The Distribution and Modeling of Nitrate Transport in Carson Valley

Carson Valley Coalition Forum April 3, 2014

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Outline of Presentation

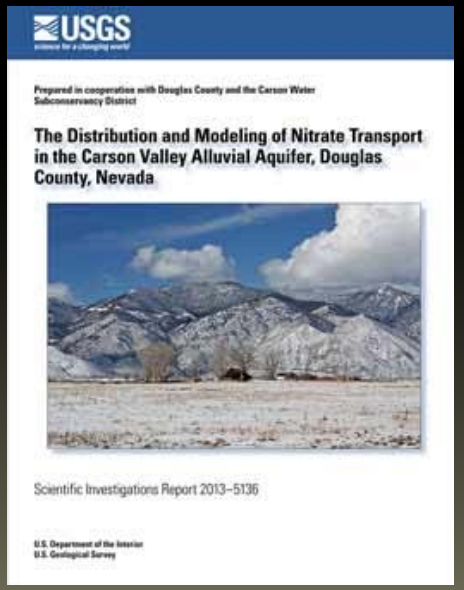
Health and Ecological Risks associated with Nitrate

Land Use Analysis
- Correlation of Nitrate-N and land-use types

Nitrate-N Concentrations in Groundwater (2008-2009)
- Trends in Nitrate (1985-2009)

Groundwater flow and transport models (1970-2059)
- Johnson Lane
- Ruhenstroth

Hypothetical scenarios



USGS Scientific Investigations Report 2013-5136

Health and Ecological Risks

Household waste contains bacteria, viruses, chemicals, and high levels of Nitrogen and Phosphorous

Nitrate in drinking water more severely affects infants. Blue baby syndrome, hypertension, central nervous birth defects, diabetes and cancer. EPA MCL 10 mg/L

Increase nutrients to surface water causes Eutrophication

Algal Bloom on the Carson River, 2012

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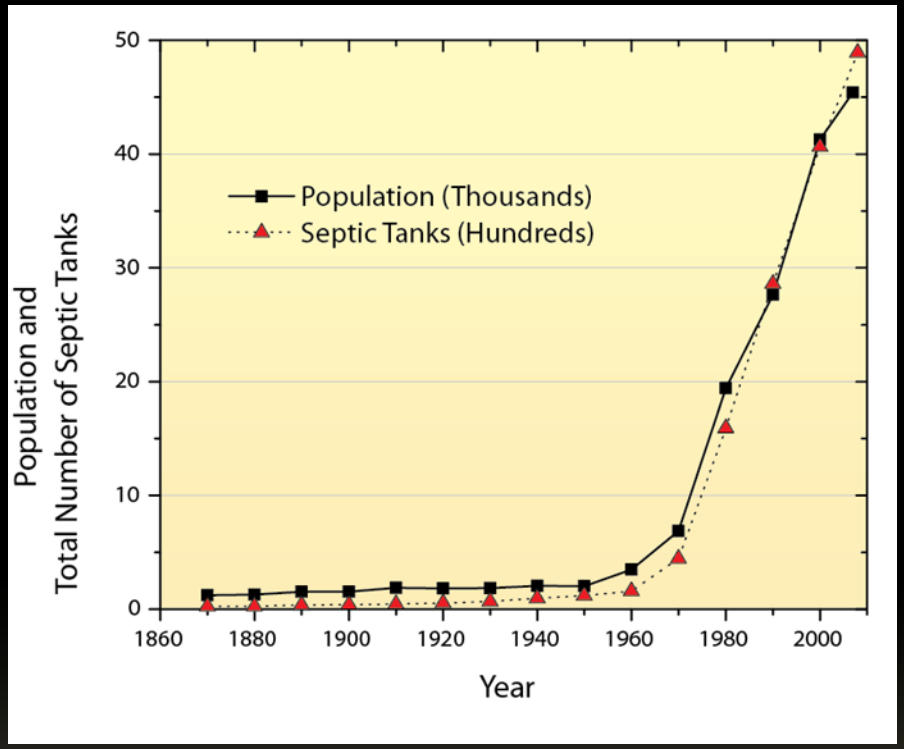
Background

Rapid growth from 1970 – 2005

Large increase in new development resulted in greater extent of domestic pumping and septic systems use

Studies found nitrates are increasing in high density residential areas.

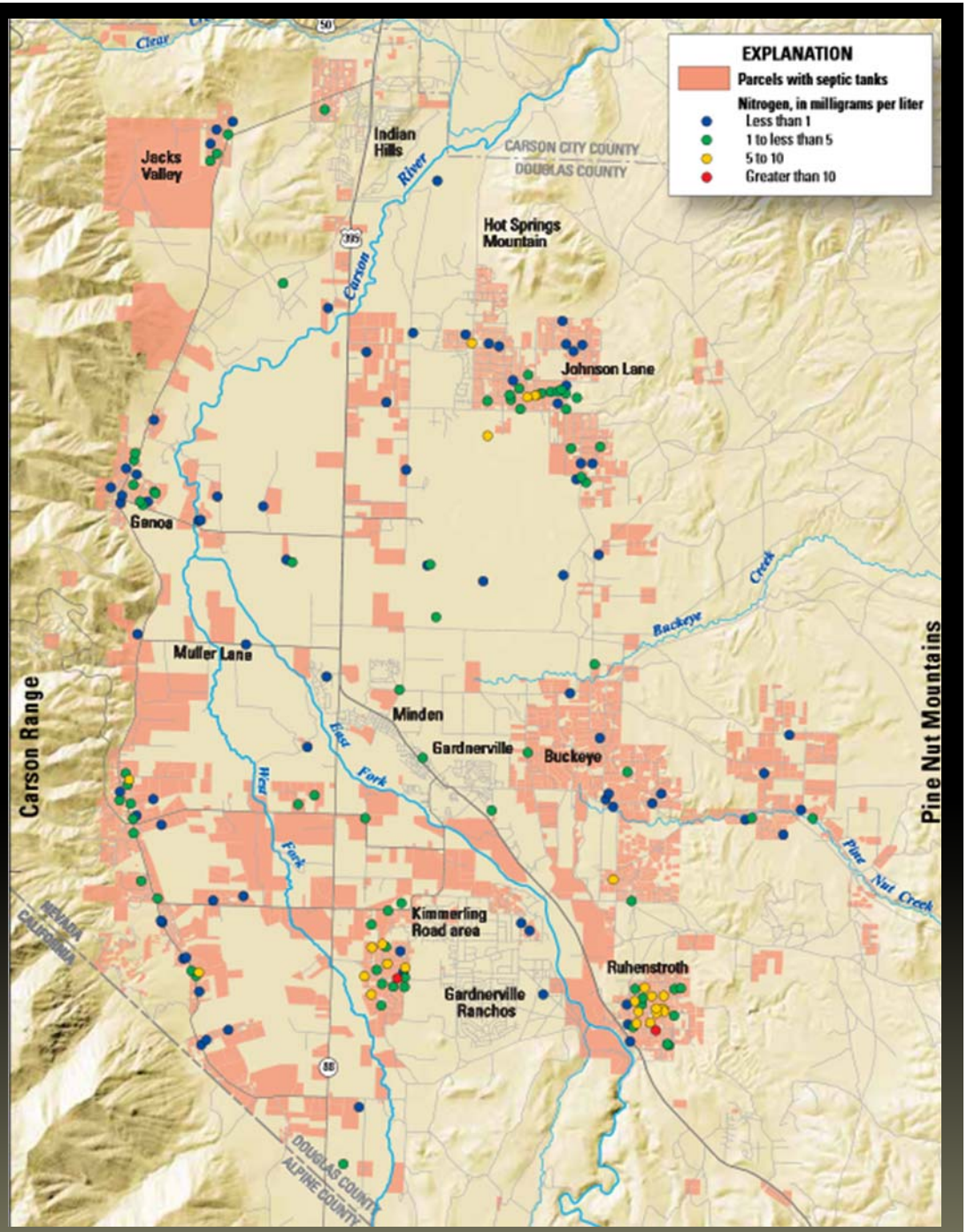
More expansive data collection was necessary to determine the extent of nitrate contamination in 8 other land-use types



Observed Data
2008-09

Wells with elevated Nitrate are in areas with highest septic density

Low nitrates in agricultural areas except for areas near development



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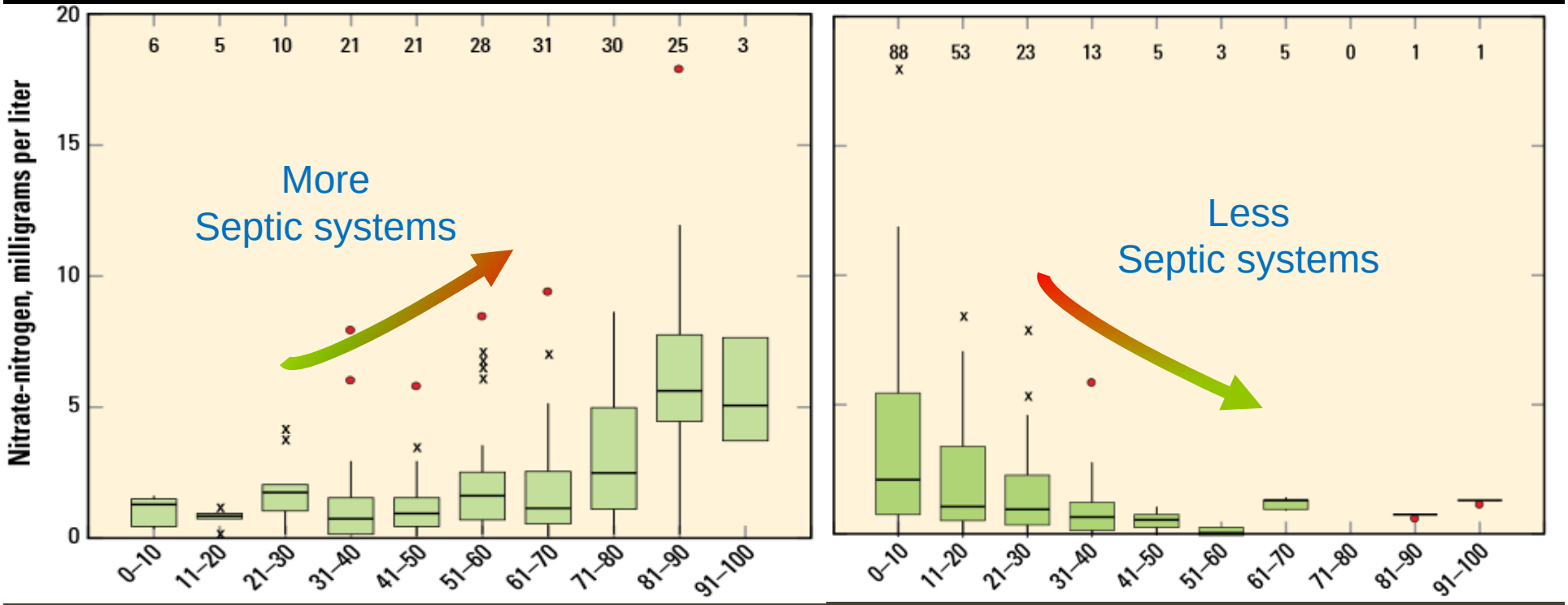
Nitrate vs Land Use

Single Family Residential

Rural and Agricultural



Percent Land-use

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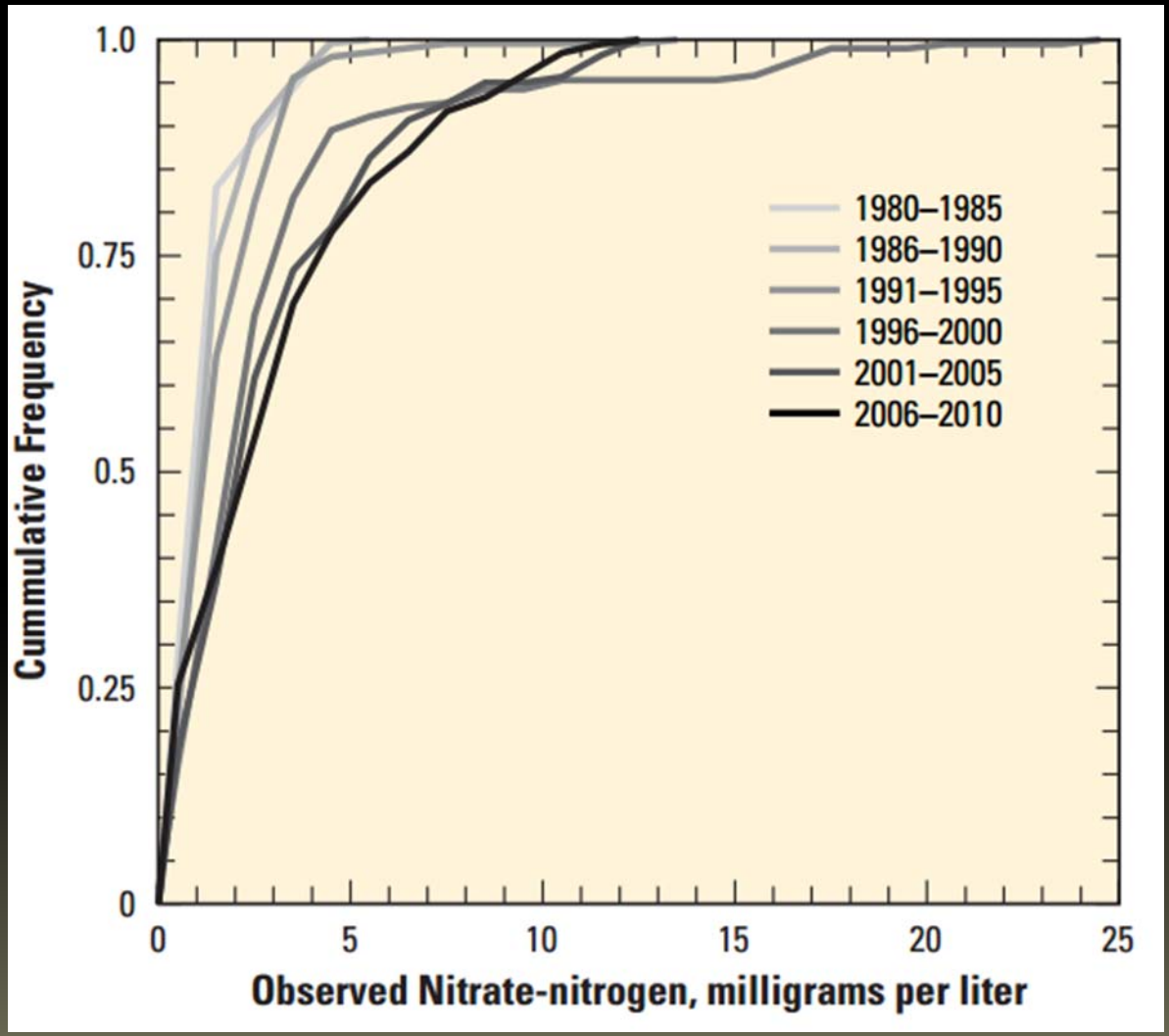
Observed Trends in Data 1980-2010

All wells in Douglas County

Concentrations are increasing



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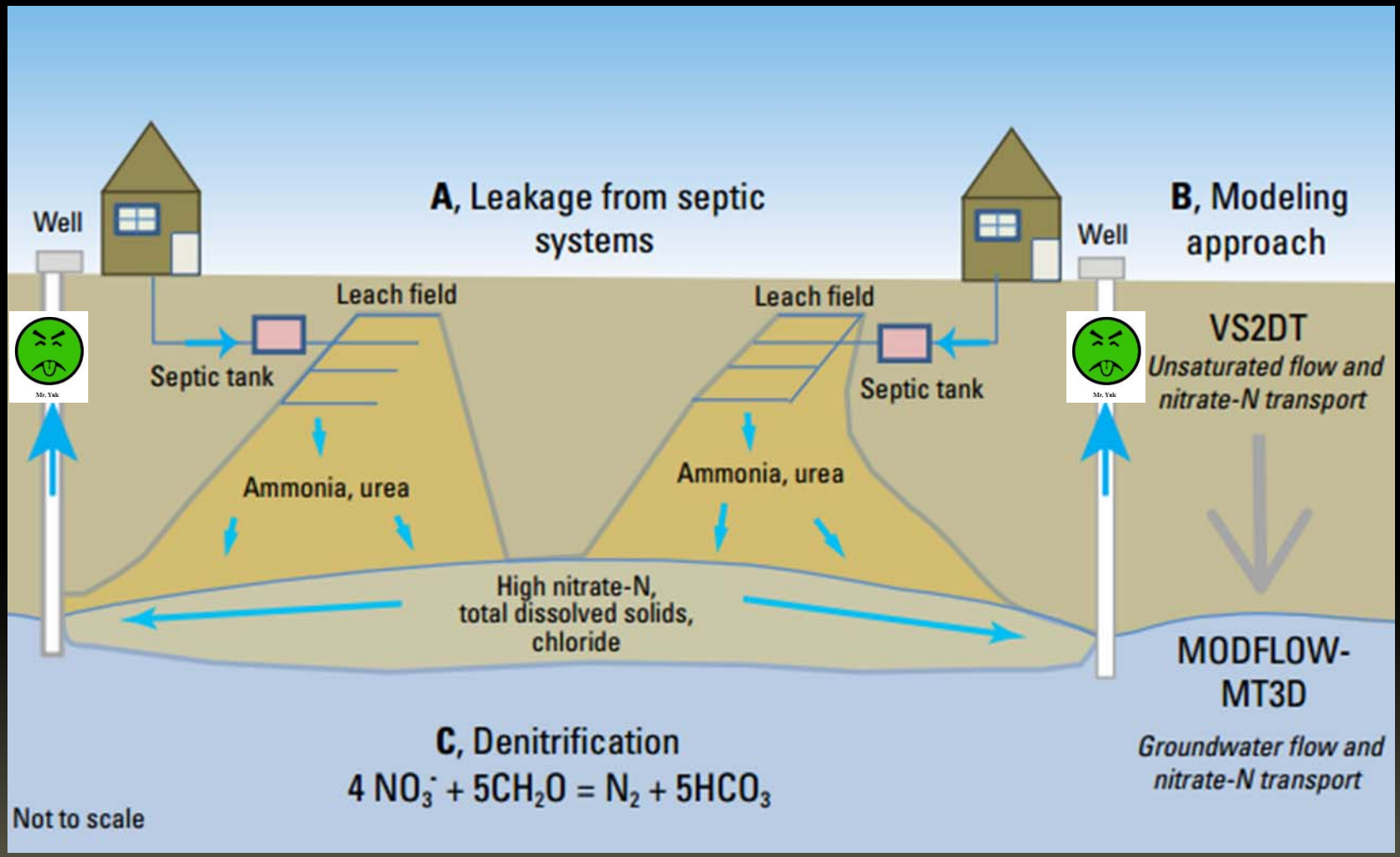
Groundwater Impacts from Septic Tank Systems



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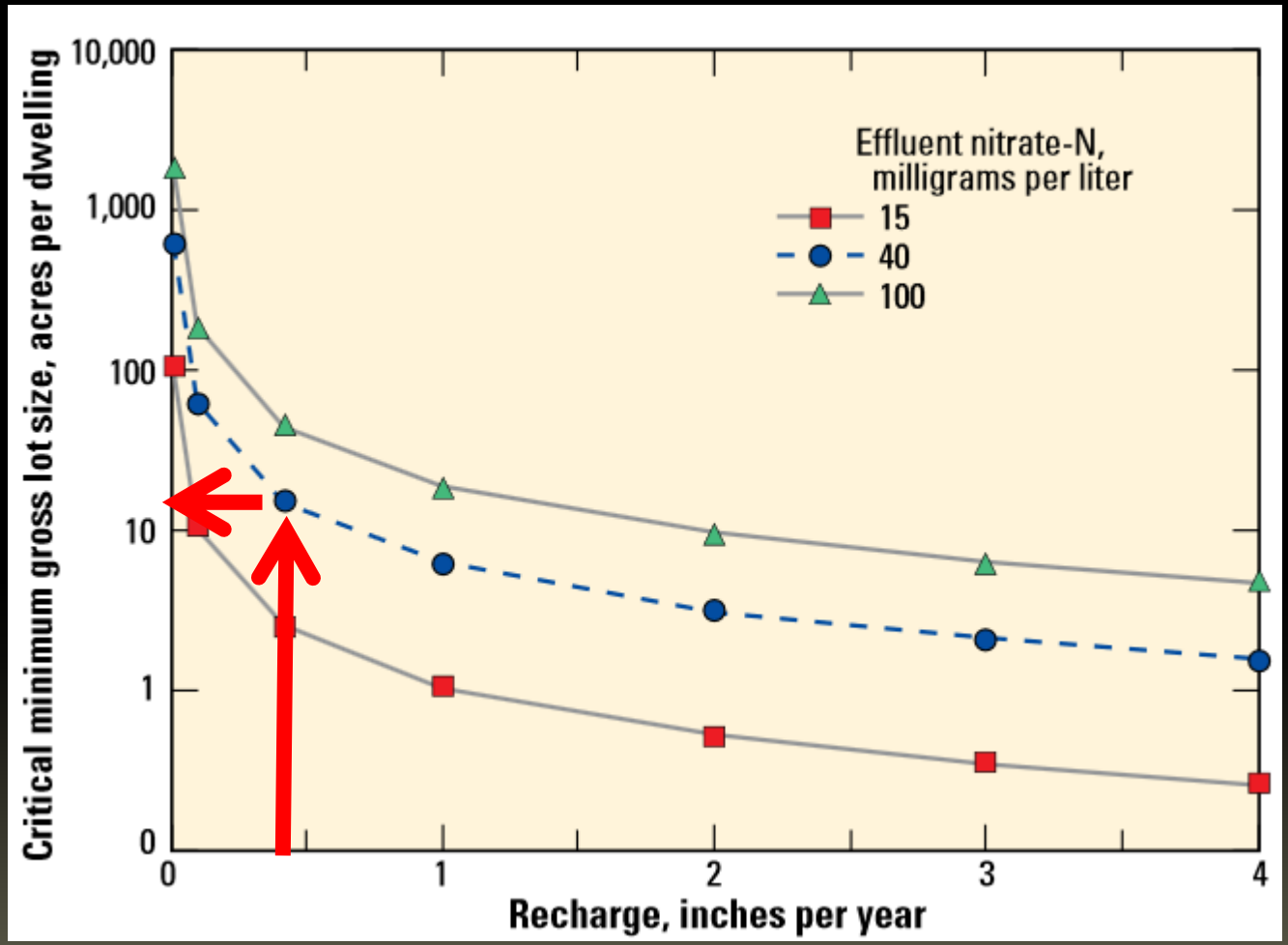
What is the lot size needed to avoid exceeding the MCL of 10 mg/L ?

15 acres!



Carson Valley average recharge ~0.4 inch/ year

(Hantzche and Finnemore, 2005)

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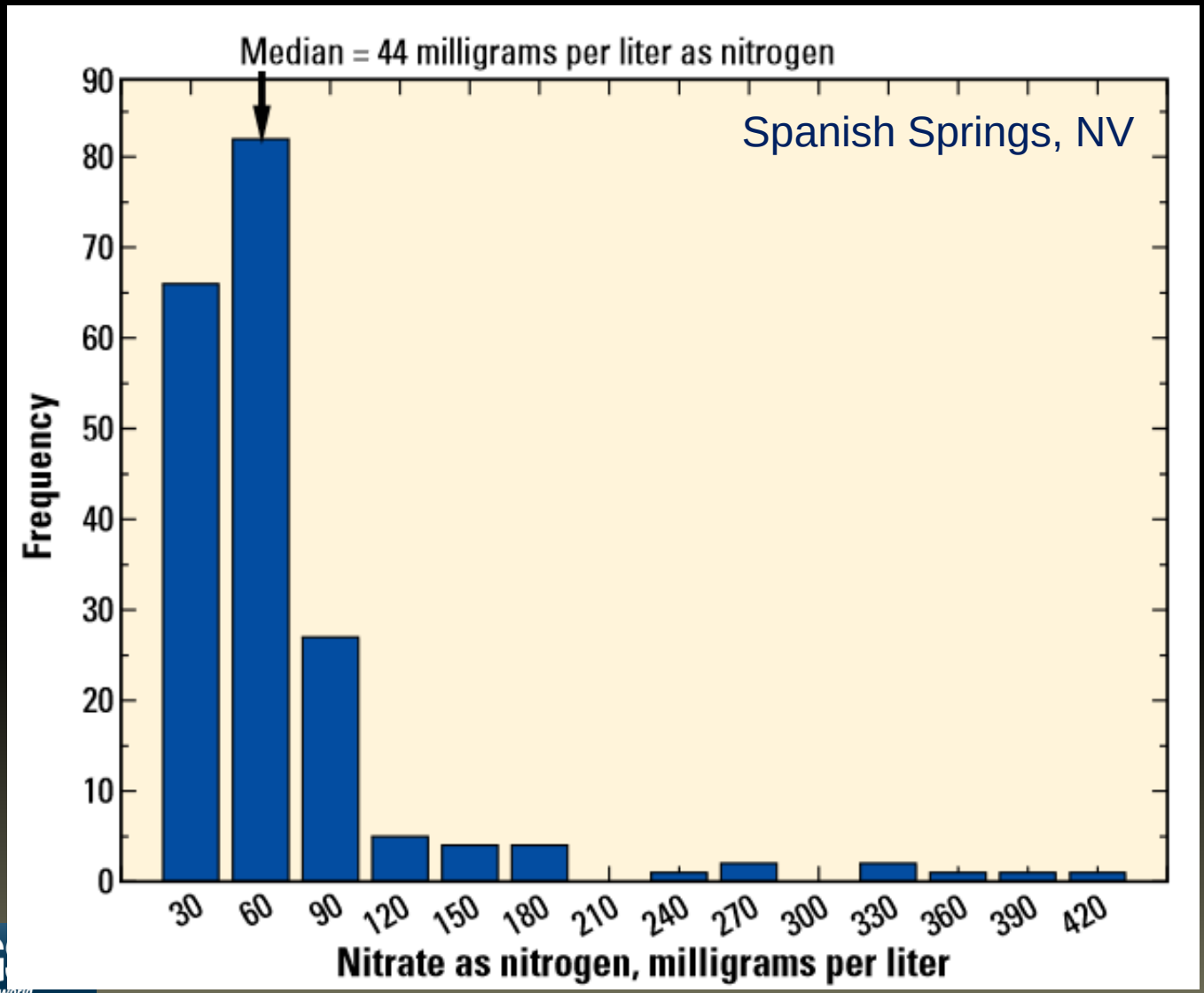

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Transport Model Objectives

(Modflow/ MT3DMS)

Develop a transport model for 1970-2009 that includes domestic, municipal and agricultural pumping

Predict (2009-2059) transport under current climate and pumping conditions - baseline model

Predict the spatial extent for two scenarios initiated in 2030:

End use of septic systems continue domestic pumping
End use of **both** septic systems and domestic pumping

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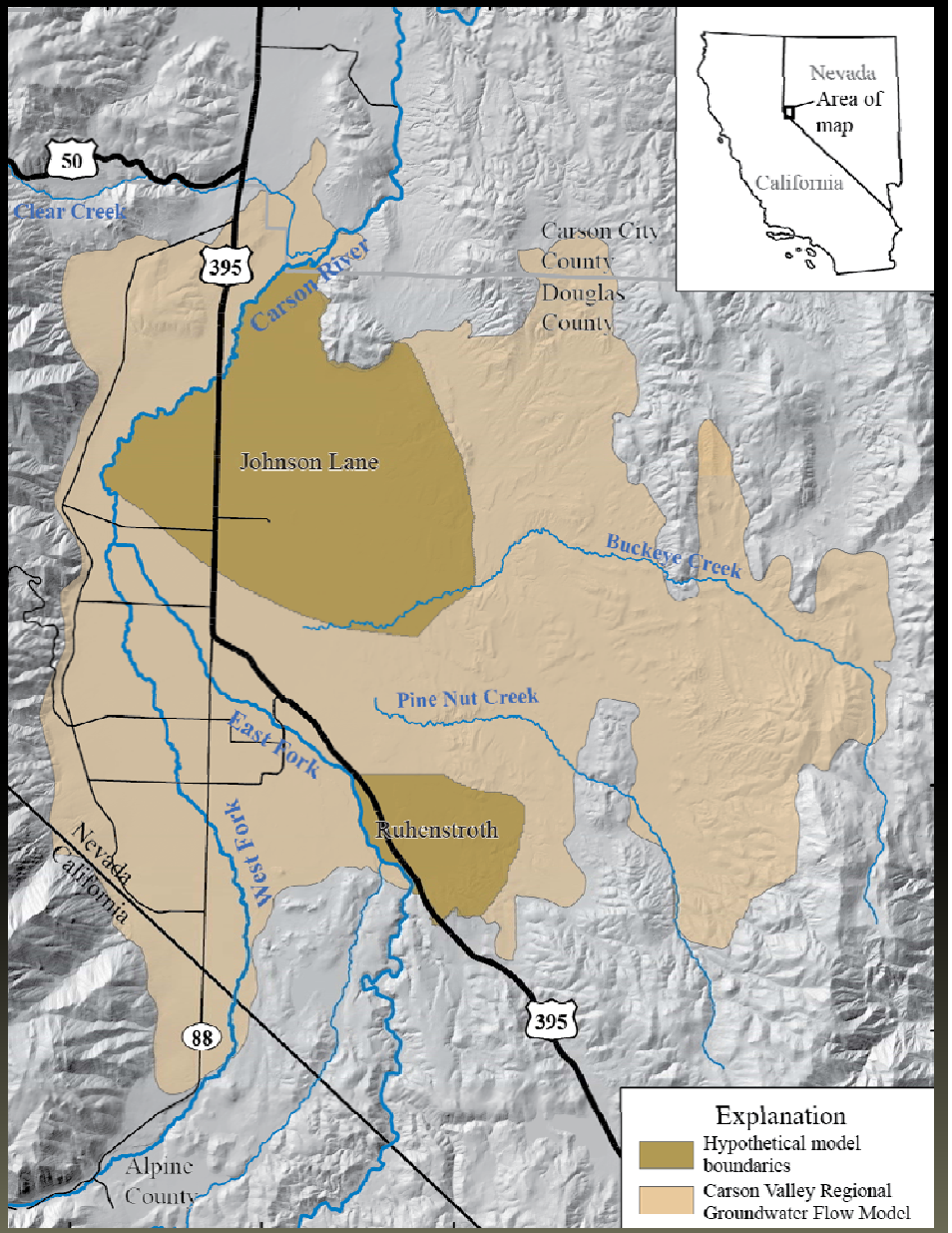
Transport Study Areas

USGS Carson Valley flow model
(Yager and others, 2012)

- Johnson Lane
  - 159.8 km²
  - 1,433 septic tanks
  - 2,627 wells
- Ruhenstroth
  - 36.8 km²
  - 500 septic tanks
  - 511 wells



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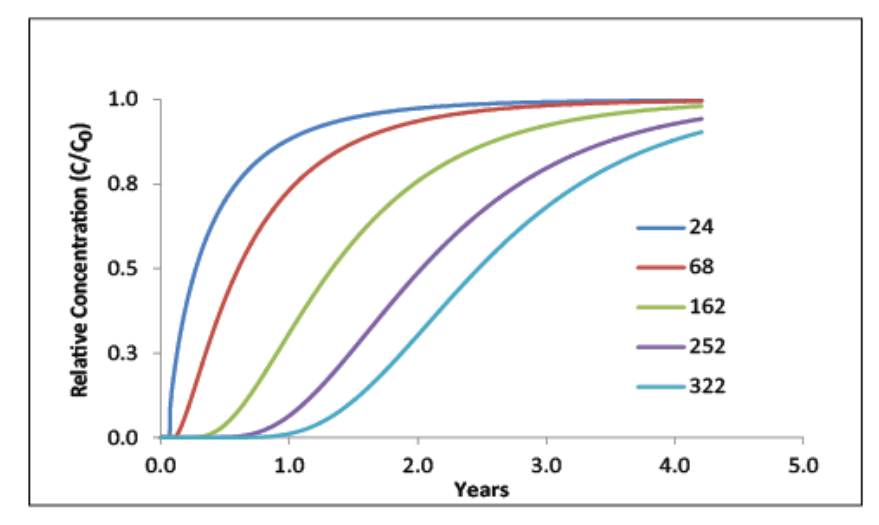
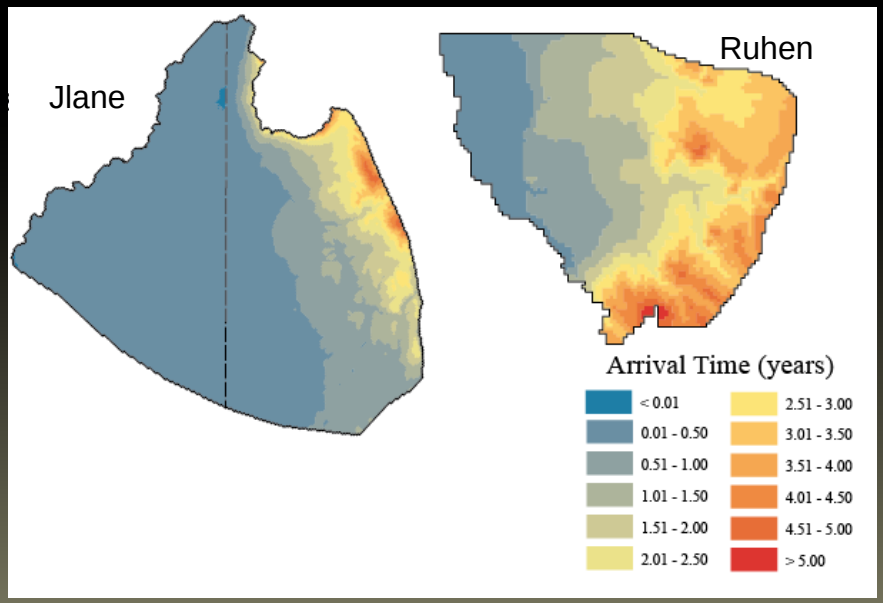
Hong does it take the mean Nitrate concentration to arrive?

Arrival time at different depths



Distribute the arrival time based on depth to groundwater and age of septic systems.



Most areas will be impacted in less than **1 year.**

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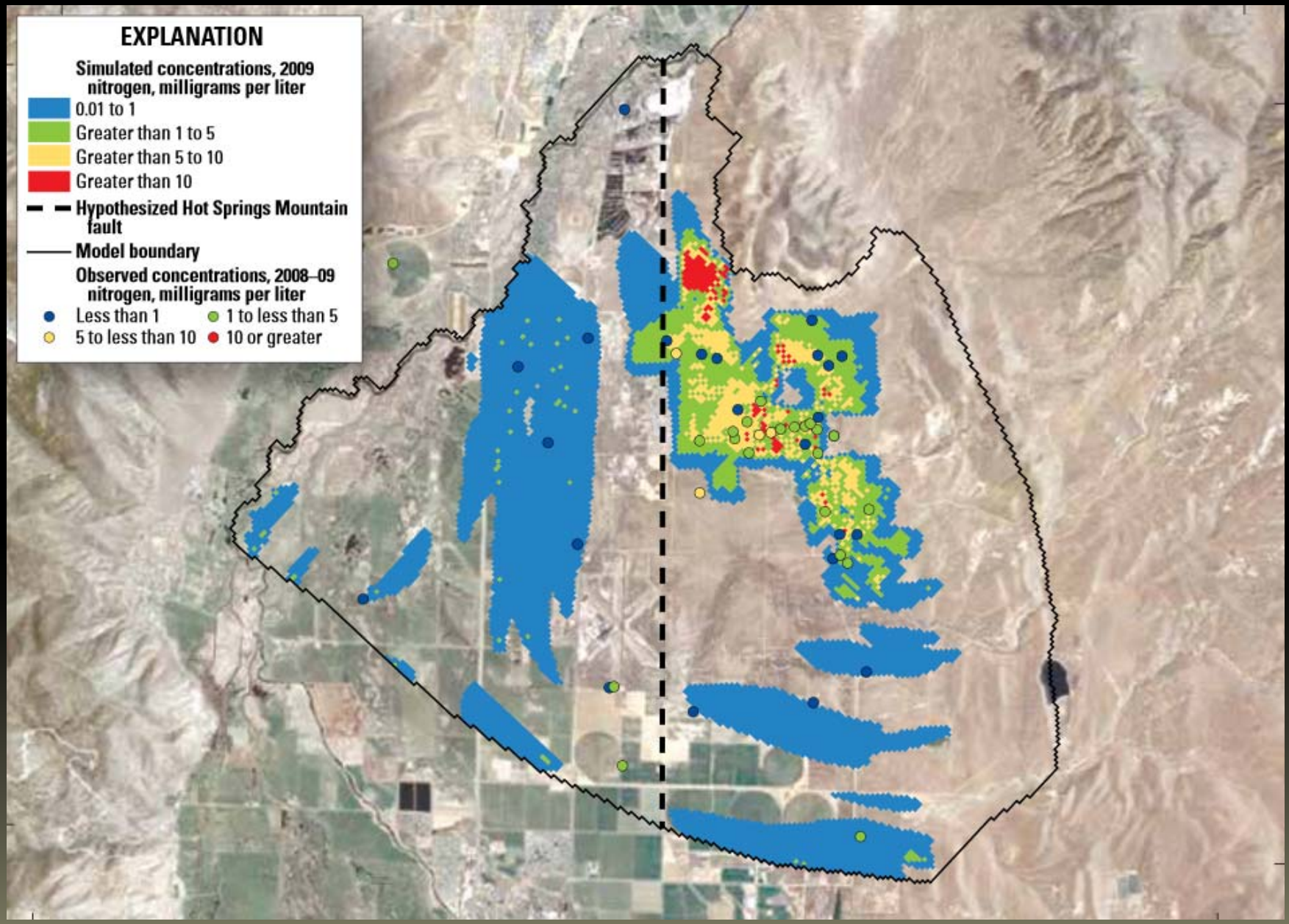
Johnson lane (2009)

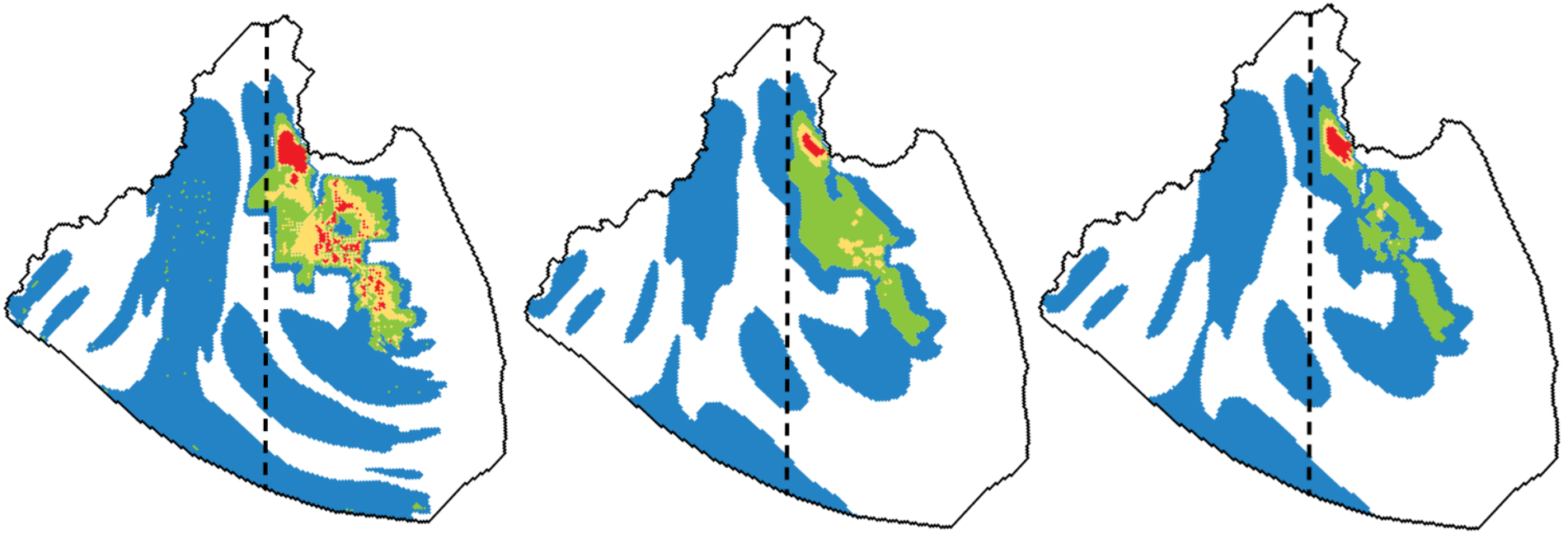


Future Concentrations- Johnson Lane (2059)

Baseline

No Septics,
Continue Domestic

No Septics,
No Domestic Pumping



EXPLANATION

Nitrogen, milligrams per liter

- 0.01 to 1
- Greater than 1 to 5
- Greater than 5 to 10
- Greater than 10

Hypothesized Hot Springs Mountain fault

Model boundary

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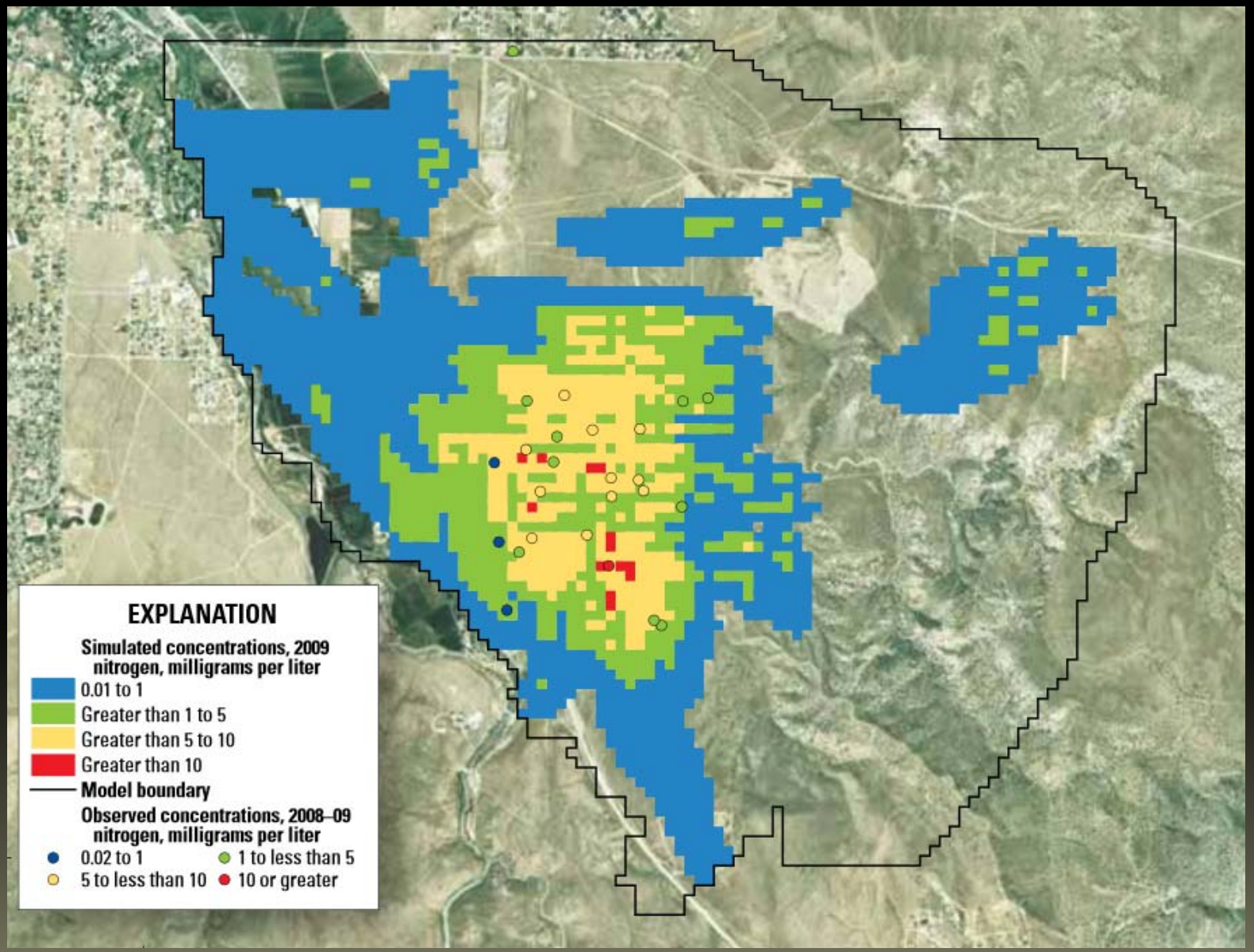
Ruhenstroth (2009)

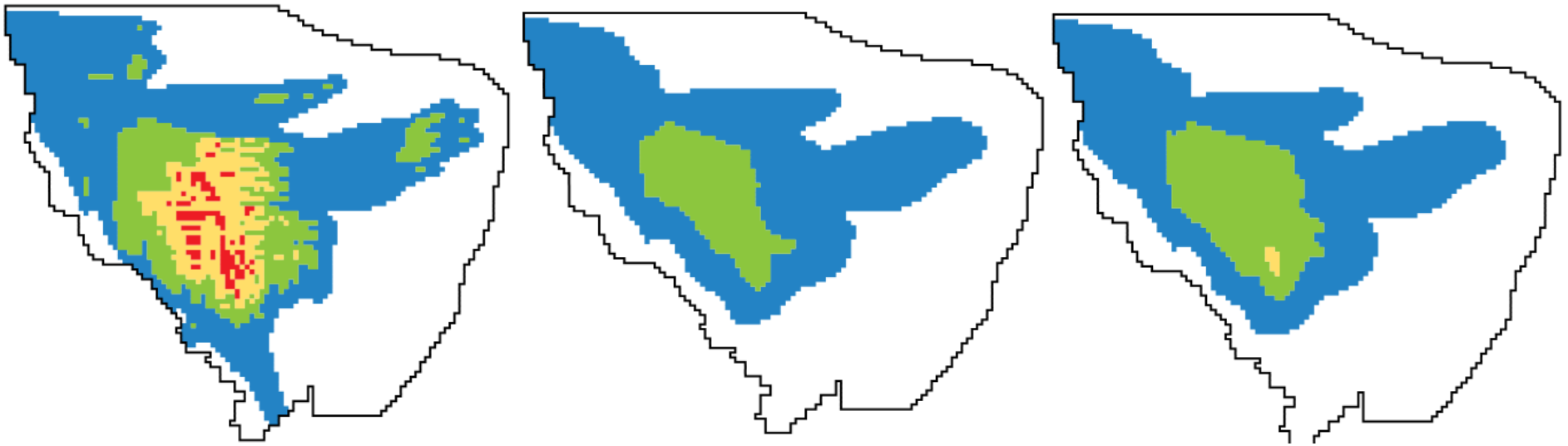


Ruhenstroth Future Concentrations (2059)

Baseline

No Septics, Continue Domestic Pumping

No Septics, No Domestic Pumping



EXPLANATION

Nitrogen, milligrams per liter

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- **Model boundary**

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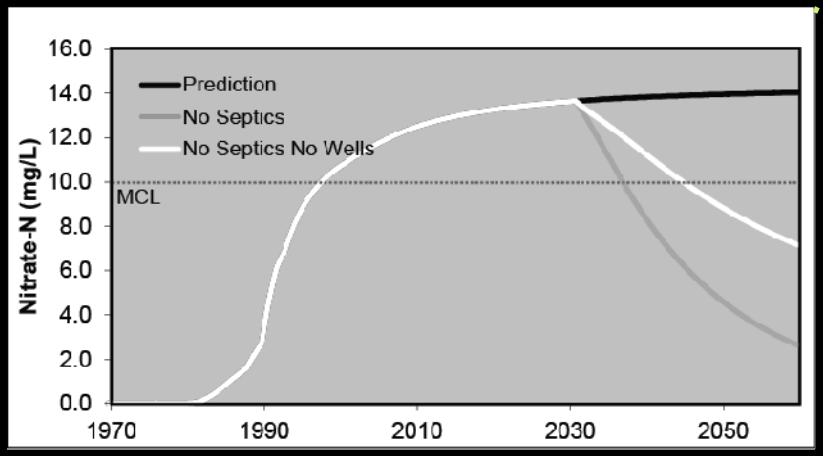
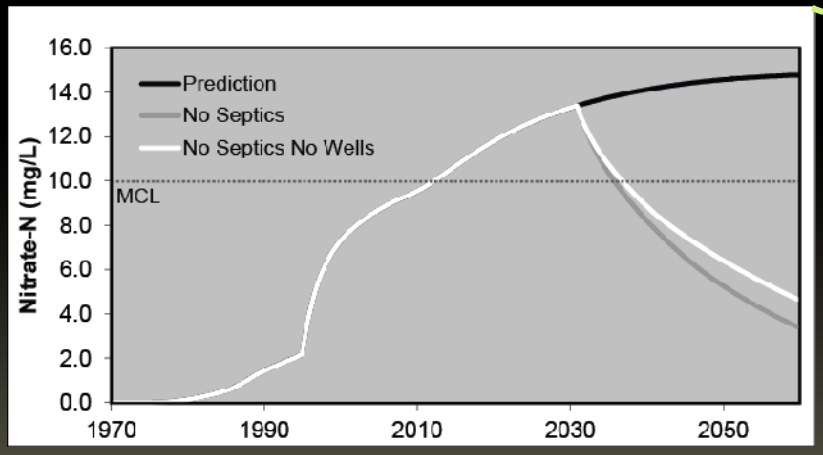
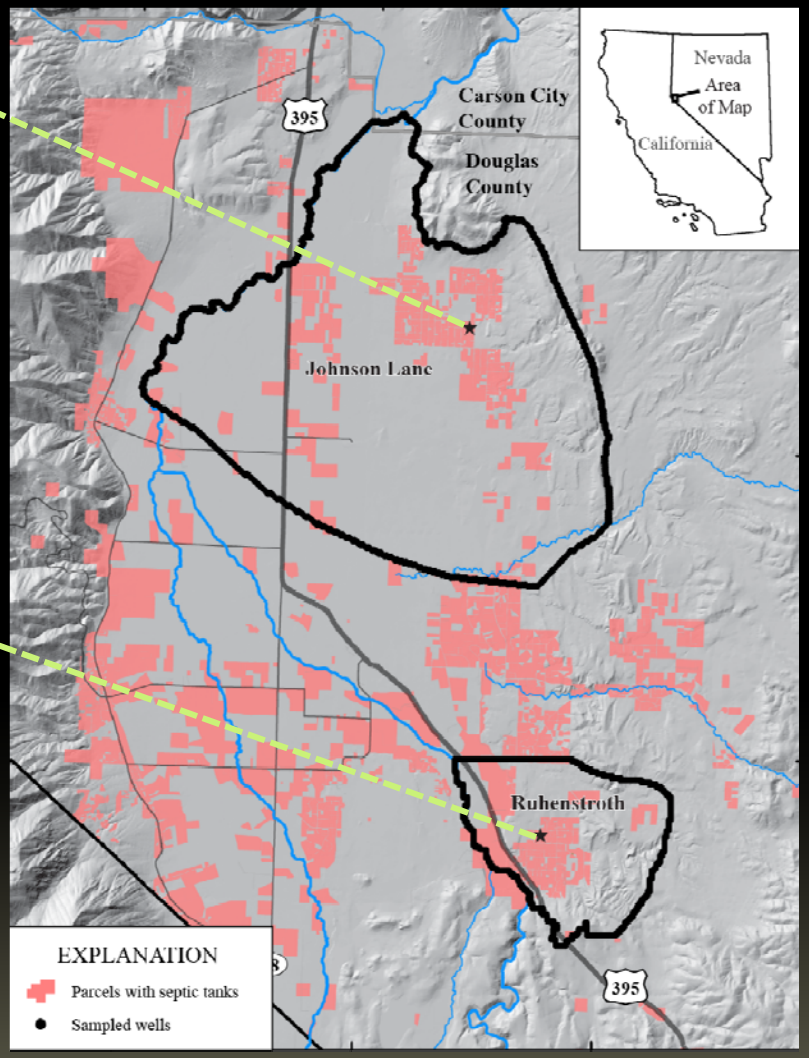
Scenarios (1970-2059)







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Summary of Scenario Results

	2009	2059		
		Prediction	H1	H2
Johnson Lane				
Maximum (mg/L)	22	30	20	19
Percentage change in maximum[1]	—	38	-34	-39
Acres > MCL (10 mg/L)	156	373	92	48
Percentage change in area[1]	—	139	-75	-87
Ruhenstroth				
Maximum (mg/L)	12	19	4	5
Percentage change in maximum[1]	—	62	-79	-72
Acres > MCL (10 mg/L)	11	112	0	0
Percentage change in area[1]	—	769	-100	-100

[1]Calculated as a percentage from prediction at 2059.

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Conclusions

Main source of nitrate is derived from septic tank systems

Nitrate concentrations in groundwater is dependent on well depth, septic tank density and age, and proximity of up-gradient sources (i.e. Johnson lane)

The ability of the aquifer to dilute the leachate concentration has been reduced due to high use of septic systems (i.e. Ruhenstroth)

Concentrations reduce more rapidly when septic tanks were removed and domestic wells continued to pump

If no action is taken, nitrate will eventually increase above the USEPA's MCL.

At Ruhenstroth, either scenario will result in concentrations less then the MCL.

At Johnson Lane, concentrations accumulate down gradient from high septic density areas

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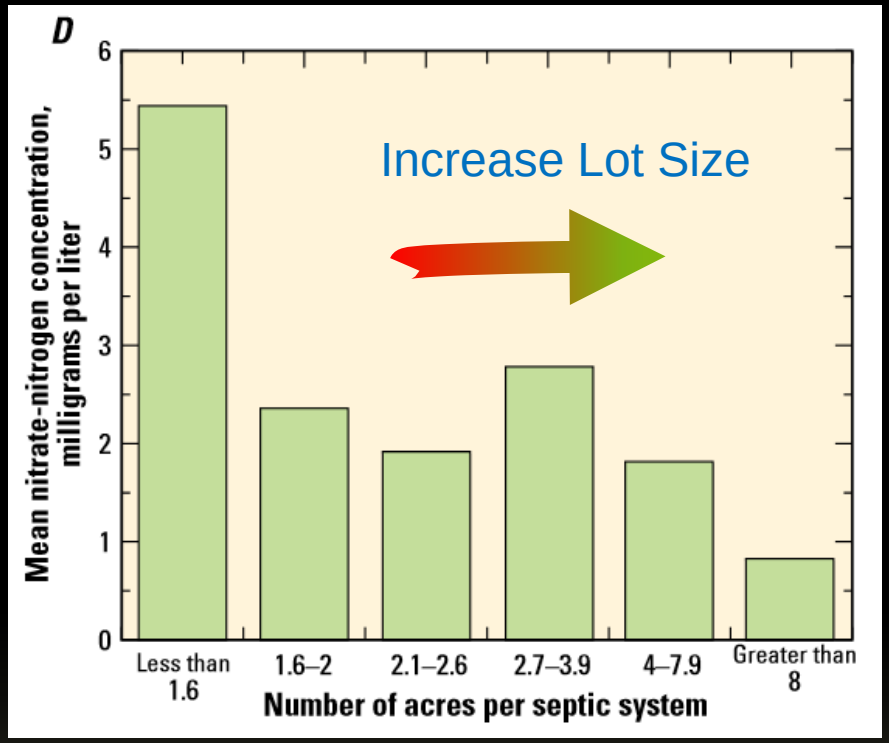
Future Considerations

State-wide evaluation of lot size should be completed

Nitrate models predict an impact to surface water and down gradient domestic wells. Continual monitoring is needed in these areas.

The impact of drought will continue to increase demand on groundwater. Therefore, in the future, water quality will be even more important.



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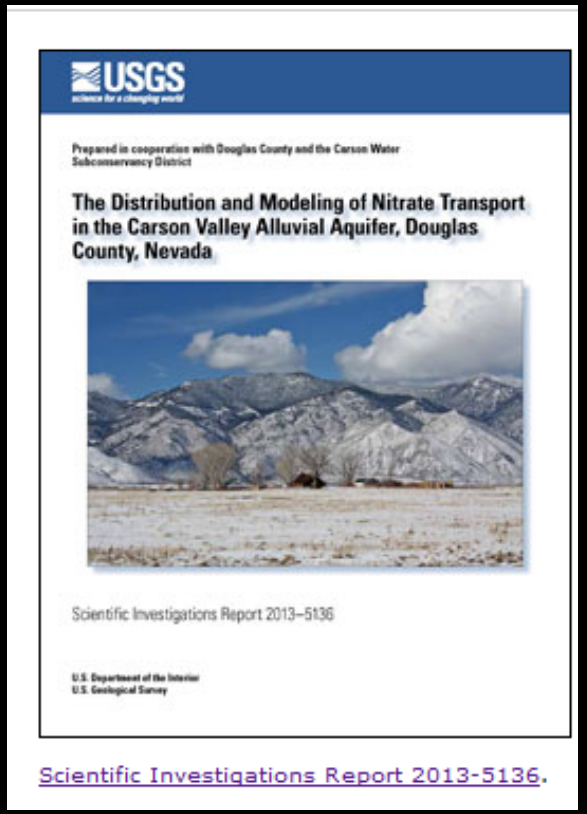
http://pubs.usgs.gov/sir/2013/5136/pdf/sir2013-5136.pdf

More Information

Homeowners can help protect precious water resources by understanding how septic systems work and how to maintain them with proper and effective treatment.

The **EPA** has extensive online resources about septic systems, and the **University of Nevada Cooperative Extension** has published two fact sheets about septic systems and how to maintain them.



Scientific Investigations Report 2013-5136.