Efficiencies and Consolidation of Groundwater Sampling at the Nevada National Security Site (NNSS)

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Historical Groundwater Sampling

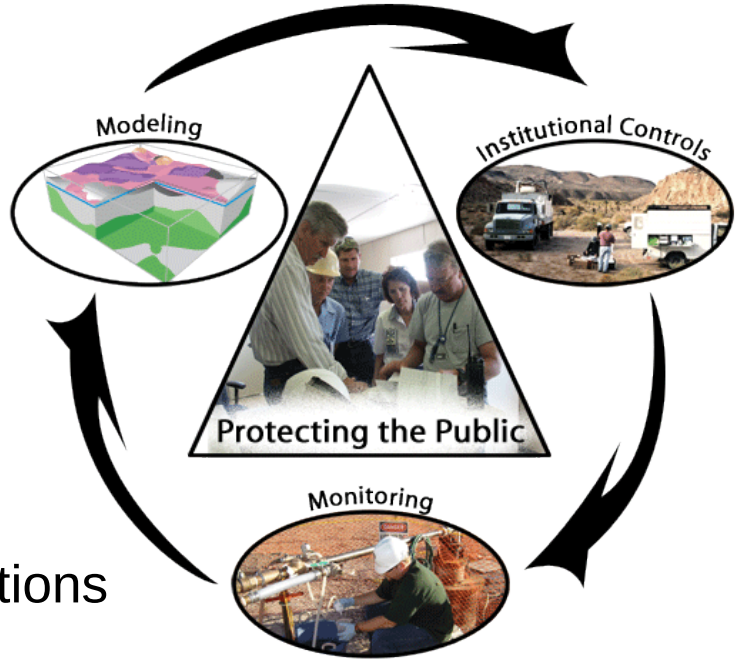
- Samples collected since 1960s
- Evolution over sampling period:
  - Sampling technologies
  - Analytical methods
  - Analytical parameter suites
- Post-test, near-field (satellite), water-supply, hydrologic test, and UGTA characterization wells
- Data stored in the UGTA Geochemistry Database

NNSS Sampling/Monitoring Programs

- Underground Test Area (UGTA) Activity
- Routine Radiological Environmental Monitoring Program (RREMP)
- Community Environmental Monitoring Program (CEMP)

UGTA Strategy

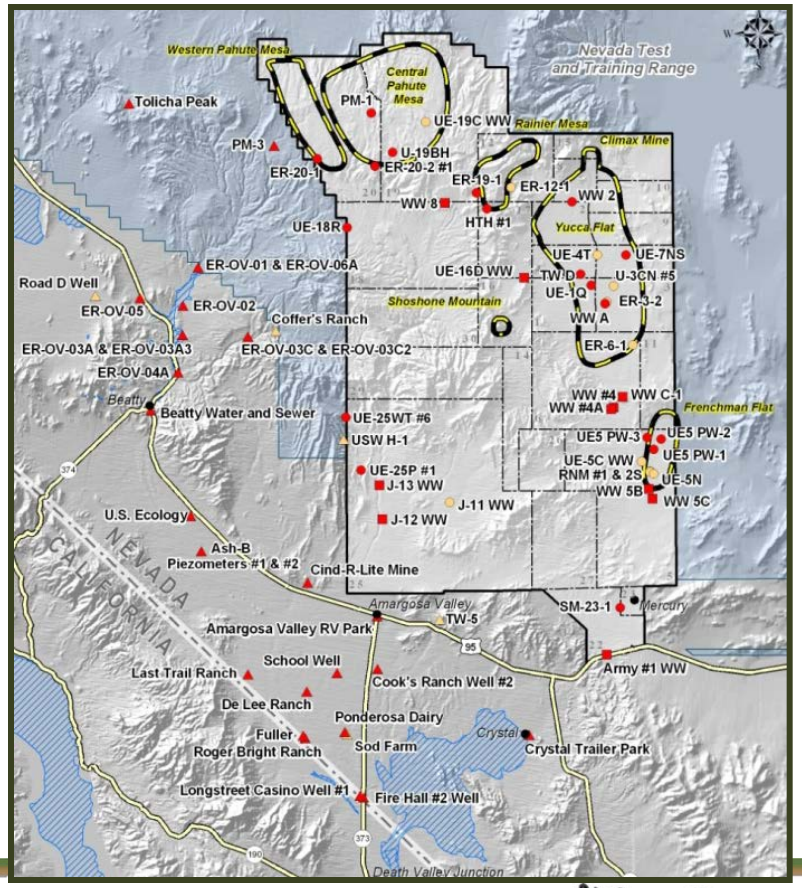
- Corrective Action Investigation
  - Geology, hydrology, chemistry characterization activities
  - 1,000 year probabilistic forecasts of Safe Drinking Water Act (SDWA) maximum contaminant level (MCL) exceedances
- Corrective Action Decision Document/ Corrective Action Plan
  - Data collection and iterative model evaluations to build confidence in model forecasts
- Closure Report
  - Develop institutional controls to restrict access to contaminated groundwater and develop/implement long-term monitoring plan



RREMP

- Demonstrates compliance with local, state, and federal regulatory requirements

- Sampling and analysis for:
  - pH, specific conductance, temperature
  - Alkalinity, total dissolved solid, total organic carbon
  - Major ions/trace elements
  - ^{3}H, gross alpha/gross beta, and gamma emitters
  - ^{14}C, ^{90}Sr, ^{99}Tc, and $^{238, 239, 240}Pu$

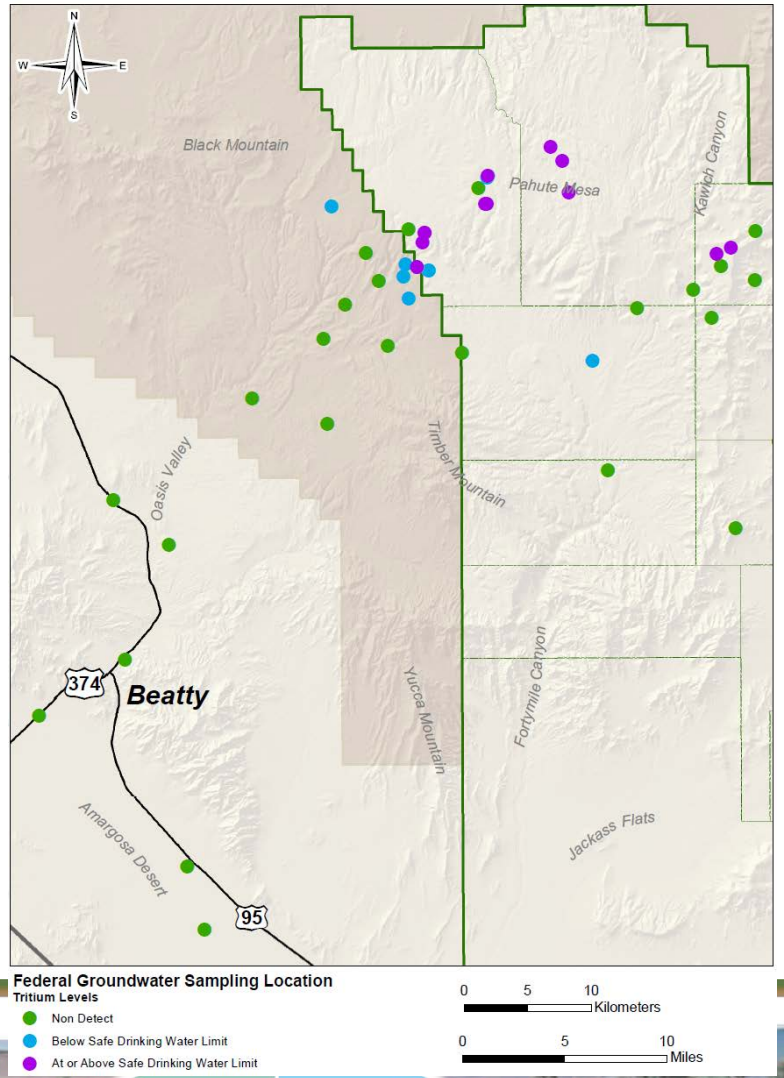


CEMP

- Performs annual, independent radiological monitoring of water supply systems in communities surrounding the NNSS
- Independent outreach program managed by the Desert Research Institute.
- Emphasizes community involvement

UGTA Sampling Plan Objectives

- Define specific sampling/analysis objectives
- Define data collection criteria (e.g., well purging requirements, minimum detection limits, sampling frequency, analytes) to meet objectives
- Standardize sample collection/analysis procedures
- Define roles and responsibilities for UGTA participants
- Define reporting mechanisms
- Integrate with other DOE programs
- Ensure compliance with Quality Assurance Plan



Radionuclides as Regulated Contaminants in Groundwater

Beta/photon emitters (^{3}H, ^{90}Sr, ^{129}I,…):	4 mrem/yr (dose)
Gross alpha particle (^{238}, ^{239}, ^{240}Pu,…):	15 pCi/L (activity)
Uranium: (^{232}, ^{233}, ^{234}, ^{235}, ^{236}, ^{238}U):	30 μg/L (mass)

- SDWA (CFR, 2014)
- Dose-based MCLs estimated from dose-conversion factors for individual radionuclides
- Total dose (4 mrem/yr) is cumulative including all beta/photon emitters

Contaminants of Concern (COC)/ Contaminants of Potential Concern (COPC)

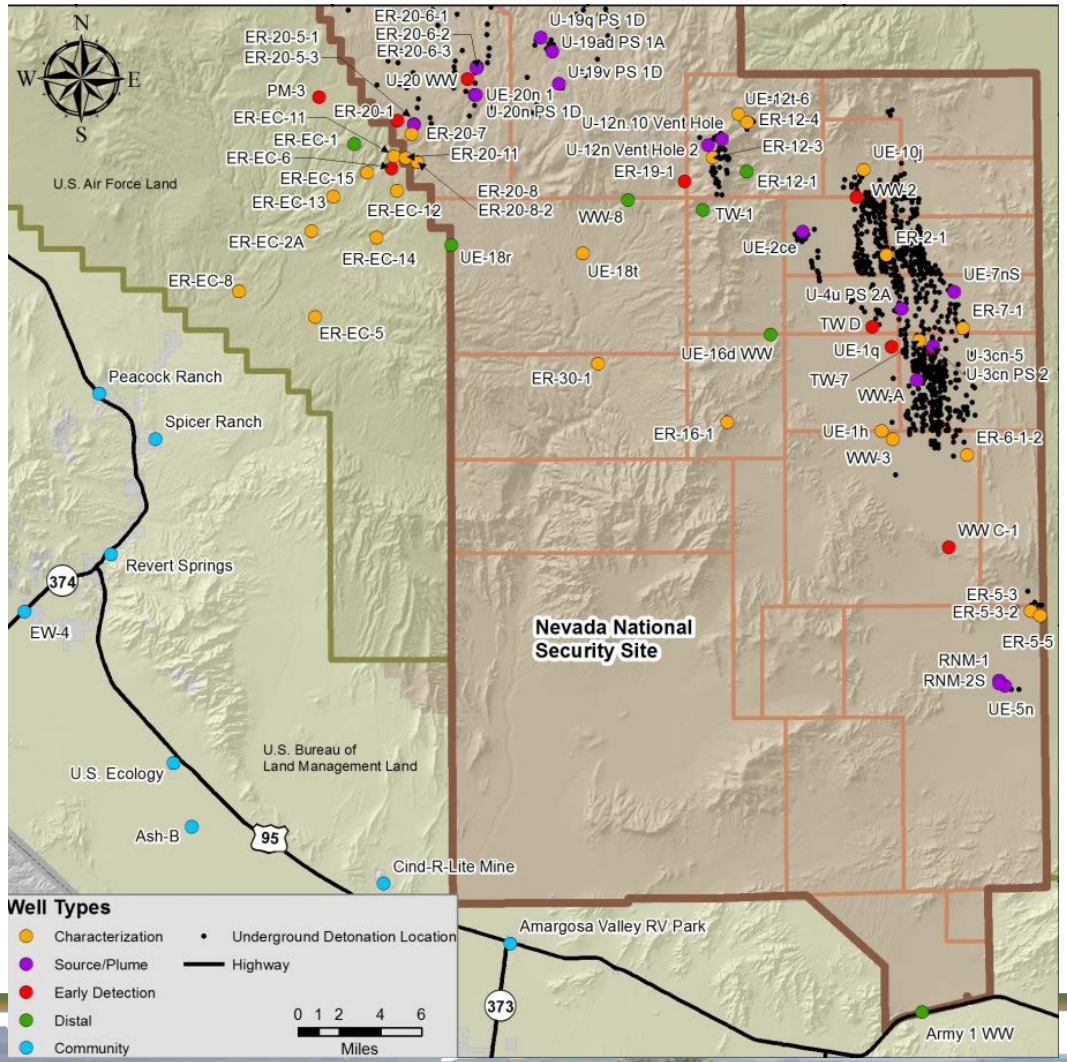
- A COC is defined as a radionuclide that exceeds 10% of the associated MCL at sampling locations other than in or near the underground nuclear test cavity

- A COPC is defined as a radionuclide that has not been detected above 10% of the MCL in sampling locations other than in or near the underground nuclear test cavity, but has some likelihood of exceeding this criterion in the future

UGTA Well Types

Well Type	Definition	Purpose
Characterization	Used for system characterization or model evaluation	• Identify groundwater flow paths • Estimate travel times • Establish COC and COPC presence
Source/Plume	Located within, near, and/or immediately downgradient of test cavity and $^{3}H \geq 300$ pCi/L	• Monitor contaminant migration • Monitor natural attenuation • Identify potential COCs
Early Detection	Located downgradient of an underground detonation and ^{3}H <300 pCi/L	• Detect plume edge
Distal	Outside the early detection area	• Verify COCs (i.e., currently tritium) do not exceed the MCL
Community	Located on federal or private land; used as water supply source or is located near one	• Verify COCs do not exceed the MCL

Sampling Plan Wells



- COCs for each well type are determined using up-gradient sample results
- For instance, COCs and levels observed in source/plume wells suggest the analytical suite and required detection limits for the early detection wells
- Well types change as contaminant transport progresses
- For instance, early detection wells become contaminant migration wells once COCs reach a pre-specified level (i.e., 300 pCi/L ^{3}H)

Characterization Analytes

- Alkalinity, pH, specific conductance
- Anions
- Total metals
- Gross alpha and gross beta
- Gamma emitters (^{26}Al, ^{94}Nb, ^{137}Cs, ^{152,154}Eu, ^{235}U, ^{241,243}Am)
- ^{3}H (standard and/or low-level)
- ^{14}C, ^{36}Cl, ^{99}Tc, ^{90}Sr,^{129}I, ^{238,239,240}Pu
- Stable isotopes (δD, δ^{18}O, δ^{13}C)
- Noble gases: If <5,000 pCi/L ^{3}H is present

State-of-the-Art Analytical Technologies

Lawrence Livermore National Laboratory (LLNL) and Los Alamos National Laboratory (LANL)

LLNL Center for Accelerator Mass Spectrometry

- ^{14}C (~10^{-2} pCi/L)
- ^{36}Cl (~10^{-6} pCi/L)
- ^{129}I (~10^{-7} pCi/L)

LANL Gamma Counting

- ^{26}Al, ^{94}Nb, ^{126}Sn, ^{137}Cs, $^{150, 152, 154}Eu$, and ^{166m}Ho (~0.1– 1 pCi/L)

LANL Beta Counting

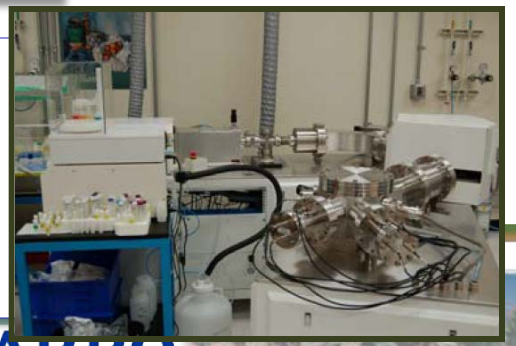
- ^{85}Kr (~0.1- 0.5 pCi/L)

LLNL Noble Gas Mass Spectrometry

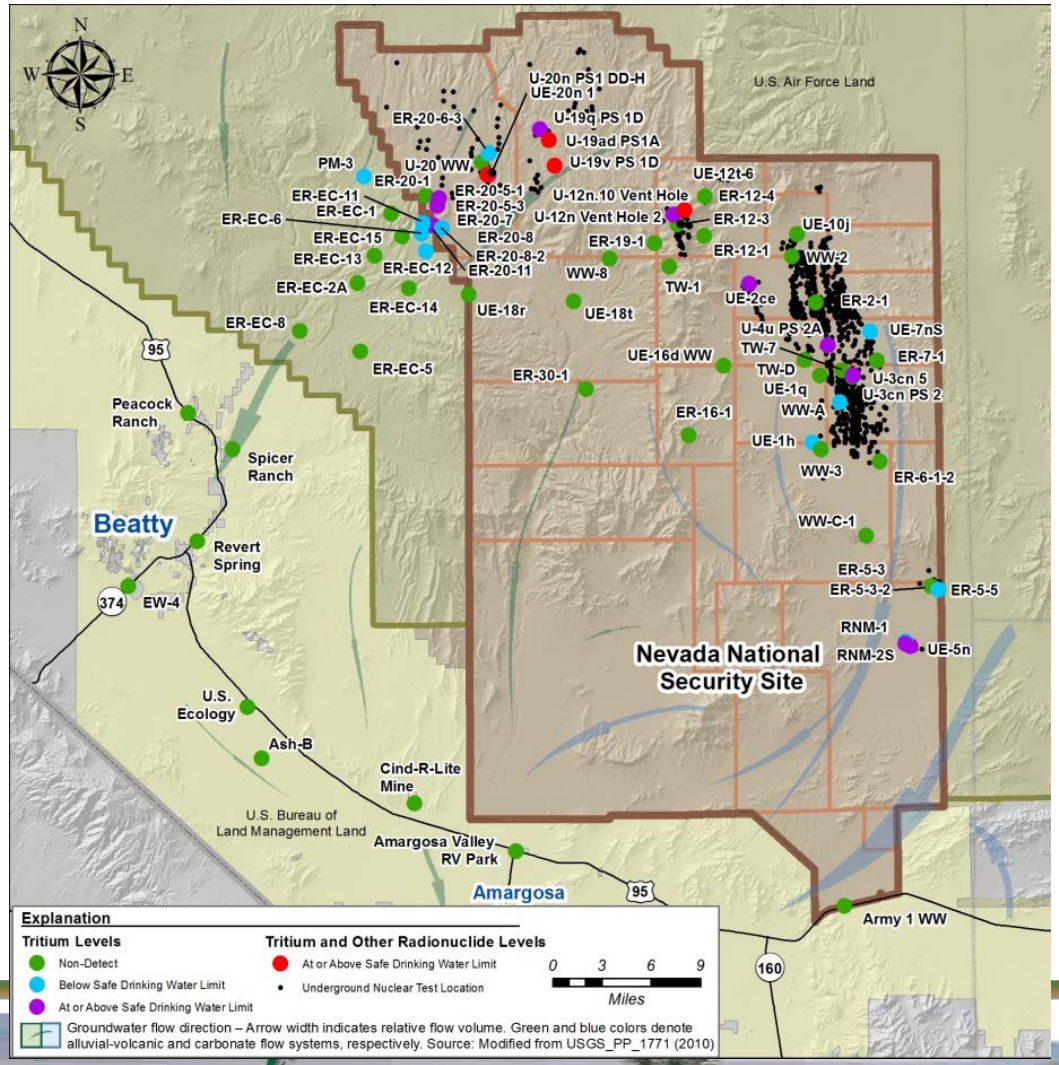
- ^{3}H (~1 pCi/L)

LLNL Inductively Coupled Mass Spectrometry

- ^{99}Tc (~10^{-4} pCi/L)
- Pu (~10^{-3} pCi/L)
- U (~0.25 ng/L)



Radionuclide Activities



- 20,000 pCi/L SDWA MCL for ^{3}H is exceeded in seventeen (17) sampling locations
- SDWA MCL is exceeded for radionuclides other than ^{3}H in four (4) sampling locations
  - Samples either from a test cavity or a tunnel where testing occurred

Sampling Criteria

Well Type	Analytes	Sampling Frequency
Source/Plume	^{3}H, ^{14}C, ^{36}Cl, ^{99}Tc, ^{129}I (all CAUs) plus Pu (Rainier Mesa/Shoshone Mountain) plus ^{90}Sr and ^{137}Cs (in carbonate aquifer samples from Yucca Flat/Climax Mine)	4 years
Early Detection	^{3}H*	2 to 5 years
Distal	^{3}H**	5 years
Community	^{3}H**	5 years

* Minimum detection limit of 1 to 10 pCi/L

**Minimum detection limit of ~300 pCi/L

Reporting Levels

- **Investigation Level** – COC/COPC significantly increases from the baseline or previous analysis
- **Notification Level** – First time COC/COPC detected above:
    1) 10% MCL on public, private, and federal land
    2) 50% MCL on Air Force land
- **Action Planning Level** – First time COC/COPC detected above:
    1) 50% MCL on public, private, and federal land
    2) MCL on Air Force land
- **Action Level** – COC or COPC is above the MCL on public, private, and federal land; defined in Closure Report

Conclusion

- Wells are categorized to select COCs/ detection limits and sampling frequency
- Contamination is primarily limited to ^{3}H with only a few MCL exceedances for other COCs
- Sampling criteria and well categorization will be evaluated periodically (i.e., bi-annually) to ensure monitoring objectives are being met