Contaminant Fate & Transport Modeling for Nitrate Impacts

By Nadine L Romero, Hydrogeologist, Thurston County

Nitrate Research

- Hydrogeologic Reviews for SEPA, Permits

- Examining the ways which hydrogeology
- Consultants make demonstrations for Nitrate Assimilative Capacity
- Build Analytical Models
- Build 3D Numerical GW Models (CFT)

Nitrate Assimilative Capacity

- Conduct 12-20 nitrate assimilative capacity reviews per year

- <u>County Requirements</u>:

$NO3\ conc_{gw} < 10\%$ of the difference

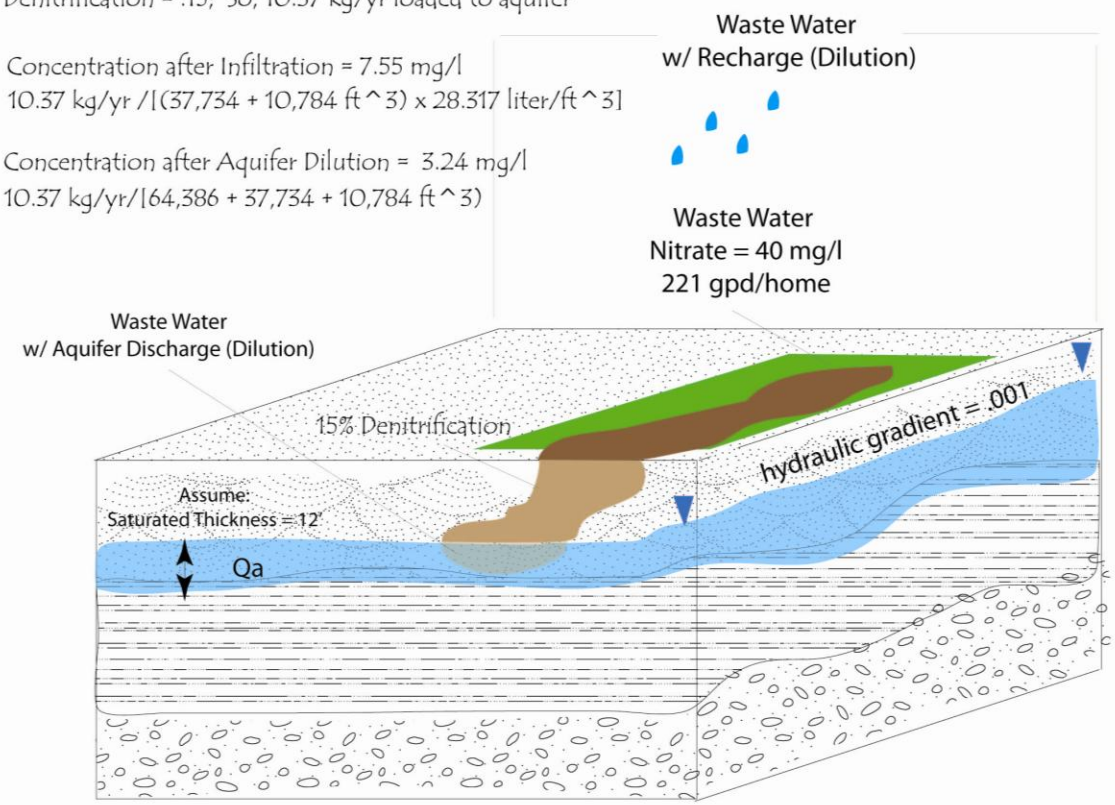
:

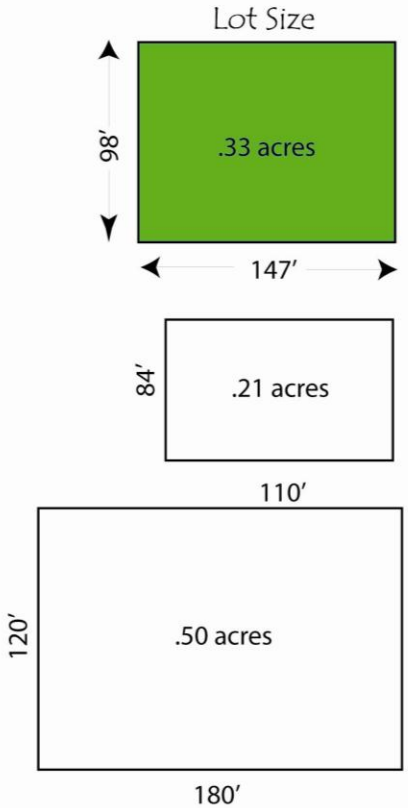
10 mg/l <u>minus</u> 'background'

12.2 kg/year of NO3 per home
Denitrification = .15; So, 10.37 kg/yr loaded to aquifer

Concentration after Infiltration = 7.55 mg/l
10.37 kg/yr /[(37,734 + 10,784 ft^3) x 28.317 liter/ft^3]

Concentration after Aquifer Dilution = 3.24 mg/l
10.37 kg/yr/[64,386 + 37,734 + 10,784 ft^3)





Infiltration = 31.5", Then 2.63 feet/yr over site; If .33 acres x 43,560 x 2.08 ft = 37,734 ft^3/yr

Waste Water Genergation = 221 gpd/home x 365 days = 80,665 gpy/home = 10,784 ft^3/yr

Aquifer Discharge = 12' x 98' x .001 x 150 ft/day = 64,386 ft^3/yr

Total = 112,904 ft^3/yr

Nitrate Policy Research

43,560 square feet = 1 acre
3.785 liters = 1 gallon
28.317 liters = 1 cu foot
.454 kg = 1 lb.
1609.34 meters = 1 mile

Thurston County Environmental Health	Title: Ground Water - Nitrate Diagram *DRAFT*	
	Drawn: Nadine L. Romero, Hydrogeologist, L.P.G., L.P.HG.	
Project Site: Number:	Date: November 17, 2008	FIGURE A

Basic Nitrate Calculations

NO3 Treated
Effluent Concentration

40 mg/l

Standard Nitrate Septic Treatment Technology

20 mg/l

RetroFast

Nitrate Loading into Ground Water Environment

Waste Water Volume

If 220 gpd/home X 40 mg/l = 12 kg/year

If 360 gpd/home x 40 mg/l = 18 kg/year

Range

20 – 40 lbs/year per household (3 bedroom)

Deschutes River System

- 118 Home Developments (on small parcels = or < .33 acres) w/ Standard Septic Field Technology

↓

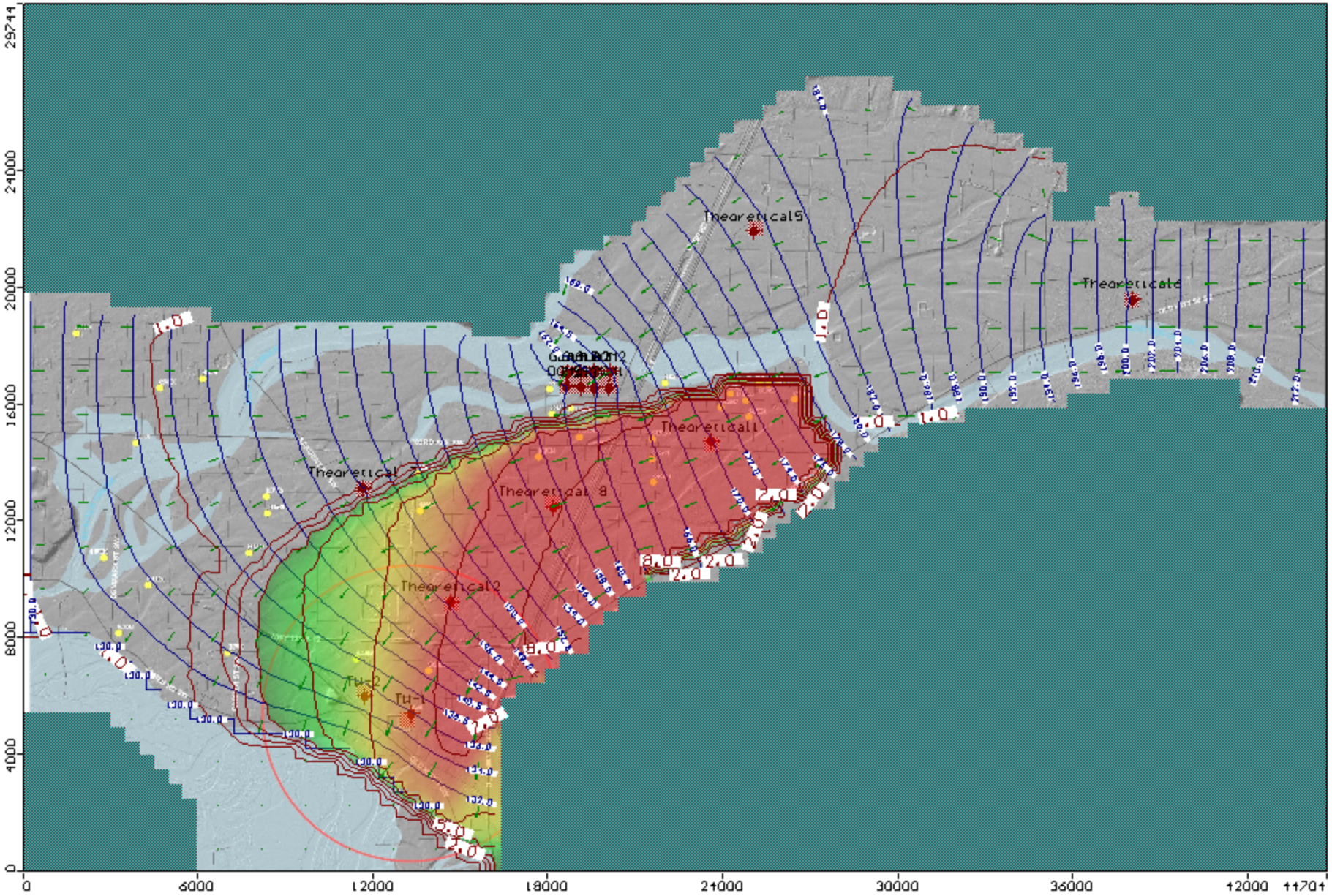
Retrofast Technology

Nitrate Reduction Load

- Reduced by 50% with new technology:

4000 lbs (reduced) to Deschutes
River Environment and Ground Water

Numerical Ground Water Modeling
Contaminant Fate &Transport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Model Building

- 8 months to complete w/ another geologist
- Geology research: 1000 well logs
- Built geologic cross-sections

- Model Calibration :
- Field Program (Sue Davis)
- 40 domestic wells
- Water level measurements (high/low)
- Water quality sampling

What Model Calibration Does:

- Allows model to be constructed
- Allows constraints to be “found”
- Eventually you produce a “thinking” program

- How are you thinking?
- Can you tell me what will happen to the municipal well field in 5 years? 10 years?
- Can you tell me what will happen if I load you with ‘heavy precipitation’ events?

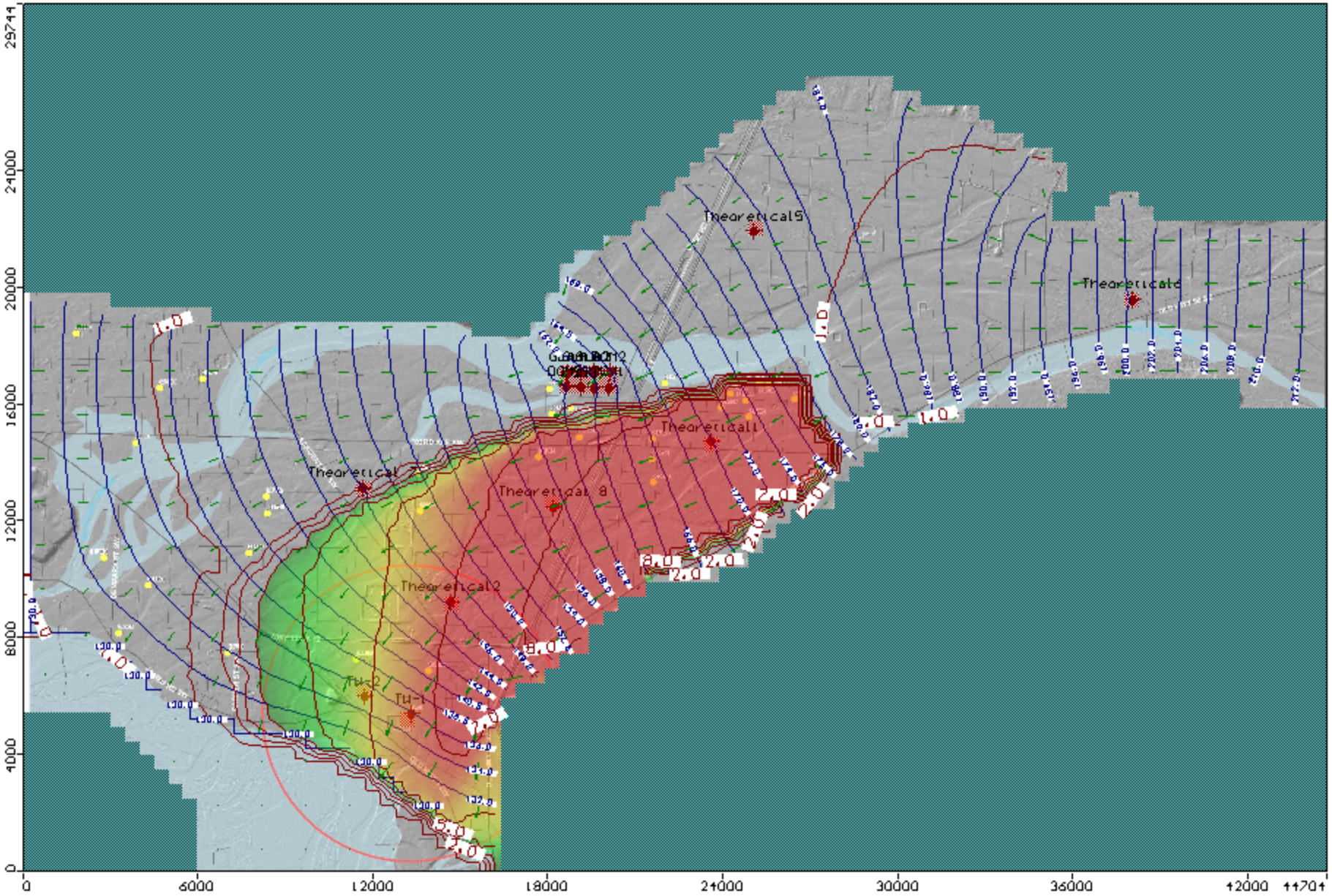
How You Can Run Models:

- Steady – State (Equilibrium)
- Transient (Steps & Pulsing System)

What the Model Tells Us:

- Your ‘Aquifer’ must have a high hydraulic conductivity (K) – a soils property that tells us how “inter-connected” the pore spaces are

- It must have a high K (800-1000 feet/day) in order to produce the ground water elevations that you measured in the aquifer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Excellent New Tools

- Models help fold in all the complexity to allow ‘learning’

- Goal: To continue to Model and see what the future will hold