

# A DERAILMENT LEGACY: CLEANING UP HEXAVALENT CHROMIUM USING EMULSIFIED VEGETABLE OIL

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HOW TOMORROW MOVES

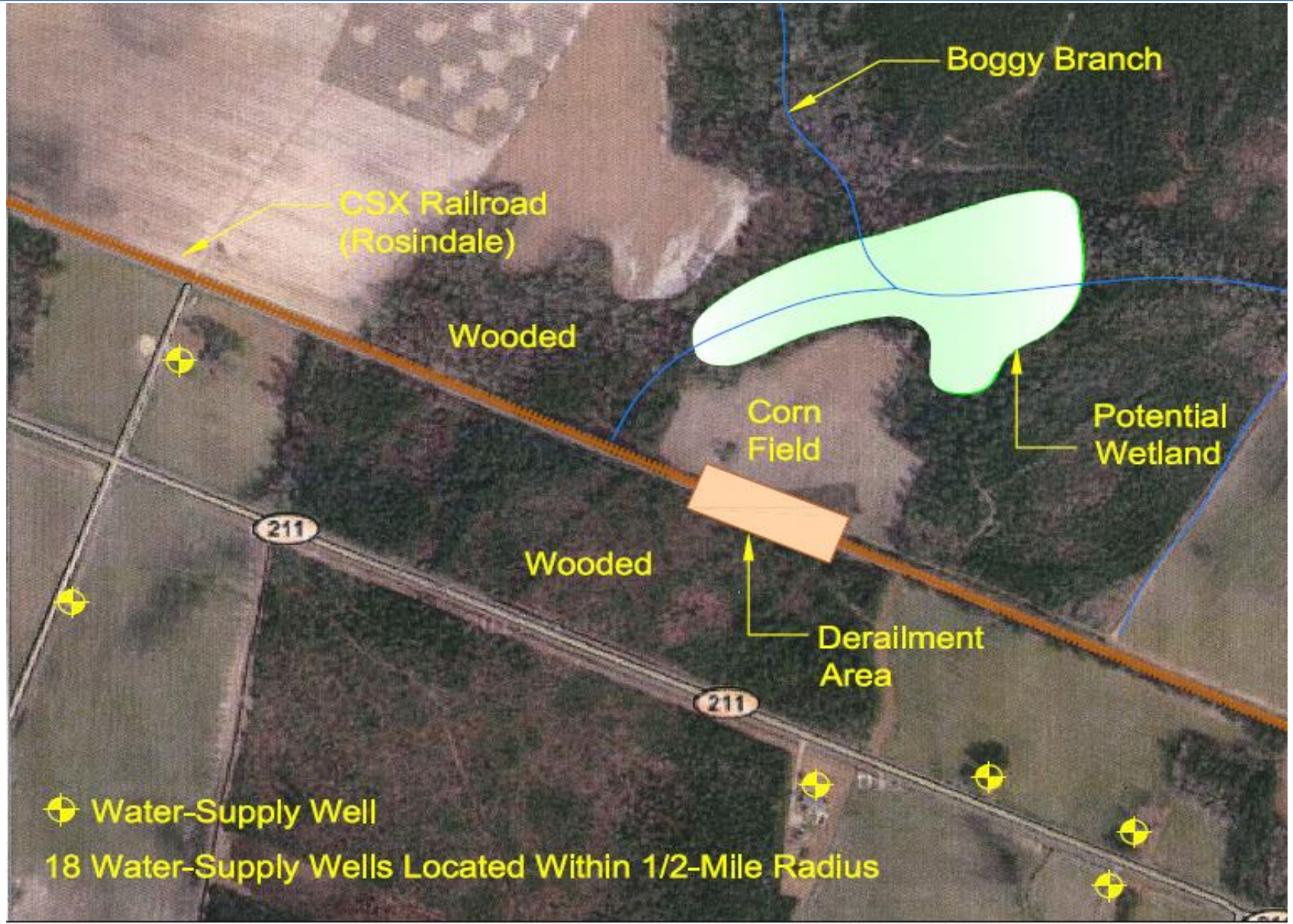


# OVERVIEW

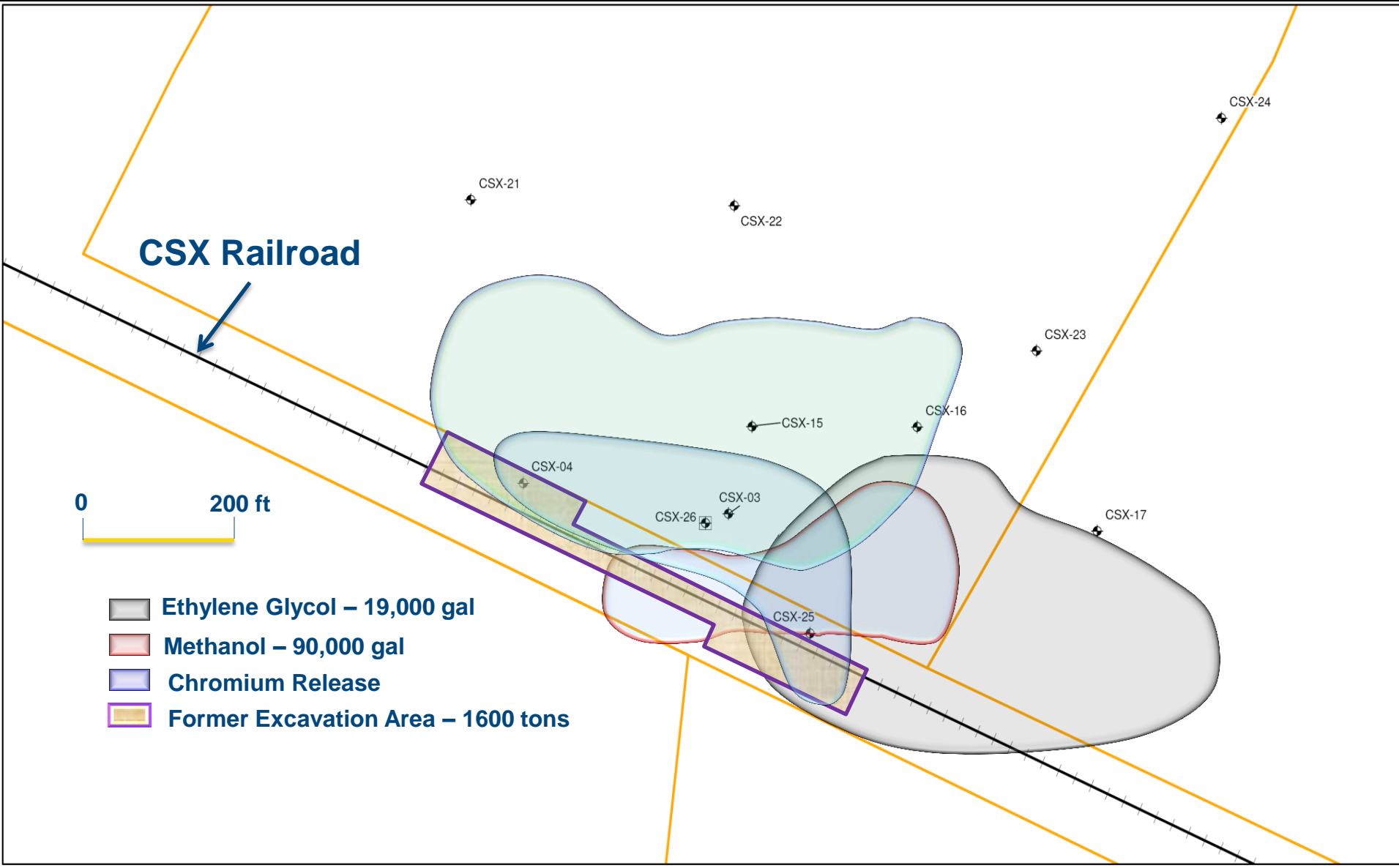
- BACKGROUND & SITE HISTORY
- REGULATORY OVERVIEW
- SITE GROUNDWATER CONDITIONS
- TREATMENT ALTERNATIVES
- GROUNDWATER REMEDY



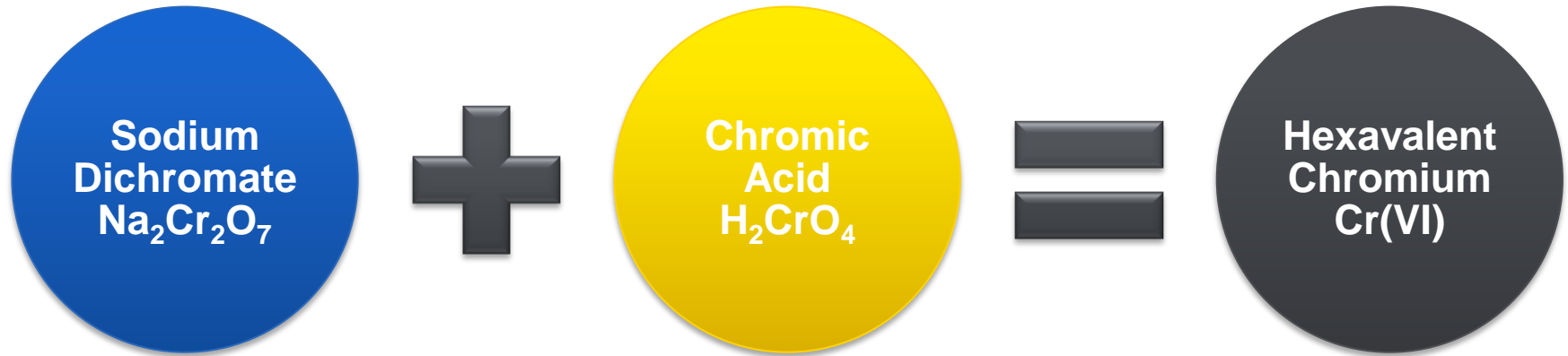
# SITE LOCATION



# TRAIN DERAILMENT – NOVEMBER 1986



# CHEMICAL RELEASE



Salt/Strong Oxidizer  
Very Soluble  
Specific Gravity – 2.35  
13,500 gal released

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13,500 gal released



# REGULATORY OVERVIEW – TIMELINE

1986

- Derailment and Emergency Response
- Initial Abatement and Assessment

1990

- Implement Pump and Treat Alternative
- Operated 6.5 yrs

1996

- Shut Down Pump and Treat
- Monitored Natural Attenuation (MNA) Implemented

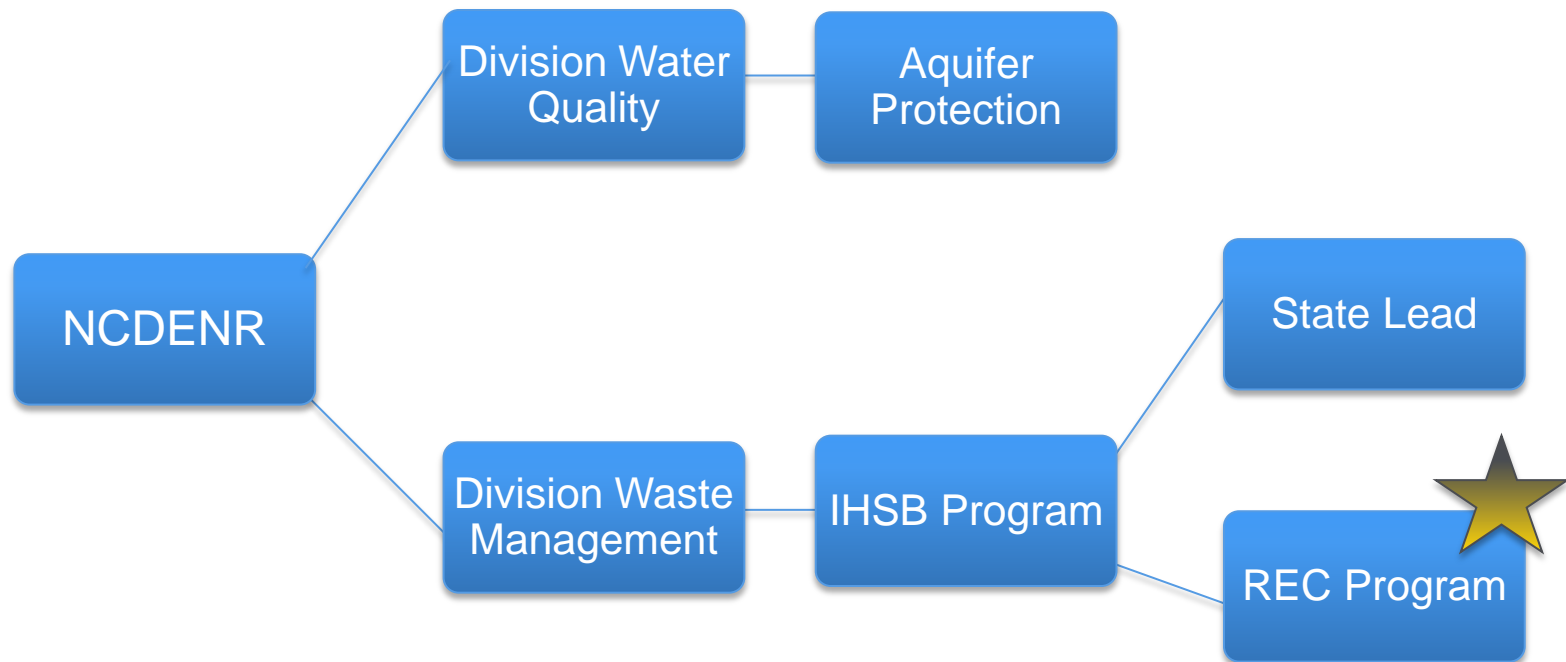
2010

- MNA Projected to take at least 40-50 yrs
- Alternative Evaluation and Implementation



# REGULATORY OVERVIEW – RELEVANT PROGRAMS

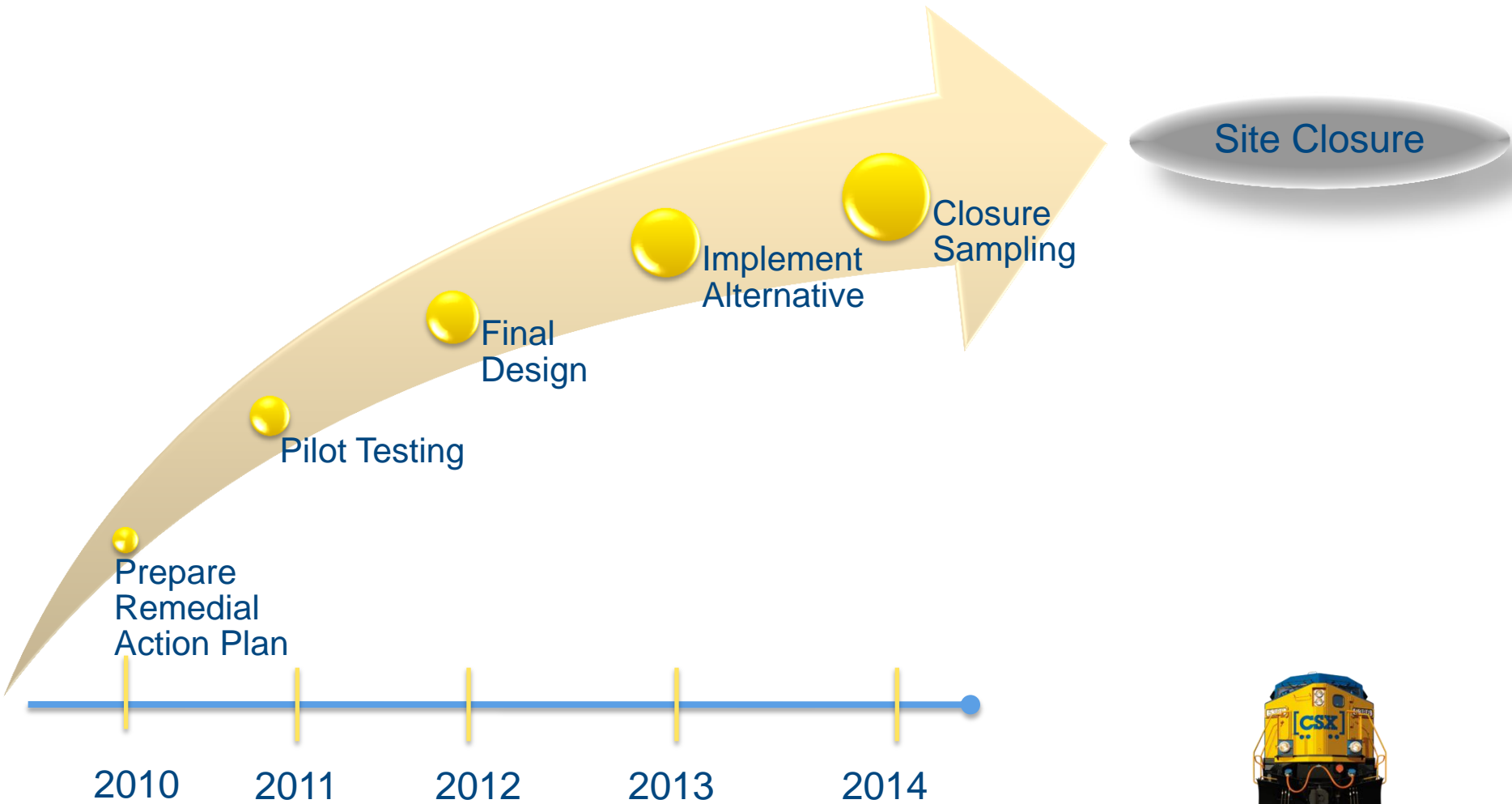
## NORTH CAROLINA PROGRAMS



NC 2L Groundwater Standard Decreased from 50 to 10 ug/L (1/1/10)

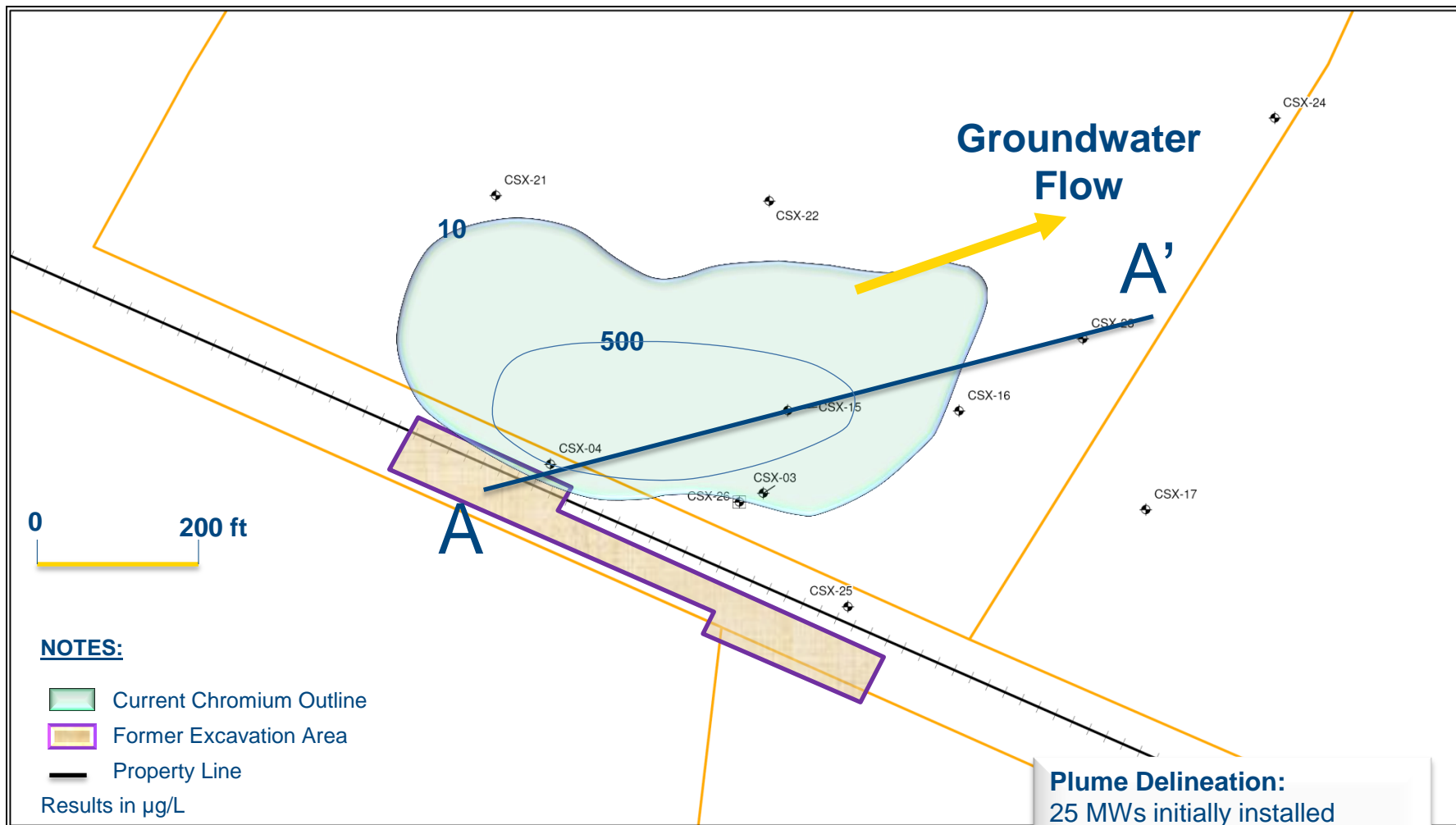


# SITE CLOSURE PATHWAY



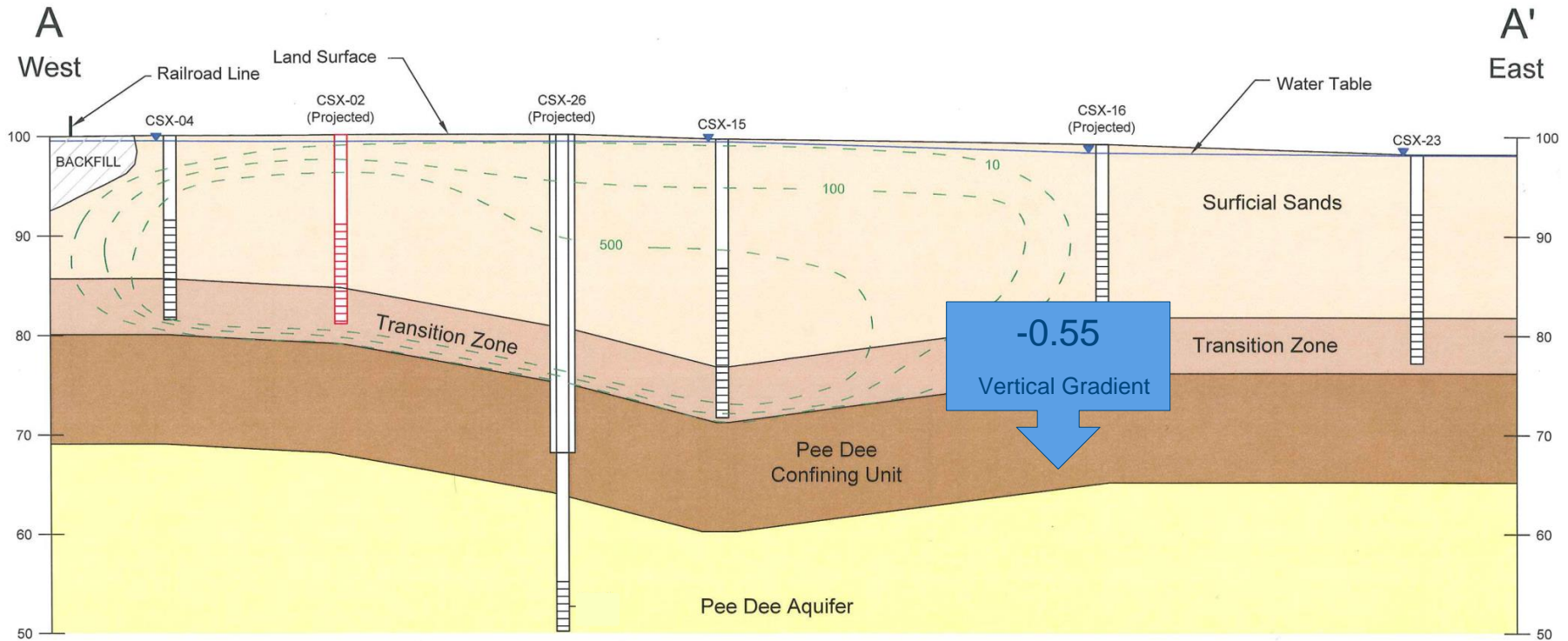


# CHROMIUM PLUME EXTENT



**Plume Delineation:**  
25 MWs initially installed  
16 MWs abandoned in 1996  
2 MWs installed in 2008  
Additional Delineation 2011

# CHROMIUM PLUME CROSS-SECTION



## SURFICIAL AQUIFER:

$K = 13 \text{ ft/day}$

$T = 195 \text{ ft}^2/\text{day}$

$V_s = 237 \text{ ft/year}$

Water Table 1 to 2 ft bls

Gradient = 0.01 ft/ft

## PEEDEE CONFINING UNIT:

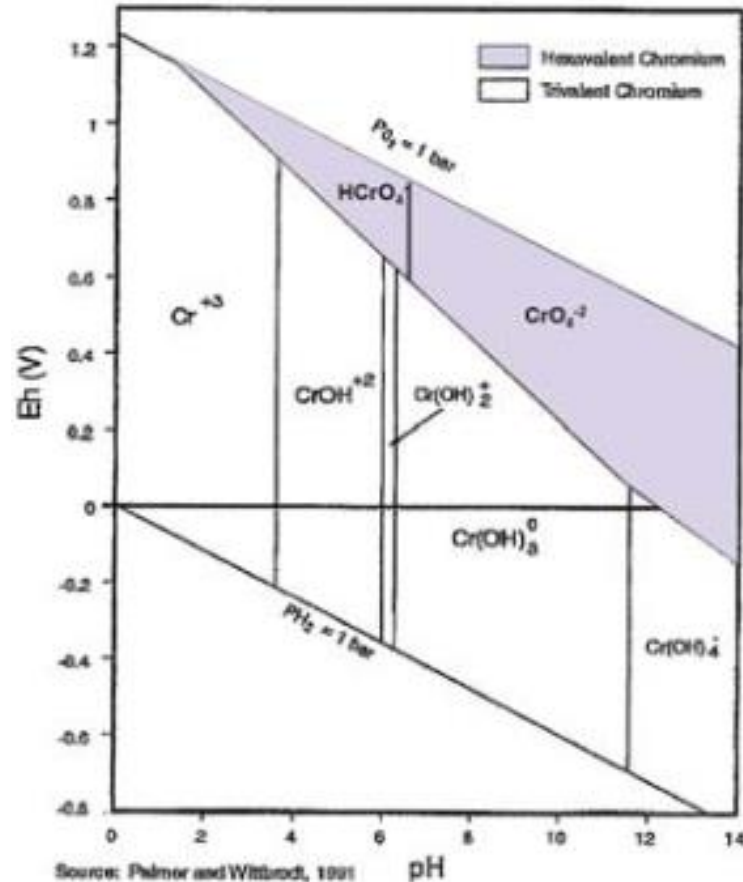
$K = 3 \times 10^{-4} \text{ ft/day}$

Results in ug/L

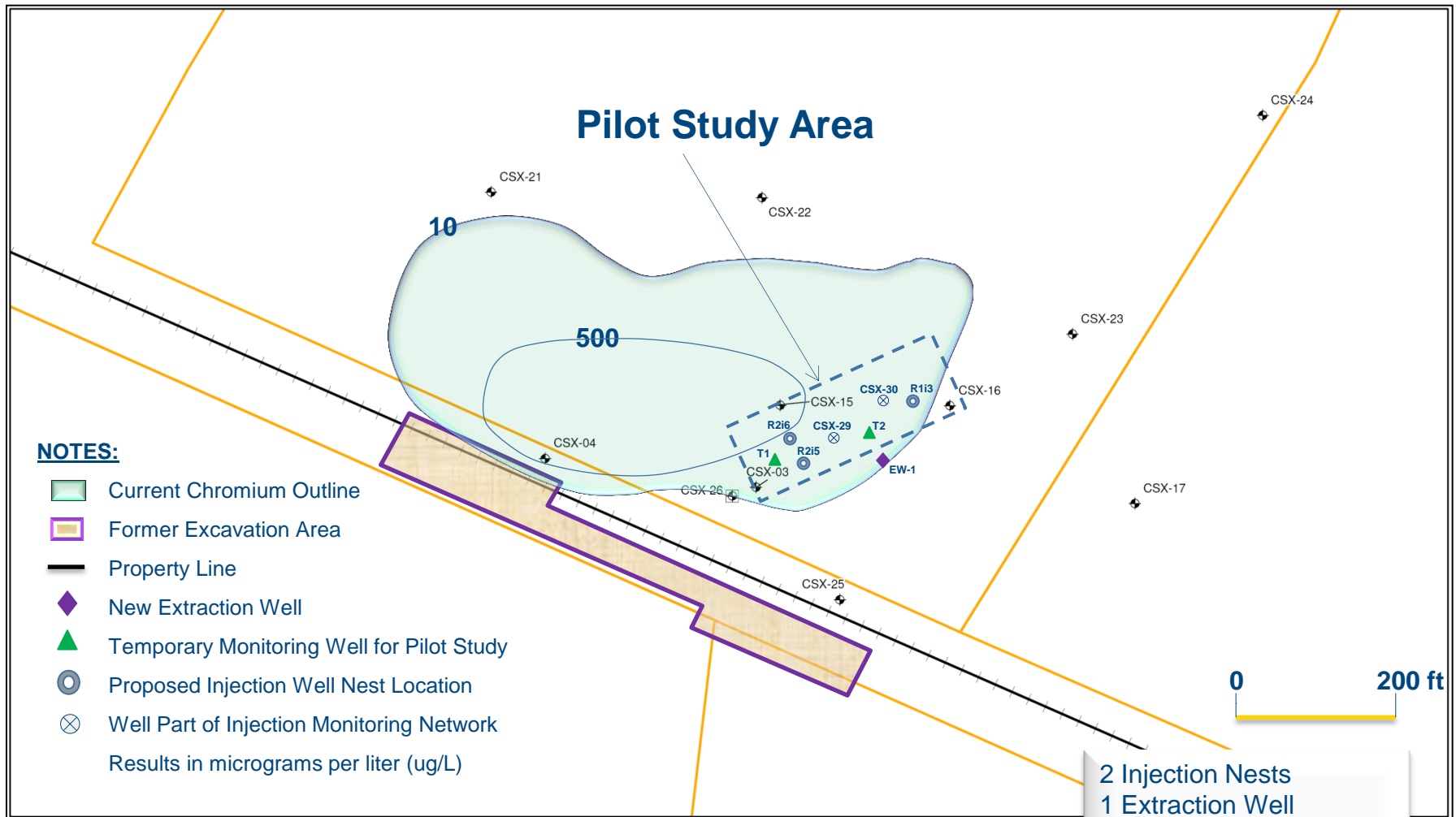


# CHEMICAL CONVERSION PATHWAY

- Conversion to Cr(III)
- MNA process hampered by multivalent ions (in fertilizer)
  - Sulfate
  - Phosphate
- Anaerobic Environments
  - $DO < 1 \text{ mg/L}$  (Fe reducing)
  - Instantaneous Reaction
  - Forms precipitate
- Better with pH values  $< 7$



# REACTIVE ZONE PILOT STUDY AREA



## NOTES:

- Current Chromium Outline
  - Former Excavation Area
  - Property Line
  - New Extraction Well
  - Temporary Monitoring Well for Pilot Study
  - Proposed Injection Well Nest Location
  - Well Part of Injection Monitoring Network
- Results in micrograms per liter (ug/L)

2 Injection Nests  
1 Extraction Well  
2 Additional Nested MW  
2 Temporary Monitoring Wells

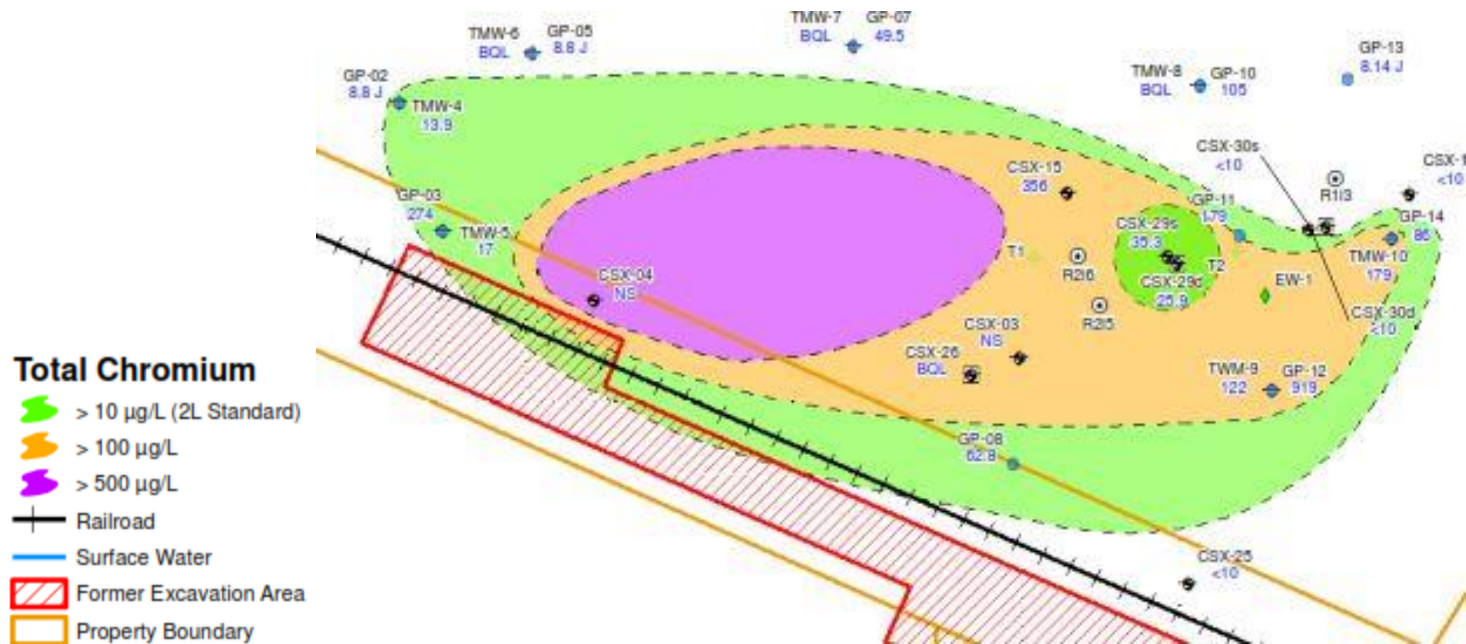
# REACTIVE ZONE PILOT STUDY

- EOS injection
- Make-up water pulled from plume
- Monitored Geochemical Field Parameters
- Groundwater Monitoring  
3 days, 45 days, 90 days

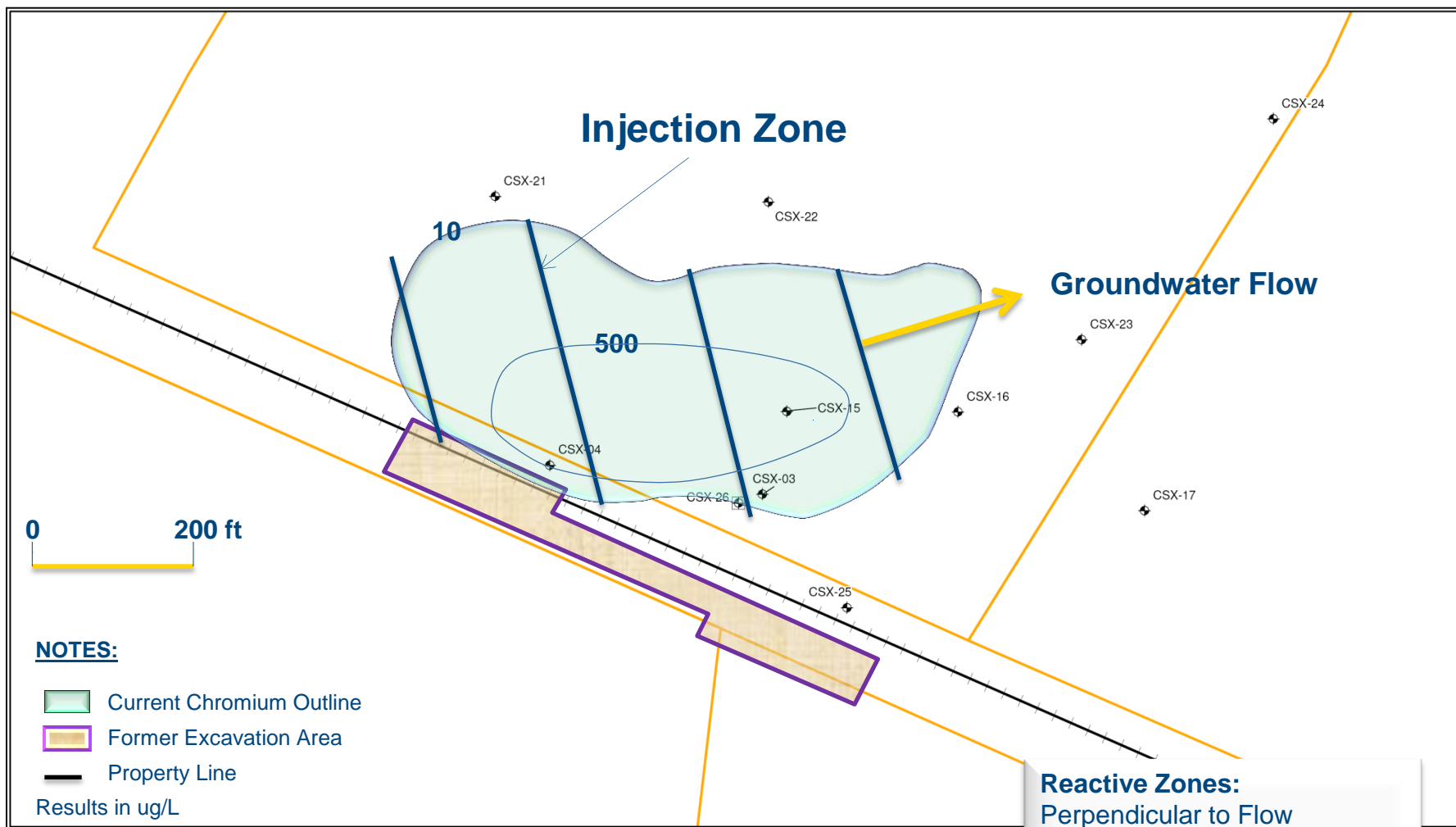


# REACTIVE ZONE PILOT STUDY – RESULTS

- Significant reduction in chromium concentrations
- Reduced hot spot concentrations
- Full scale implementation of groundwater remedy



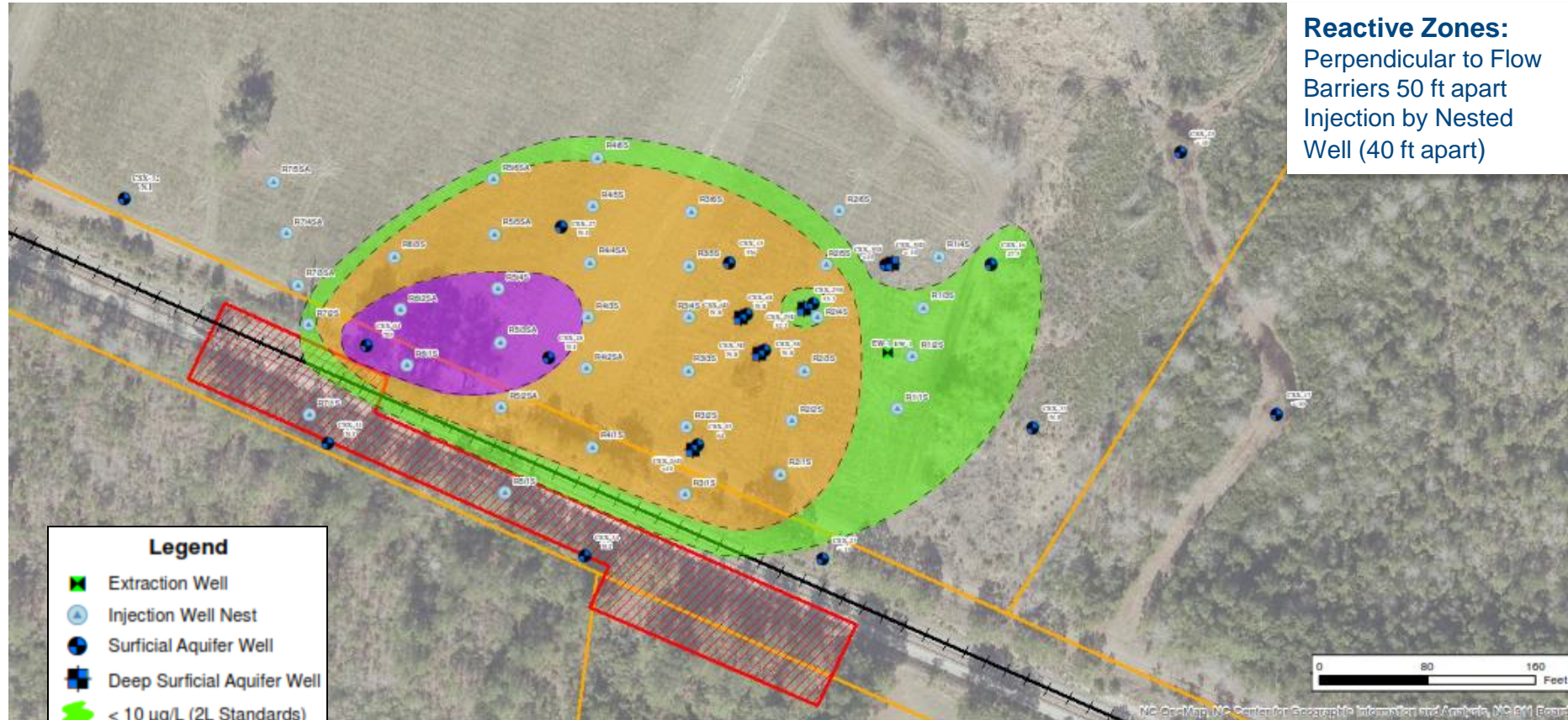
# CONCEPTUAL FULL SCALE REMEDY



**Reactive Zones:**  
Perpendicular to Flow  
150 ft apart  
Injection by Trench or Well Pts.  
(Points 30 ft apart)

# GROUNDWATER REMEDY – FULL SCALE DESIGN

## Baseline Groundwater Conditions





# GROUNDWATER REMEDY – FULL SCALE IMPLEMENTATION

- Injection of 2% EVO solution
  - 7,800 gallons EOS Pro
  - 390,000 gallons chase water
- 35 Injection Points
  - Shallow & Deep Wells



# GROUNDWATER REMEDY – FULL SCALE IMPLEMENTATION

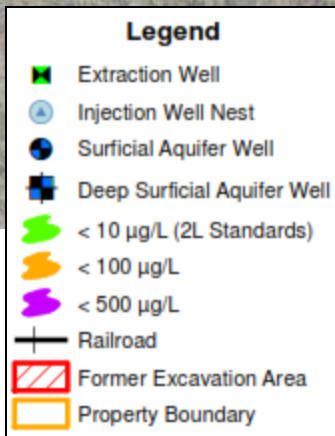
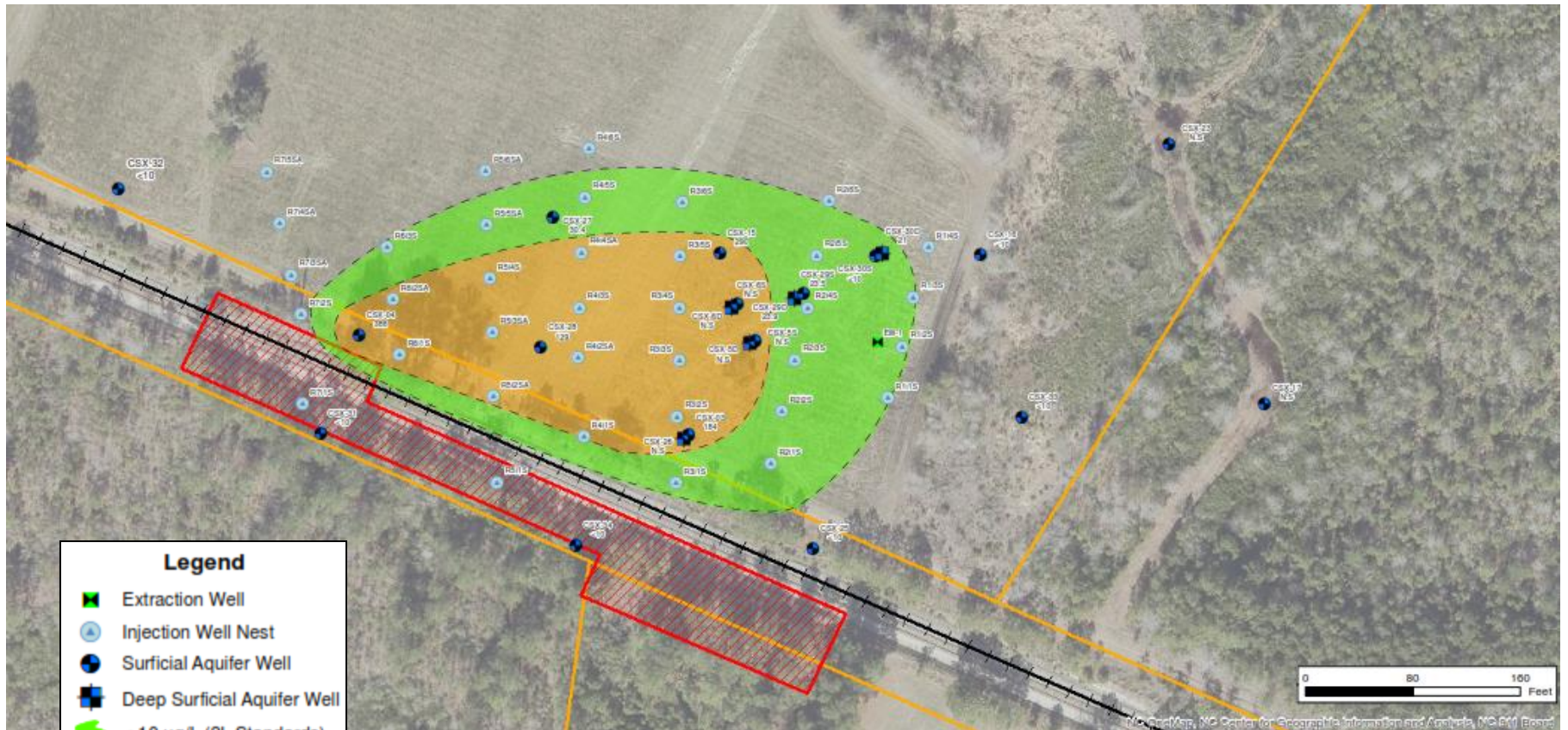


# GROUNDWATER REMEDY – FULL SCALE IMPLEMENTATION



# GROUNDWATER REMEDY – RESULTS

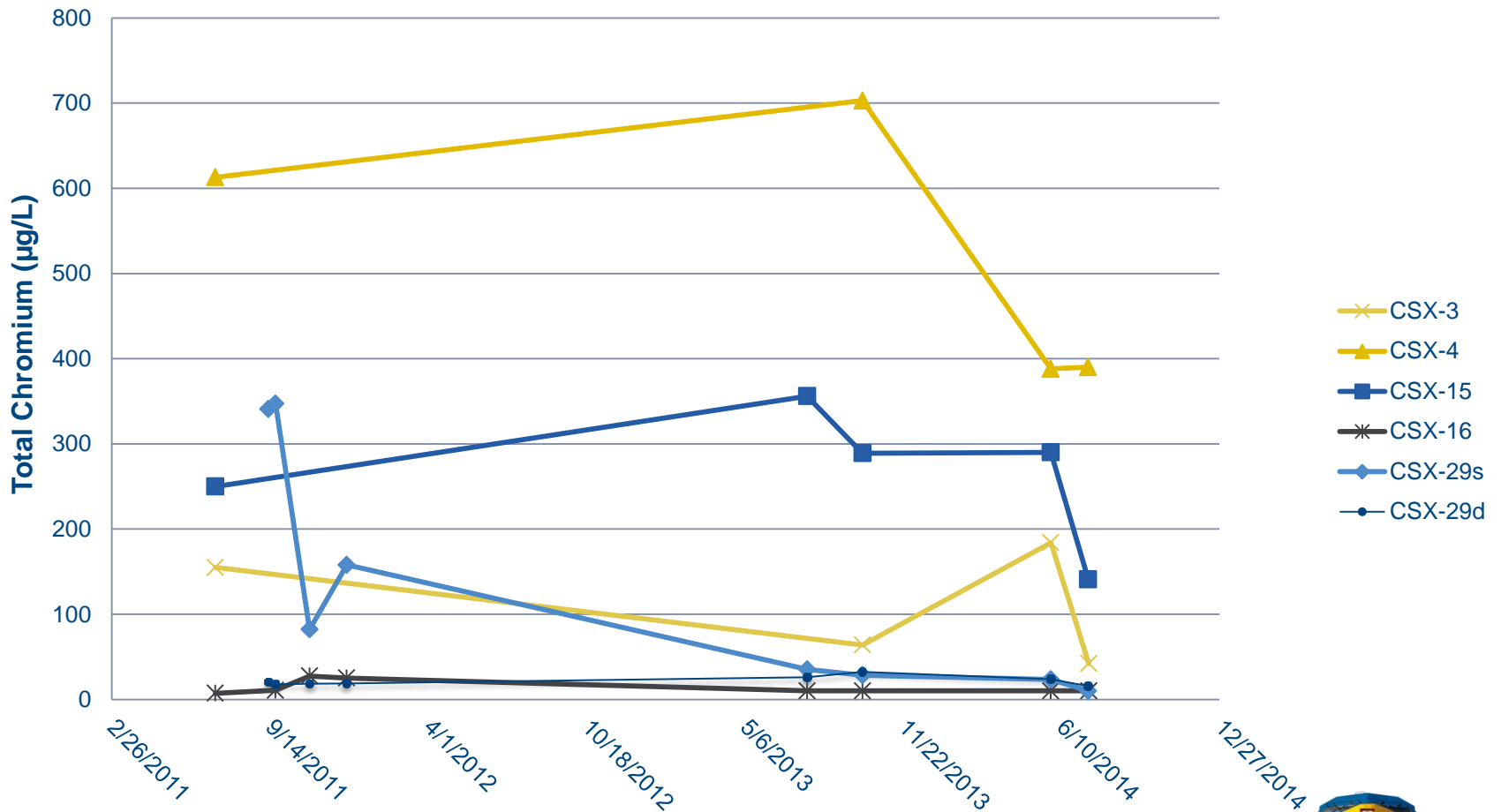
## 45-Day Post-Injection Groundwater Monitoring Event



# GROUNDWATER REMEDY – HEXAVALENT CHROMIUM



# GROUNDWATER REMEDY – TOTAL CHROMIUM



NC 2L Groundwater Standard  
Total Chromium = 10 µg/L



# SUMMARY

- Significant reduction (50 – 95%) in total Cr(VI) and Cr (VI) concentrations in key monitoring wells
- Reduction in areal extent of chromium plume
- Complete performance monitoring
- Closing the “No Progress Loop”



# QUESTIONS

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# HOW TOMORROW MOVES

