300 Area Uranium Plume: Monitoring System and Seasonal Trends

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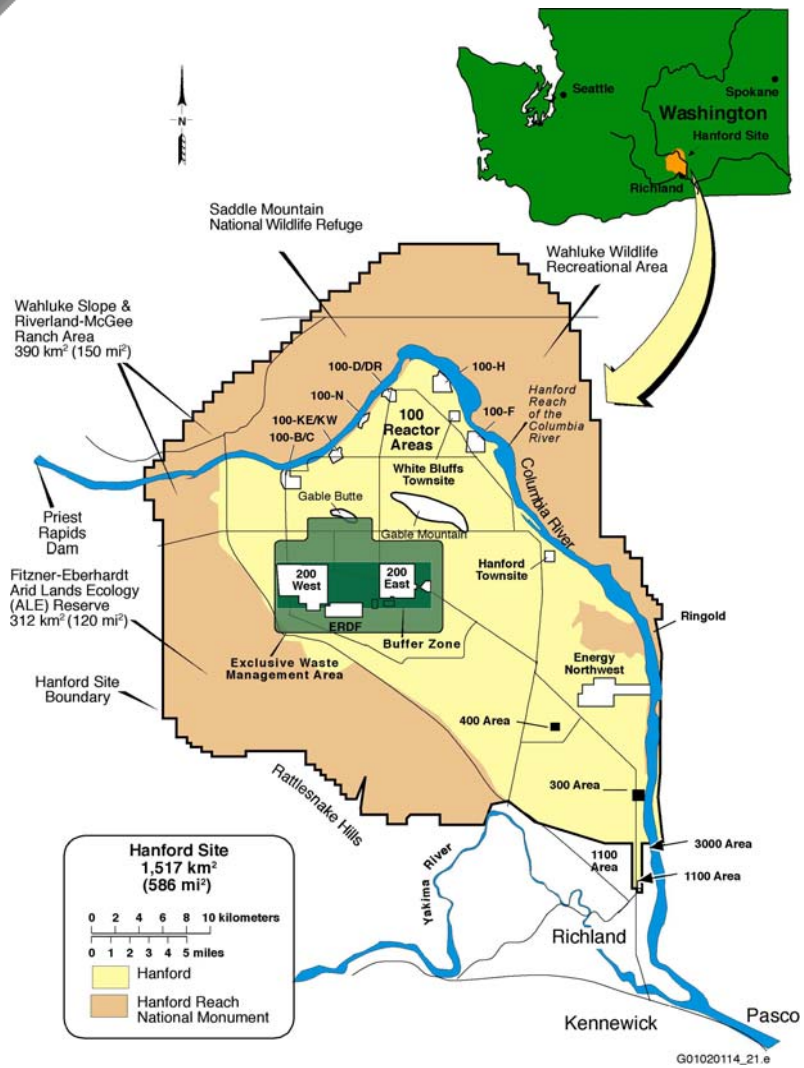


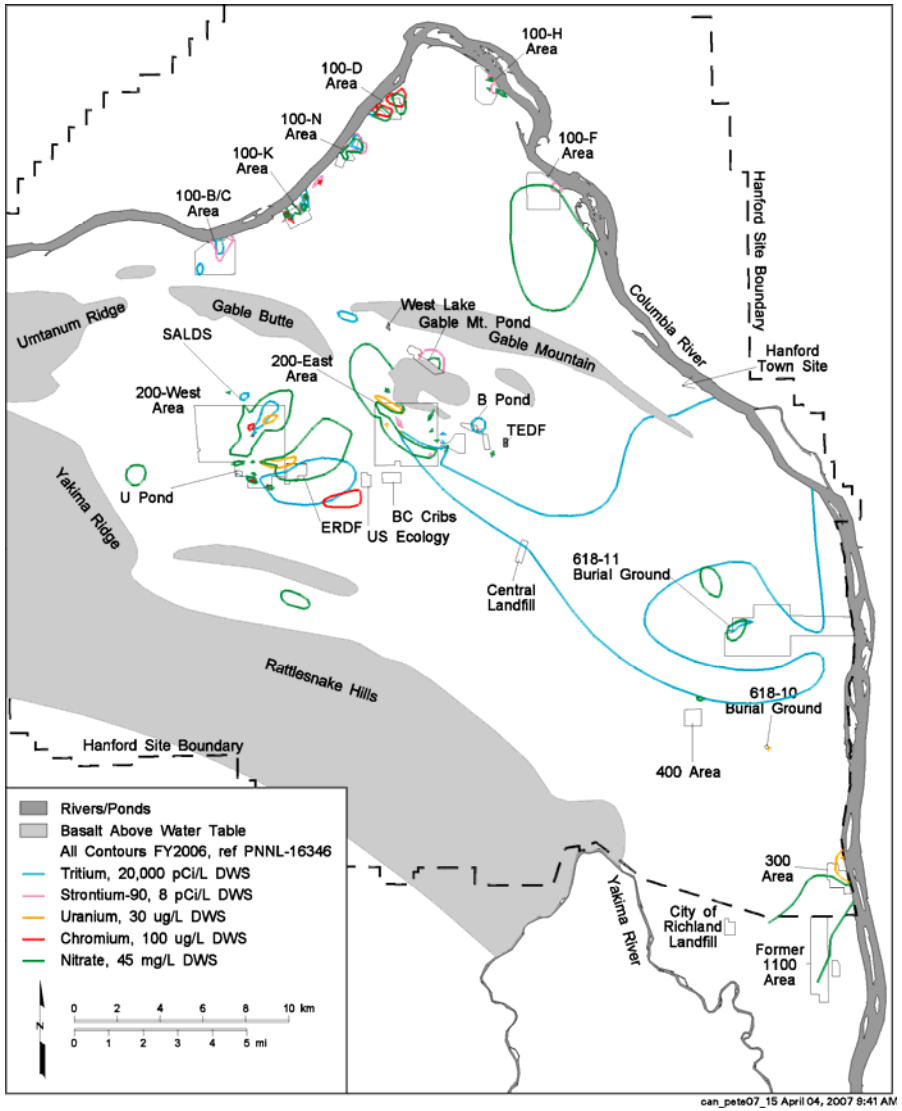
- **Hanford Site established in 1943 to produce plutonium for nuclear weapons.**
- **Major buildup during the Cold War years, i.e., late-1940's thru mid-1960's.**
- **The cycle: Fabricate fuel (300 Area), irradiate fuel (100 Areas), and separate strategic radionuclides (200 Areas).**
- **Current DOE mission is to manage legacy wastes, decommission facilities, and perform environmental cleanup.**

For more information:

"Hanford: A Conversation about Nuclear Waste and Cleanup," by Roy E. Gephart, Battelle Press, 2003

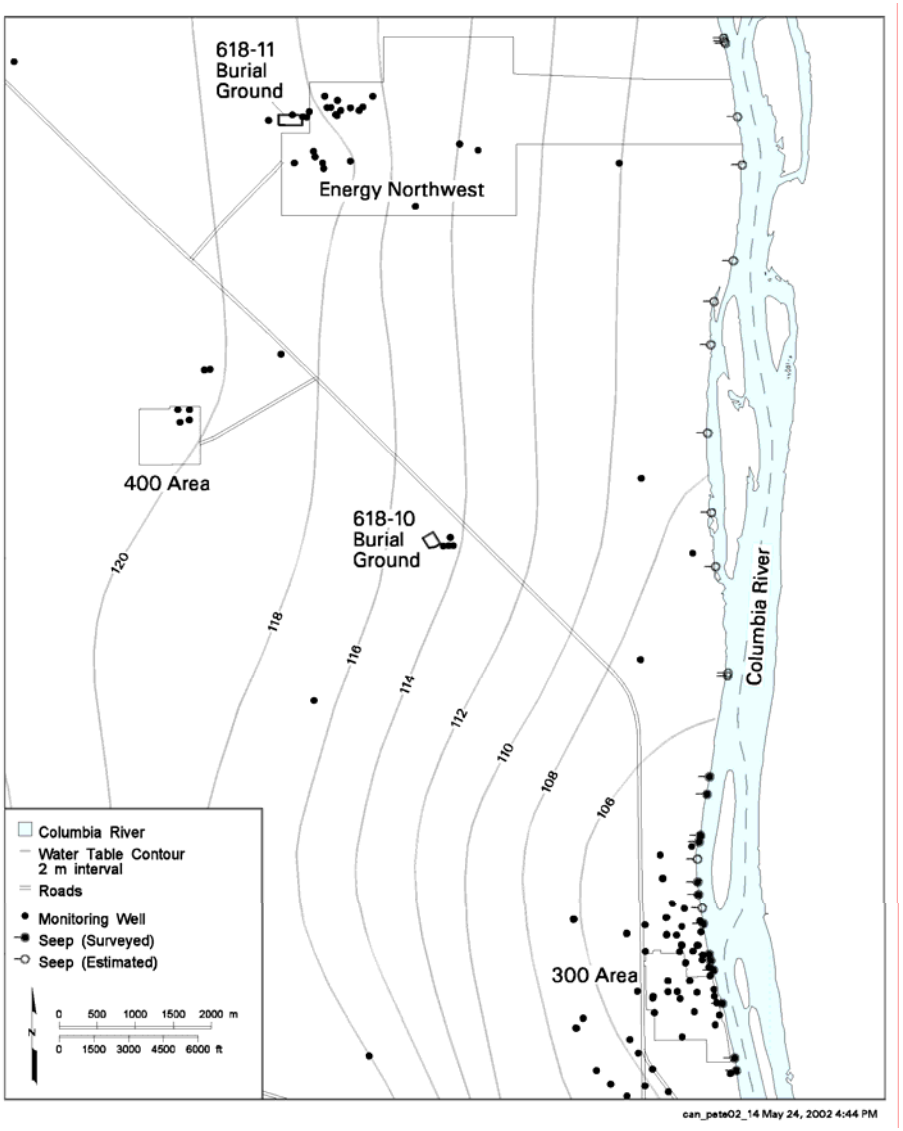
HANFORD SITE GROUNDWATER PLUMES AFFECTING RIVER CORRIDOR (FY 2006)

- Most widespread plume is tritium and it is dissipating.
- Chromium (Cr+6) and strontium-90 in 100 Areas are being remediated by pump-and-treat and *in situ* barrier systems under decisions for interim action.
- Uranium in the 300 Area persists beyond expectations of remedial investigation. Interim action includes continued monitoring and institutional controls.



GROUNDWATER FLOW NEAR 300 AREA

- Regional long-term average flow is towards the east, with a shift to southeast near the 300 Area.
- In the 300 Area, flow patterns are variable, because of heterogeneous aquifer properties and short-term gradient changes caused by river stage fluctuations.
- Flow velocities beneath the 300 Area are high, with various evidence indicating 10 meters/day and higher.

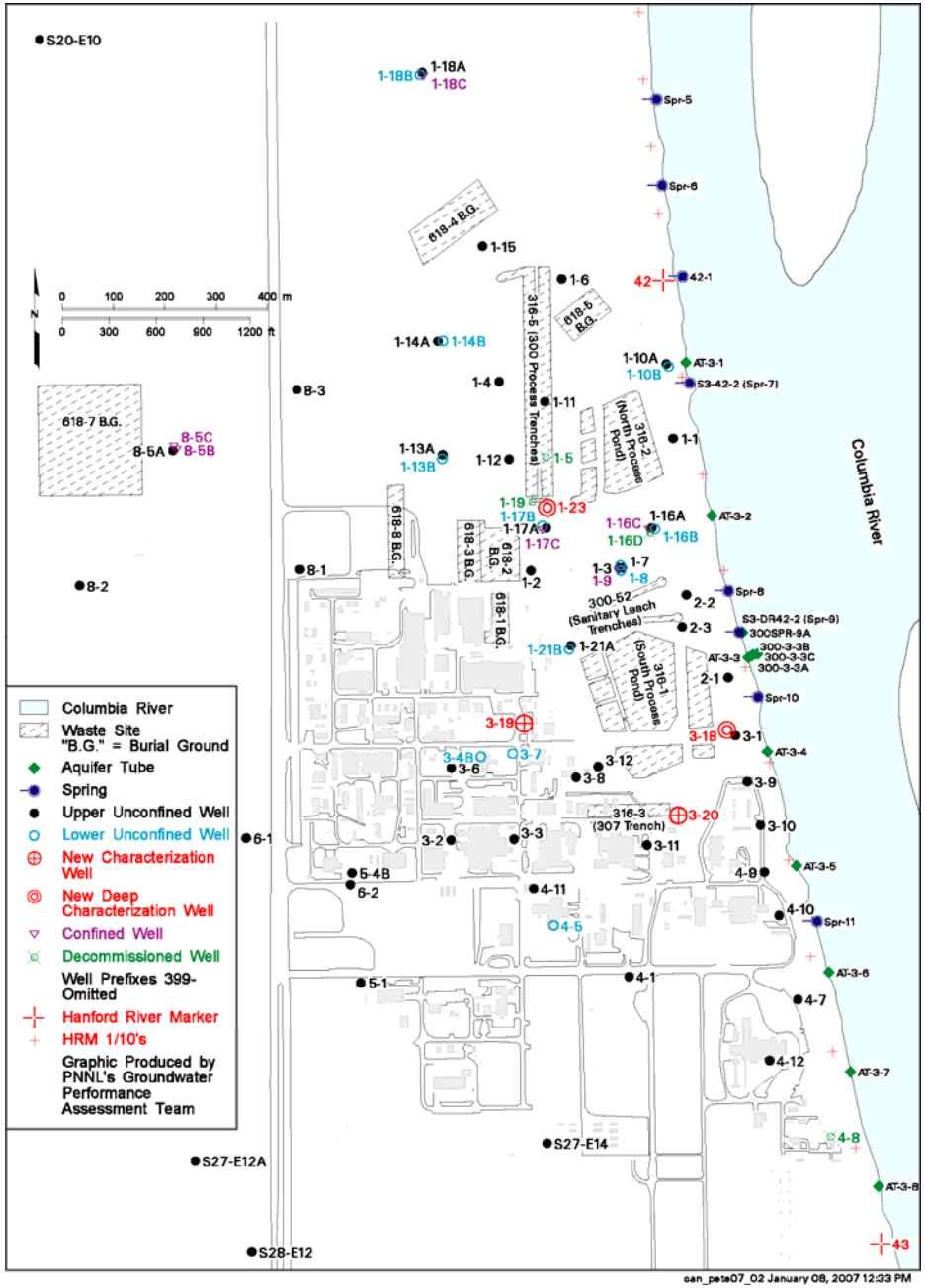


Representative of long-term average conditions (March 2002)

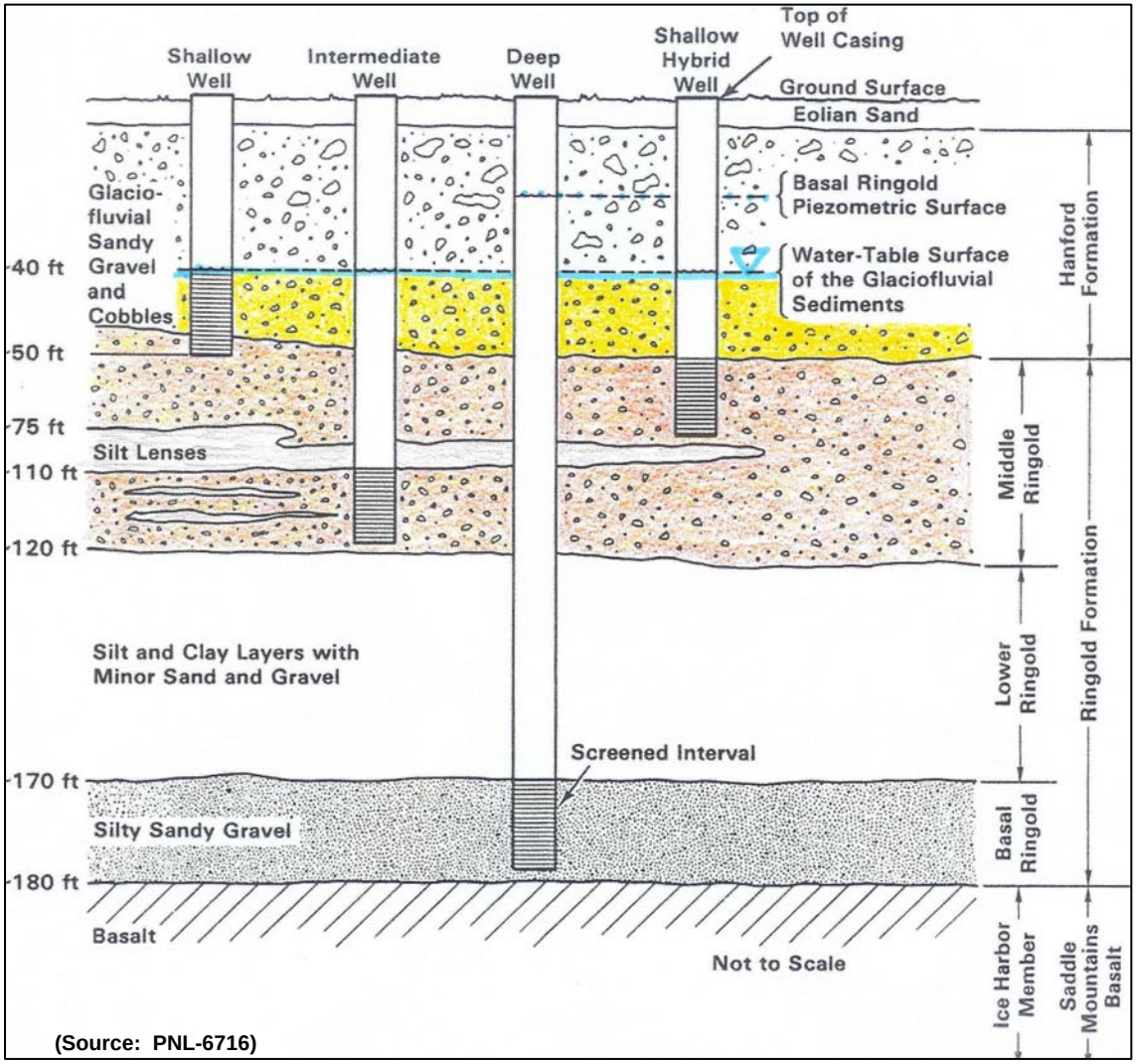

300 Area, view to south (~2000)


300 Area, view to south (March 2007)

300 Area Monitoring Wells and Shoreline Monitoring Sites

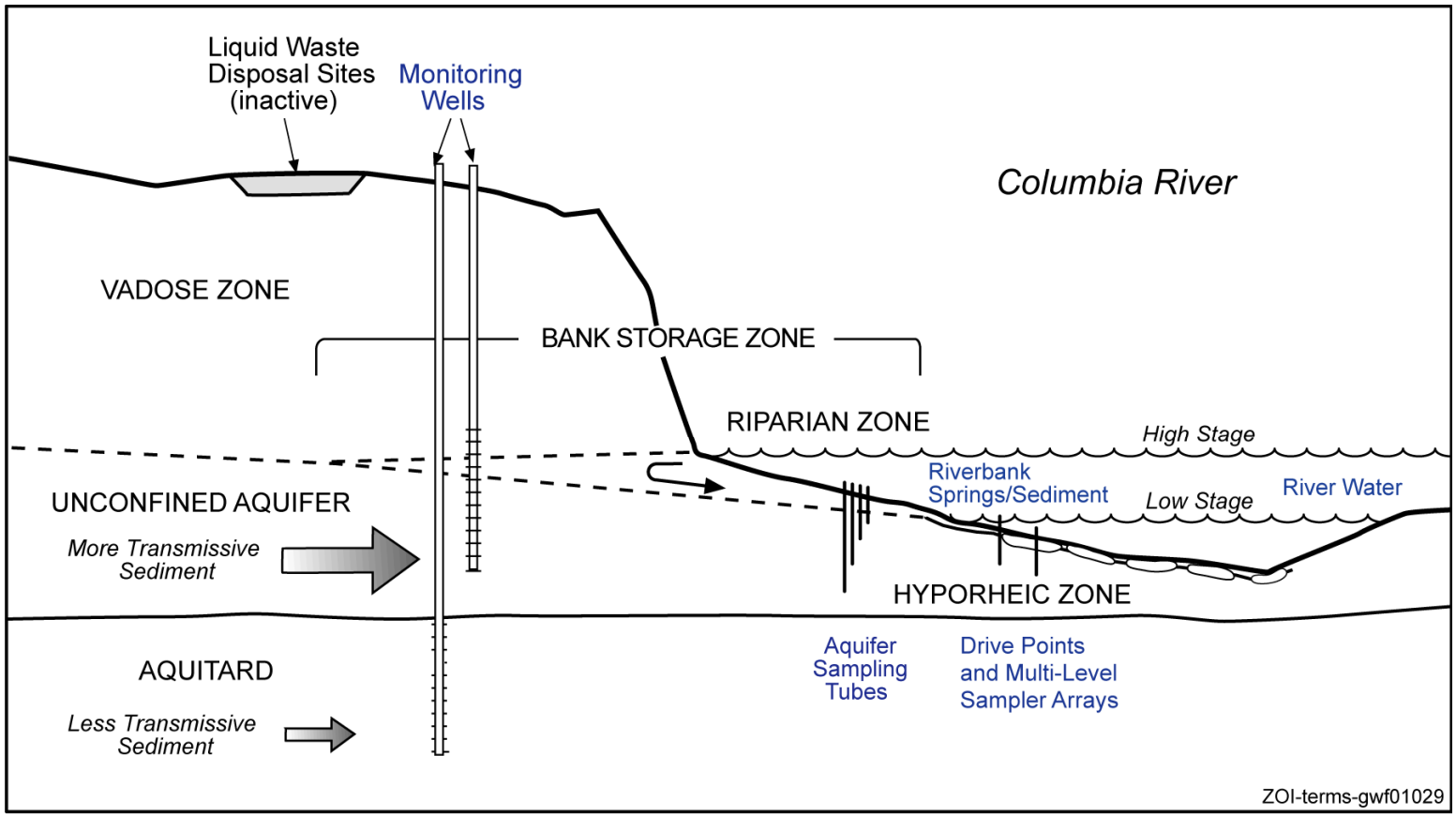


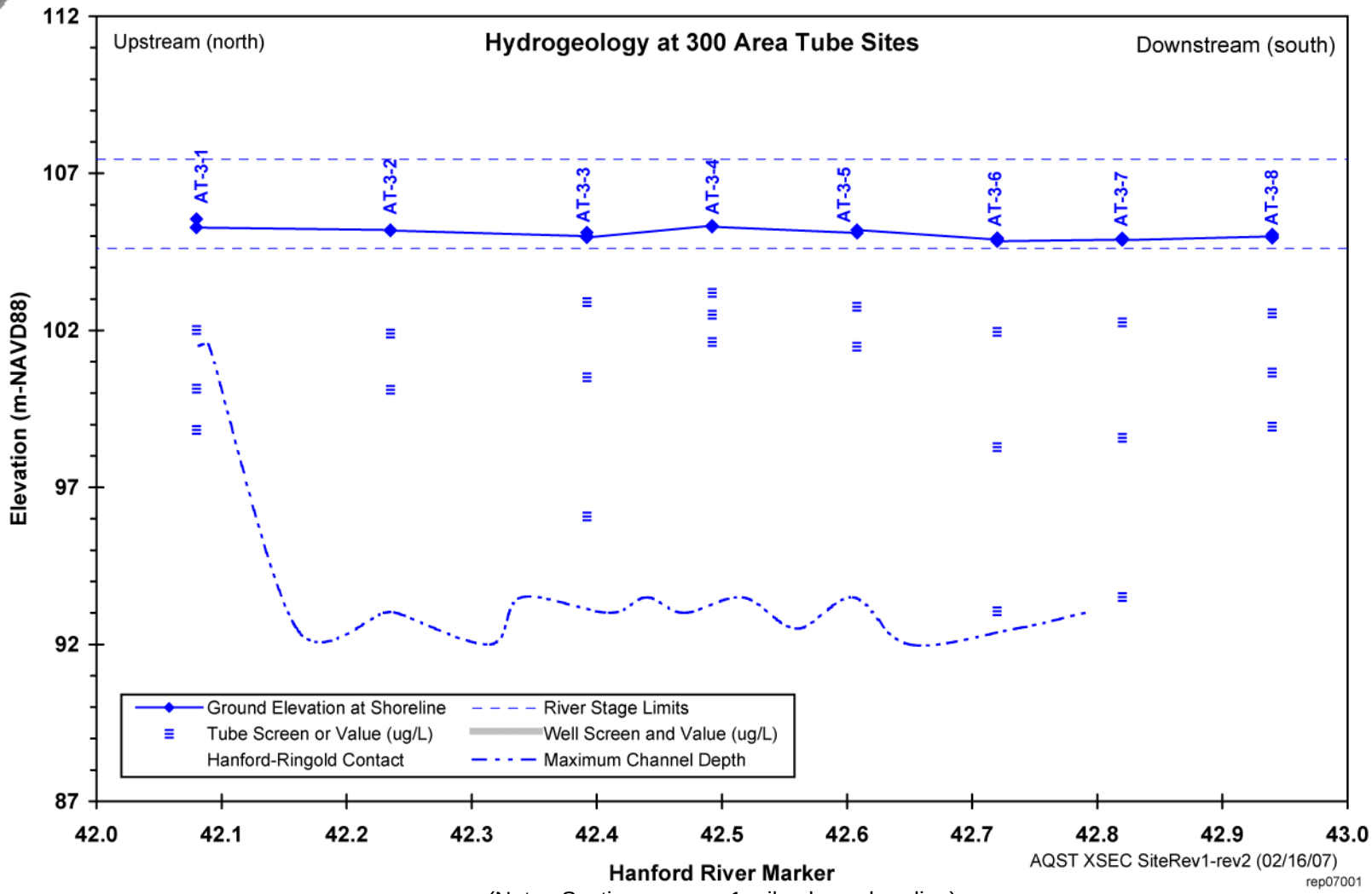
Monitoring Well Coverage of Uppermost Hydrologic Units of Interest



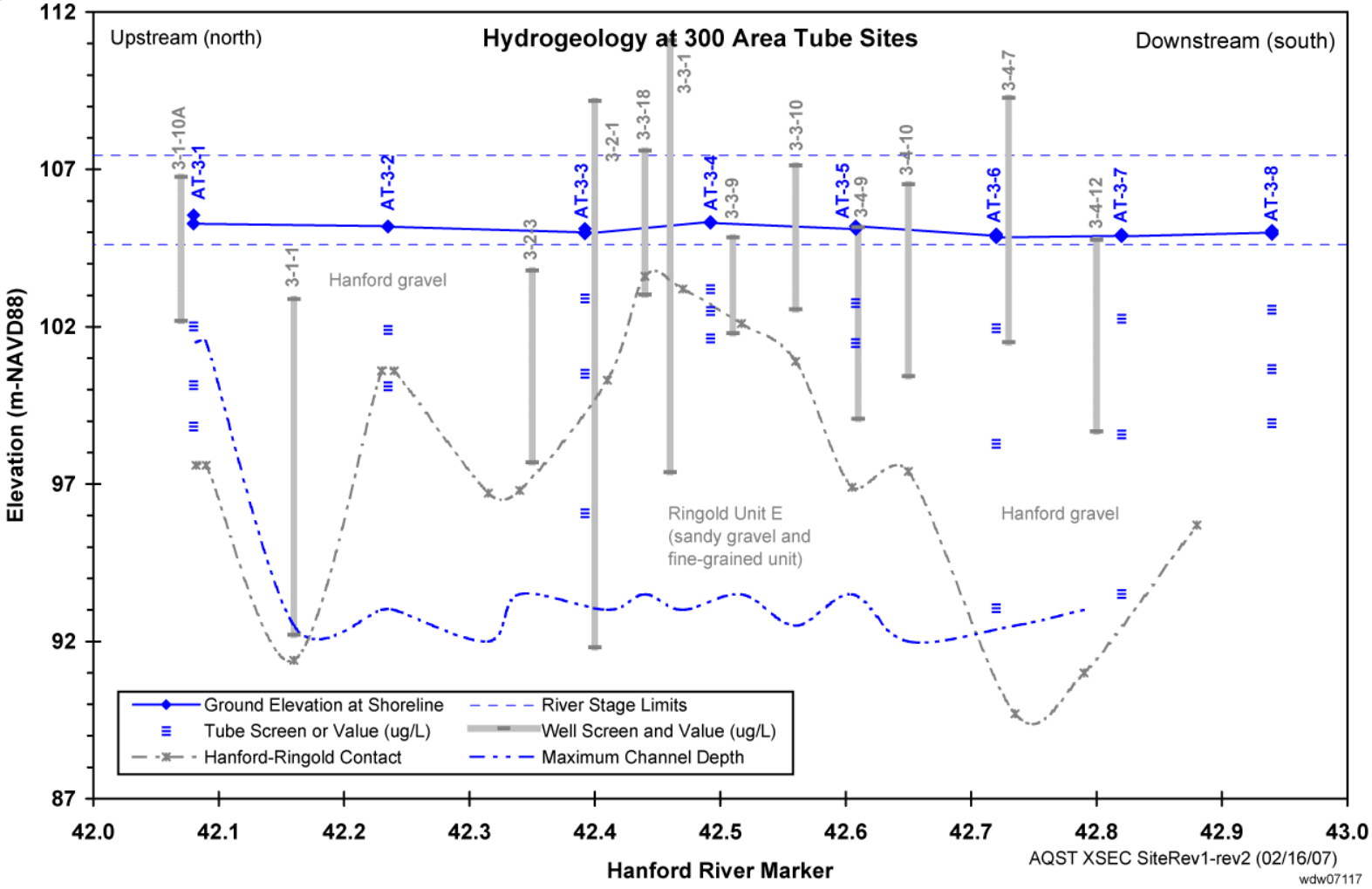
(Source: PNL-6716)

Terminology and Monitoring Facilities at Groundwater/River Interface





(Note: Section covers ~1 mile along shoreline)



(Note: Section covers ~1 mile along shoreline)

CONTAMINANTS in 300 AREA GROUNDWATER

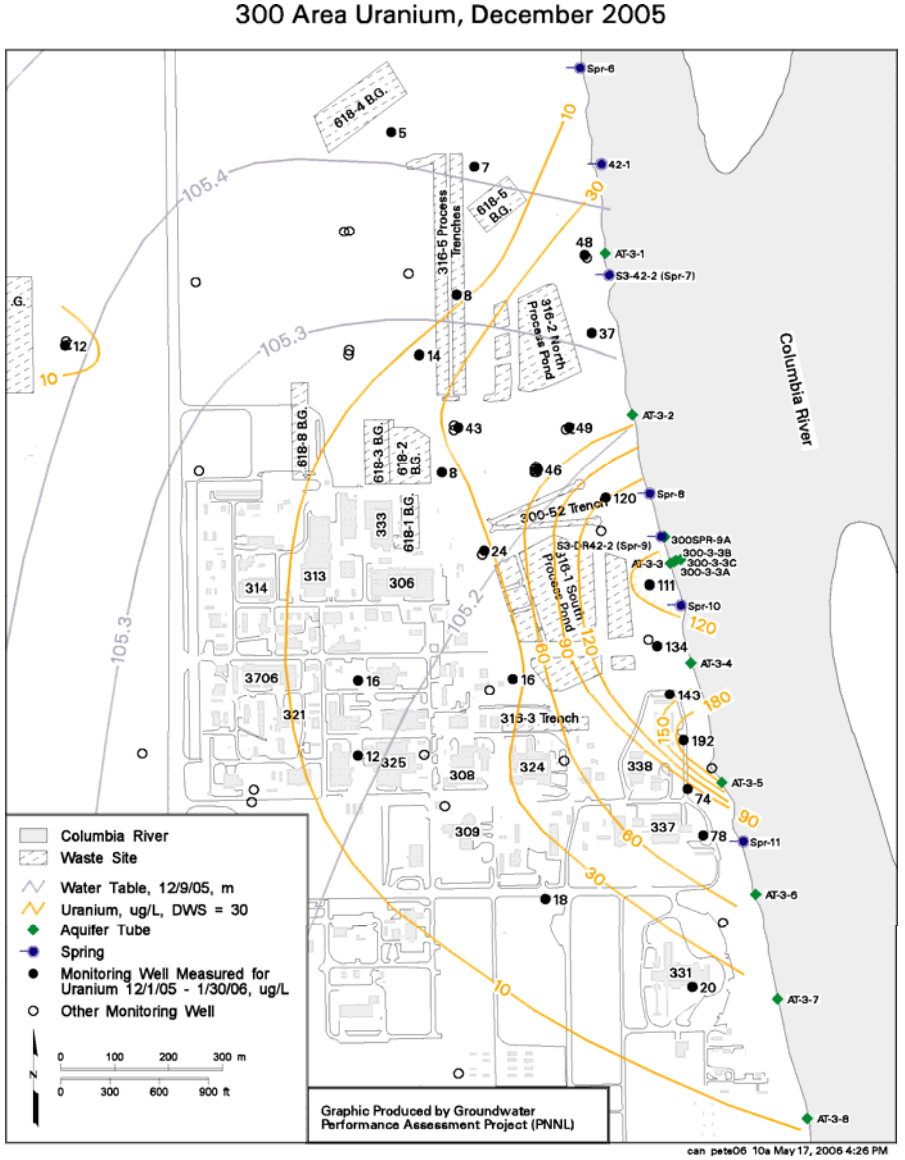
- **Contaminants of concern, as identified in decision documents:**
  - **Uranium -- Widespread in upper portion of unconfined aquifer**
  - **Trichloroethene, widespread at low levels near water table; relatively high levels recently discovered at deeper levels in unconfined aquifer**
  - **Cis-1,2-dichloroethene exceeds drinking water standard in lower portion of unconfined aquifer at one location**

- **Additional contaminants of potential concern include:**
  - **Localized occurrences of tetrachloroethene and strontium-90**
  - **Nitrate and tritium, which migrate into the 300 Area from other sources**

- **Current levels of these contaminants, along with their annual maximum values since 1992, are described in:**
  - ***"Contaminants of Potential Concern for the 300-FF-5 Operable Unit: Expanded Groundwater Report for FY 2004" (PNNL-15127, March 2005)***

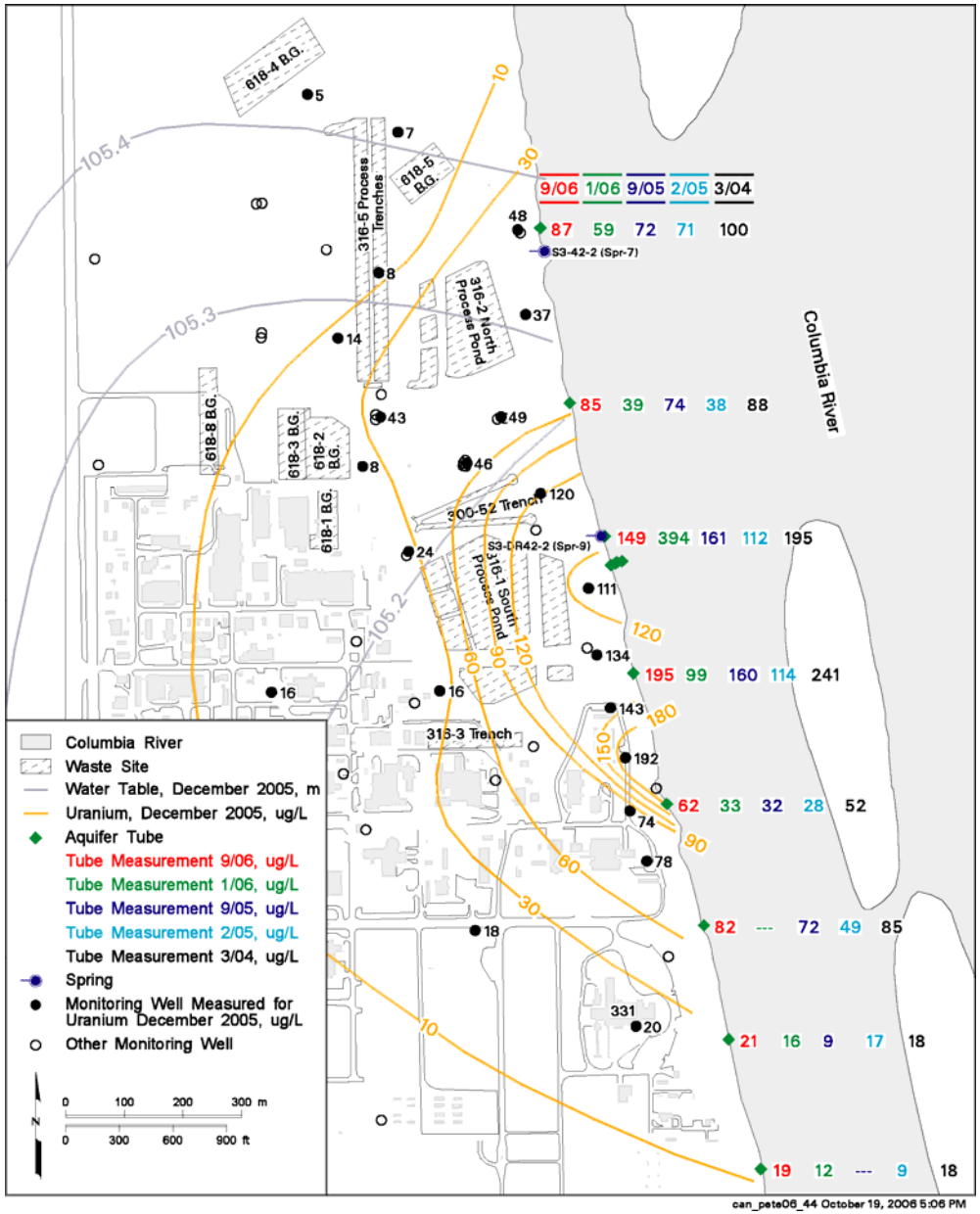
URANIUM

- Early contributors to this plume included disposal at the South Process Pond and the 316-3 Trench (late 1940s to mid-1960s).
- Subsequent contributors included disposal to the South and North Process Ponds.
- The most recent disposal of effluent containing uranium occurred at the 316-5 Process Trenches (1975 to 1985). All discharges to ground ceased in December 1994.
- Removal of contaminated soil at waste sites has been completed. Some residual uranium likely remains in the lower vadose zone.

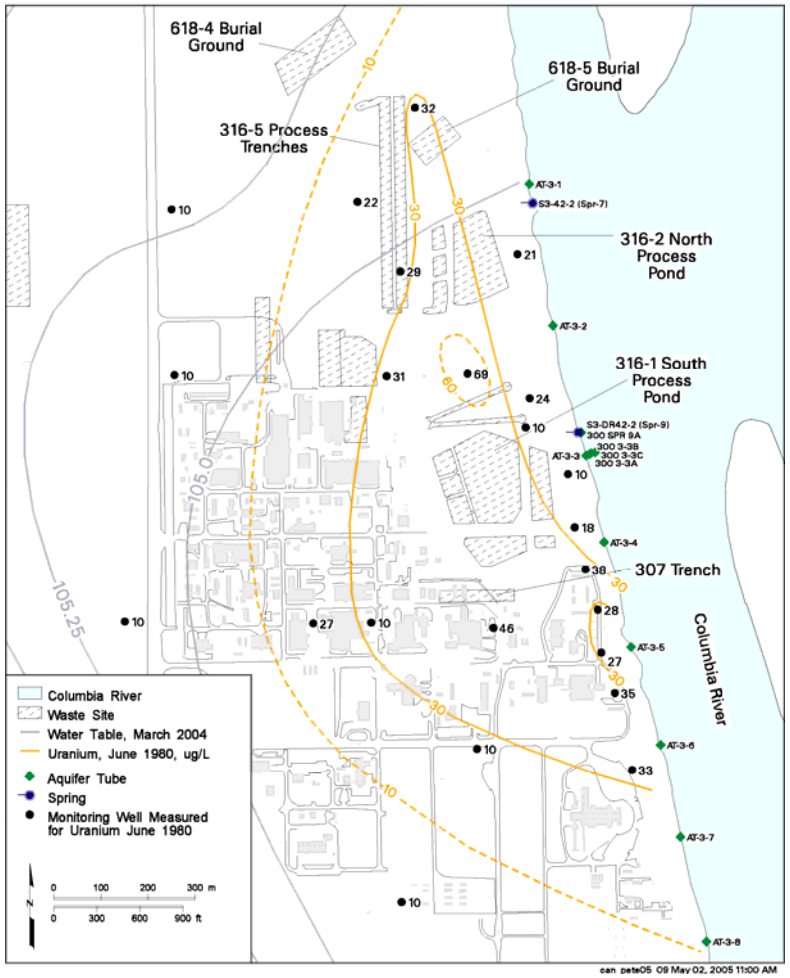


Source: PNNL-16346

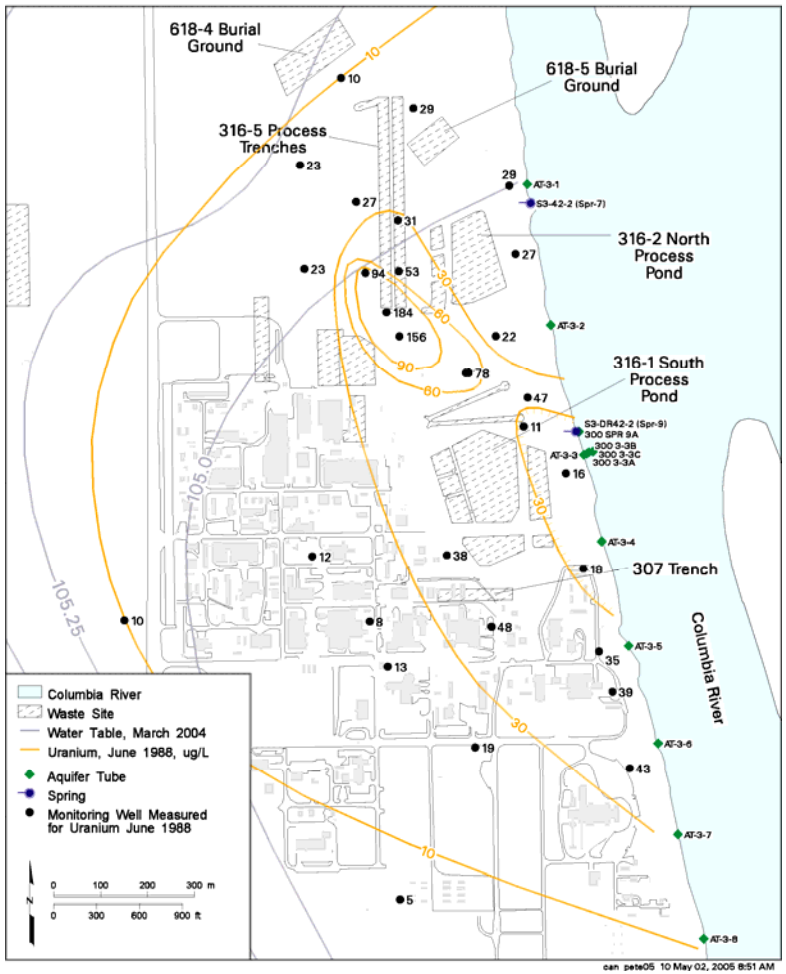
Uranium at Shoreline: Results from Aquifer Tube Sites



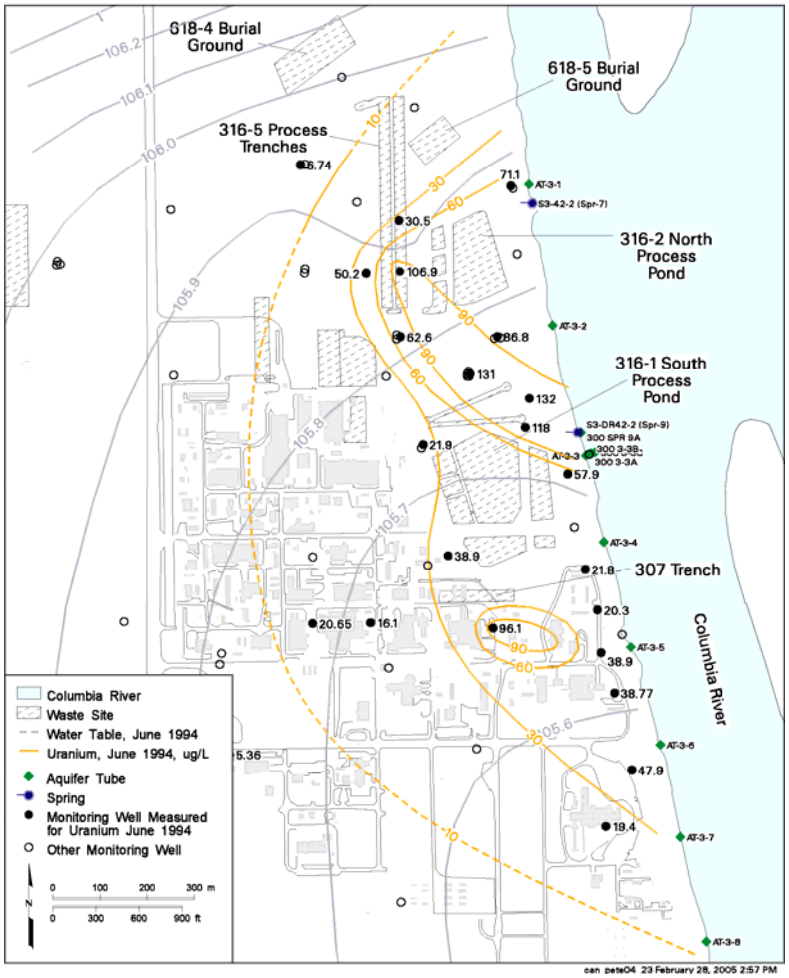
300 Area Uranium, June 1980



300 Area Uranium, June 1988



300 Area Uranium, June 1994



300 Area Uranium, June 2004

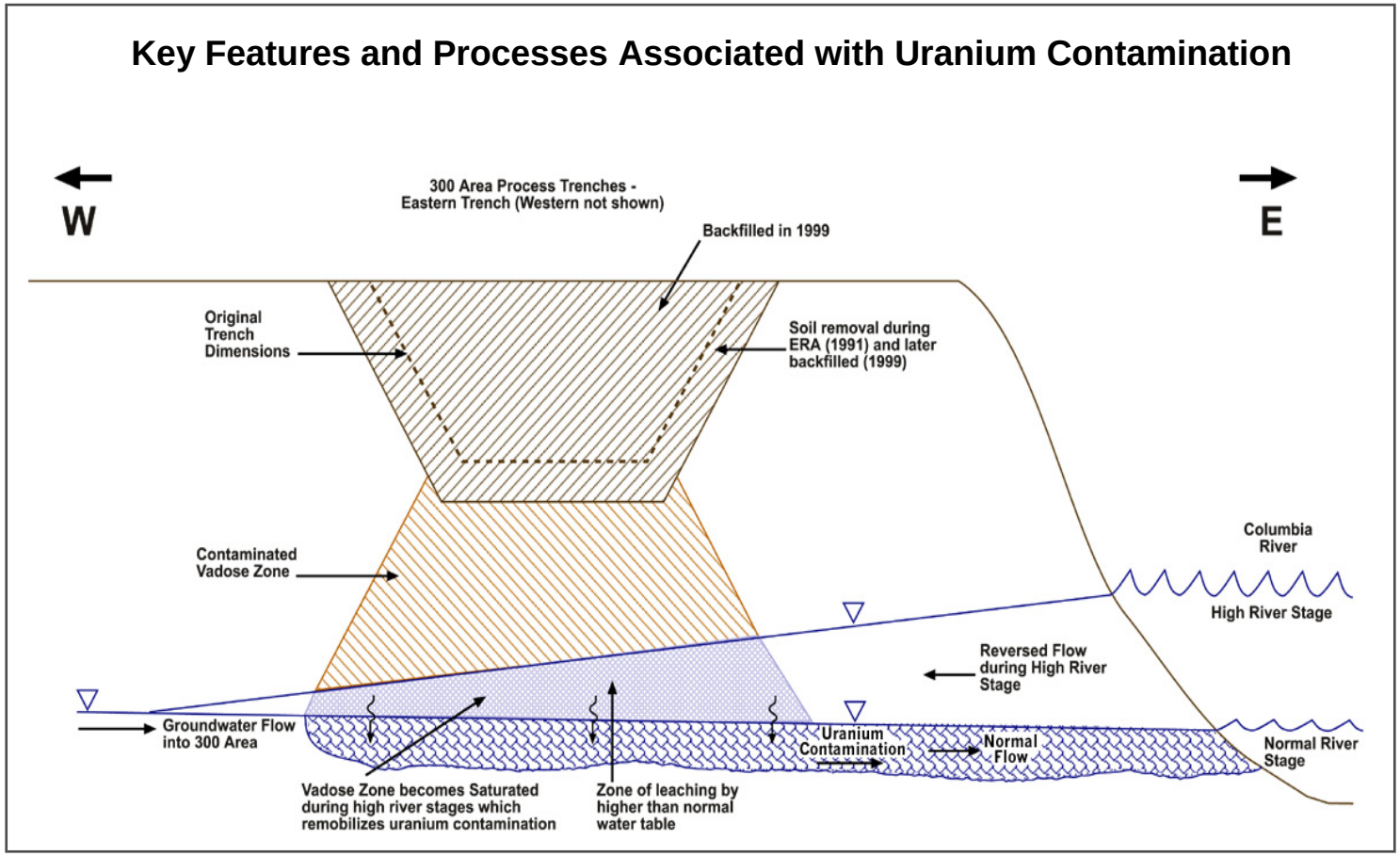
NEED FOR ADDITIONAL INFORMATION ON URANIUM

- **Uranium plume has persisted in the 300 Area in spite of:**
  - **Ground disposal of uranium-bearing effluent ended in ~1985**
  - **Removal of uranium-contaminated soil from major waste sites**
  - **Rapid movement of groundwater beneath the 300 Area**
  - **Removal of groundwater via a water supply well since 1982**

- **Five-year reviews of the 1996 Record-of-Decision:**
  - **Remedial investigation during early 1990's predicted that uranium concentrations would decrease to the drinking water standard in 3 to 10 years, starting 1993. This has not happened.**

- **Desire to restore the aquifer to its most beneficial use, i.e., as a source for drinking water (Phase III Feasibility Study).**

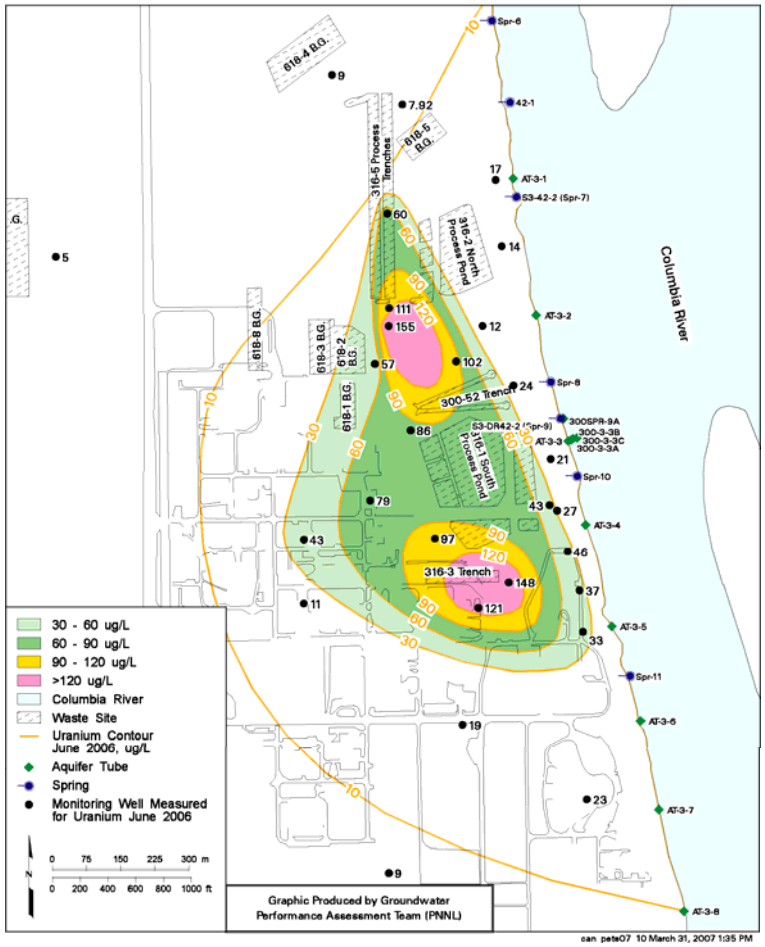
Key Features and Processes Associated with Uranium Contamination



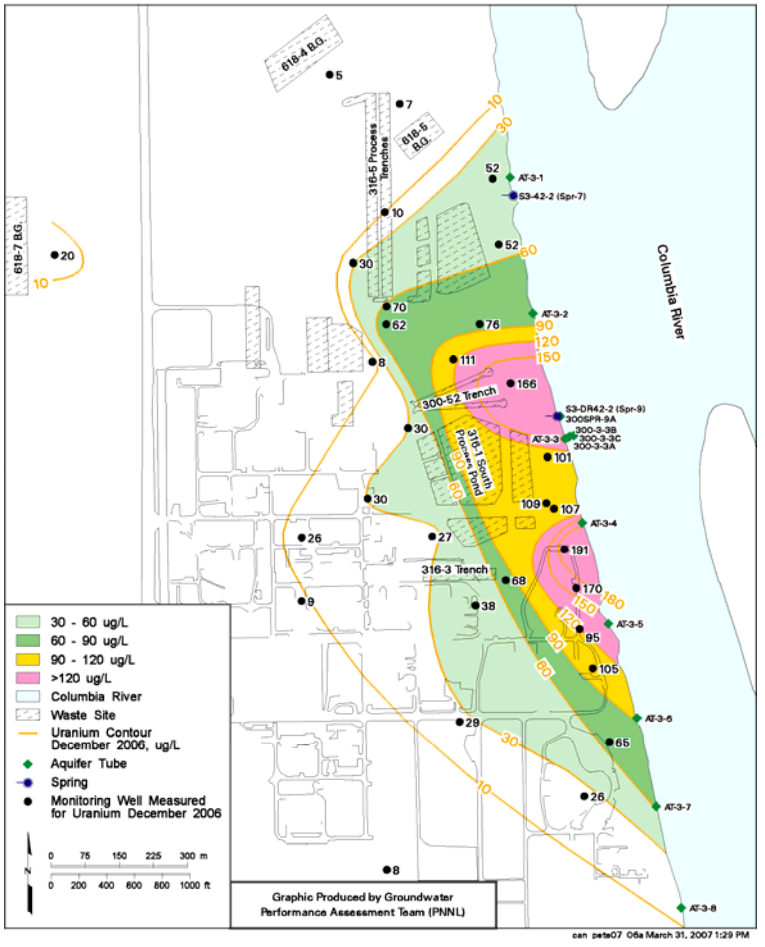
Source: PNNL-13645 (Lindberg and Chou 2001)

300 Area Uranium Plume, Recent Conditions

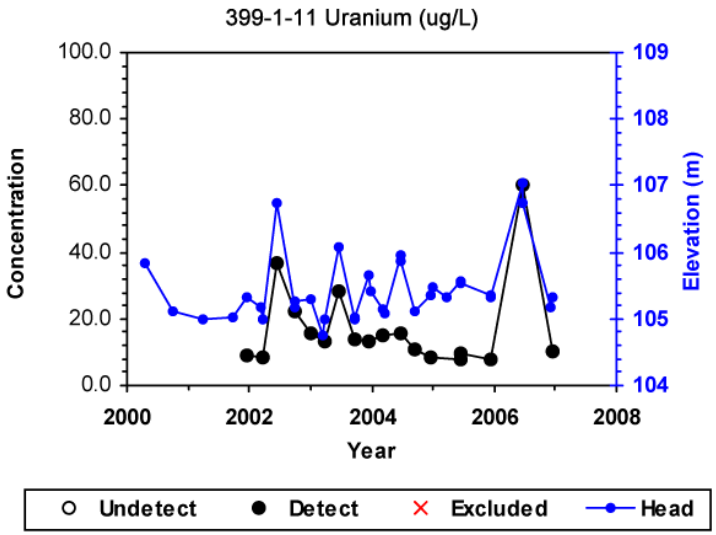
300 Area Uranium, June 2006

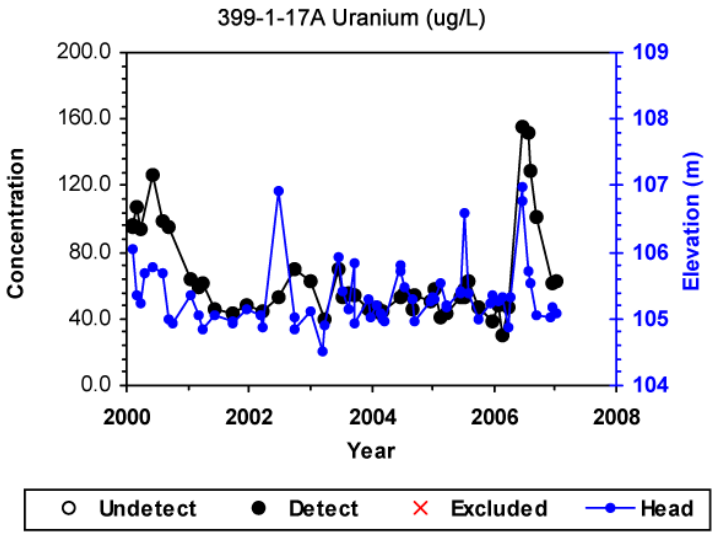


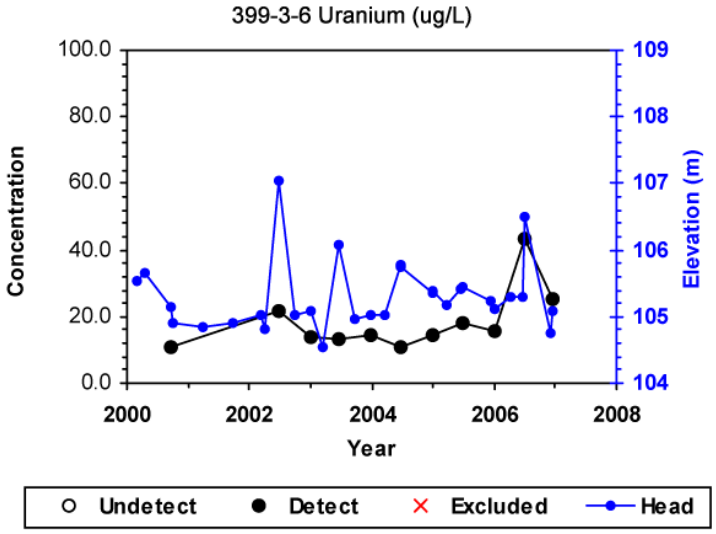
300 Area Uranium, December 2006

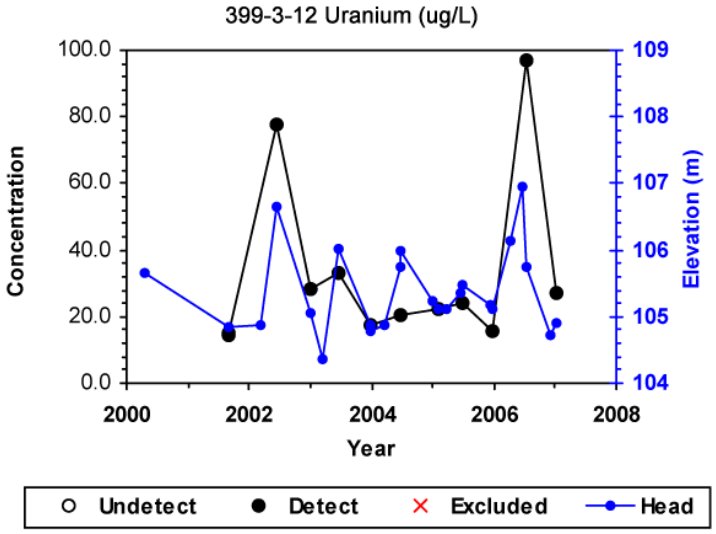


Remobilization at Inland Wells

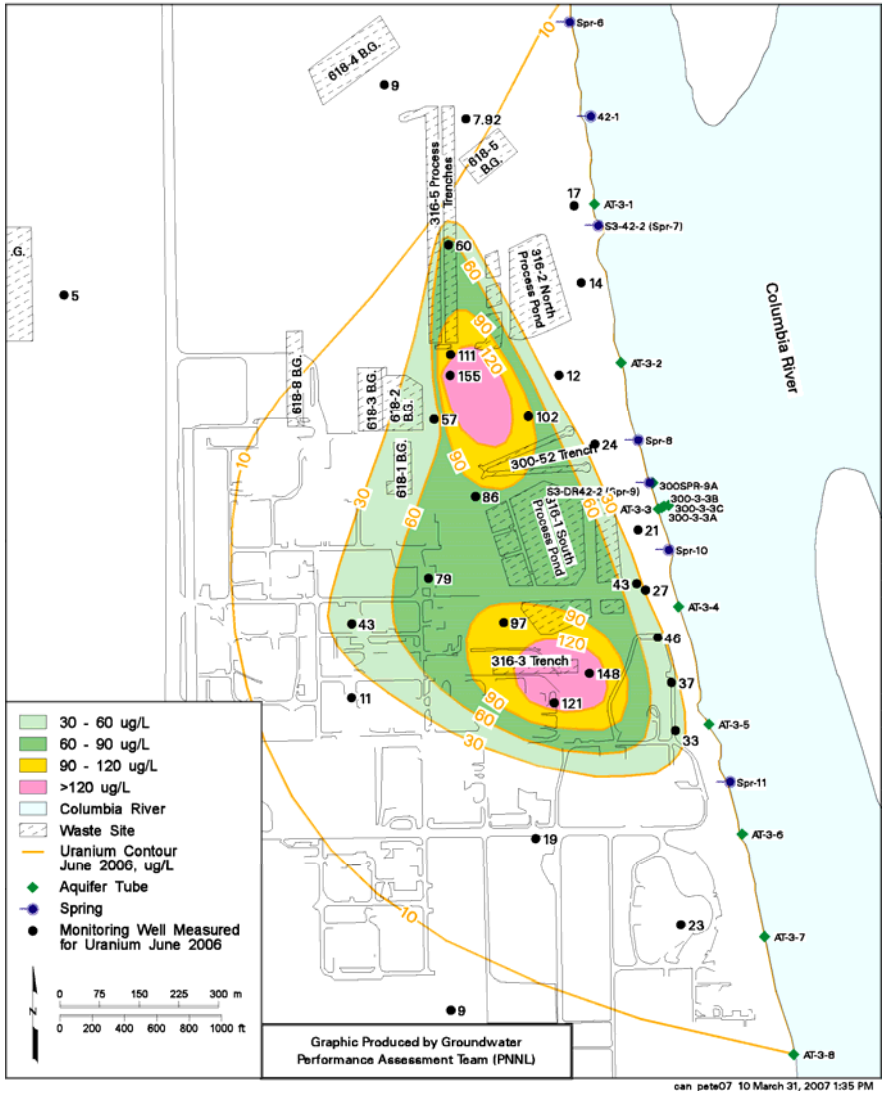




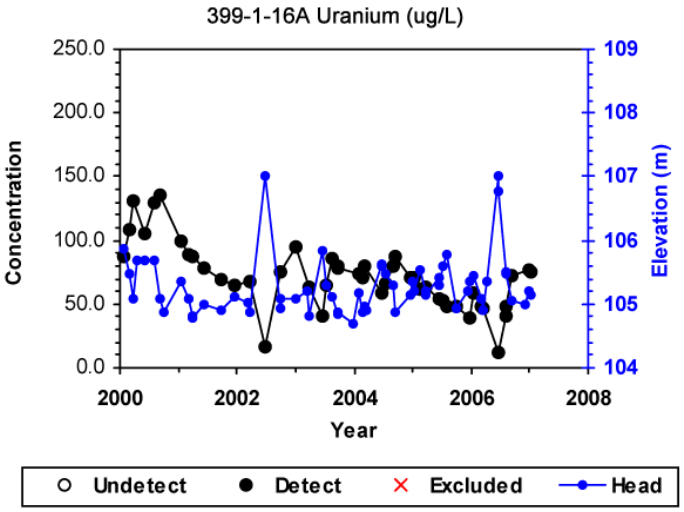


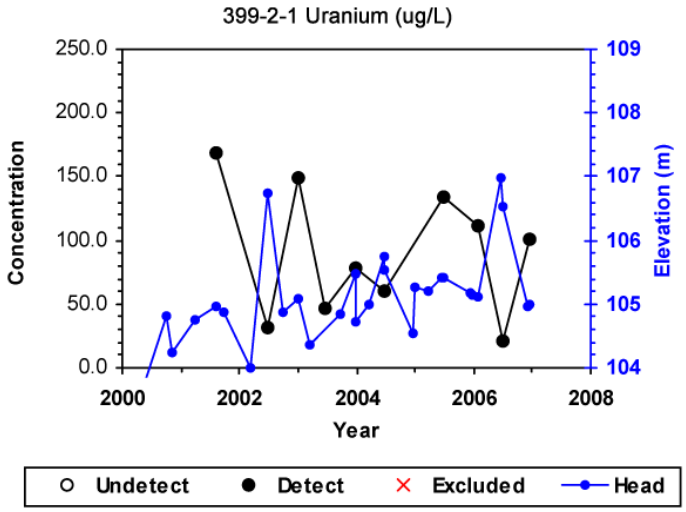


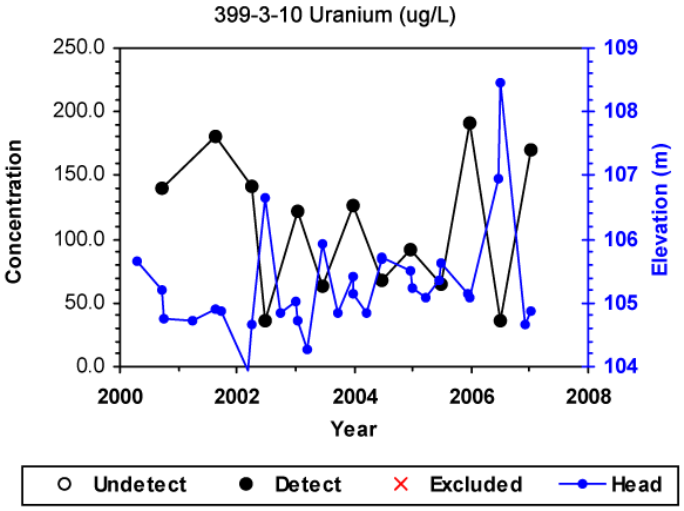
300 Area Uranium, June 2006

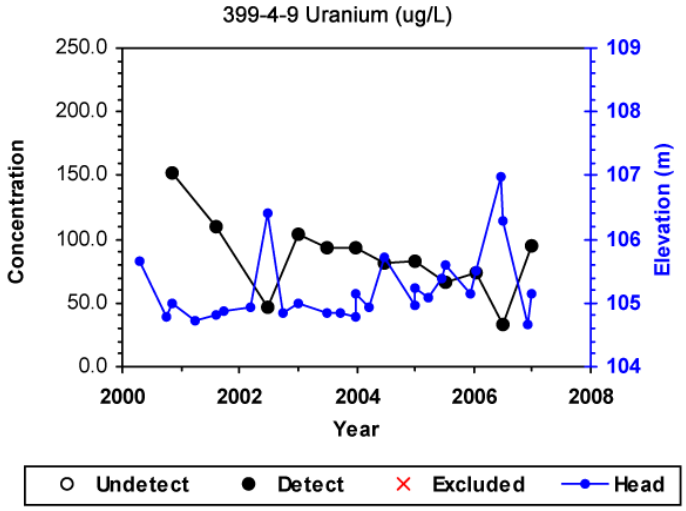


Influence of Infiltrating River Water at Shoreline Wells (Dilution/Adsorption)

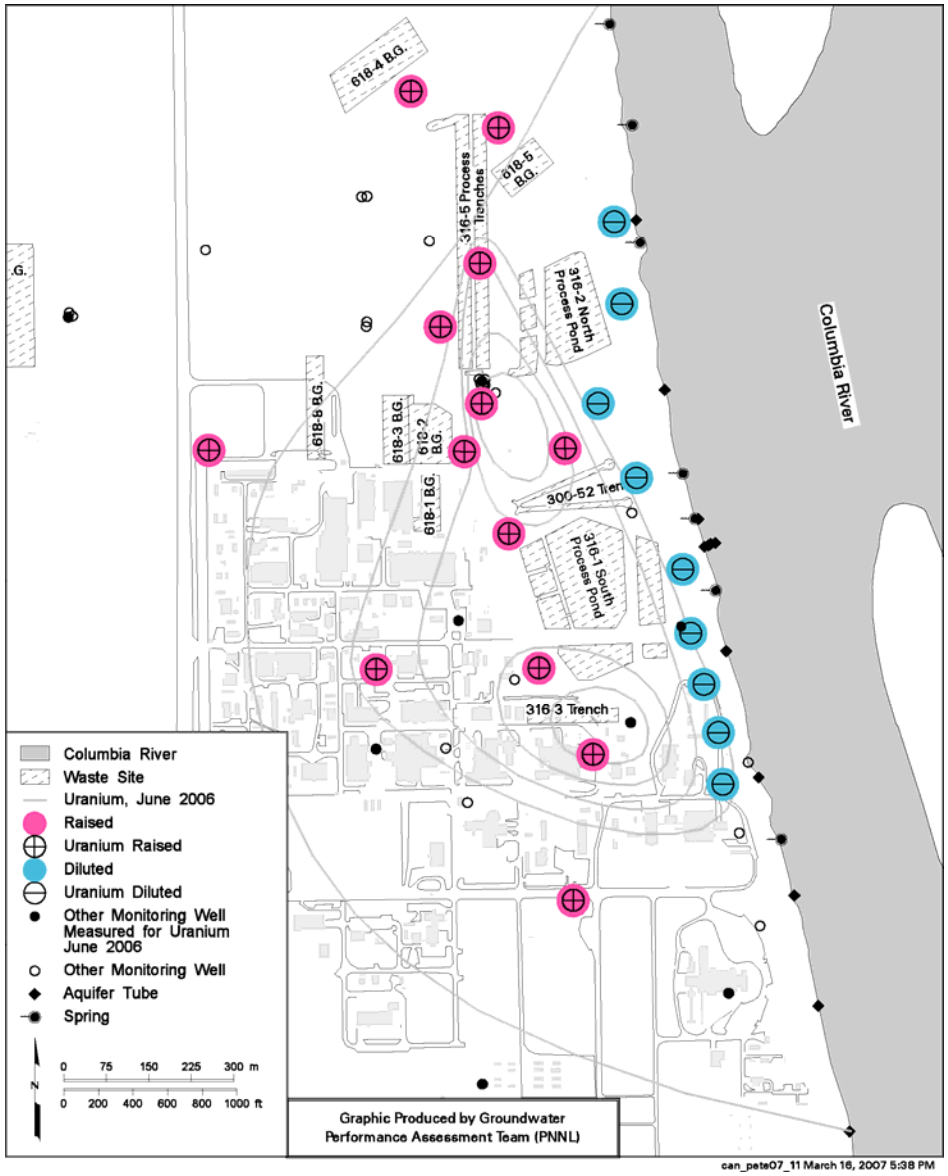








Variability in Uranium Concentrations During Seasonal High Water Table Conditions



SUMMARY and KEY POINTS

- **Uranium plume has persisted in the 300 Area far longer than expected following cessation of liquid effluent discharges and removal of contaminated soil, suggesting continual re-supply.**
  - **Downward migration beneath former liquid waste disposal sites.**
  - **Release from uranium sequestered in the capillary fringe zone.**

- **Variability in uranium concentrations is primarily seasonal.**
  - **Infiltration of river water causes dilution of contamination near the river and a change in geochemistry that promotes sorption onto sediment.**
  - **Elevated water table conditions promotes remobilization of uranium from the lower vadose zone.**

- **When using historical monitoring data, consider what the sample represents with regard to aquifer conditions.**
  - **Wells with varying screen lengths and completion depths.**
  - **Aquifer tubes at the shoreline.**
  - **Timing of sample collection.**