Natural Contamination of Domestic Wells in Rural Northern Nevada

Ralph Seiler
(rseiler@usgs.gov)
U.S. Geological Survey
Nevada Water Science Center
Carson City, Nevada

April 28, 2010

Background

Lahontan Valley is an agricul-tural area located about 60 mi. east of Reno.

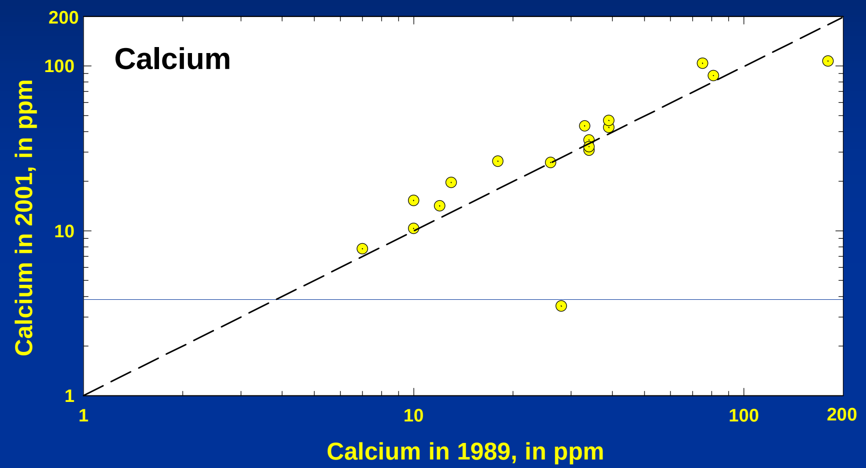
It was the location of a pilot groundwater NAWQA study during 1987-89.

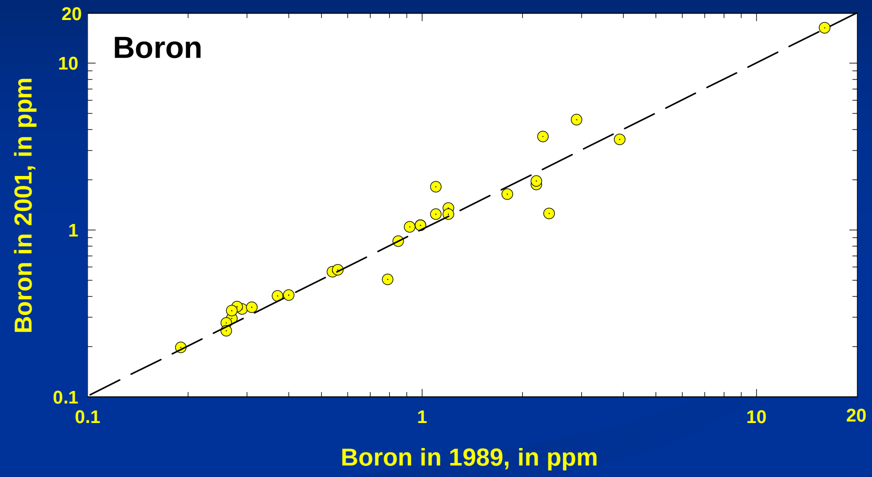
- Lahontan Valley is located in a closed basin on the lakebed of a dessicated Pleistocene lake.
- Trace elements carried into the basin over millions of years have been sequestered in the sediments.

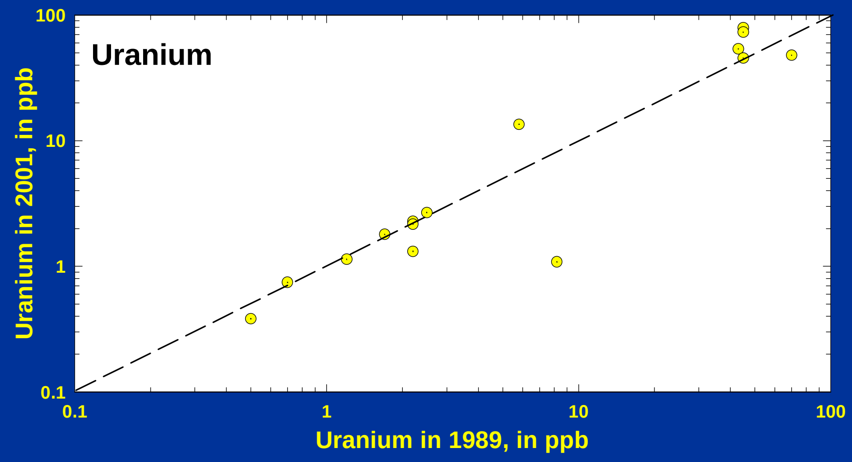
Groundwater-quality investigations in Lahontan Valley

- In 2001-2002, the USGS participated with CDC and the State of Nevada in an investigation of a cancer cluster Lahontan Valley. The goals of the USGS investigation were to determine:
  1. Whether water quality had changed between 1989 and 2001, and
  2. What contaminants were residents exposed to in their water.
- Subsequent follow-up investigations by USGS have examined linkages between geochemistry and unsuspecting exposure to toxic trace elements and radionuclides by owners of domestic wells.

Changes between 1989 and 2001





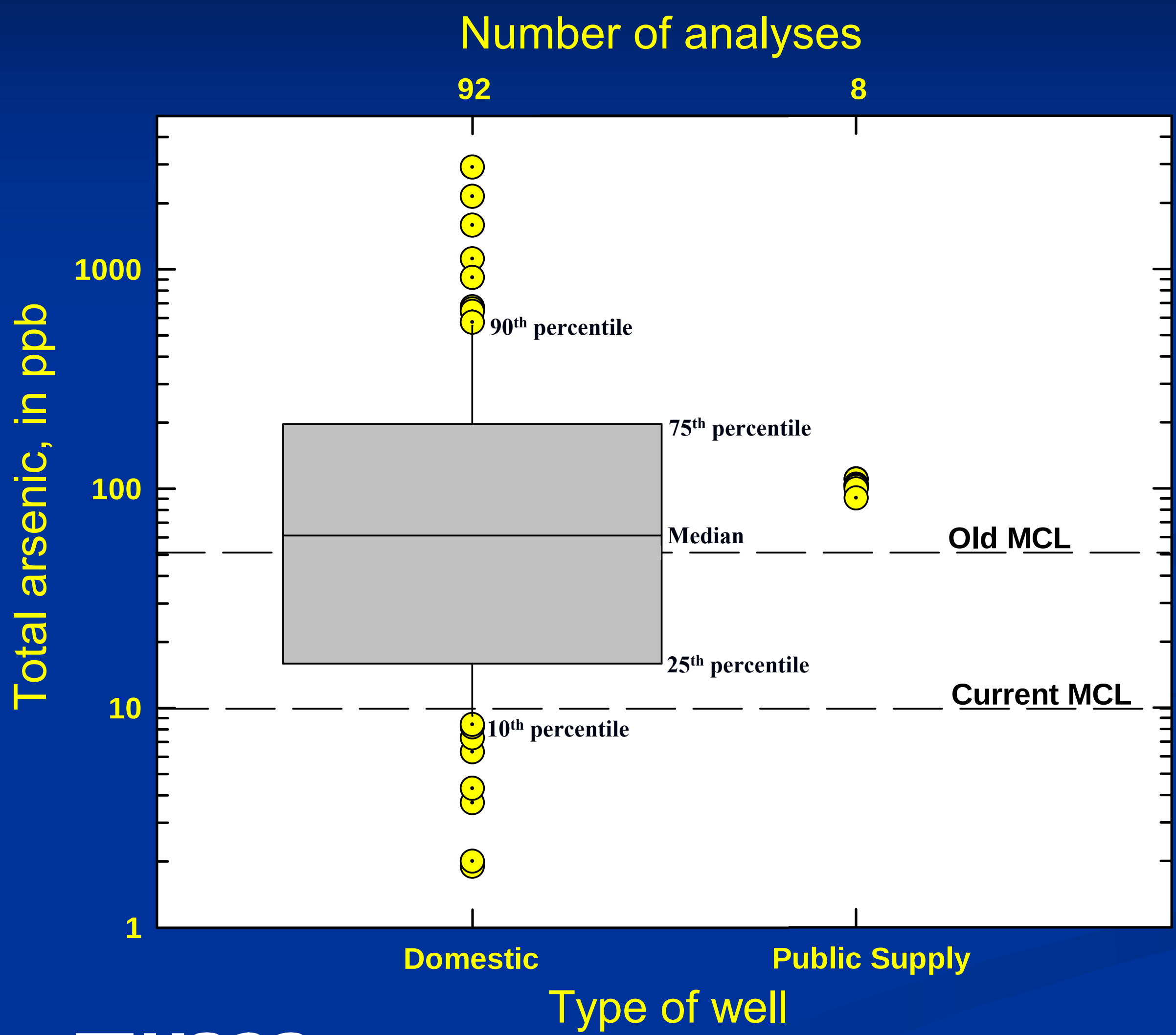


The data suggested there were no significant changes in water quality between 1989 and 2001.

USGS

April 2010

Arsenic in 2001

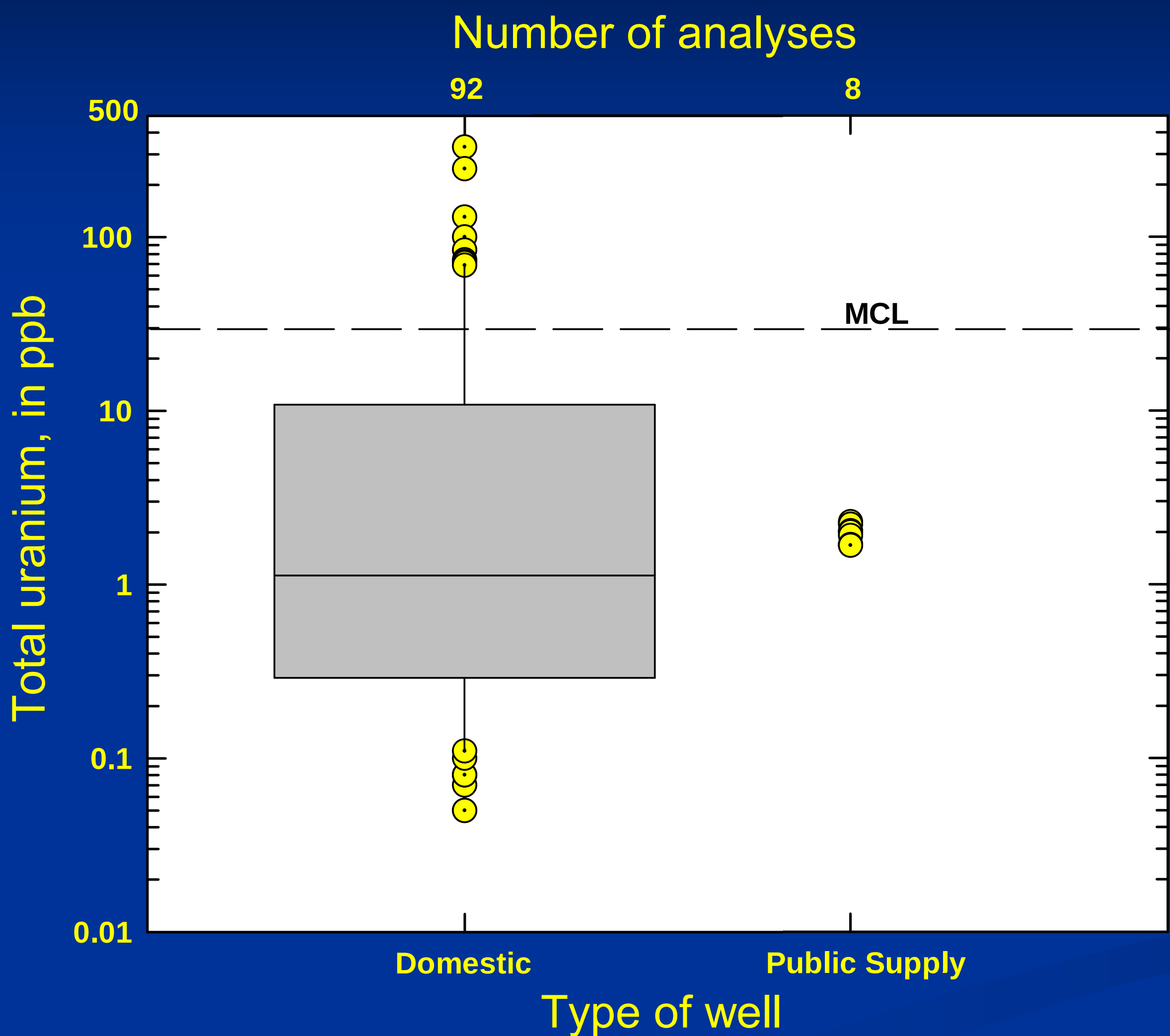


89 percent of all the samples exceeded the current MCL.

Since 2004 public-supply wells are now treated to meet the MCL

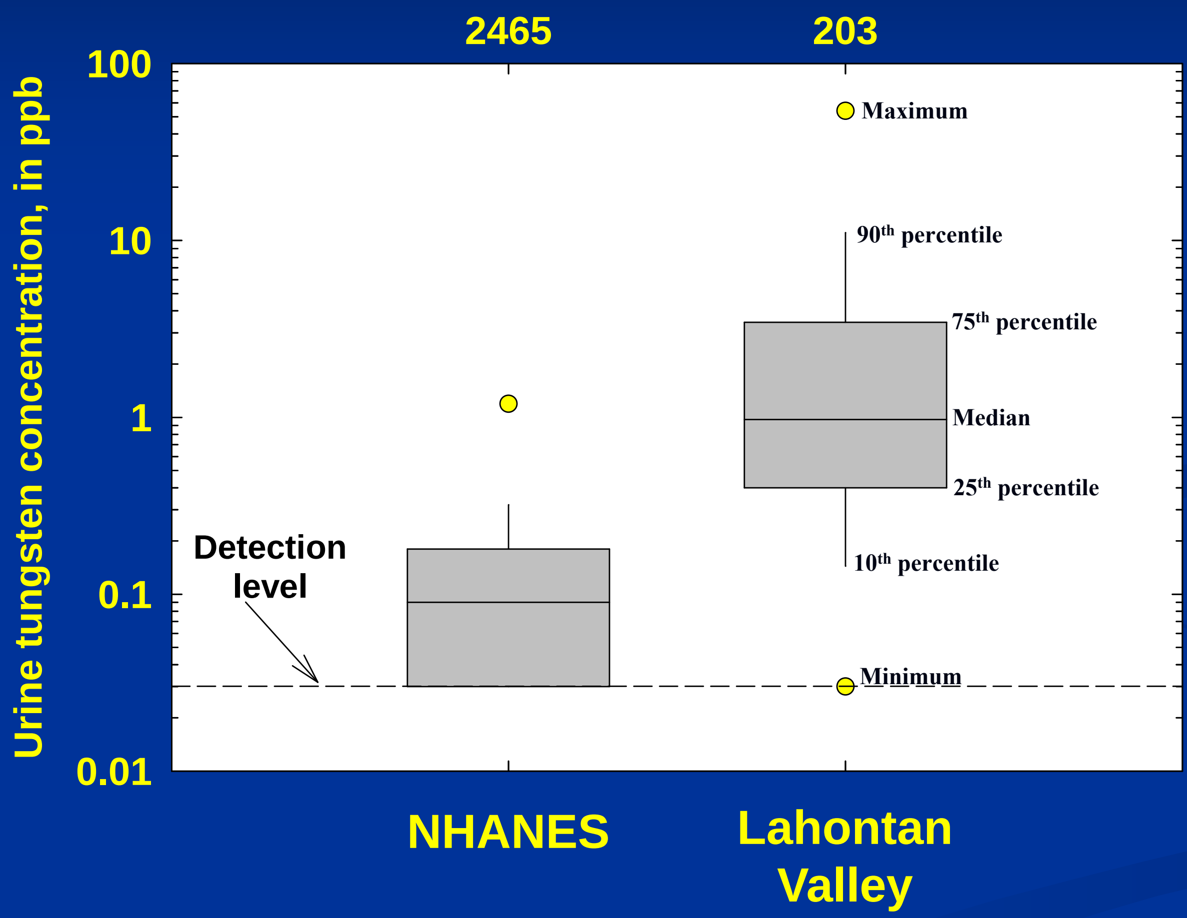
USGS

Uranium in 2001



18 percent of the samples, all from domestic wells, exceeded the MCL.

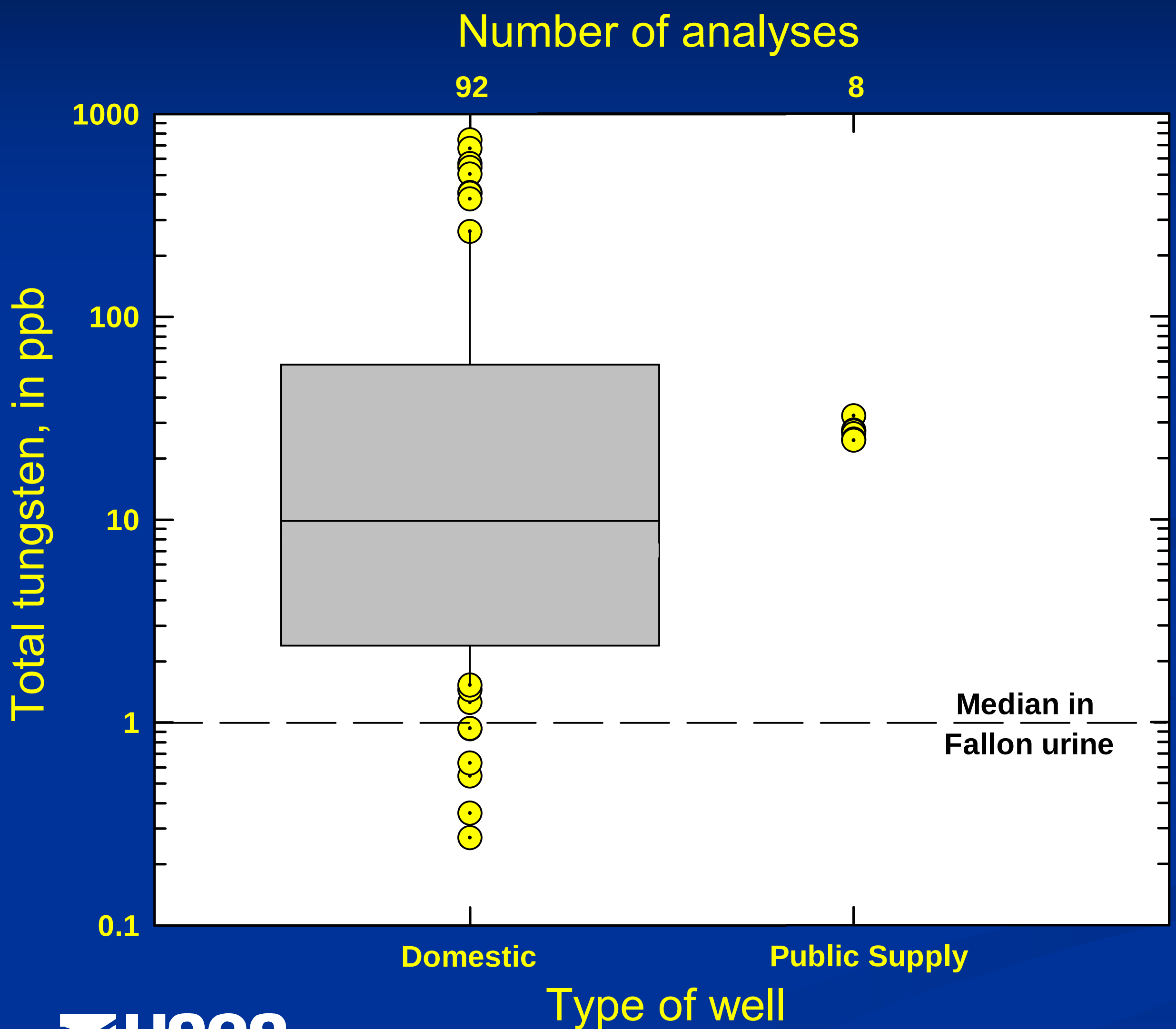
Tungsten in urine



In 2002, CDC found that tungsten in the urine of Lahontan Valley residents is very high compared to the rest of the nation.

USGS

Tungsten in groundwater in 2001

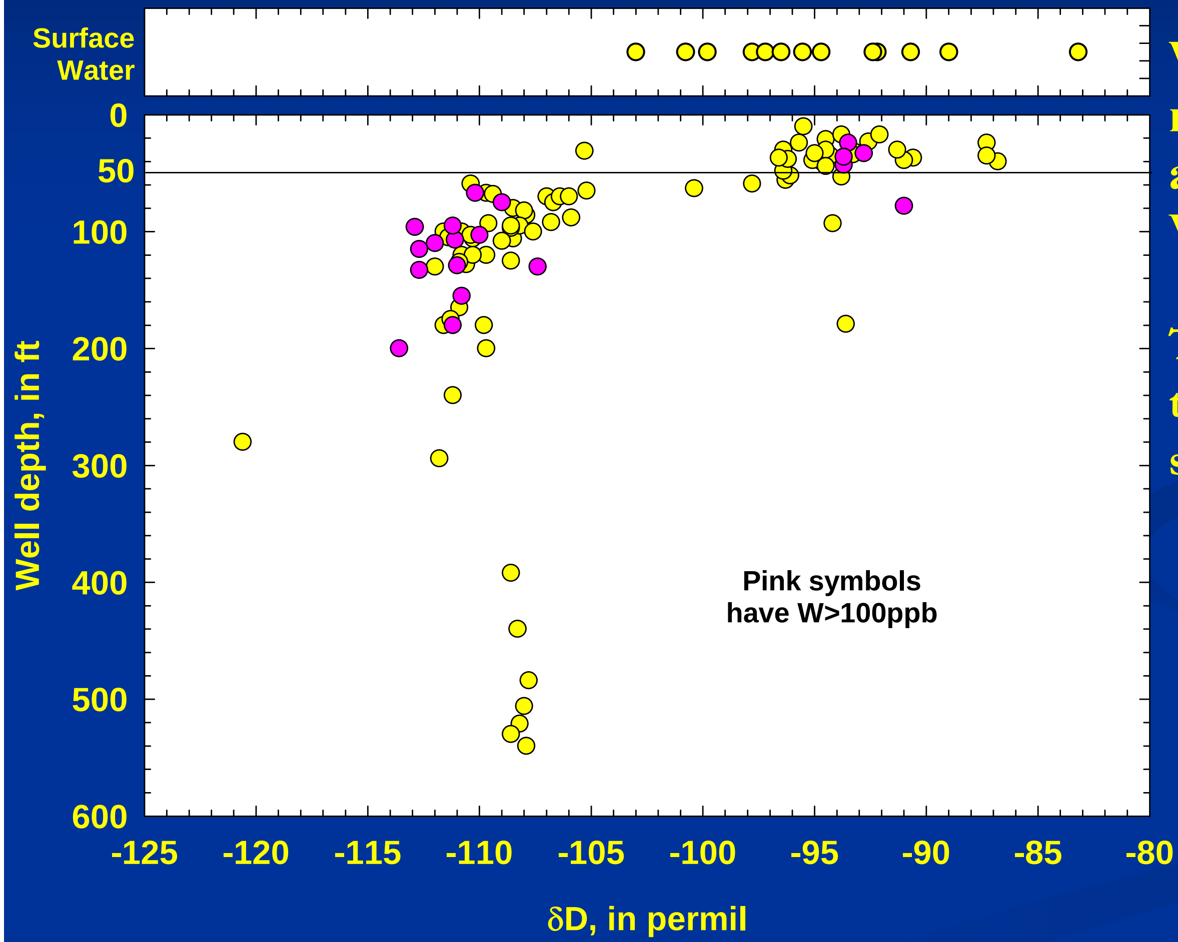


Concentrations ranged from 0.3 to 740 ppb, and are high enough to explain the observed tungsten concentration in urine.

Where is the tungsten coming from— A tungsten mill in town, or natural sources?

USGS

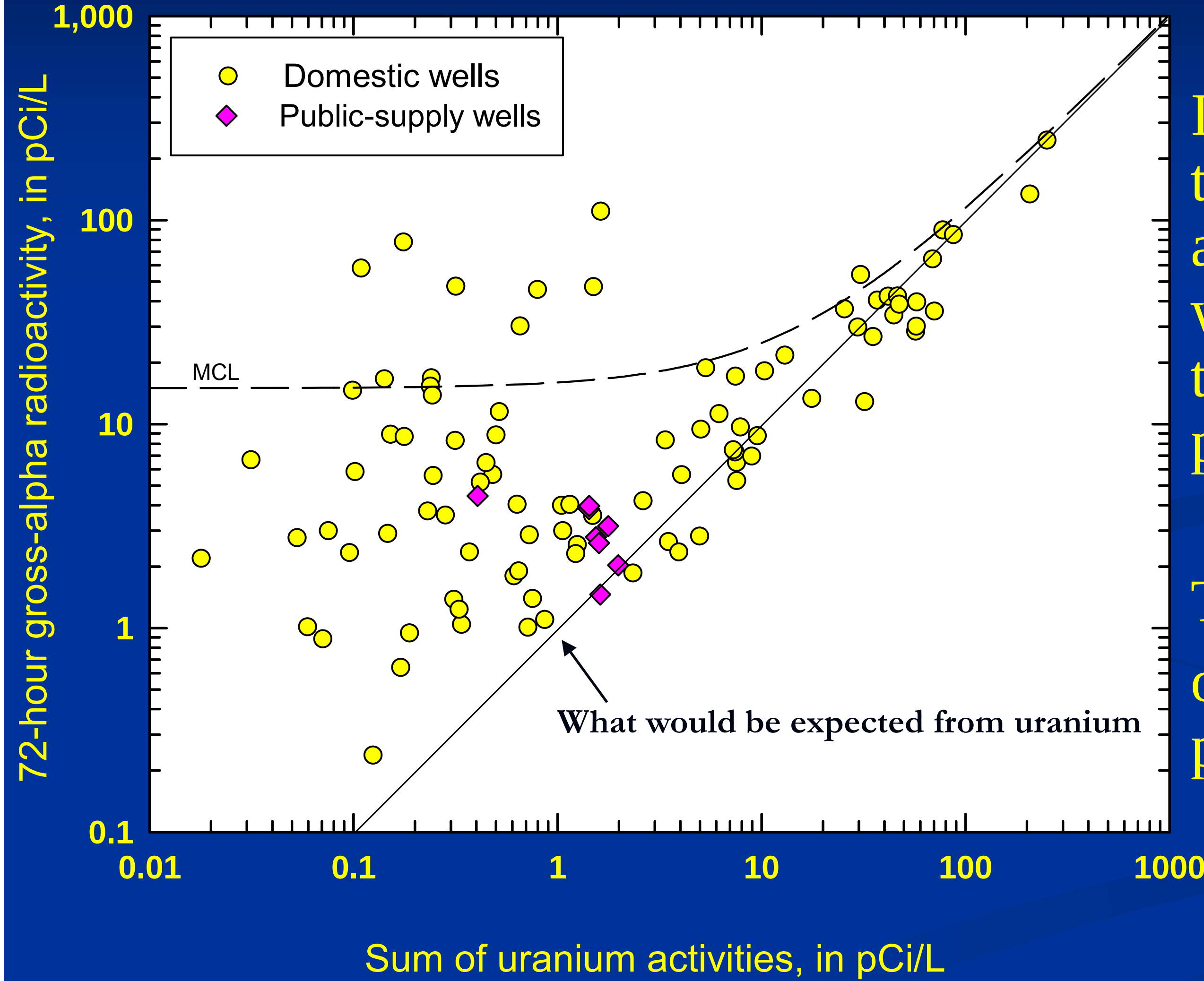
Tungsten and age of the water



Water in deep wells was probably recharged prior to construction of a reservoir upstream of Lahontan Valley in 1915.

These data suggest that the tungsten is old and has a natural source.

Gross alpha radioactivity in 2001

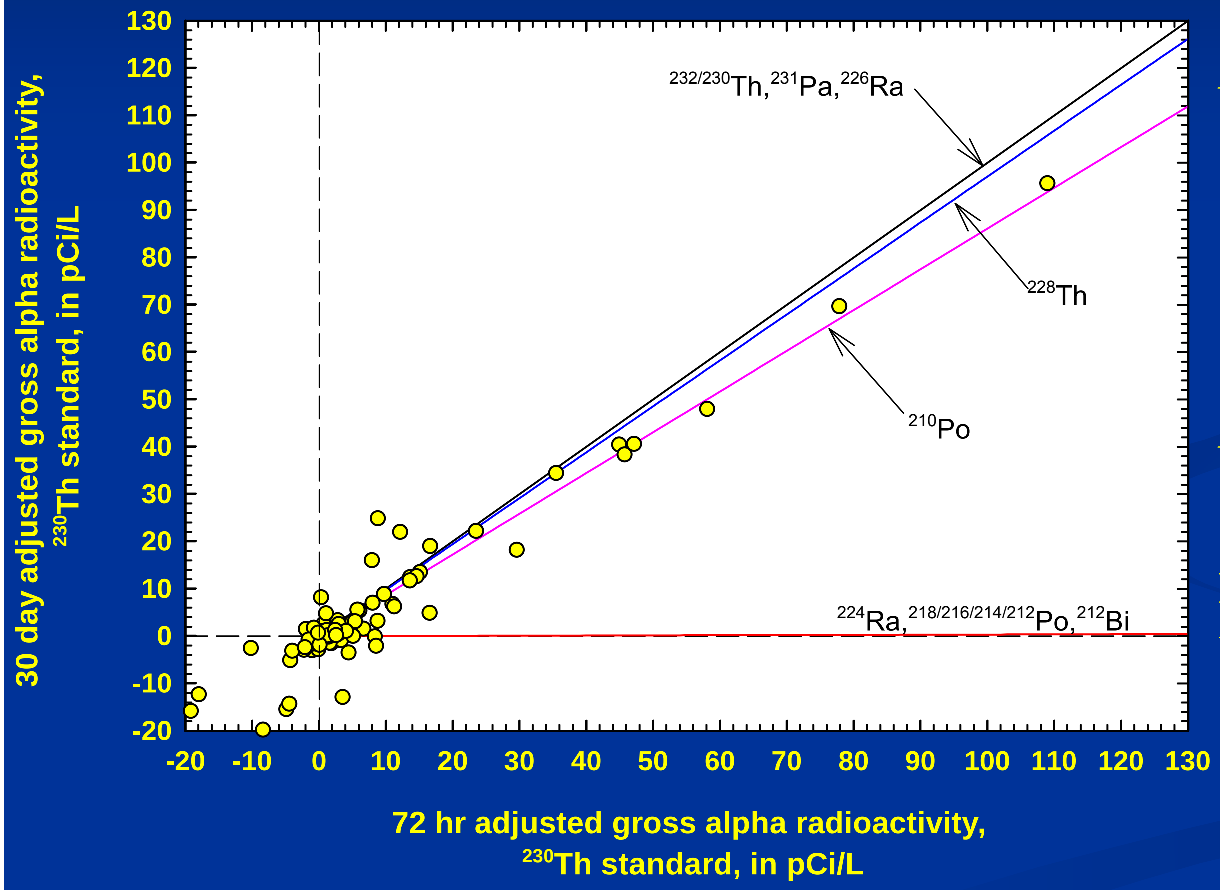


In some domestic wells there was much more alpha radioactivity than would be expected from the amount of uranium present.

This suggested some other alpha emitter was present.

USGS

Gross alpha and polonium-210



A comparison of the 72 hr and 30 day gross alpha suggested the other alpha emitter was ^{210}Po.

A follow-up investigation starting in 2007 confirmed numerous domestic wells had very high ^{210}Po levels.

What is polonium-210?

^{238}U $T_{1/2} = 4.5 \times 10^{9}$ y

^{222}Rn $T_{1/2} = 3.8$ d

^{210}Pb $T_{1/2} = 22.3$ y

β

^{210}Po $T_{1/2} = 138.4$ d

α

^{206}Pb Stable

^{210}Po will be present in the environment wherever uranium or radon are present.

Health effects and drinking-water standards

- Polonium-210 is an established human carcinogen.
- An acute lethal dose is probably $<1\ \mu g$.
- In the US, ^{210}Po is only regulated by the standard for adjusted Gross Alpha Radioactivity (15 pCi/L).
- The Canadian Maximum Acceptable Concen-tration is 5.4 pCi/L.
- The WHO guideline is 2.7 pCi/L.
- The comparable MCL associated with a lifetime total cancer risk of 1:10,000 is 1.1 pCi/L .

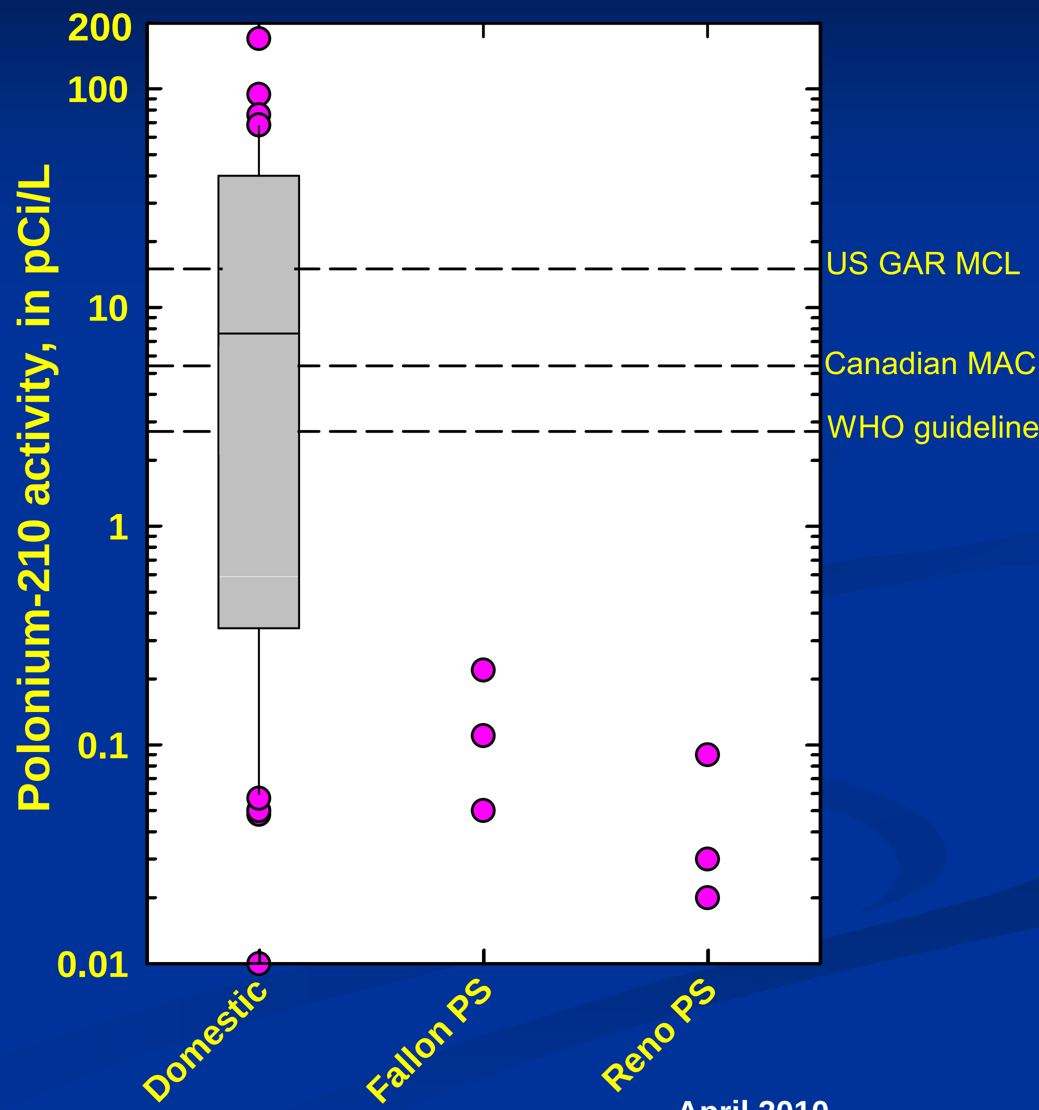
USGS

Polonium-210 in Lahontan Valley groundwater

Polonium-210 strongly binds to aquifer sediments. Values in groundwater are typically <1 pCi/L.

Values ≥ 15 pCi/L are only known from <100 wells in five States (California Florida, Louisiana, Maryland, and Nevada).

Mobilization of ^{210}Po from the sediments probably involves sulfate-reducing bacteria.



USGS

April 2010

Implications of these studies

- Owners of many domestic wells in Lahontan Valley may be exposed to levels of trace elements and radio-nuclides that greatly exceed safety thresholds.
- Chemical analyses are not required for domestic wells in many States and homeowners may never discover they are being exposed to toxic trace elements and radionuclides.
- Discoveries of problems at public-supply wells may be fixed without owners of nearby domestic wells learning they also need to fix a problem.

Implications of these studies

- ^{210}Po will be present wherever radon occurs, but it is extremely rare in groundwater.
- Is ^{210}Po rare because:
  - It really is rare? Or
  - Ground water is rarely sampled for ^{210}Po and the gross alpha method used to monitor for ^{210}Po can volatilize ^{210}Po from the sample? Or
  - We look in the wrong places?
- ^{210}Po could be more common at levels exceeding safety thresholds than currently believed.

Sources of additional information

- Seiler, R.L., 2004. Temporal changes in water quality at a childhood leukemia cluster. Groundwater 142(3):446-455.
- Seiler, R.L., Stollenwerk, K.G., and Garbarino, J.R., 2005. Factors controlling tungsten concentrations in ground water, Carson Desert, Nevada. Applied Geochemistry 20:423-441.
- Seiler, R.L., 2006. Mobilization of lead and other trace elements following shock chlorination of wells. Science of the Total Environment 367:757-768.
- Walker, M., Seiler, R.L., and Meinert, M., 2008. Effectiveness of household reverse-osmosis systems in a Western U.S. region with high arsenic in ground-water. Science of the Total Environment 389:245-252.
- Seiler, R.L., *in press*. ^{210}Po in Nevada groundwater and its relation to gross alpha radioactivity. Groundwater
- USEPA, 2000, Radionuclides Notice of Data Availability Technical Support Document. http://www.epa.gov/safewater/rads/tsd.pdf