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# **Perchlorate at Edwards Air Force Base**

## **Current Progress: Site 285 & Air Force Research Laboratory**

**Environmental Restoration Program  
Edwards AFB, CA**

**Bruce Oshita & Patrice Hallman  
18 February 2010**

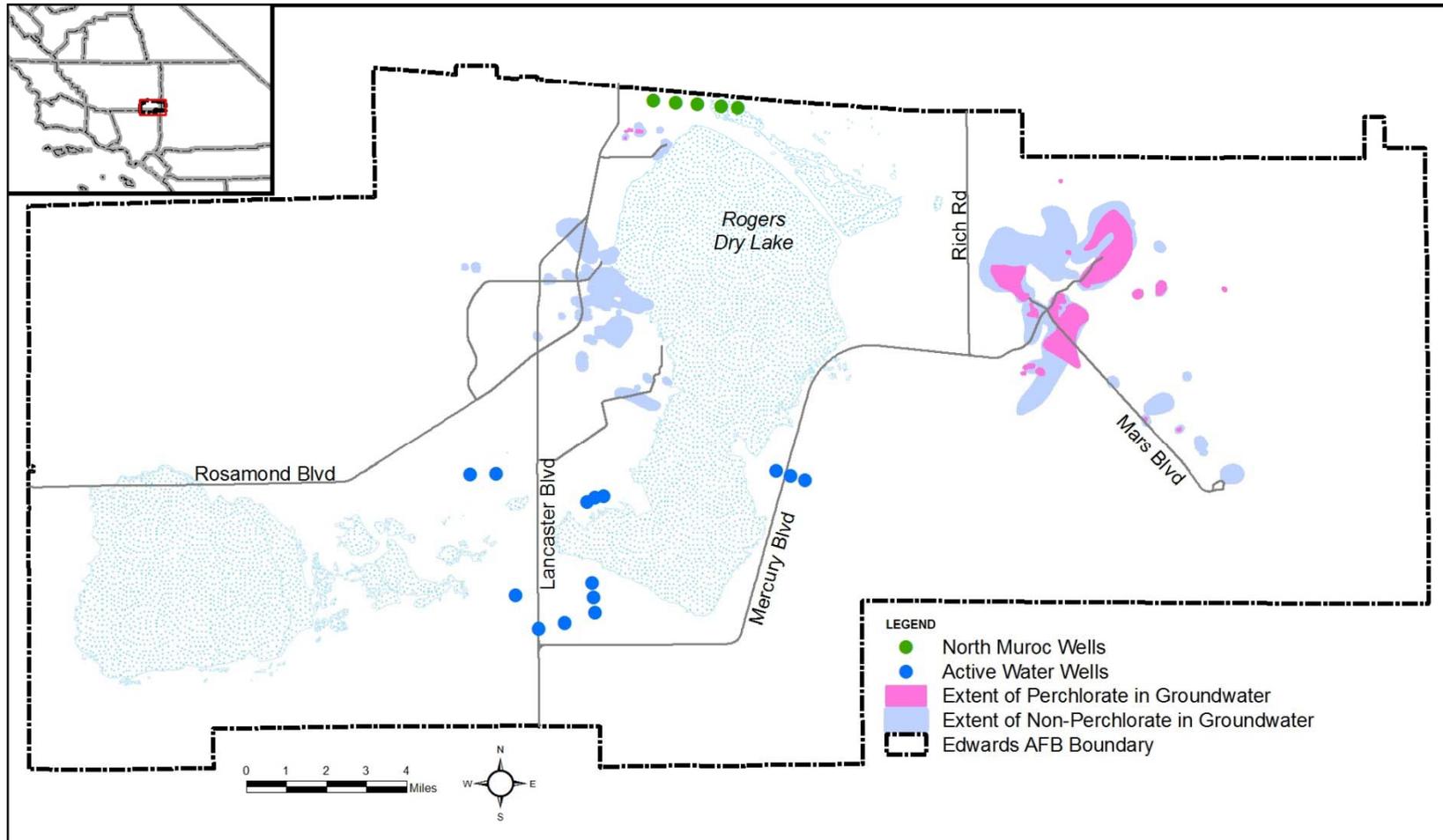




# Basewide Plume Map, Perchlorate



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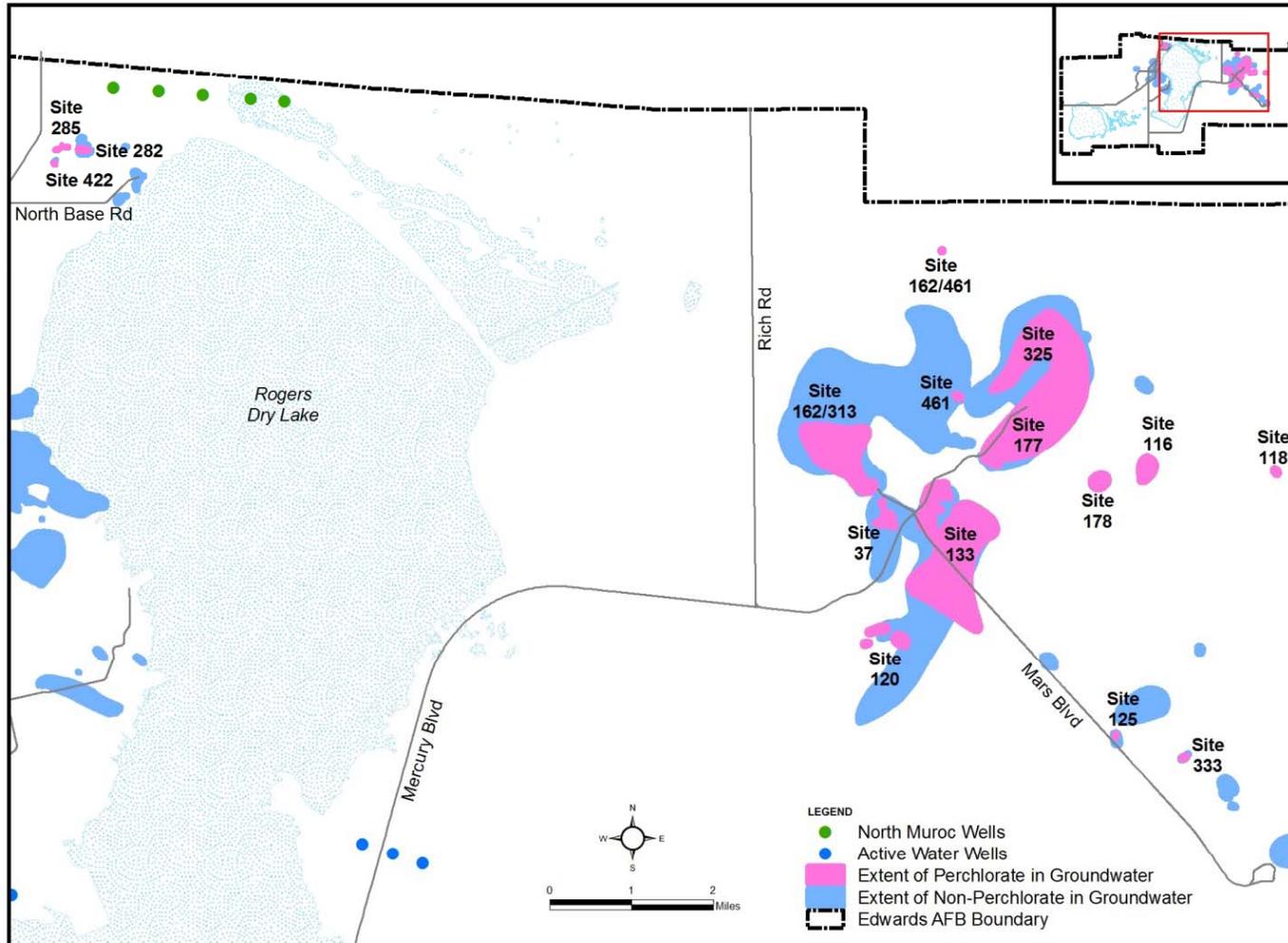




# Basewide Plume Map, Perchlorate [cont'd]



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# Perchlorate Characterization



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- **1997: Perchlorate first detected in soil (June) and groundwater (October) at OU5**
- **1998: Perchlorate first detected at OU4/9, Air Force Research Laboratory (AFRL)**
- **Perchlorate limited to OUs 4/9 and 5/10**
  - Detections reported in AF Perchlorate Database
- **No perchlorate detections off-base or on-base production wells**
- **OU5/10 wells along north property line show no perchlorate (sampled every summer and winter)**
- **Antelope Valley East Kern (AVEK) Water Agency pipeline helps provide base drinking water**



# North Base Background, OU5



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- **Former NASA Jet Propulsion Laboratory(JPL) at North Base, OU5 – JPL left North Base 1995**
- **1940s-1990s: JPL conducted solid/liquid propellant manufacturing for research and development (R&D)**
  - Included solid propellant mixing, casting, and machining
- **Perchlorate groundwater max detected**  
**October 1999 = 160,000 parts per billion (ppb)**
  - August 2005 = 72,400 ppb
  - September 2009 = 3,700 ppb



# Site 285 Perchlorate Treatability Studies, OU5



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- **Groundwater Extraction Treatment System (GETS) with ion exchange resin at Site 285 – started March 2003**
  - (4) extraction wells and (5) aquifer reinjection wells
  - Continues to remediate groundwater with expansion in May 2010
  - Operating under R&D status
- **Soil flushing from unsaturated zone (Bldg 4283)**
  - Treatability study conducted April 2005 to July 2006
  - Effectively removed perchlorate from vadose zone soils
  - Air Force Center for Engineering and the Environment (AFCEE) Headquarters supports soil flushing as final remedy



# Site 285 Perchlorate Treatability Studies, OU5 [cont'd]



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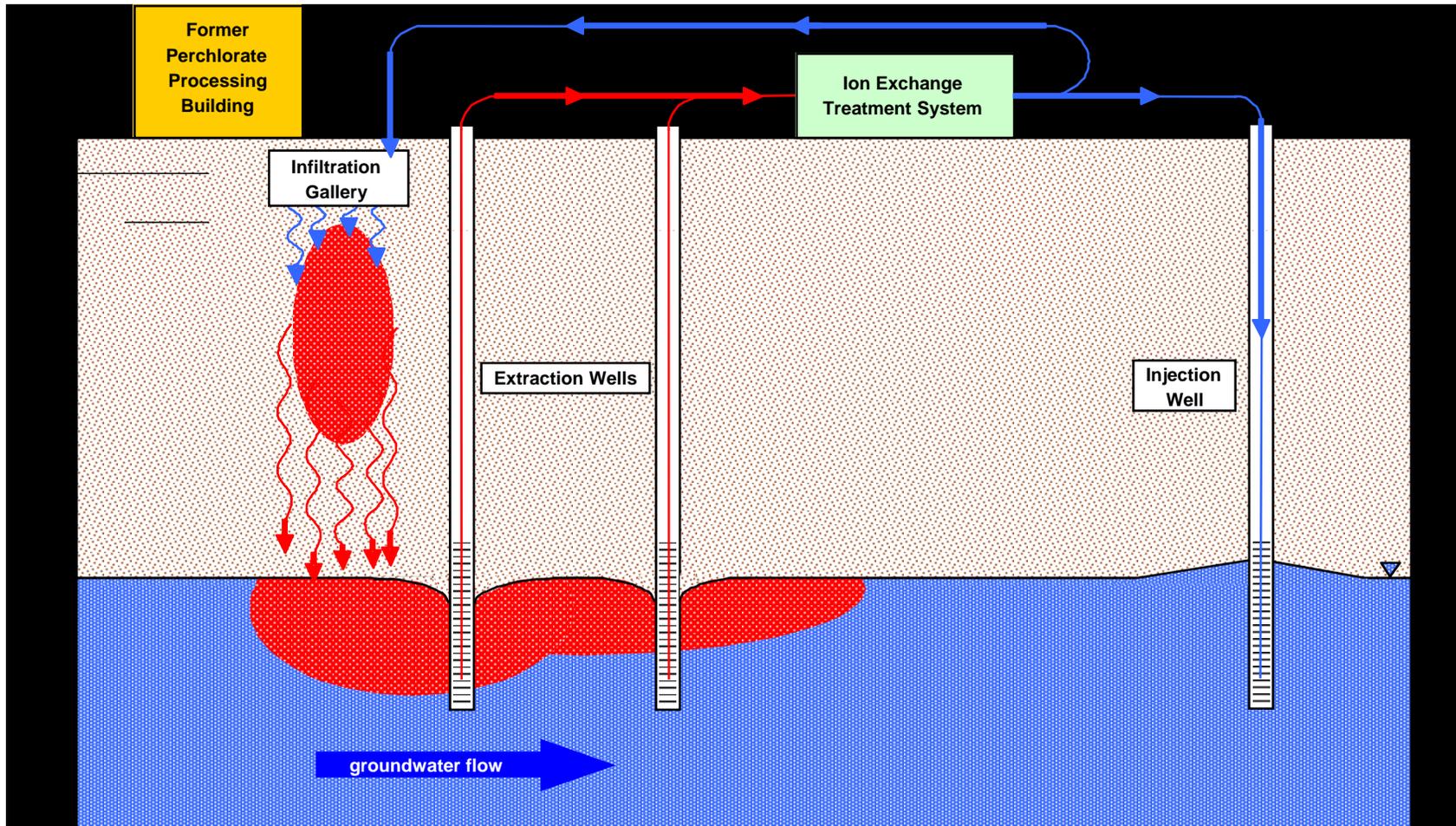
- **Remedies being considered are GETS and soil flushing**
  - Requires Record of Decision (ROD) – February 2012
  - GETS will require Air Force pump and treat (P&T) waiver
- **Enhanced *in situ* bioremediation (Site 285)**
  - Treatability study completed November 2005 to January 2007
  - Difficulty distributing substrate into aquifer due to preferential flow paths



# Site 285 GETS Extraction, Treatment and Reinjection Cycle



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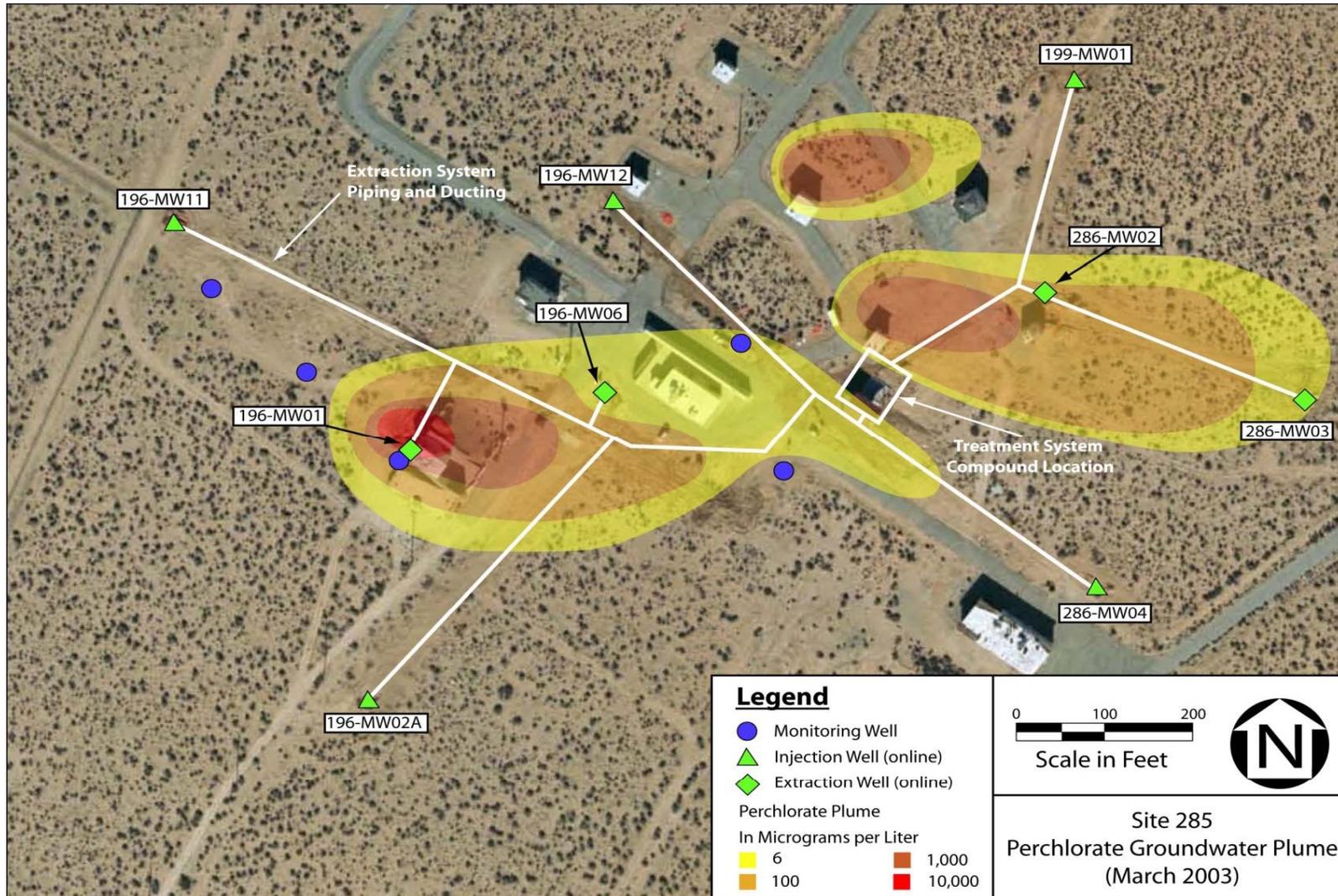




# Site 285 Perchlorate Plumes, 2003



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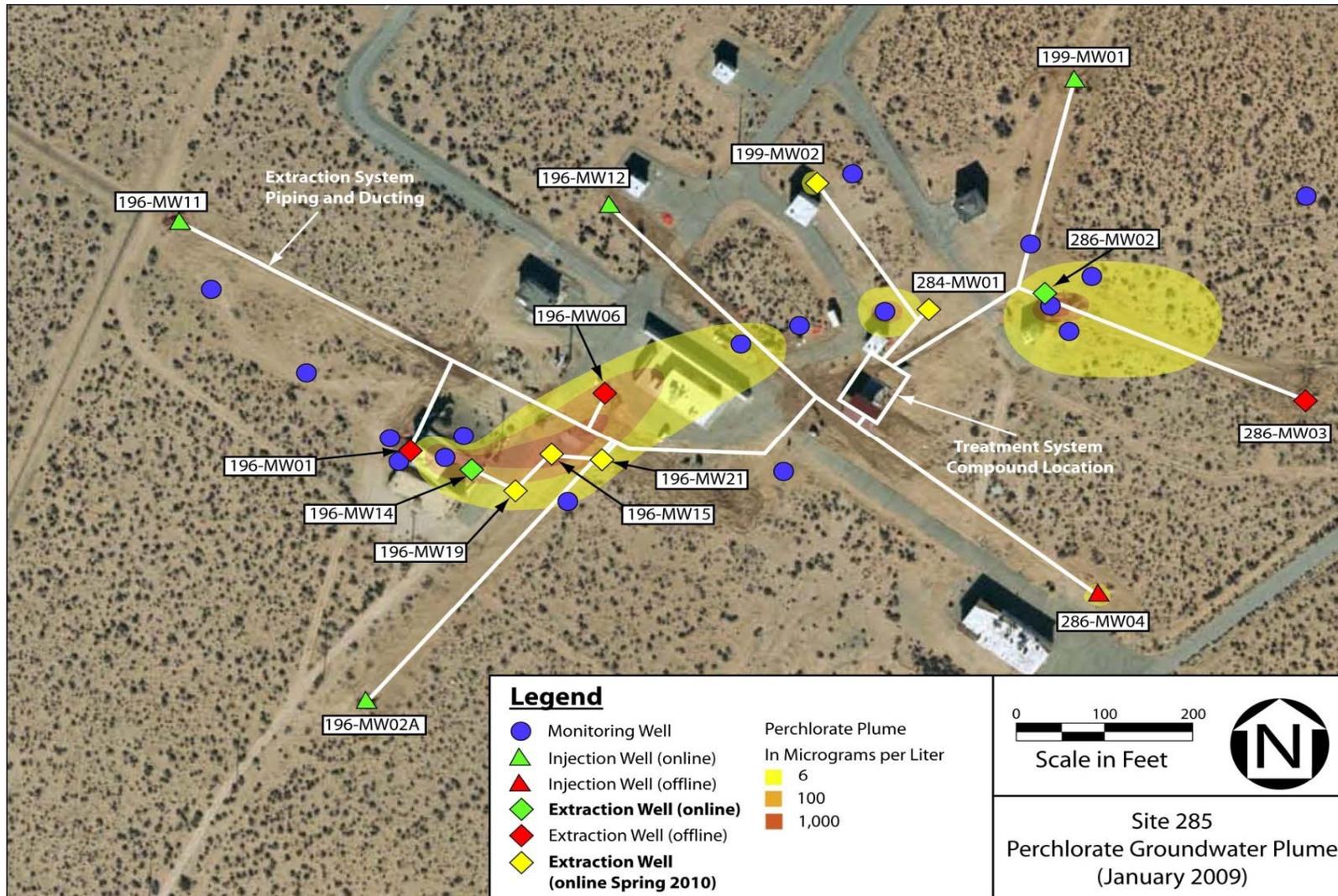




# Site 285 Perchlorate Plumes, 2009



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# Site 285 GETS R&D System



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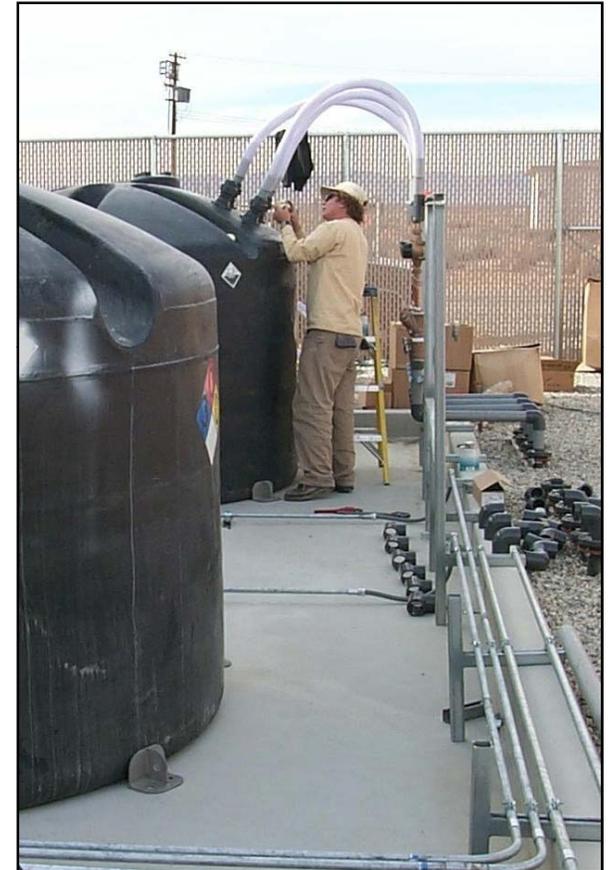


# Site 285 GETS System Performance to Date



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- **California maximum contaminant level (MCL): 6 ppb**
- **Started continuous treatment March 2003**
- **Perchlorate analysis in accordance with DOD policy using EPA protocol**
- **Between March 2003-December 2009**
  - 50 million gallons of groundwater treated and reinjected
  - 151 pounds of perchlorate removed



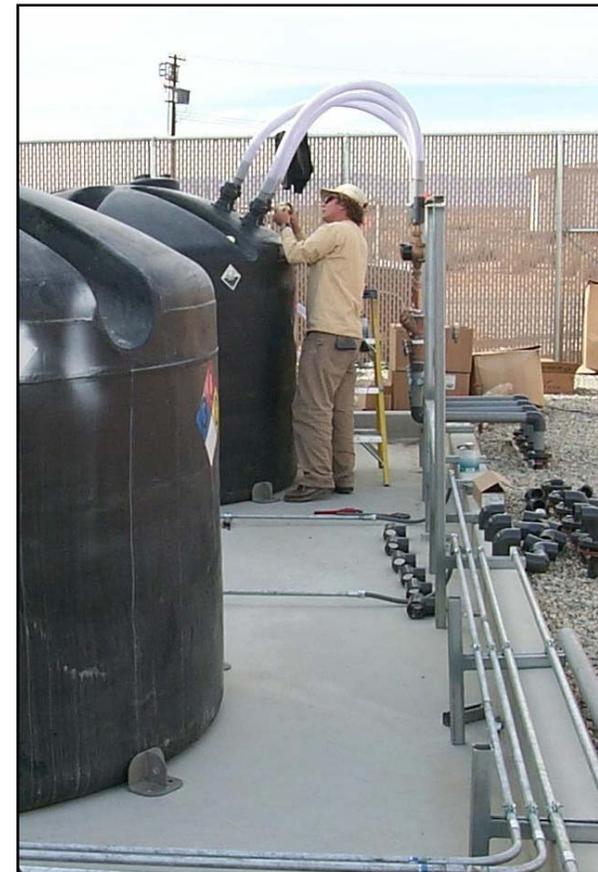


# Site 285 GETS System Performance to Date [cont'd]



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- **92% removal rate for perchlorate reduction**
  - Highest and lowest detections from groundwater monitoring program
- **FS modeling indicates perchlorate concentrations will be reduced below state MCL (6 ppb) in 7-10 years**

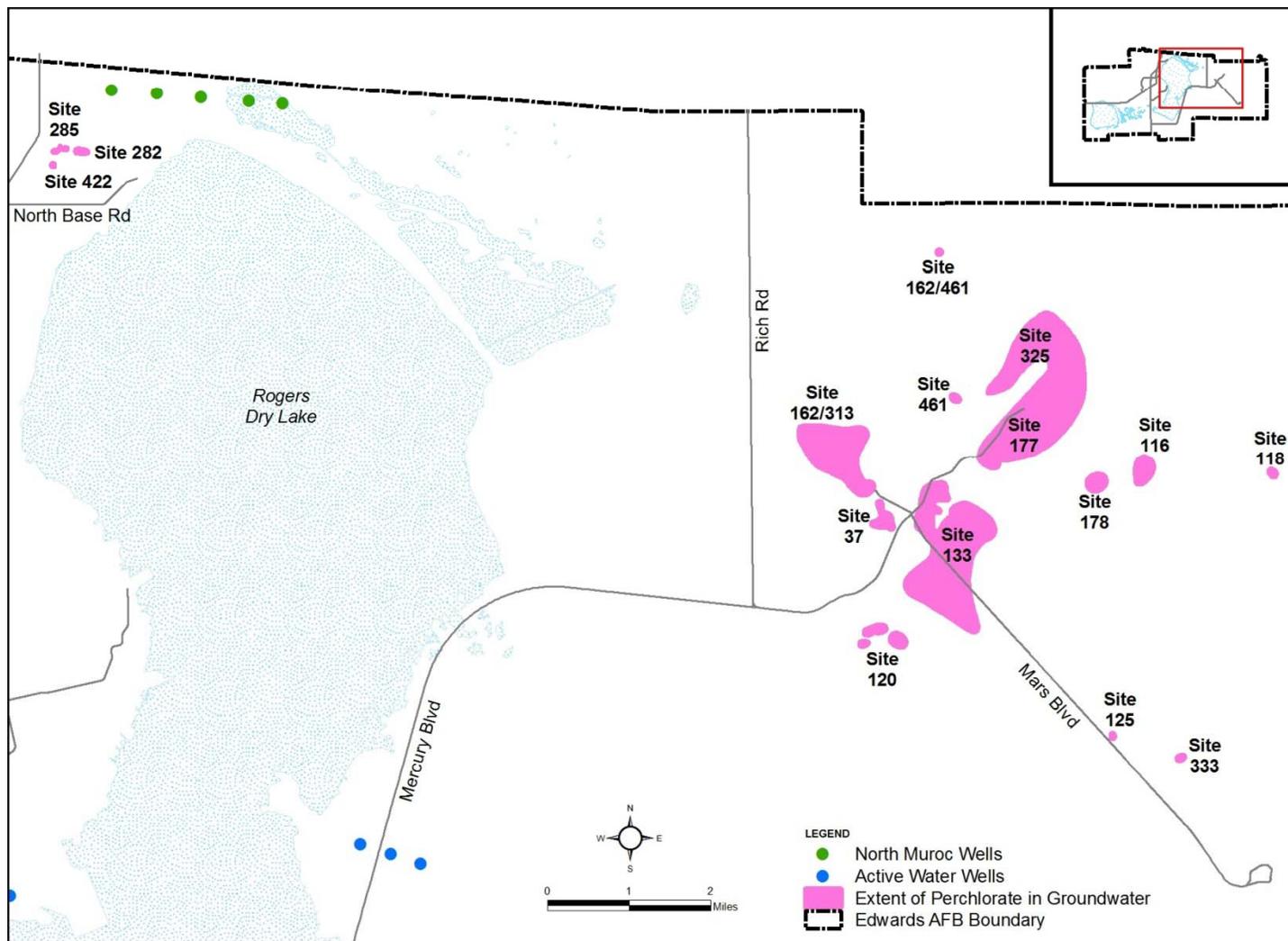




# Edwards AFB Perchlorate Groundwater Plumes (OU4/9)



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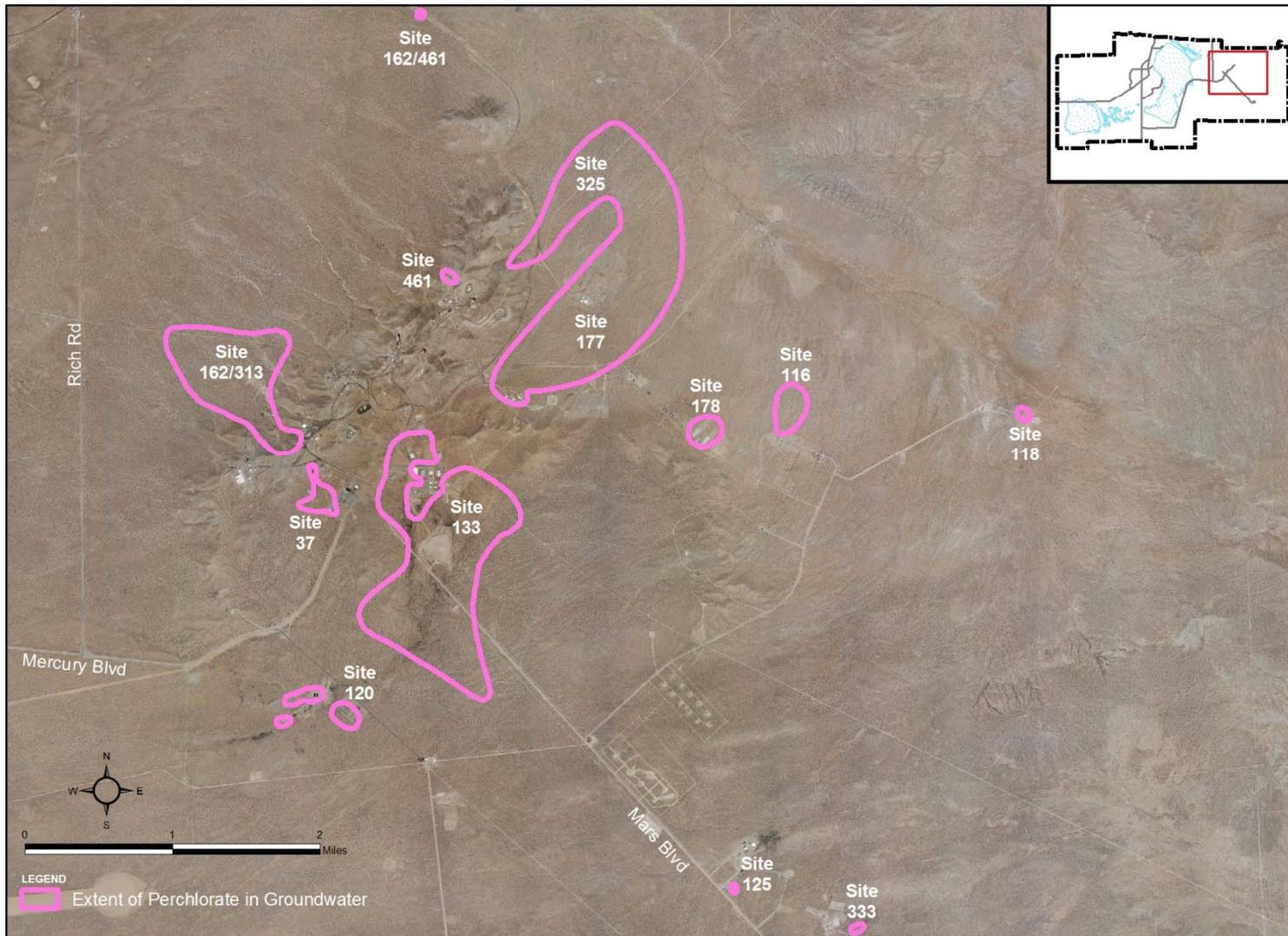




# Operable Units 4/9 Perchlorate Groundwater Plumes



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## Past Releases at OU 4/9



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- **Solid rocket propellants containing perchlorate have been tested at the AF Research Laboratory since the 1960s**
- **Two “propellant sampling cutting” facilities at AFRL**
  - Test Area 1-21 (Site 36, source area for Site 162)
  - Test Area 1-32 (Site 177)
- **Propellant dust from cutting, not captured by vacuum system or filters, was historically rinsed into unlined catch basins until a modern filtration/water evaporation system was constructed. Dried materials are removed and treated to hazardous waste standards**



## Past Releases at OU 4/9 [cont'd]



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- Solid rocket propellant was tested or burned at multiple test areas
- Some test stands use deluge water for cooling





# Remedial Action Progress



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Plume	Zone	Action
177/325	NE AFRL	Treatability Study – 2005
133	South AFRL	Record of Decision - 2007
162/313	Arroyos	Source Removal Site 36 - 2004, Proposed Plan - 2009
37	South AFRL	Record of Decision - 2007
120	South AFRL	Record of Decision - 2007
461	Arroyos	Proposed Plan - 2009
178	NE AFRL	Draft Feasibility Study - April 2010
116	NE AFRL	Draft Feasibility Study - April 2010
318	NE AFRL	Draft Feasibility Study - April 2010
333	Mars Blvd.	Treatability Study - 2008
125	Mars Blvd.	Draft Feasibility Study - April 2010
127	Mars Blvd.	Draft Feasibility Study - April 2010



# Site 36 - Source Removal, 2004



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# Site 36 Remedial Actions



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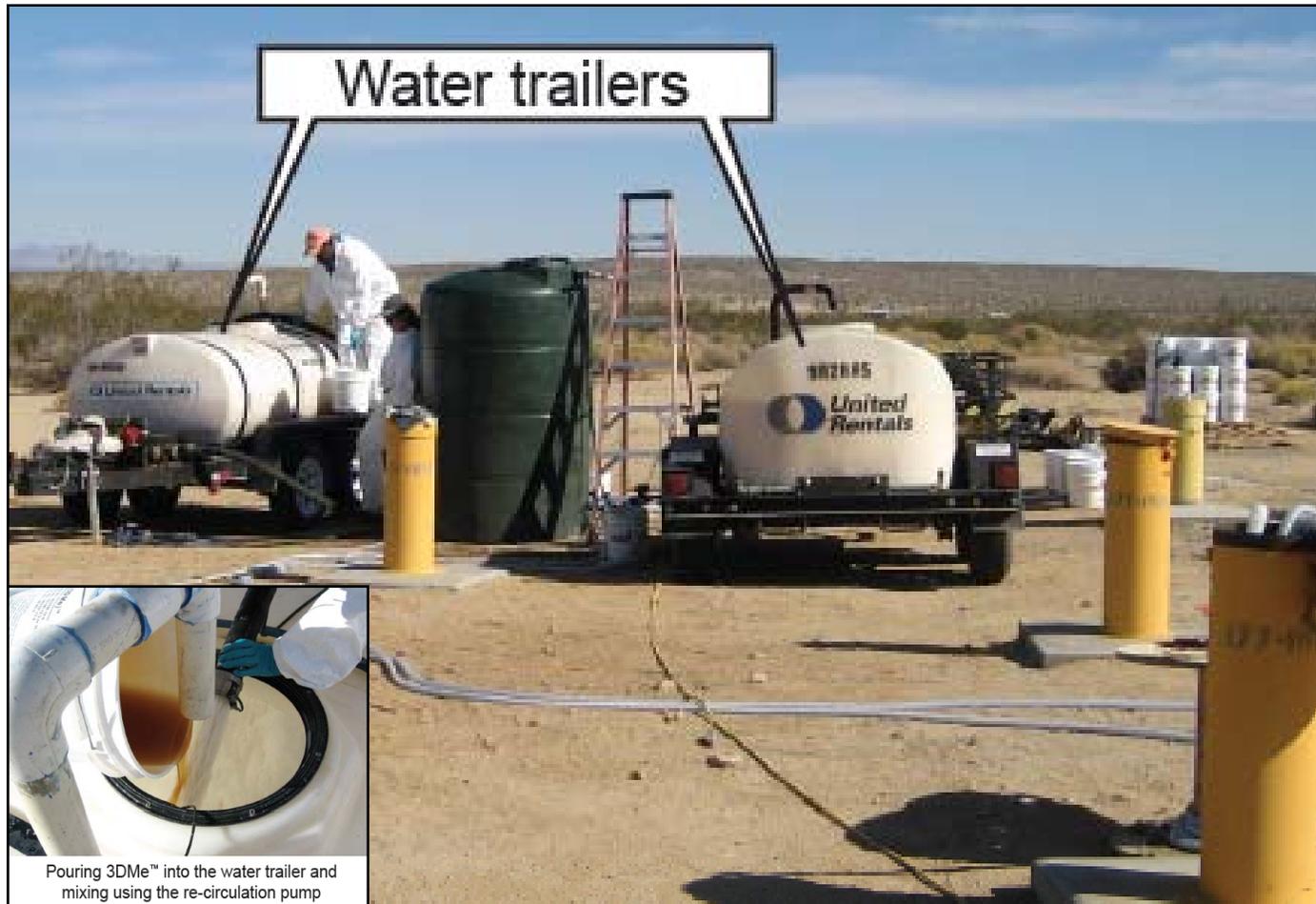
- **Site 36 removal of evaporation tank for propellant cutting operation achieved source removal for Sites 162/313 plume**
- **Site 36 soil cleanup of approximately 40 cubic yards of perchlorate contaminated soil is under contract to be removed in fiscal year 2010 (2008 Record of Decision)**
- **Site 36 cost to complete \$747K**



# Site 177/325 Treatability Study



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## Injection Equipment Layout



# Site 177/325 Treatability Study – HRC®



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# Site 177/325 Treatability Study



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- **Conducted in two phases using HRC<sup>®</sup>/3DMe<sup>™</sup> starting in 2005**
- **Added commercially available bacterial culture (KB-1<sup>™</sup>) to enhance biodegradation of chlorinated solvents (PCE, TCE, etc.) and perchlorate**
- **Successful in reducing chlorinated solvents and perchlorate levels in pilot-scale**
- **Levels remain low within the barrier as of November 2009**

PCE = tetrachloroethene

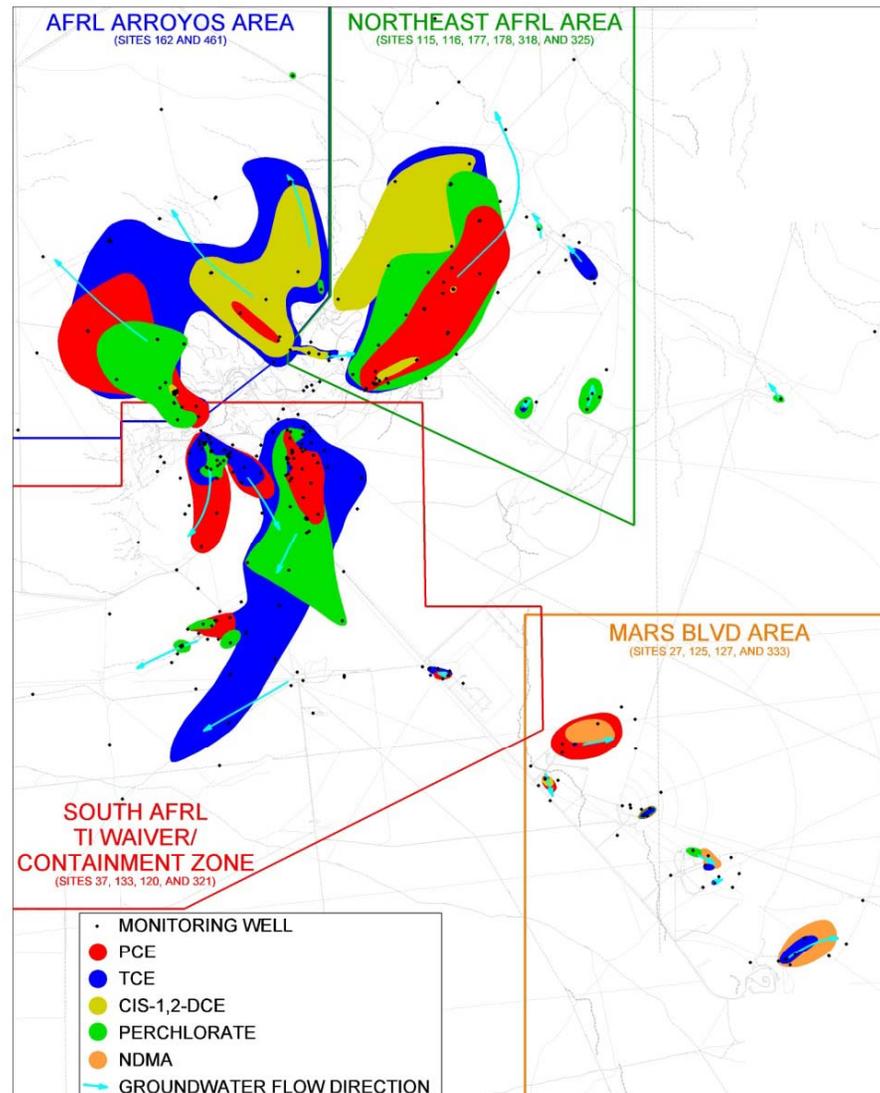
TCE = trichloroethene



# OU4/9 Groundwater Contamination by Zone



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# Technical Impracticability Waiver



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- **South AFRL – ROD signed 2007**
- **Arroyos – Technical Impracticability (TI) Waiver proposed 2010**
- **Northeast (NE) AFRL and Mars Boulevard (Blvd) – TI Waiver proposed 2012**
- **No current technology available for efficient, cost-effective treatment of contamination in fractured granite bedrock**
  - Depth to first groundwater ranges from 20 to more than 200 feet
  - Fracture flow is complex – not all fractures are water-bearing nor interconnected
  - Wells generally pump at less than 0.5 gallons per minute



# Technical Impracticability Waiver [cont'd]



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- **Estimated time to clean entire South AFRL plume by pumping and treating exceeds 1,000 years, based on groundwater modeling, and would cost \$200 million in the first 30 years**
- **Estimated cost to aggressively clean entire Arroyos plume by pumping and treating would be \$941 million over 200 years**
- **Costs for NE AFRL and Mars Blvd Site cleanups are similar to Arroyos**



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**Questions?**