Tuba City Landfill Closure

Site Background, Investigation Groundwater Quality, Closure Alternatives

Hopi Water Resources Program

Hopi Environmental Protection Office

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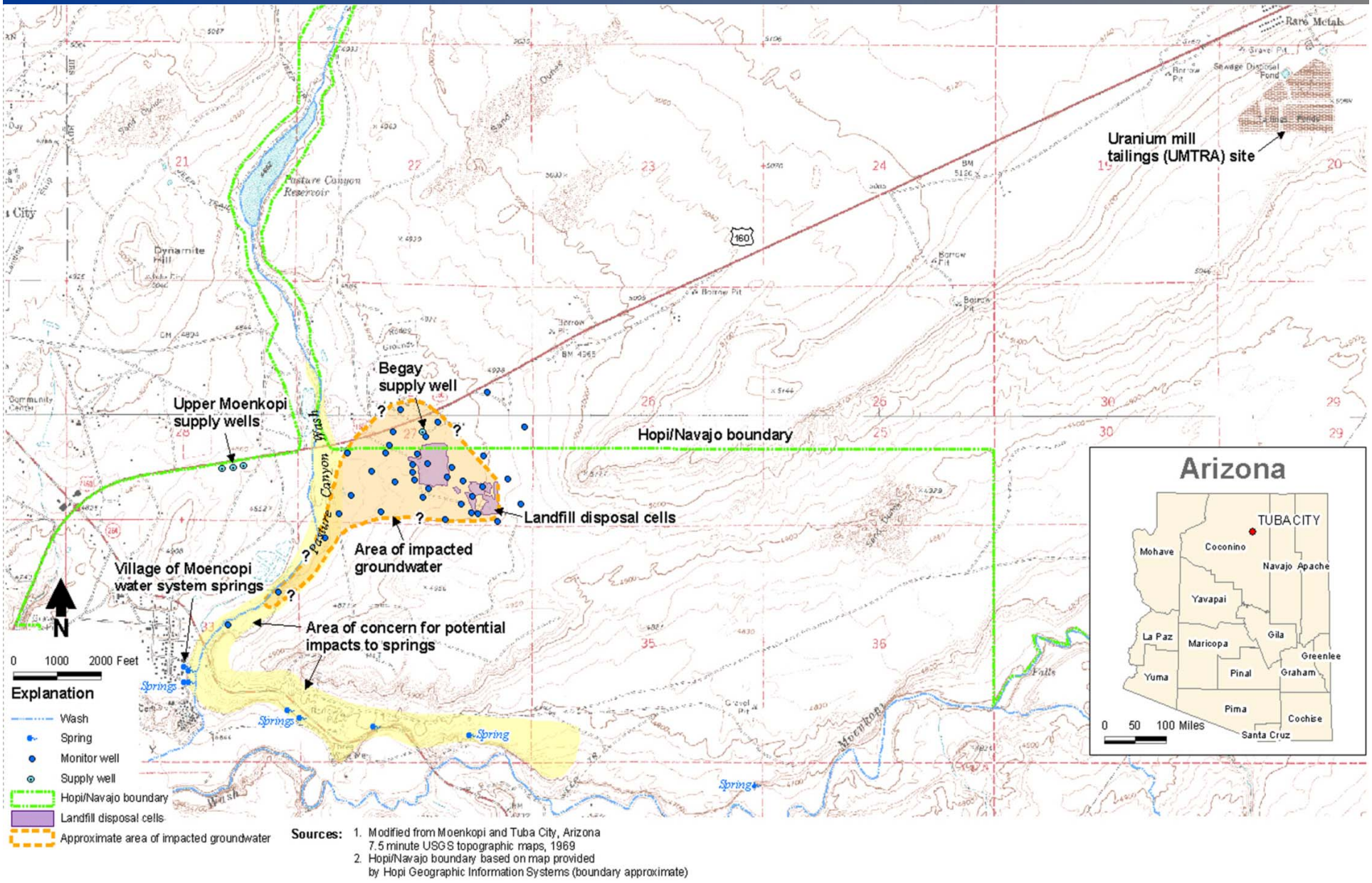
Presentation Outline

- Site Background
  - Operating history
  - Hydrogeologic setting
  - Final closure efforts
- Site Investigation
  - Waste conditions
  - Groundwater conditions
- Closure Alternatives Assessment

Site Background

- 1950s to1990s - Landfill opened and operated by the Bureau of Indian Affairs (BIA)
  - Land withdrawn from the Navajo Reservation
  - Dumping generally unregulated and unsupervised
- 1950's to 1980's - Old waste cells (10-acres) active
- 1980's to 1997 - New waste cells (20-acres) active
- 1997 - Waste disposal ended in 1997
  - Surface debris consolidated and covered
  - New cells fenced

Site Location Map



Sources:
1. Modified from Moenkopi and Tuba City, Arizona 7.5 minute USGS topographic maps, 1969
2. Hopi/Navajo boundary based on map provided by Hopi Geographic Information Systems (boundary approximate)

Tuba City Landfill

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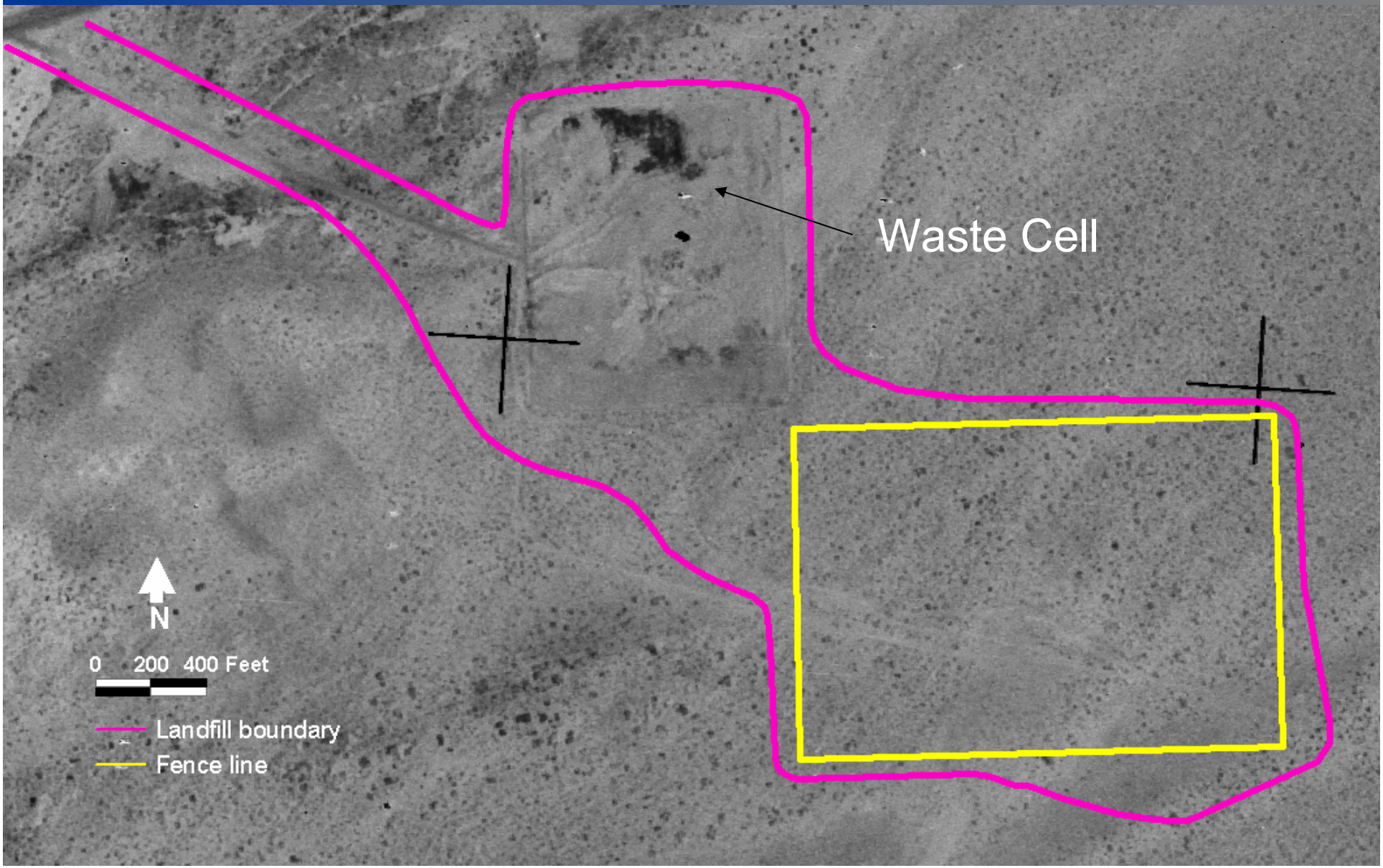
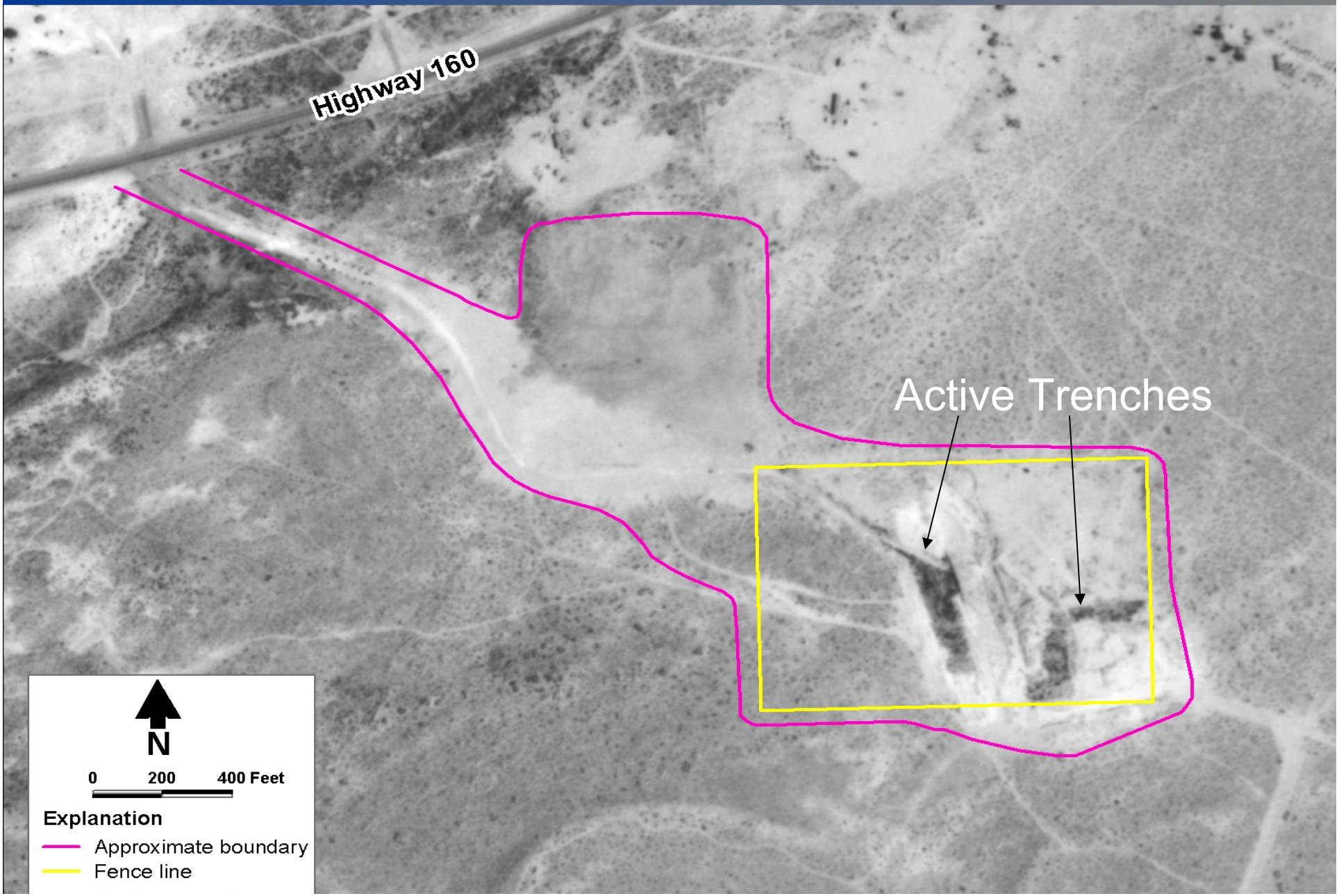
Aerial Photograph - 1973



Aerial Photograph 1995



Aquifer is Sole Drinking Water Supply

- Landfill overlies alluvium and Navajo Sandstone
- Drinking water supply wells for the Village of Upper Moenkopi are completed in Navajo Sandstone and underlying Kayenta Formation (N-Aquifer)
- Drinking water spring for the Village of Moencopi discharges from the N-Aquifer
- Springs provide irrigation water in areas downgradient from the landfill
- No alternate drinking water supply is readily available to serve needs of community

Susungva Spring, Moenkopi

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Steps Taken Toward Final Closure

- 1995 - BIA contractor prepares closure plan for 3-acres of open disposal trenches
- 1997 - BIA ends disposal; surface waste is covered
- 1999 - Hopi Tribe submits a site investigation and engineering assessment to BIA and EPA
- 2001 - Hopi Tribe completes expanded investigation of groundwater contaminant plume
- 2001 - Regional Landfill Feasibility Study completed for BIA and Hopi Tribe to consider disposal alternatives

Steps Taken Toward Final Closure

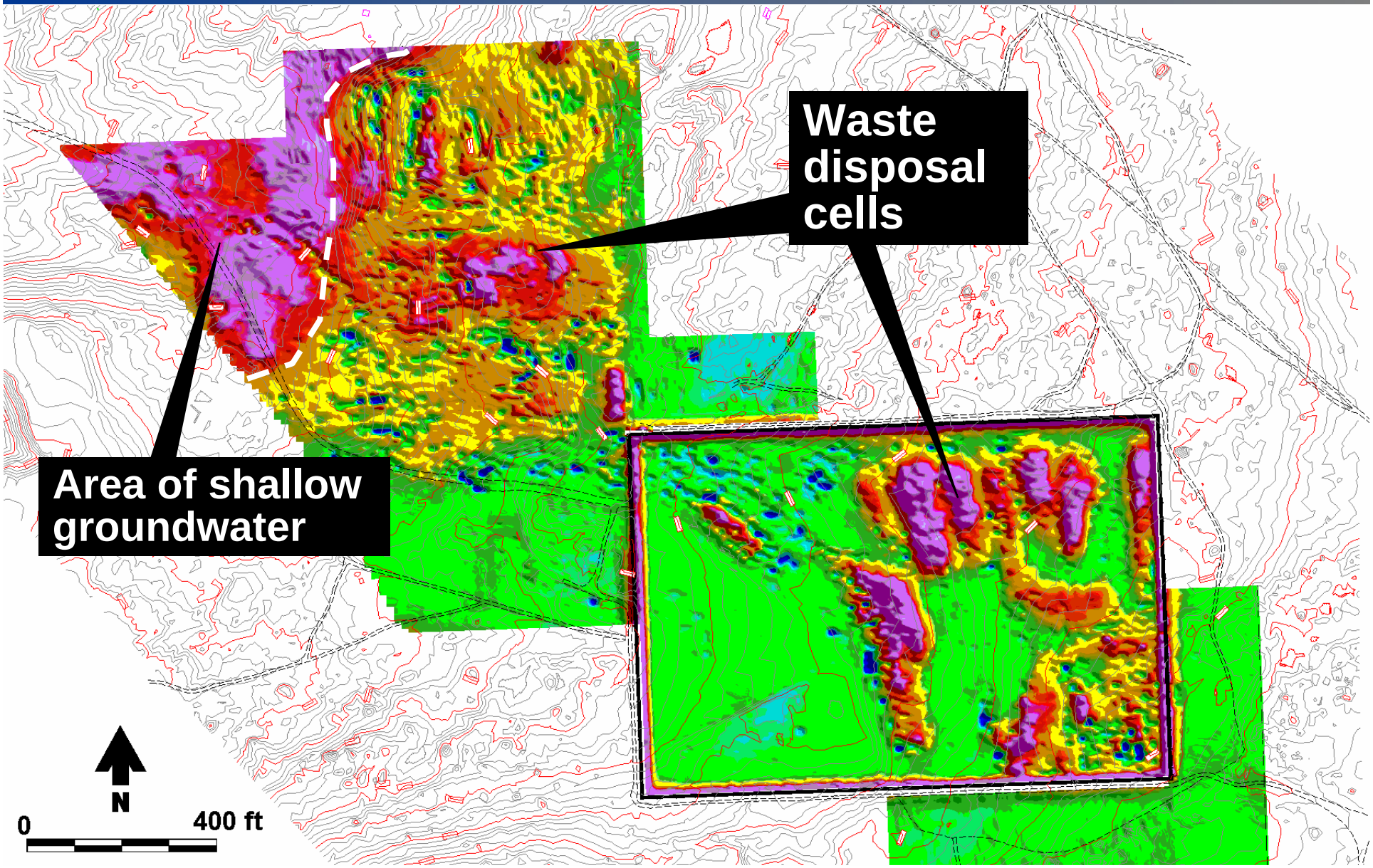
- 2002 - Hopi Tribe samples representative wells multiple times to establish statistical significance of contaminants
- 2004 to 2006 - Navajo Nation installs additional monitor wells along north side of landfill
- 2006 - Preliminary Assessment and closure cost estimate completed to pursue BIA/DOI funding
- 2007 - Hopi Tribe completes waste characterization and expanded groundwater investigation
- 2007 to 2008 - BIA initiates RI/FS Work Plan and interim studies

Site Investigation Summary

- Waste disposal locations mapped by geophysical survey
- 119 borings drilled in the waste:
  - Waste samples tested for hazardous materials
  - Accurate determination of depth of waste
- Landfill gas survey found methane and VOCs at low levels
- Total of 38 groundwater monitor wells have been installed (shallow and deep).
- Investigation activities are continuing

Waste Location

Geophysical Survey of Disposal Cells (1999)



Waste Location

Refined Survey of Northern Disposal Cell

Sunbelt Geophysics 2005

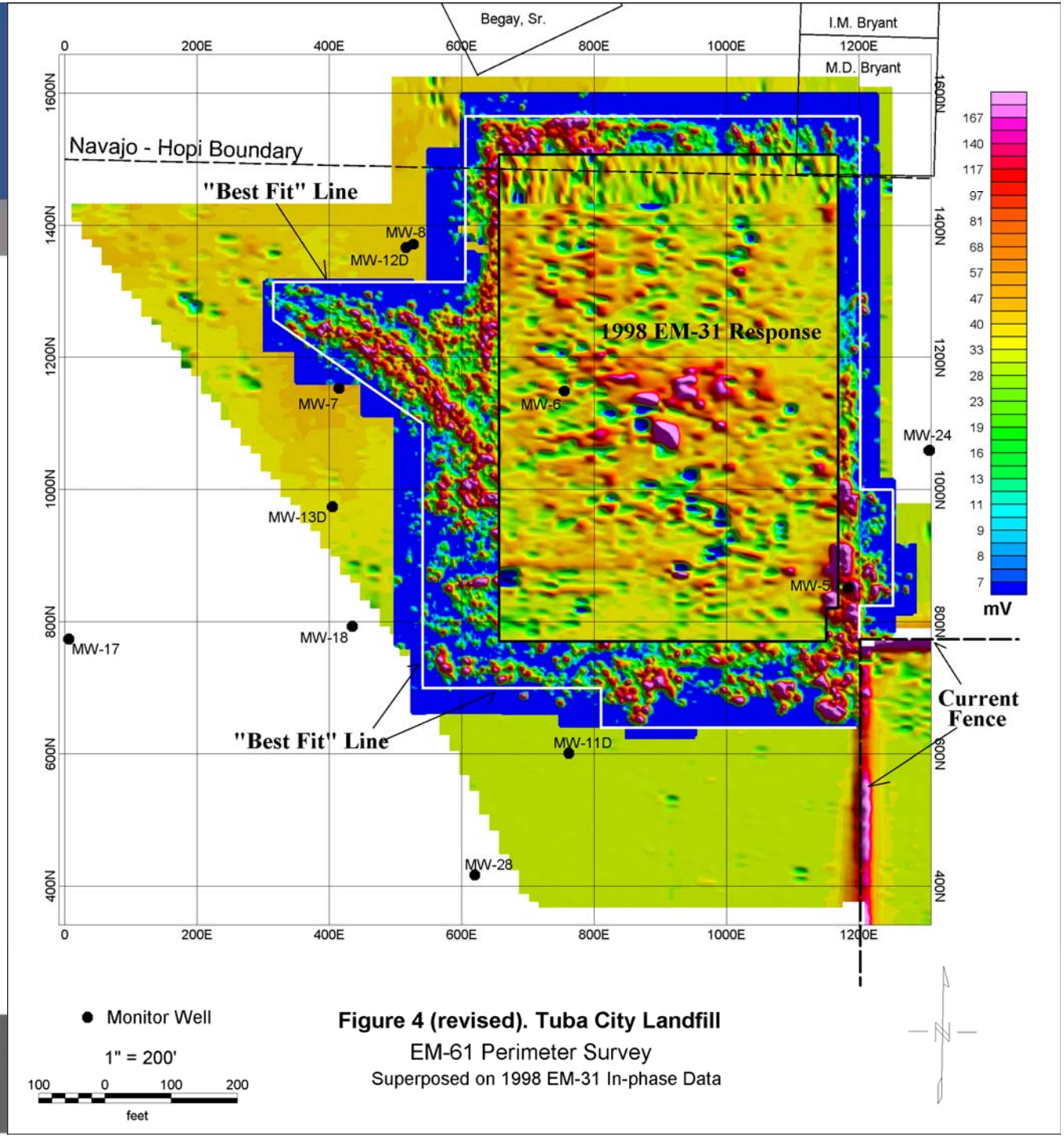


Figure 4 (revised). Tuba City Landfill
EM-61 Perimeter Survey
Superposed on 1998 EM-31 In-phase Data

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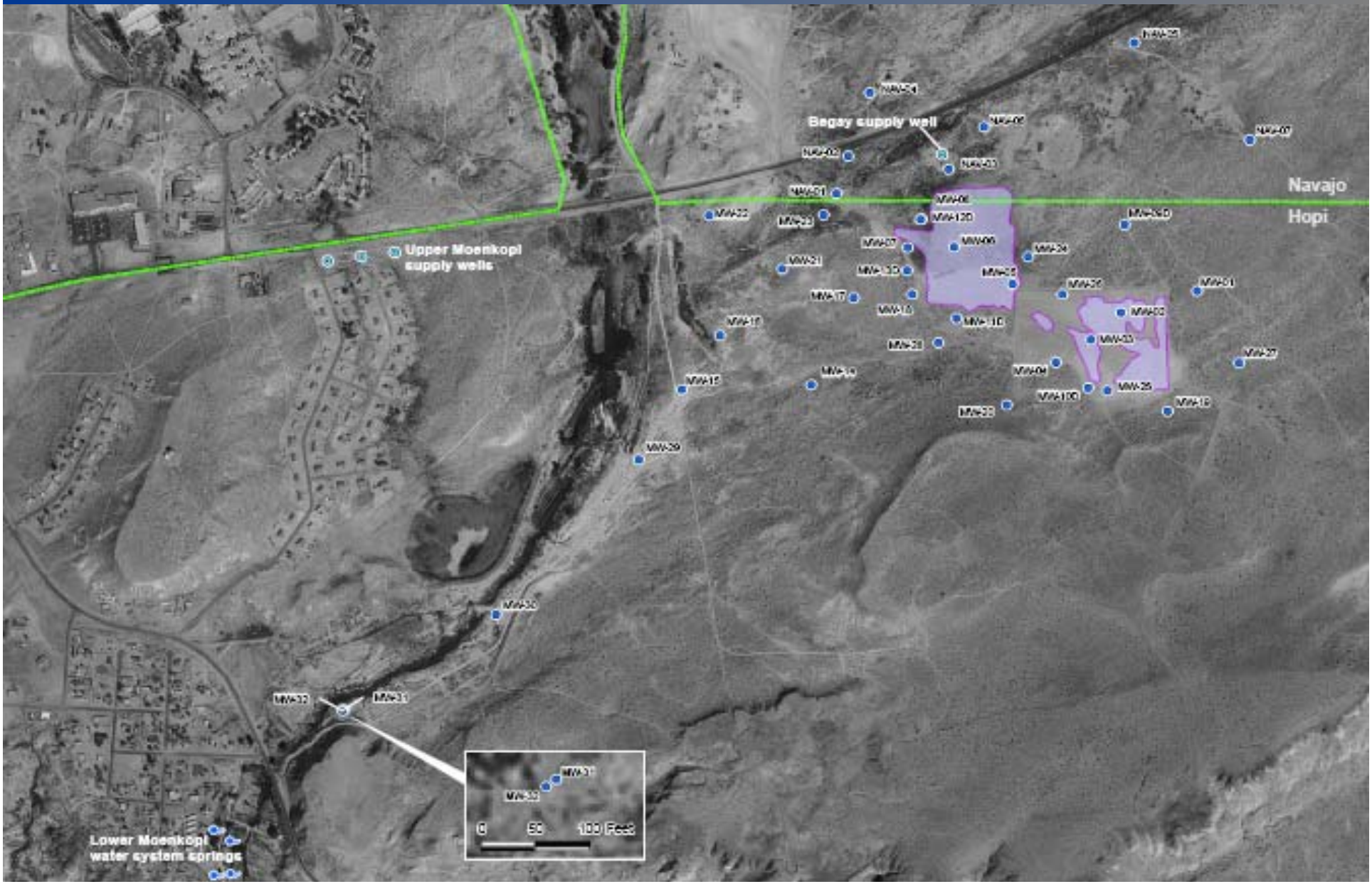
Waste Drilling Results - 1999

- 18 borings drilled in the landfill disposal cells
- Borings penetrated waste, stopped at bedrock
- Confirmed geophysical survey
- Waste depth 10 - 20 feet
- Water table and saturated waste encountered
- Leachate monitor wells installed in saturated waste
- No hazardous waste (metals or organics) identified
- With waste area and depth; waste quantity approximately 330,000 cubic yards

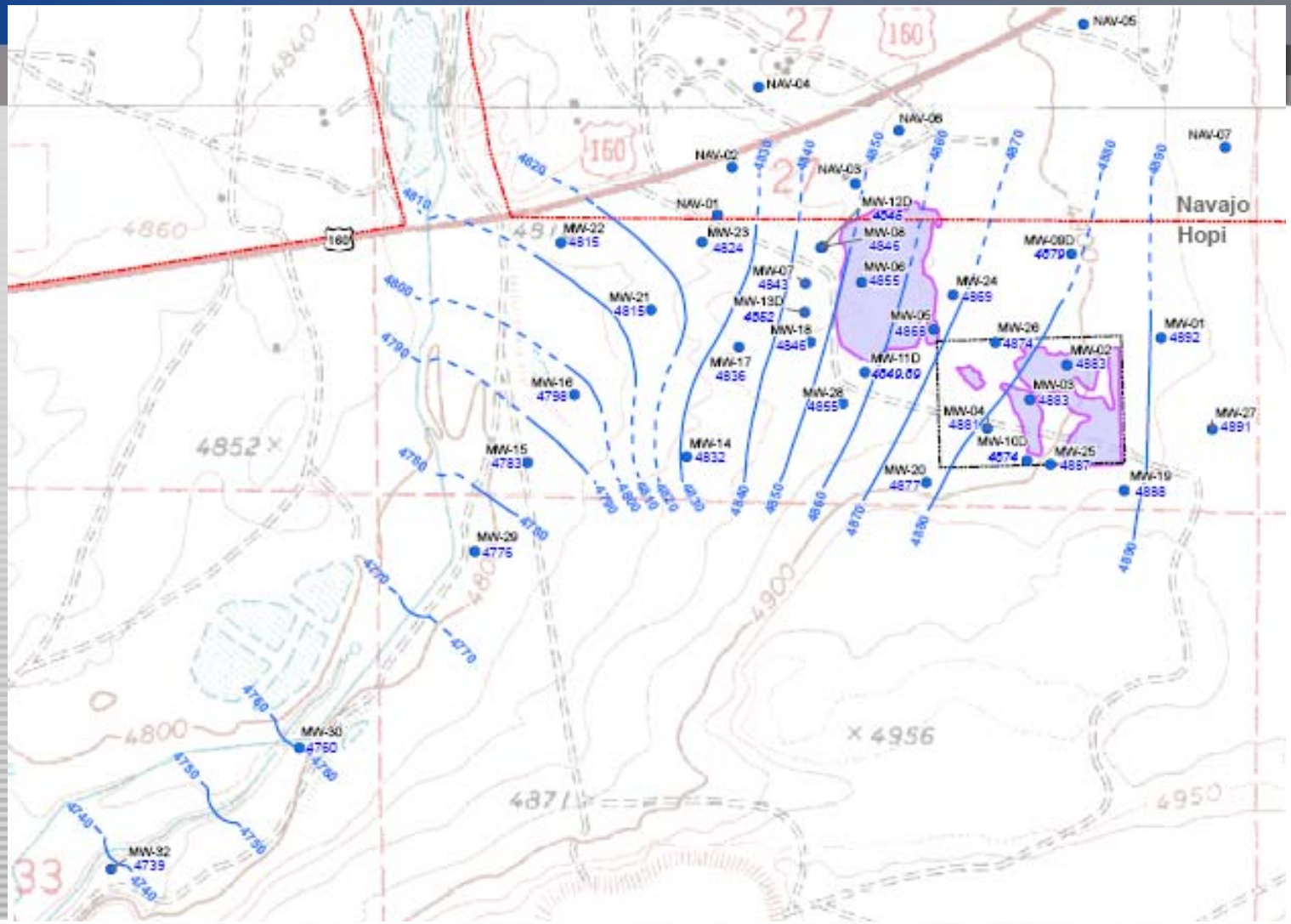
Groundwater Investigation Summary

- 13 monitor wells drilled in 1999
  - 8 shallow wells into alluvium, sandstone, and waste cells
  - 5 deep wells into the Navajo Sandstone
- Water table 6 to 20 feet below ground surface
- 14 additional shallow wells drilled in 2001
- 7 additional shallow wells drilled by Navajo Nation from 2004 to 2006
- 3 drive point wells drilled near Pasture Canyon in 2007
- Current groundwater monitoring includes testing of key parameters on select wells

Waste Cells and Monitor Wells



Groundwater Investigation Summary



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Groundwater Quality Results

- Samples analyzed for 40 CFR 258 Appendix I parameters plus additional chemical parameters found in landfill leachate
  - Parameters exceeding the drinking water Maximum Contaminant Level (MCL) include:

Arsenic	Chloride
Lead	TDS
Selenium	Nitrate
Strontium	Sulfate
Vanadium	Total coliforms
Uranium	Gross alpha

Radionuclide Contaminants in Groundwater

- Detected anomalous concentrations of uranium and alpha radiation
- Landfill site is not in a formation where naturally occurring uranium exists
- Geochemical forensics studies completed by:
  - Hopi Tribe Water Resources Program and DBS&A
  - BIA by U.S. Geological Survey and Walker & Associates
- Landfill leachate has transported uranium downgradient where it is mobile in geochemical (Eh/pH) conditions

Water Quality Results

- Water quality compared from upgradient (MW-27) to on-site wells
  - MW-6 within the old cell leachate
  - MW-7 downgradient of the old cell
- MW-27 has high quality N-aquifer water that conforms with Hopi Water Quality Standards
- Impacts greatest near old cell
- Impacts also exceed standards near new cell
- Groundwater contaminant plume 4,000 feet downgradient to Pasture Canyon

Rare Metals Uranium Mill

- Rare Metals Uranium Mill operated from 1956 to 1966
- DOE UMTRCA surface remediation completed from 1988 to 1990
- DOE investigated groundwater contamination and operates a treatment system
- Studies at Tuba City Landfill and the Rare Metals Mill Site have identified a striking similarity of groundwater quality impacts

TUBA CITY TAILINGS SITE
MAY 1980 -- VIEW NE

Tuba City UMTRA Site

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Comparison of Landfill and UMTRA Site Contaminant Concentrations

Comparison of UMTRA and Tuba City Landfill Contaminants		
Contaminant	**Tuba City Landfill**	**Rare Metals Median UMTRA**
Selenium	158 µg/L	96 µg/L
Uranium	240 µg/L	404 µg/L
Sulfate	3,590 mg/L	2,257 mg/L

Source: USDOE, 1998, Environmental Assessment of Ground Water Compliance at the Tuba City Uranium Mill Tailings Site

Waste Characterization (2007)

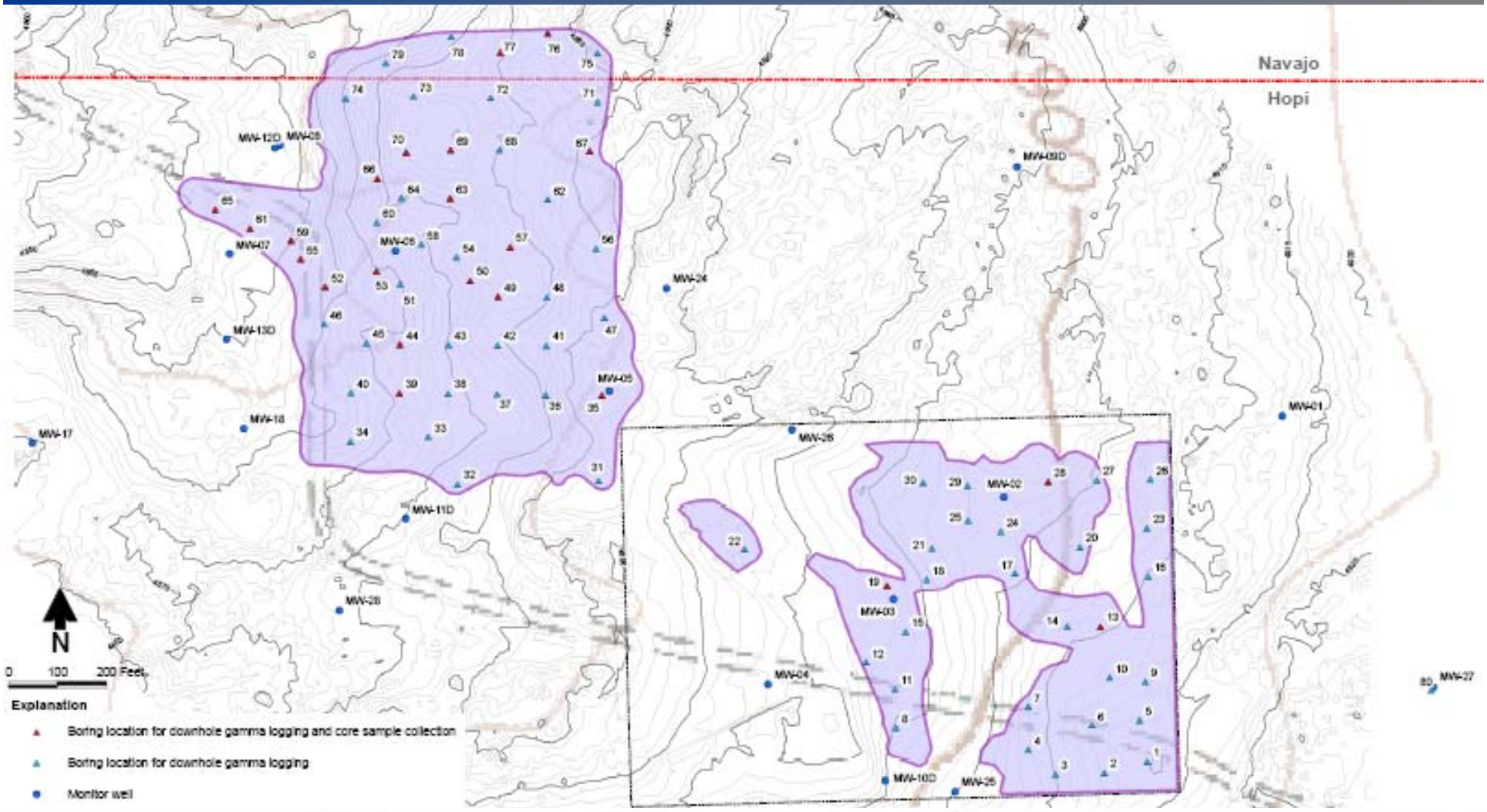
Goals:

- Determine whether any waste meets the criteria of radioactive waste - key issue for final closure
- Compare measured radiation levels to criteria for radioactive waste disposal
- If radioactive waste is encountered, estimate the quantities potentially on-site
- Confirm requirements for off-site disposal facilities that may accept waste during a clean-closure operation
- Critical issue affecting clean-closure costs

Waste Characterization Summary

- 101 borings drilled in the waste:
  - 79 small-diameter borings for radiation measurement
  - 22 large-diameter cores for waste sample collection
  - Field measurement of radioactivity
  - Logged background radioactivity upgradient at MW-27
  - Waste samples tested for hazardous materials
  - Accurate determination of depth of waste

Waste Characterization Boring Grid (2007)



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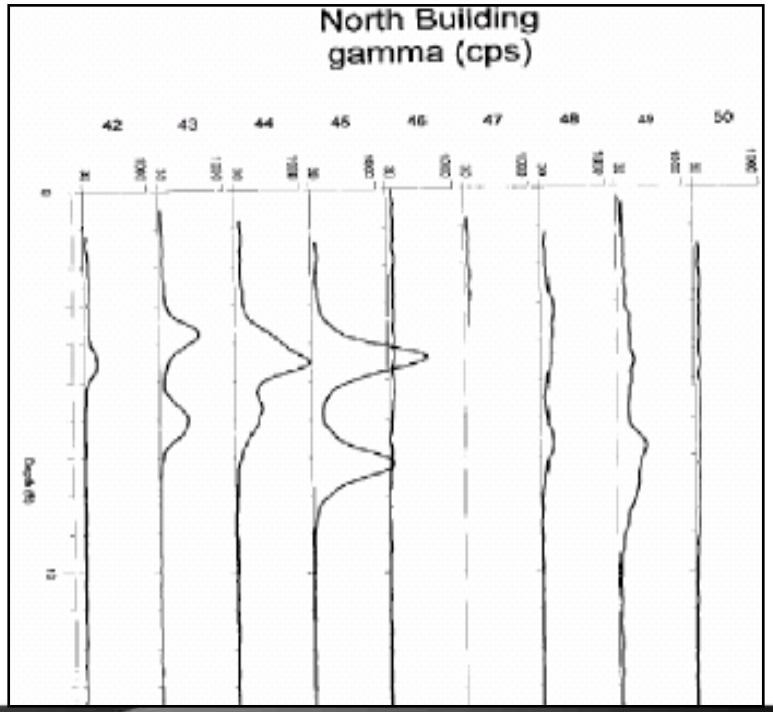
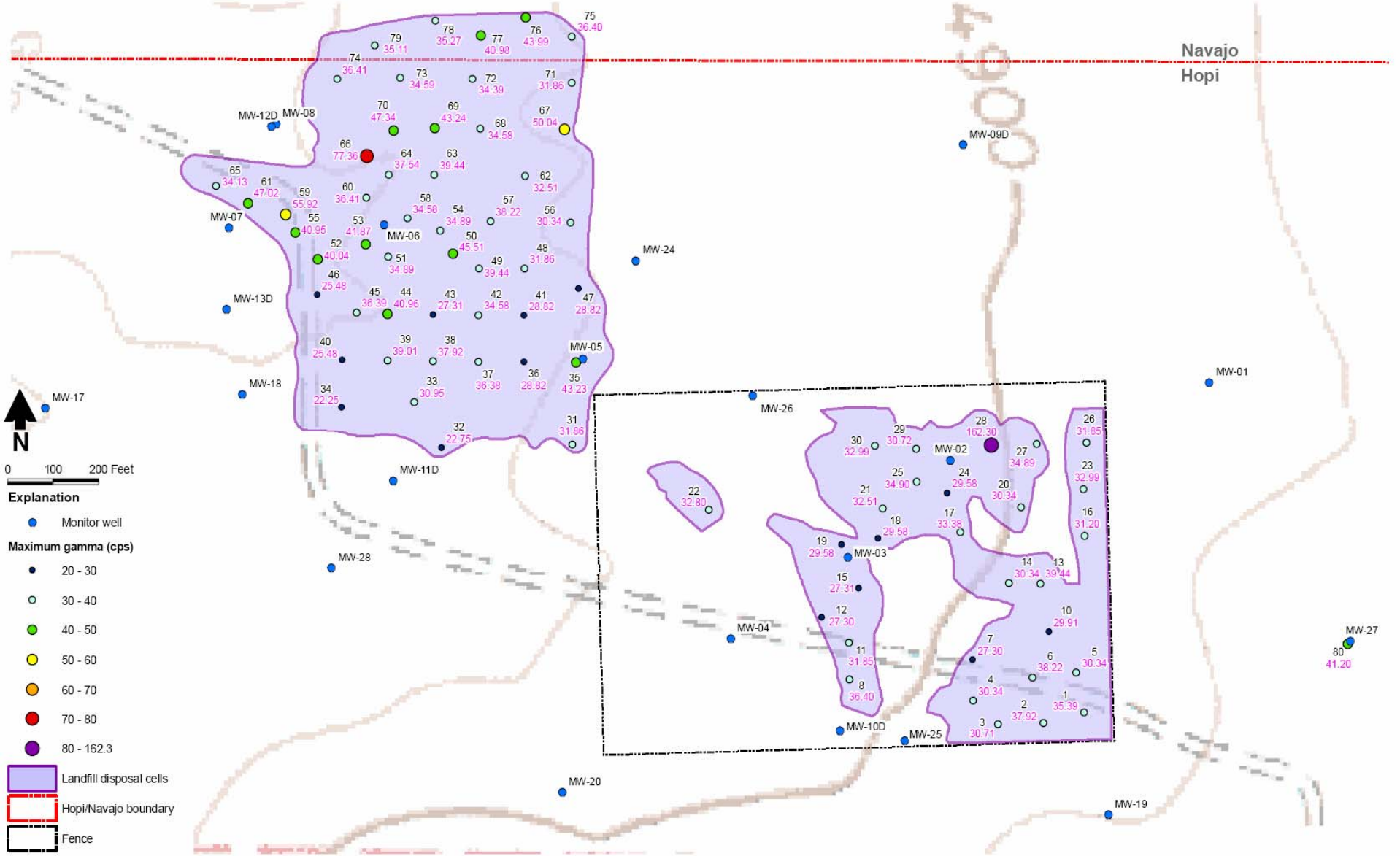
Gamma Logging

- Geophysical tool uses sodium iodide crystal
- Native material ranges from 30-150 cps
- Uranium mill tailings >3,000 cps



Peak Gamma Levels from Downhole Logging of Waste Characterization Borings



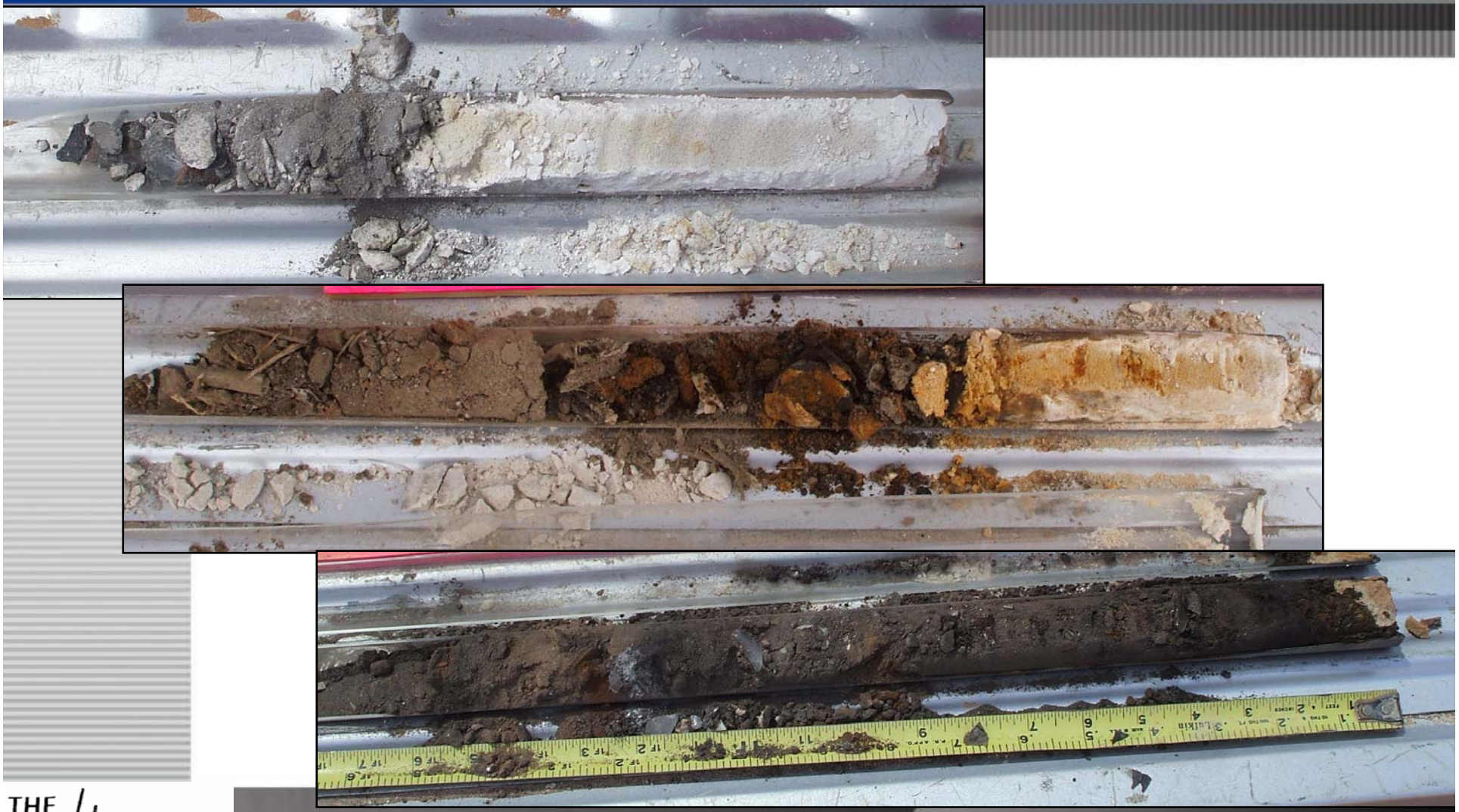
Waste characterization

- Contact easily identified in cores giving accurate depth waste and allowing inspection
- Sandstone appeared white at some locations but leachate often discolored the sandstone to a rust color

Typical waste identified consisted of:

- Sand
- Ashes
- Minor amounts of:
  - Metal
  - Glass
  - Plastic
  - Bone
  - Paper
  - Wallboard

Waste and Sandstone Contact



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Waste Characterization Results

- Borings penetrated waste; stopped at bedrock
- Waste depth 2 - 15 feet
- Saturation encountered at water table in 4 borings
- With waste area and depth; waste quantity approximately 307,000 cubic yards
- Analytical testing to determine radioactive waste and hazardous waste classification
  - Exempt waste < 0.05 wt%
  - Municipal waste <0.01 pCi/g or <2x background
  - Hazardous waste RCRA C criteria

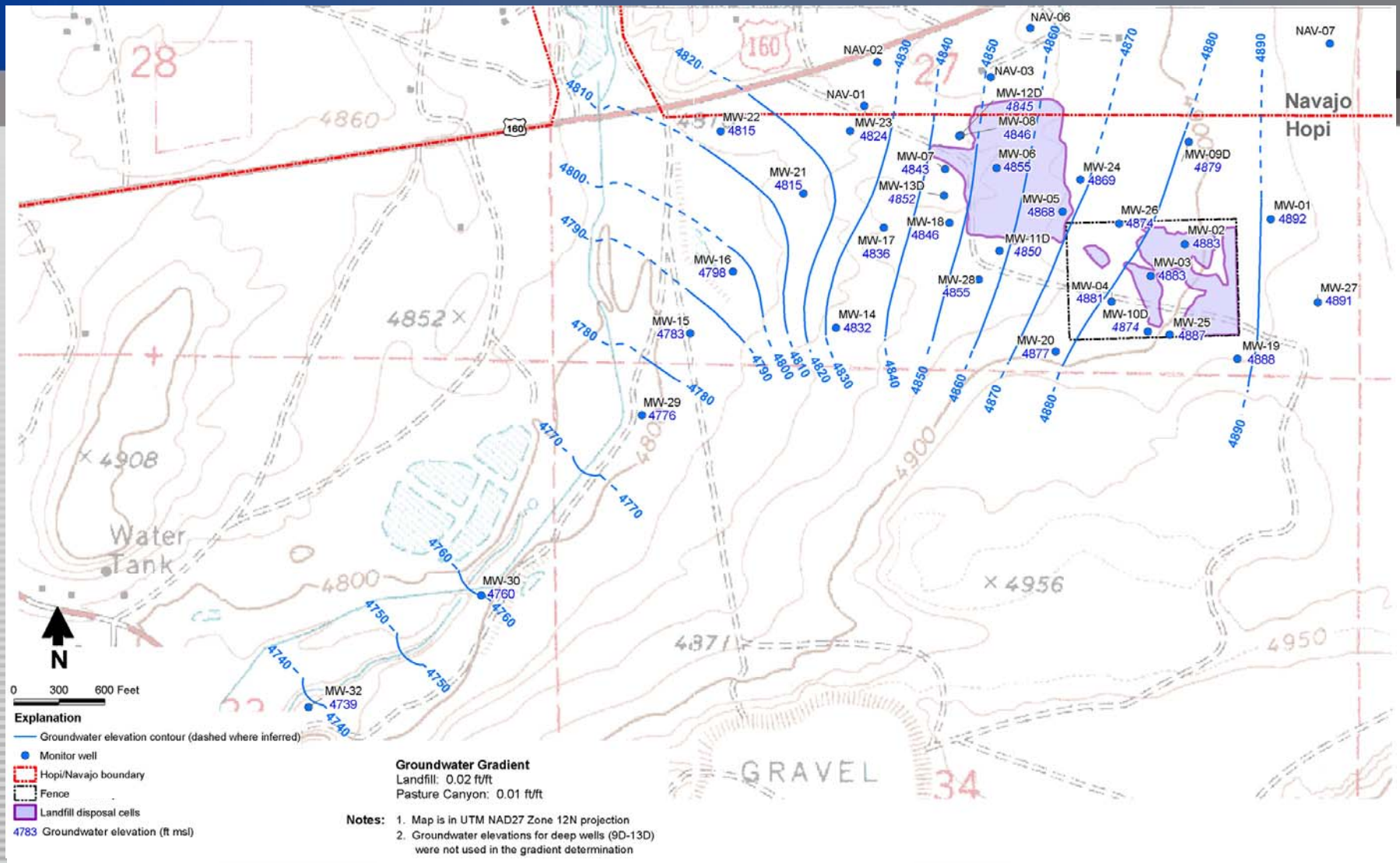
Waste Characterization Results

- Testing to determine radioactive and hazardous waste classification
  - Background gamma levels
  - Exempt waste (< 0.05 wt% uranium)
  - No hazardous waste identified
    - TCLP tests for metals and organics
  - Disposal allowed in RCRA Subtitle D landfill
  - Possible uranium or mill-related waste may be found during closure, but not prevalent

Drive-Point Groundwater Monitor Wells (2007)

- Delineate westward, downgradient groundwater contaminant migration
- 3 drive-point monitor wells installed in alluvial soils near Pasture Canyon
  - Pasture Canyon surface water or irrigation supplies could be affected by landfill water quality
- Geoprobe drive-point wells installed in the alluvial soils
  - Constructed permanent, small-diameter monitor wells
  - Sampled groundwater quality for recommended analytes
  - MW-29 and MW-30 exceed uranium MCL
  - MW-32 below uranium MCL, above As, equal alpha MCL

Groundwater Elevations (August 9, 2007)



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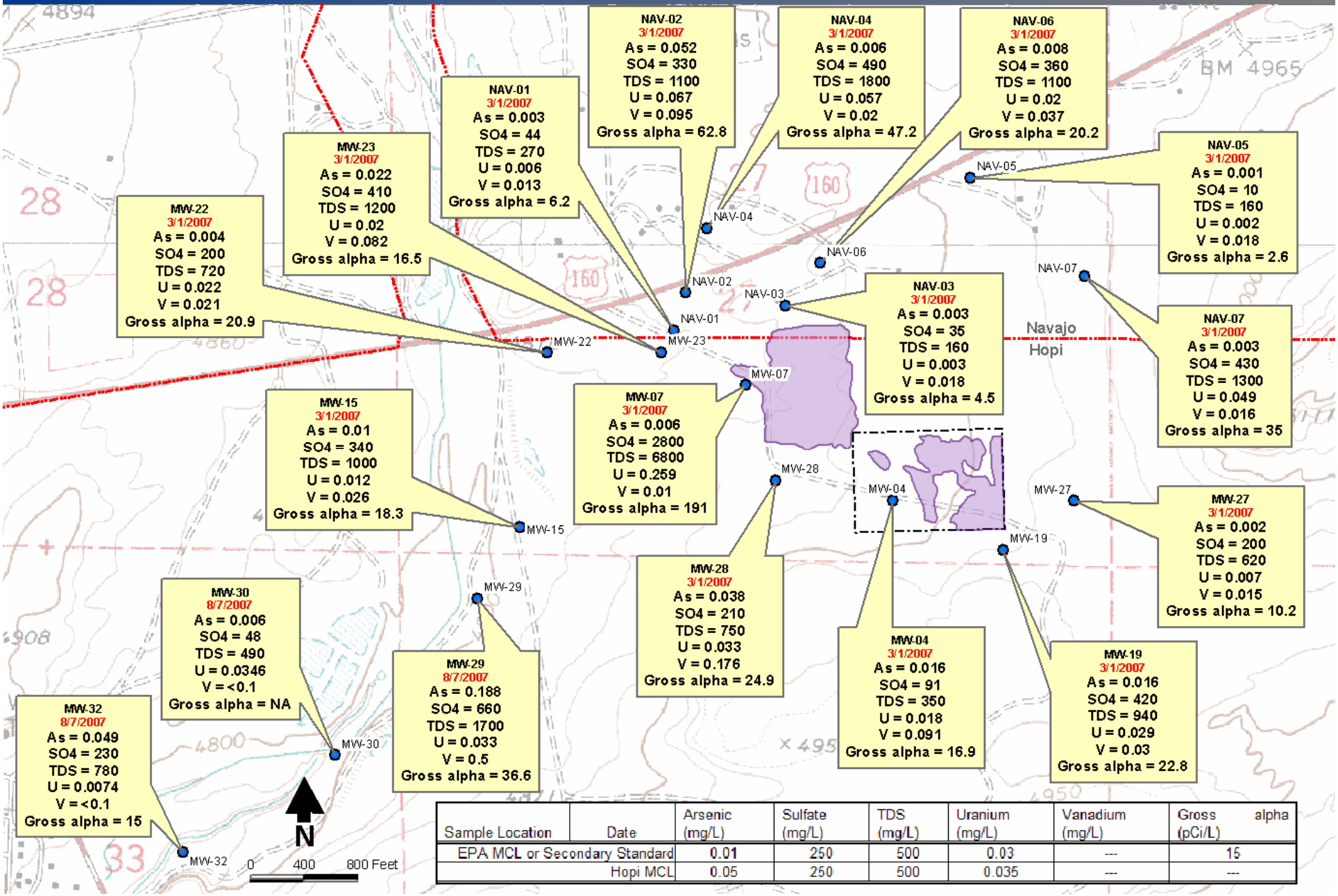
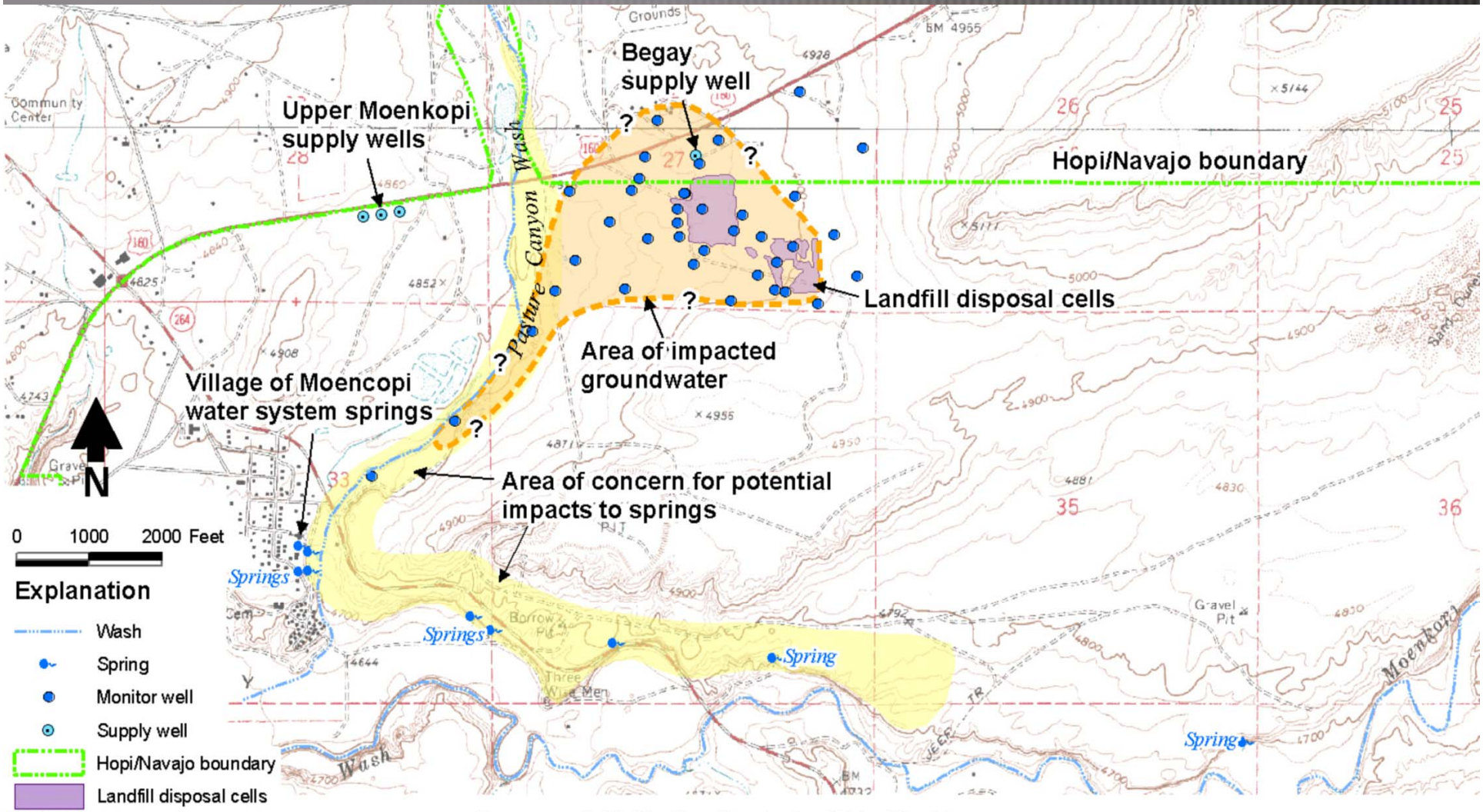
Key Water Quality Parameters for Wells Sampled 2007



Sample Location	Date	Arsenic (mg/L)	Sulfate (mg/L)	TDS (mg/L)	Uranium (mg/L)	Vanadium (mg/L)	Gross alpha (pCi/L)
EPA MCL or Secondary Standard		0.01	250	500	0.03	---	15
Hopi MCL		0.05	250	500	0.035	---	---

Contaminant Plume and Water Source Locations



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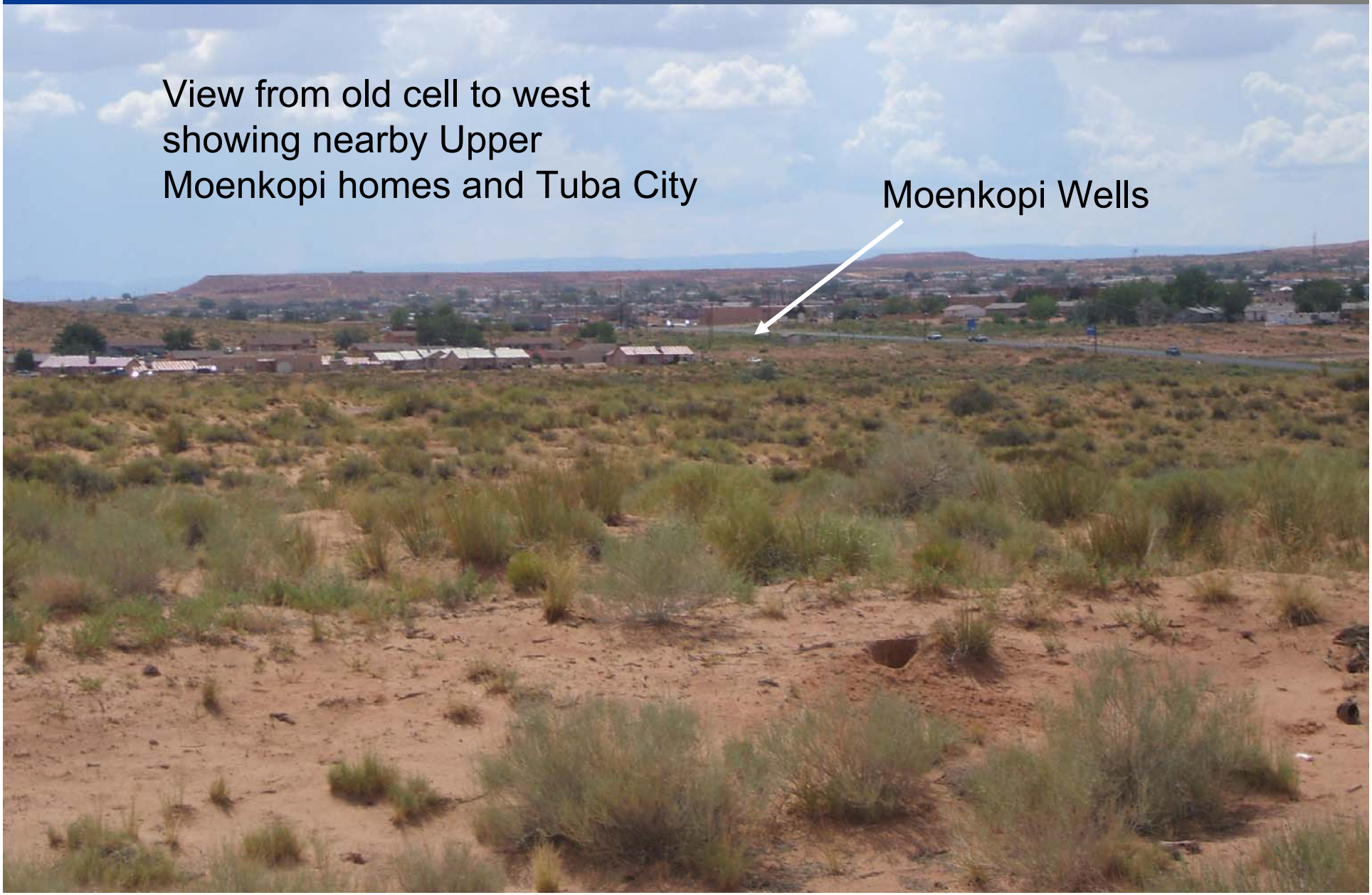
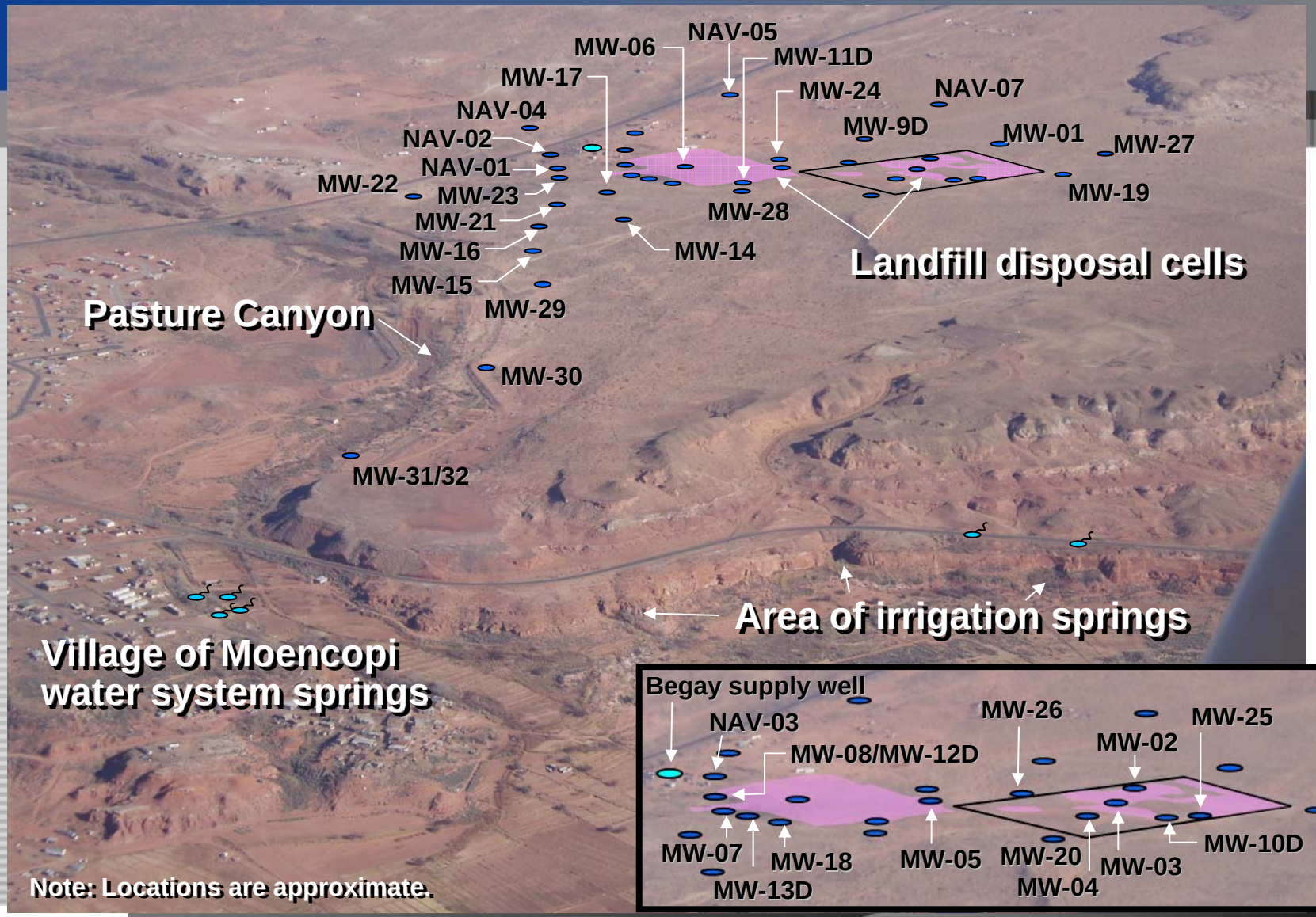
Proximity to Supply Wells



Wells and Site Features



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Closure Alternatives Assessment

- Developed final closure alternatives and cost estimates for 1999 engineering evaluation
- Preliminary Assessment Report 2006
  - Requested by BIA to plan for funding
  - Describes site conditions and contamination
  - Updated closure alternatives and costs August 2006
  - Presented multiple alternatives
  - Highlighted Hopi Tribe, Navajo Nation, and local community selection of clean-closure

Closure Alternatives Assessment

Closure Alternatives

- Based on Preliminary Engineering Evaluation (1999) and Regional Landfill Feasibility Study (2001)
- Clean-closure
  - Off-site disposal at permitted landfill
  - Off-site disposal in new regional landfill
  - On-site disposal in lined disposal cell
- In-place closure with final cap not feasible
  - Groundwater flow through waste cells
  - Waste isolation ineffective in permeable Navajo Sandstone
  - Long-term maintenance undesirable to BIA

Closure Alternatives Assessment

Updated Closure Cost Estimates

- 307,000 cubic yards or 410,000 tons
- Clean-closure with off-site disposal
  - $33 million in 2009 to 2010
  - Waste hauling and disposal tipping fees are 70% of total
- Clean-closure with new regional landfill disposal
  - Intermediate cost depending on landfill size and location
- Clean-closure with new lined disposal cell
  - $22 million in 2009 to 2010
- Costs include groundwater remediation with 3 years of operation at $1.8 million

Closure Alternatives Assessment

Additional Issues Affecting Final Closure

- Groundwater
  - Disproportionate current risk to Moenkopi water supply
  - At least 6 groundwater contamination sites in vicinity
  - Water resources are limited
  - Springs are used for drinking water and irrigation
- Navajo Nation has identified additional waste disposal sites near the Rare Metals mill
- Funding for closure is needed; cost estimates have doubled over 10 year of study
- BIA completed potentially responsible party study 2007

Conclusions and Recommendations

- Technical evidence shows:
  - Landfill is not in compliance with RCRA
  - Contaminant plume has migrated 4,000 feet
  - Plume is near water supply sources
  - Failure to contain the plume threatens springs used for drinking water and irrigation
- Immediate remedial action needed to contain the plume
- Groundwater remediation can proceed while a complete closure plan is being developed
- The Hopi Tribe reasonably believes that action to contain the plume must begin in 2008

Tuba City Landfill Closure

Questions/Discussion?

Hopi Water Resources Program

Hopi Environmental Protection Office