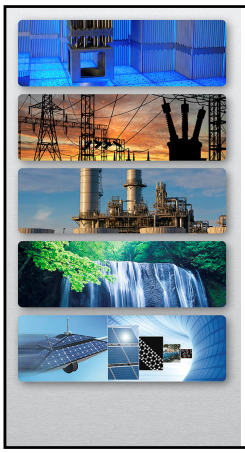

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EPRI Perspectives on Nuclear Plant Groundwater Protection Programs

Sean Bushart
EPRI Sr. Program Manager
Low Level Waste, Chemistry and Radiation Protection

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Overview

- Question #1: How were conceptual models formulated for the various radionuclide sources and site-specific features, events and processes?
- Question #5: What root-cause analyses are carried out to identify abnormal release mechanisms and to assist in identifying corrective actions?
- Question #10: If remediation was needed, what monitoring data is used to select the remediation methods and their efficacy?

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Scope of Nuclear Plant Groundwater Protection Programs

Systems Investigated
- Spent fuel pools
- Buried piping and tanks
- Liquid effluent discharge valves
- Operational leaks and spills

Tritium
- Low levels of tritium observed in on-site monitoring wells
  - U.S. EPA safe drinking water limit is 20,000 pCi/L
- A few sites have detected other radionuclides (Co, Cs, Sr)

Levels observed do not present a health concern to public

Sites have implemented voluntary groundwater protection programs to prevent off-site migration of contamination

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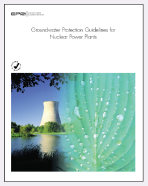
The EPRI Groundwater Protection Program

Industry Experiences and Lessons Learned

Decommissioning Plant Experiences | Operating Plant Experiences

Annual Groundwater Protection Workshops

Technical Guidance



Groundwater Protection Guidelines for Nuclear Power Plants (2007 EPRI Report 1015118)

EPRI Groundwater and Soil Remediation Guidelines for Nuclear Power Plants (2010 EPRI Report)

Research and Technology Innovation

Advanced Technologies for Groundwater Monitoring and Remediation | New Plant Designs and Deployment

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Panel Question #1: How were conceptual models formulated for the various radionuclide sources and site-specific features, events and processes?

Summary Answer: EPRI groundwater protection guidelines provide a "graded approach" for characterizing and investigating sources

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EPRI Groundwater Protection Guidelines (Report 1016099)

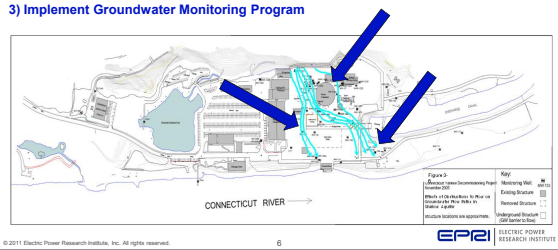
Guidelines Approach

- Provides guidance for development of robust and technically sound *graded approach* to meet the objectives of the Groundwater Protection Initiative

1) Evaluate Systems, Structures, Components (SSCs) and Work Practices

2) Understand Site Hydrogeology and Characteristics

3) Implement Groundwater Monitoring Program



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Developing a Site Conceptual Model: Key Guidelines Statements-Baseline Program

- Examine references that show SSCs located below the water table that may divert local groundwater and contaminant flow
- Examine available reports of previous hydrogeologic investigations of the site
- Evaluate records relating to groundwater elevation
- Evaluate geologic studies that were conducted during the initial siting investigation of the plant
- Locate monitoring wells so as to adequately characterize the horizontal groundwater flow.

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Developing a Site Conceptual Model: Key Guidelines Statements-Elevated Program

- If contamination is detected in the shallow aquifer, install additional monitoring wells to characterize the vertical extent of the plume
- Consider the use of data-logging pressure transducers to record changes in water level in selected monitoring wells
- Consider conducting aquifer testing to estimate the rate of groundwater flow
- Hydrophysical testing may be conducted to identify water-bearing fractures and fractured zones within consolidated bedrock formations
- Evaluate the need for a fate and transport numerical model

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Panel Question #5: What root-cause analyses are carried out to identify abnormal release mechanisms and to assist in identifying corrective actions?

Summary Answer: If radionuclides are identified in monitoring wells, plants implement investigations that can include more advanced groundwater monitoring, characterization, and modeling, as well as SSC and work practice evaluations to identify the source of the radionuclides.

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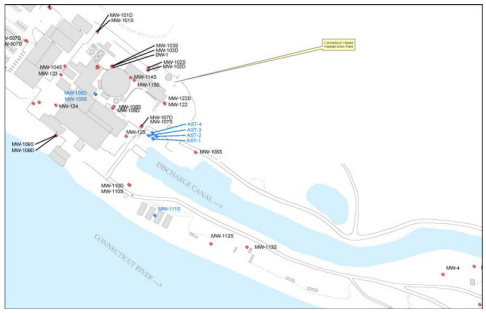
Case Study: Connecticut Yankee
Monitoring Well Locations



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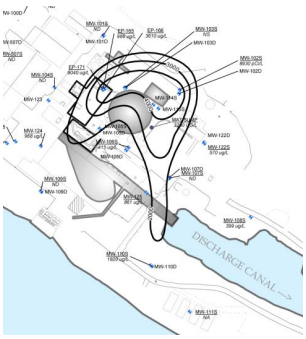
Connecticut Yankee: Tritium in the Unconfined Aquifer



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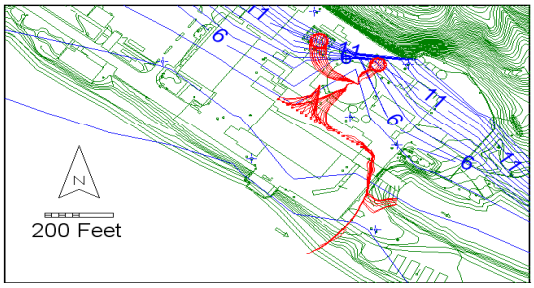
Particle Traces from Groundwater Model Simulation



Results Indicated Three Source Areas

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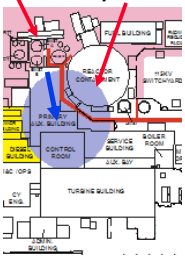
Media Removal Areas at Connecticut Yankee

Outside Tank Leakage

Tanks

Ground Water plume



Removal of Media

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Panel Question #10: If remediation was needed, what monitoring data is used to select the remediation methods and their efficacy?

Summary Answer: The types of radionuclides, the concentrations of radionuclides, soil type, hydrogeological measurements, as well as the extent of contamination all factor into the most effective remediation method for each contamination situation.

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Technical Evaluation of Remediation Options

Remediation Option	Potentially Affects Plant Operation	Potentially Effective for Radionuclide Group
Monitored Natural Attenuation	No	Groups 1 and 2
Pump and Discharge	No	Group 1
Pump and Treat	No	Group 1 Minus H-3
Engineered Confinement	Yes	Group 1
Permeable Reactive Barriers	No (assumes barrier is away from plant systems/ structures)	Group 1 Minus H-3
Soil and Bedrock Removal	Yes	Groups 1 and 2
Biological Remediation	No	Group 1

Group 1: Relatively mobile radionuclides (Distribution Coefficient (K_d) values generally < 50)
Group 2: Relatively immobile radionuclides (K_d values that are generally 50 or higher)

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Evaluating Remediation Efficacy

Example for Monitored Natural Attenuation:

- Continue to monitor contamination concentrations and extent, ensure progress is acceptable to meet remediation objectives
- Ensure any institutional controls continue to be effective
- Ensure site-conceptual models are up to date for the purposes of monitored natural attenuation
- Develop contingency plan if:
  - Contamination migrates beyond established plume or compliance boundary.
  - Contamination is increasing or not decreasing as expected.

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