Groundwater Flow Model of the Southern Willamette Valley Groundwater Management Area

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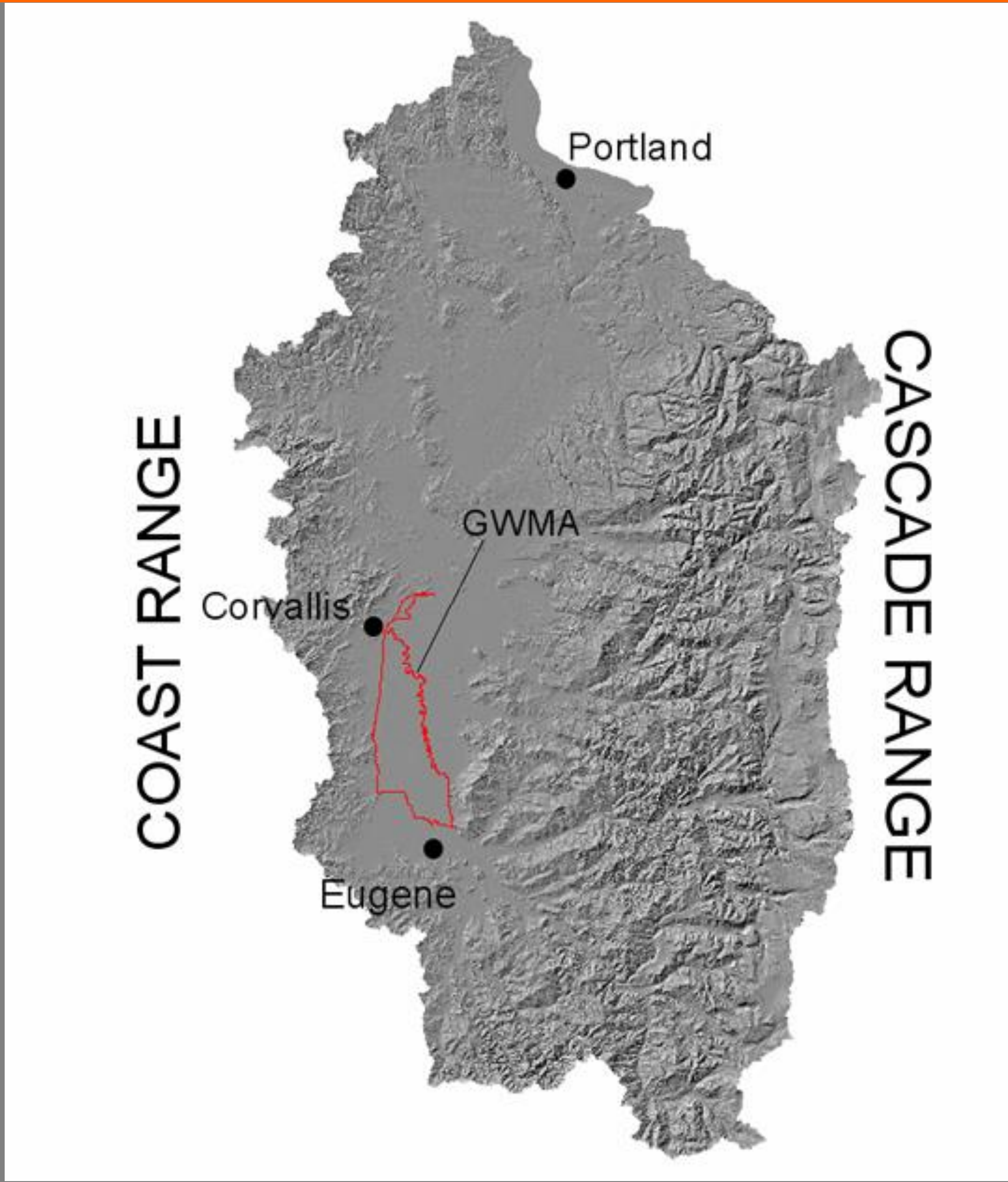
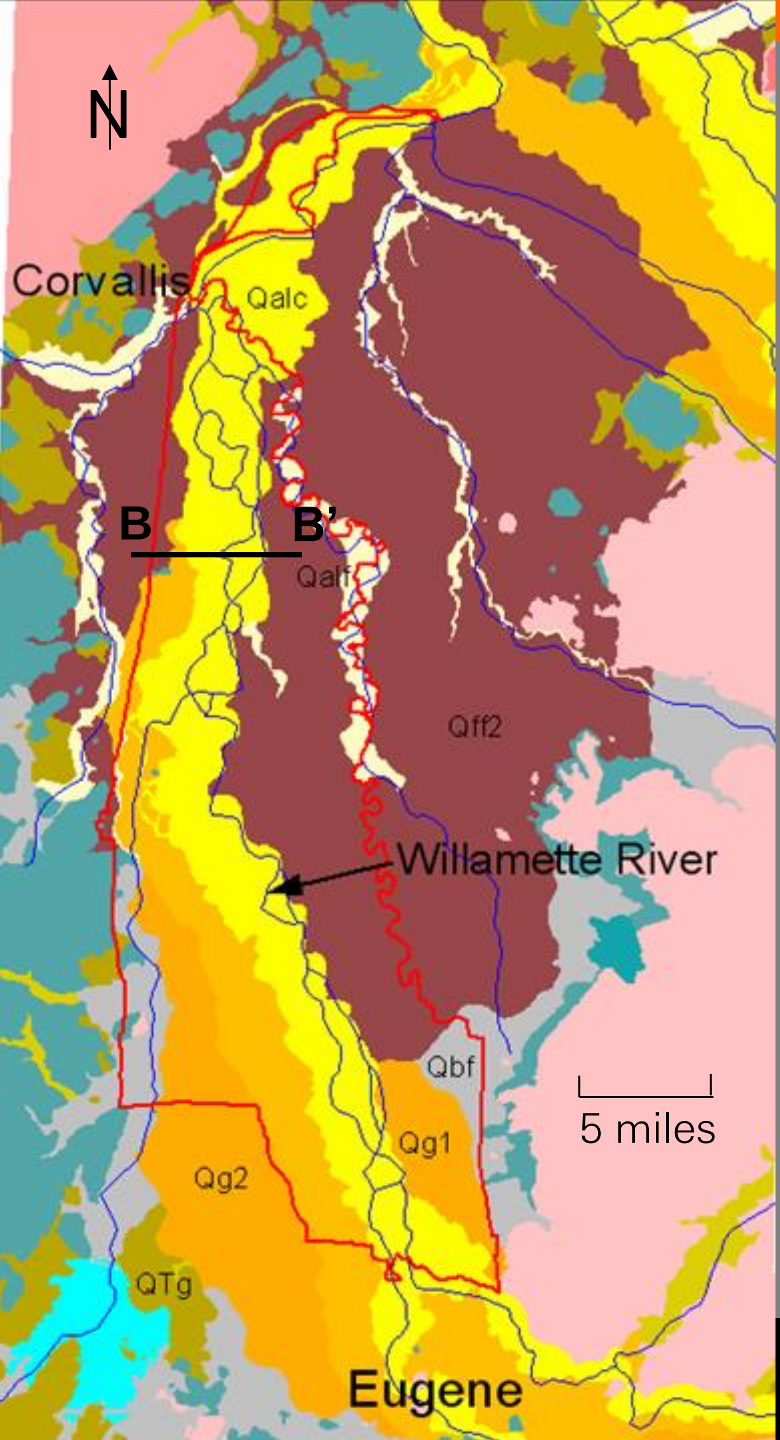
Overview

- Local Geology and Hydrogeology
- Development of conceptual model
  - Data collection and field work
- Model Design
  - Model development
  - Model calibration
  - Preliminary Results

Project Goal

To develop a three-dimensional groundwater flow model to be used as a tool by local policy makers, water quality educators, and scientists to help make management decisions.


Portland
COAST RANGE
CASCADE RANGE
GWMA
Corvallis
Eugene



Geologic and Hydrogeologic Units

Qalc = Upper Sedimentary Unit

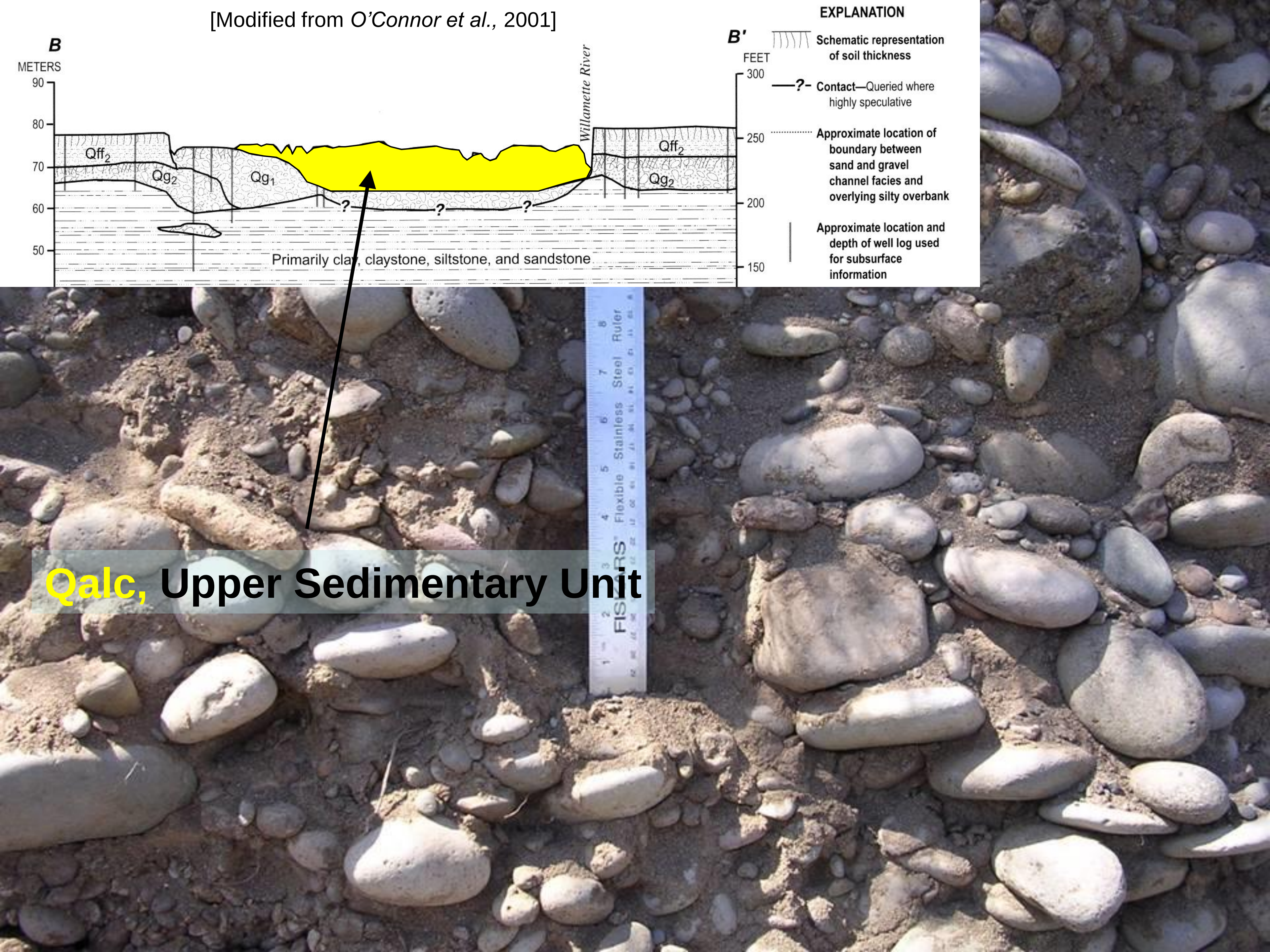
Qff2 / Qalf = Willamette Silt Unit

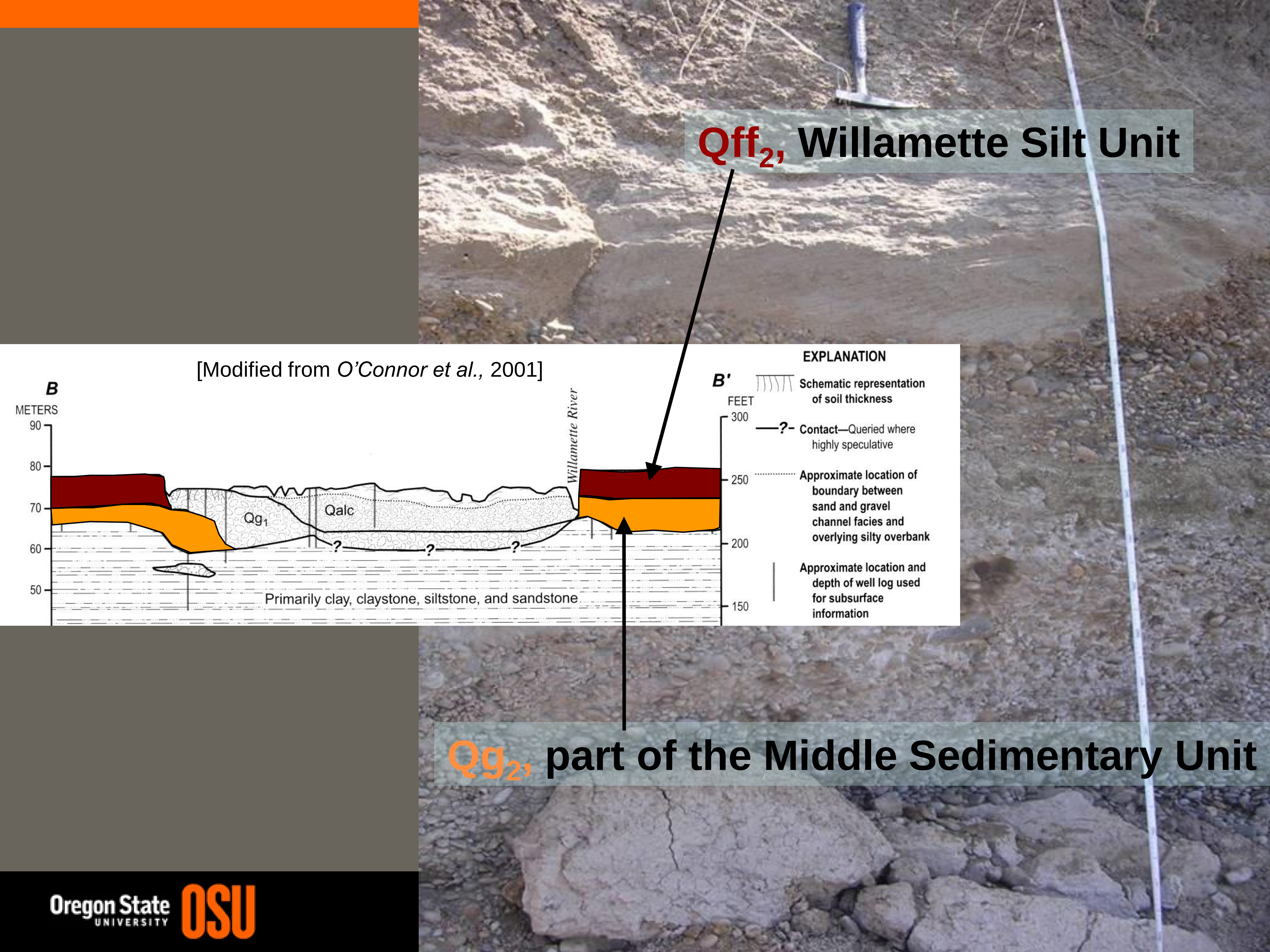
Qg1 / Qg2 = Middle Sedimentary Unit

Qbf = Lower Sedimentary Unit

*Bedrock units not included in model

[Modified from *O'Connor et al*., 2001]


[Modified from O'Connor et al., 2001]
B
B'
METERS
90
80
70
60
50
FEET
300
250
200
150
Willamette River
Qff2
Qg2
Qg1
Qff2
Qg2
Primarily clay, claystone, siltstone, and sandstone
EXPLANATION
Schematic representation of soil thickness
Contact—Queried where highly speculative
Approximate location of boundary between sand and gravel channel facies and overlying silty overbank
Approximate location and depth of well log used for subsurface information
Qalc, Upper Sedimentary Unit
FISKARS Flexible Stainless Steel Ruler



Qff2, Willamette Silt Unit
Qg2, part of the Middle Sedimentary Unit
[Modified from O'Connor et al., 2001]
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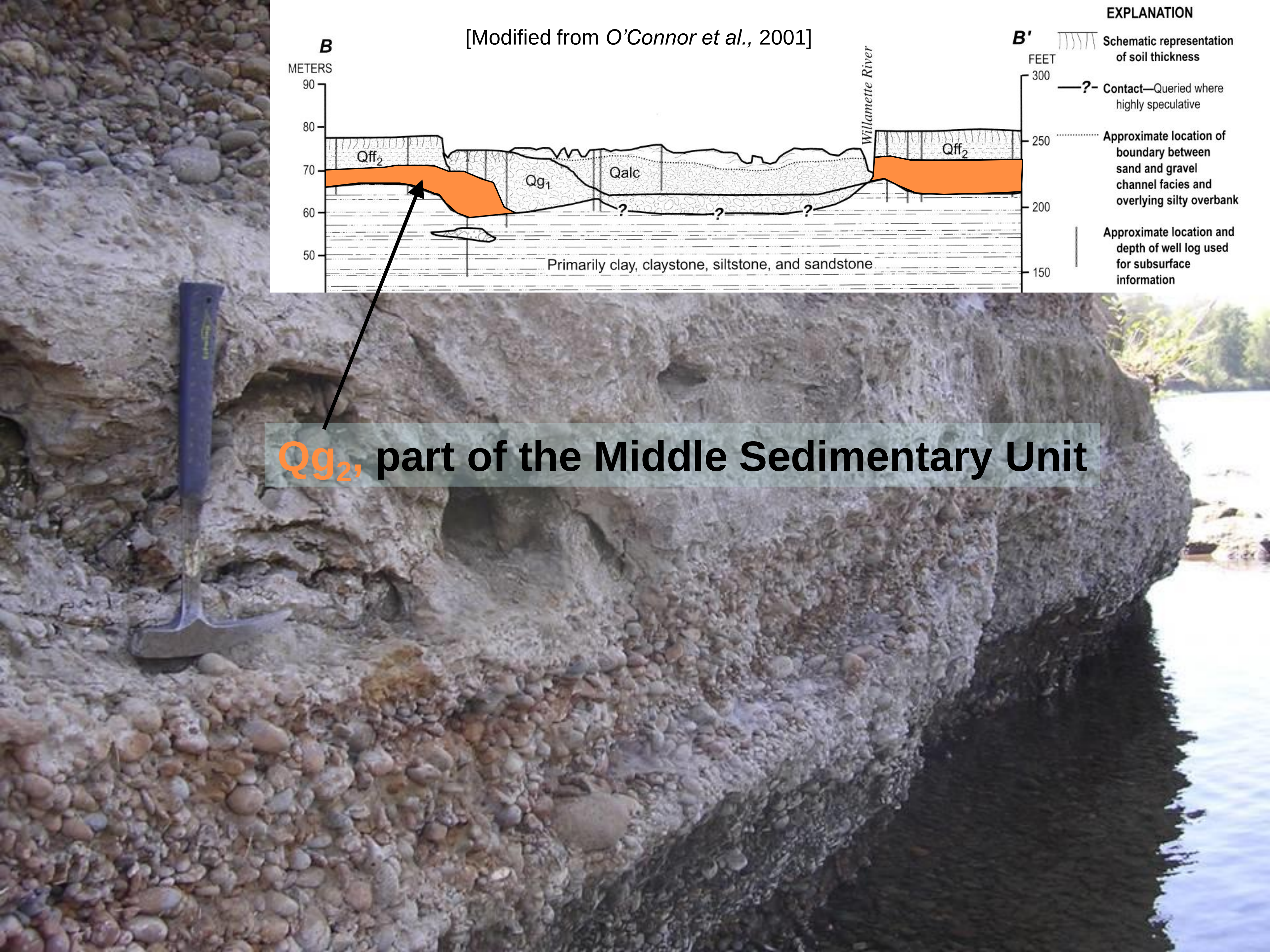

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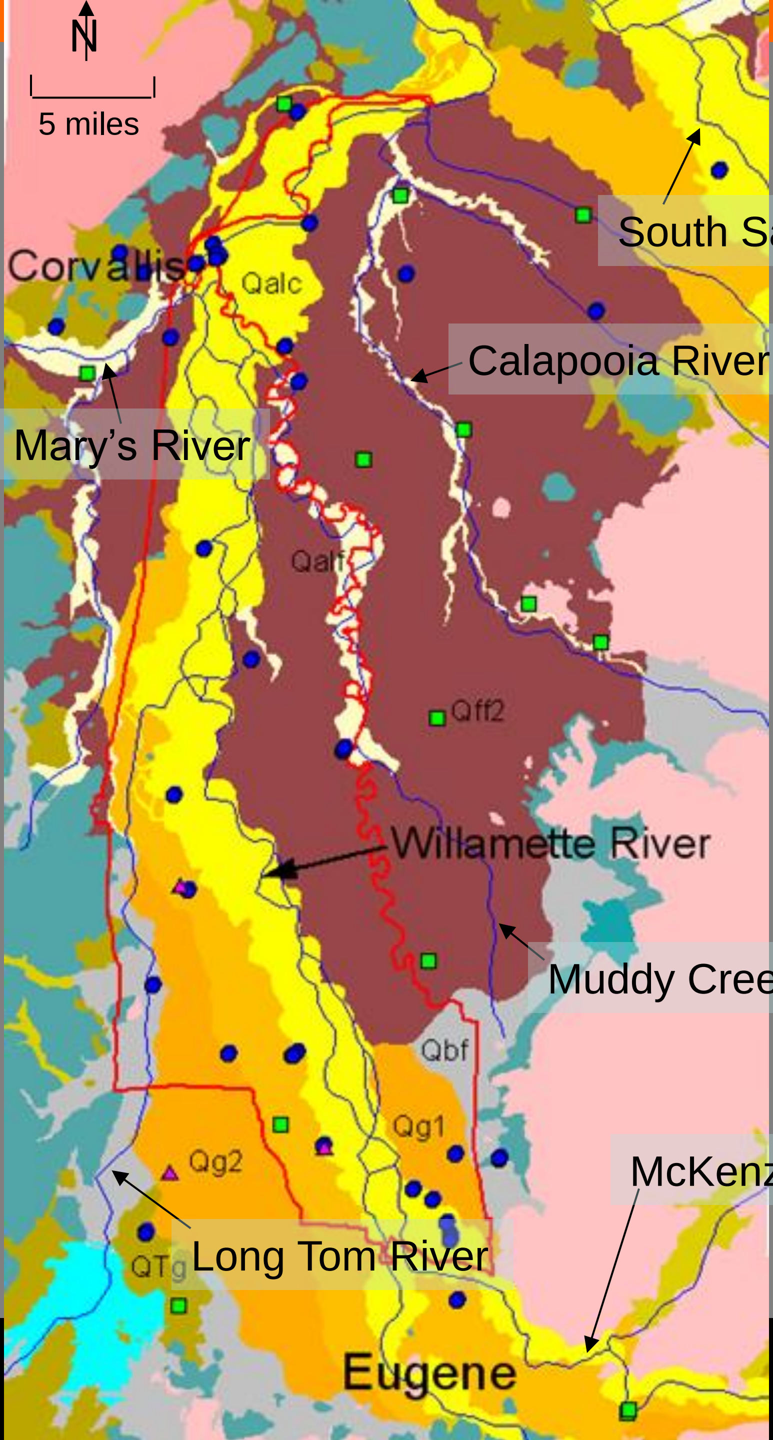


Field Work

- Water level measurements
  - 6 sets of quarterly measurements from network of 42 wells, 14 from Oregon Water Resources Department, 1 from Eugene Water and Electric Board
  - Long-term water level data from 3 locations

[Modified from *O'Connor et al.,* 2001]

Field Work

Aquifer Tests

- Pump Tests (N = 3)

  - ranges of K from 1.0 x 10^2 - 1.7 x 10^3 ft/day;

  3.5 x 10^{-4} - 6.0 x 10^{-3} m/s

  - Neuman curve-fitting method

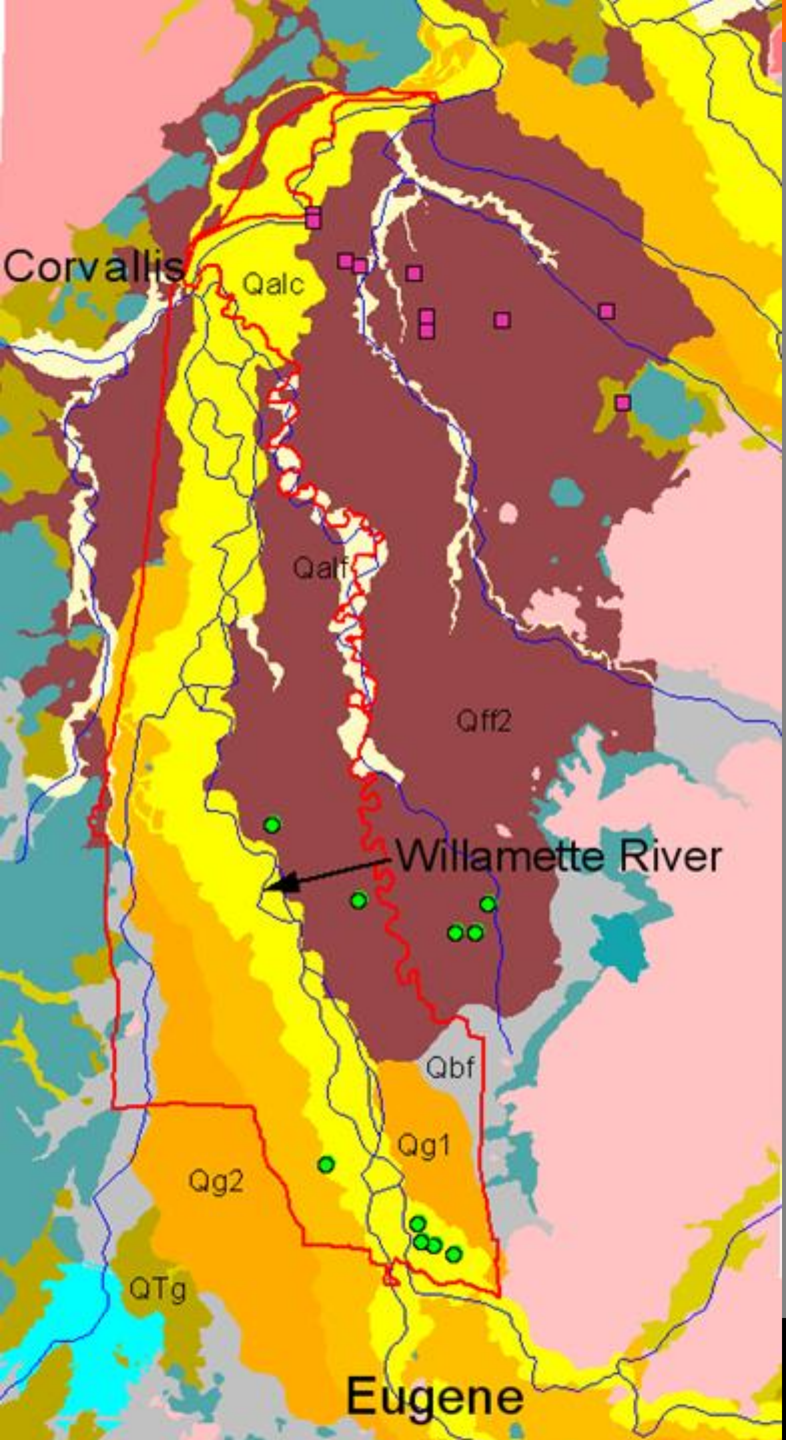
- Slug Tests (N = 17)

  - ranges of K from 4.0 x 10^{-2} - 4.3 x 10^2 ft/day;

  1.4 x 10^{-7} - 1.5 x 10^{-3} m/s

  - Bouwer-Rice's method

Construction of cross-sections and stratigraphic columns

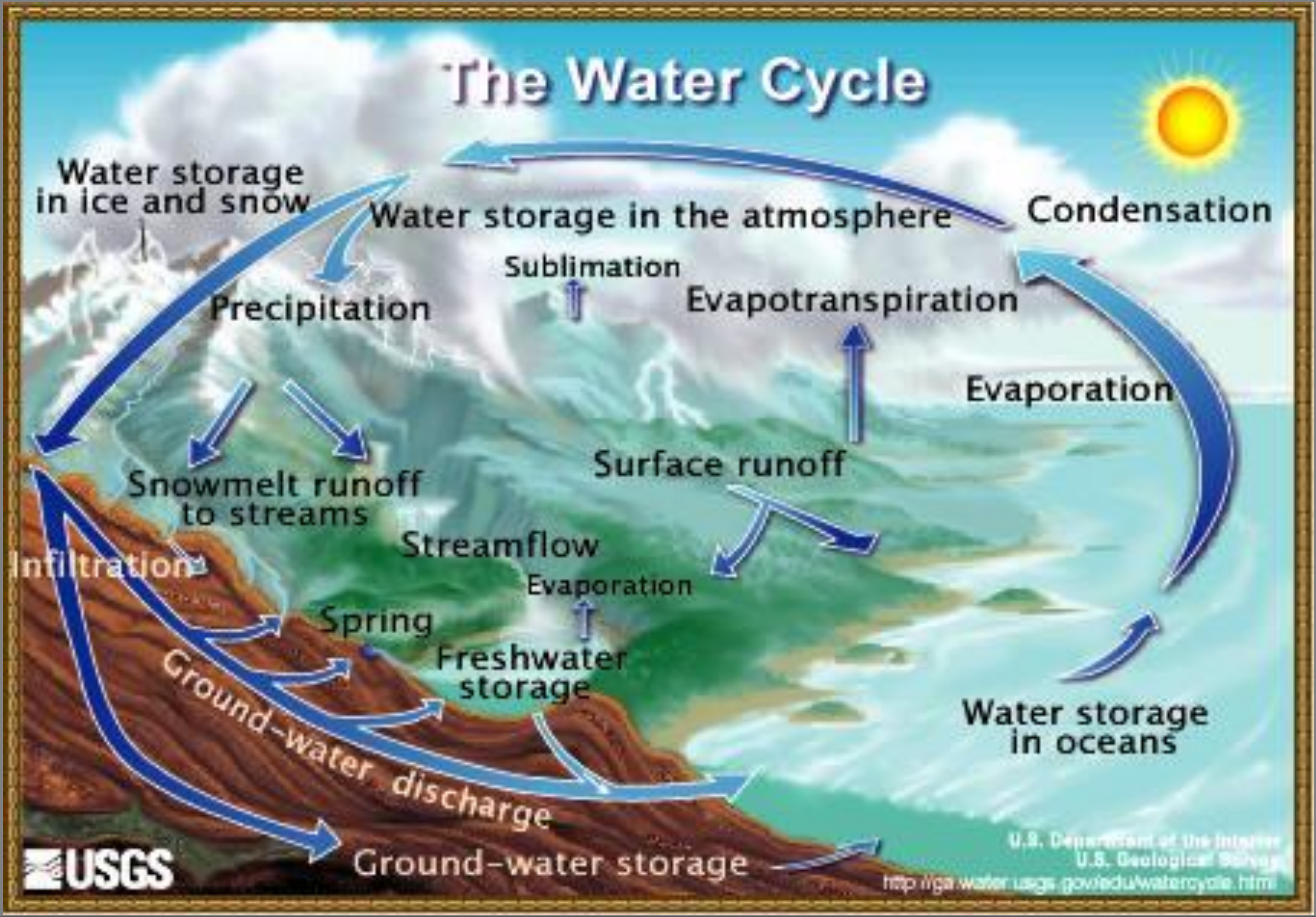


Field Work

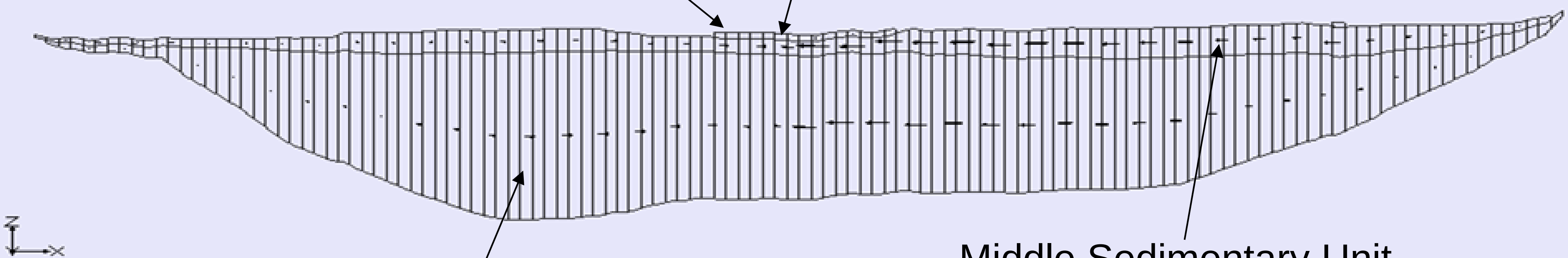
- Groundwater age and chemistry sampling
- Results indicate ages from 13 to >57 years [*Conlon et al.*, 2005 and this study]
- Groundwater sampled where Qff2 exists greater in age than groundwater sampled where no Qff2 exists

[Modified from *O'Connor et al.,* 2001]

MODFLOW w/GMS Model

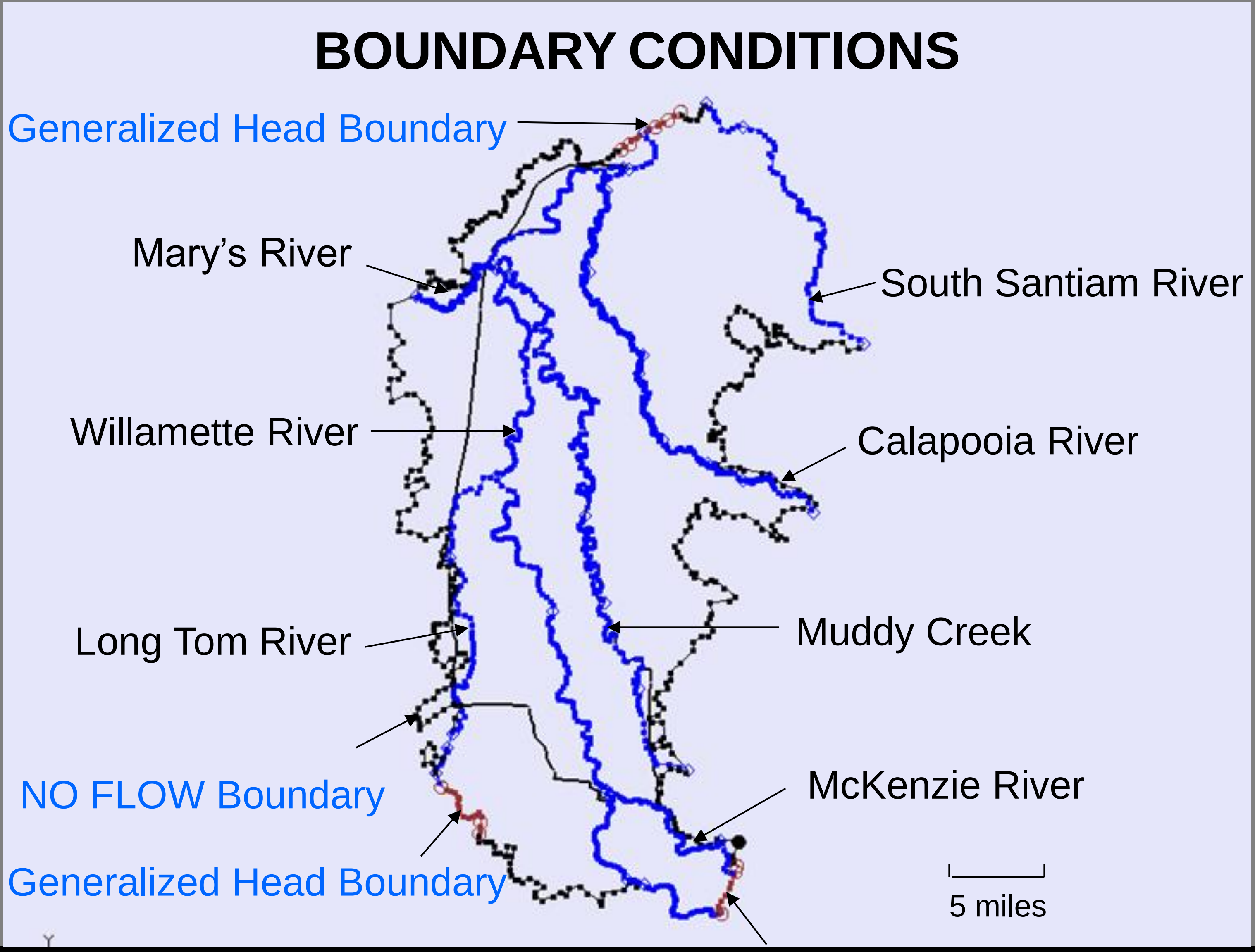


MODFLOW w/GMS Model



x30 vertical exaggeration

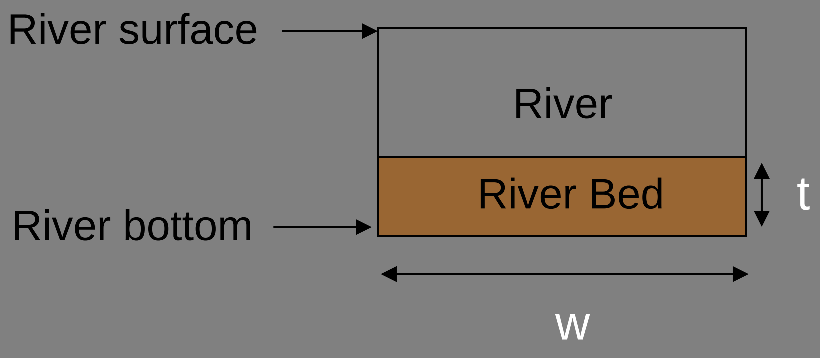
MODFLOW w/GMS Model



MODFLOW w/GMS Model

- Model input

  - River stage, discharge, and conductance



  - Recharge

  - Potential evapotranspiration

MODFLOW w/GMS Model

- Steady-state model developed

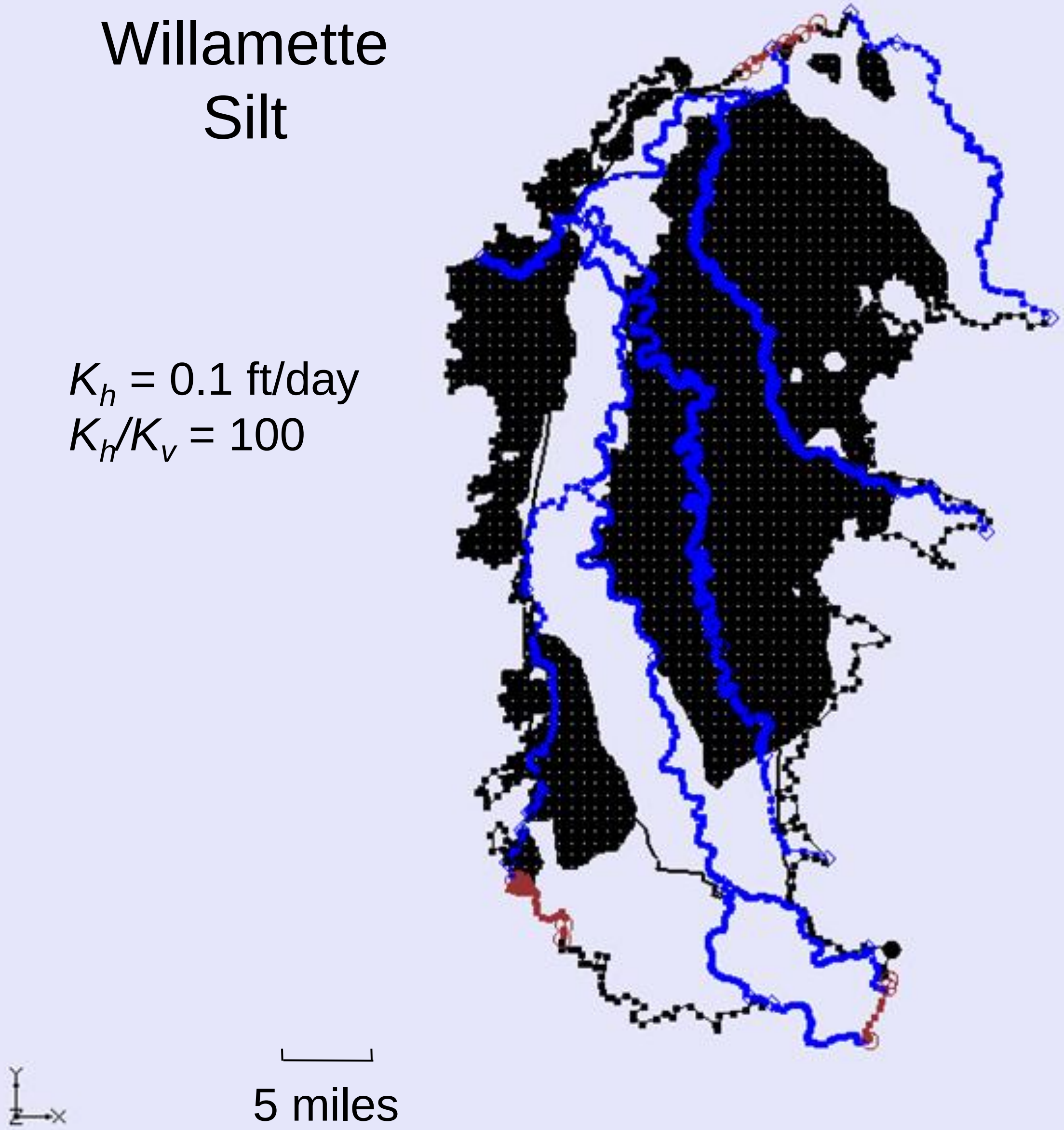
- Used **"average"**
  - water level
  - river stage and flow
  - potential evapotranspiration (45 in/year)
  - precipitation (28 in/year)

  data from June 2004 – July 2005

- Used **hydraulic conductivity** estimates from local pump/slug tests and specific capacity data to simulate spatial heterogeneity

Willamette Silt

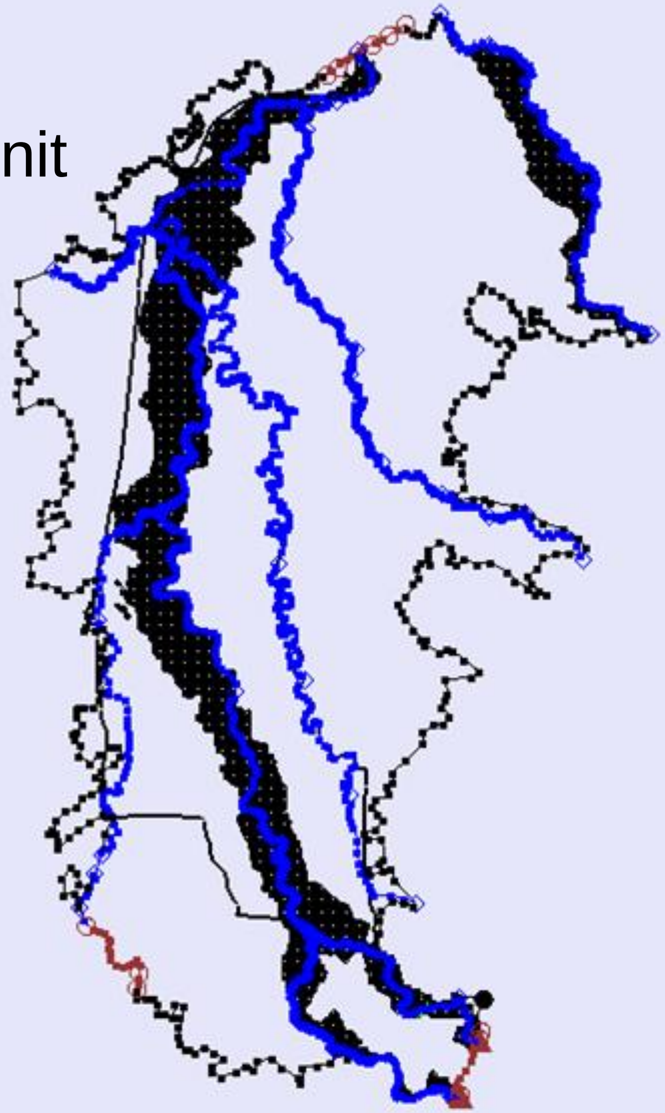
K_h = 0.1 ft/day
K_h/K_v = 100



Upper Sedimentary Unit

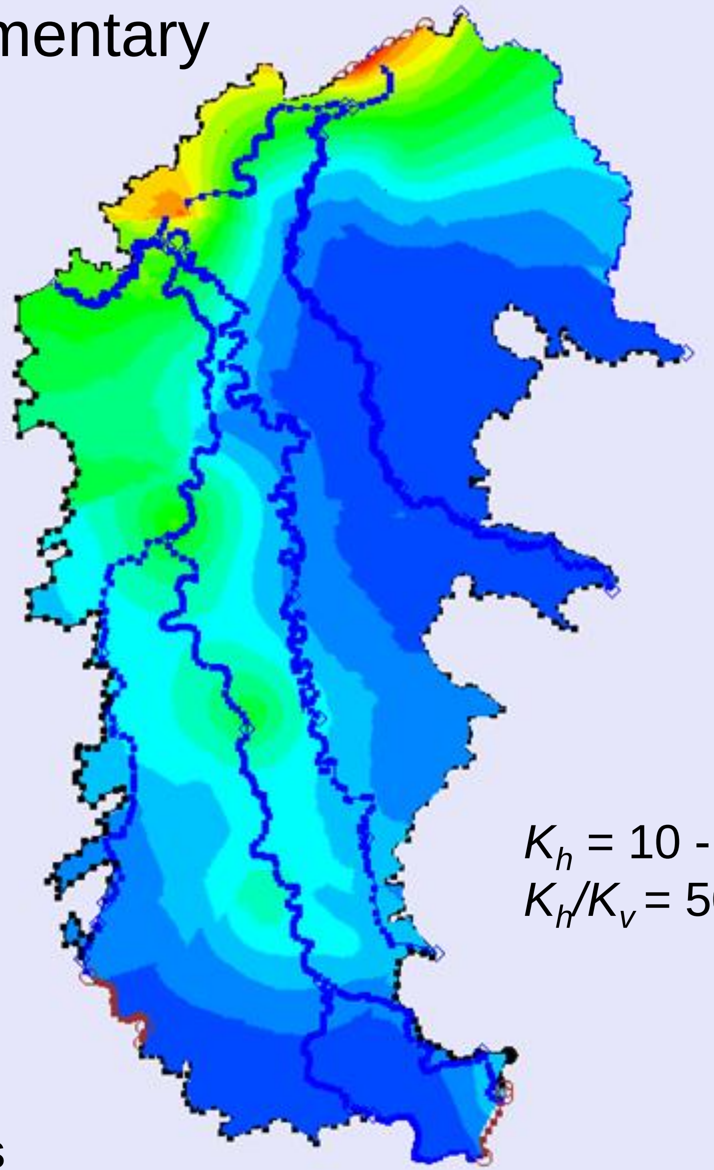
K_h = 550 ft/day

K_h/K_v= 50



5 miles

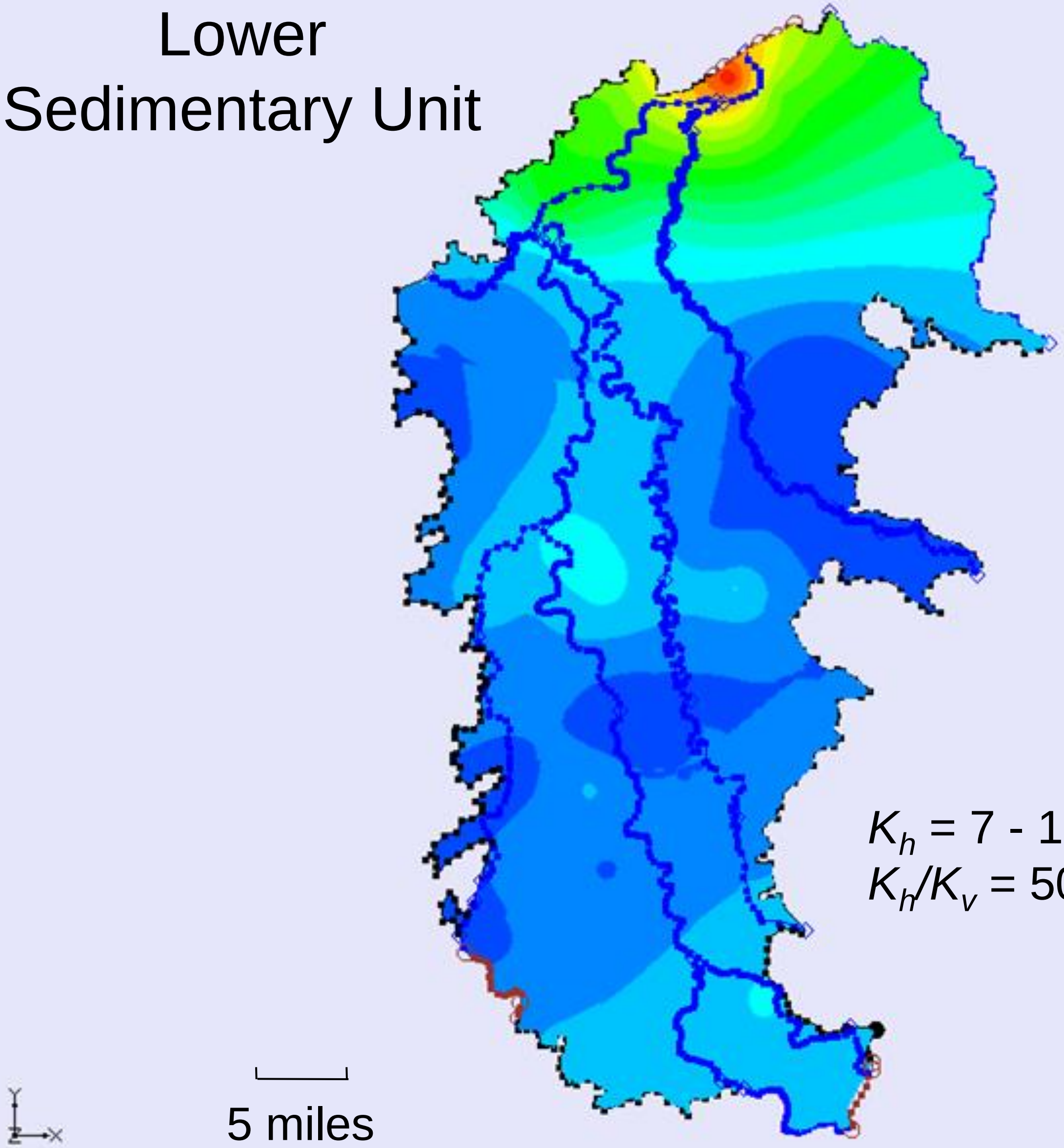
Middle Sedimentary Unit



K_h = 10 - 500 ft/day (x12)
K_h/K_v = 50

5 miles

Lower Sedimentary Unit



K_h = 7 - 105 ft/day (x12)
K_h/K_v = 50

MODFLOW w/GMS Model

- Model Calibration

  - Gain and loss of river stream reaches

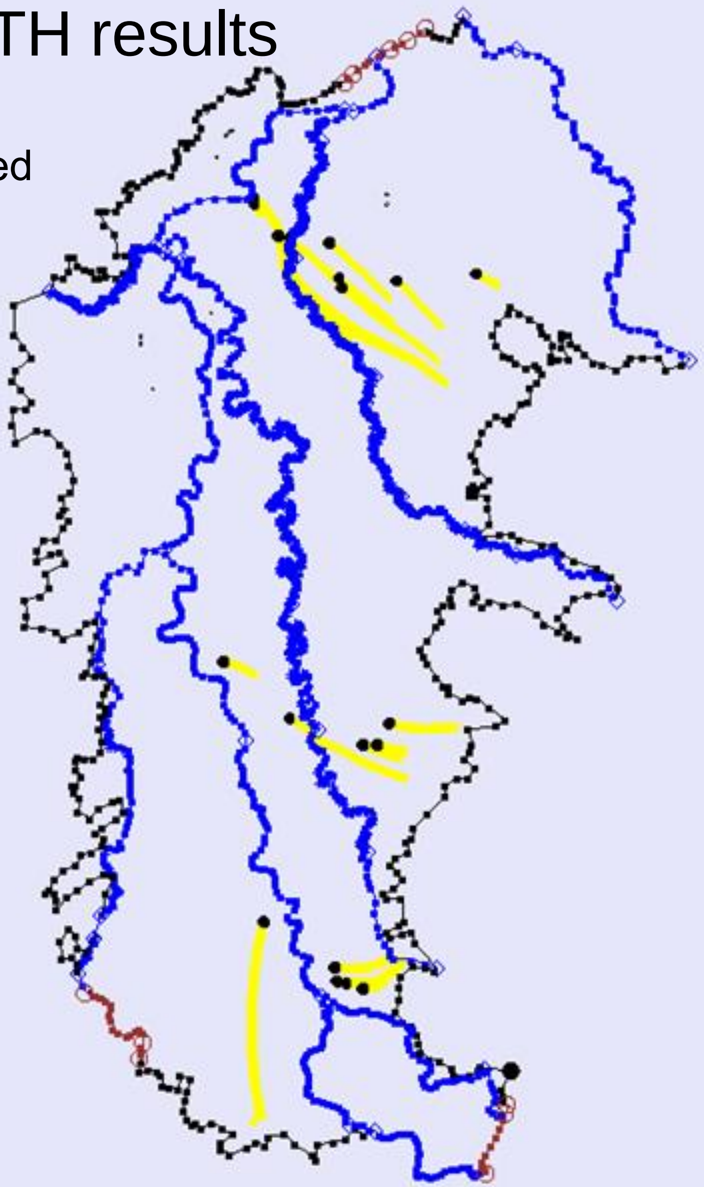
  - Total Flow in vs. Total Flow out (~0.05% discrepancy)

  Compared **<u>simulated</u>** vs. **<u>observed</u>**:

  - ❑ Water levels in well network
  - ❑ Groundwater ages using MODPATH

Initial MODPATH results

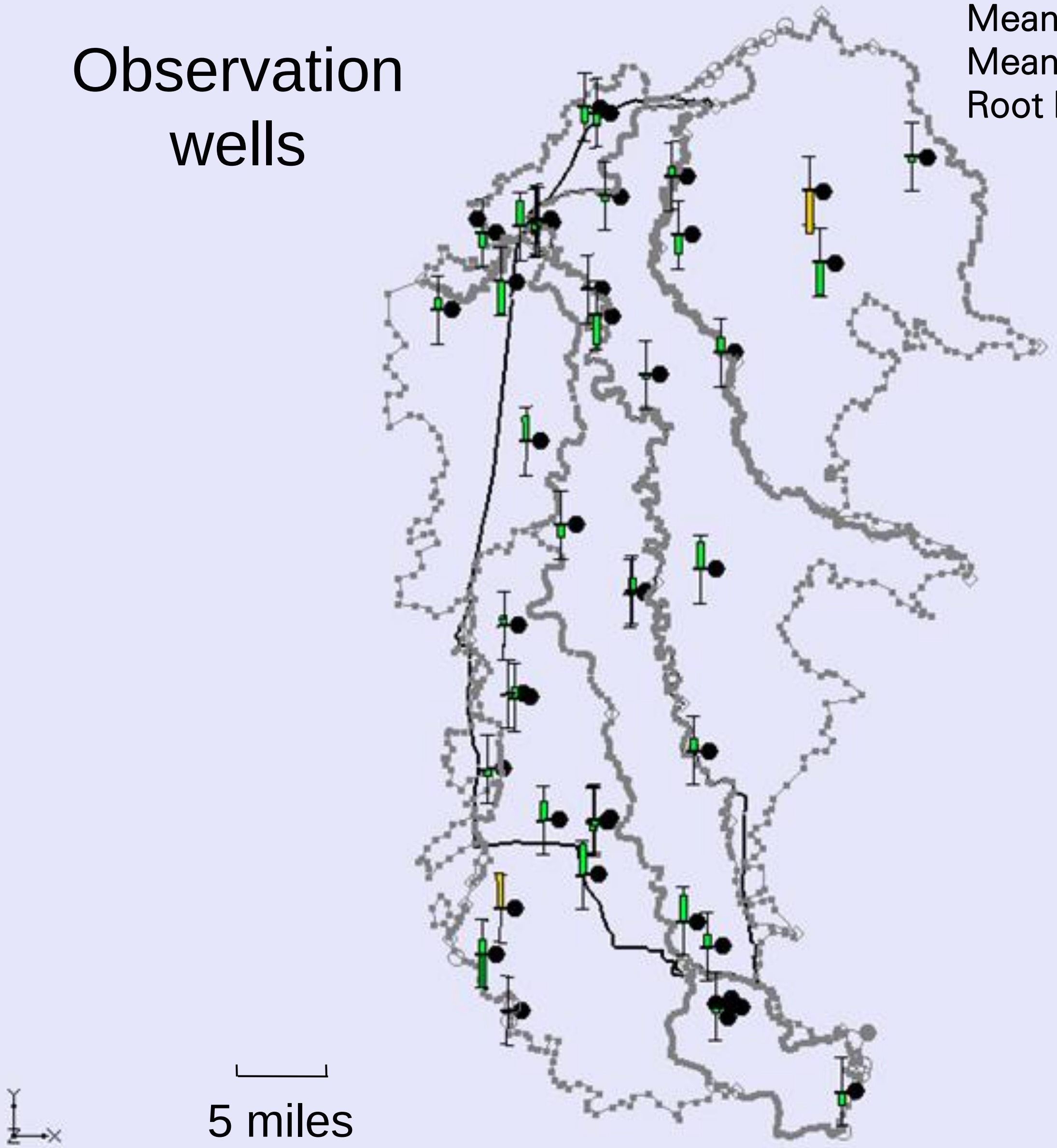
- Modeled ≈ Measured



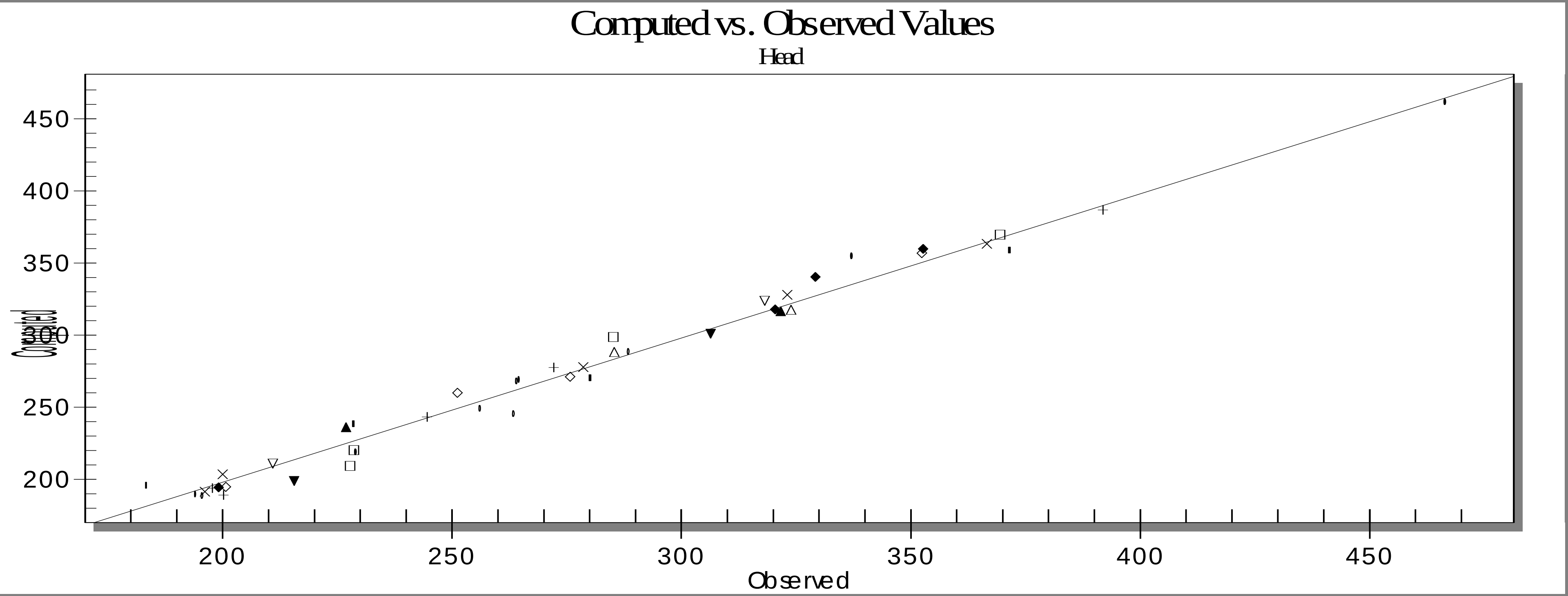
5 miles

Observation wells

Mean Error: 0.02 ft
Mean Abs. Error: 6.9 ft
Root Mean Sq. Error: 8.4 ft

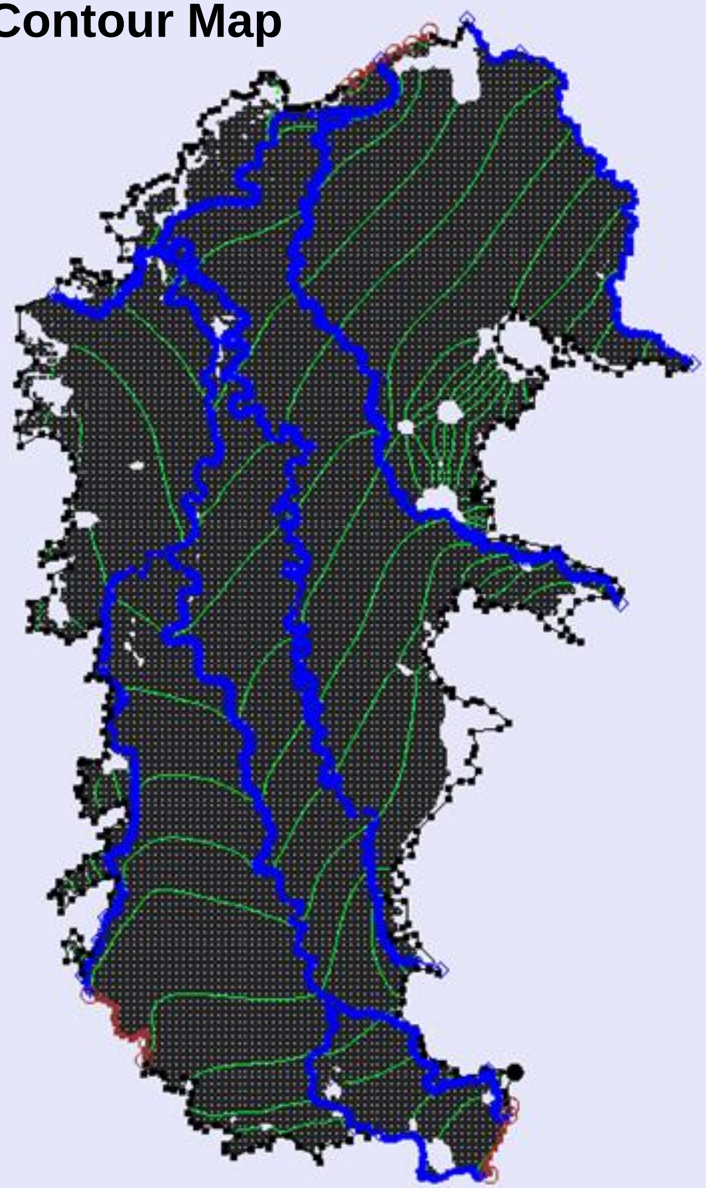


MODFLOW w/GMS Model



Simulated Head Contour Map

20 ft. contours



5 miles

Preliminary Results/Conclusions 1/2

- MODFLOW-MODPATH along with groundwater age and chemistry data useful in determining fate of nitrate (Willamette Silt vs. no Willamette Silt)

- Geology in the SWV plays a large role in determining groundwater flow and nitrate transport (*Iverson 2002*, *Kite-Powell 2003*, *Vick 2004*, *Arighi 2004*, Oregon DEQ’s work, and this study)

- Time-scale of problem 10’s of years

- The model will be made available to public

Preliminary Results/Conclusions 2/2

- The model will be used for public presentations as a tool to help illustrate and describe groundwater flow

- The model will be able to help answer questions addressed by the GWMA Committee

  - Where is the nitrate coming from?
  - How long?
  - How can we reduce current nitrate levels?

- Future work with model includes using projected land-uses in the Southern Willamette Valley to determine effects on groundwater flow, nitrate transport, and groundwater management

Thanks!

- To the Environmental Protection Agency for funding (Regional Geographic Initiative 2004 grant # X5-970838-01)

- To the many people and agencies who have contributed time and information as this project developed