U.S.NRC

UNITED STATES NUCLEAR REGULATORY COMMISSION

Protecting People and the Environment

Evaluating Abnormal Releases to the Subsurface and ANS 2.17 Guidance

James Noggle, Region I Inspector
Thomas Nicholson, Office of Nuclear Regulatory Research

November 2, 2011
2011 Winter Meeting of the American Nuclear Society
Washington, DC

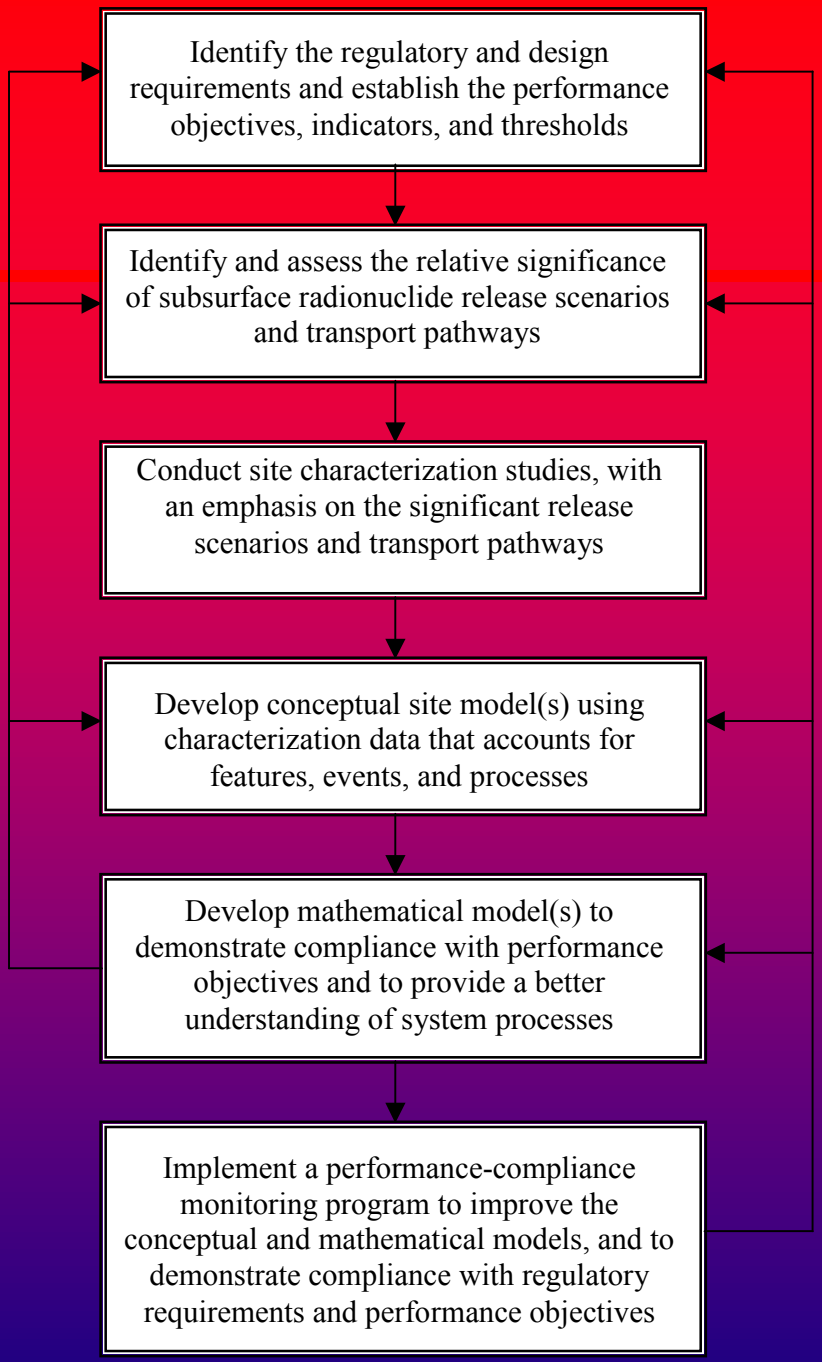
U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

NRC Inspection Activities

- **Investigate the Characterization of Abnormal Release**
- **Evaluate Significance of Release and Potential Exposure Pathways**
- **Review Development of Conceptual Site Model (CSM)**
- **Assess Numerical Models Used to Simulate Ground-Water Transport**
- **Review Confirmatory Performance Monitoring to Evaluate Contaminant Plume Behavior and Performance Assessment**
- **Verify ODCM to Determine Compliance**

Comparison of NRC Inspection under Deviation Memorandum with ANS 2.17

Normal Inspection Procedure 71124.06 stipulates monitoring in accordance with NEI 07-07



Flowchart from ANS 2.17 describing Performance Assessment activities and their relationships

Deviation Memorandum specifies regulatory and closure criteria

Identify sources their concentrations and possible pathways

NRC regulatory criteria 10 CFR Part 20.1302

NEI 07-07 Ground-Water Protection criteria for site-specific information and pathways

Ground-water contaminant flux estimates to support ODCM dose reporting

Confirmation of ODCM estimates and CSM for updating FSAR

Conceptual Site Hydrologic Model

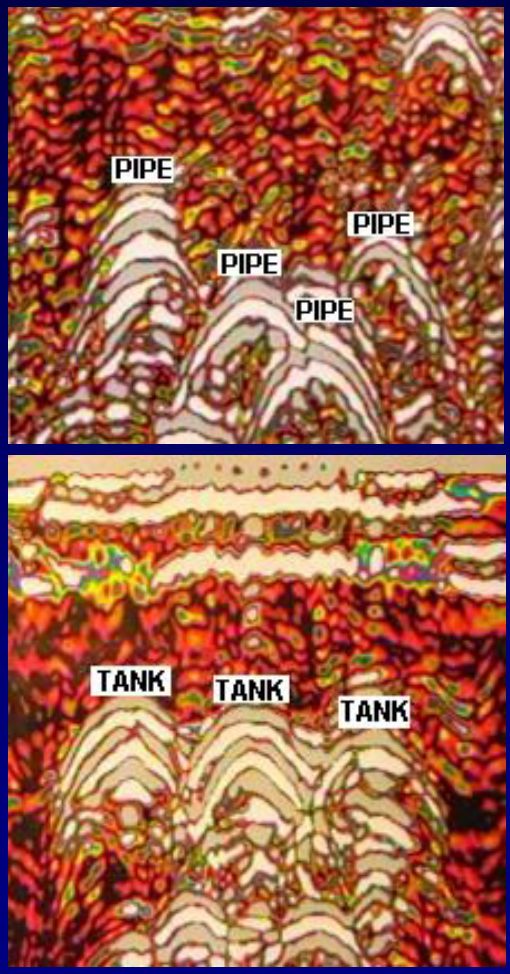
Once surface and/or subsurface contamination is detected, **evaluate its significance and develop an appropriate response**

Factors affecting the level of effort needed (hierarchical approach):

- **Complexity of geologic/hydrologic conditions**
- **Radionuclides and their concentrations in the SSCs**
- **Barriers to ground-water transport**
- **Proximity to the accessible environment**

Site-Specific FEP's for Developing Alternative Conceptual Site Models

- Preferential fast pathways for rapid spread of leaking contaminants
  - pipe or cable trenches
  - gravel backfill
- May drive contaminants in directions not predicted by water-table map analysis
- Local precipitation, washout and drainage (roof and storm drains)
- Sources of abnormal leaks
  - can inject large amounts of water into the vadose zone, sometimes creating perching
  - drive ground water and contaminants in directions not predicted based on water levels from scattered monitoring wells



GPR Images

Integrate Modeling with Monitoring

Why monitor and model?

Couple sources to site characteristics and receptors:

- ✓ **Collect information to identify significant Features, Events and Processes**
- ✓ **Develop and evaluate site conceptual models**
- ✓ **Guide data collection including monitoring, sampling and geophysical surveys**
- ✓ **Formulate scenarios involving human and natural conditions**
- ✓ **Identify Performance Indicators as measureable quantities for both monitoring and modeling**
- ✓ **Analyze Monitoring Data to Determine Compliance to Dose**

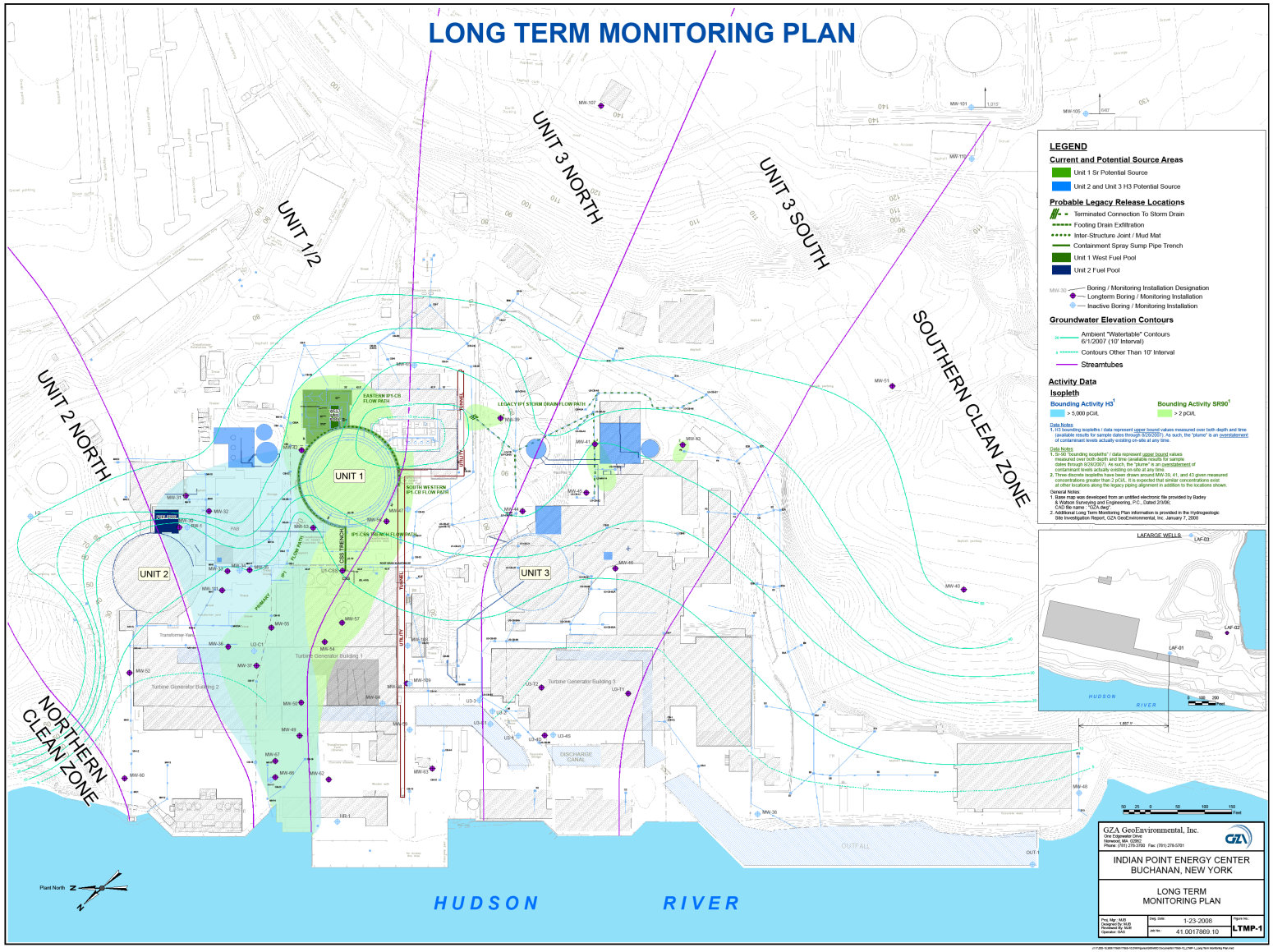
Case Histories – IPEC & Vermont Yankee

Indian Point Energy Center

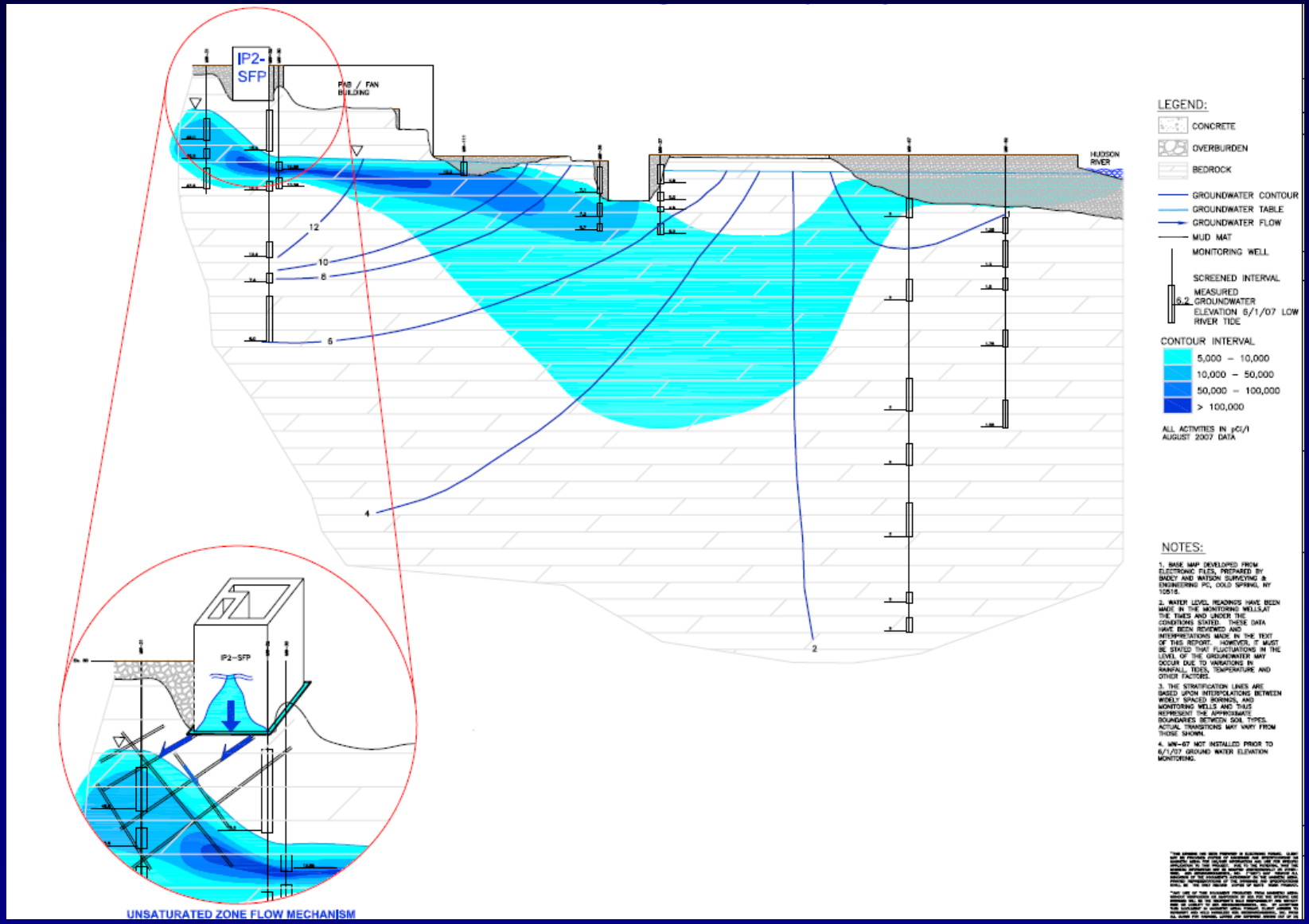
Vermont Yankee

Indian Point Groundwater Plume

(from Entergy, 2009)



Indian Point Groundwater Plume Profile



(from Entergy, 2009)

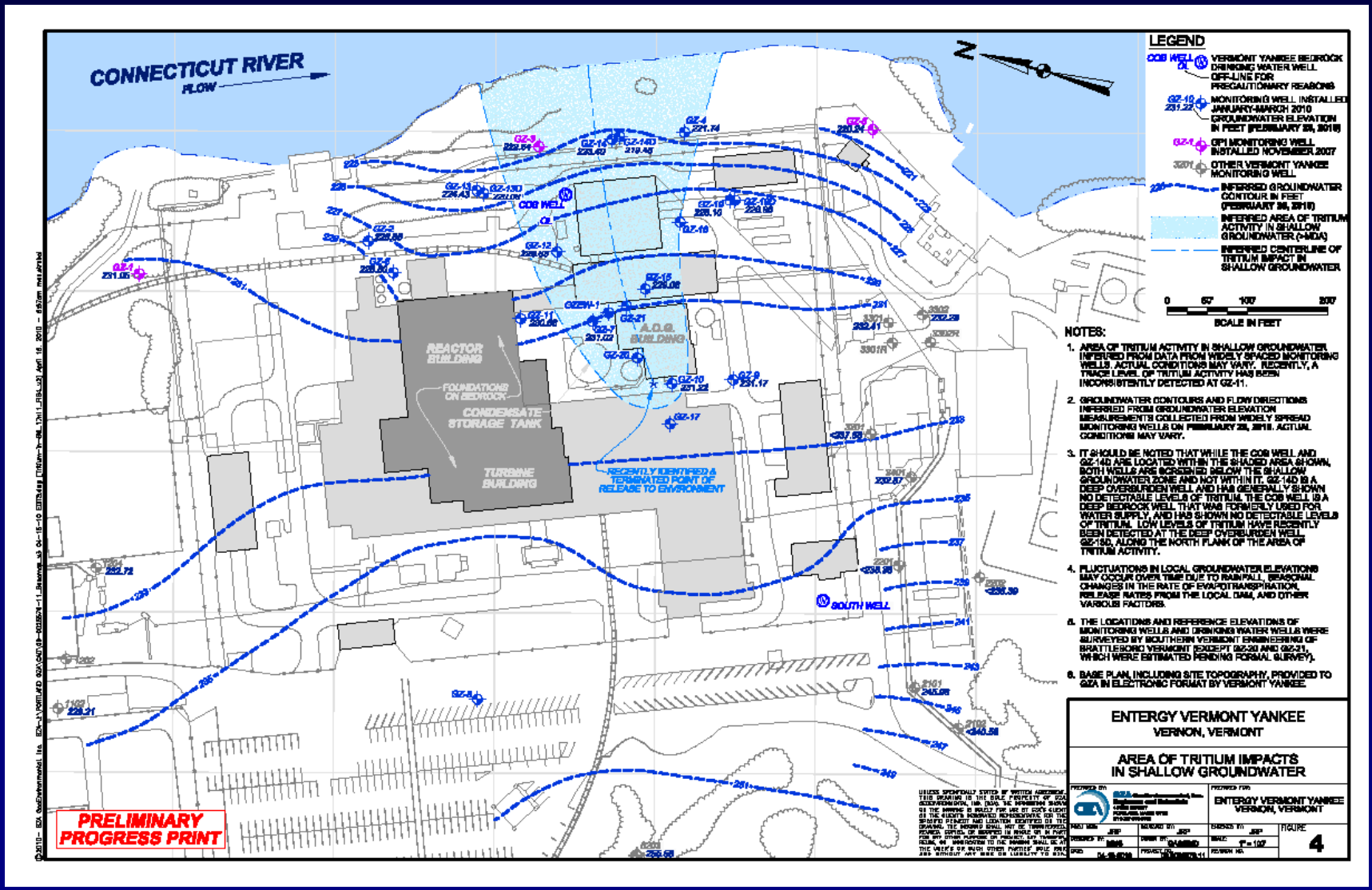
Indian Point Precipitation Mass Balance

- Categorize the site watershed into pathways

  e.g. run-off, infiltration, storm drain, foundation drains
- Establish mathematical model to determine groundwater flux based on precipitation and hydraulic gradient measurements
- Calibrate the model based on Darcy's Law
- Validate the groundwater flux model periodically based on re-measurement of model parameters

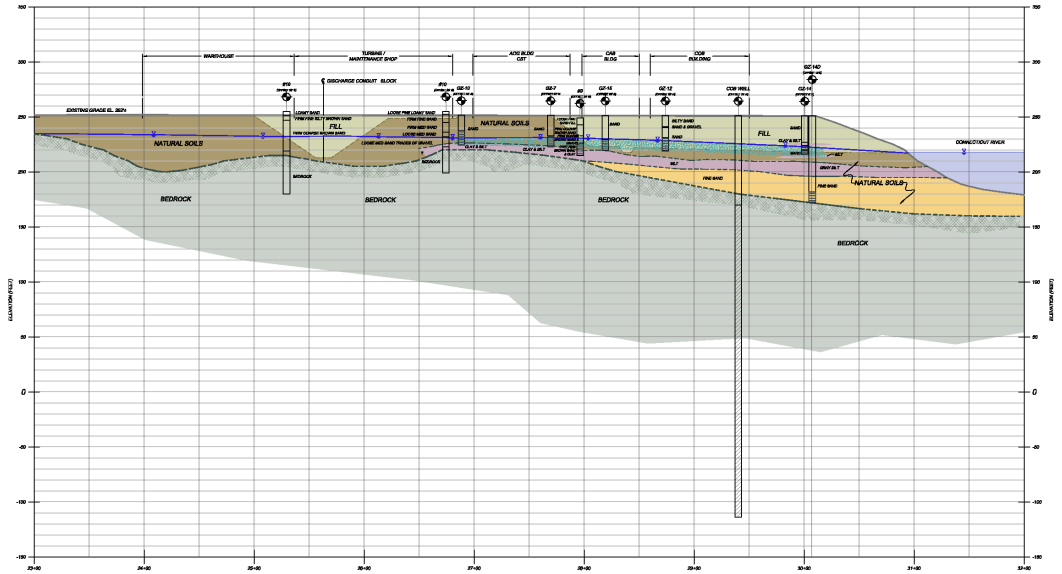
VY February 2010 Tritium Plume

(from Entergy, 2010)



Vermont Yankee Groundwater Profile

(from Entergy, 2010)



ENTERGY VERMONT YANKEE
VERNON, VERMONT

CONCEPTUAL SUBSURFACE PROFILE B-B'

PREPARED BY: GZA GeoEnvironmental, Inc. Engineers and Scientists

PREPARED FOR: ENTERGY VERMONT YANKEE VERNON, VERMONT

DESIGNED BY: JMP | DRAWN BY: JMP | CHECKED BY: | SCALE: 1" = 30' | DATE: 03-01-2010 | PROJECT NO. 09.0025978.11 | REVISION NO. | FIGURE

DRAFT PROGRESS PRINT 03-01-2010

Groundwater flux – Darcy's Law

- Hydraulic gradient (i) – groundwater level data
- Hydraulic conductivity (K) – soil & rock permeability
- Area (A) – cross-sectional area of flow

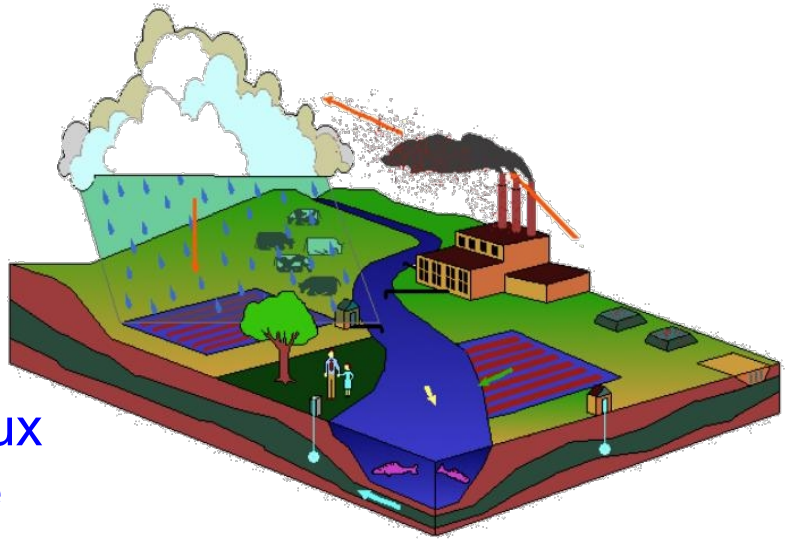
$$\text{Groundwater flux } (Q) = -\ K\ i\ A$$

Offsite Dose Calculation Approach

- Contaminated groundwater flux calculation
- Monitoring well contaminant concentration data
- Determine groundwater effluent release
- Utilize ODCM site-specific exposure pathway analysis to estimate public dose
- Determine compliance with NRC dose criteria

Dose Assessment to Determine Need for Remediation

Decision to Remediate Based upon Source and Site Characterization



- ✓ Identify contaminant sources
- ✓ Determine if releases are continuous or episodic, their radiochemistry and mass flux
- ✓ Collect soil and water samples to estimate contaminant concentrations and properties
- ✓ Identify subsurface pathways to receptors
- ✓ Estimate attenuation and sorption characteristics of subsurface
- ✓ Calculate dose to receptors and compare to dose criteria

- ❖ ***If Dose exceeds regulatory criteria consider the need for remediation***

On-Site Monitoring Needed at Nuclear Facility Sites

- ✓ Minimization of contamination required at new nuclear facilities [10 CFR Part 20.1406 (a) (b) (c)]
  - How facility design and operating procedure will minimize to the extend practicable contamination of the facility and the environment
  - Facilitate eventual decommissioning and minimize generation of radioactive waste
- ✓ Existing radionuclide contamination at operating facilities
- ✓ Facilities being decommissioned

Modeling and Monitoring establish the Technical Basis for Decision-Making such as the need for and selection of Remediation Methods

References

- ✓ Indian Point Energy Center Final Inspection Report
  in ADAMS with accession number **ML092920121**
- ✓ Vermont Yankee Final Inspection Report
  in ADAMS with accession number **ML112630475**
- ✓ Today's Presentation Slides
  in ADAMS with accession number **ML112910162**