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TO: Ken Hooks
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DATE 03/08/00	PROJECT NO. 32114
ATTENTION	
RE: Paper copy of March 3, 2000 presentation - Church Rock	

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COPIES	DATE	NO.	DESCRIPTION
1	03/08/00	1	Paper printout of presentation excluding plume maps.

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REMARKS: As requested during the meeting on March 3, 2000. Electronic copy provided to Jane Glenn during the meeting.

COPY TO: Roy Blickwedel, Larry Bush (w/o enclosure) SIGNED: Suzie duPont

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NMSSOIPublic

United Nuclear Corporation
Church Rock Site

Meeting

March 3, 2000

Church Rock Site Presentation

- ***Overview of problem***
- Technical discussion
- Solution

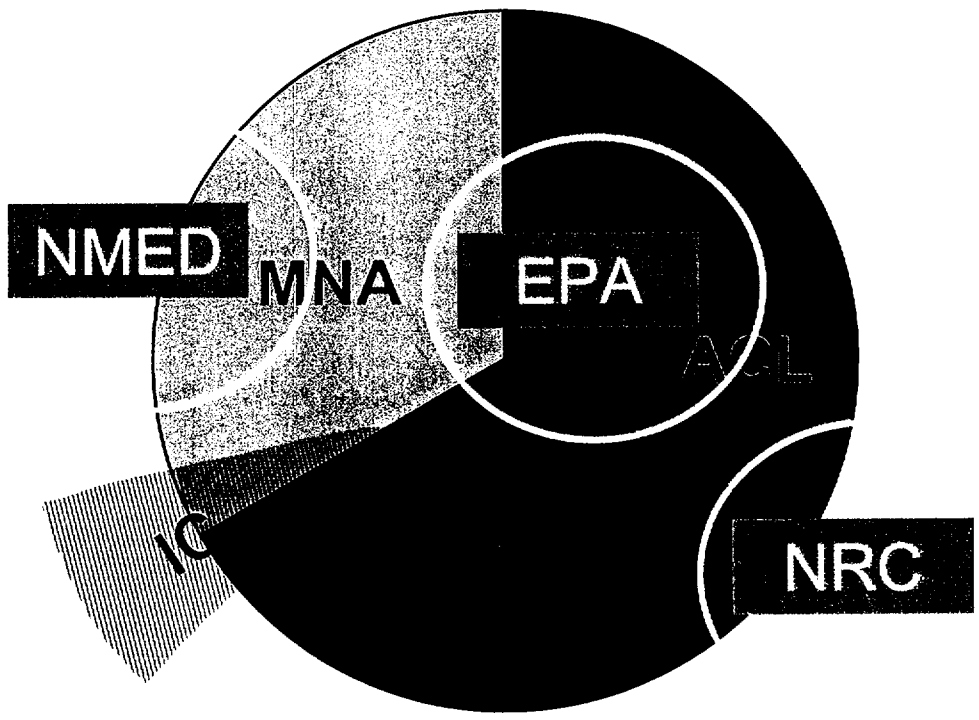
Milestones

(Overview of Problem)

- **Completed 17 years of active remediation**
  - Neutralization and pre-CERCLA groundwater extraction
  - Source Removal (1989)
  - Ground Water Extraction
  - Tailings Reclamation
- **EPA issued 5-Year Review Sept. 1998**
  - Active remediation meets ALARA goals
  - Stop Pumping Zone 1
  - Apply for ACLs
- **Zone 1 pumping wells shut off July 1999**
- **Initiated ACL process**

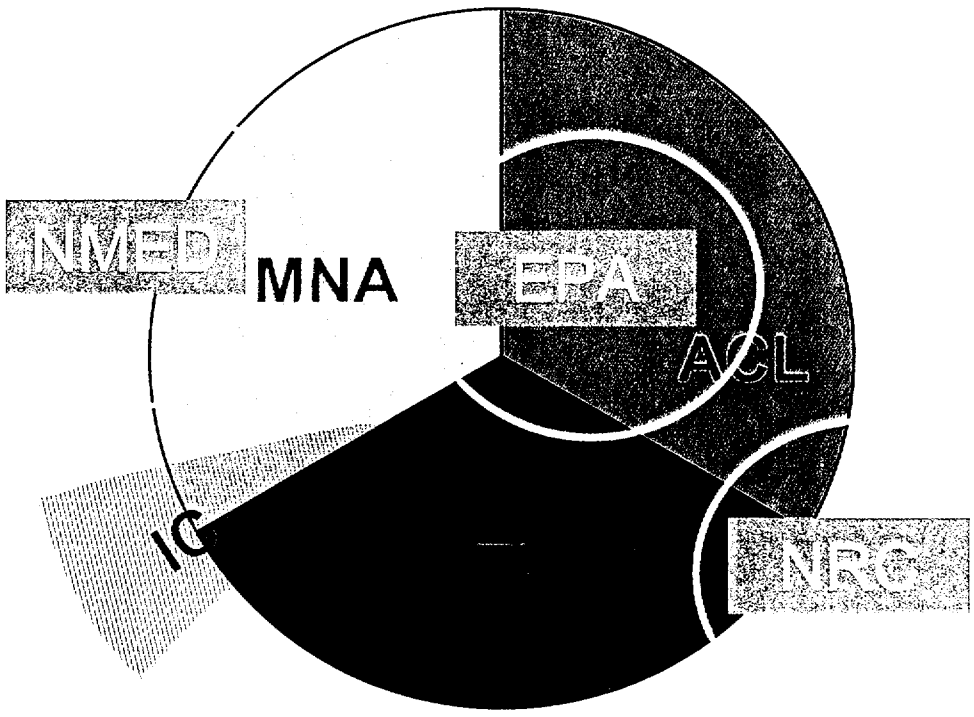
Where We Are

(Overview of Problem)



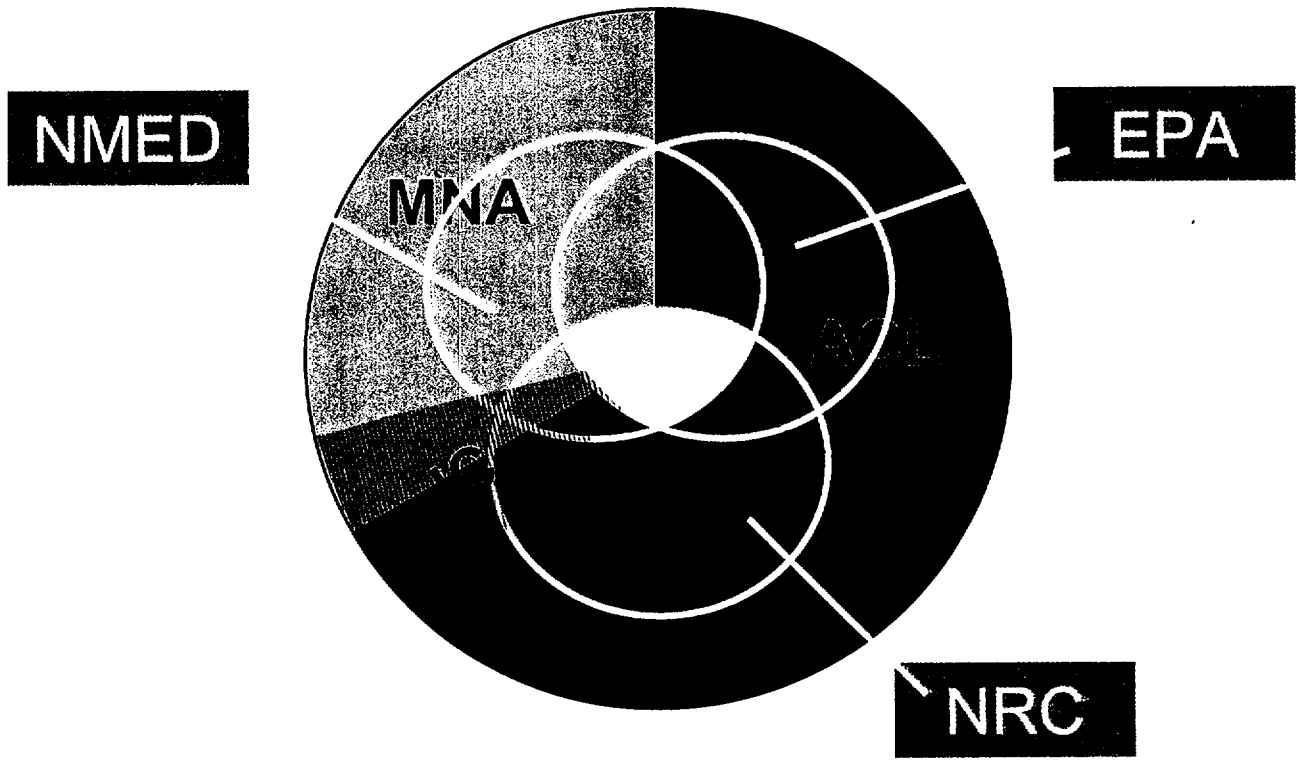
Where We Are

(Overview of Problem)



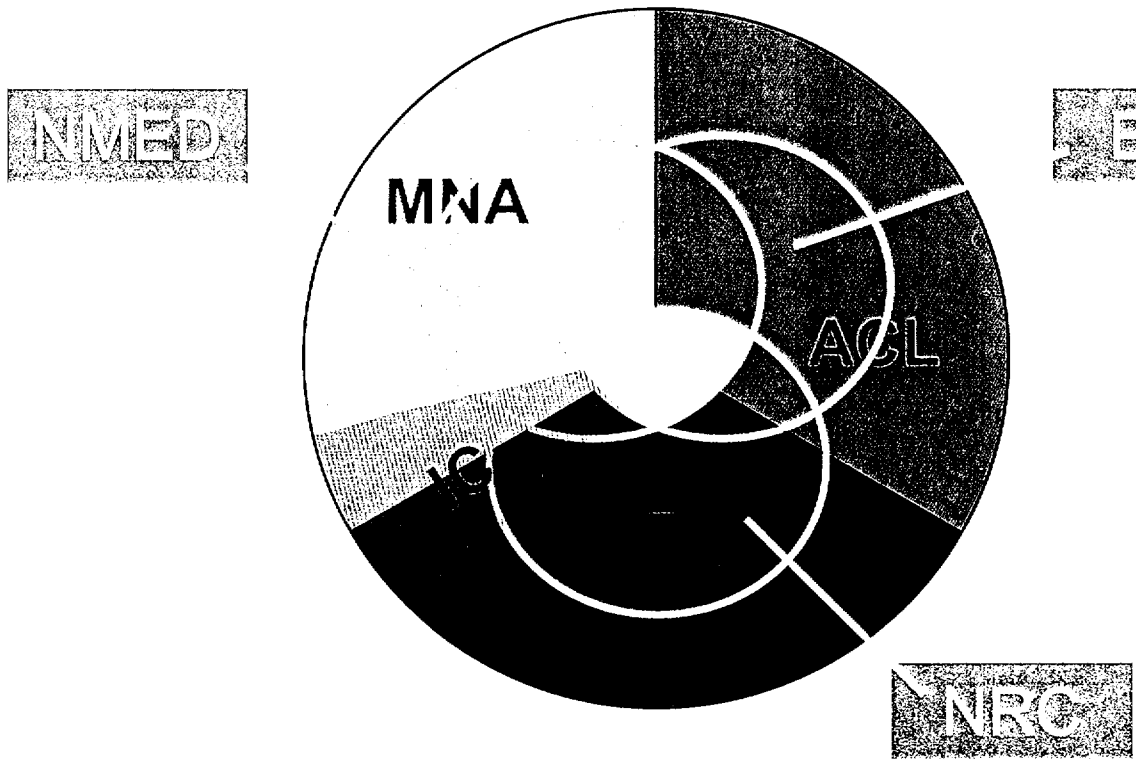
Where We Have To Go

(Overview of Problem)



Where We Have To Go

(Overview of Problem)



- Continuing the corrective action program will not further the attainment of water quality standards.

- Natural geochemical controls have and will continue to stabilize and contract the extent of seepage impacts.

- Institutional controls will prevent exposure to seepage-impacted groundwater

Church Rock Site Presentation

- Overview of problem
- ***Technical presentation***
- Solution

Technical Presentation Goals

Show that:

Natural geochemical processes govern:

- **Why some standards are currently exceeded**
- **Why some standards will be exceeded in future**
- **How the plume will be controlled by natural processes**

Technical Presentation Topics

- ***Evolution of Zone 1 Water***
- Zone 1 Geochemical Processes
  - Current conditions
  - Metals and radionuclides
  - Manganese
  - Sulfate and TDS
- Summary

Condition Prior To Mine Water Discharge

(No Contiguous Ground Water System Present)

(Evolution of Zone 1 Water)

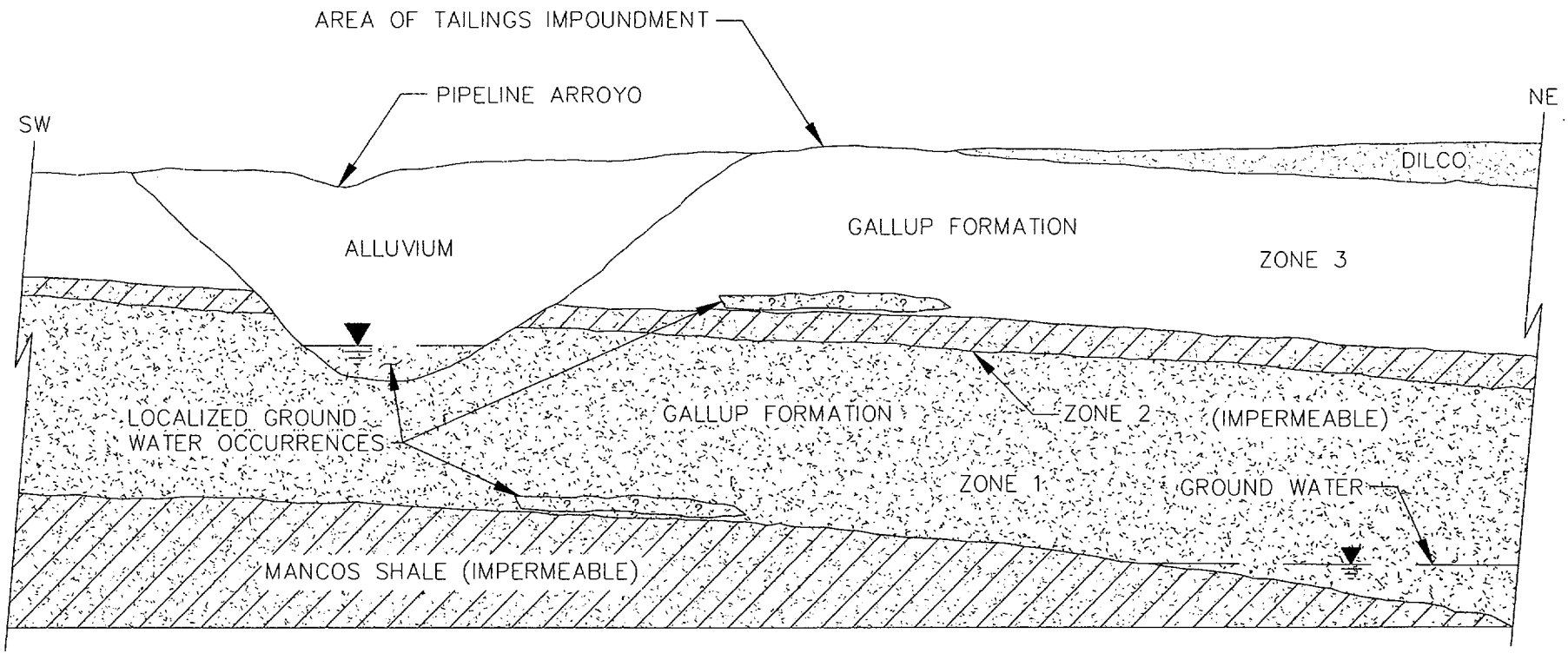


FIG. A865A

Condition During Mine Water Discharge

(Evolution of Zone 1 Water)

Develop
"Postmining-Pretailings Background Water"

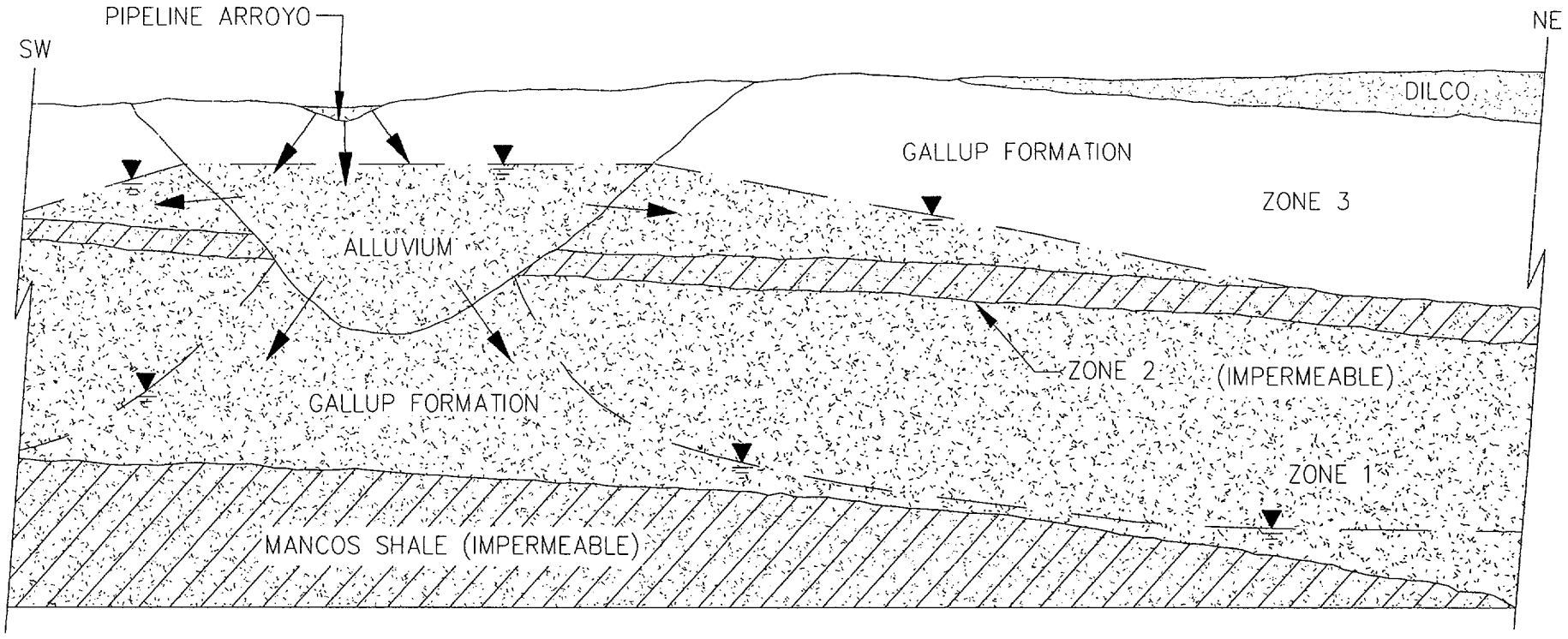
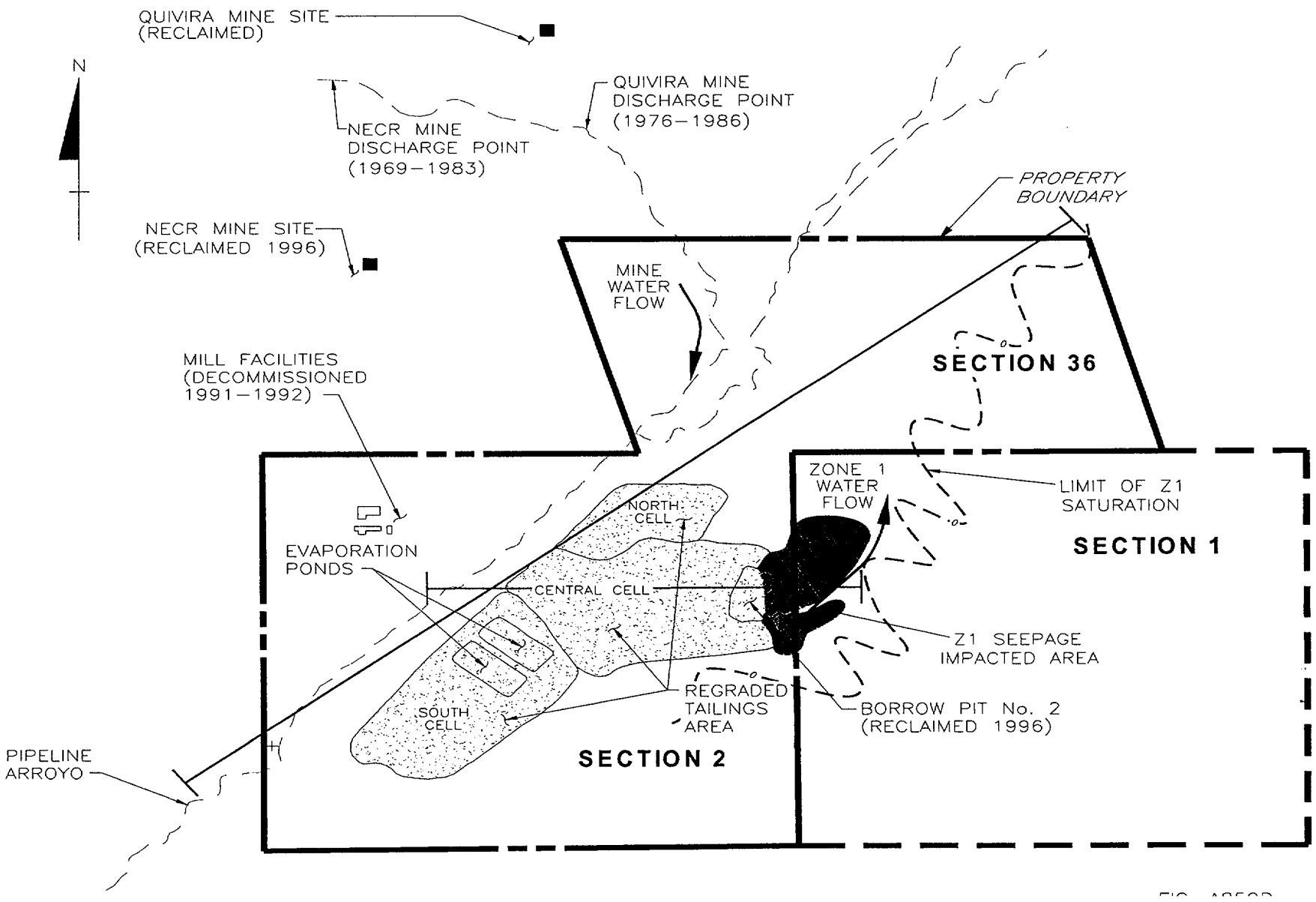


FIG. A866A

Tailings Seepage in Zone 1

(Evolution of Zone 1 Water)



Source of Acidic Plume In Zone 1

(Evolution of Zone 1 Water)

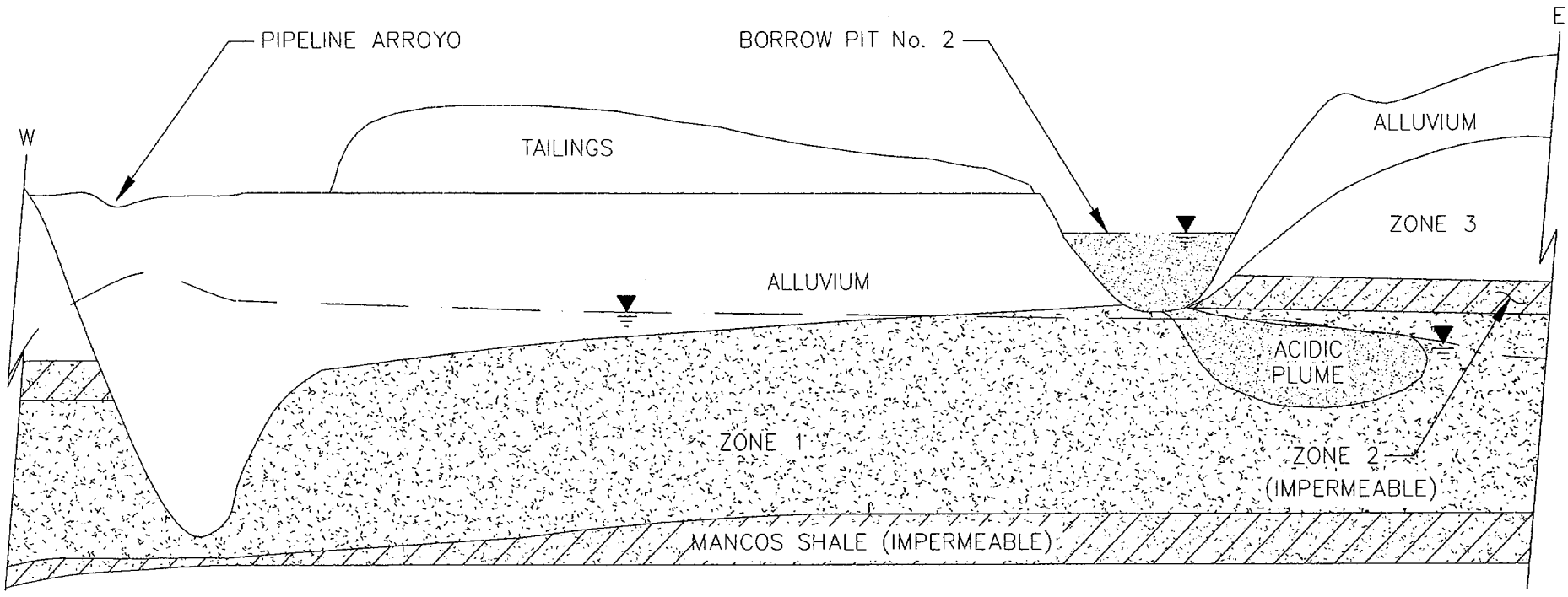
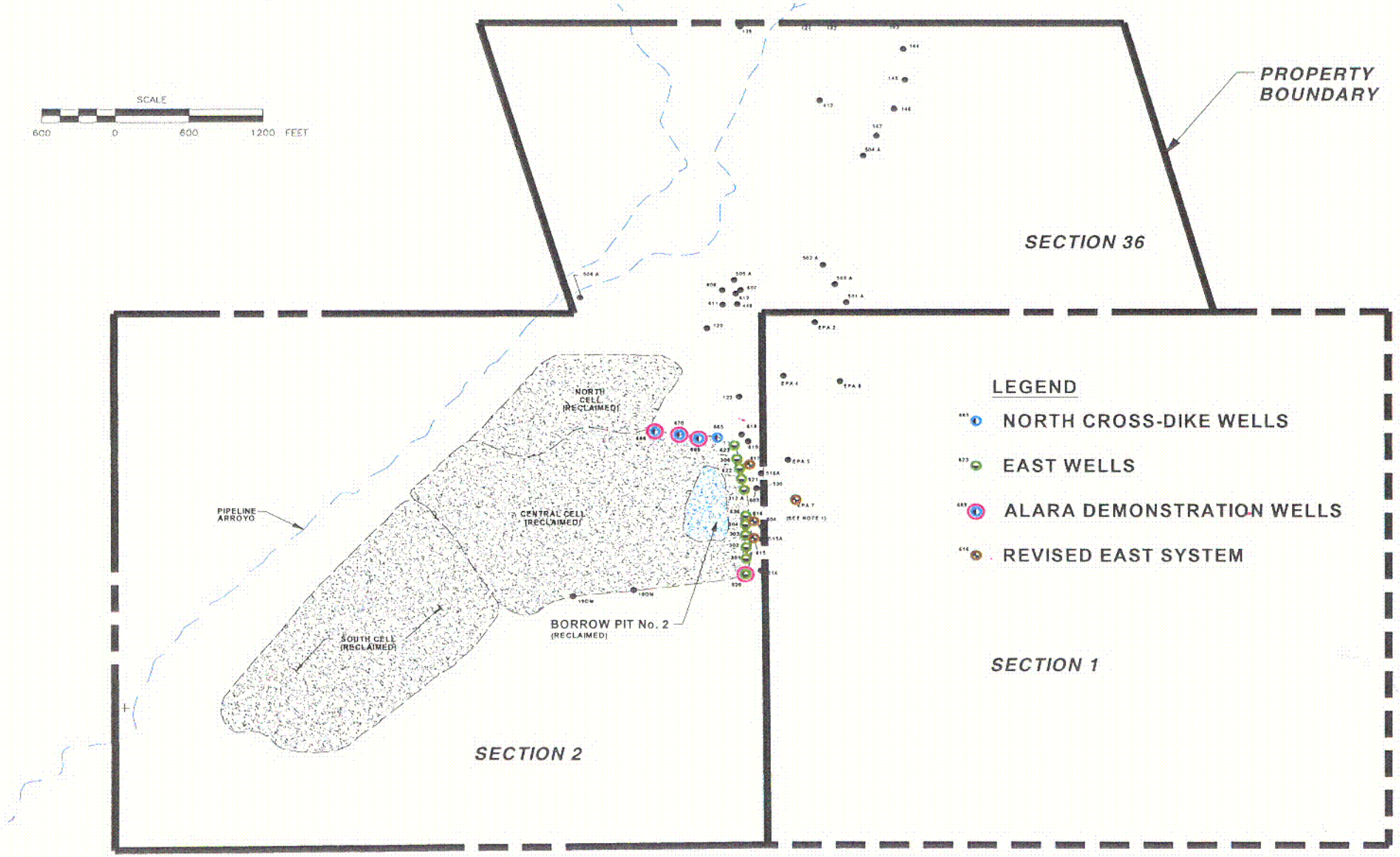


FIG. A877A1

SOURCE IS TAILINGS LIQUIDS IN BORROW PIT No. 2

Zone 1 Corrective Action

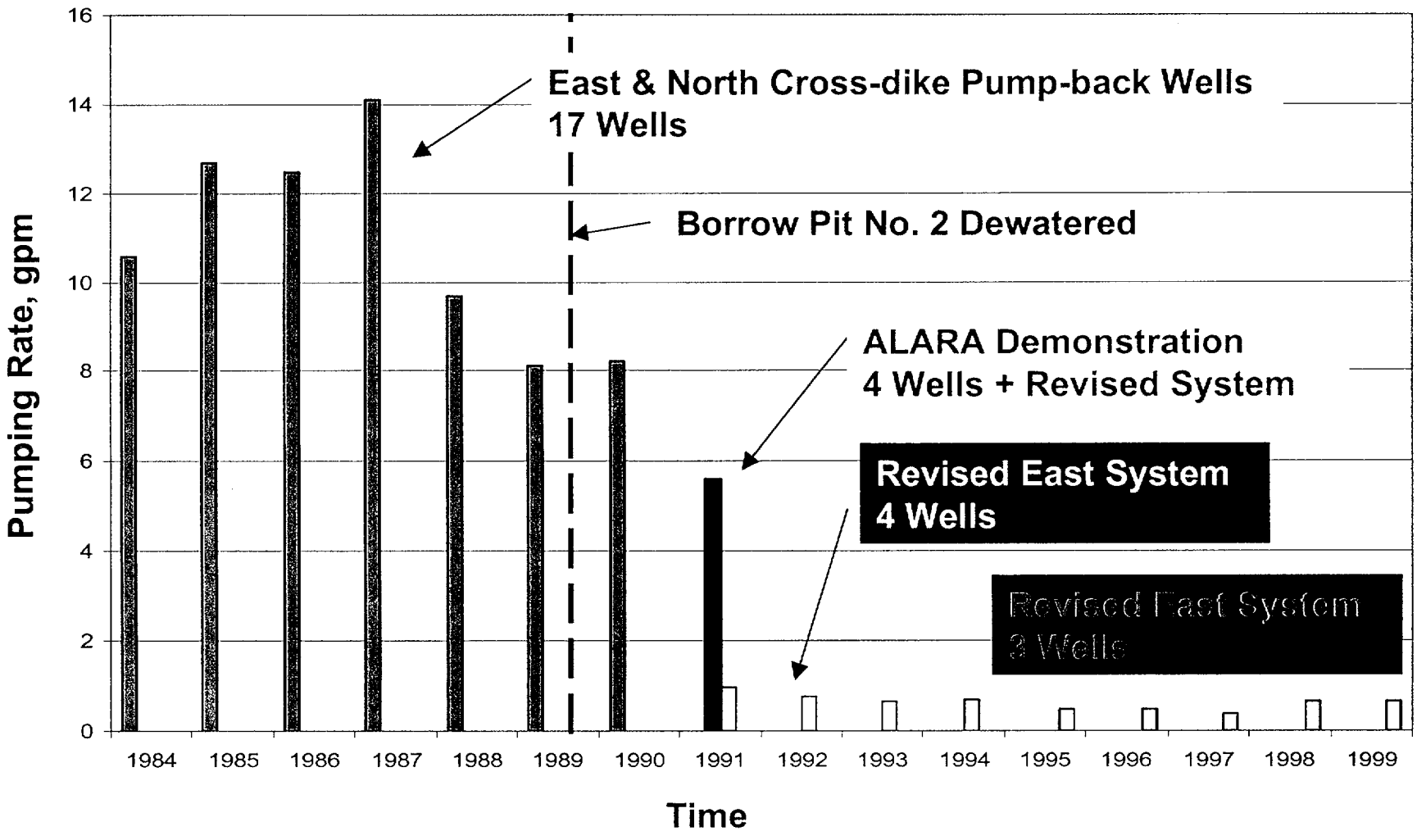
(Evolution of Zone 1 Water)



C-1

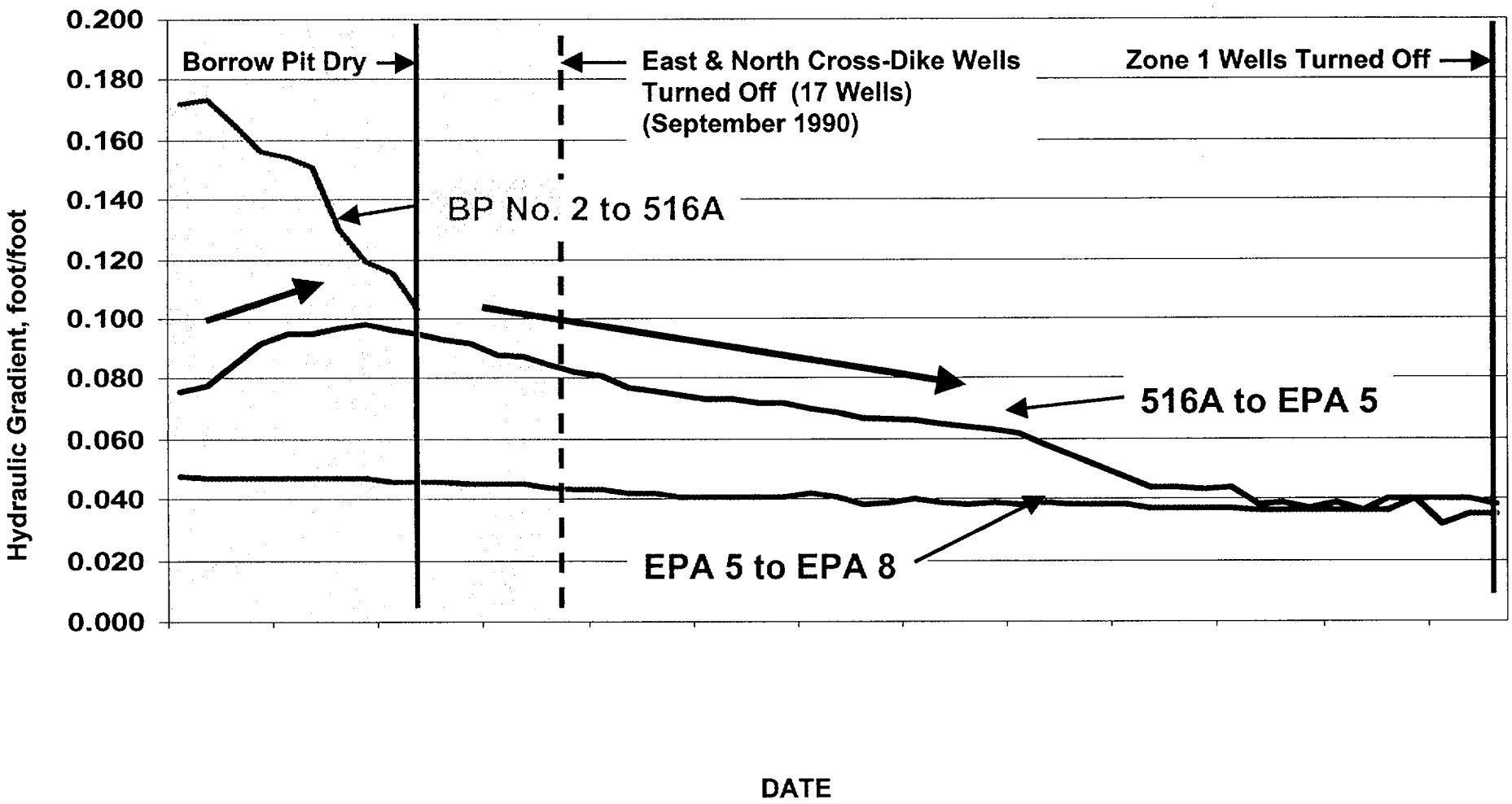
Zone 1 Pumping Rates

(Evolution of Zone 1 Water)



Effect of Borrow Pit No. 2 on Zone 1 Hydraulic Gradients

(Evolution of Zone 1 Water)



Seepage Impacts Over Time

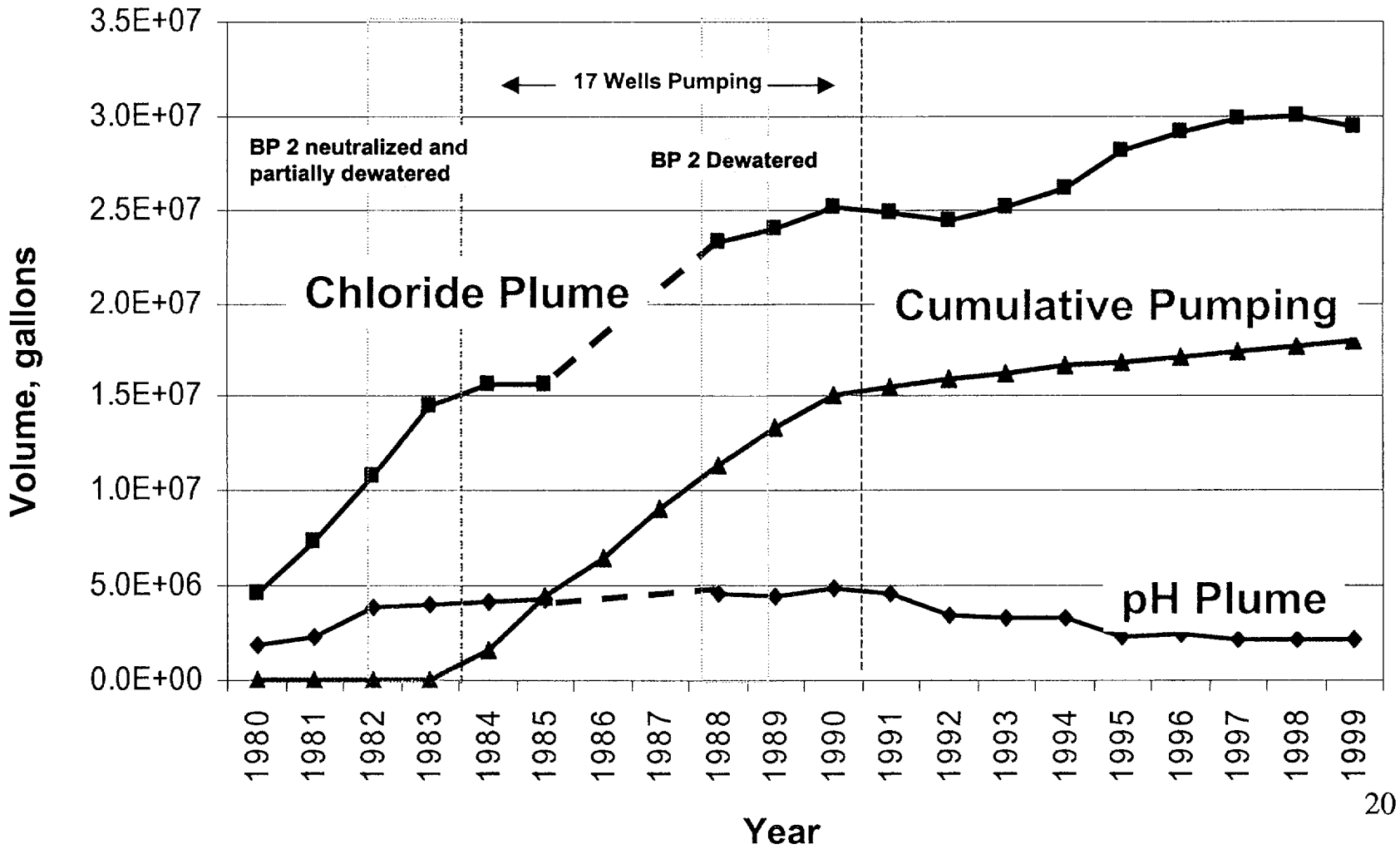
(Evolution of Zone 1 Water)

Place Holder

Go to Cl/pH plume animation

Effect of Pumping on Plume Volume

(Evolution of Zone 1 Water)



Results of Dewatering Borrow Pit

(Evolution of Zone 1 Water)

- Source removed
- Gradient reduced
  - Natural neutralization process more effective
    - Mass of metals and radionuclides is reduced
  - Migration of conservative species slowed

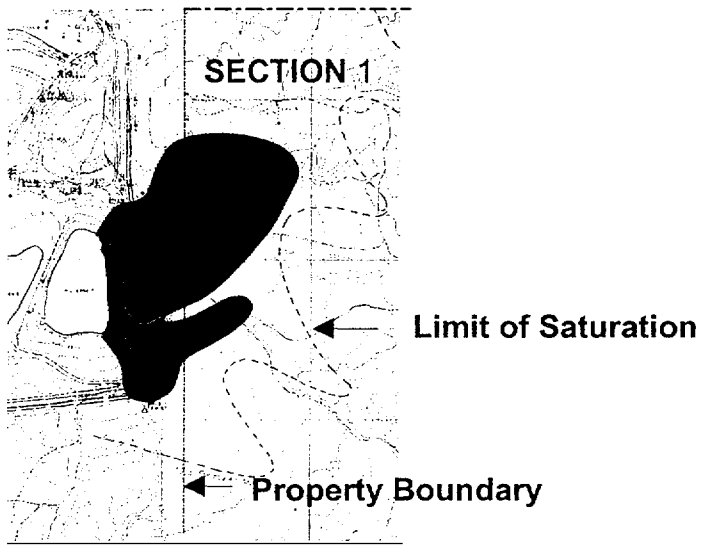
Monitored Natural Attenuation

Technical Presentation Topics

- Evolution of Zone 1 Water
- ***Zone 1 Geochemical Processes***
  - ***Current conditions***
  - ***Metals and radionuclides***
  - ***Manganese***
  - ***Sulfate and TDS***
- Summary

Summary Of Current Conditions

(Zone 1 Geochemical Processes)



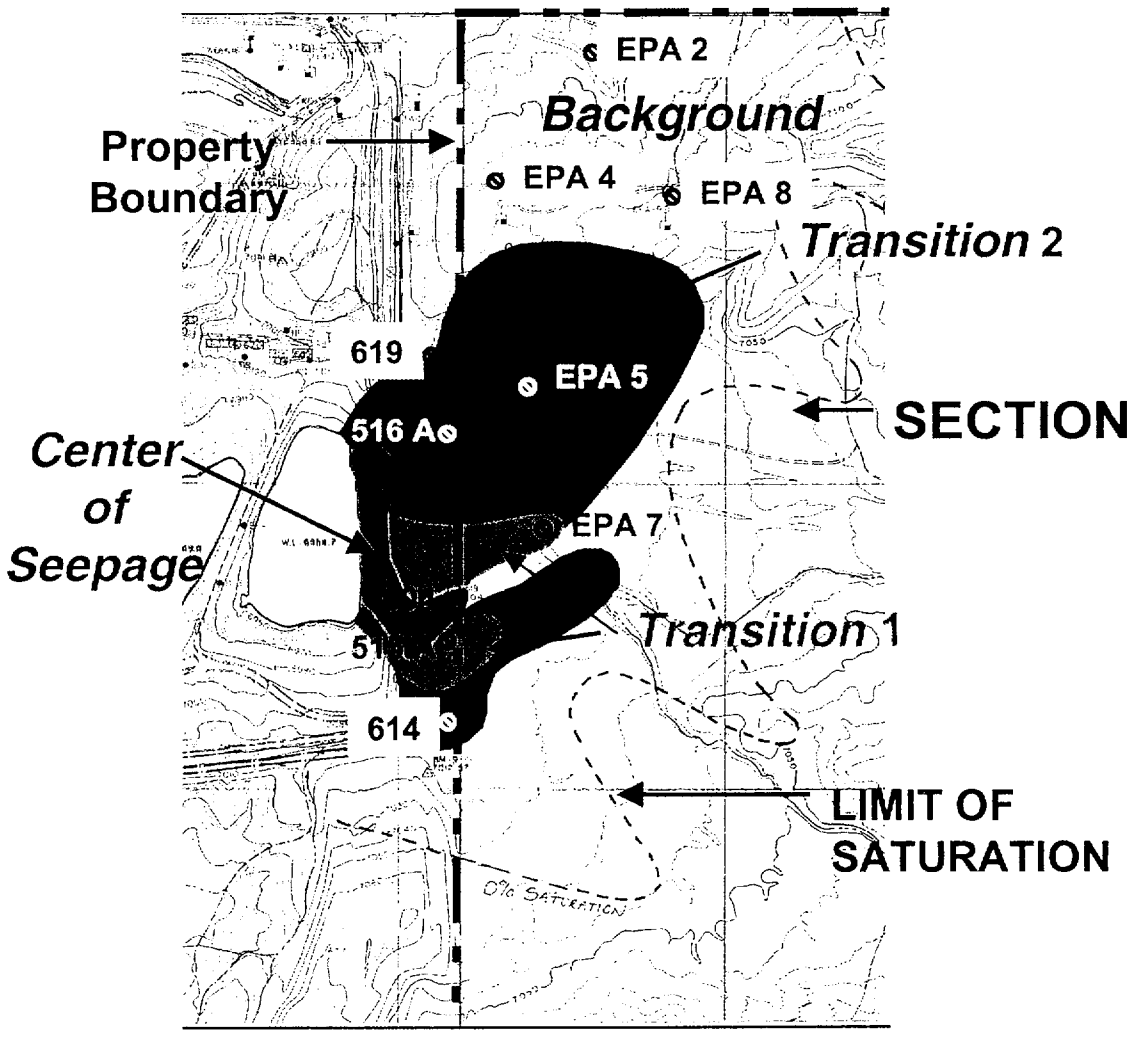
Zone 1 Standards Exceeded in Section 1 for:

- **Metals and radionuclides:**
  (cobalt, nickel, combined radium and manganese)

- **Sulfate and TDS**

Location of Geochemical Areas

(Zone 1 Geochemical Processes)



1999 Zone 1
Geochemical Area Chemistry

(Zone 1 Geochemical Processes)

	Field pH (SU)	Chloride (mg/l)	Bicarbonate (mg/l)	Sulfate (mg/l)	Aluminum (mg/l)	Manganese (mg/l)
NRC Standard	NA	NA	NA	NA	NA	NA
EPA Standard	NA	250	NA	2,125	5.0	2.6
Well						
Center of Seepage						
604*	4.6	55.3	3.0	5,120	15.70	14.00
Transition 1						
515A	5.7	254	272	4,800	0.40	13.6
EPA 7*	6.1	166	361	4,500	<0.10	9.3
Transition 2						
516A*	6.5	254	1,370	6,920	<0.10	1.67
614*	7.0	239	1,280	4,000	<0.10	0.23
EPA 5	6.5	198	1,090	4,580	<0.10	0.49
Background						
619	6.6	50.3	194	3,460	<0.10	2.34
EPA 2	6.7	29.0	307	1,650	<0.10	1.35
EPA 4*	6.5	40.0	207	2,550	<0.10	2.33
EPA 8	6.4	47.0	119	2,710	<0.10	2.40

Metals and Radionuclides

(Zone 1 Geochemical Processes)

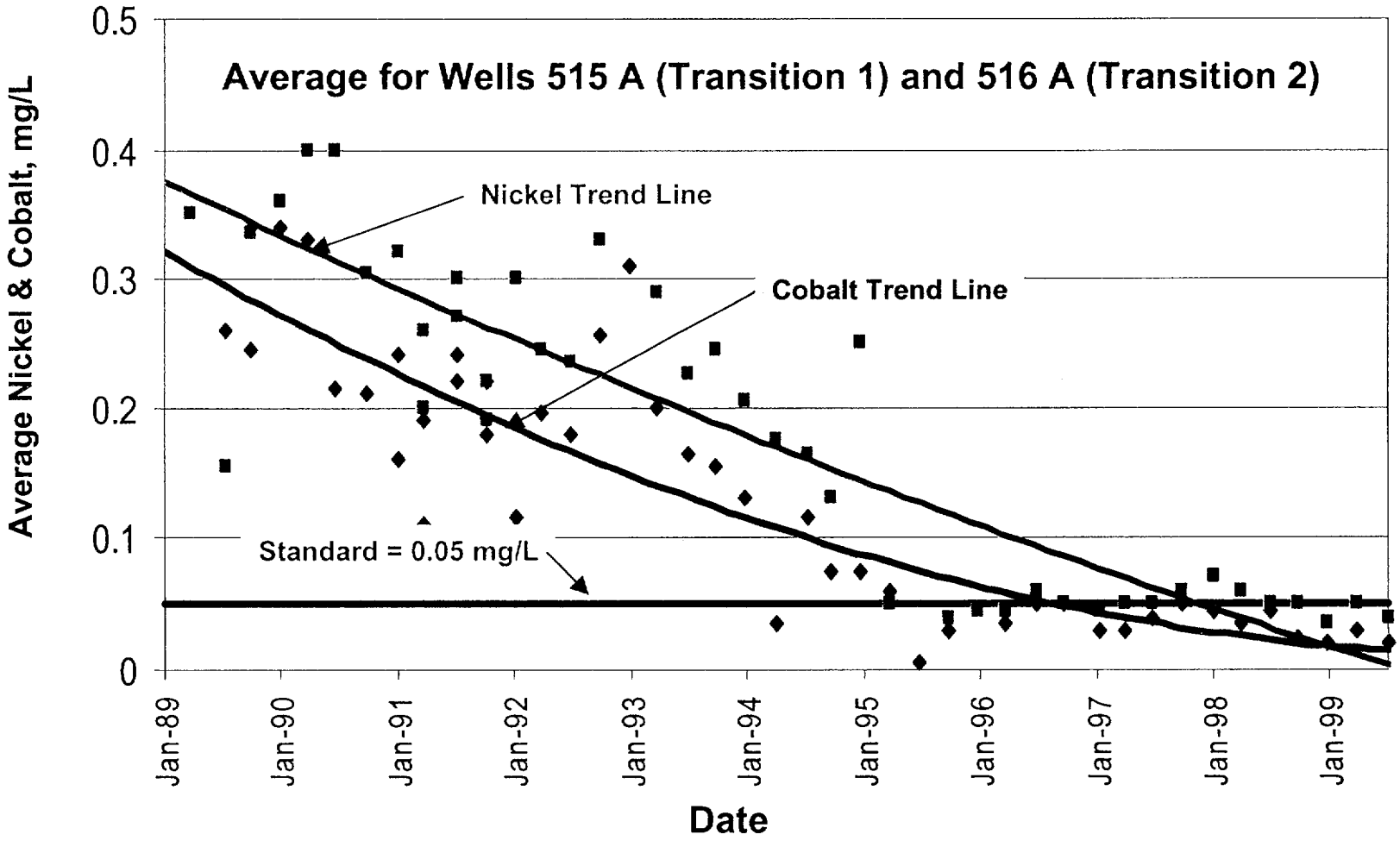
- **Dominant attenuation mechanism =**
  Precipitation by neutralization
- **Mechanism is demonstrated by:**
  - Empirical data for:
    - nickel, cobalt, aluminum and combined radium
  - Modeling for manganese
- **Effect of neutralization on metals and radionuclides:**

Standards are attained

Reduction In Metals Concentrations

(Zone 1 Geochemical Processes)

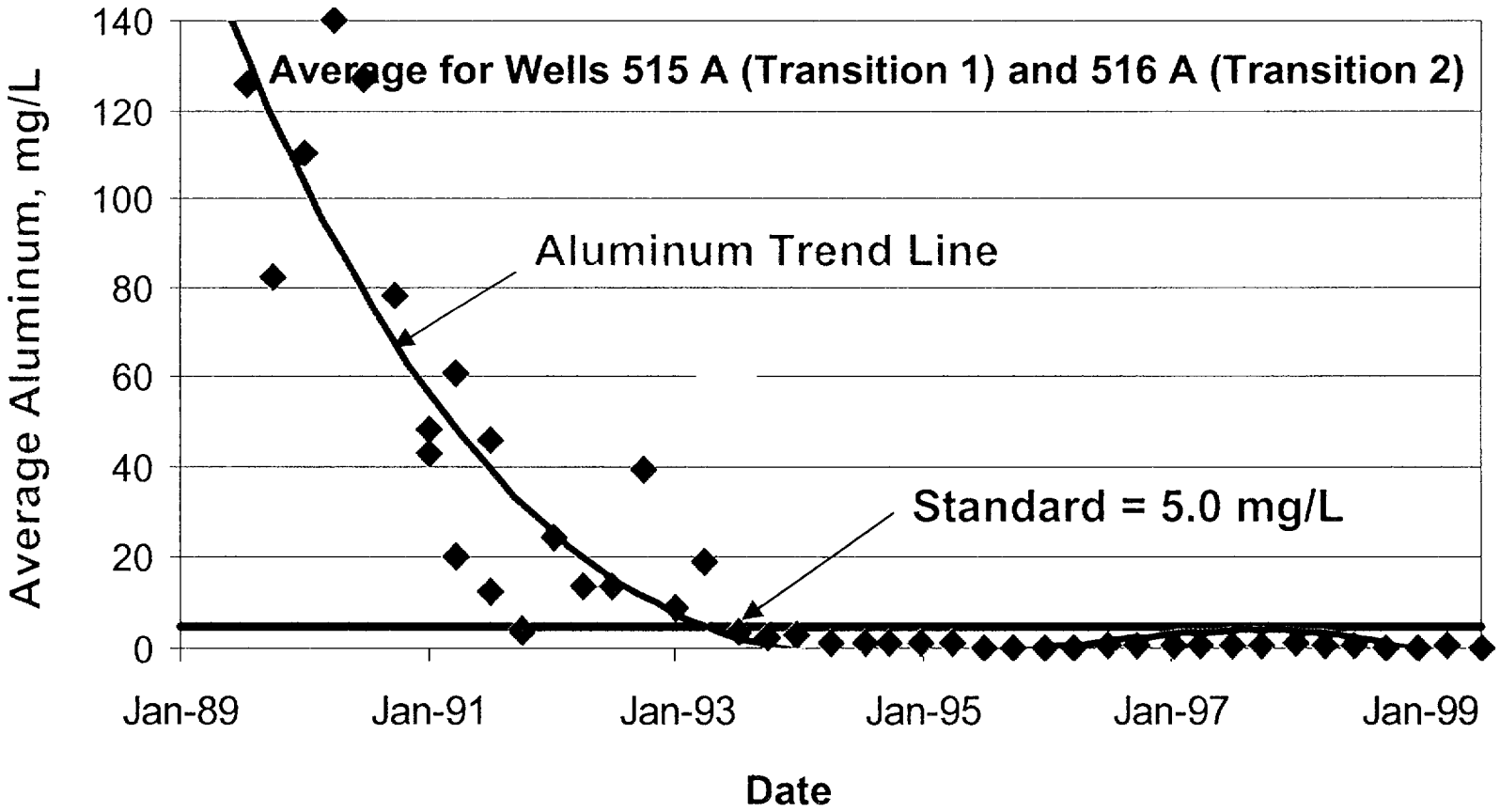
Nickel and Cobalt



Reduction In Metals Concentrations

(Zone 1 Geochemical Processes)

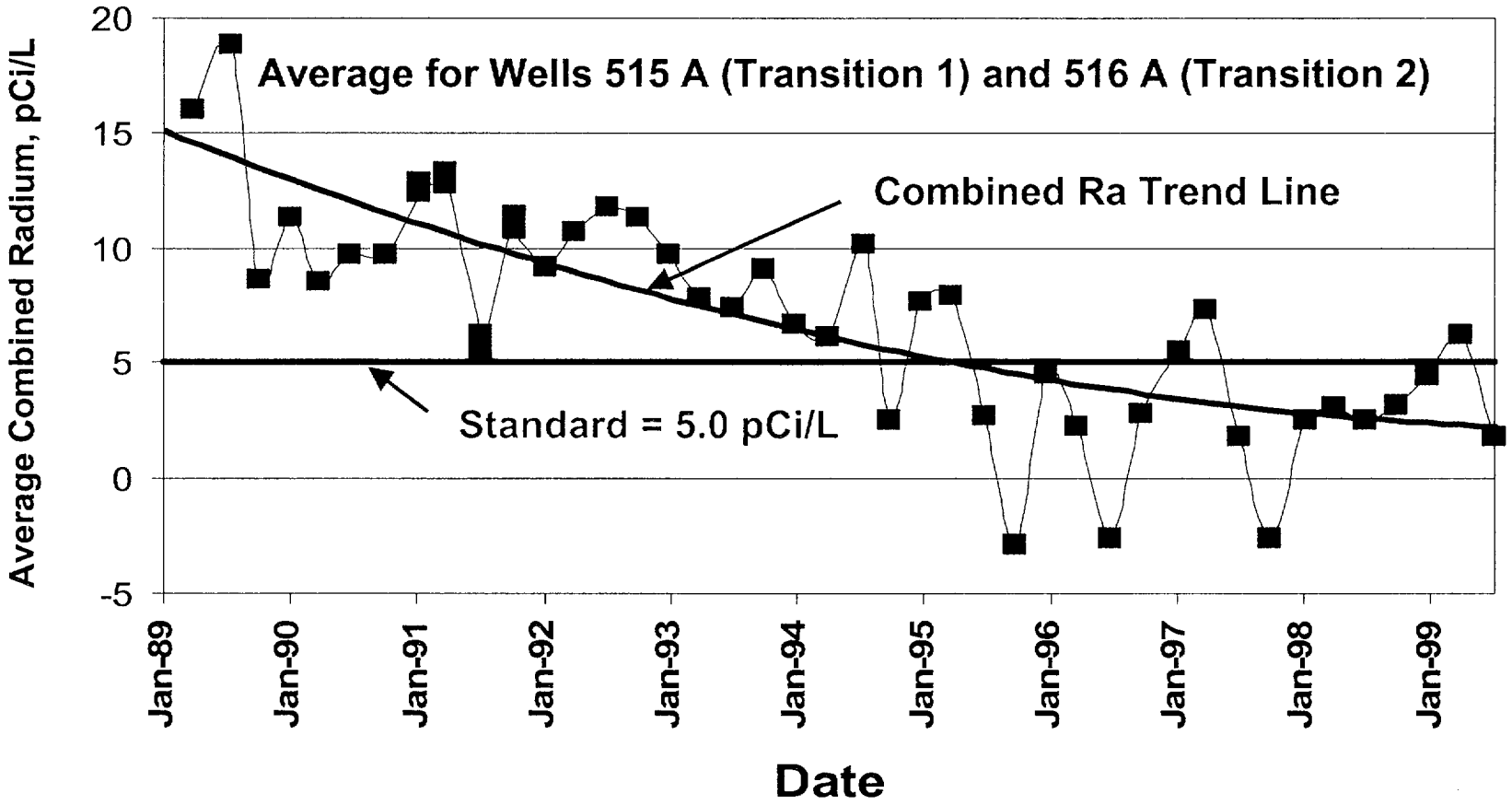
Aluminum



Reduction In Radionuclide Concentrations

(Zone 1 Geochemical Processes)

Combined Radium 226 and 228



Result For Metals and Radionuclides

(Zone 1 Geochemical Processes)

Standards are attained via:
natural processes (neutralization)

↓

Solution

↓

Monitored Natural Attenuation

Manganese The Metals Exception

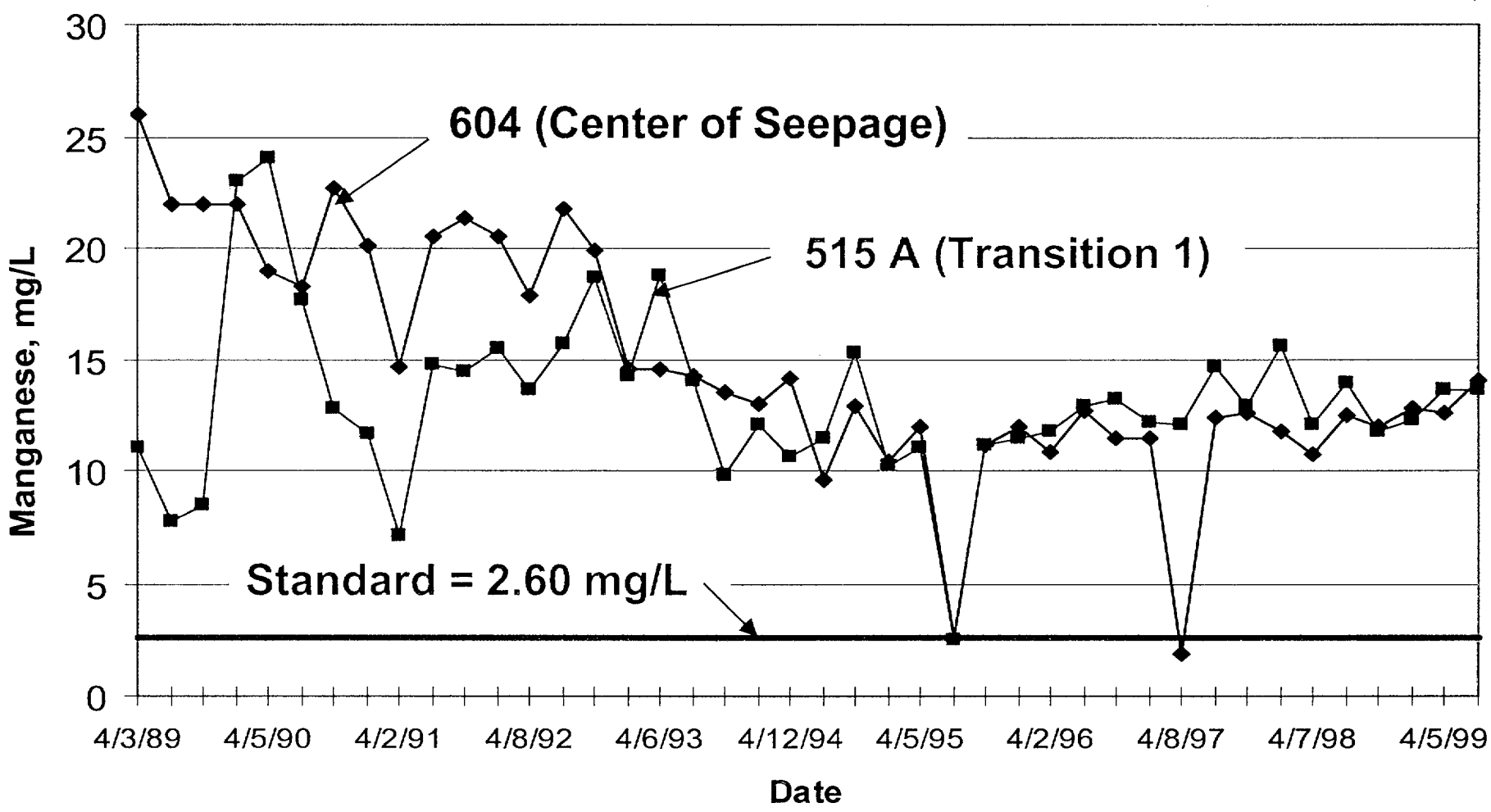
(Zone 1 Geochemical Processes)

- Empirical data show:
  - Manganese standard:
    - Not always attained through neutralization
    - Exceeded in background
- Modeling and empirical data show:
  - Manganese reduction limited by bicarbonate availability

Manganese Concentrations

(Zone 1 Geochemical Processes)

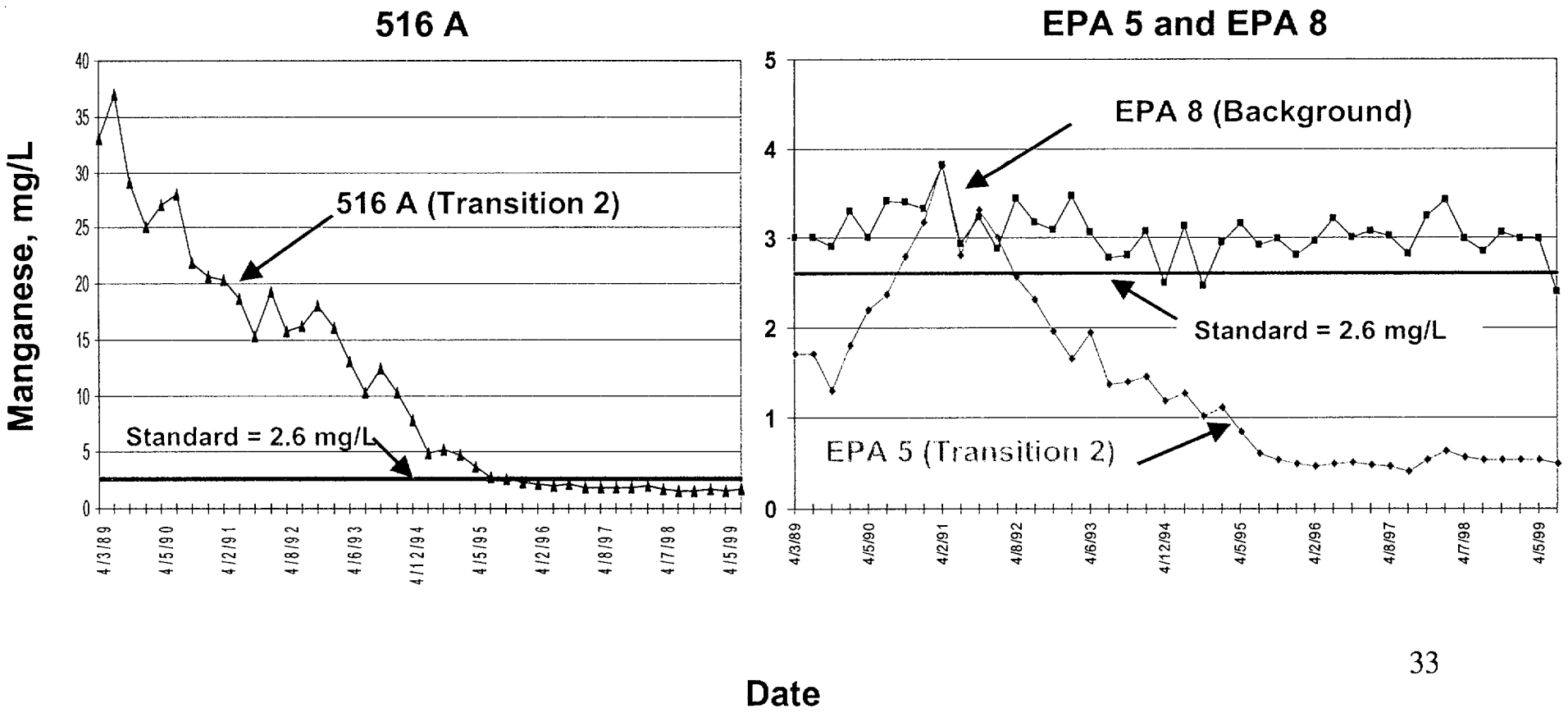
Center of Seepage and Transition 1



Manganese Concentrations

(Zone 1 Geochemical Processes)

Transition 2 and Background



Dominant Attenuation Mechanism For Manganese

(Zone 1 Geochemical Processes)

$$CaCO_3 + H^+ \text{ ------> } Ca^{2+} + HCO_3^-$$

Carbonate (calcite/dolomite) dissolved during contact with acidic plume

$$Mn^{2+} + HCO_3^- + OH^- \text{ ------> } MnCO_3 + H_2O$$

Manganese carbonate precipitated

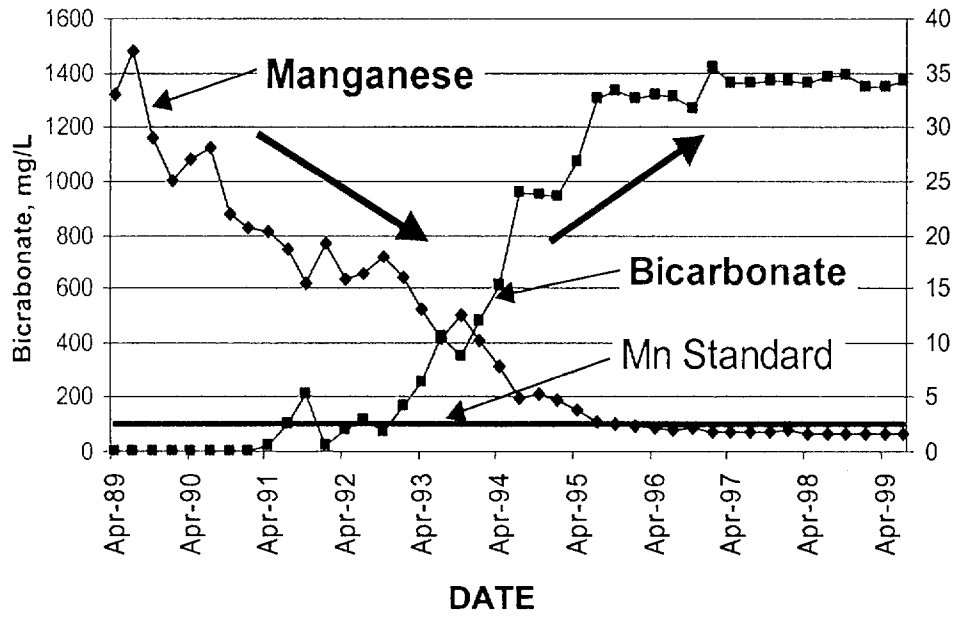
Net result:

- Manganese concentration reduced when bicarbonate concentration increases

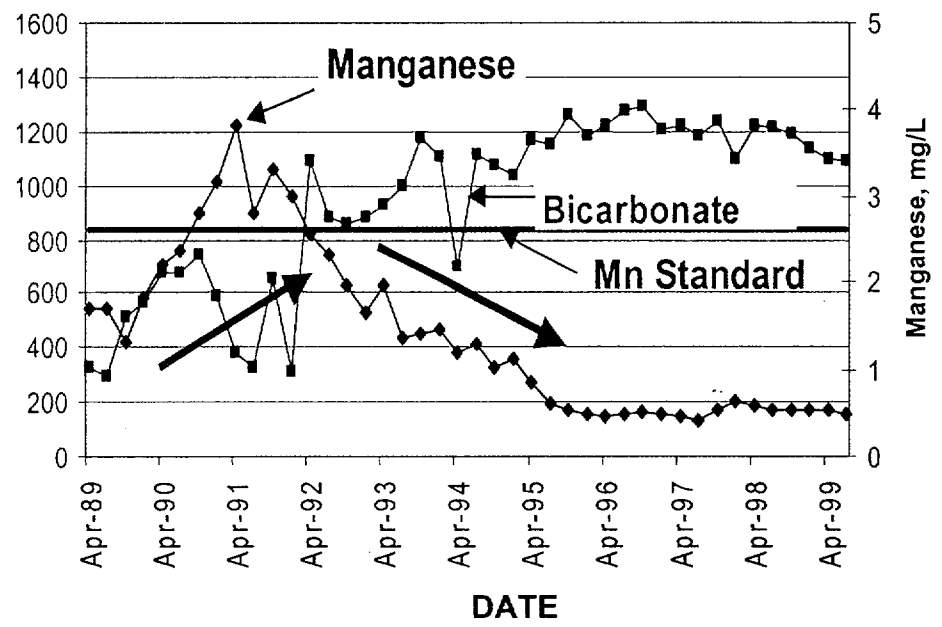
Manganese vs Bicarbonate

(Zone 1 Geochemical Processes)

516 A



EPA 5



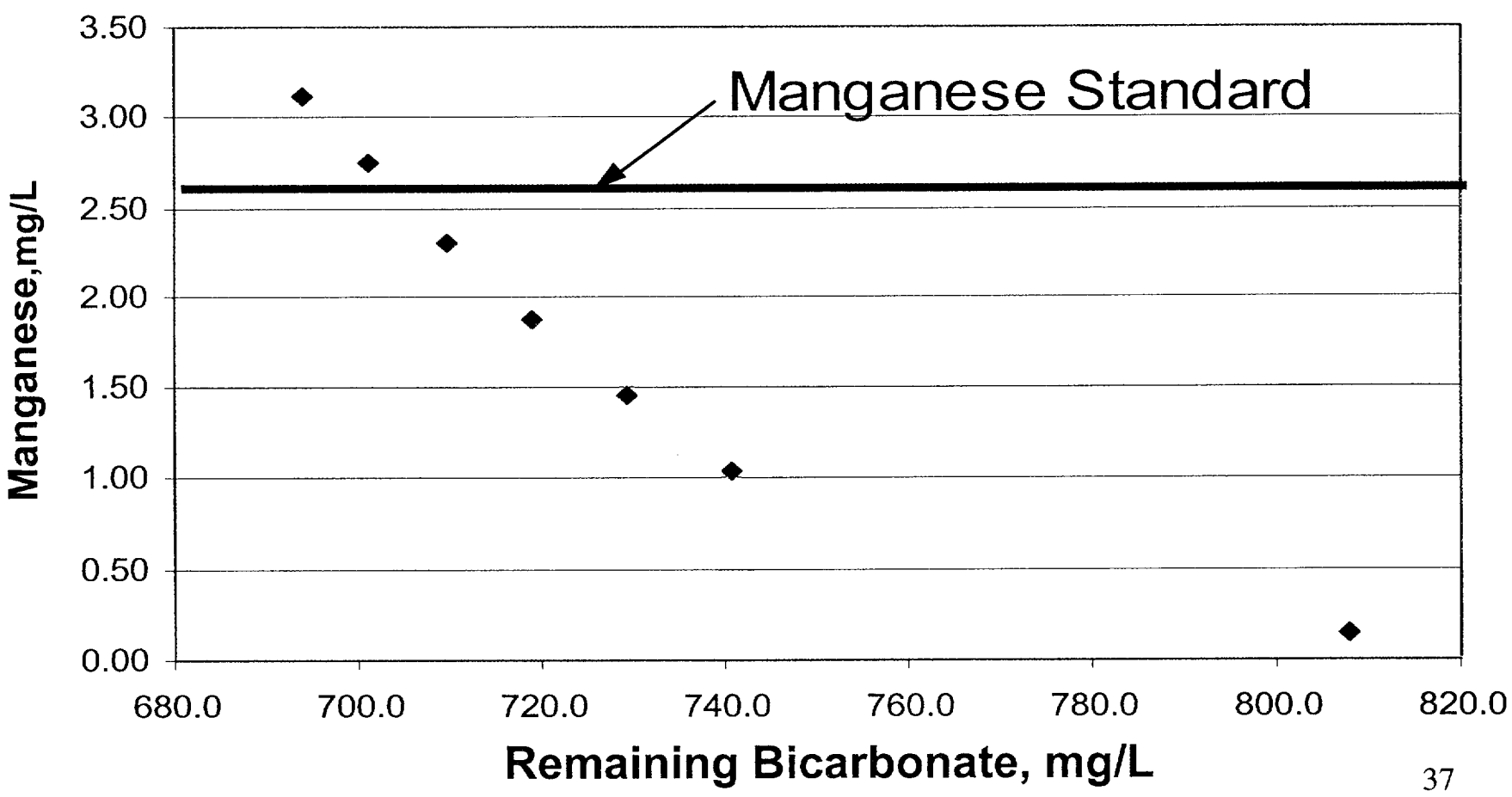
Geochemical Model For Manganese

(Zone 1 Geochemical Processes)

- Model used:
  - MINTEQA2
  - Peer-reviewed, widely accepted EPA model
- Assumptions:
  - Equilibrium Conditions
- Verification:
  - Compared to empirical data

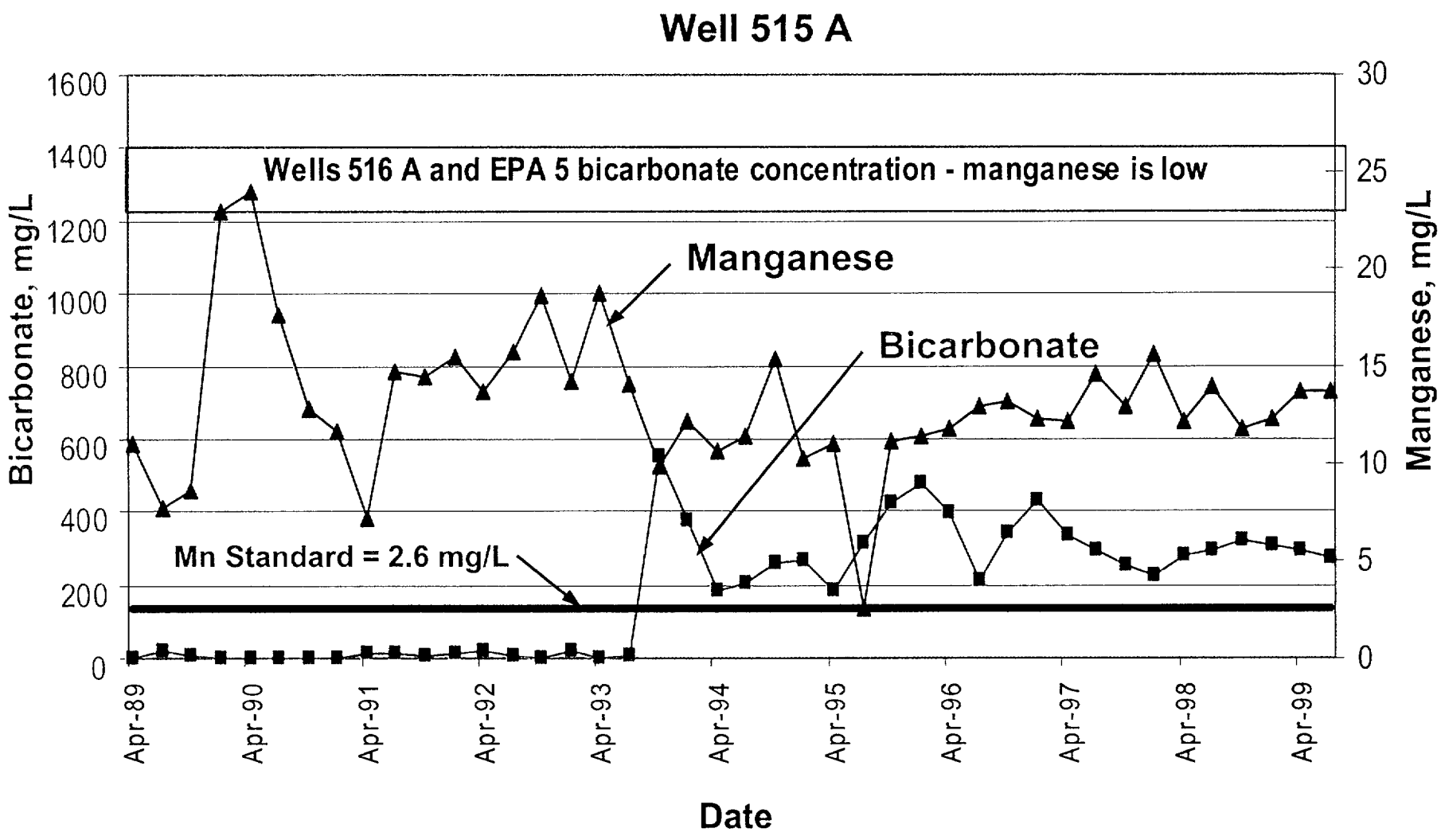
Modeled Manganese Concentrations

(Zone 1 Geochemical Processes)



Bicarbonate Limiting Manganese Precipitation

(Zone 1 Geochemical Processes)



Model Results

Manganese

(Zone 1 Geochemical Processes)

- Carbonate precipitation can occur
  - Manganese concentrations decrease
    (Below the standard in Transition 2 area)
- Decrease limited by bicarbonate availability
    (Above standard in Transition 1 Area)
- Standards may not be attained
  - Sufficient bicarbonate not available
  - Naturally exceed standards in background

Result For Manganese

(Zone 1 Geochemical Processes)

Standards may not be attained because of natural conditions

Solution

Technical Impracticability Waiver

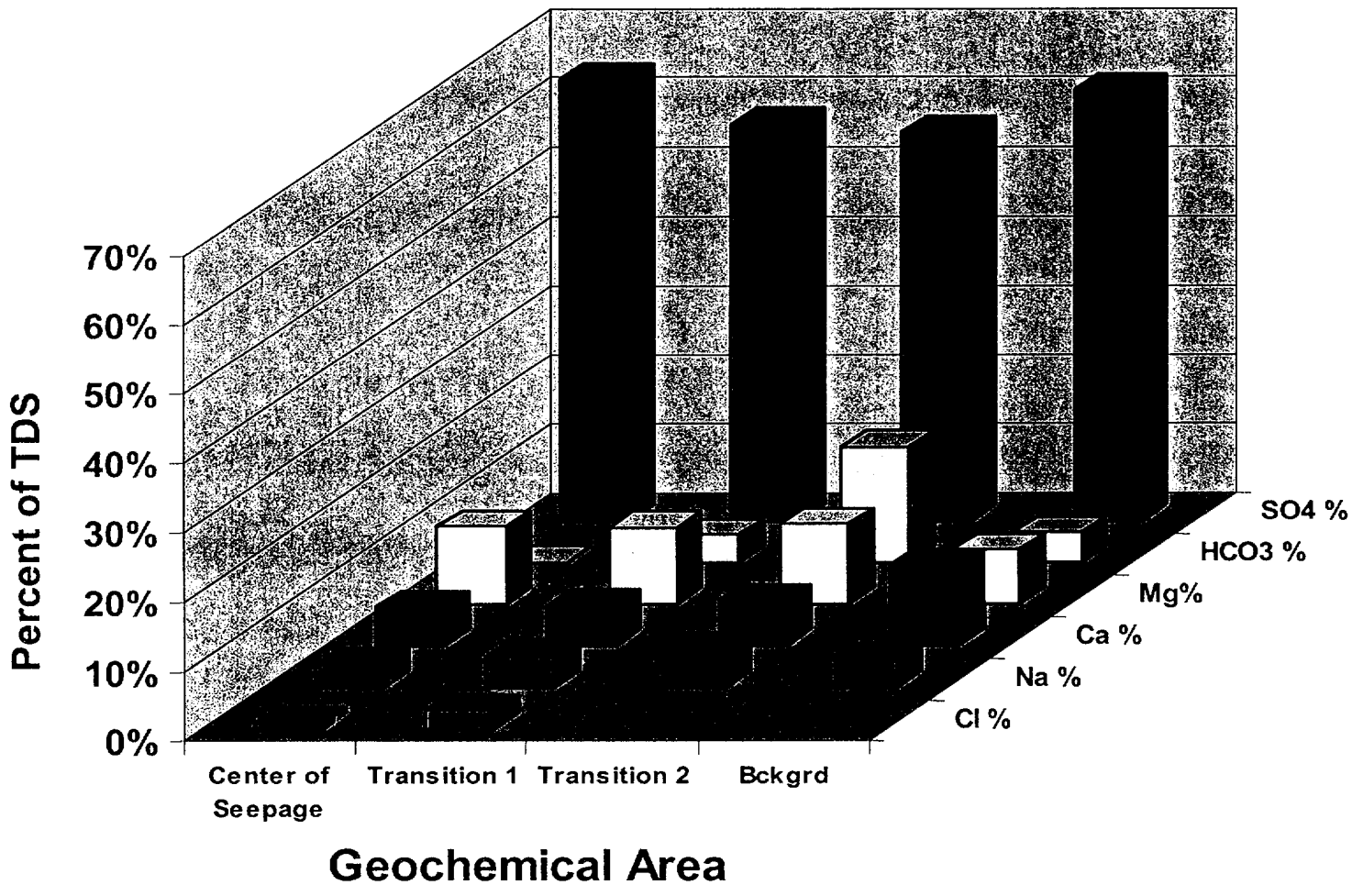
Sulfate and TDS

(Zone 1 Geochemical Processes)

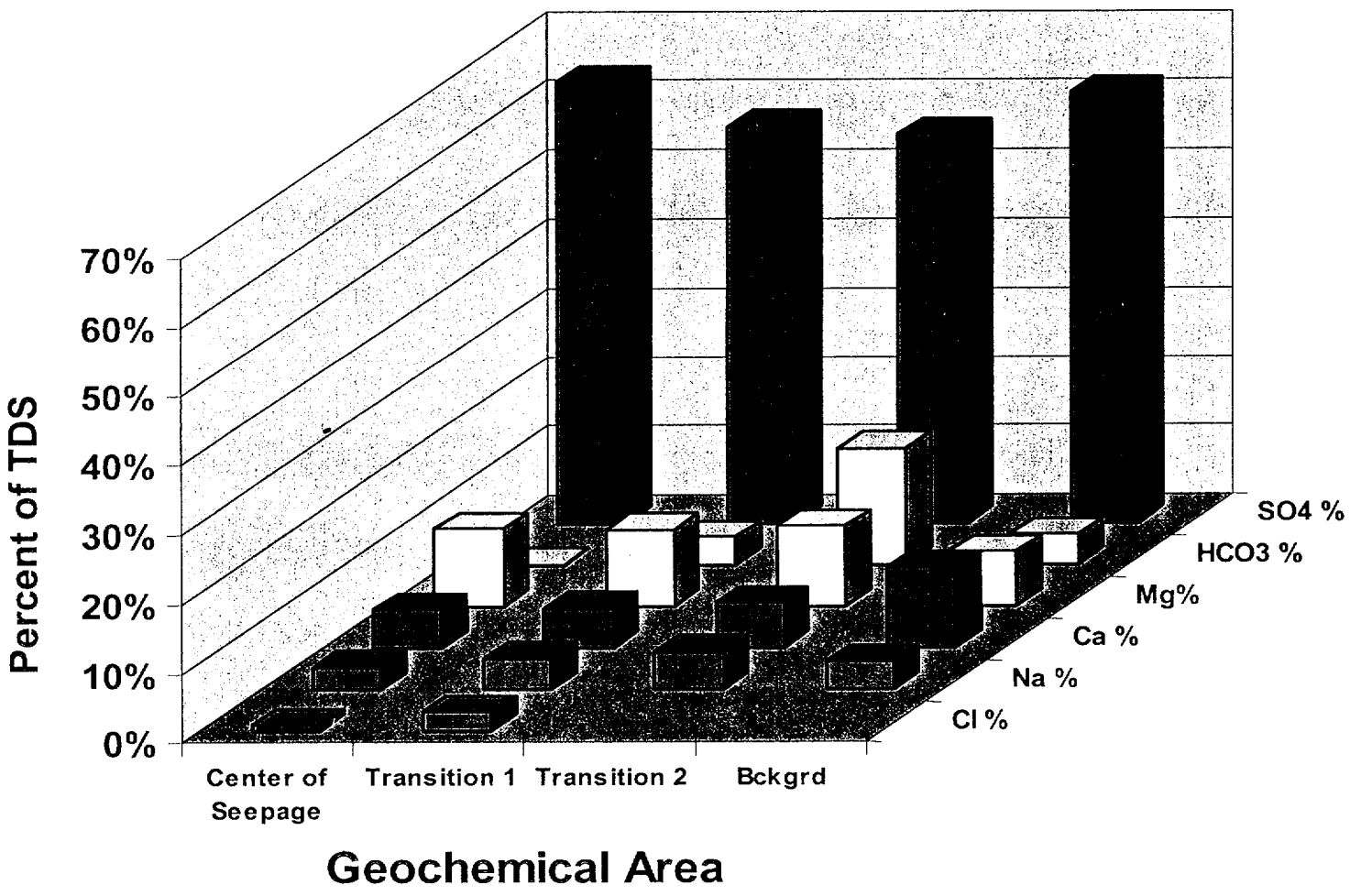
- Dominant attenuation mechanism = gypsum precipitation
- Mechanism demonstrated by :
  - Empirical data
  - Modeling
- TDS mimics sulfate
- Effect of gypsum precipitation is limited

Standards will not be attained

TDS
Primary Components
(Zone 1 Geochemical Processes)

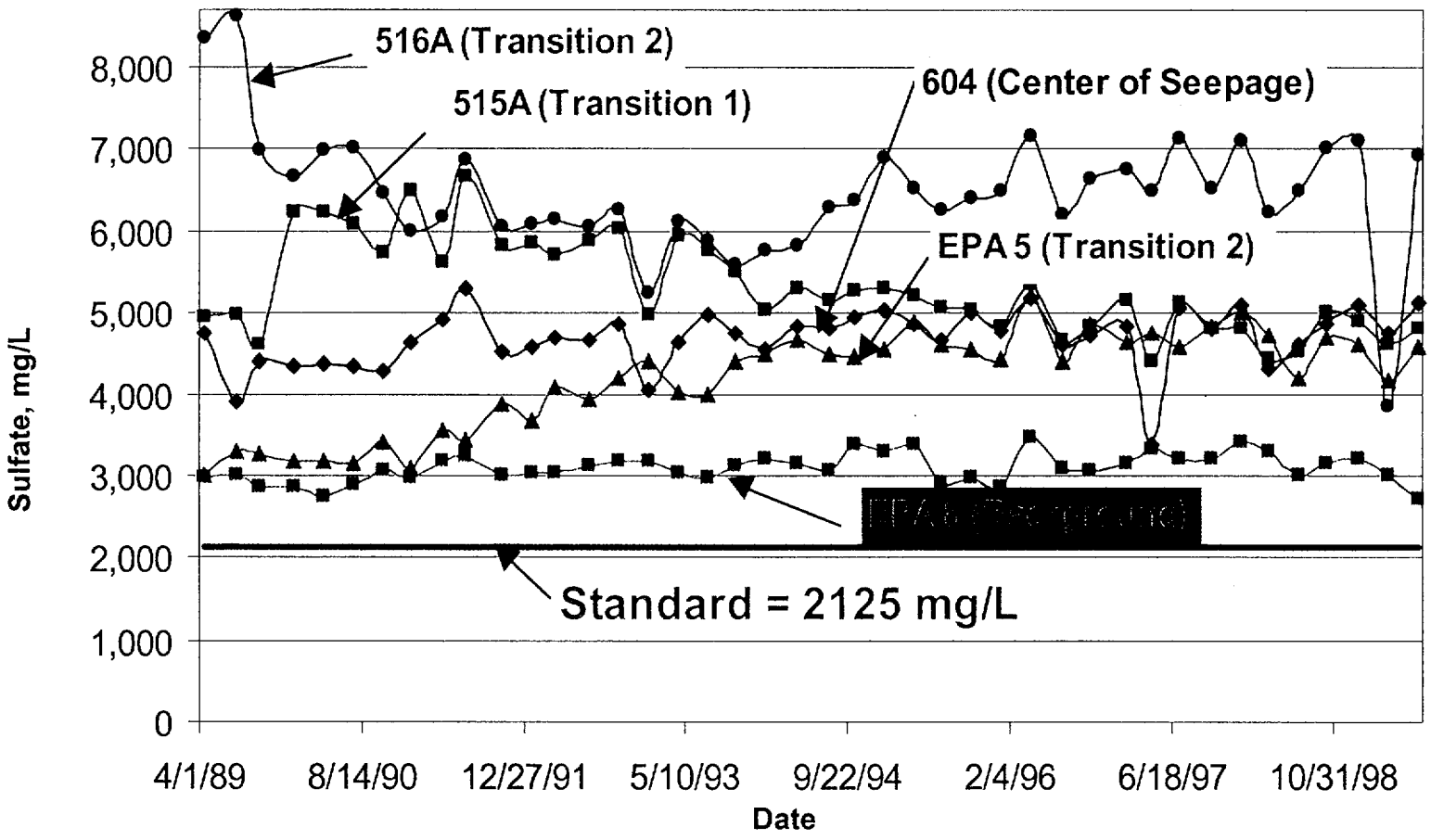


TDS
Primary Components
(Zone 1 Geochemical Processes)



Sulfate Concentrations

(Zone 1 Geochemical Processes)



Dominant Attenuation Mechanism For Sulfate

(Zone 1 Geochemical Processes)

$$CaCO_3 + H^+ \text{ ------> } Ca^{2+} + HCO_3^-$$

Carbonate (calcite/dolomite) dissolved during contact w/ acidic plume

$$Ca^{2+} + SO_4^{2-} + H_20 \text{ ---------> } CaSO_4 \cdot H_20$$

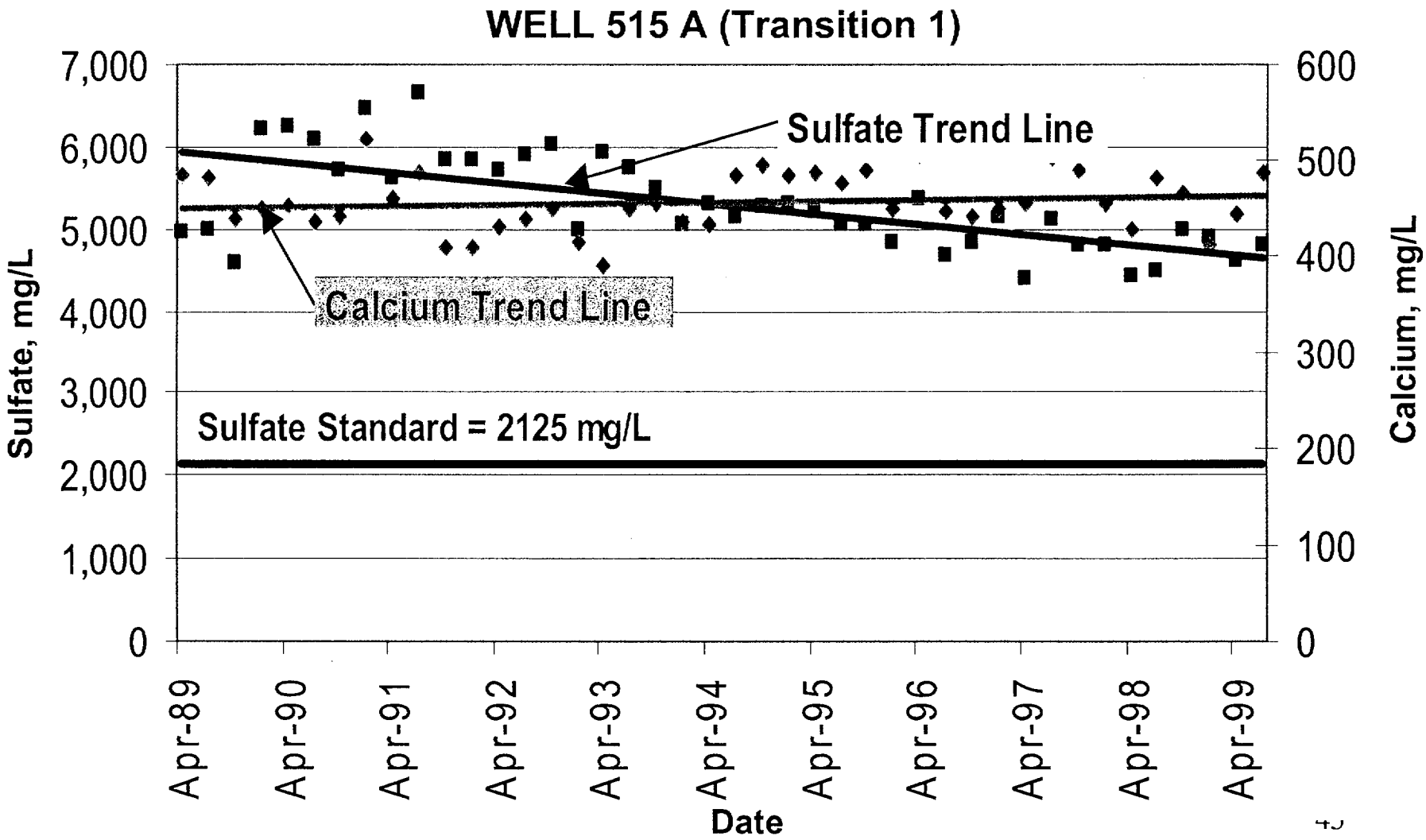
Gypsum precipitated

Net Result:

- Sulfate concentration reduced when calcium is available

Sulfate and Calcium

(Zone 1 Geochemical Processes)



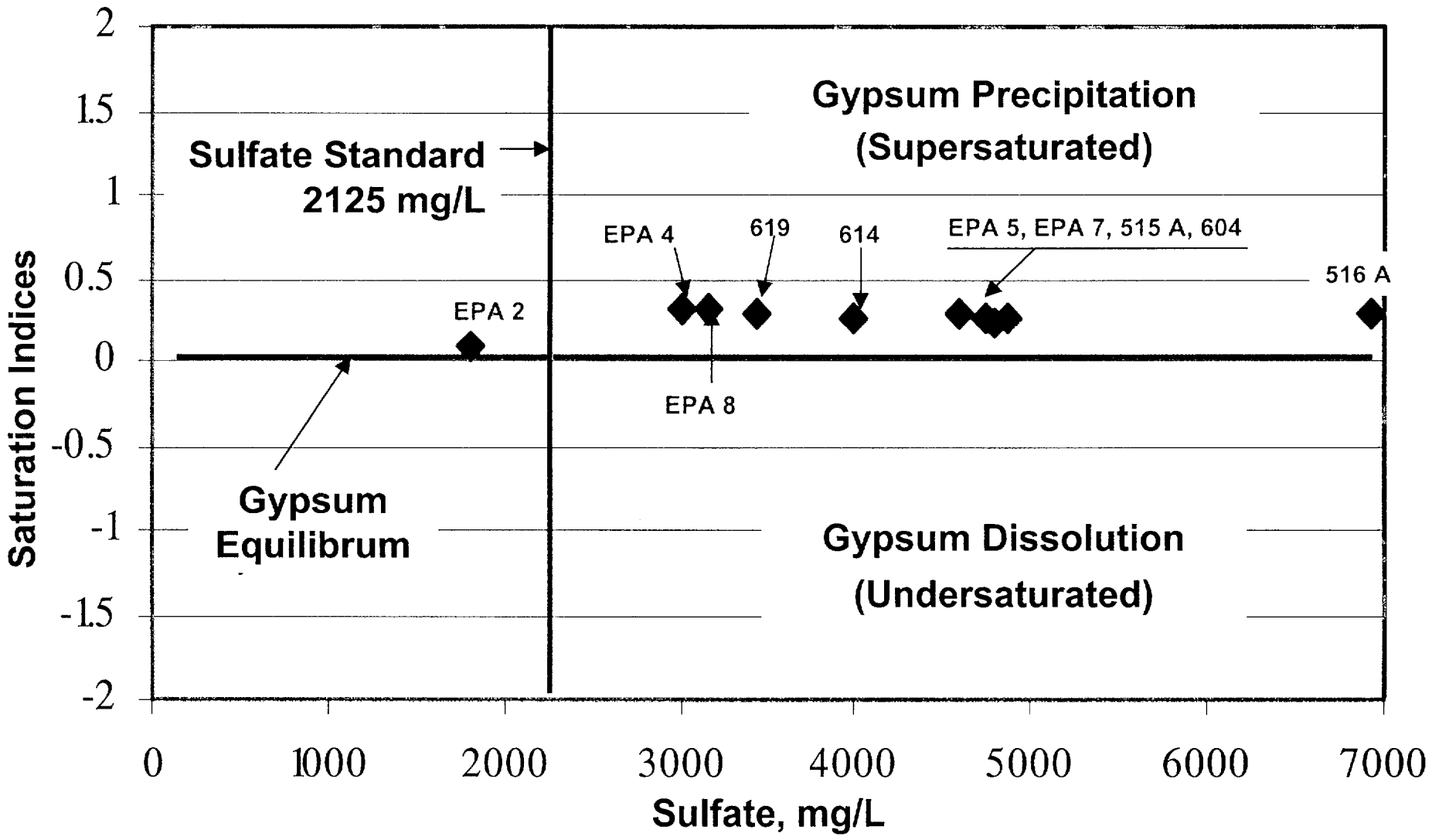
Geochemical Model For Sulfate

(Zone 1 Geochemical Processes)

- Model used:
  - MINTEQA2
  - Peer-reviewed, widely accepted EPA model
- Assumptions:
  - Equilibrium Conditions
- Verification:
  - Compared to empirical data

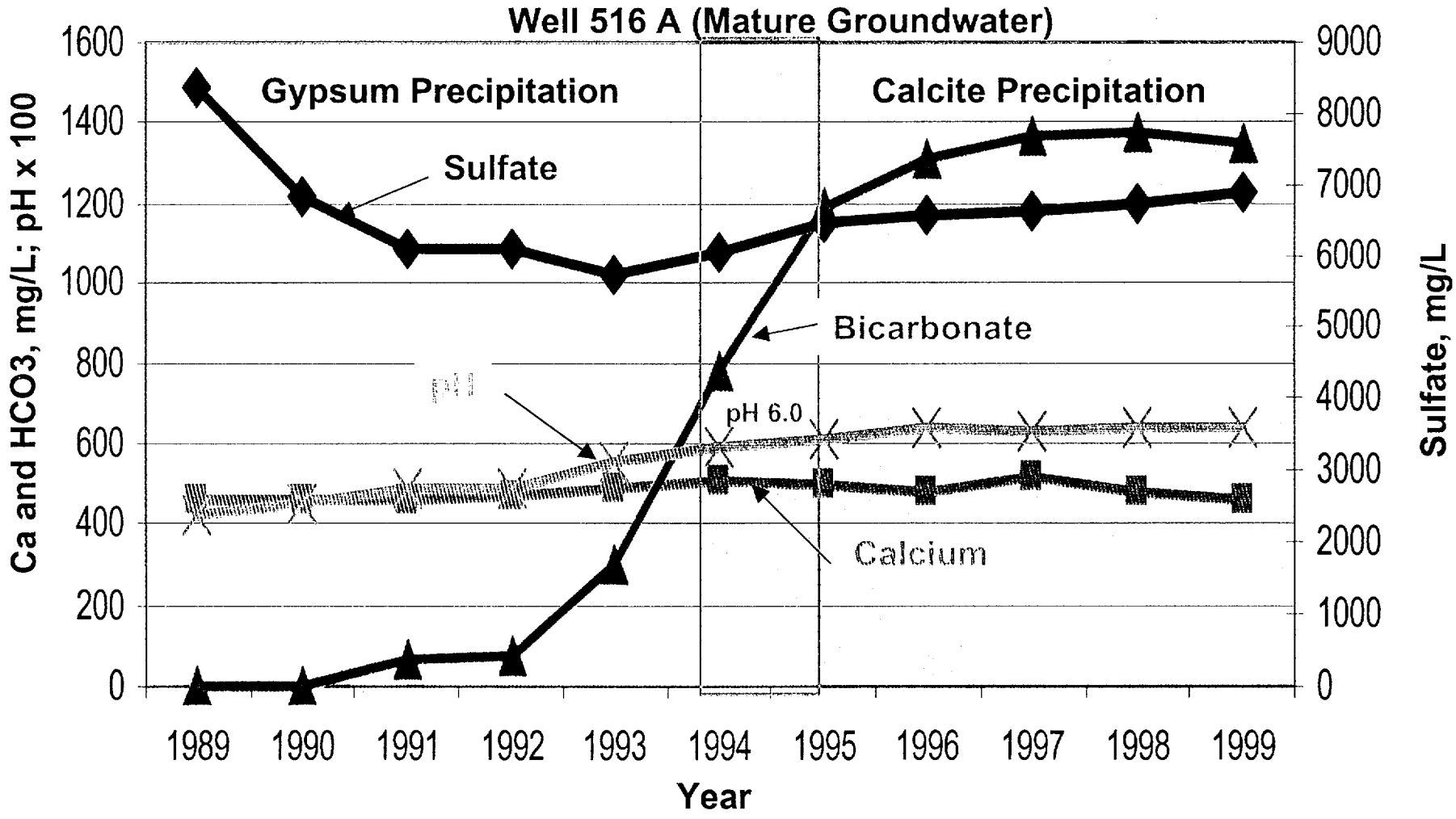
Gypsum Saturation Indices

(Zone 1 Geochemical Processes)



Sulfate,Calcium, pH and Bicarbonate Relationship

(Zone 1 Geochemical Processes)



Model Results

Sulfate

(Zone 1 Geochemical Processes)

- All Zone 1 water is:
  - Supersaturated with gypsum
  - Gypsum occurs naturally throughout Zone 1(background)
- Gypsum precipitation can occur
  - Sulfate concentrations can decrease
- Decrease limited by calcium availability
  - Calcite no longer dissolved when pH neutralized
- Standards will not be attained
  - Gypsum equilibrium throughout the formation
  - Neutral pH does not favor further sulfate reduction

Result for Sulfate and TDS

(Zone 1 Geochemical Processes)

Standards will not be attained because of natural conditions

↓

Solution

↓

Technical Impracticability Waiver

Technical Presentation Topics

- Evolution of Zone 1 Water
- Zone 1 Geochemical Processes
  - Current conditions
  - Metals and radionuclides
  - Manganese
  - Sulfate and TDS
- ***Summary***

Summary

- Source removal (Borrow Pit No. 2 dewatering):
  - Reduced gradient
  - Slowed plume migration
  - Enhanced natural attenuation
- Geochemical mechanisms:
  - Control pH, metals and radionuclides
  - Possibly control manganese
  - Are insufficient to control sulfate and TDS

Predictions

(Summary)

Constituent	Will Standards Be Met? Section 1	Section 36	Remarks
Manganese	Maybe	Maybe	Dependent on bicarbonate availability
Sulfate	No	No	Limited by calcium availability
TDS	No	No	Governed by sulfate concentration
Metals	Yes	Yes	Attenuated by neutralization and adsorption
Radionuclides	Yes	Yes	Attenuated by neutralization and adsorption

Church Rock Site Presentation

- Overview of problem
- Technical presentation
- ***Solution***

Solution

Combination of:

- Monitored natural attenuation
- Technical impracticability waiver
- Institutional controls

Monitored Natural Attenuation

(Solution)

- Source removed in 1989
  - Borrow pit dewatered
- Natural attenuation
  - Contracts plume
    - pH neutralized causing metals and radionuclide precipitation
  - Stabilizes plume
    - Sulfate precipitation as gypsum when calcium available

Technical Impracticability Waiver

(Solution)

- Natural hydraulic conditions
  - Low formation yield
  - Cannot achieve hydraulic control
- Natural geochemical conditions
  - Certain standards cannot be achieved
    - Manganese - bicarbonate availability
    - Sulfate and TDS - gypsum equilibrium

Institutional Controls

(Solution)

- Support MNA and TI
- Protective
- Meets administrative needs

Administrative Mechanisms

- EPA
  - UNC submit TI Waiver to EPA
- NRC
  - UNC submit Alternatives Analysis to NRC (Appendix A to 10 CFR 40)
- Navajo Superfund
  - Concurrence on IC and submittals
- NMED
  - Concurrence on approach and submittals