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# Progress in Remediating ARD-Contaminated Groundwater at Bingham Canyon Mine, Utah, USA

Kennecott Utah Copper


# Presentation Outline

- Nature of Problem
- Regulatory Framework
- Containment and Remediation
- Water Treatment
- Cleanup Timeframe
- Questions

# Acknowledgements






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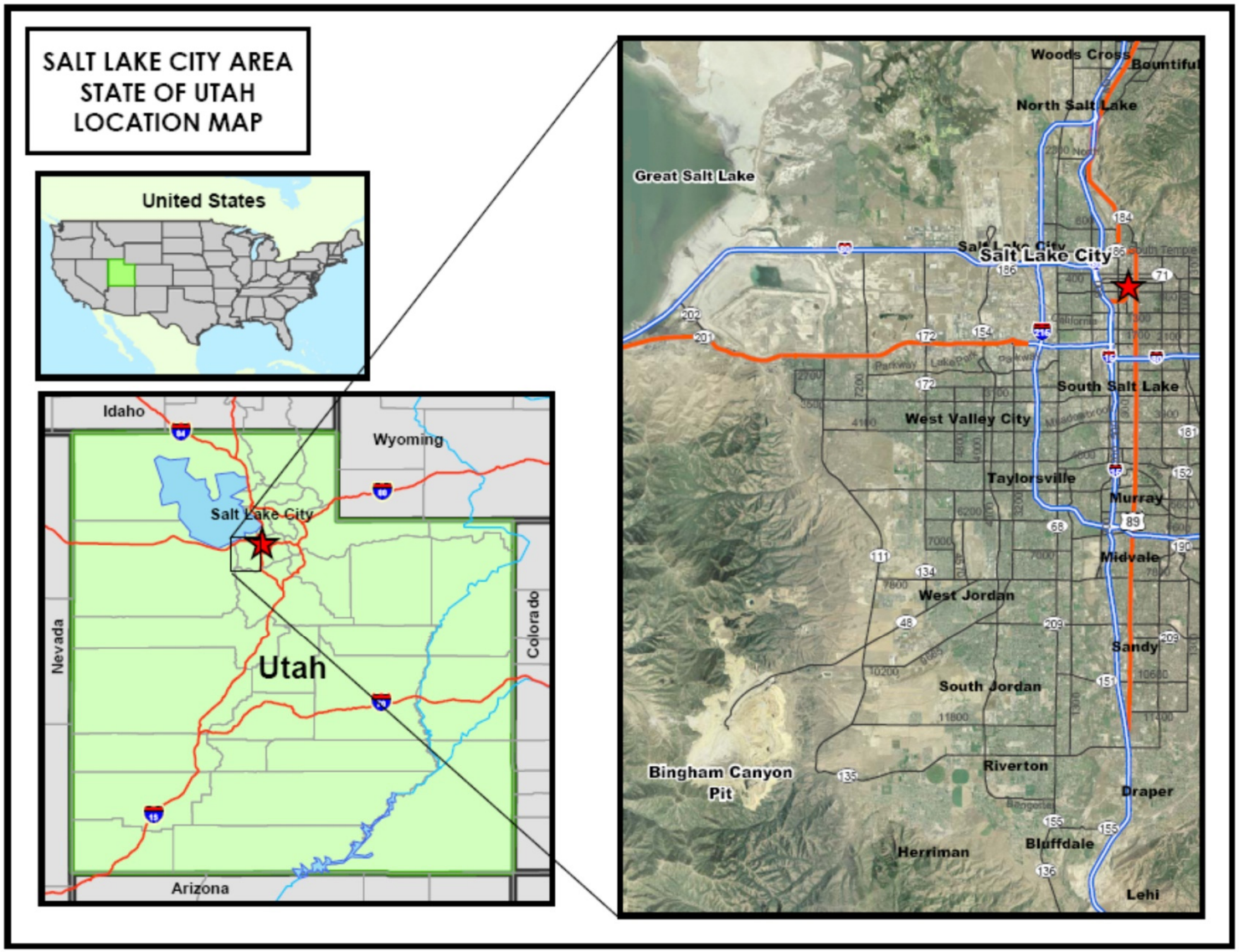
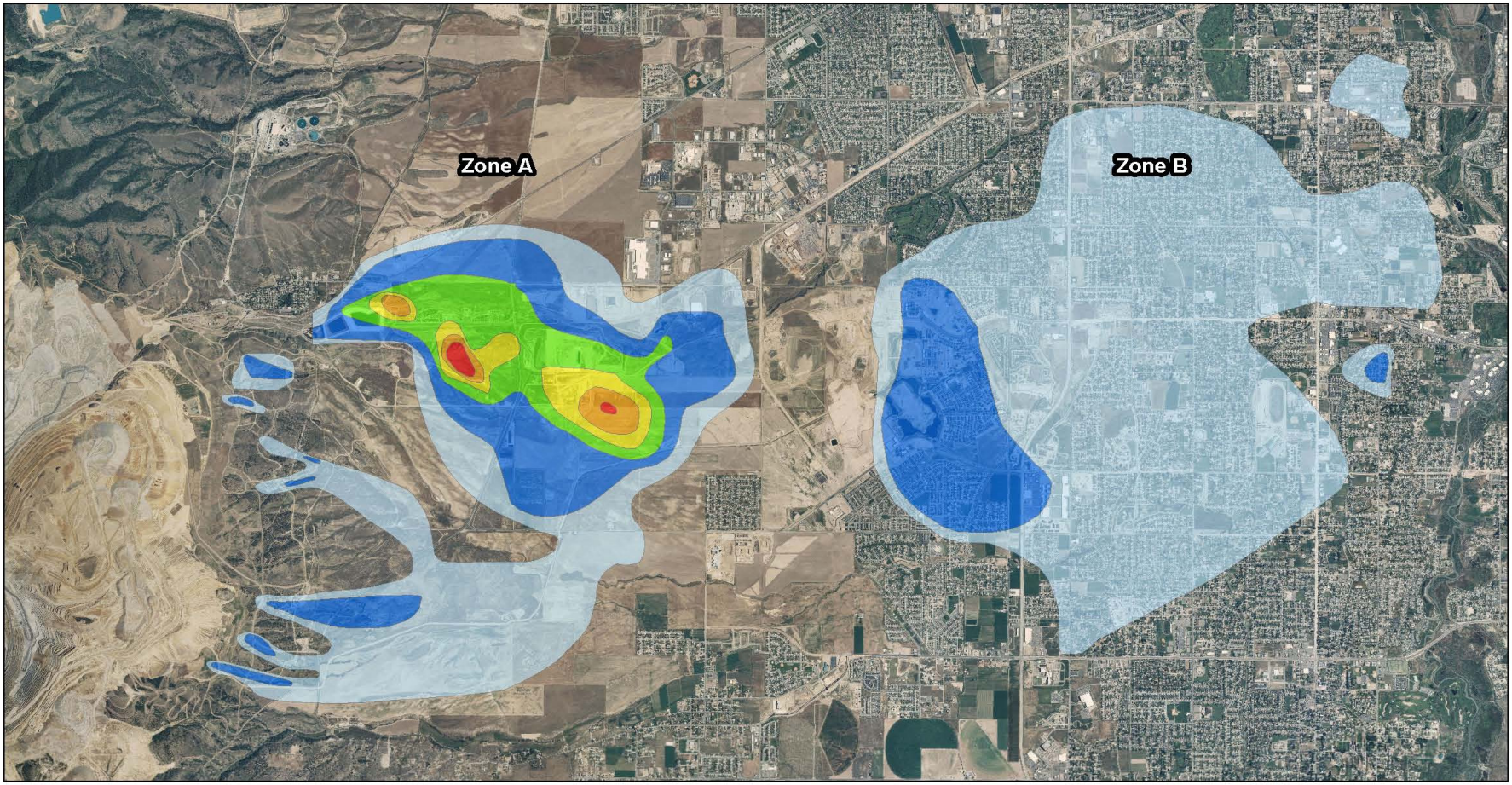
# Nature of Problem

# Kennecott Utah Copper (KUC)
# Bingham Canyon Mine






**2010 Sulfate Concentrations**

- 20,000+ mg/L
- 15,000 - 19,999 mg/L
- 10,000 - 14,999 mg/L
- 5,000 - 9,999 mg/L
- 1,500 - 4,999 mg/L
- 500 - 1,499 mg/L

0 2,000 4,000 8,000
Feet

N

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# Regulatory Framework


# Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)

- 1986 — EPA begins Preliminary Site Investigation
- 1994 — EPA proposes site for National Priority List (NPL)
- 1995 — Memo of Understanding between EPA, State of Utah, and Kennecott Utah Copper (KUC)
- 1998 — RI/FS completed *(Site Investigation)*
- 2000 — ROD issued *(Approval of Cleanup Plan)*
- 2002 — RDRA completed *(Design and Implementation)*
- 2008 — Consent Decree issued *(Legal Agreement)*
- 2008 — NPL proposal withdrawn

# Natural Resource Damage (NRD)

- 1986 — State of Utah files NRD claim for groundwater impacted by ARD
- 1992 — Initial NRD settlement rejected after Jordan Valley Water Conservancy District (JVWCD) intervenes
- 1995 — NRD settlement approved; KUC provides funding to "restore, replace, or acquire equivalent"
- 2004 — State of Utah approves a joint KUC/JVWCD groundwater treatment project
- 2006 — KUC commissions Reverse Osmosis (RO) water treatment plant for Zone A
- 2012 — JVWCD anticipated to open KUC funded RO water treatment plant for Zone B

# Remedies Summary

- EPA through CERCLA:
  - Maintain source controls and provide plume containment through pumping
  - Remediate aquifer through pumping and monitored natural attenuation (MNA)
  - Treat extracted groundwater and dispose of treatment residuals
- State of Utah through NRD:
  - Construct and operate a RO water treatment plant for Zone A
  - Fund construction of RO water treatment plant for Zone B to be owned and operated by JVWCD
  - Each plant to produce 3,500 acre-feet/year for 40 years

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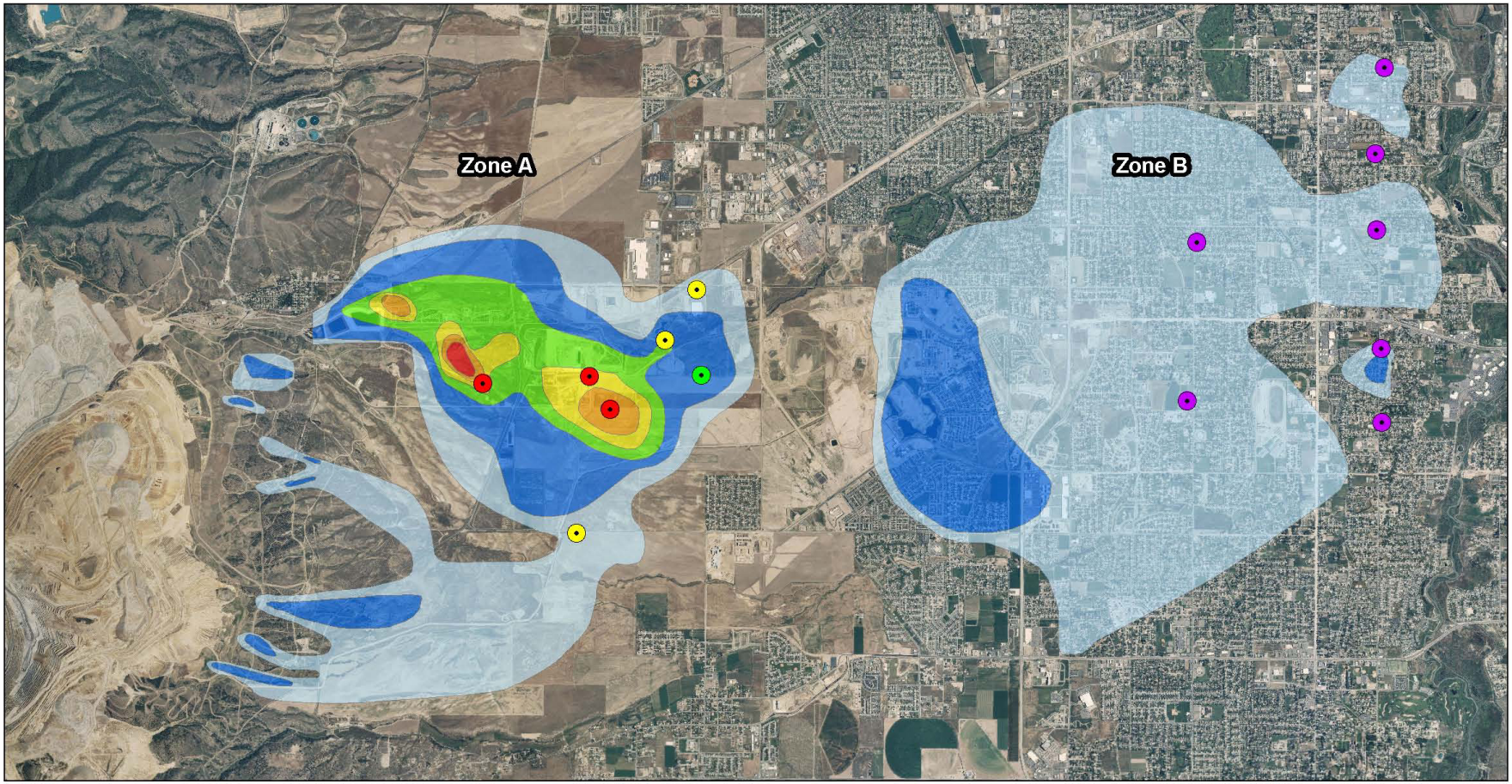
# Containment and Remediation

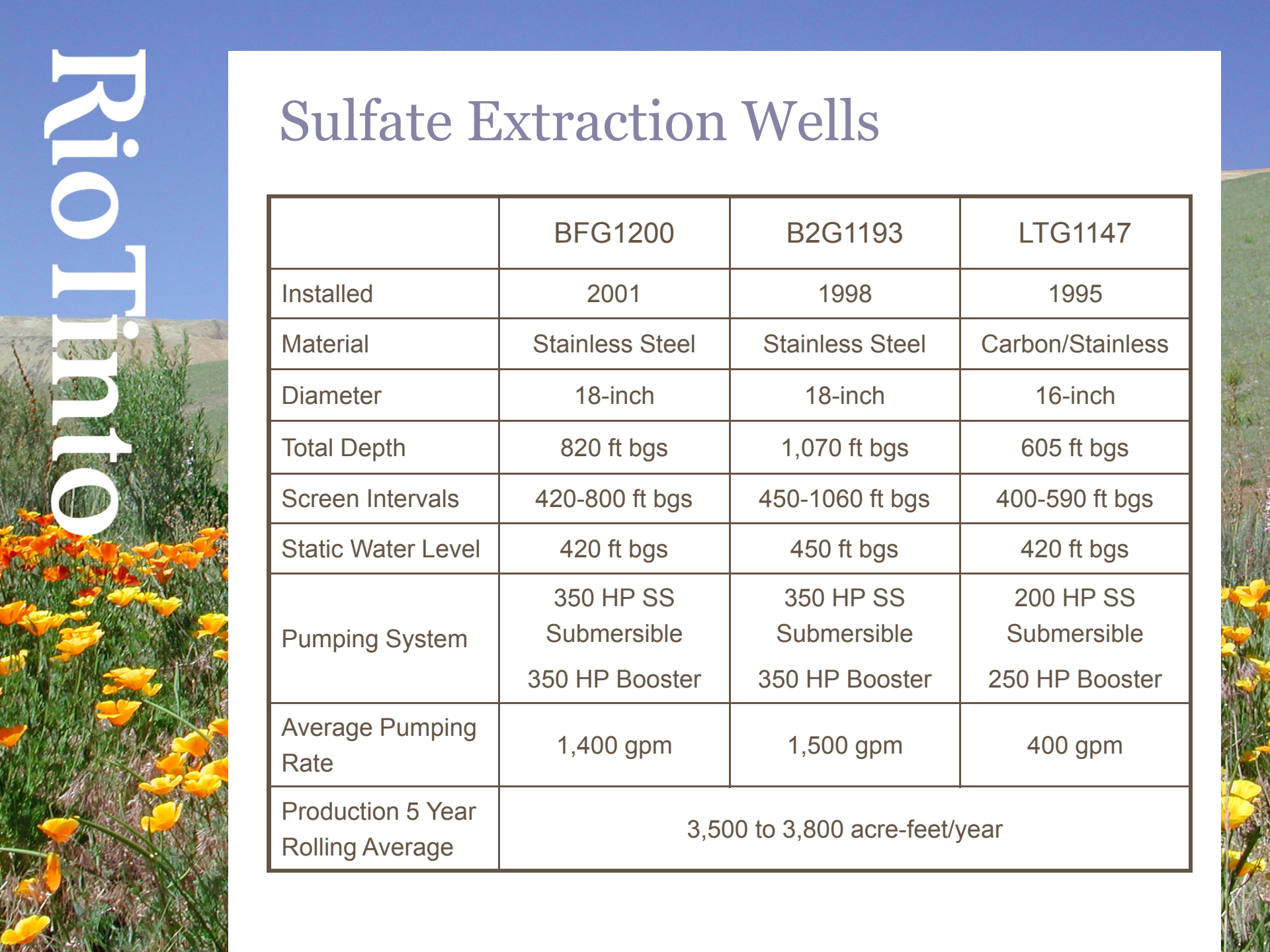

Zone A
Zone B
2010 Sulfate Concentrations
20,000+ mg/L
15,000 - 19,999 mg/L
10,000 - 14,999 mg/L
5,000 - 9,999 mg/L
1,500 - 4,999 mg/L
500 - 1,499 mg/L
Extraction Wells
Acidic Extraction Well
Sulfate Extraction Wells
New Sulfate Extraction Well
JVWCD Extraction Wells
0 2,000 4,000 8,000
Feet
N


7 16 '92


4 15 98

# Acidic Extraction Wells

| | ECG1146 | BSG1201 | BSG2784 |
|---|---|---|---|
| Installed | 1995 | 2003 | 2008 |
| Material | Stainless Steel | Stainless Steel | Stainless Steel |
| Diameter | 18-inch | 18-inch | 18-inch |
| Total Depth | 760 ft bgs | 752 ft bgs | 870 ft bgs |
| Screen Intervals | 500-700 ft bgs | 500-740 ft bgs | 490-600 ft bgs<br>700-850 ft bgs |
| Static Water Level | 390 ft bgs | 460 ft bgs | 420ft bgs |
| Pumping System | 200 HP SS Submersible | 200 HP SS Submersible | 200 HP SS Submersible |
| Average Pumping Rate | 670 gpm | 620 gpm | 620 gpm |
| Production 5 Year Rolling Average | 2,100 to 2,600 acre-feet/year | | |




# Sulfate Extraction Wells

| | BFG1200 | B2G1193 | LTG1147 |
|---|---|---|---|
| Installed | 2001 | 1998 | 1995 |
| Material | Stainless Steel | Stainless Steel | Carbon/Stainless |
| Diameter | 18-inch | 18-inch | 16-inch |
| Total Depth | 820 ft bgs | 1,070 ft bgs | 605 ft bgs |
| Screen Intervals | 420-800 ft bgs | 450-1060 ft bgs | 400-590 ft bgs |
| Static Water Level | 420 ft bgs | 450 ft bgs | 420 ft bgs |
| Pumping System | 350 HP SS Submersible<br>350 HP Booster | 350 HP SS Submersible<br>350 HP Booster | 200 HP SS Submersible<br>250 HP Booster |
| Average Pumping Rate | 1,400 gpm | 1,500 gpm | 400 gpm |
| Production 5 Year Rolling Average | 3,500 to 3,800 acre-feet/year | | |

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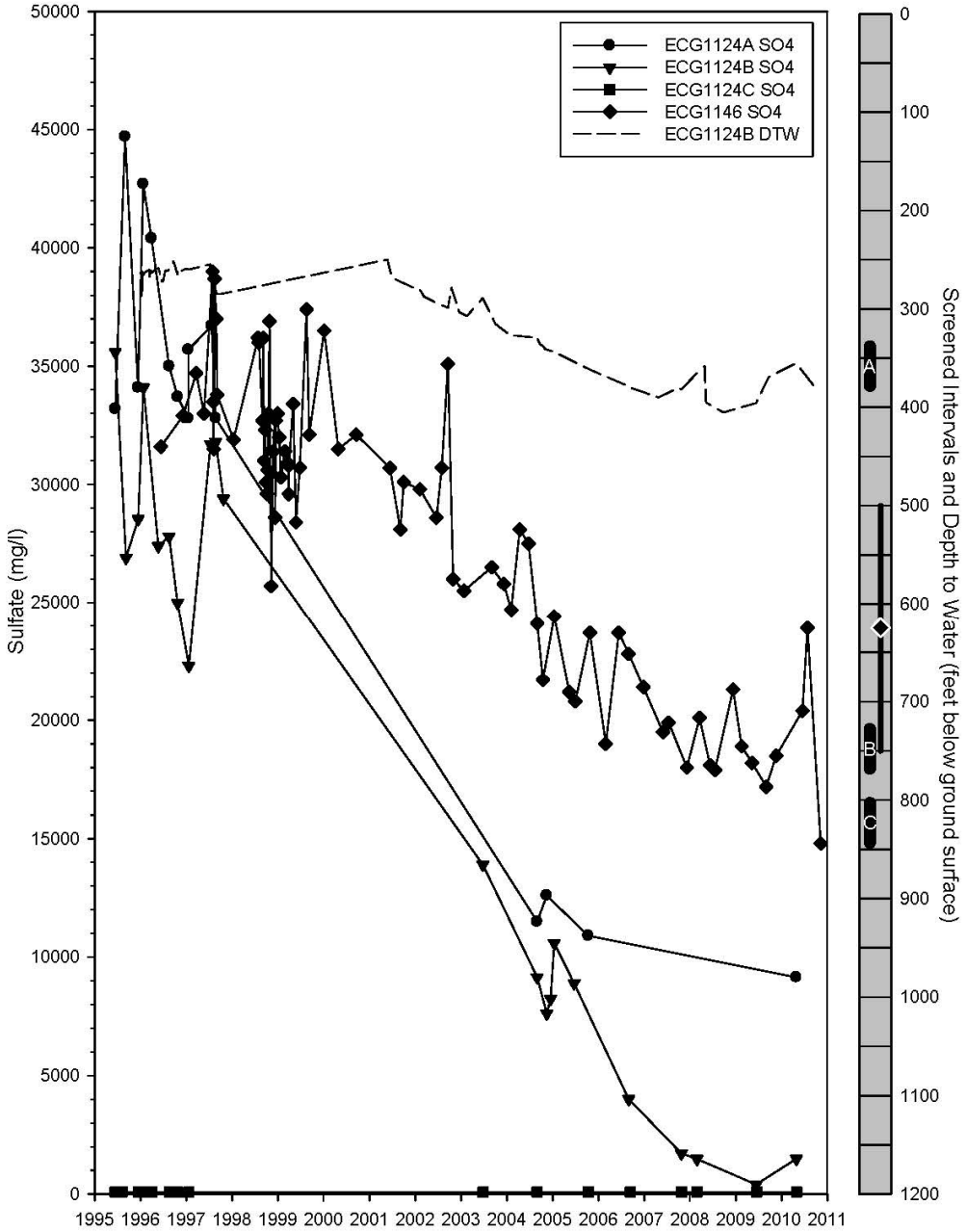
ECG1124A SO4
ECG1124B SO4
ECG1124C SO4
ECG1146 SO4
ECG1124B DTW
Sulfate (mg/l)
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011
Screened Intervals and Depth to Water (feet below ground surface)
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
A
B
C

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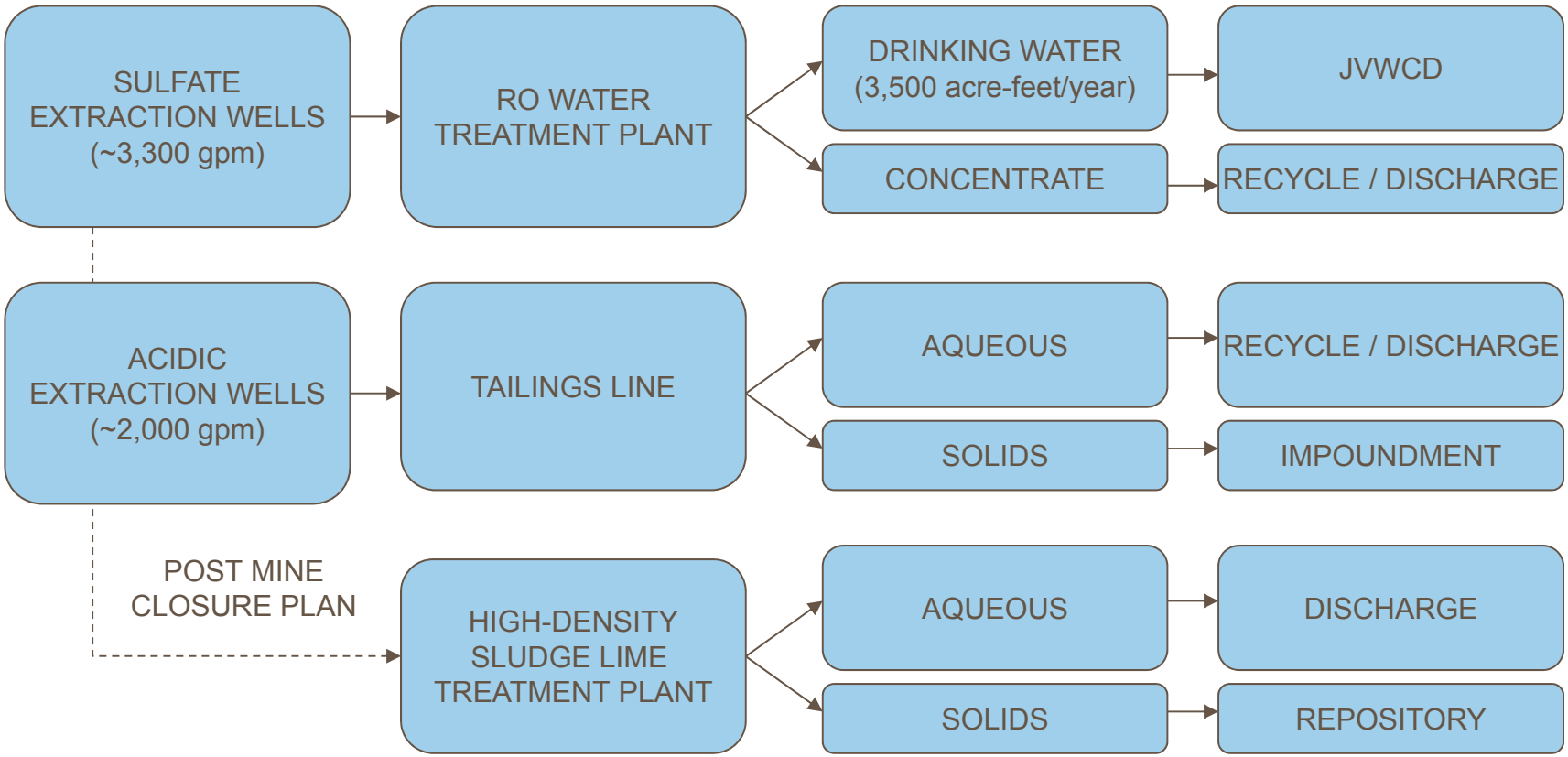
# Water Treatment

# Pump and Treat Strategy



# Reverse Osmosis Treatment Plant

| | |
|---|---|
| Configuration | Two X 2-stage skids |
| Membranes | Hydranautics ESPA2 (Spiral Wound Polyamide) |
| Pressure Vessels | Protec and CodeLine |
| Feed Rate | 3,000 gpm to Membranes |
| Recovery Rate | 71 to 74% |
| Remineralization | 200 gpm |
| Production Rate | 2,400 gpm |
| Production Goal | 3,500 acre-feet/year |


5 TON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# Tailings Line Management Criteria

- Compliance point is the North Splitter Box (located north of the Copperton Concentrator)
- Neutralization potential (NP) in a given month should be either; greater than or equal to the Copperton Concentrator tailings NP, OR at least 5 t $CaCO_3$ eq/kt
  - Evaluated as a six-month rolling average
- Aqueous alkalinity should be greater than or equal to 10 mg $CaCO_3$ eq/L at least 90% of the time
  - Evaluated as a six-month rolling average
- Aqueous pH should be greater than or equal to 6.7 at least 90% of the time
  - Evaluated per calendar year


DEAD
END

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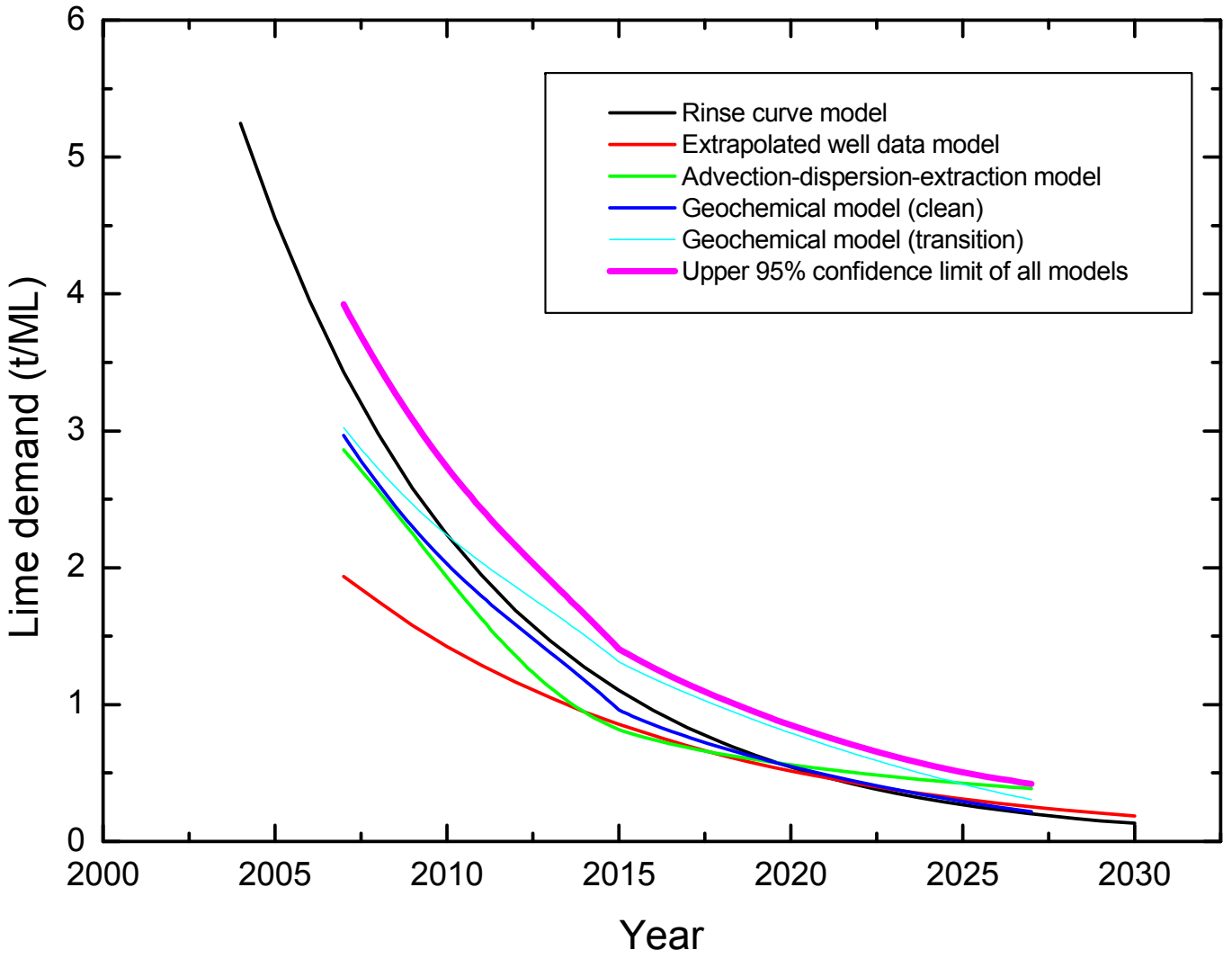
# Cleanup Timeframe

# Column Leaching Tests and Geochemical Modeling Summaries

- Performed in 1990's as part of the RIFS process to:
  - Evaluate remedial options and assist with designing remedial pumping network
- Column Leaching Tests:
  - Approximately 40 pore volumes, equivalent to approximately 800 years
- Geochemical Modeling:
  - Five different models were developed to evaluate lime demand, with a total of 9 different simulations
  - Extrapolation column data, extrapolation of data from complete recovery wells, expanded 1D geochemical model, empirical rinse curve model, and an extended 1D advection-dispersion model with mass extraction

# Calculated Lime Demand



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# Questions