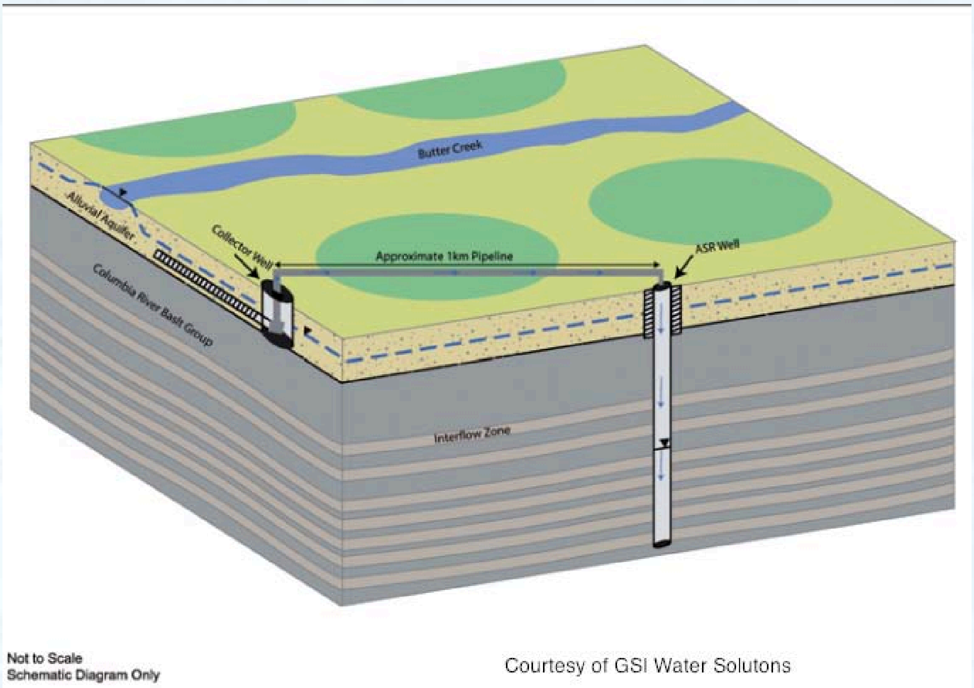
Agricultural ASR

At Madison Farms


Race to the Bottom
Quality good except for nitrates
Quantity very limited

20 years

The Madison Farms Solution



Regulatory Challenges: Water Quality

Injected water quality must not exceed half of any state or federal drinking water standard

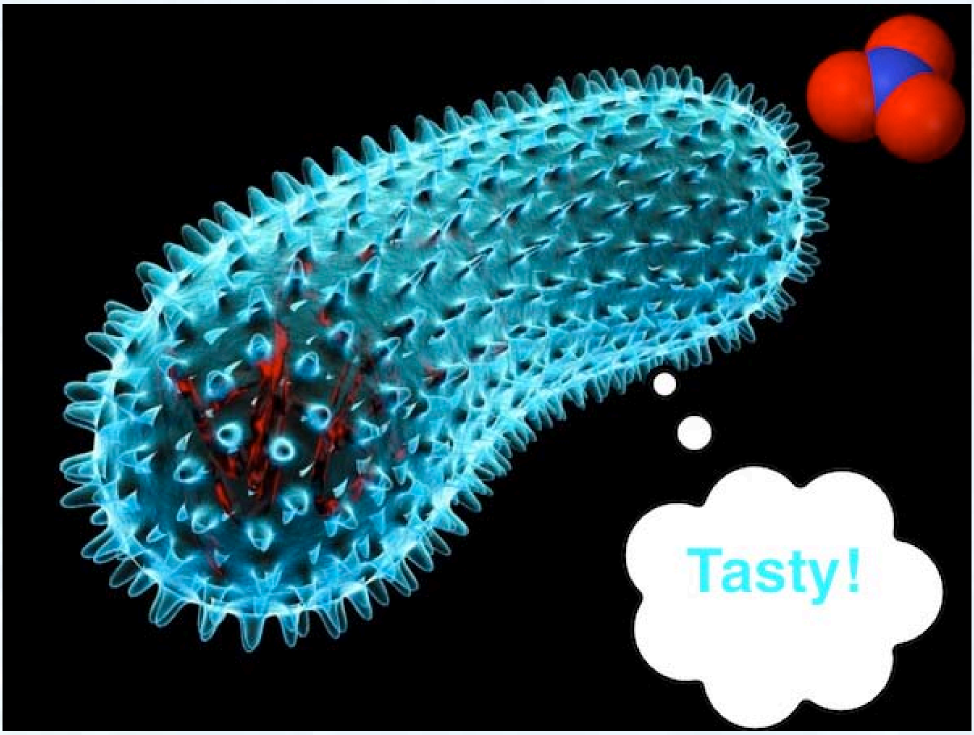
1990 DEQ Lower Umatilla Basin Groundwater Management Area

Nitrates are the main concern: DEQ allows 7mg/L here

Given strong denitrification of recovered water, Madison's limit is now 9mg/L

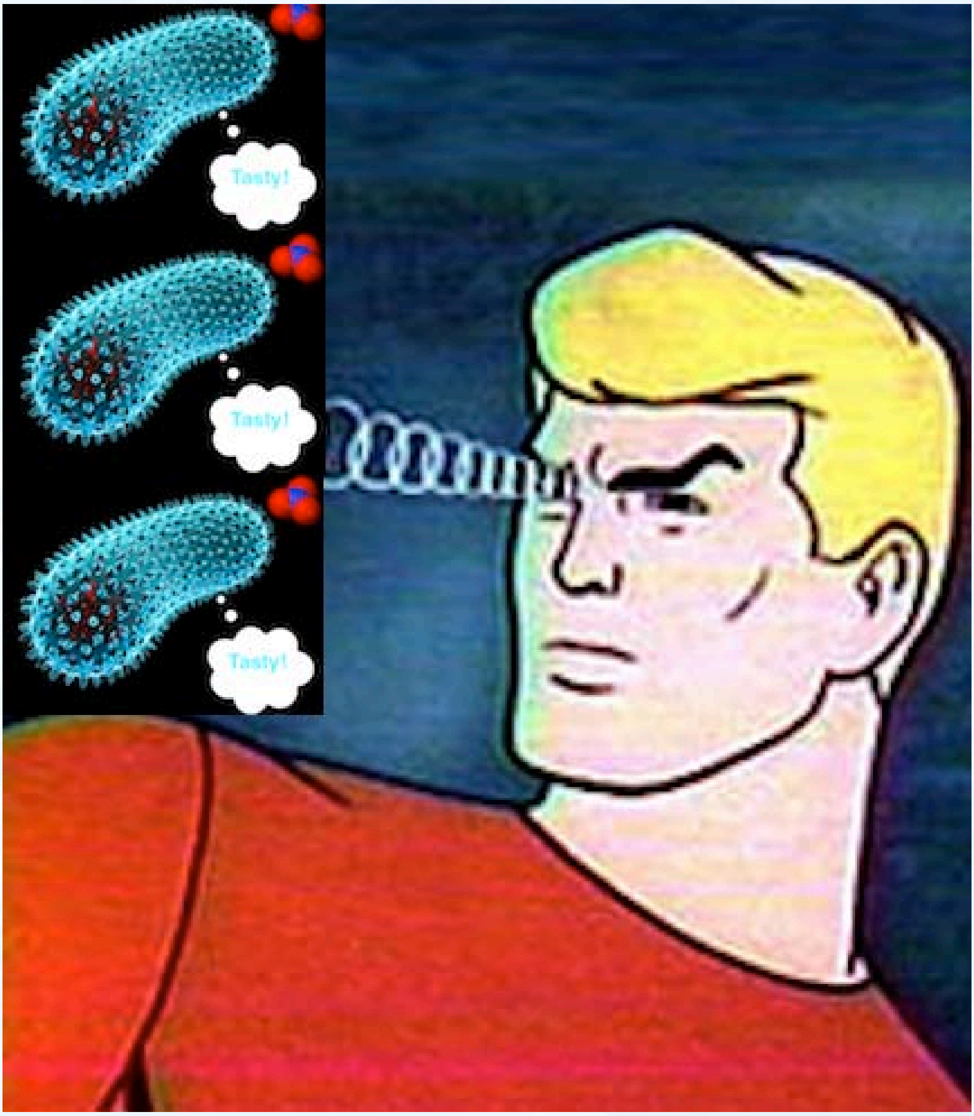
Denitrification by ?

Suboxic conditions in CRBG aquifers thermodynamically favor denitrifying bacteria



But shortly after, CRBG aquifers found deficient in organic matter

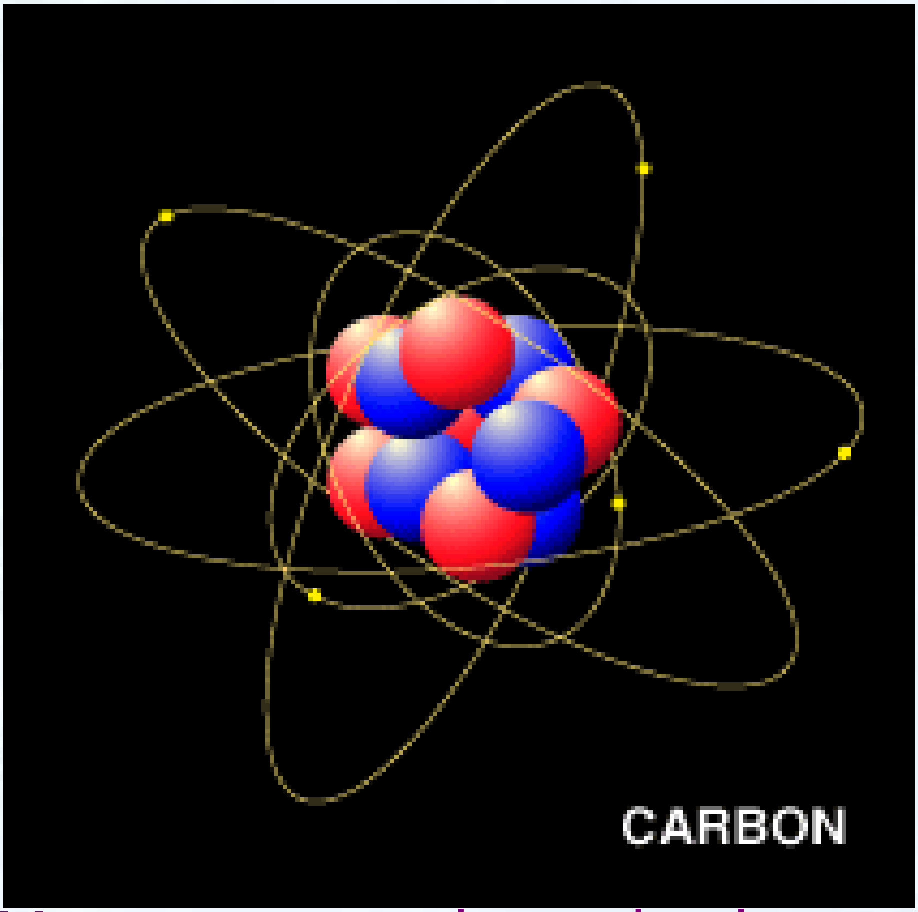
Denitrification via telepathic recruitment



AquiferMan!

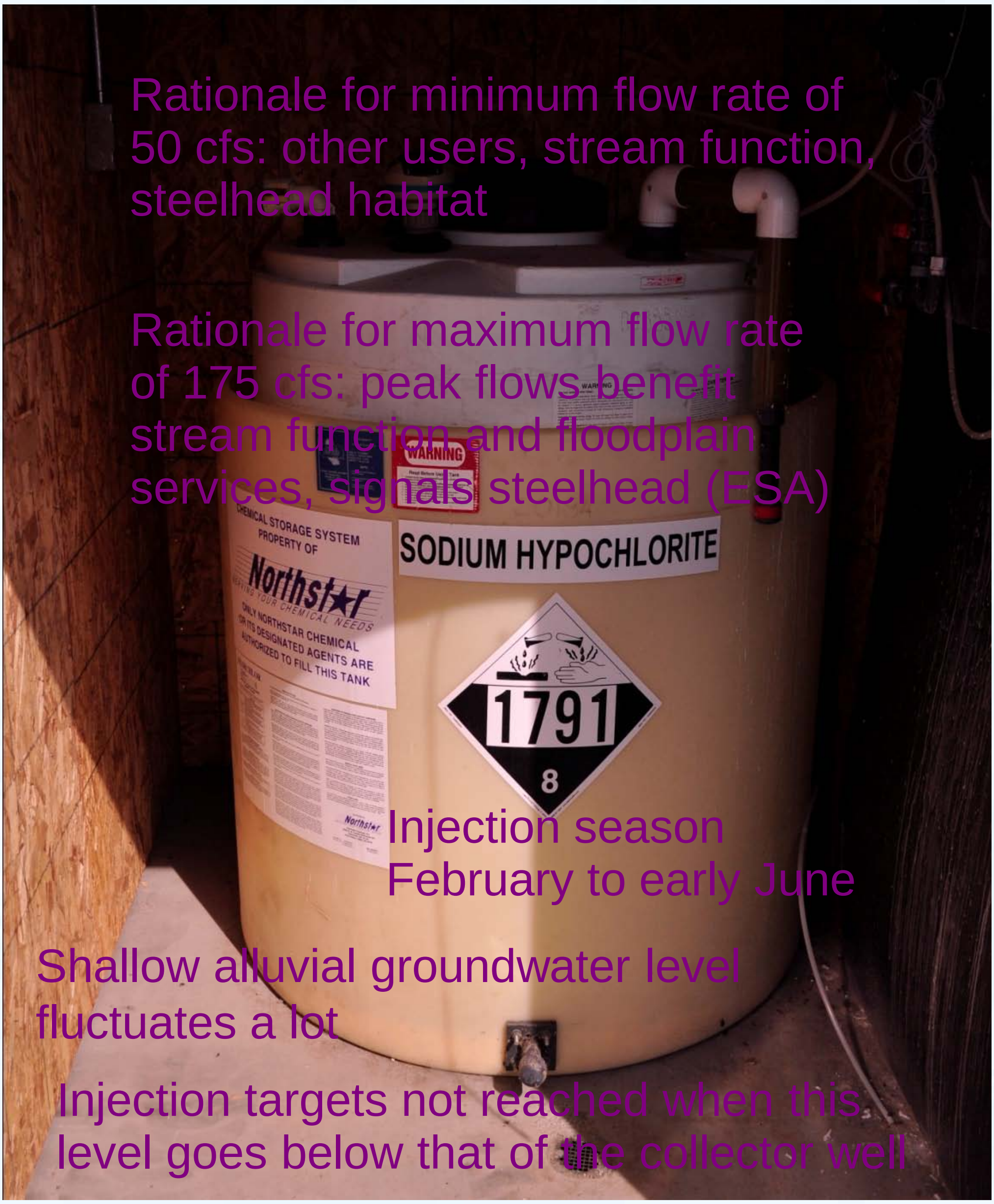
Denitrification by . . .

Total Organic Carbon in Source Water



May augment other suboxic denitrification processes

Regulatory Challenges: Water Quantity: Source Water



Rationale for minimum flow rate of 50 cfs: other users, stream function, steelhead habitat

Rationale for maximum flow rate of 175 cfs: peak flows benefit stream function and floodplain services, signals steelhead (ESA)

Injection season February to early June

Shallow alluvial groundwater level fluctuates a lot

Injection targets not reached when this level goes below that of the collector well

Regulatory Challenges: Water Quantity: Recovery

OWRD required 95% - 98% recovery. Now at 98%

Submitted data suggests no leakage of underground reservoir; how about 100%?

Distinctive Technical Features

3r Valve with nitrate metering stops injection when nitrates exceed target level without entraining air

Regeneration technology captures energy of water falling into deep well; permitting costs often onerous

Economics of ASR versus alternative

ASR Costs

Capital Expenditures Required to Initiate ASR

Retrofit of existing well for ASR	$25,000
ASR downhole control valve	$35,000
ASR wellhead piping	$8,000
Nitrate water quality meter	$13,500
Consulting/Engineering	$60,000
TOTAL ASR CAPITAL COSTS	$141,500

Annual Operation and Maintenance for ASR

Electric cost for collector well	$9,200
Electric cost for ASR well	$27,500
Chlorination of ASR water	$3,000
Consulting and laboratory fees	$20,000
Miscellaneous costs	$1,200
TOTAL ANNUAL ASR COSTS	$60,900

Alternative Water Supply - Columbia River

Estimated Capital Expenditures Required to Use Columbia River

Conveyance piping	$8,000,000
New pump station on Columbia River	$200,000
Consulting/Engineering	$1,000,000
TOTAL ALTERNATIVE CAPITAL COST	$9,200,000

Estimated Annual Operation and Maintenance for Columbia River Diversion

Raw water purchase cost	$61,300
Electric cost for Columbia River pump	$25,000
TOTAL ANNUAL COLUMBIA RIVER COST	$86,300

Gross Annual Profit for 200 Acres (0.8 Square Kilometer) of Irrigated Crop	$122,600

Note: All costs presented are in U.S. dollars.

Courtesy GSI Water Solutions

Summary

- Regains some lost groundwater
- SAR component benefits neighbors: static water level rises, lowers pumping cost
- Regeneration may be feasible for all ASR applications
- As with DFBs, nitrates seem to spontaneously reduce, important for ASR in agricultural areas
- Alluvial sediment filtration may be required, but agricultural ASR may be viable in many aquifer types