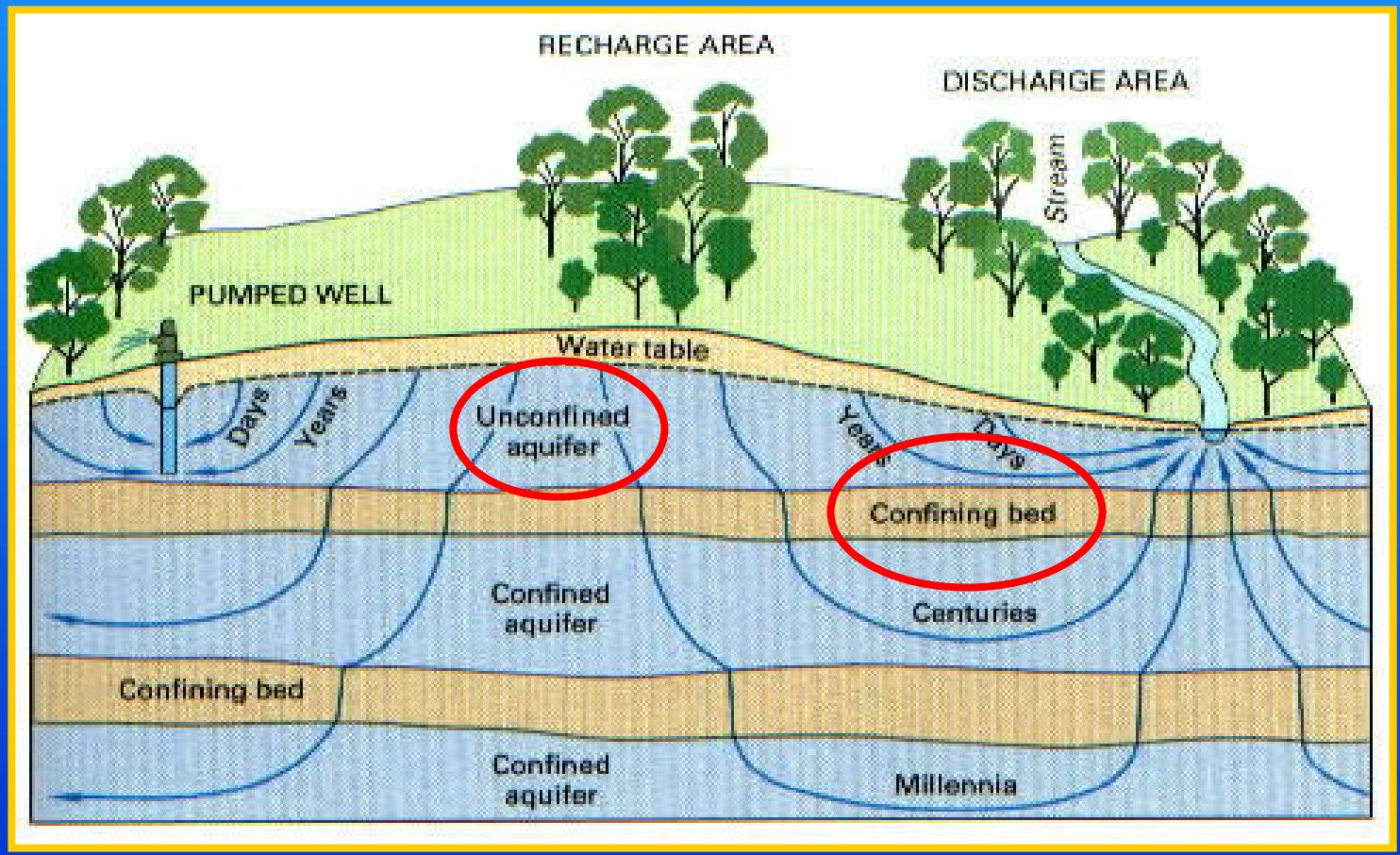
- Sources of water pumped from well
  - Increase in inflow
  - Decrease in outflow
  - Change in amount stored

Aquifers and Aquitards

- **Aquifer**: layer of geologic material that transmits water relatively easily - like sand, gravel, basalt flow tops & bottoms, well sorted sandstone…

- **Aquitard or Confining Layer:** layer of geologic material that transmits water very slowly - like clay or dense rock

Aquifers and Aquitards



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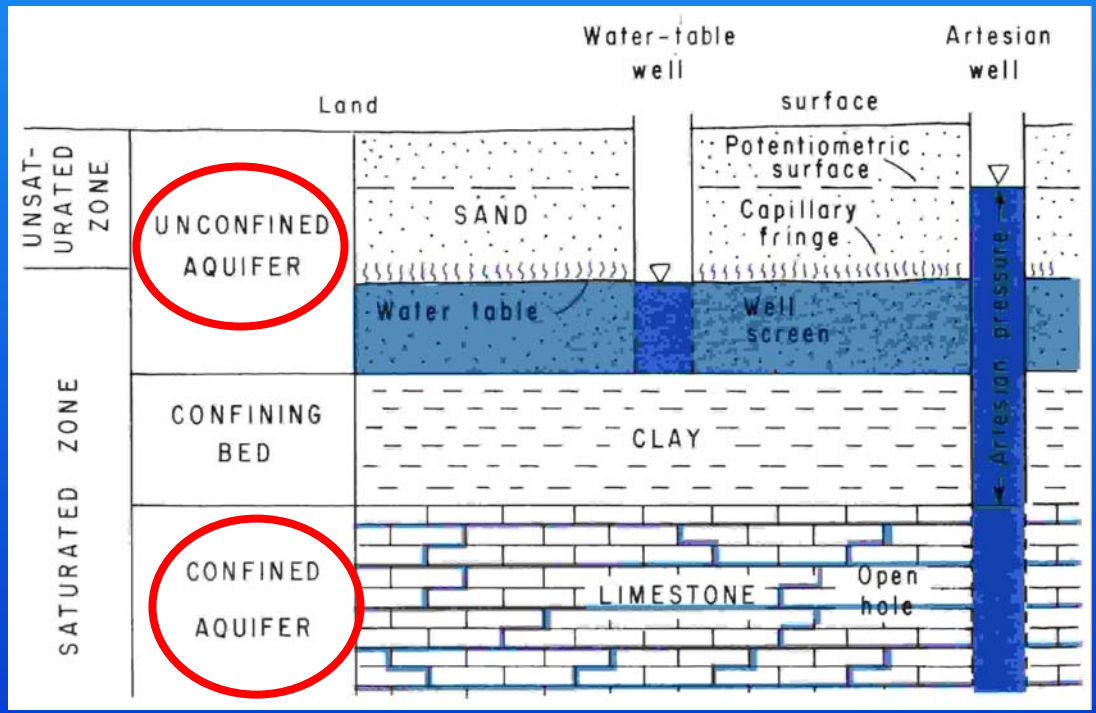
Two Primary Types of Aquifers

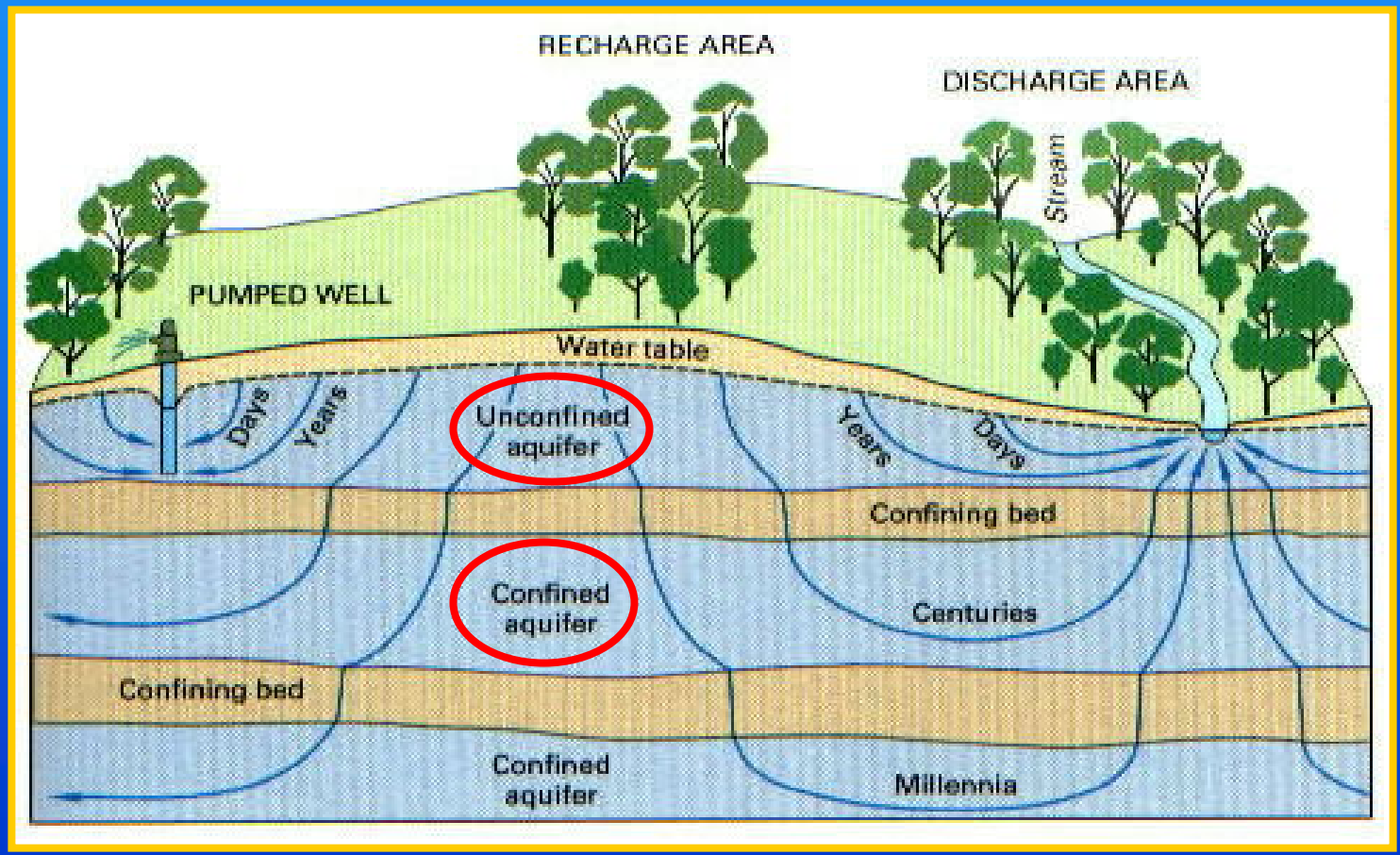
Unconfined
(Water Table)

Confined
(Artesian)



USGS WSP 2220

Unconfined and Confined Aquifers



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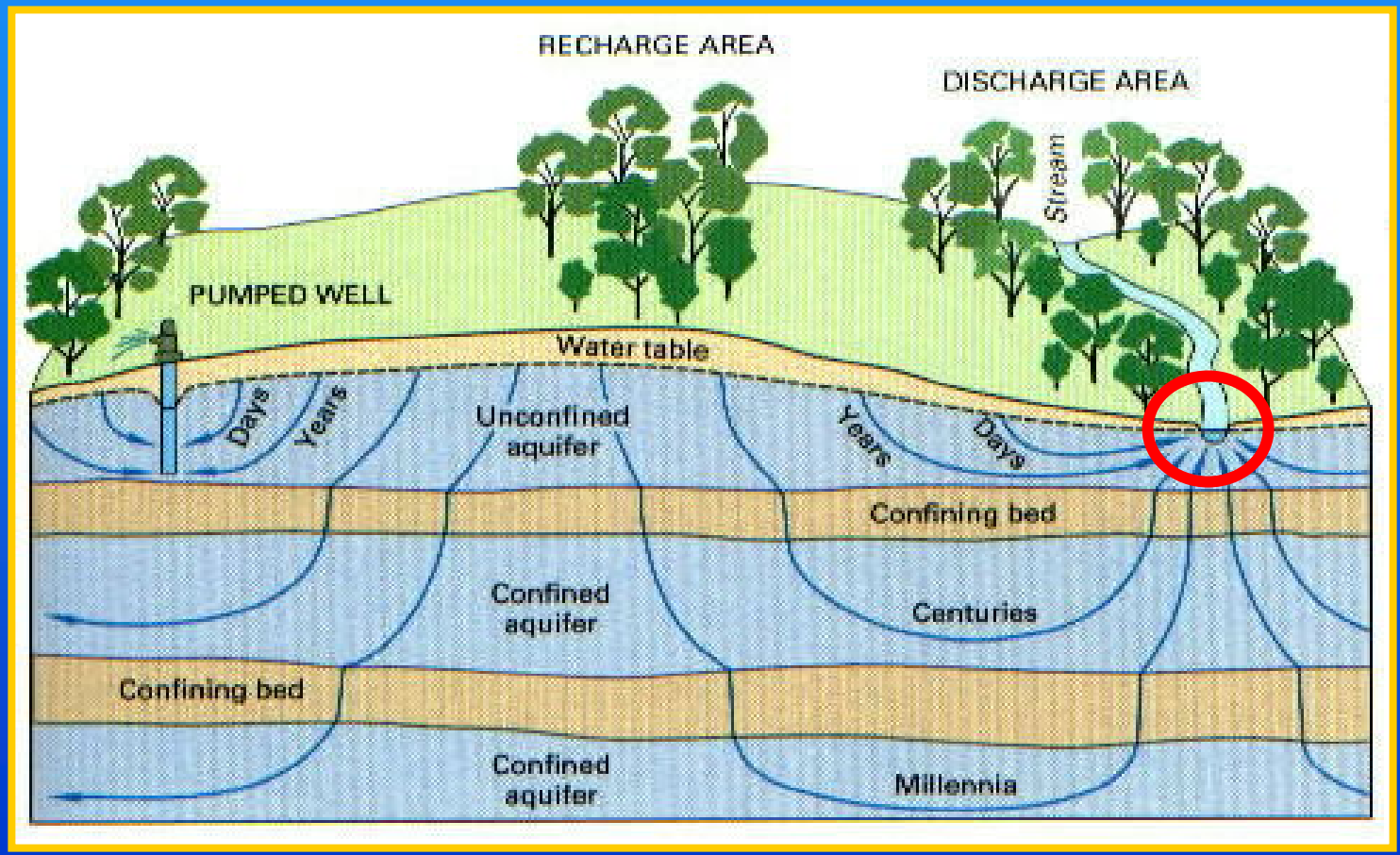
Ground Water-Surface Water Interaction



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Ground Water Flow in the Dungeness

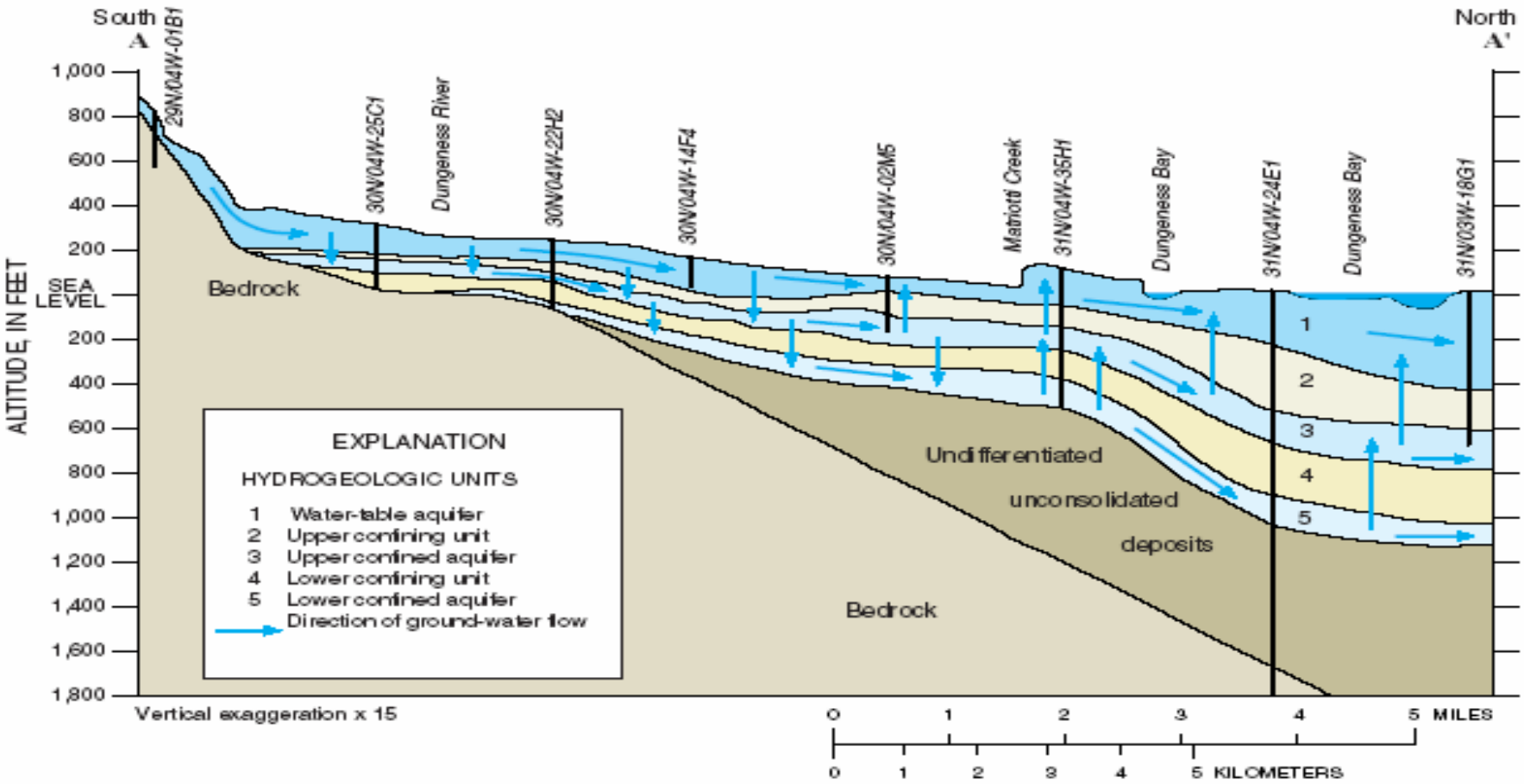


Figure 4. Hydrogeologic section showing the principal aquifer and confining units and directions of ground-water flow on the Sequim-Dungeness peninsula, Clallam County, Washington.
(Modified from Drost, 1983) See figure 1 for the trace of the section.

Dungeness River Discharge & Monthly Precipitation

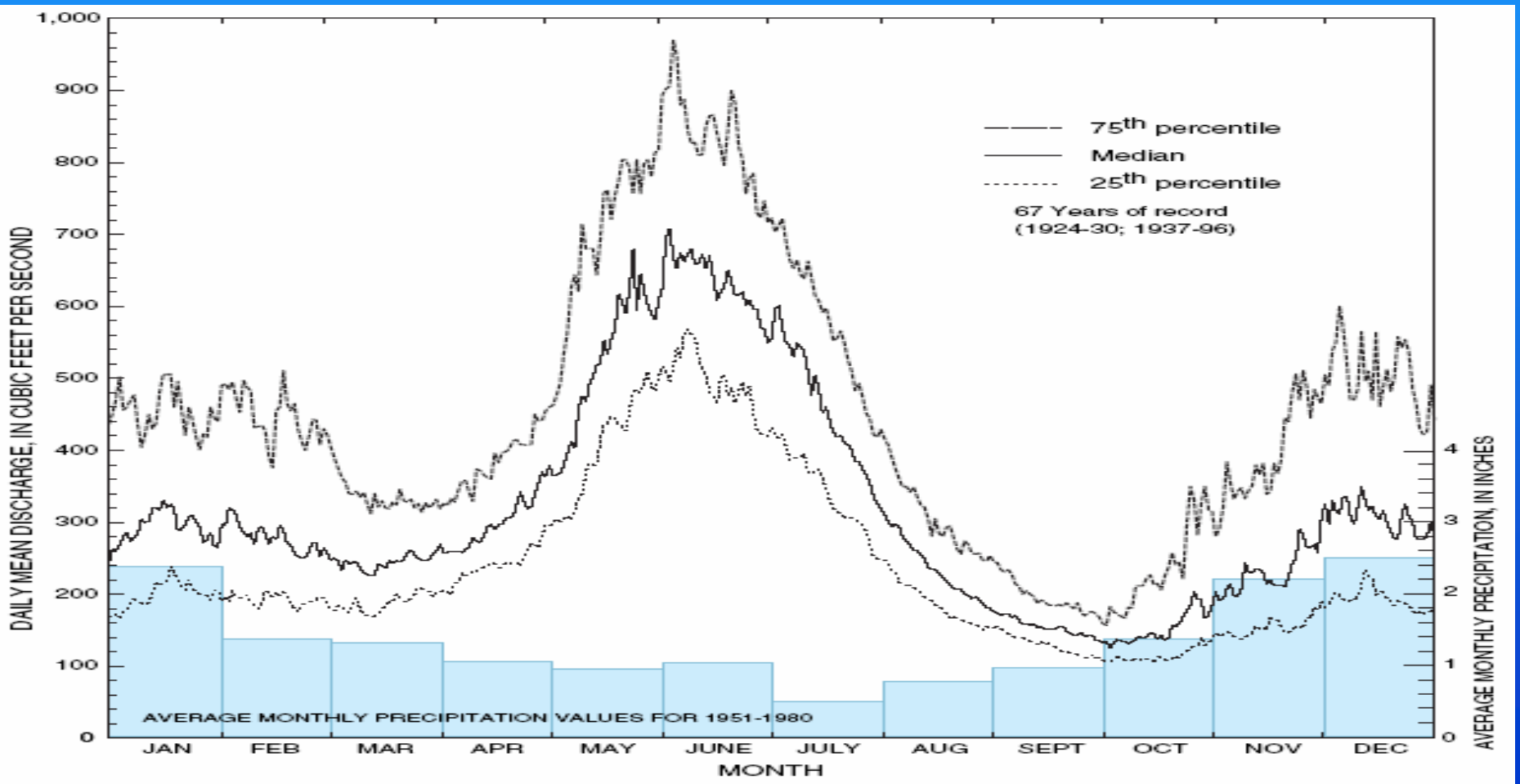


Figure 5. Mean daily discharge for the Dungeness River and average monthly precipitation near Sequim, Washington.

Discharge data are from U. S. Geological Survey streamgaging station 12048000 and precipitation data are from the National Oceanic and Atmospheric (1982).

Ground Water Flow in the Dungeness

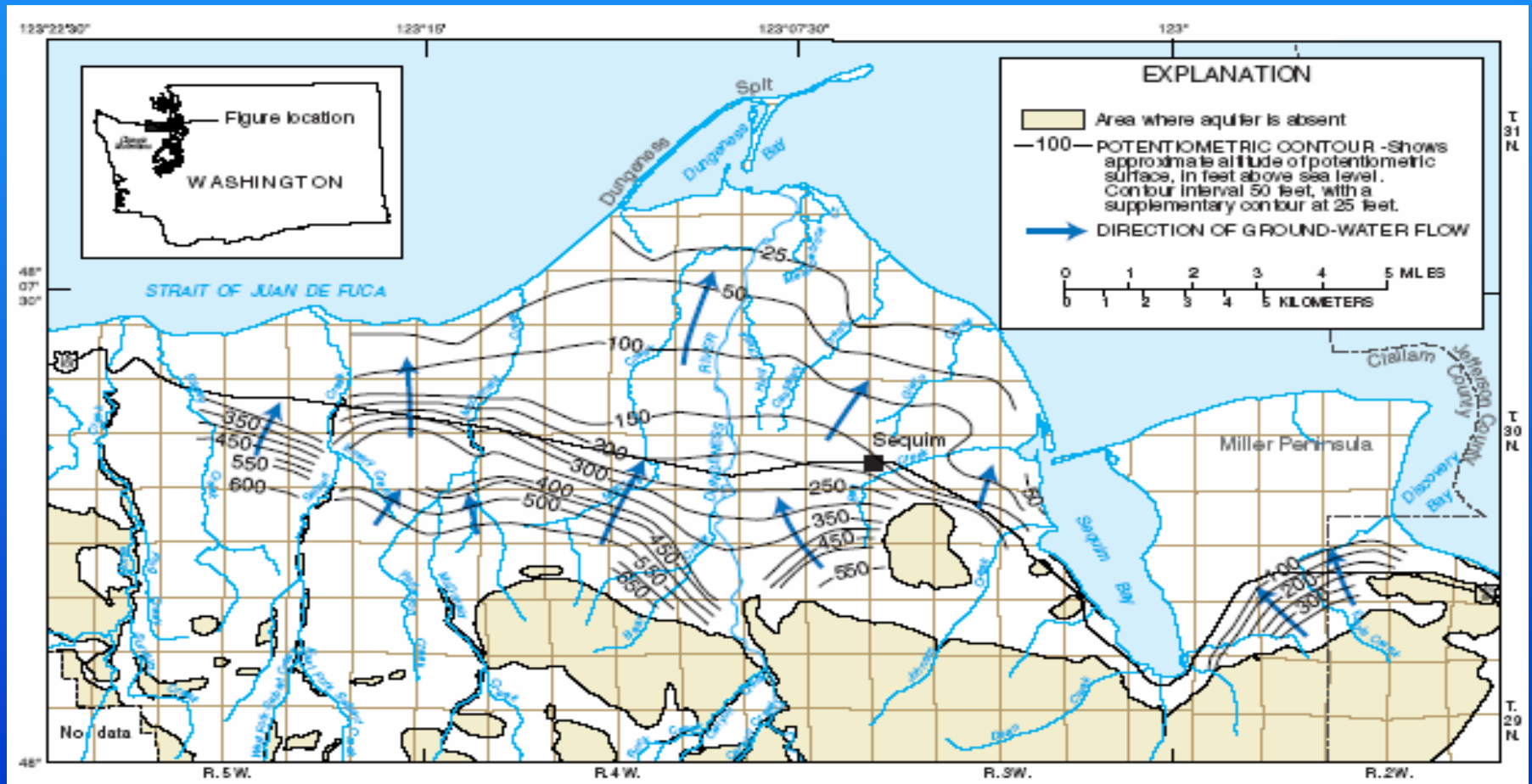
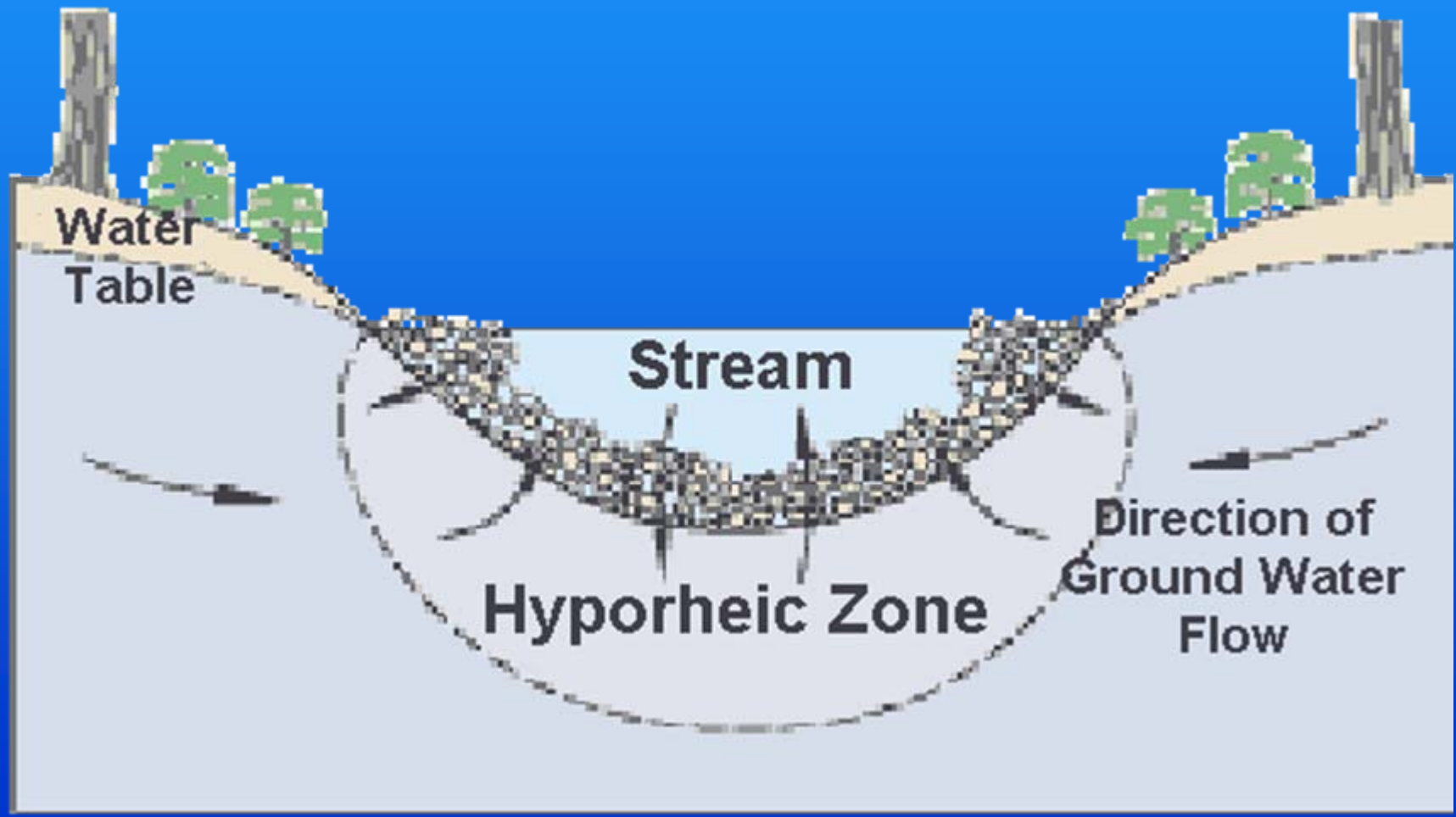


Figure 6. Horizontal ground-water flow in the water-table aquifer on the Sequim-Dungeness peninsula, Clallam County, Washington. (Modified from Thomas and others, 1999).

Baseflow

- That component of streamflow derived from ground water inflow or discharge
  - From WA Department of Ecology, Estimated Baseflow Characteristics of Selected Washington Rivers and Streams, Water Supply Bulletin No.60, October, 1999, Publication No 99-327

How Ground and Surface Water Interact



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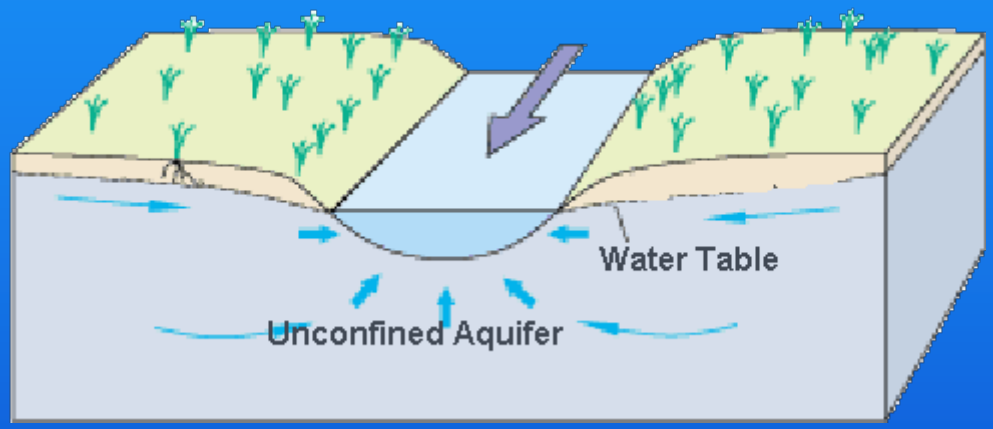
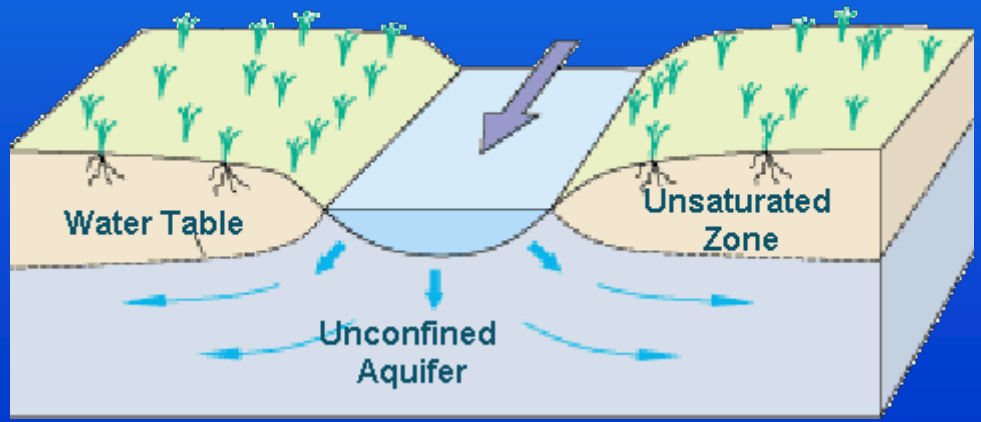
How Ground Water and Surface Water Interact

Gaining Stream



Loosing Stream



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Measuring Surface –Ground Water Interaction

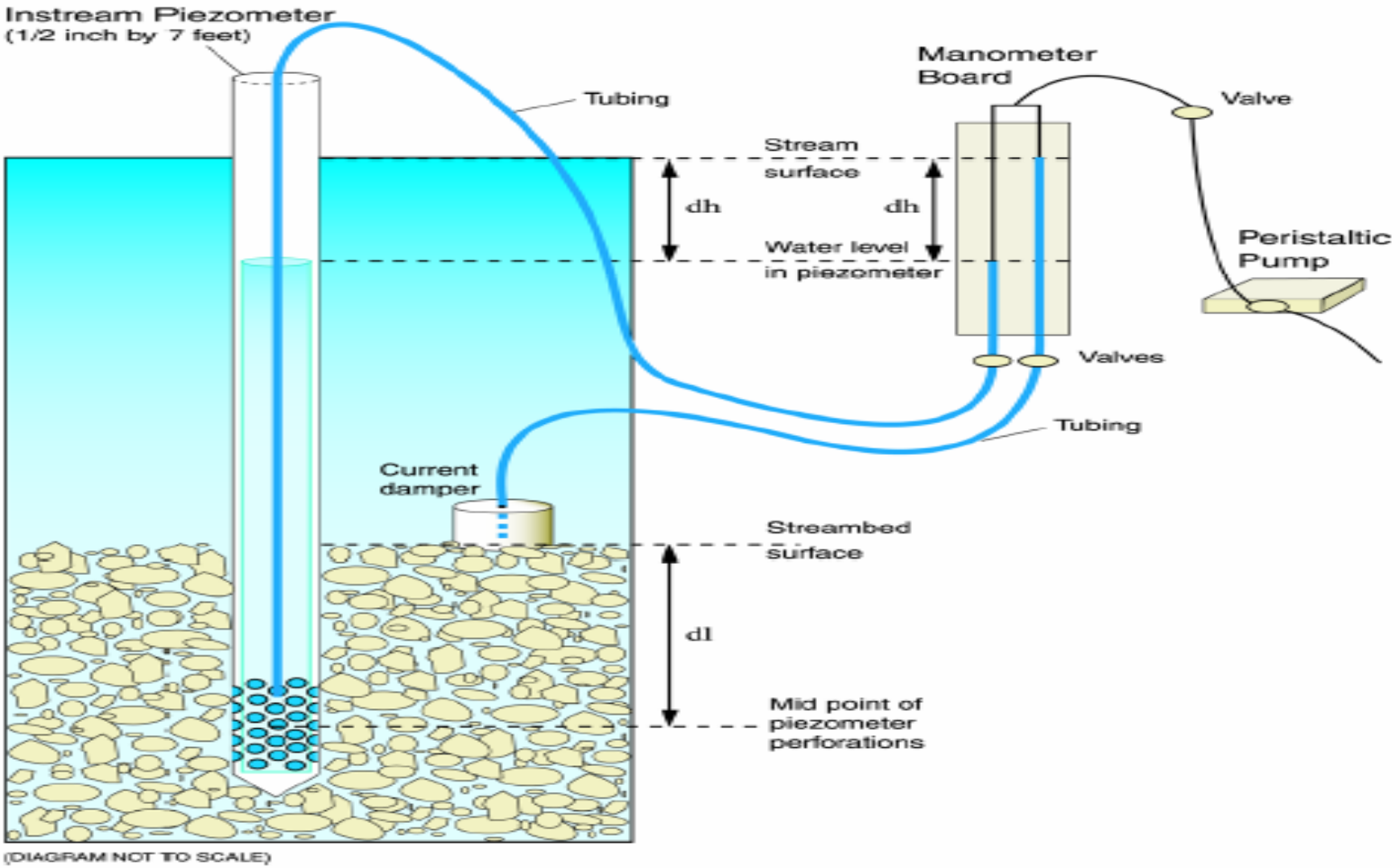


Figure 7. A typical in-stream mini-piezometer installation and manometer board configuration. From equation 1 in the report, *dh* is the difference between head in the mini-piezometer and river stage, and *dl* is the vertical distance between the streambed and the midpoint of the mini-piezometer perforations.

How Ground and Surface Water Interact

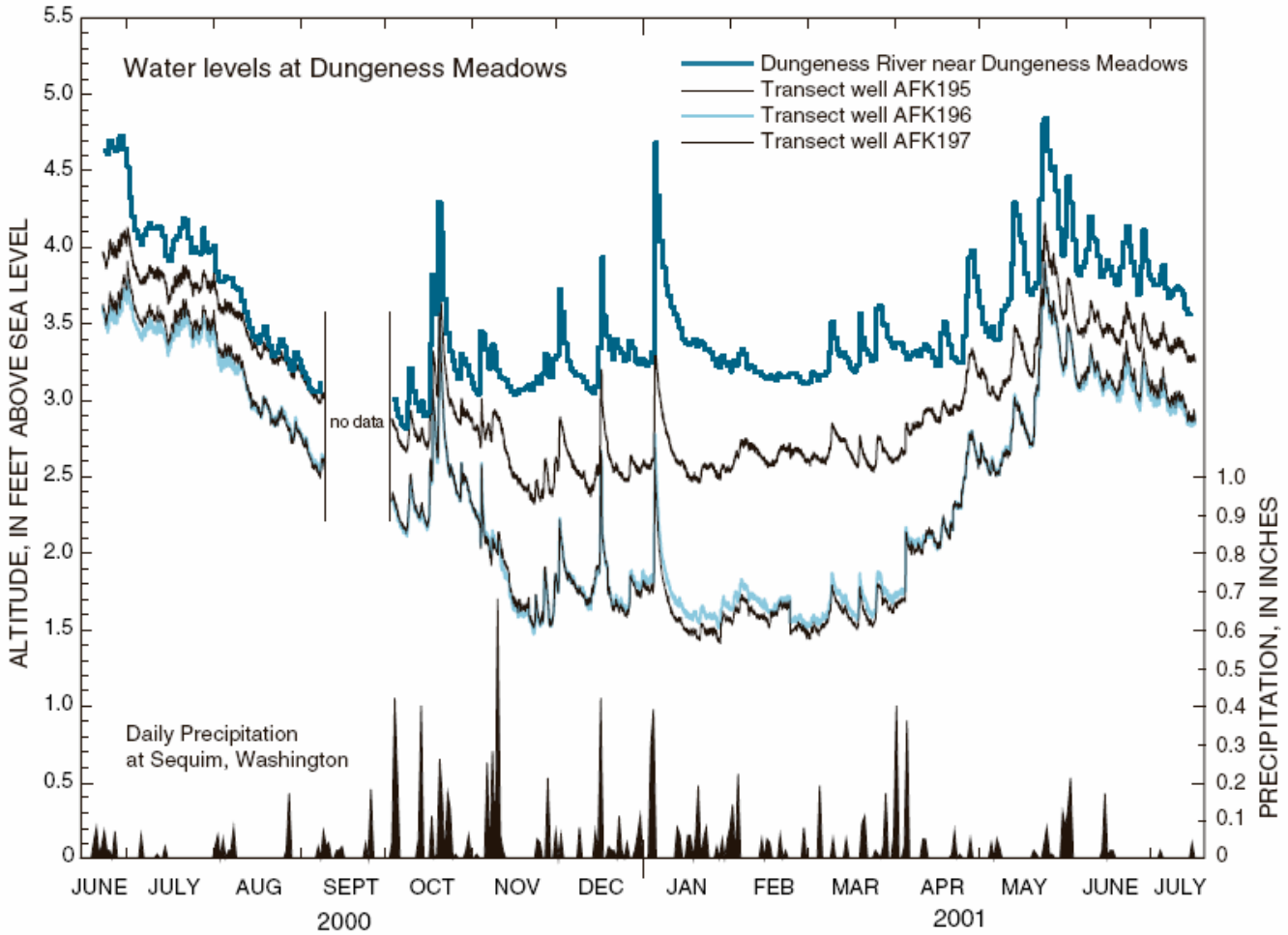
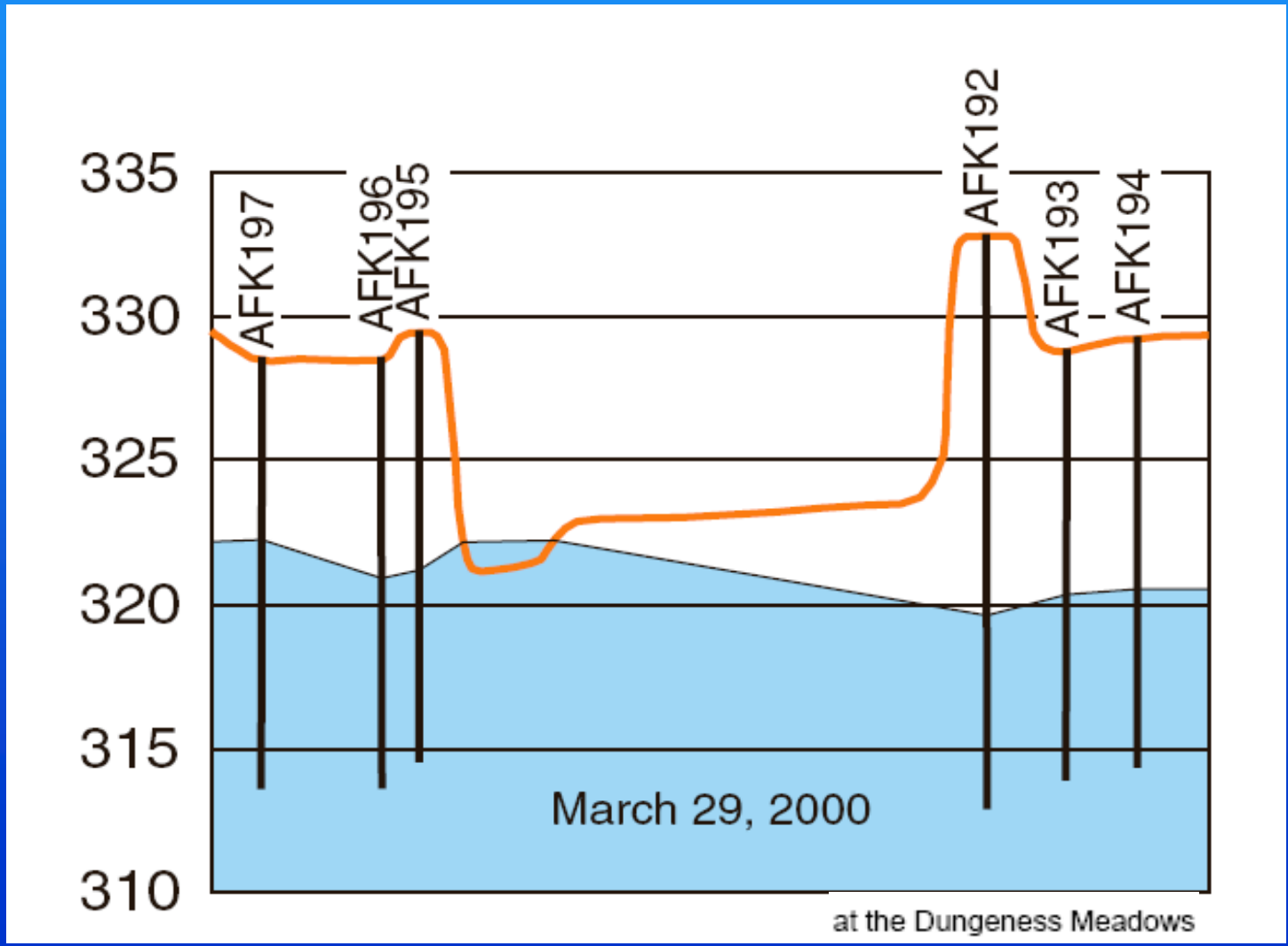


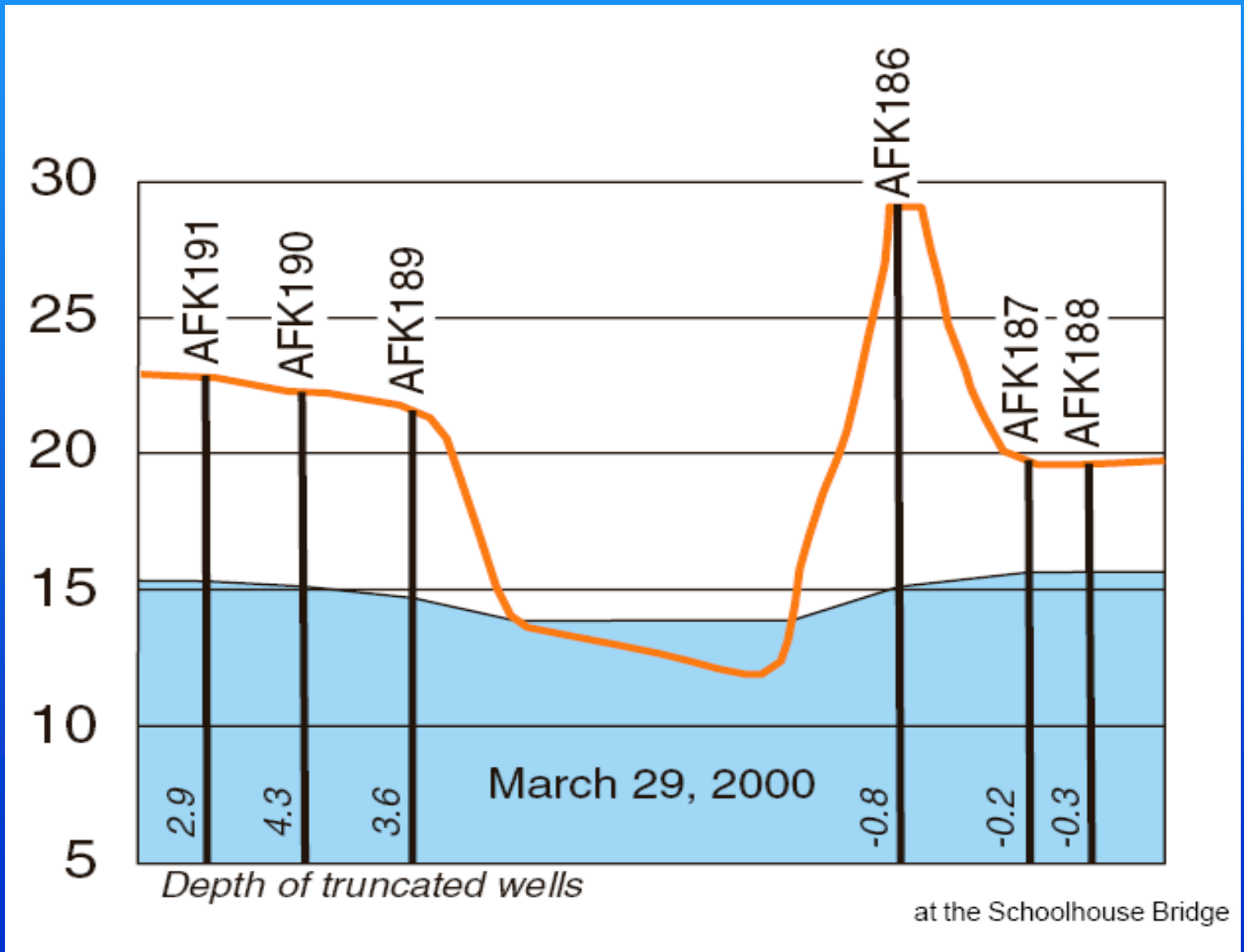
Figure 16. Continuous surface- and ground-water level data collected from June 2000 to July 2001 at the Dungeness Meadows off-stream well transect on the Sequim-Dungeness peninsula, Clallam County, Washington.

Daily precipitation recorded at the wastewater treatment facility at Sequim, Washington, is shown for comparison.

Water Table Profile across River



Water Table Profile across River



Gains and Loses along River

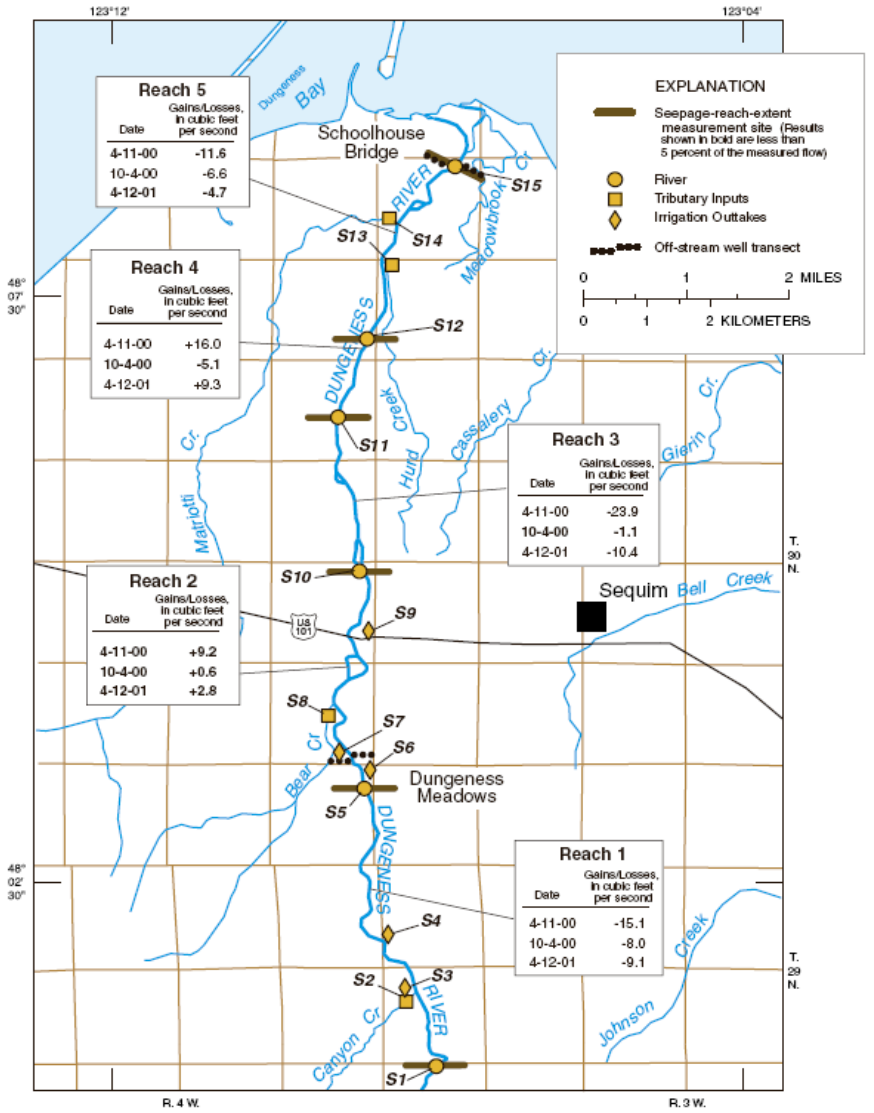
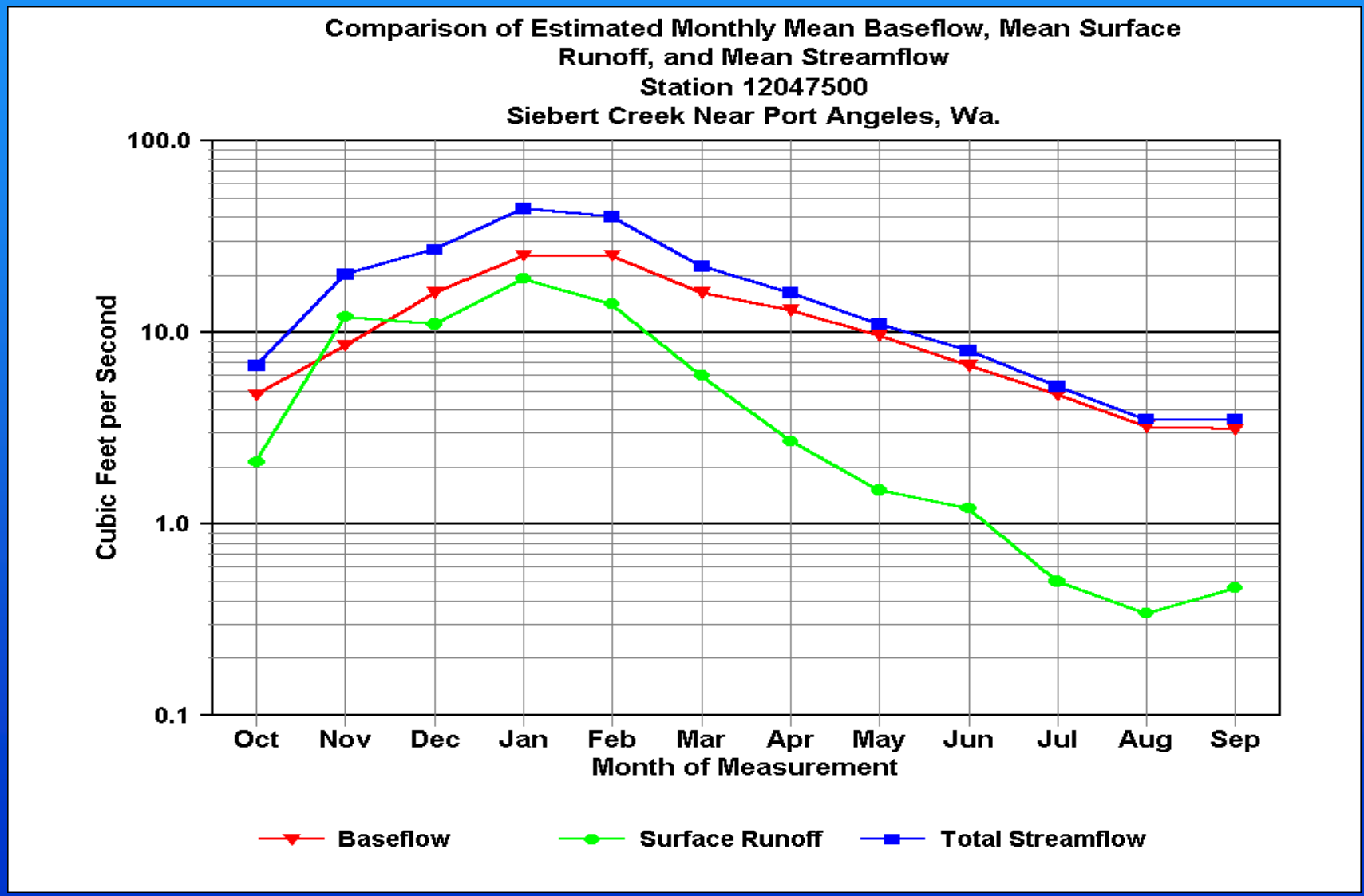
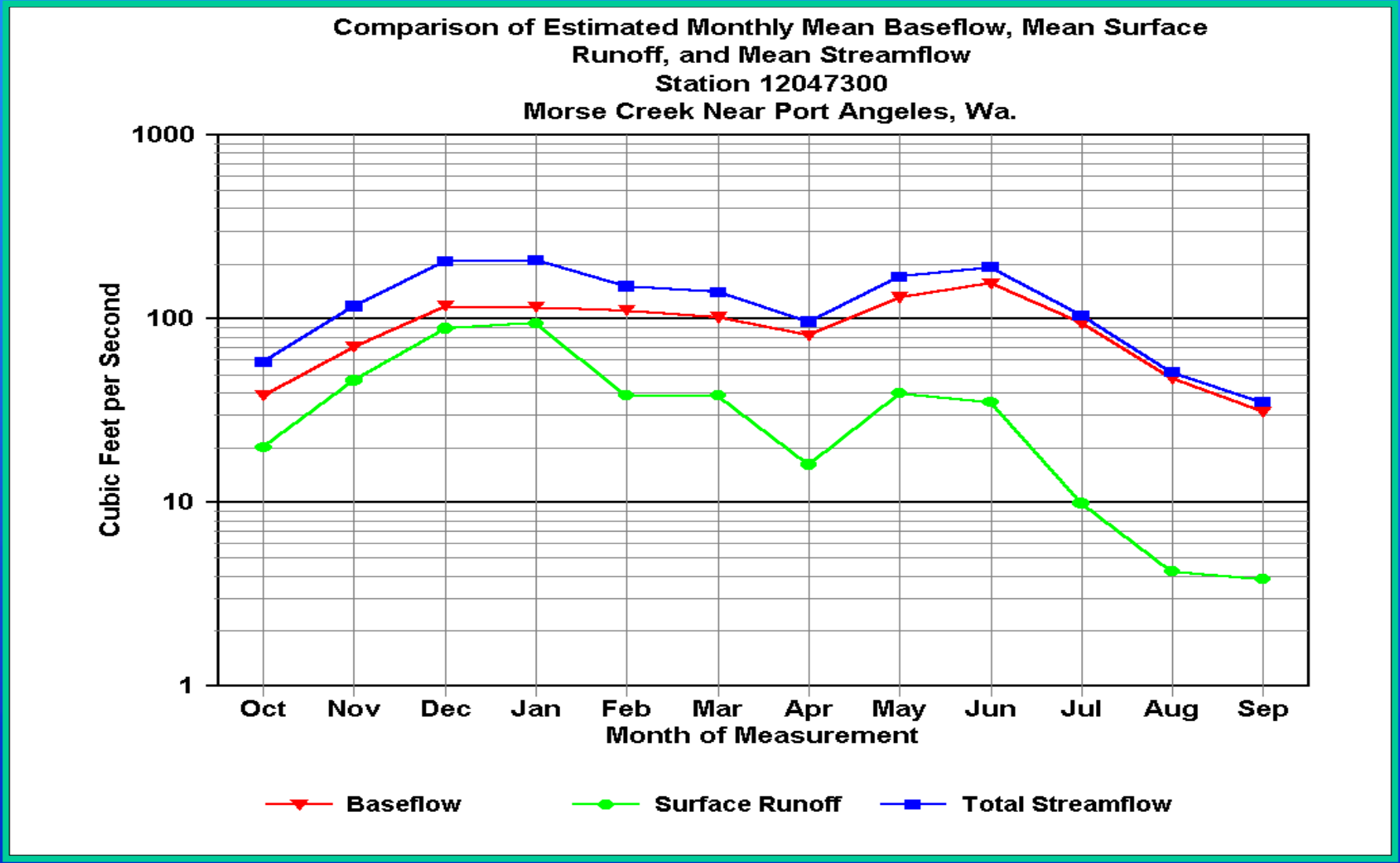


Figure 13. Results of the seepage runs on the five study reaches of the lower Dungeness River on the Sequim-Dungeness peninsula, Clallam County, Washington, April 11 and October 4, 2000, and April 12, 2001.

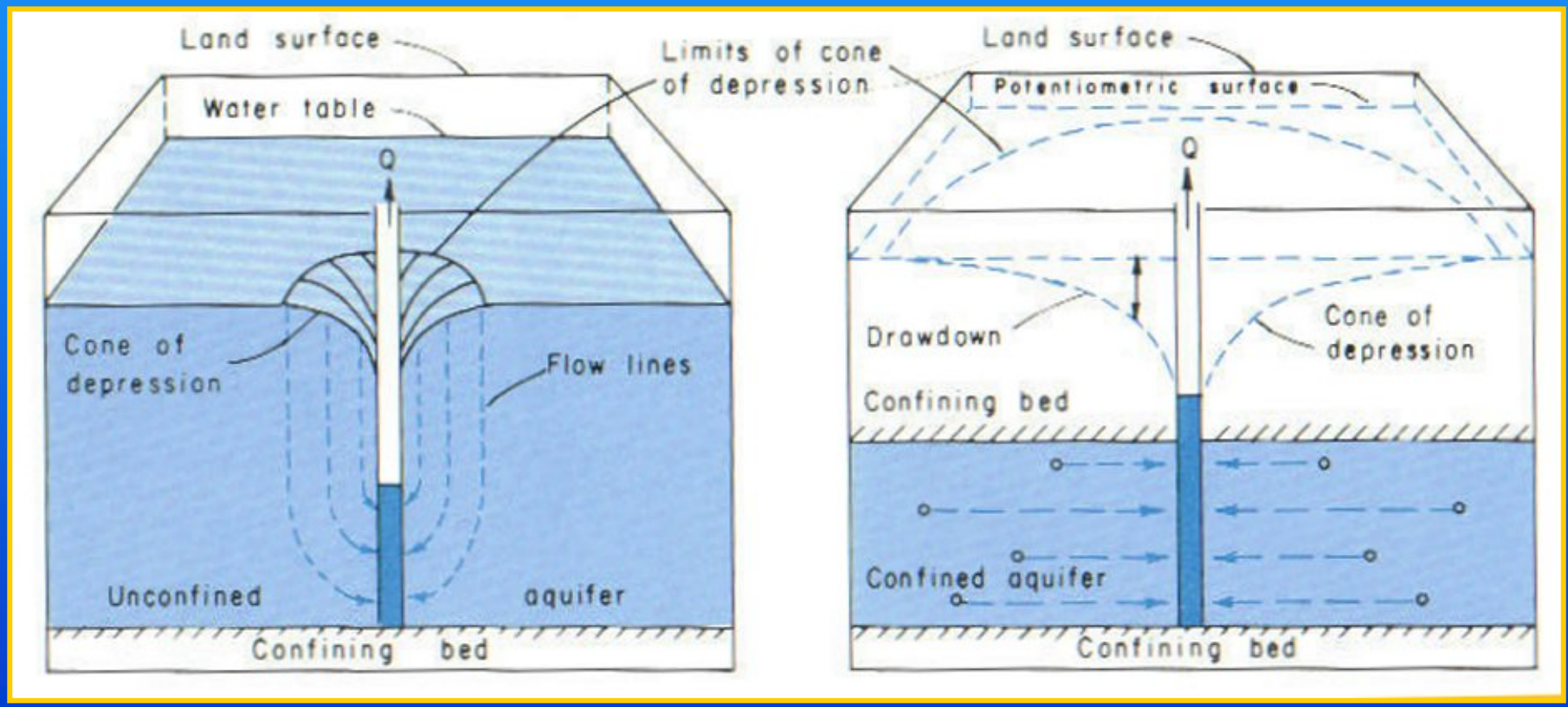
Importance of Baseflow to Streamflow



Importance of Baseflow to Streamflow



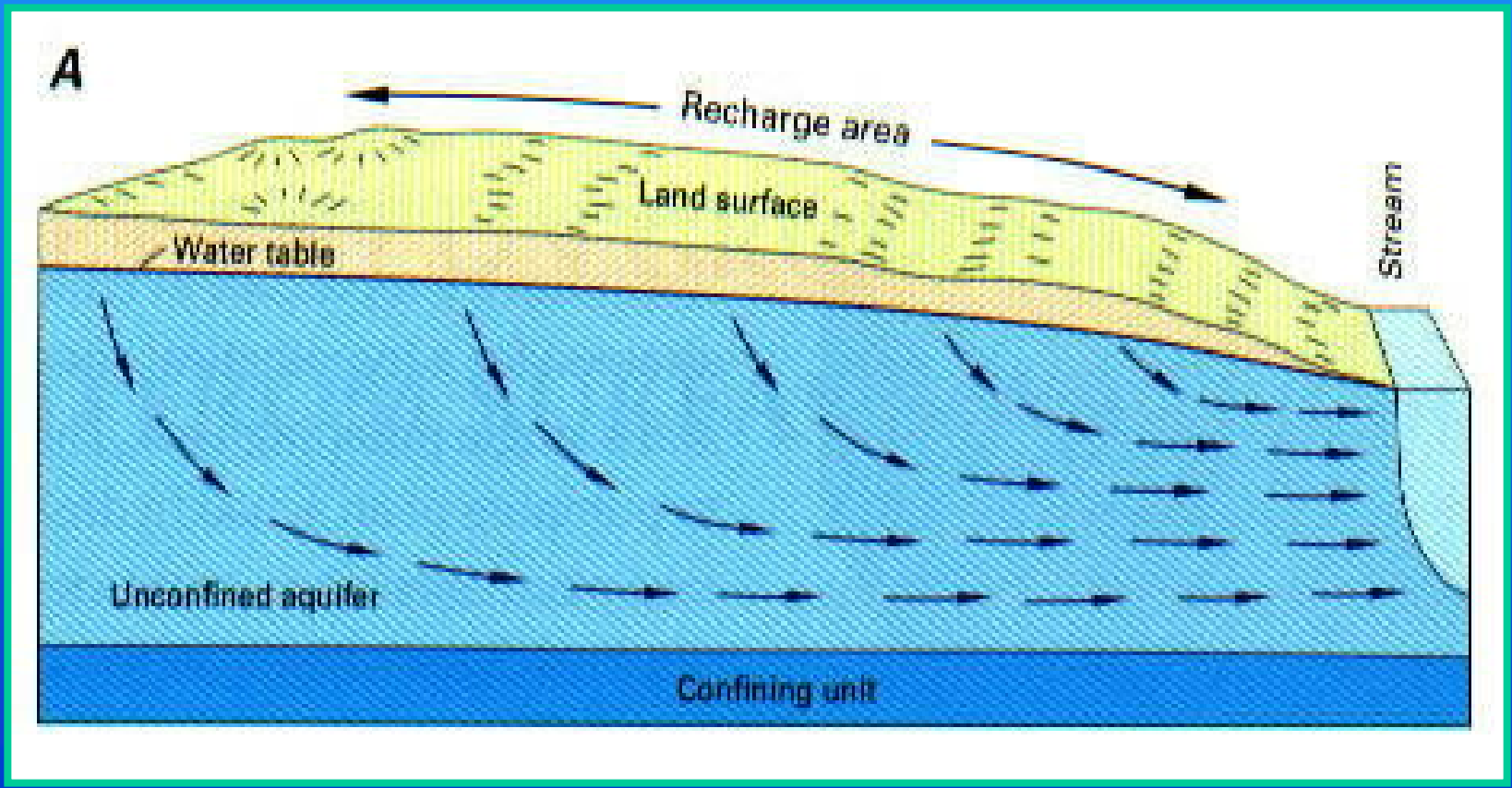
Pumping a Well forms a Capture Zone or “Cone of Depression”



Unconfined

Confined

How Do Wells Capture Surface Water?



Natural Conditions

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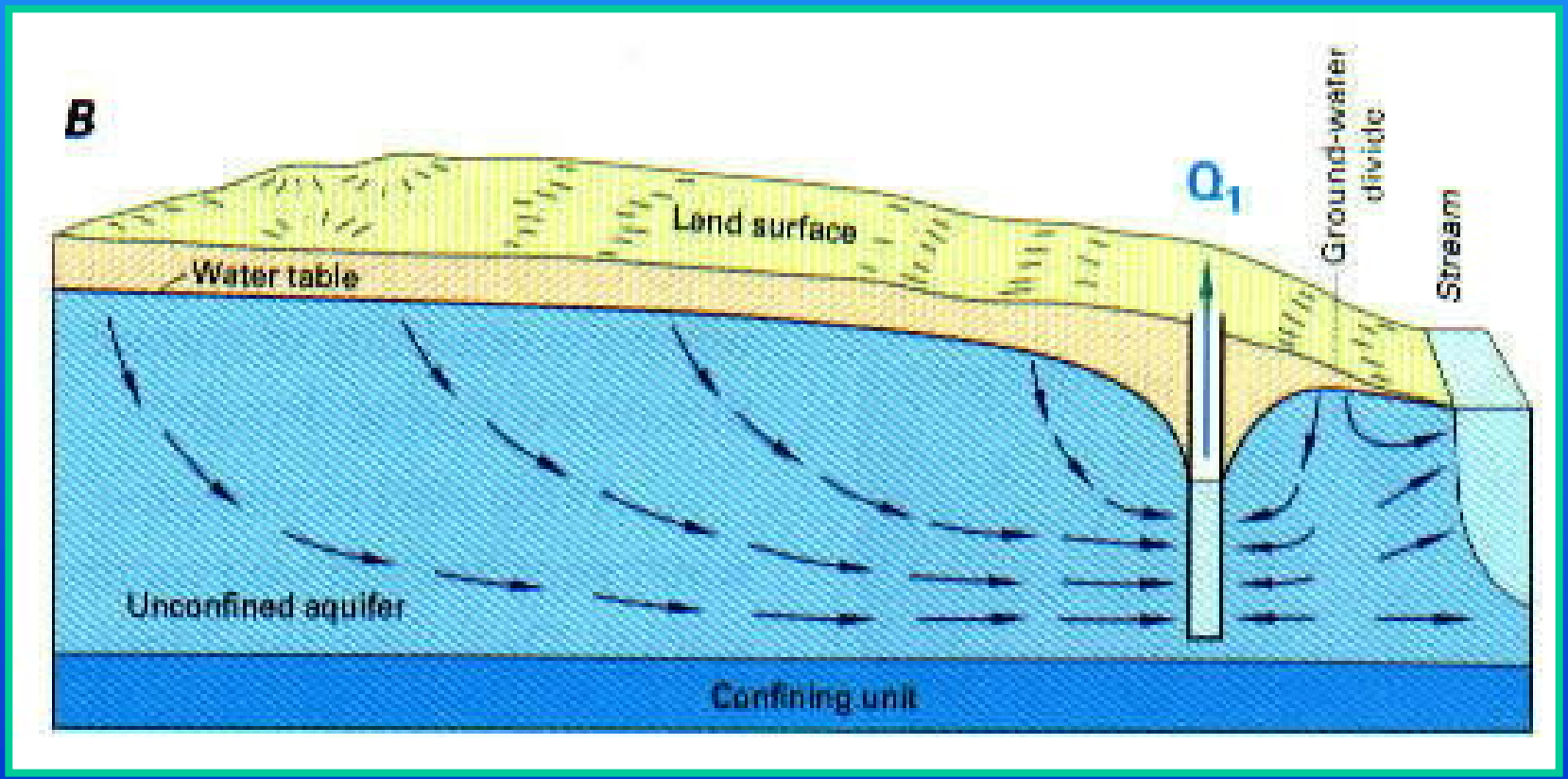
How Do Wells Capture Surface Water?



Pumping 1

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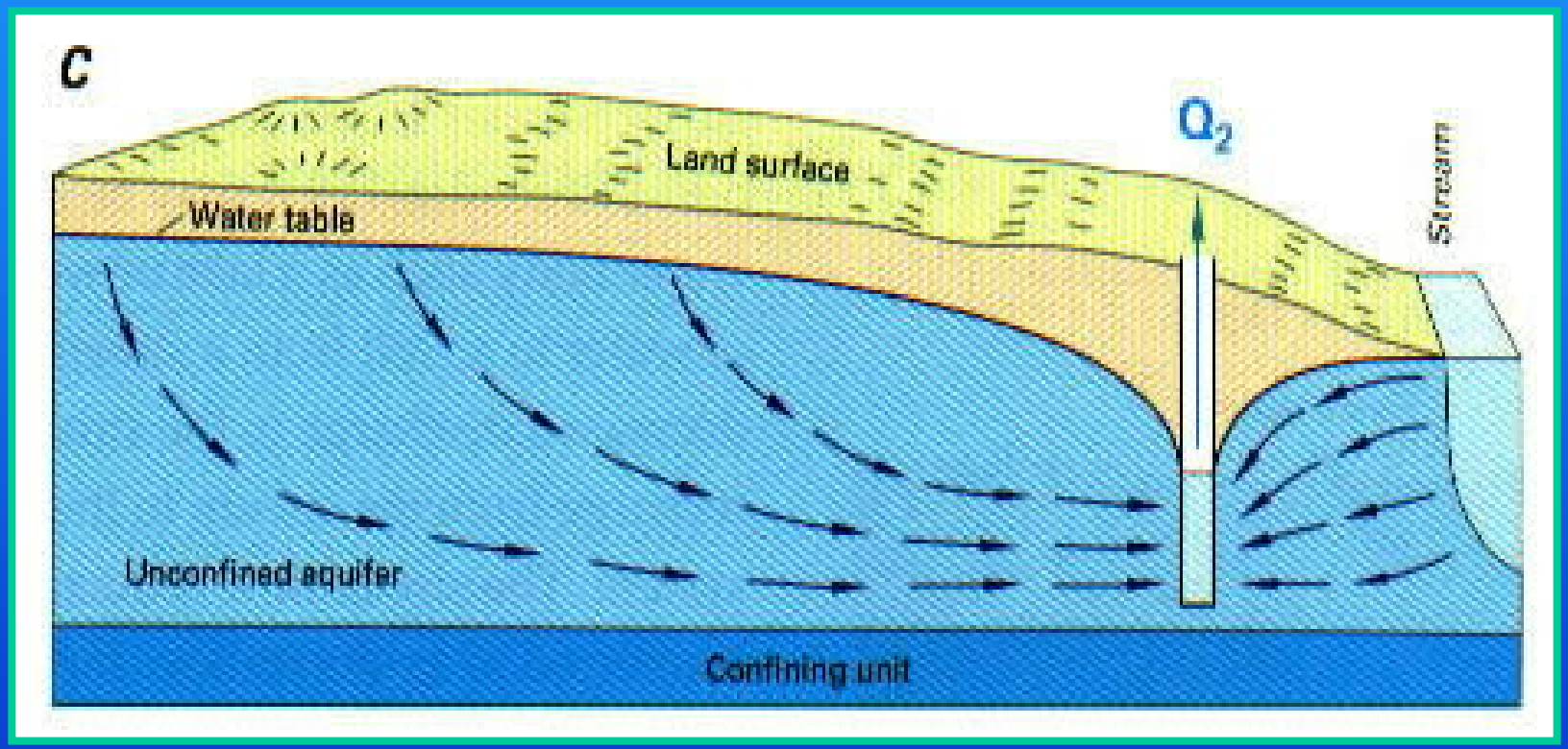
How Do Wells Capture Surface Water?



Pumping 2

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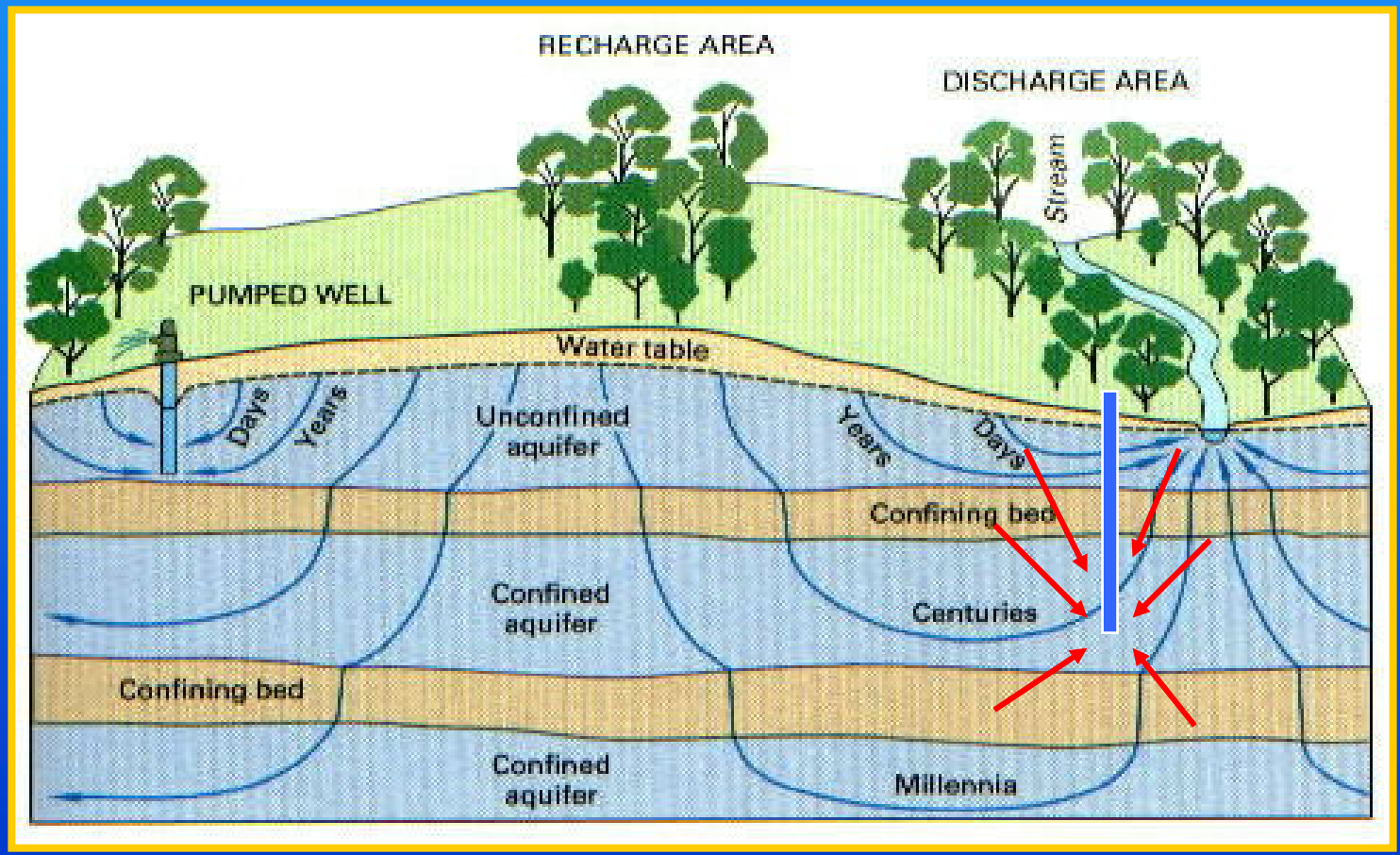
Pumping from Deeper Aquifers Can Also Affect Surface Water



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Hydraulic Connection Between Aquifers

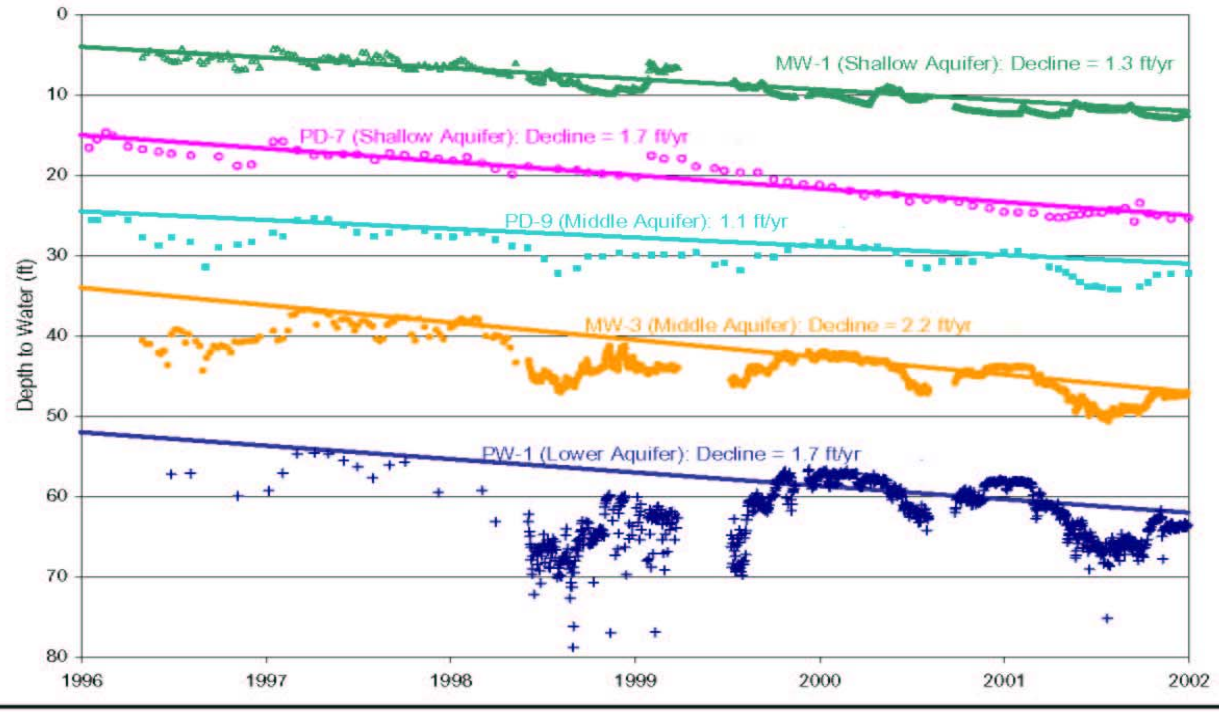

FIGURE 15
COMPARISON OF GROUNDWATER LEVEL TRENDS NEAR THE PORT WILLIAMS WELLFIELD FROM WELLS COMPLETED IN THREE MAJOR AQUIFERS

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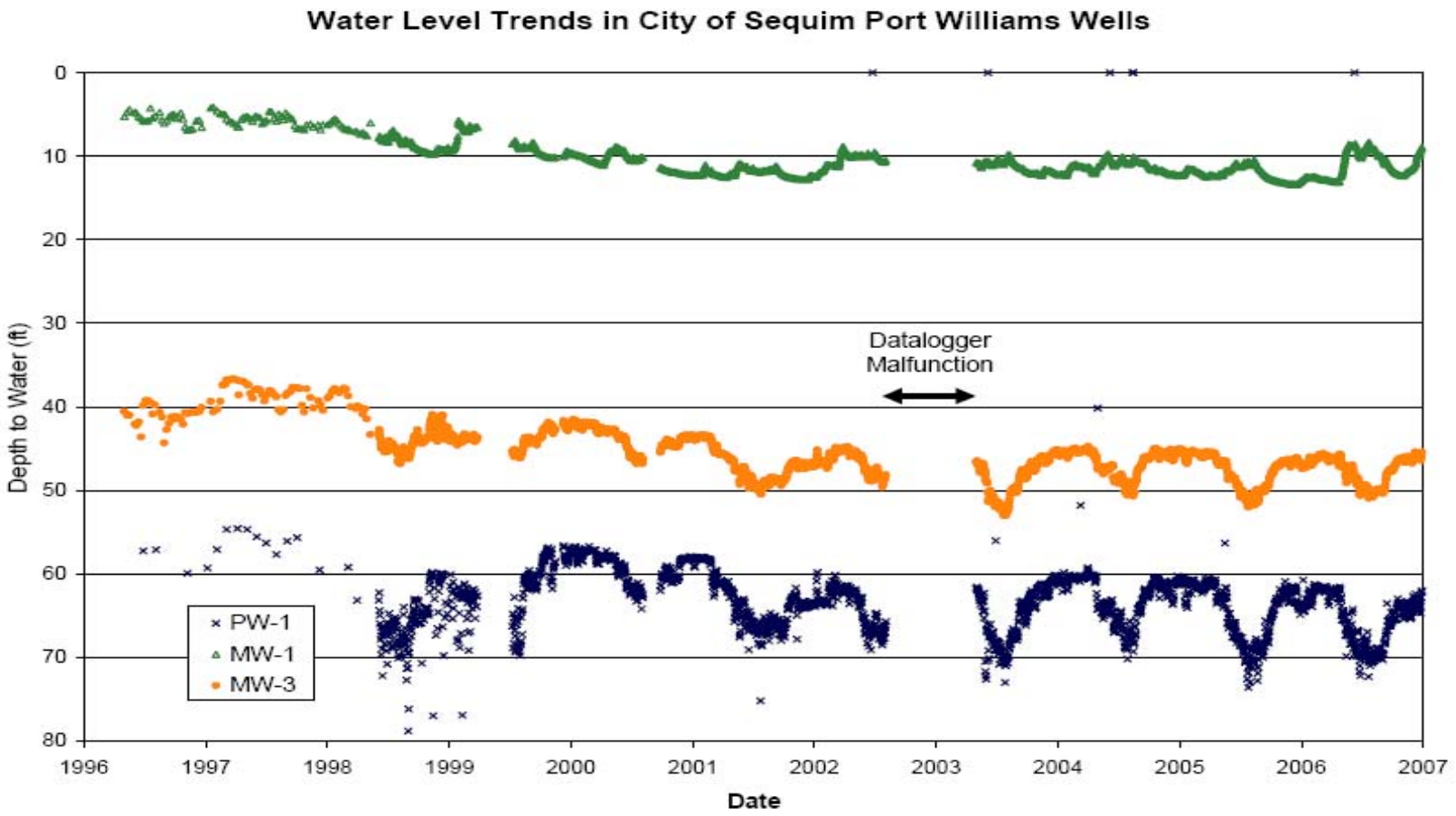
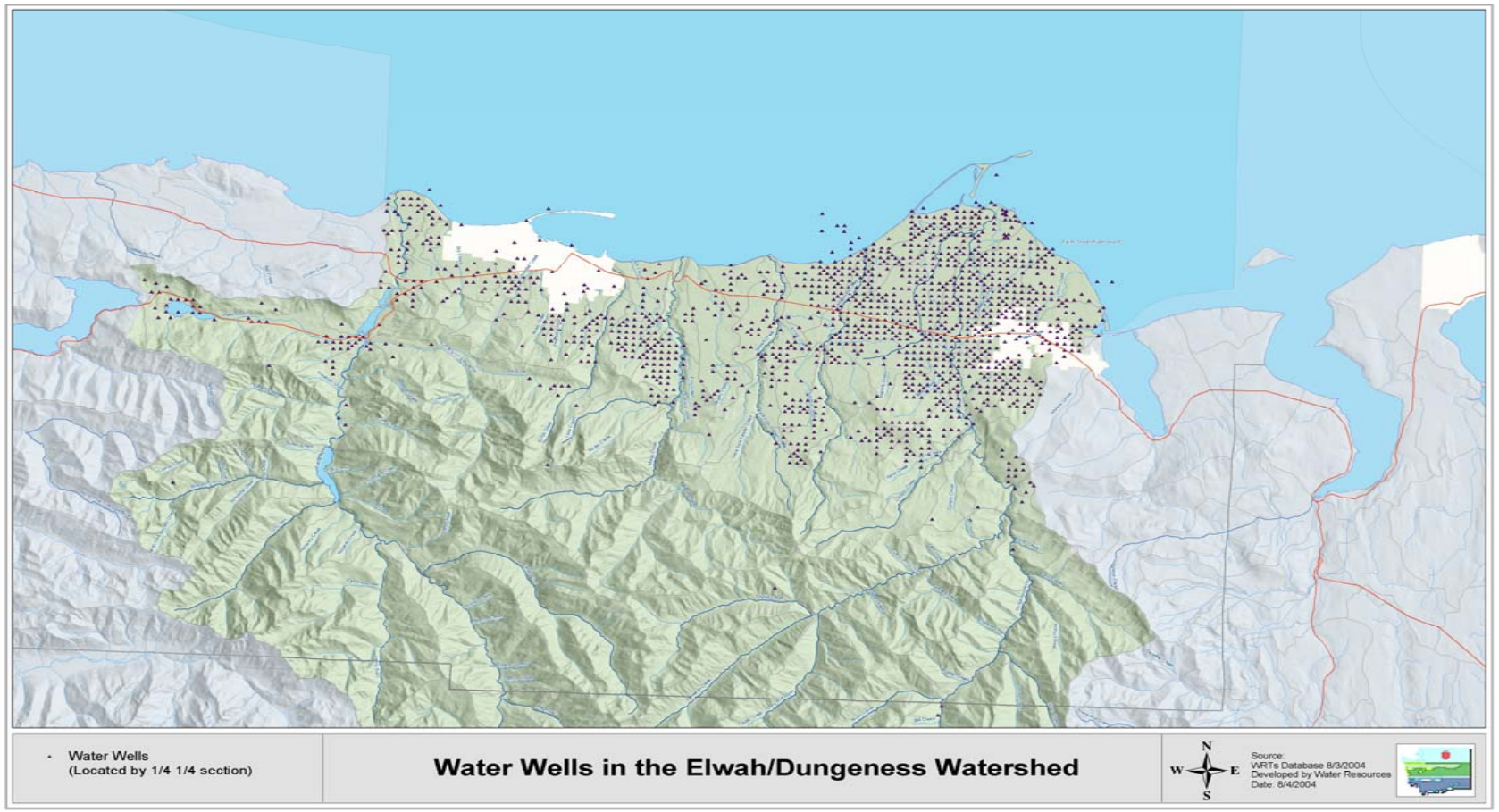
Hydraulic Connection Between Aquifers



Existing Water Wells



New Water Wells

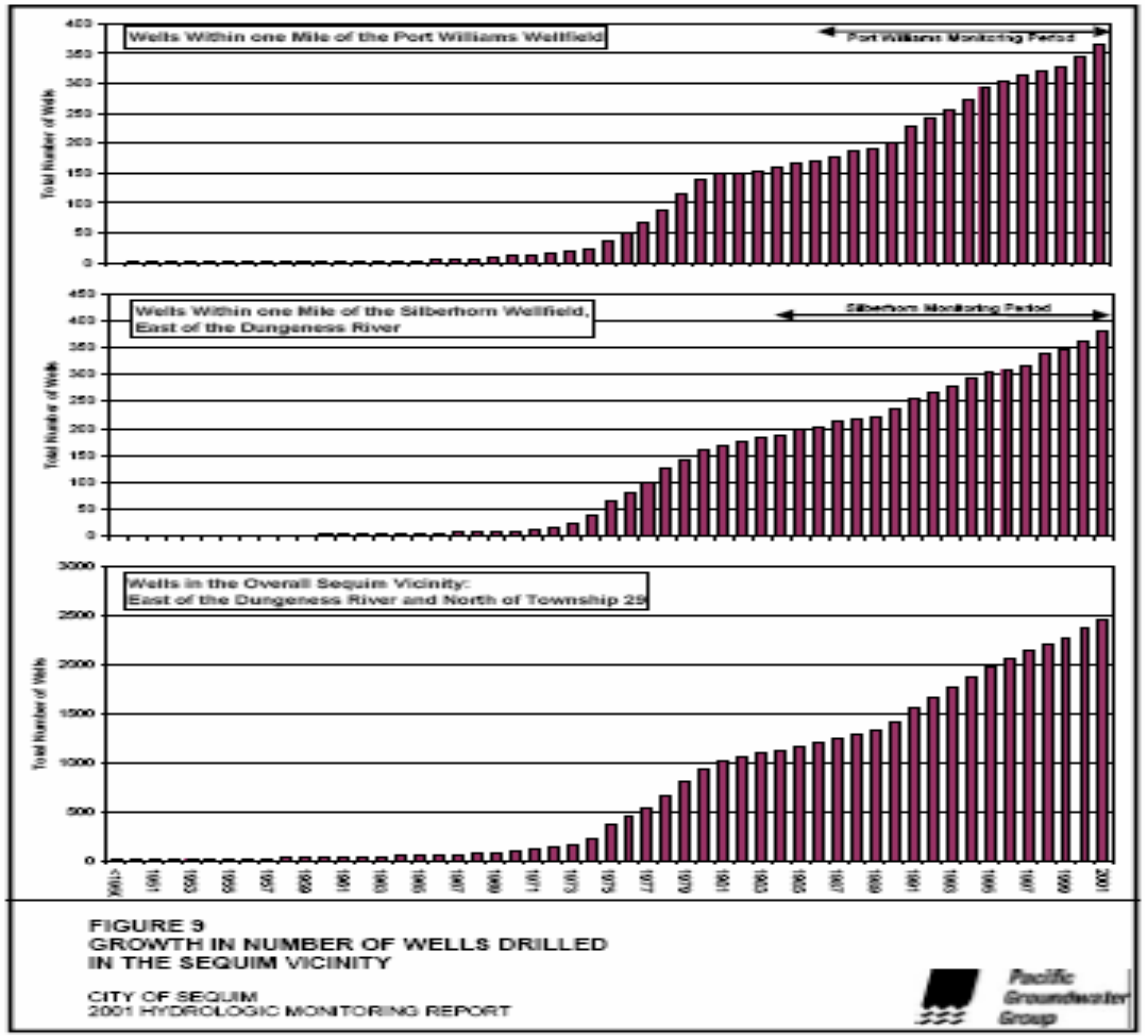


FIGURE 9
GROWTH IN NUMBER OF WELLS DRILLED
IN THE SEQUIM VICINITY

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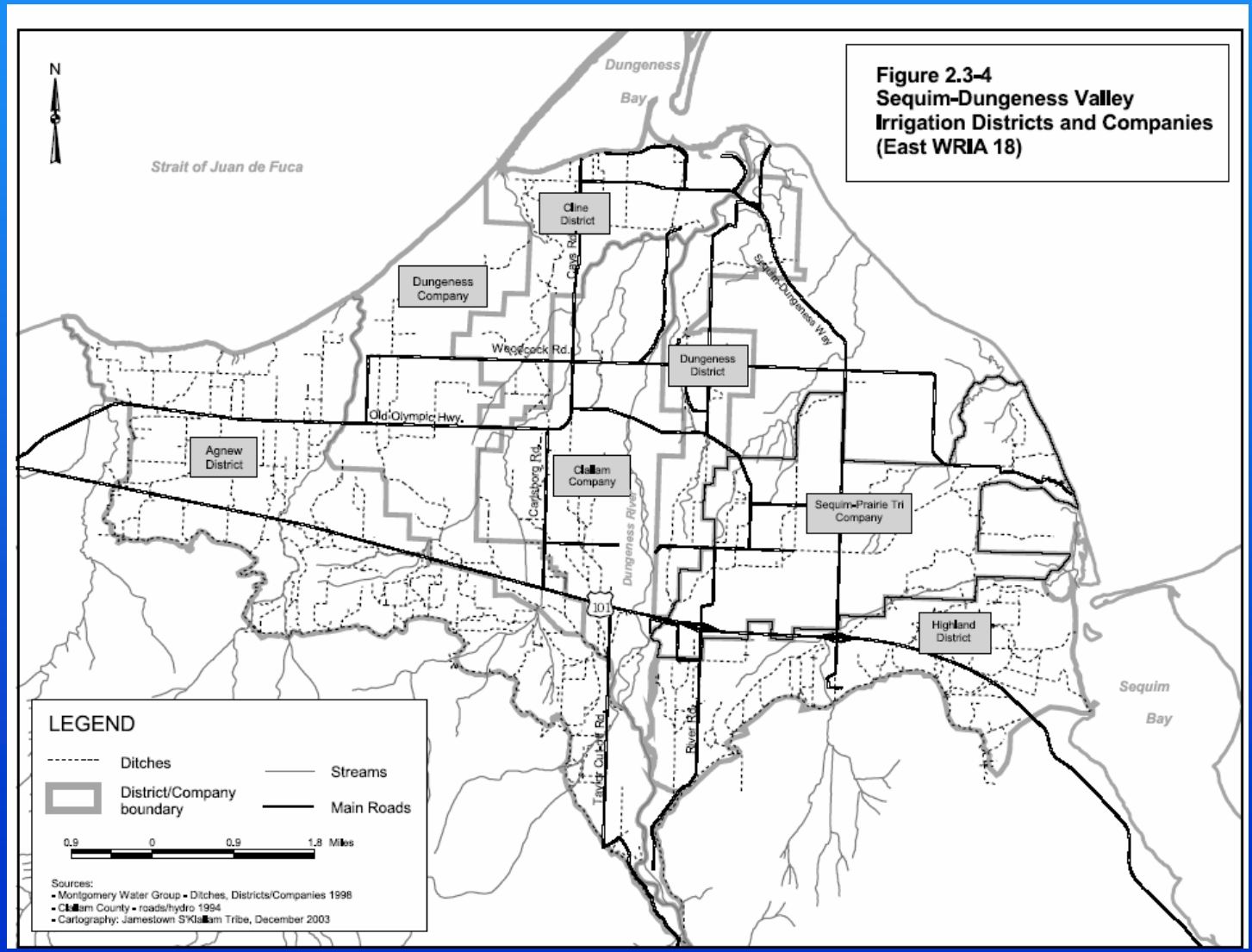
2001 HYDROLOGIC MONITORING REPORT

Pacific Groundwater Group

Dungeness Irrigation Districts and Companies Distribute Dungeness River Water across Watershed



Irrigation Withdrawals

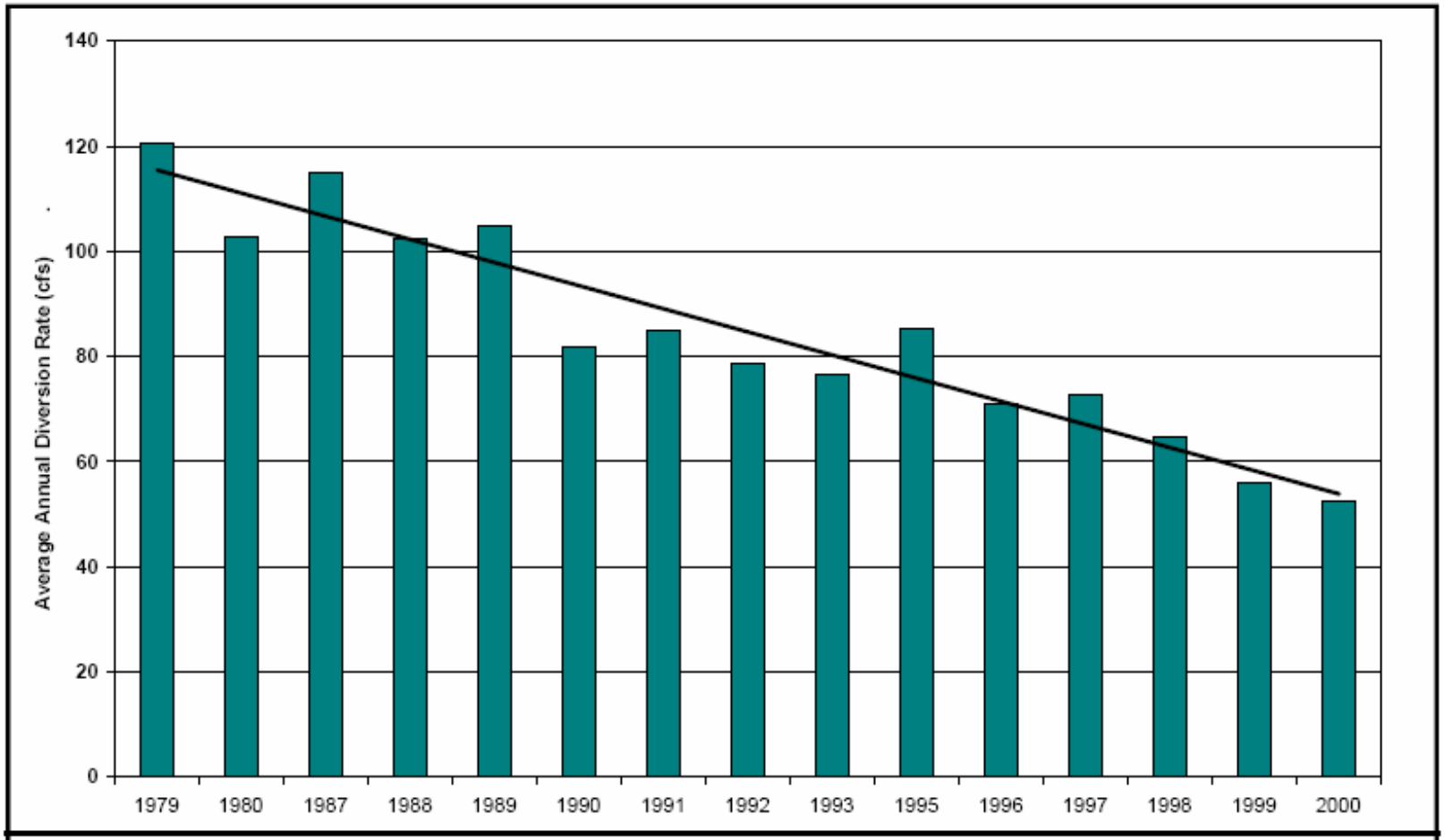


FIGURE 12
AVERAGE ANNUAL STREAMFLOW DIVERSIONS BY DUNGENESS IRRIGATORS
(Source: Mike Jeldness, Pers. Comm., 2002)

CITY OF SEQUIM
2001 HYDROLOGIC MONITORING REPORT

Pacific Groundwater Group

Irrigation Ditch Recharge

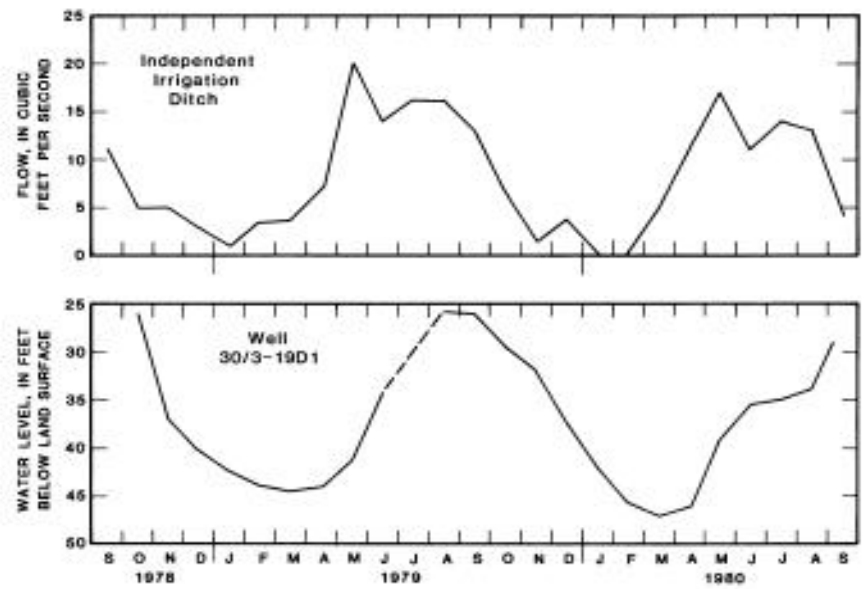
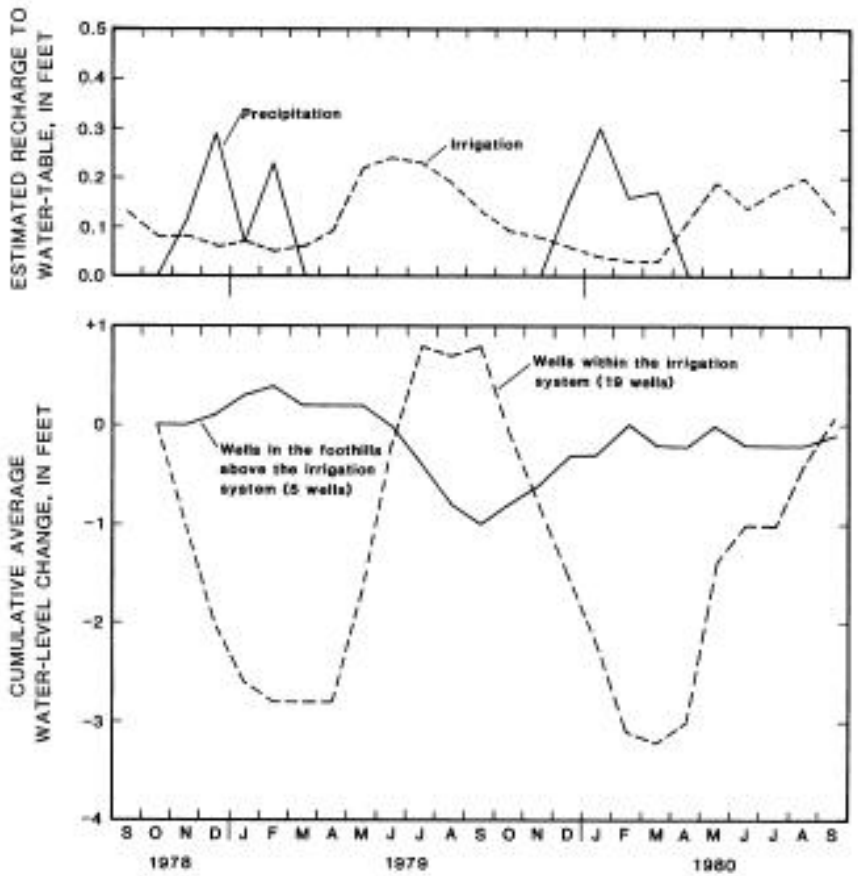
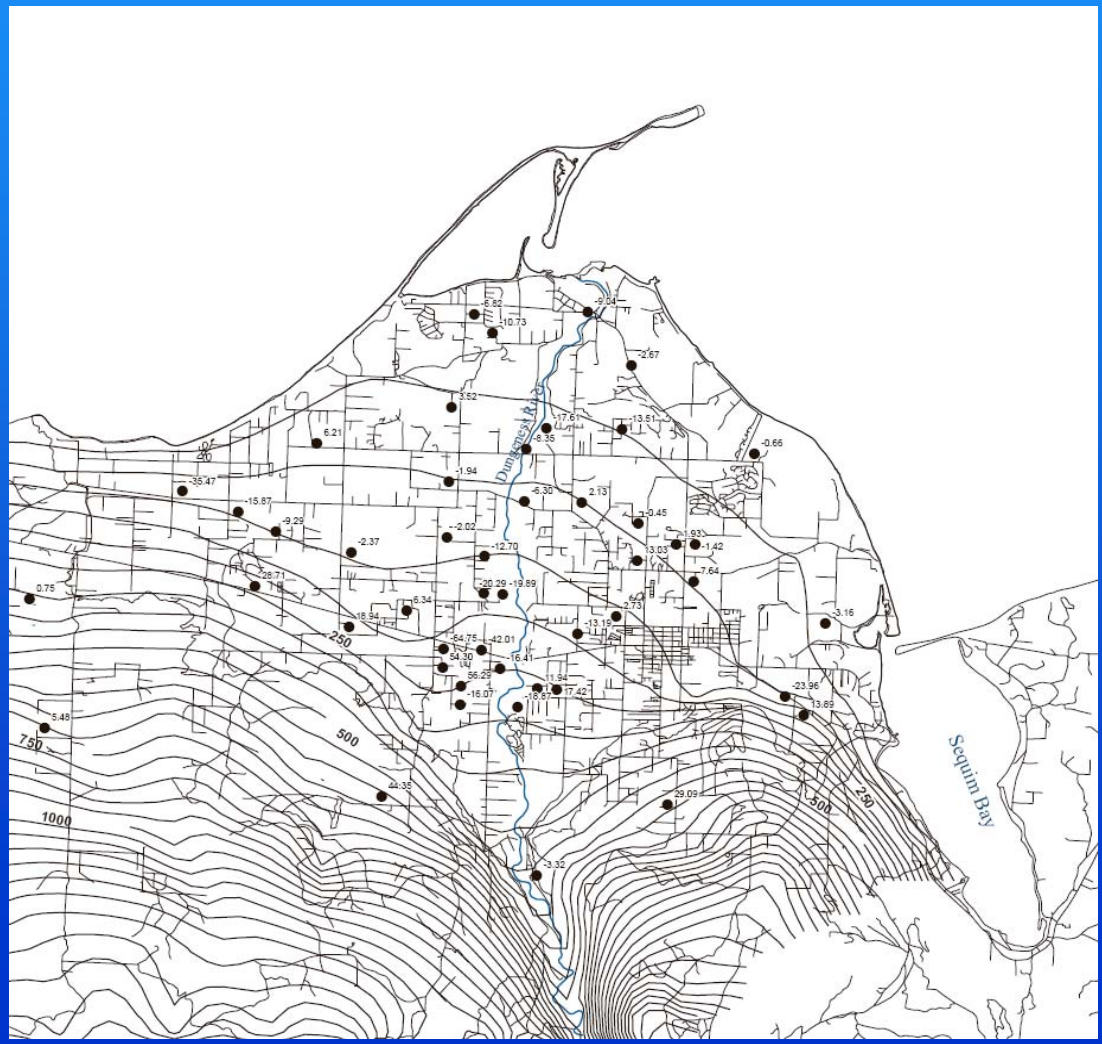


FIGURE 10.--Flow in the Independent Irrigation Ditch and water levels in well 30/3-19D1, September 1978-September 1980.

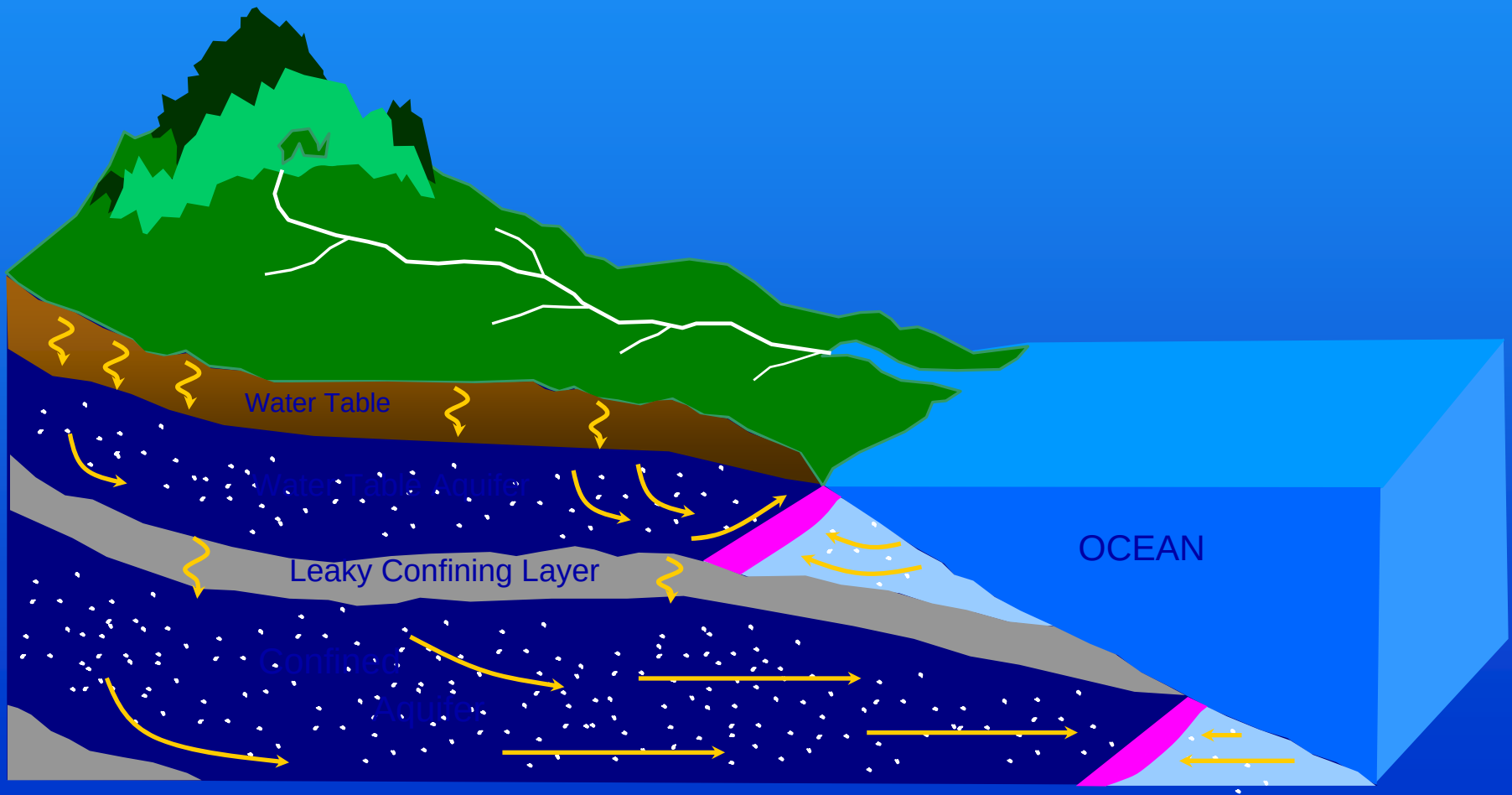
Irrigation Ditch Recharge



Ground Water Model

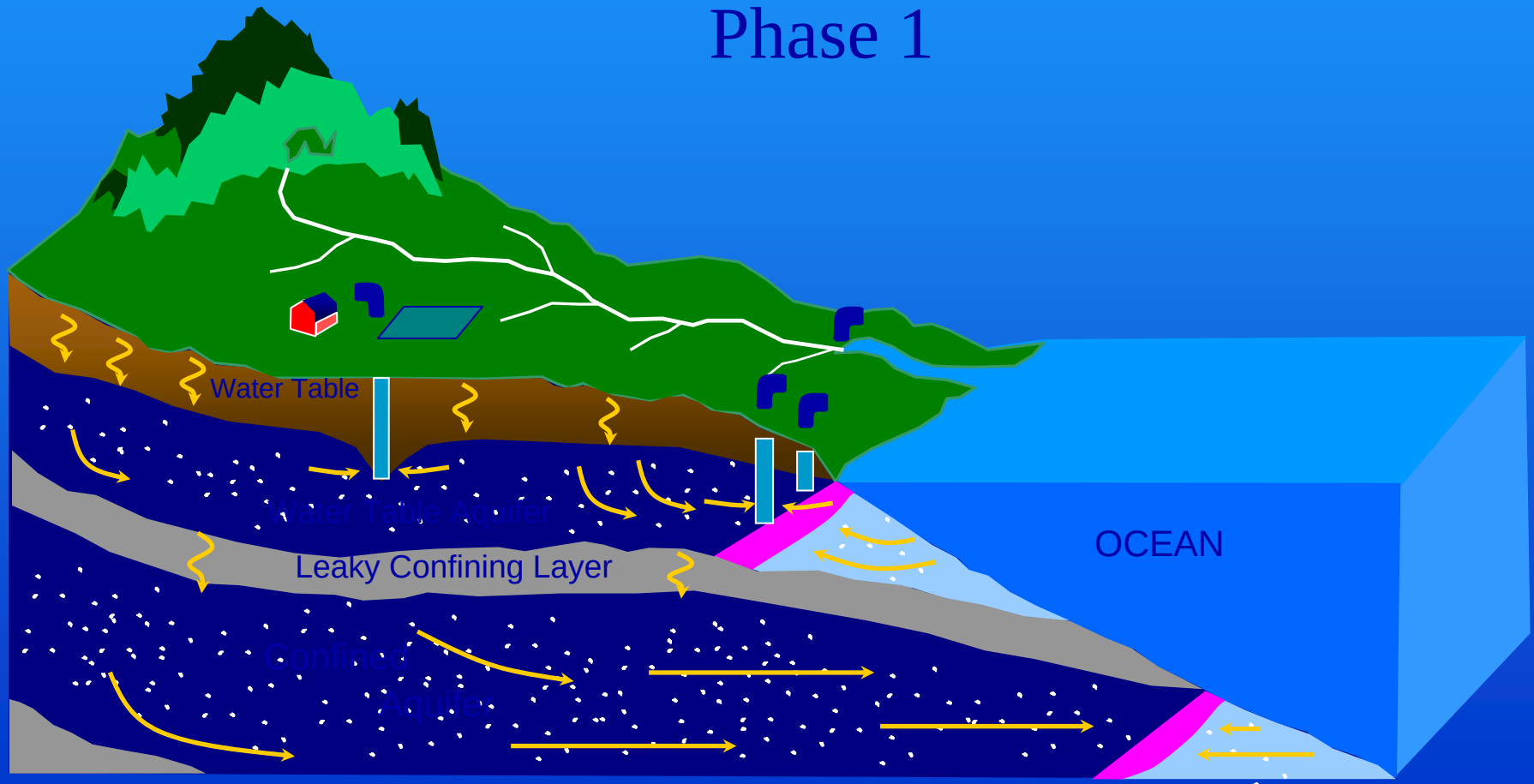


Natural System



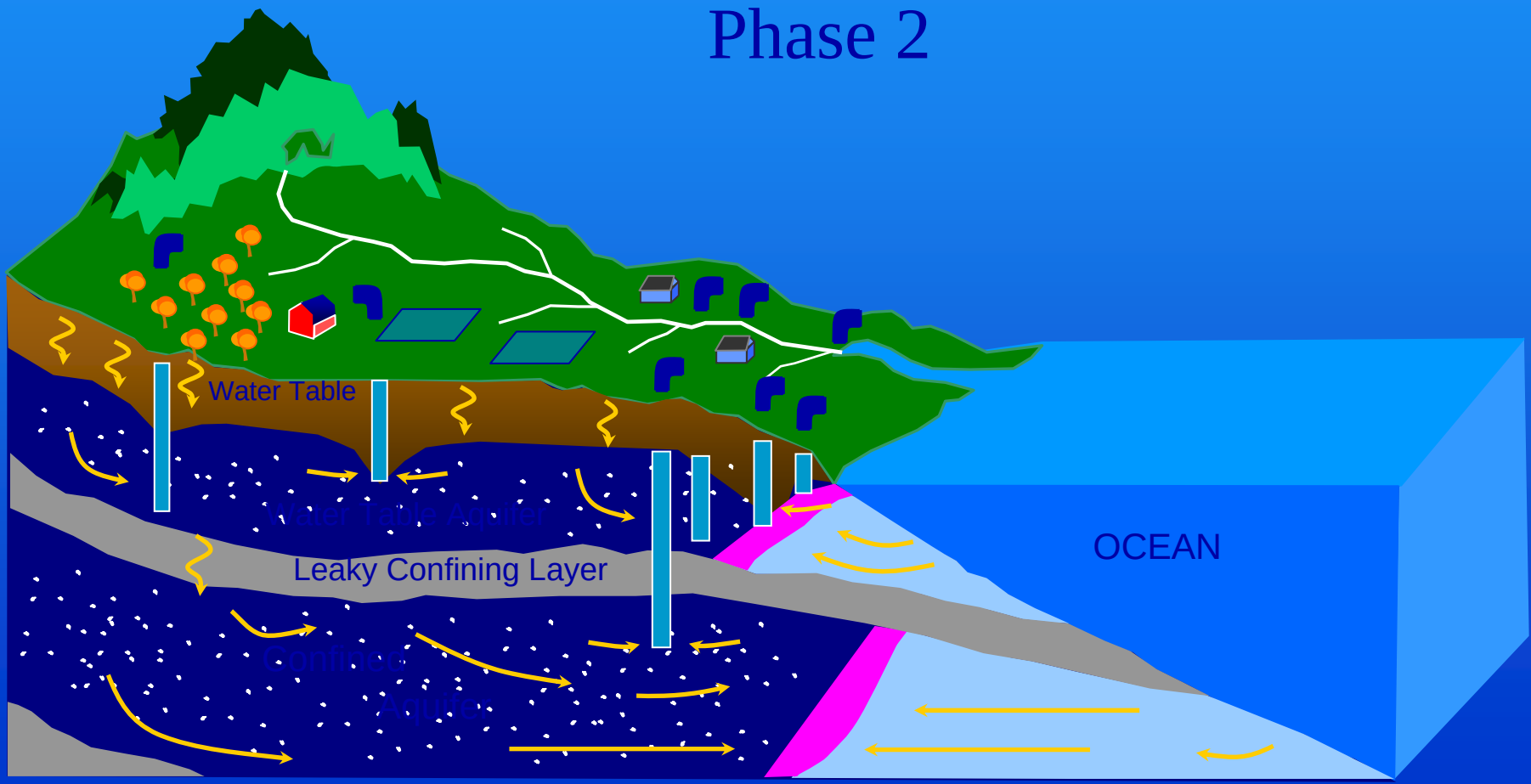
Seawater Intrusion

Phase 1



Seawater Intrusion

Phase 2



Seawater Intrusion

Phase 3