

Groundwater Flow Beneath Waste Management Area A-AX

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Contractor for the U.S. Department of Energy
under Contract DE-AC06-08RL14788



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Date

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Groundwater Flow Beneath Waste Management Area A-AX



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May 1, 2015

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Plateau Remediation Company



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- RCRA Groundwater quality assessment monitoring conducted at Waste Management Area (WMA) A-AX
- Groundwater flow direction needed to assess the adequacy of the monitoring well network
- Water table in 200 East Area is very flat; regional hydraulic gradient magnitude estimated to be $1.8\text{E}-05$ m/m (1.8 cm per kilometer); too low to measure locally
- Flow directions determined in the past at WMA A-AX by movement of contaminant plumes
- New methodology now being used to map the 200 East Area water table

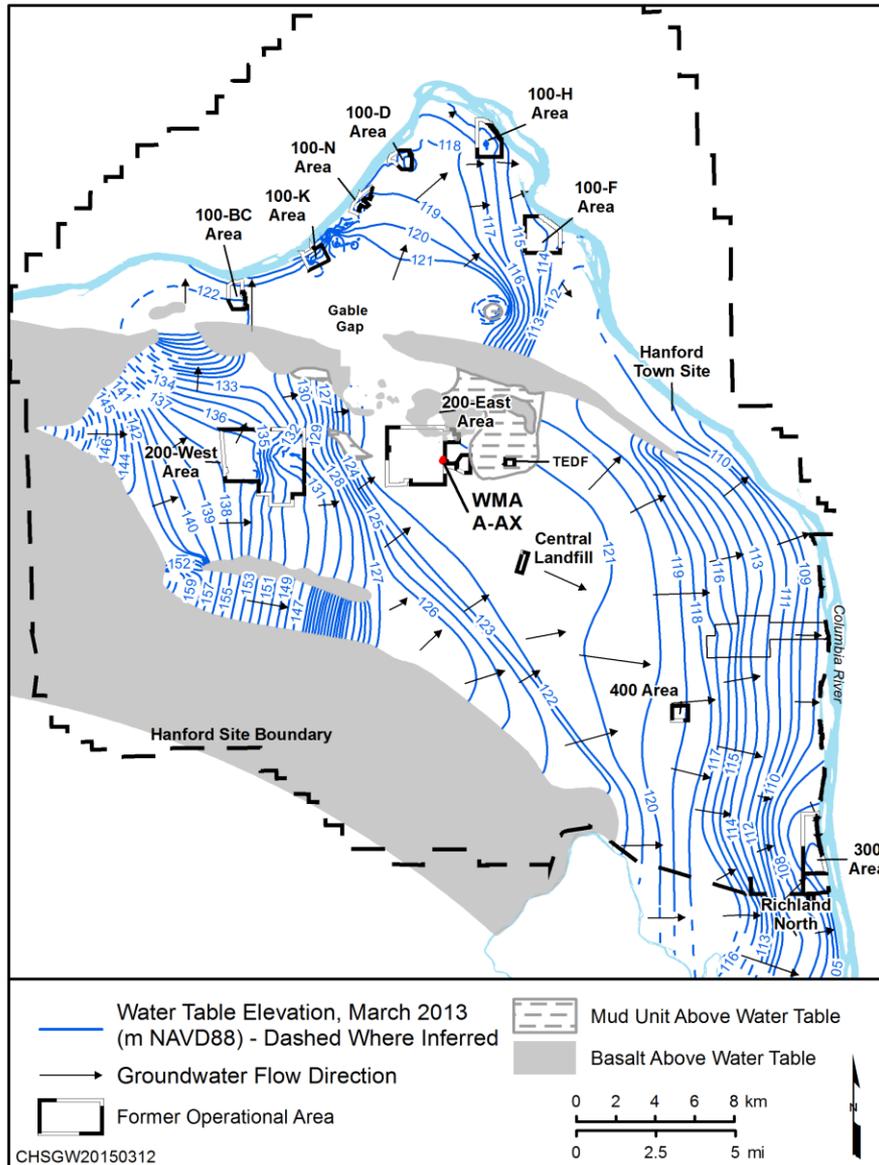


- Regional groundwater flow
- Groundwater sample results
- Collection and analysis of water-level measurements
- 200 East Area water table maps



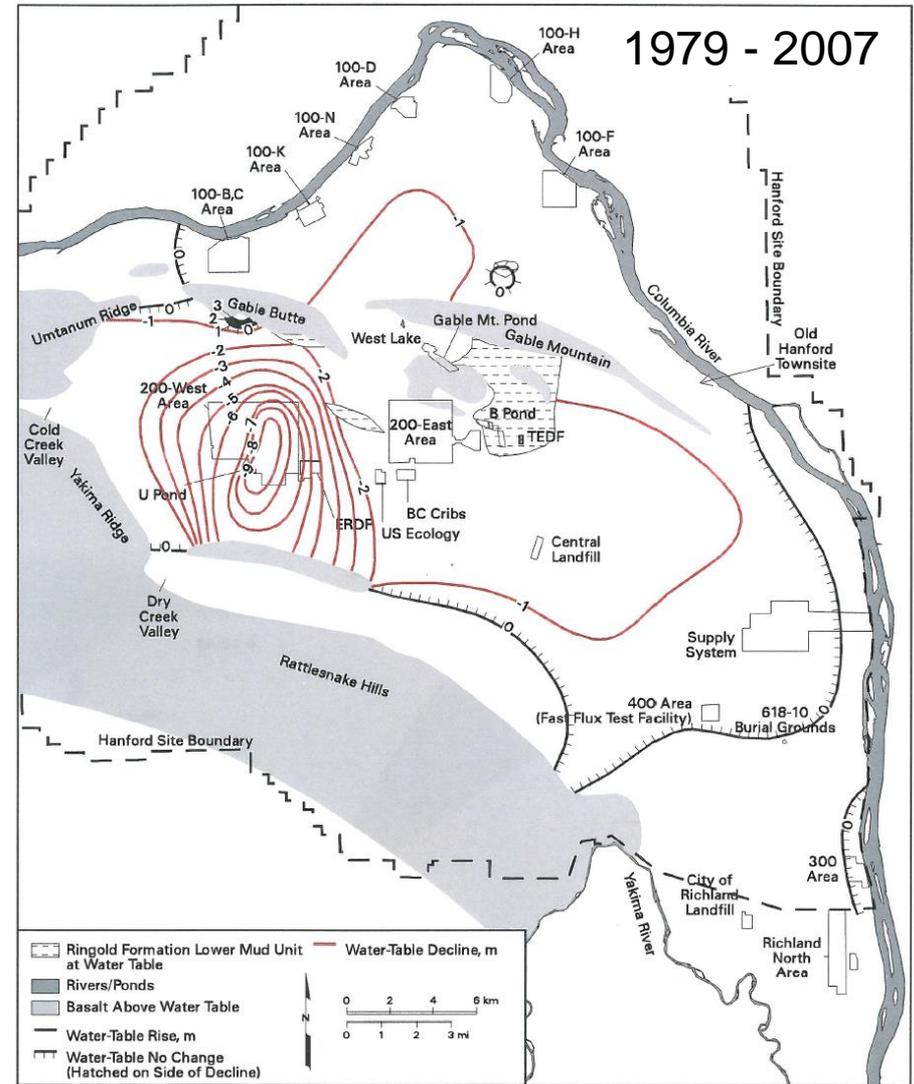
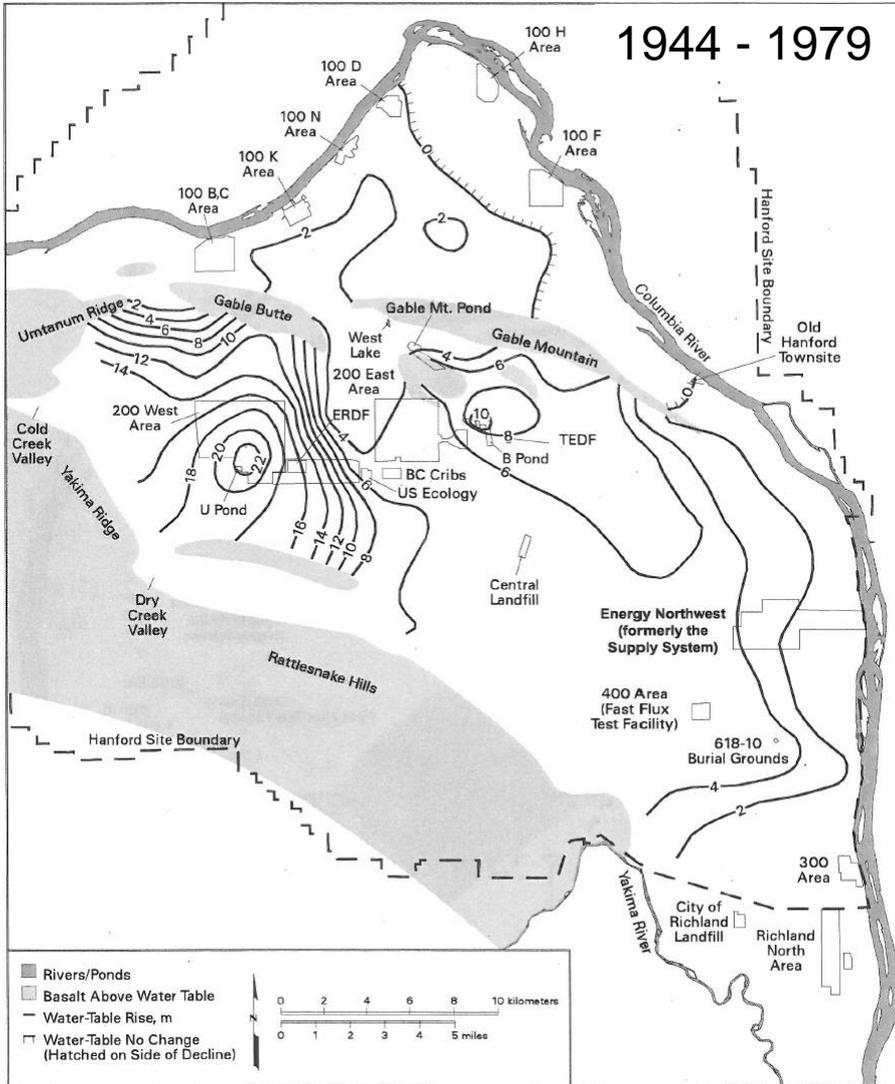
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Hanford Site Water Table Map



- Water table increased when Hanford was operating due to effluent discharges
- Water declining since mid-1980s due to reduced discharges
- Flow generally from west to east toward Columbia River
- Region of low hydraulic gradient extends from west of 100-BC Area through Gable Gap to 200 East Area and into central part of site

Water Table Elevation Changes



Stressors Affecting the 200 East Area Water Table



- Large seasonal changes in Columbia River stage
 - Propagates along high transmissivity sediments from west of 100-B/C through Gable Gap and the 200 East Area and into the central portion of the site
- Discharges to the Treated Effluent Disposal Facility (TEDF)
 - Discharges are episodic in nature
 - Large volume discharges occur in months when the 242-A Evaporator is operating

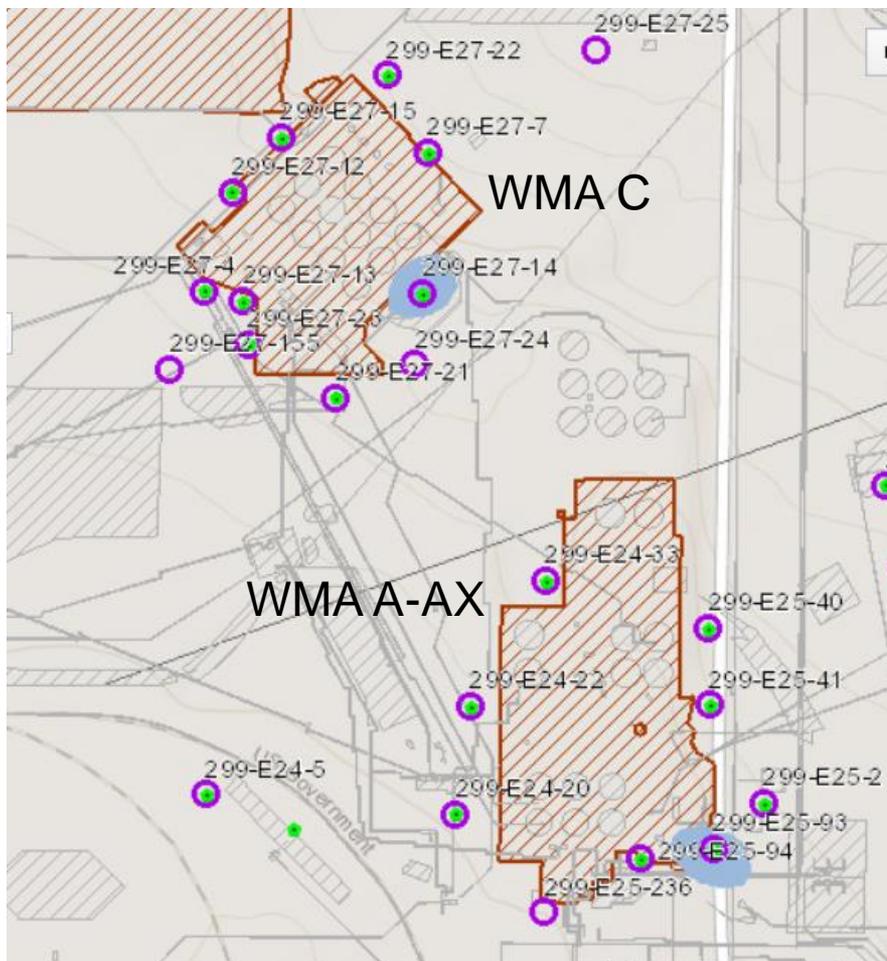


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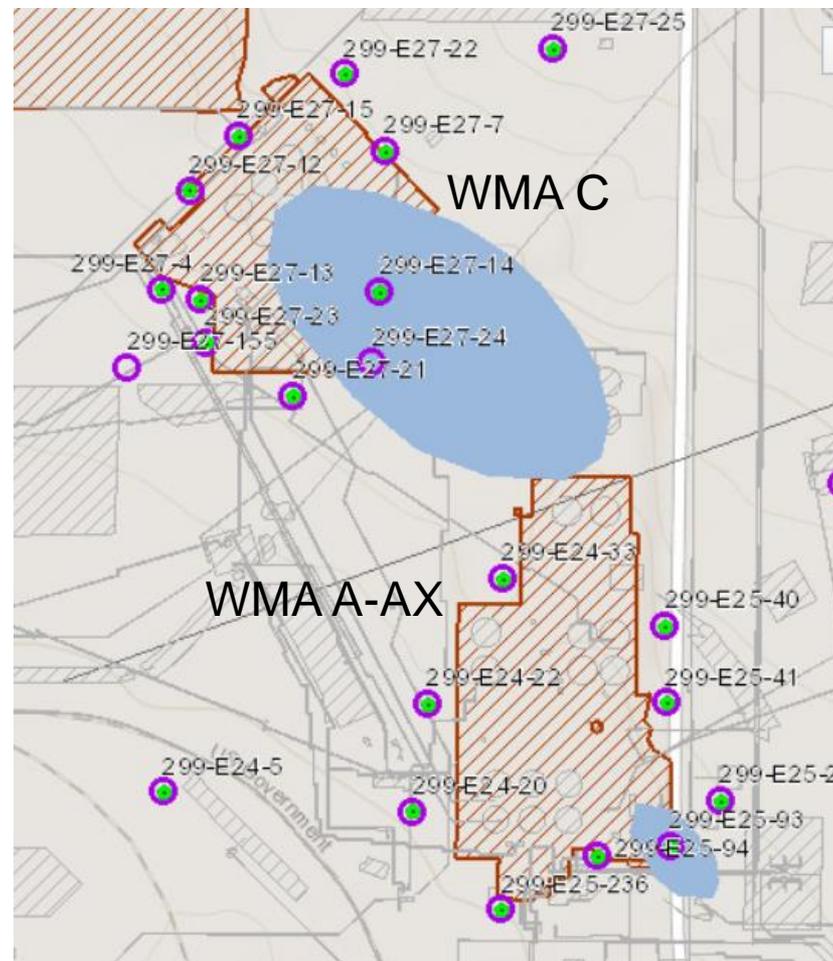
Nitrate Plume Migration



Nitrate 2006



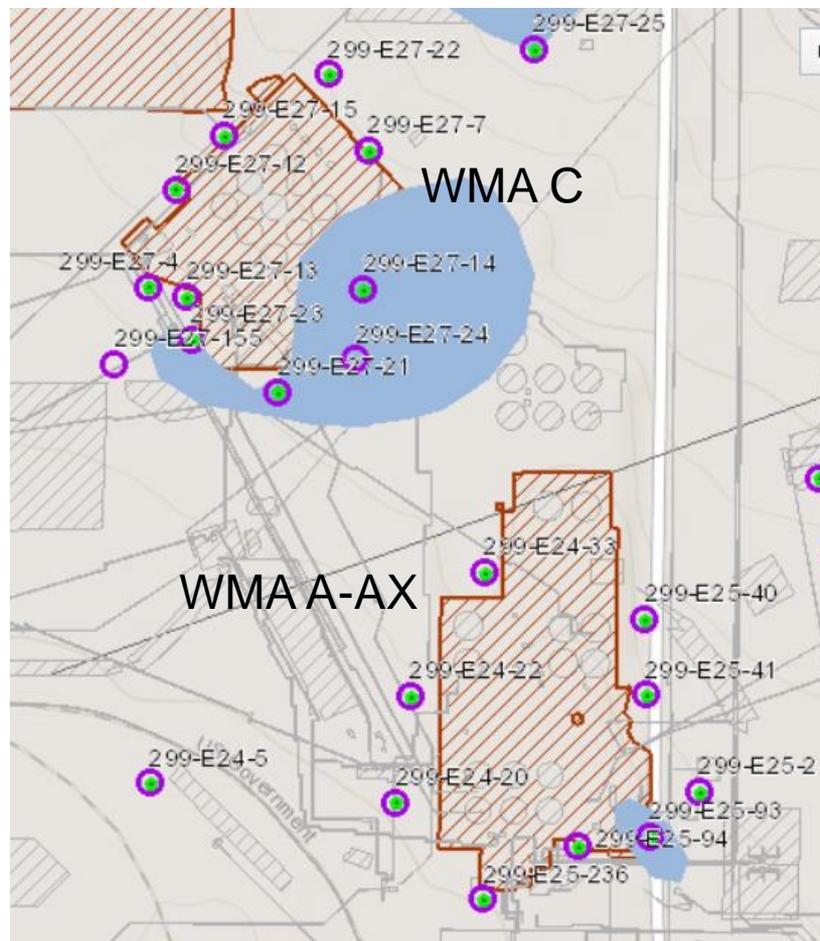
Nitrate 2011



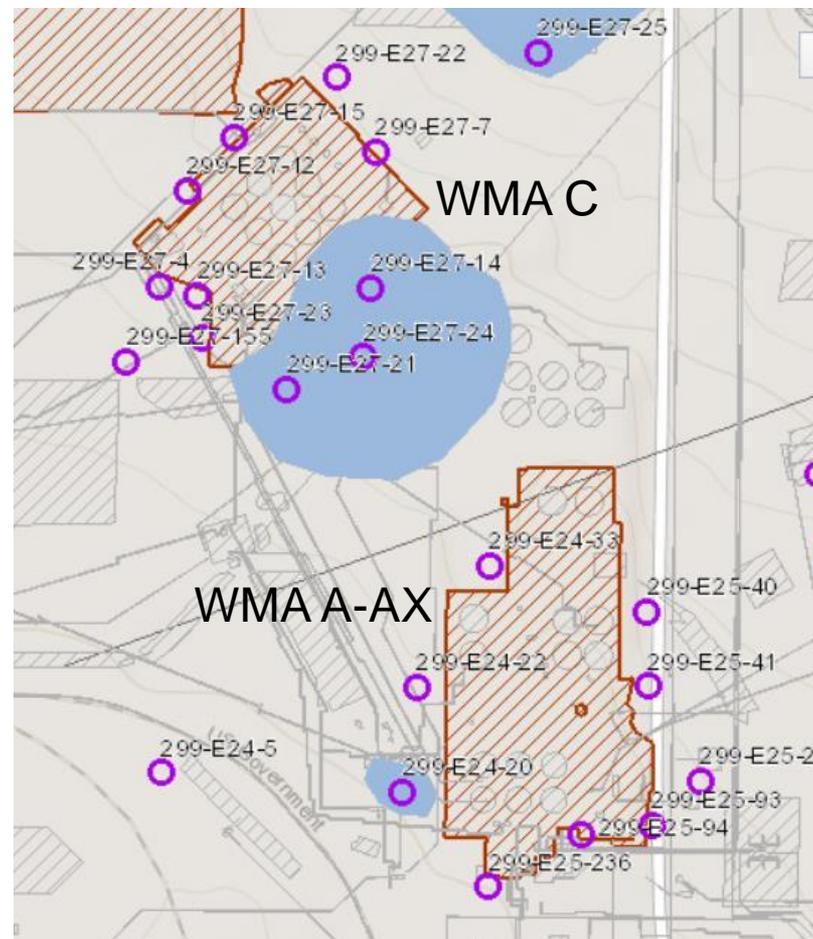
Nitrate Plume Migration



Nitrate 2012



Nitrate 2013

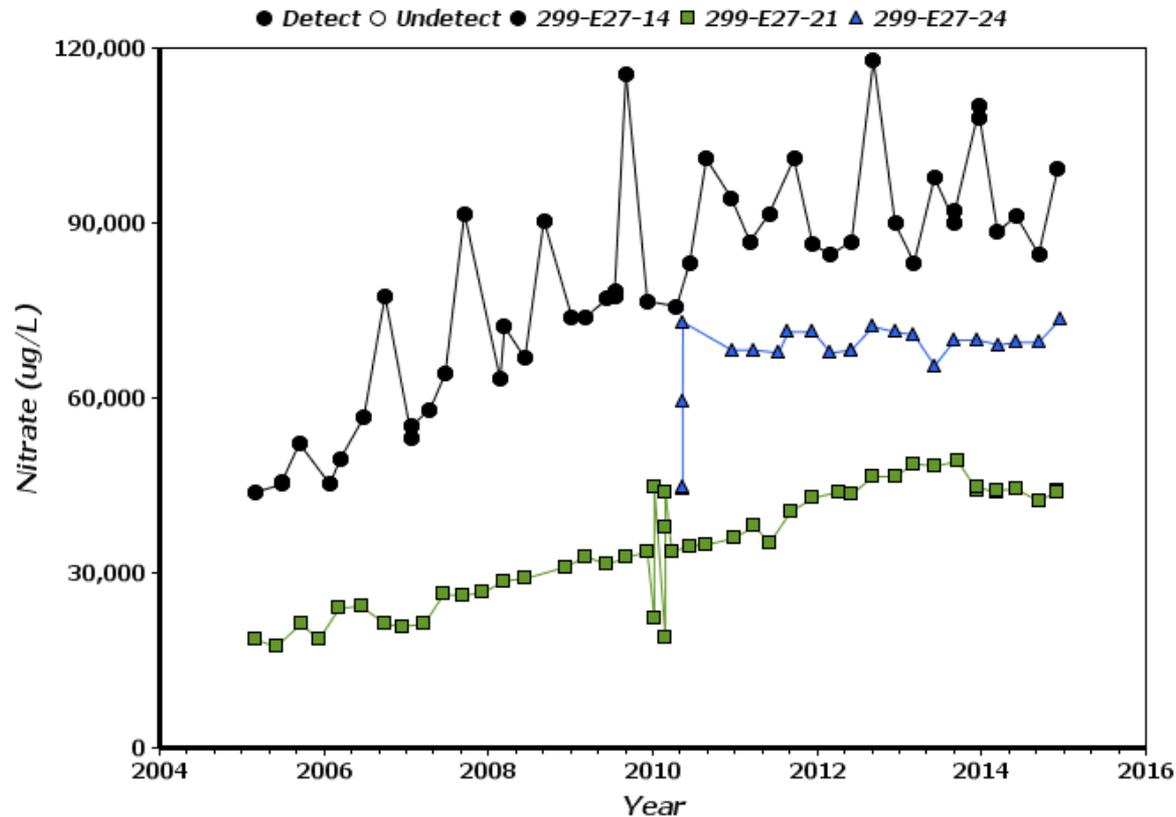


Nitrate Concentration Trends (WMA C)



Southeast WMA C Wells

299-E27-14, 299-E27-21, 299-E27-24
Nitrate (ug/L)



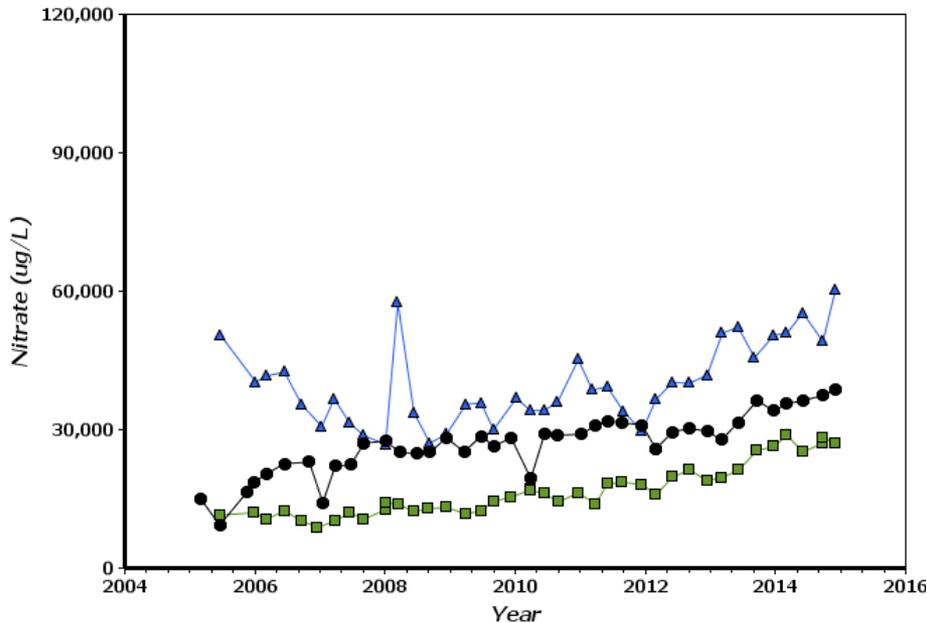
Nitrate Concentration Trends (WMA A-AX)



Northwest WMA A-AX Wells

299-E24-33, 299-E24-22, 299-E24-20
Nitrate (ug/L)

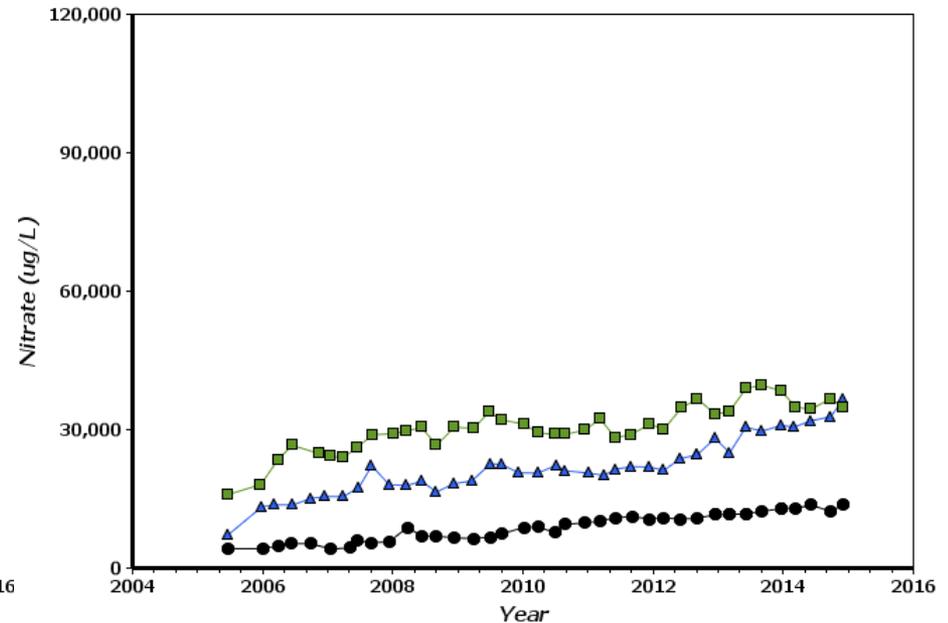
● Detect ○ Undetect ● 299-E24-33 ■ 299-E24-22 ▲ 299-E24-20



Southeast WMA A-AX Wells

299-E25-40, 299-E25-41, 299-E25-2
Nitrate (ug/L)

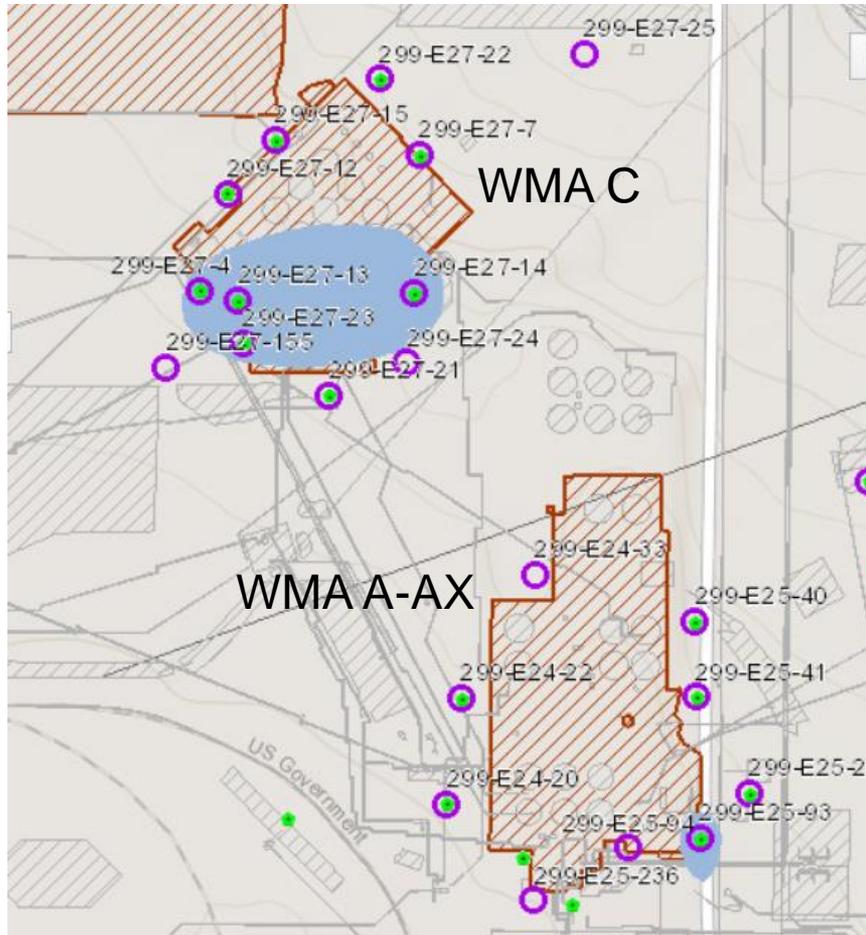
● Detect ○ Undetect ● 299-E25-40 ■ 299-E25-41 ▲ 299-E25-2



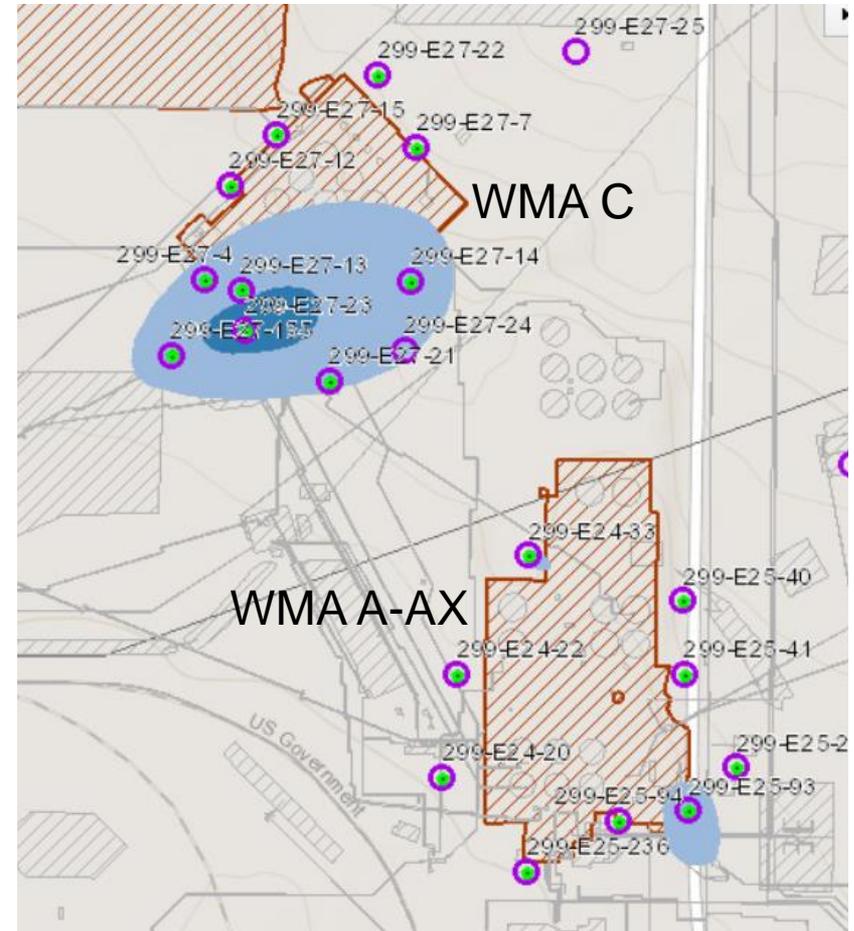
Technetium-99 Plume Migration



Tc-99 2004



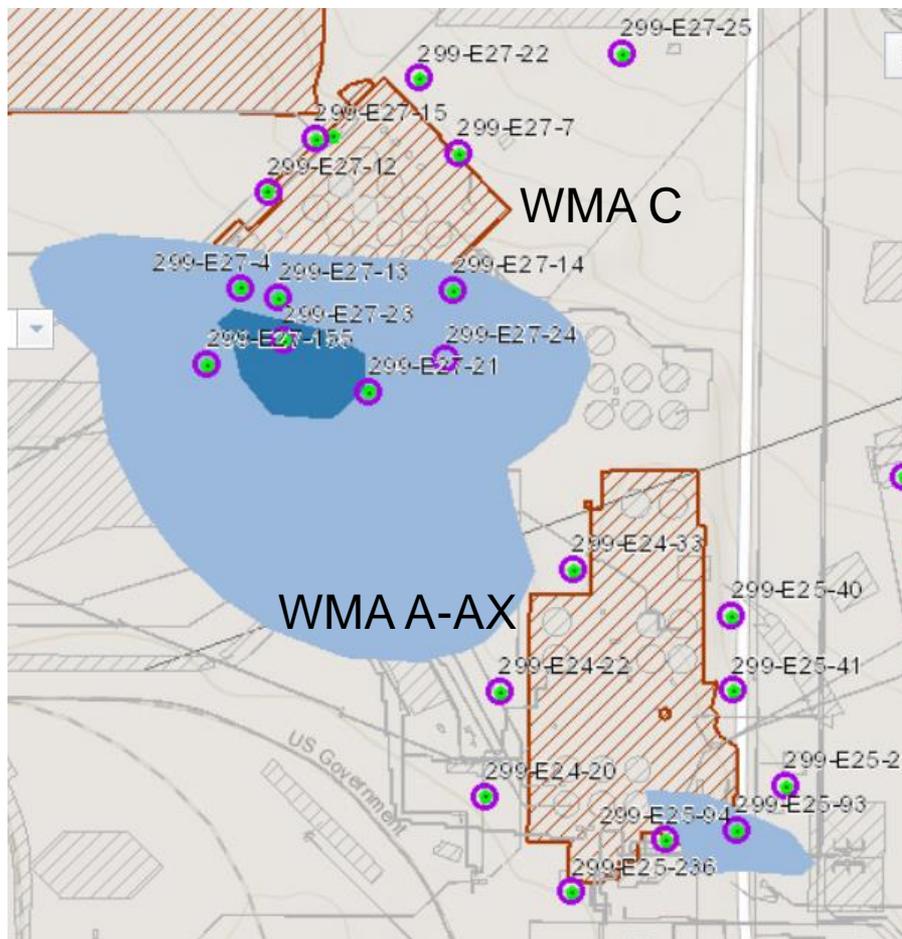
Tc-99 2009



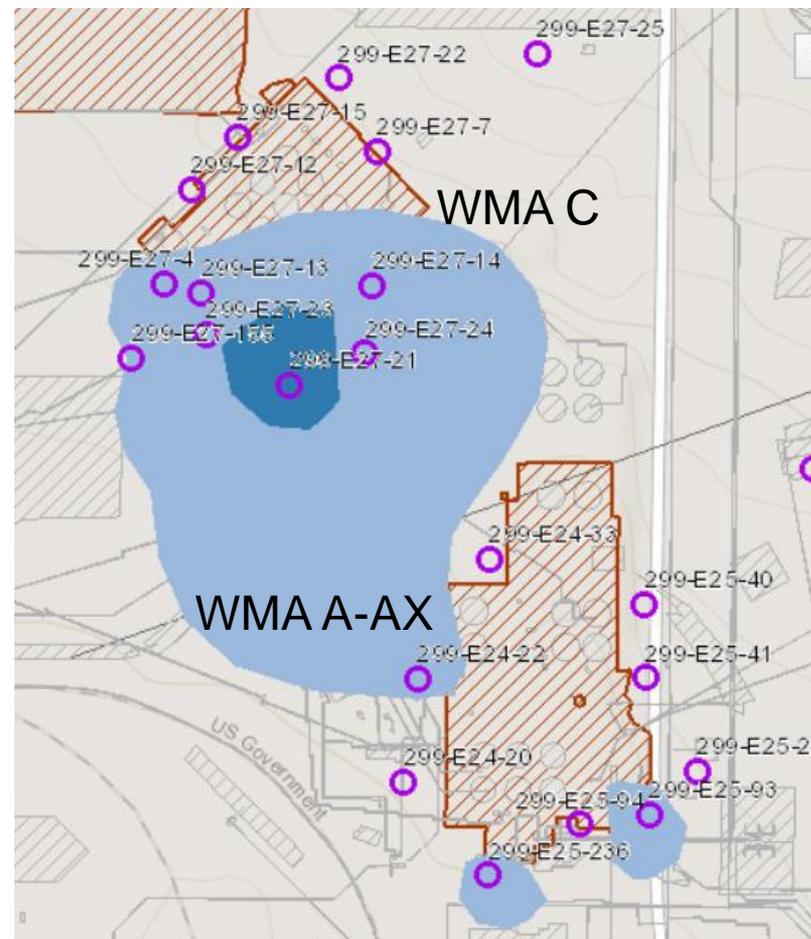
Technetium-99 Plume Migration



Tc-99 2012



Tc-99 2013

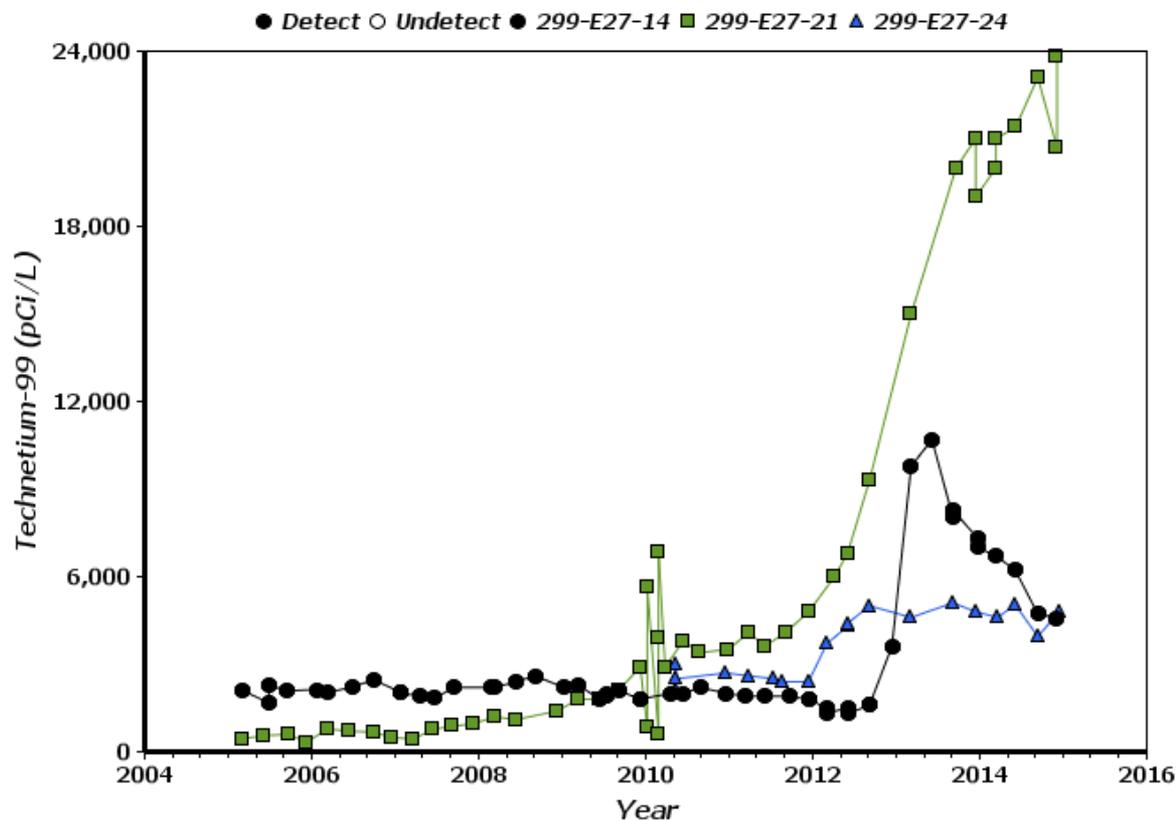


Technetium-99 Concentration Trends (WMA C)



Southeast WMA C Wells

299-E27-14, 299-E27-21, 299-E27-24
Technetium-99 (pCi/L)



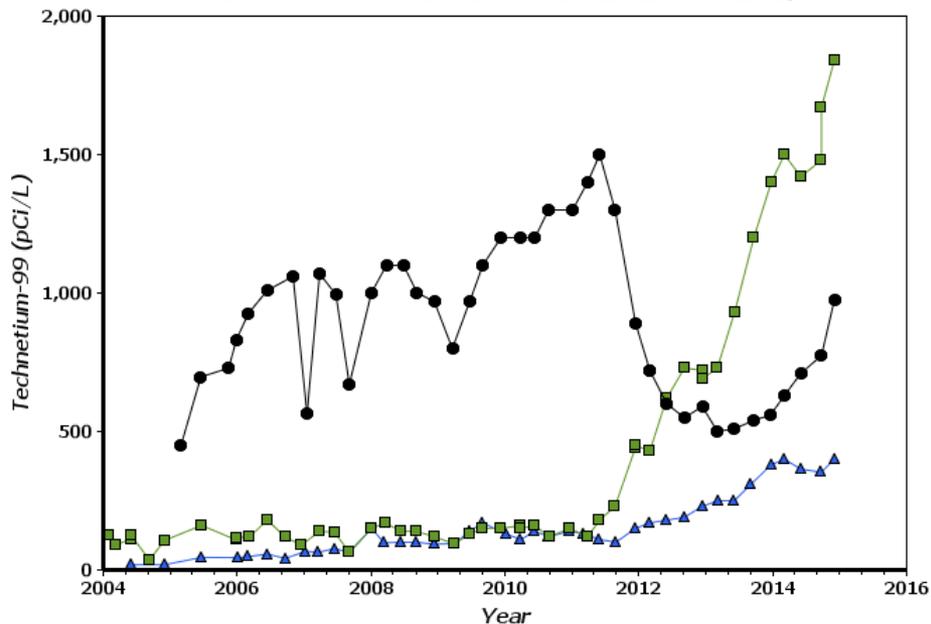
Technetium-99 Concentration Trends (WMA A-AX)



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Technetium-99 (pCi/L)

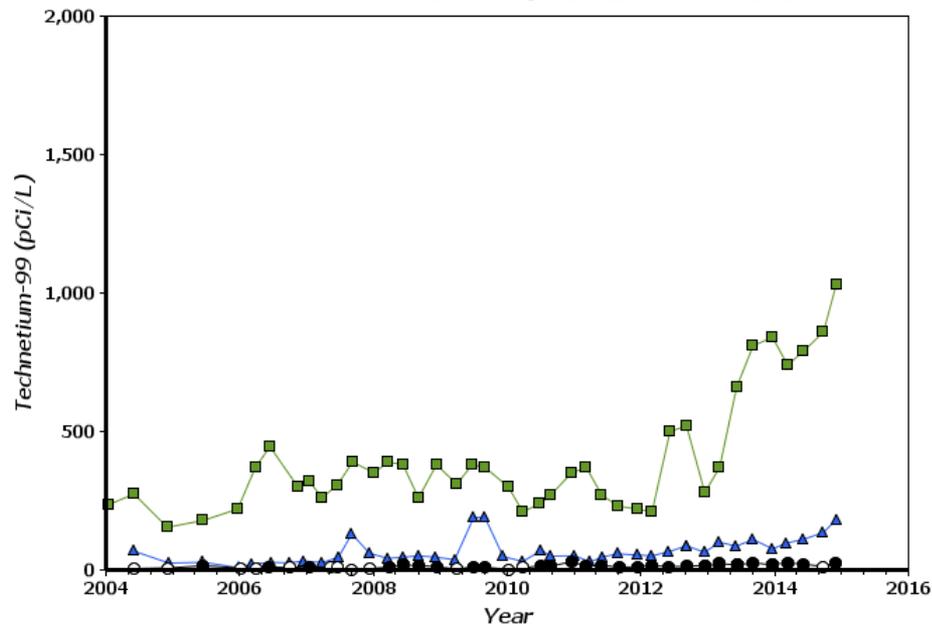
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Southeast WMA A-AX Wells

299-E25-40, 299-E25-41, 299-E25-2
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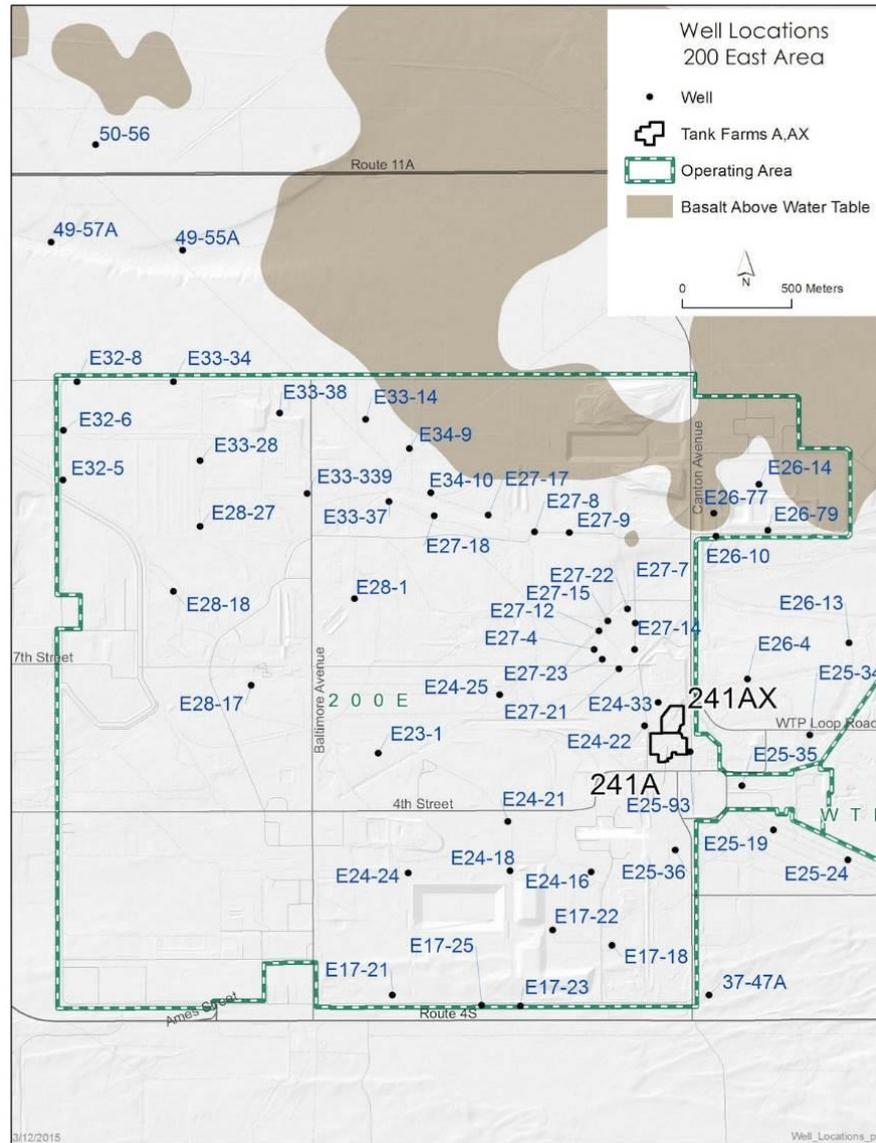
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Sources of Error/Variability in Water-Level Measurements



- Accuracy of well casing elevation surveys
 - All wells in network resurveyed using a highly accurate survey method, double runs between wells, common benchmark
- Well verticality
 - Borehole path surveys performed in all wells using a gyroscope
- Water-level measuring device accuracy
 - Measurements collected with laminated steel e-tapes; calibrated by manufacturer; one tape calibrated by standards lab found to be accurate to within 0.001 m (1 mm) throughout its length
- Well construction
 - Where possible, wells in network have relatively short screened intervals to minimize vertical flow
- Barometric pressure fluctuations
 - Measurements temporally averaged before mapping

200 East Area Low-Gradient Evaluation Well Network



Water-Level Measurement Collection and Analysis



- Water level measurements collected monthly beginning May 2013
- Measurements collected over two consecutive days using the same e-tape
- Results of trend surface analyses (least squares fit of a plane) of water-level measurements near WMA A-AX were unsatisfactory; not statistically significant
- Remaining error/variability in the measurements were greater than local changes in the water table at WMA A-AX
- Needed a method of data analysis that spatially averages the data

Digital Grids of the 200 East Area Water Table

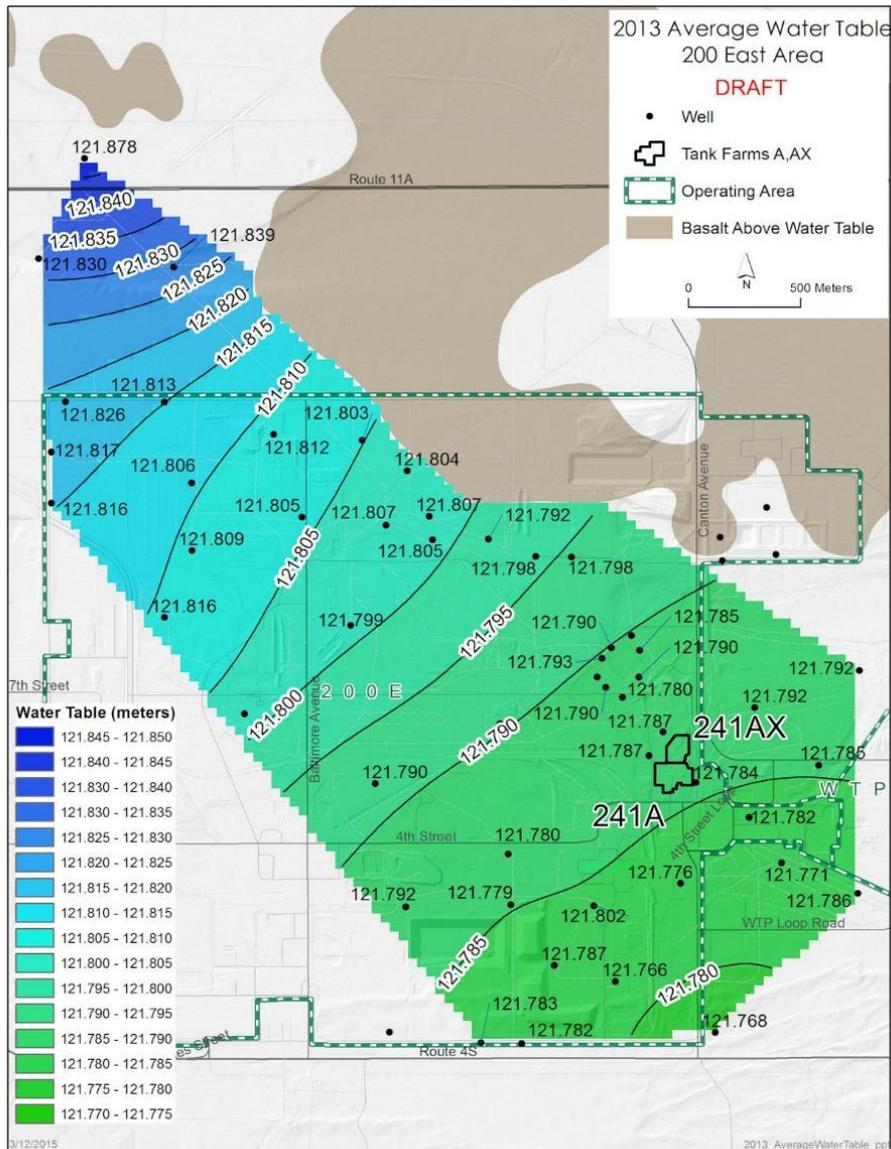


- Measurements were temporally averaged (yearly)
- Many different gridding methods evaluated: point and block Universal Kriging, inverse distance to a power, minimum curvature, polynomial regression, local polynomial, moving average, and others
- Best results were achieved with inverse distance to a power with a large smoothing factor
 - Calculates the hydraulic head at each grid node as a weighted average of all wells in the study area where the weight of each measurement decreases with distance from the node.
 - Smoothing factor: minimum distance of well from grid node
- Cross validation used to remove wells with large errors
 - Same 4 wells removed from both the 2013 and 2014 maps: 299-E17-4, 299-E17-22, 299-E24-25, and 299-E28-17

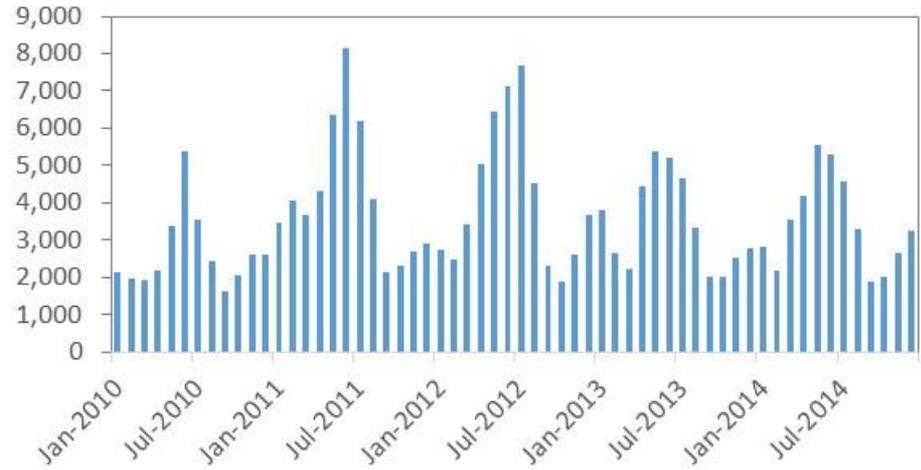


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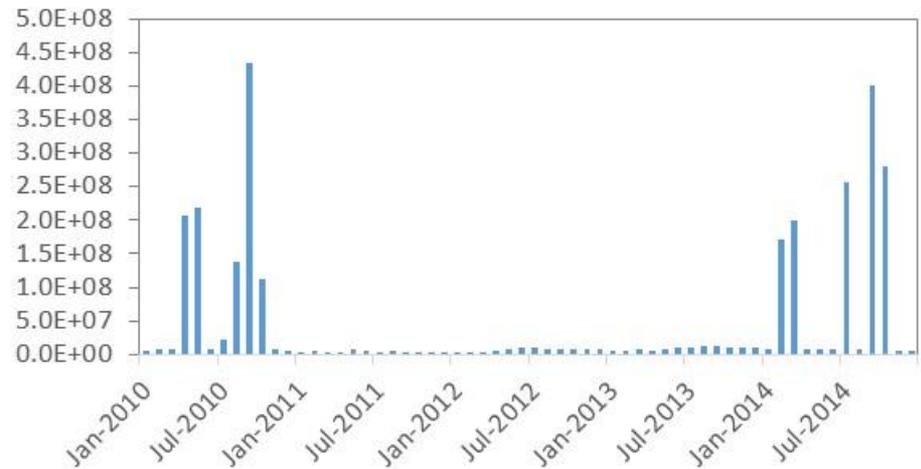
2013 Average Water Table



Monthly Columbia River Discharge (cms)



Monthly TEDF Discharges (L)



Conclusions



- Groundwater flow direction beneath WMA A-AX determined in the past by plume movement: flow toward the southeast
- 200 East Area water table mapped by generating digital grids of average water-level measurements: inverse distance to a power method with a high smoothing factor
- Local flow direction at WMA A-AX inferred from the water table maps agree with interpretations based on plume movement: flow toward the southeast
- Hydraulic gradient magnitude decreased in 2014 due to TEDF discharges, but flow direction remained southeast