AQUIFER RECHARGE: A SHAKOPEE MDEWAKANTON SIOUX COMMUNITY PILOT PROJECT

April 22, 2014

MGWA Spring Conference

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SMSC Water Resources Scientist

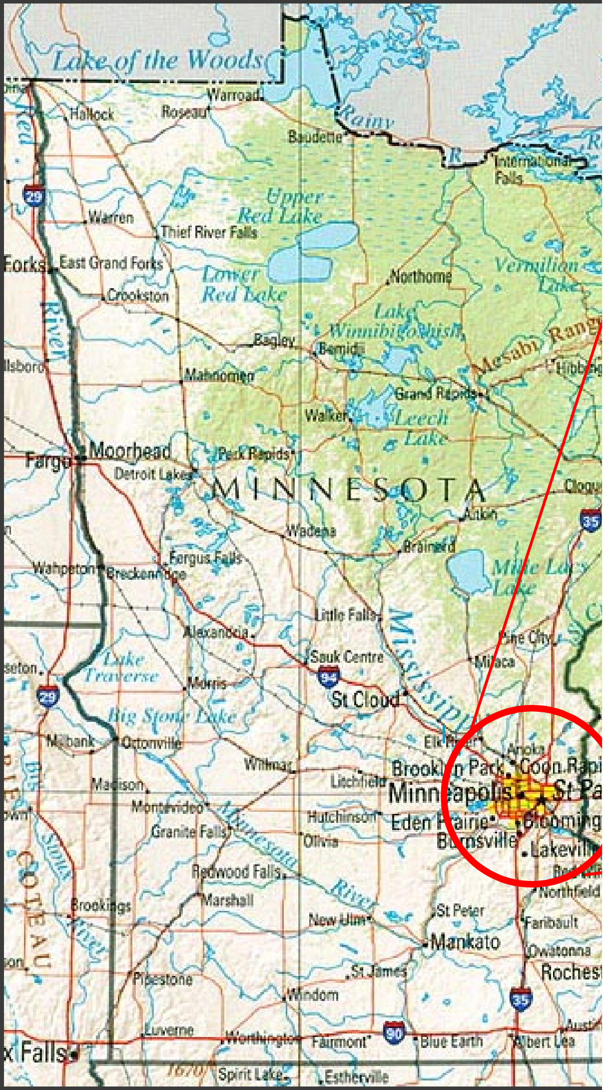
Overview

- Community profile
- Geologic setting
- Current water system
- Modeling
- Treatment tests
- Column tests
- System specifications

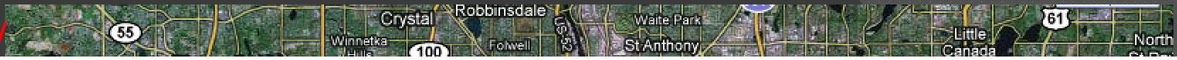
Shakopee Mdewakanton Sioux Community (SMSC) Specifics

- Federally recognized tribe
  - Not subject to MN authority
  - Population - 325
- About 3900 acres
  - Geographically constrained
- Strives for self sufficiency
  - Enterprises/services
- Effective population of 15,000 people

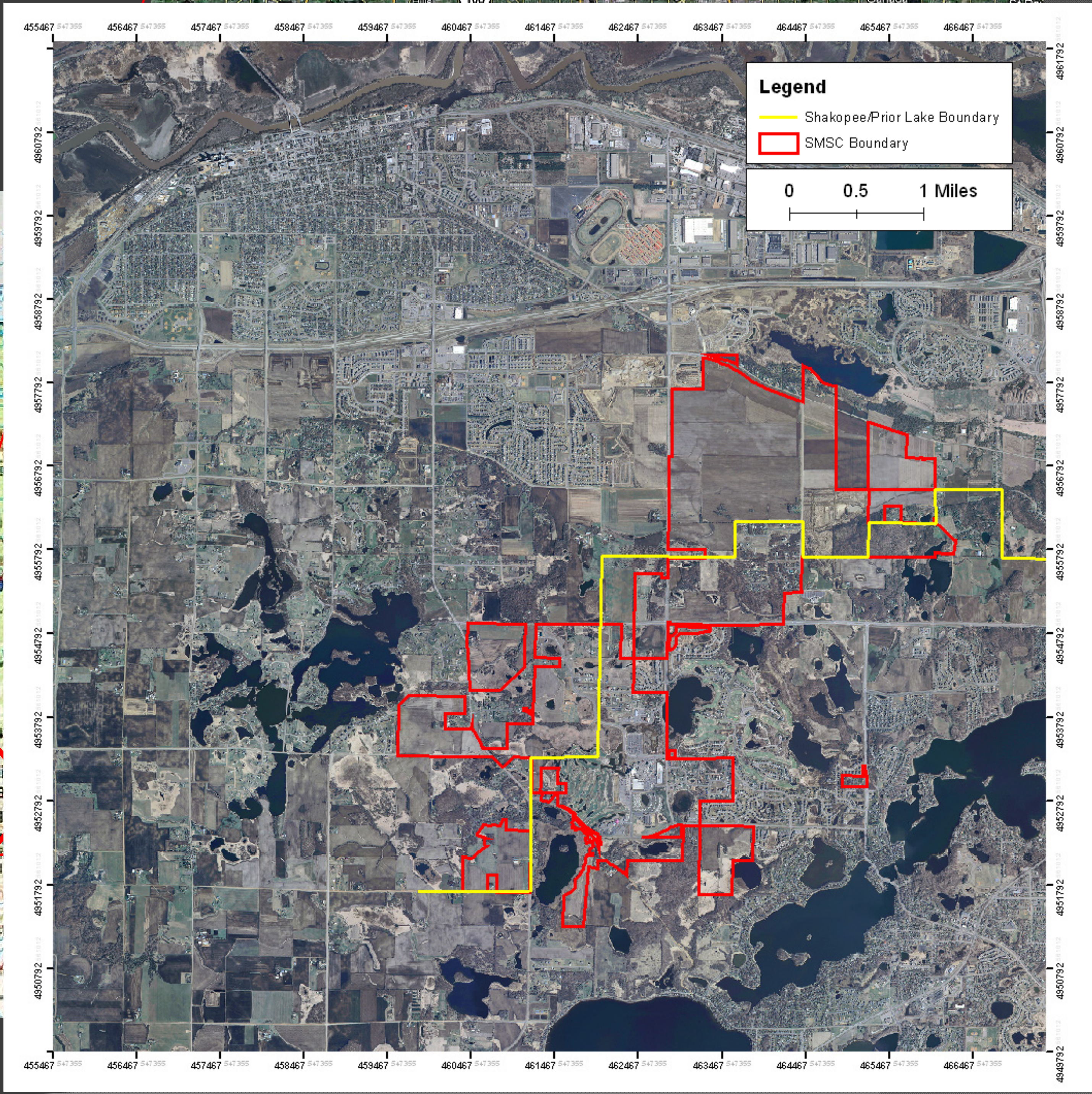
Location



Lake of the Woods
Warroad
Hallock
Roseau
Baudette
Rainy
International Falls
Upper Red Lake
Warren
Thief River Falls
East Grand Forks
Crookston
Lower Red Lake
Northome
Vermilion Lake
Bagley
Bemidji
Lake Winnibigoshish
Mesabi Range
Mahnomen
Grand Rapids
Walker
Leech Lake
Moorhead
Fargo
Detroit Lakes
Park Rapids
MINNESOTA
Wadena
Aitkin
Brainerd
Wahpeton
Breckenridge
Fergus Falls
Mille Lacs Lake
Little Falls
Alexandria
Sauk Centre
Lake Traverse
Morris
St Cloud
Mississippi
Milaca
Big Stone Lake
Ortonville
Willmar
Litchfield
Elk River
Anoka
Brooklyn Park
Minneapolis
Eden Prairie
Burnsville
Lakeville
Madison
Montevideo
Granite Falls
Hutchinson
Olivia
Redwood Falls
Marshall
Brookings
New Ulm
St Peter
Faribault
Northfield
Mankato
Owatonna
Pipestone
St James
Windom
Luverne
Worthington
Fairmont
Blue Earth
Albert Lea
Spirit Lake
Estherville



Crystal
Robbinsdale
Winnetka
St Anthony
Little Canada
North

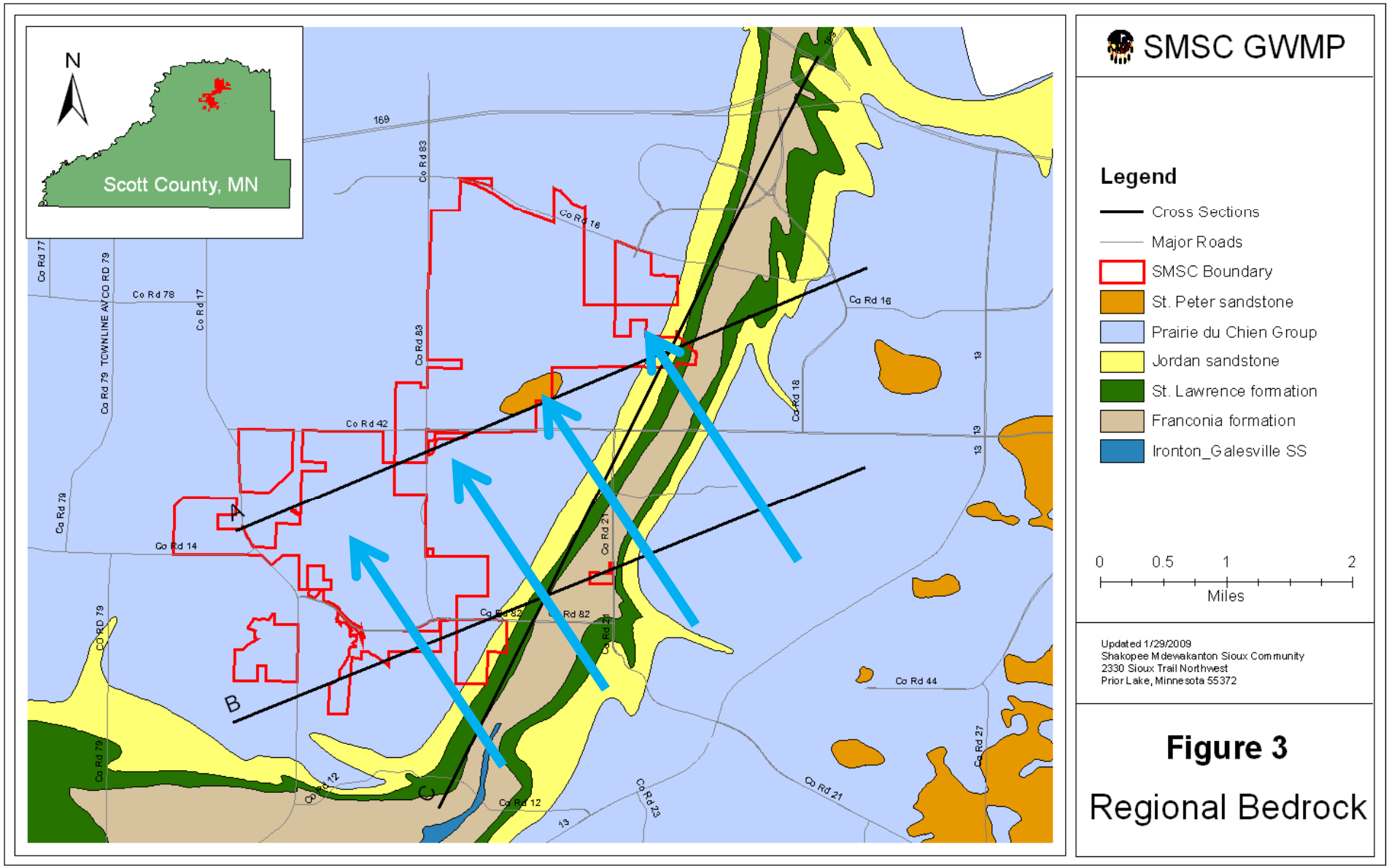


Legend
Shakopee/Prior Lake Boundary
SMSC Boundary
0 0.5 1 Miles

Water Supply and Treatment

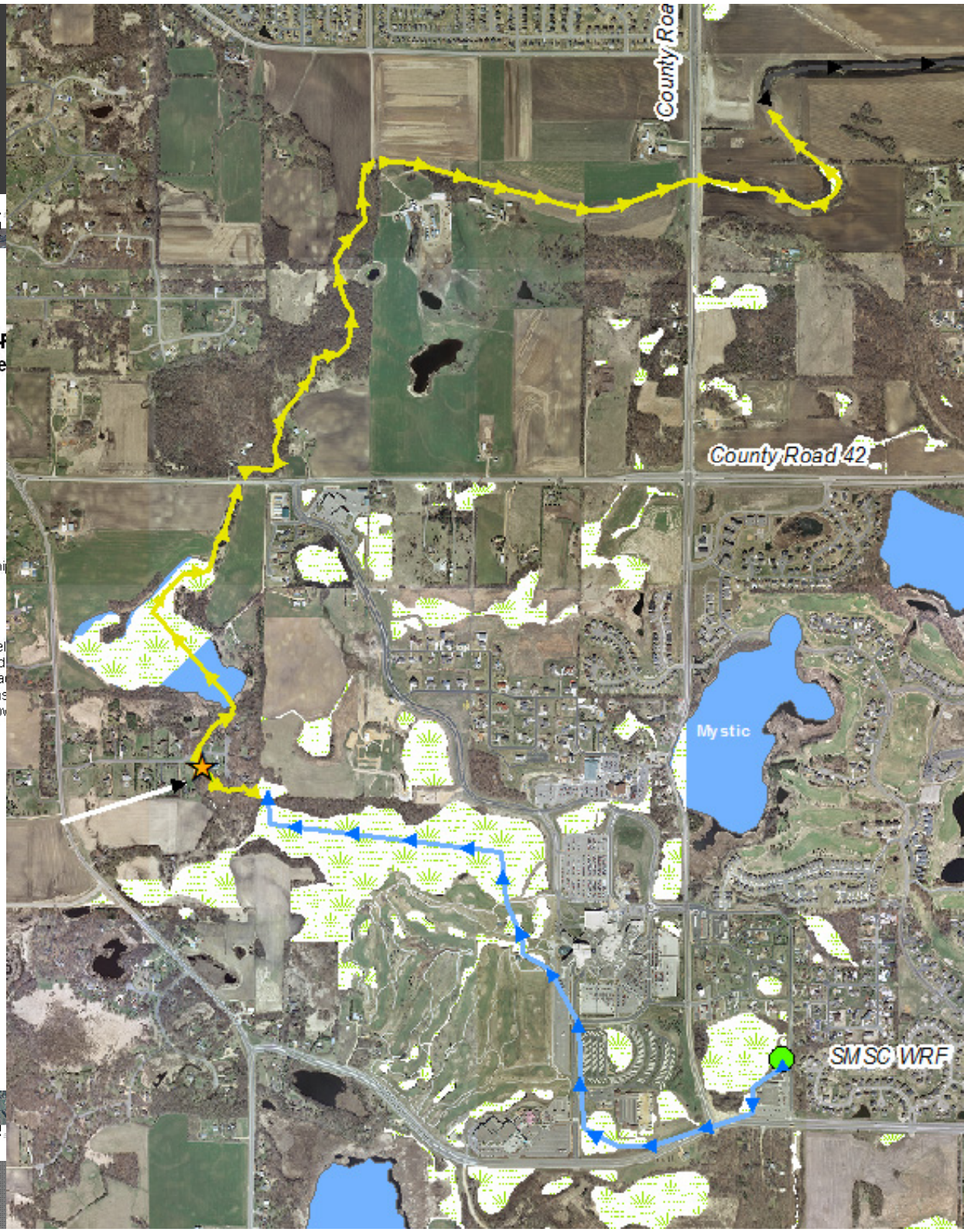
- 3 production wells – 2 Jordan, 1 deeper
  - 190 million gallons per year
  - Drinking water treatment
    - Iron and manganese
    - Reverse osmosis
- Modern waste water treatment
  - 145 million gallons treated annually
  - Discharged to surface water
  - Capable of treating 900 million gallons/year

Geologic Features

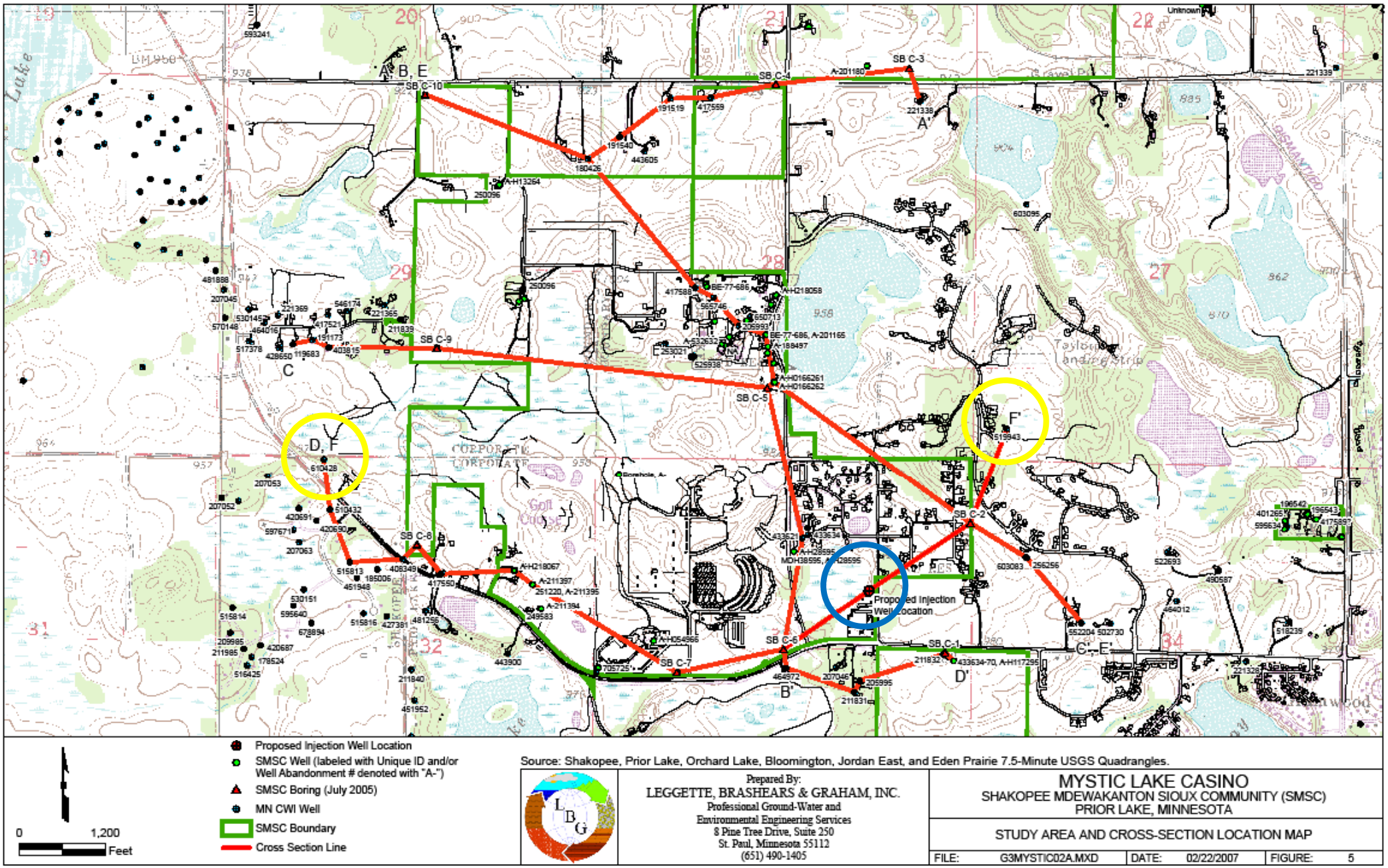


Why inject?

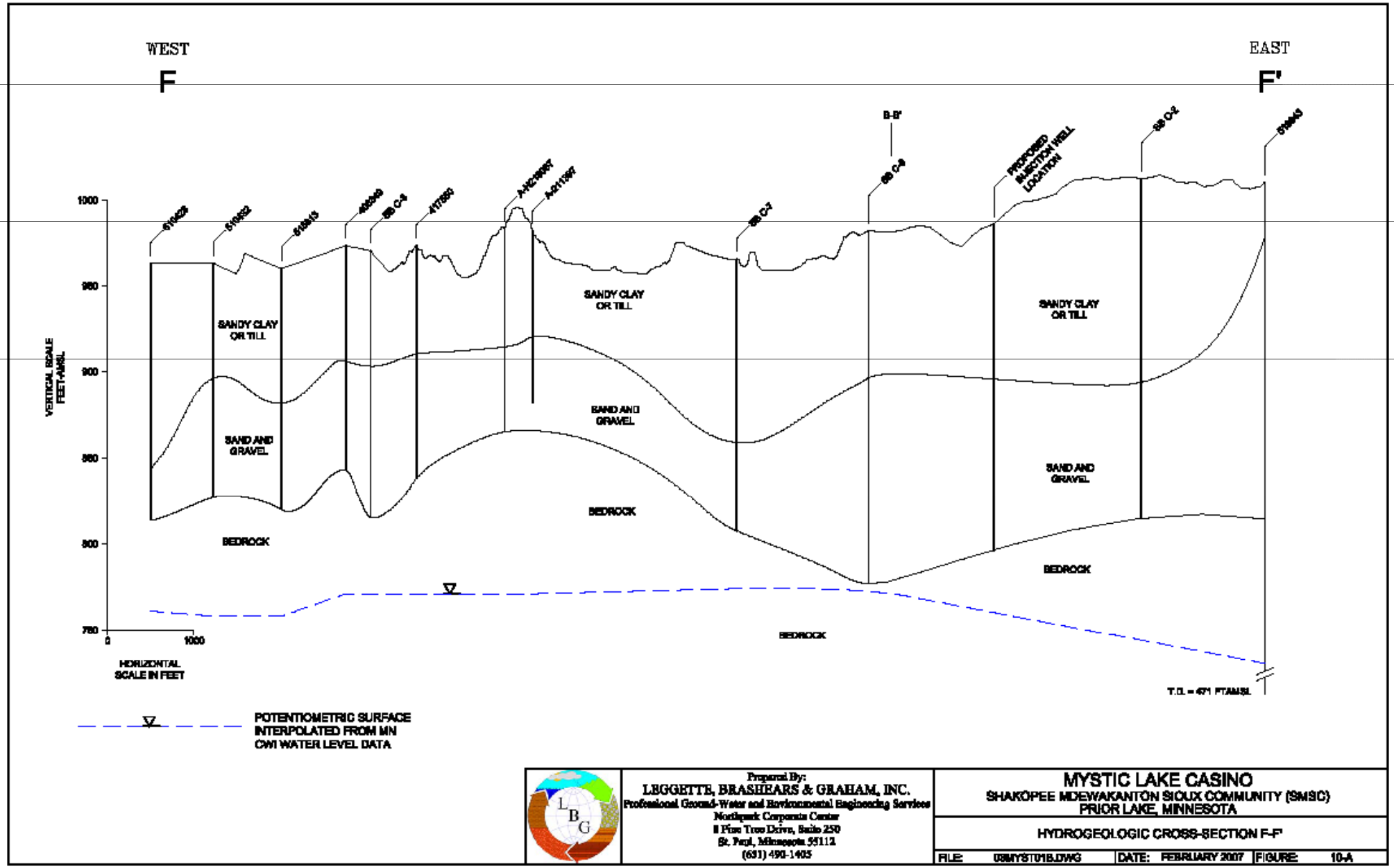
- Growing population
- Increased pumping
- Predicted drawdown
- Higher elevation
- Effluent is lost



Boreholes 2005



Cross Section F – F’



Injection specifications

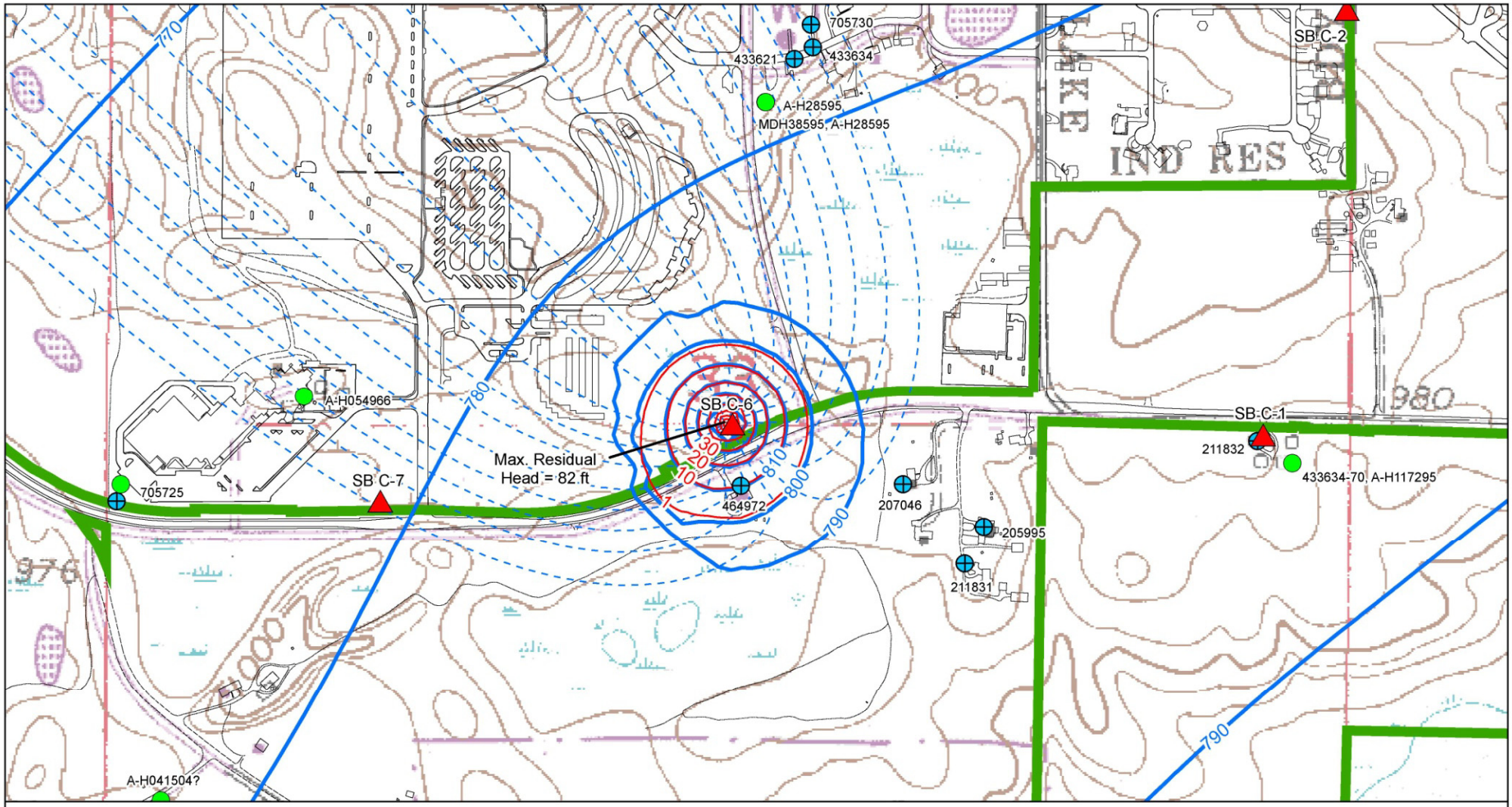
- Well will be screened across the entire gravel layer directly above the aquifer
- Seasonal – injection for 5 months during the fall, winter, and spring each year
- 100% of the fully treated stream injected
- Currently have about 300 gpm available (400k gpd)
- Can go as high as 1332 gpm (1.9M gpd)

Modeling 2006

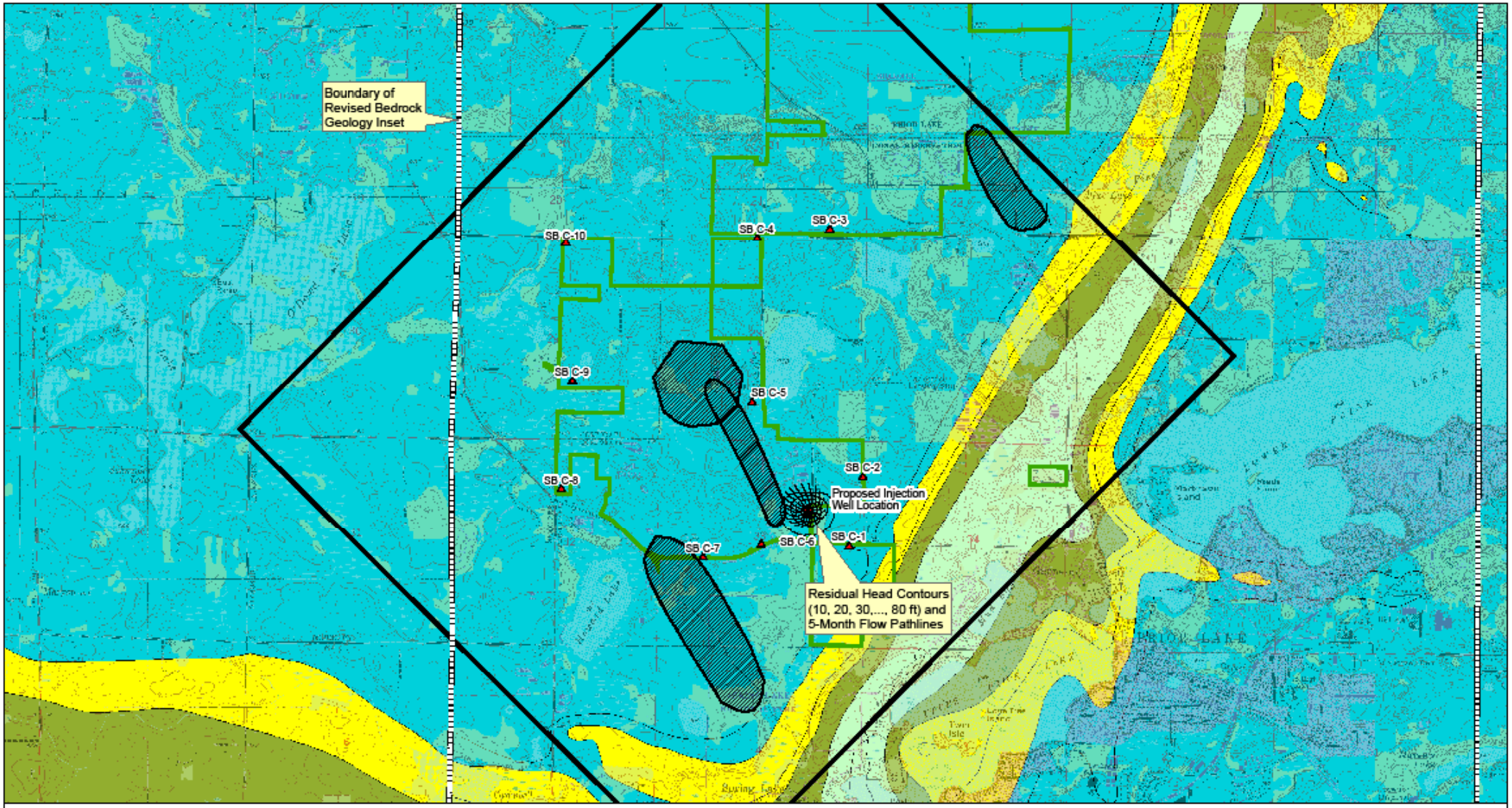
Simulation	Injection rate gpm	Layer 1 Hydraulic conductivity (ft/day)		Layer 2 Hydraulic conductivity (ft/day)	
		K_h	K_z	K_h	K_z
1	450	25	2.5	40	4
2	900	25	2.5	40	4
3	1332	25	2.5	40	4
4	1332	25	2.5	40	0.04

Simulation	Injection rate gpm	Water table elevation at injection well		Change in head (ft)	Head space remaining
		Pre-injection	Post-injection		
1	450	783	834	51	149
2	900	783	861	78	122
3	1332	783	882	99	101
4	1332	783	958	171	25

Levels at max pumping



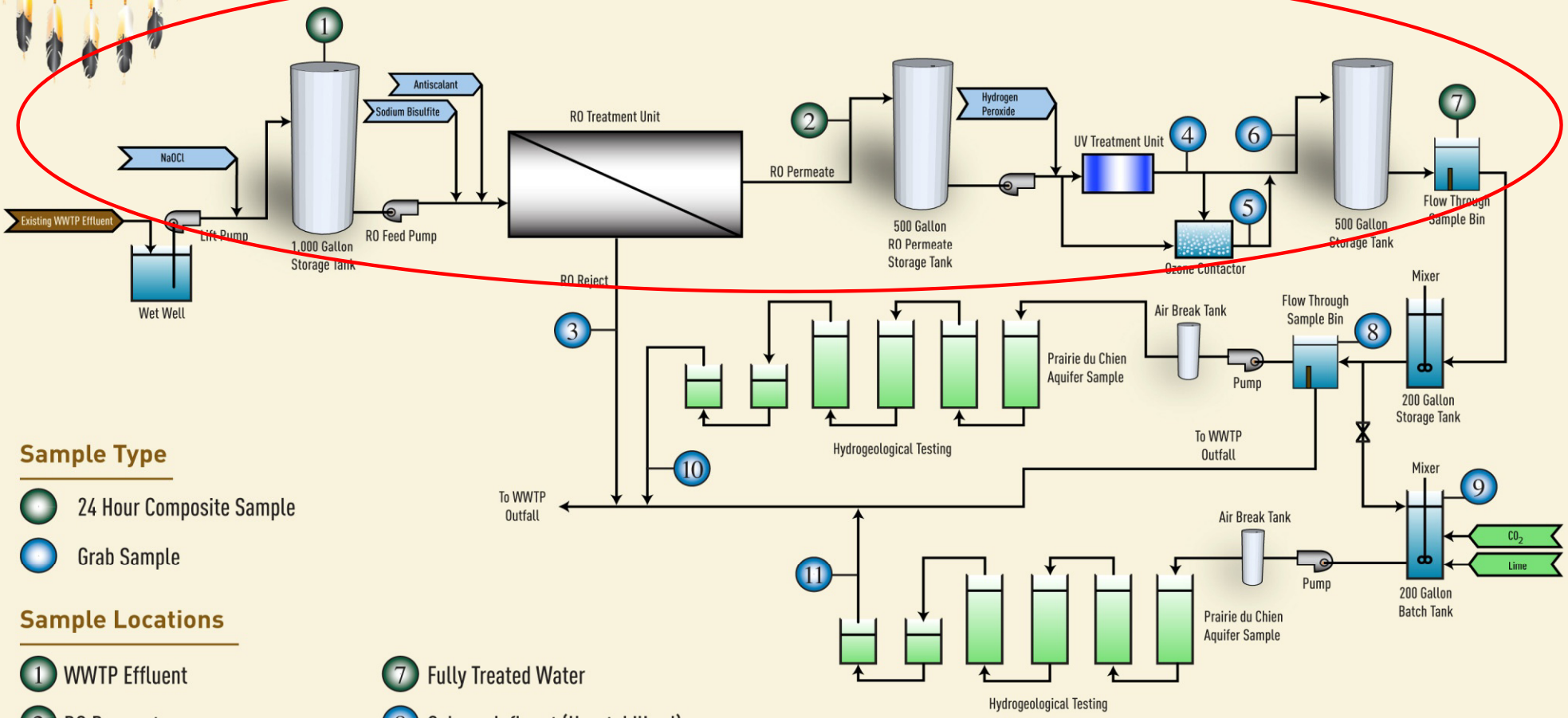
Interaction with public wells



Pilot Project 2007

- Additional treatment
  - RO
  - UV
  - Ozone

SMSC Water Reuse Pilot Study
Sample Locations for Emergent Contaminants Analysis



Sample Type

- 24 Hour Composite Sample
- Grab Sample

Sample Locations

1. WWTP Effluent
2. RO Permeate
3. RO Reject
4. After UV/Peroxide Treatment
5. After Ozone/Peroxide Treatment
6. After UV/Ozone/Peroxide Treatment
7. Fully Treated Water
8. Column Influent (Un-stabilized)
9. Column Influent (PH adjusted)
10. Column Effluent (Un-stabilized)
11. Column Effluent (PH adjusted)

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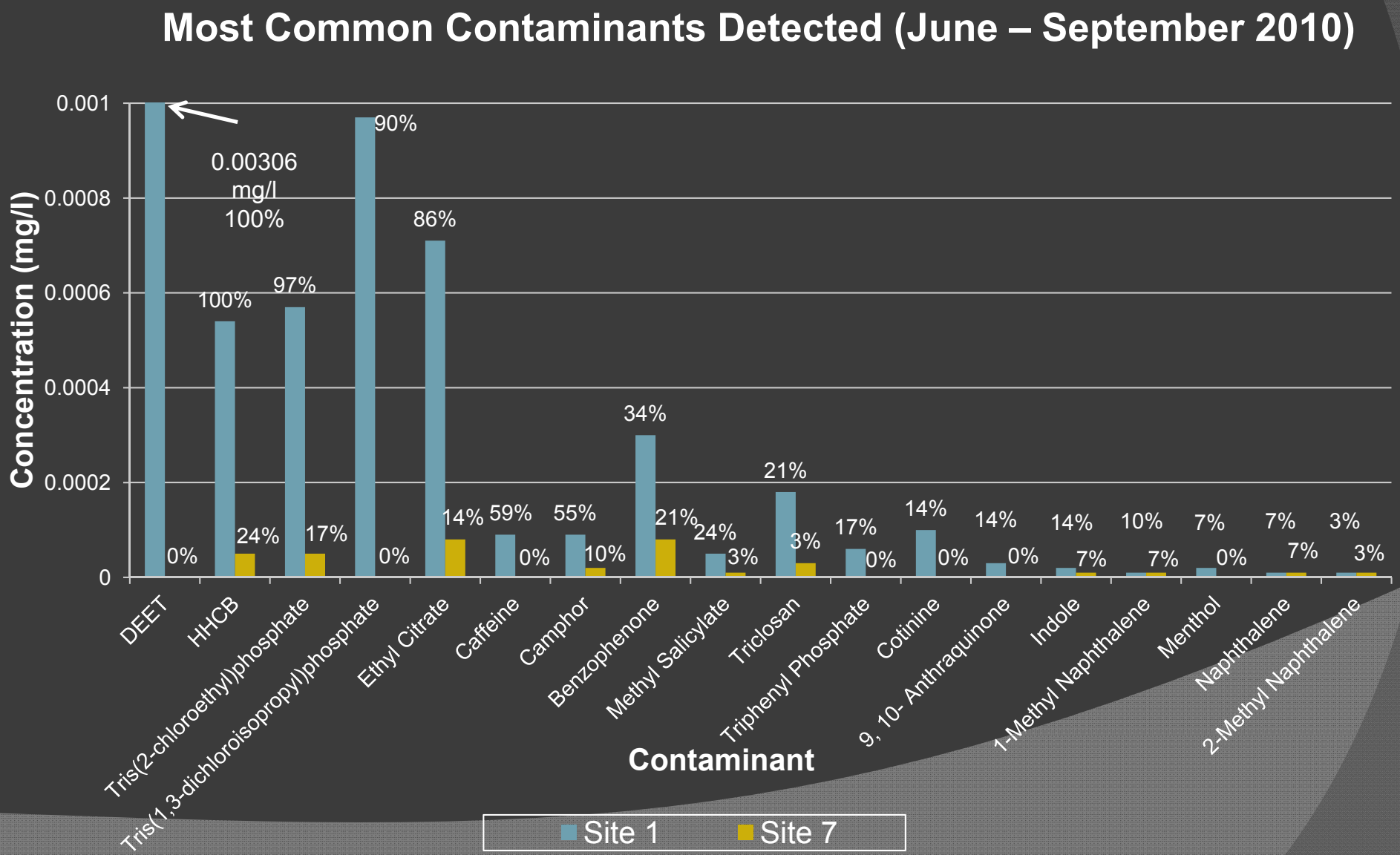
Water Quality Goals

- Return water in as good or better condition
- EPA
  - National Primary Drinking Water Standards
  - National Secondary Drinking Water Standards
  - Contaminant Candidate List (CCL3)
- MDH Human Health-Based Water Guidance Table
- California Drinking Water Notification Levels
- Additional contaminants

Final List

- 52 contaminants that represent
  - Particular classes e.g. pharmaceutical, personal care products, or industrial chemicals
  - Diverse properties
  - Common and affordable measurement
  - Expected to be found locally
  - Health or environmental risk

Test Results



Removal Summary

- Pilot treatment removed
  - 61% mass of all measured contaminants
  - Many below detectable limits
- Remaining contaminants far below health based risk levels

Ready to Inject?

- Great results
- Clean, drinkable water
- Turn on the pumps

- Not quite
- Need to consider properties of receiving body
  - pH – hardness – mineral types
- Need more tests

Batch Testing

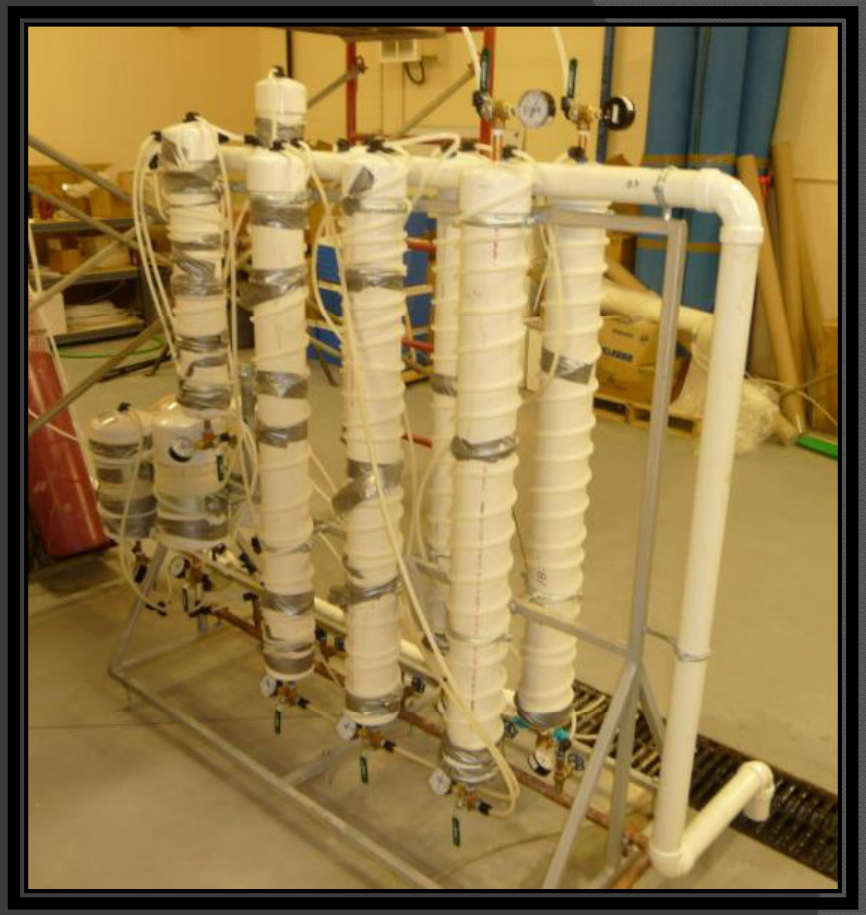
- What happens when treated water contacts the geologic units?
  - Iron oxidation could plug screen
  - PDC could dissolve
  - Mobilization of arsenic, lead, mercury etc.
- Test A
  - Combined sand and gravel unit and PDC
  - Treated water and various treatments of lime and CO_2
  - No problematic constituents were mobilized

Batch Testing

- Test B
  - Water treated with 55 mg/L lime and used CO2 to adjust pH to 7.5
  - Test environments representative of various depths
  - Arsenic reported in low concentrations for 25% of samples

Column Tests

- Determine effects of treated water moving through aquifer
- Original borehole cores saved
- Treated water run through
- Two tests
  - pH adjusted with CO_2 + lime
  - No pH adjustment



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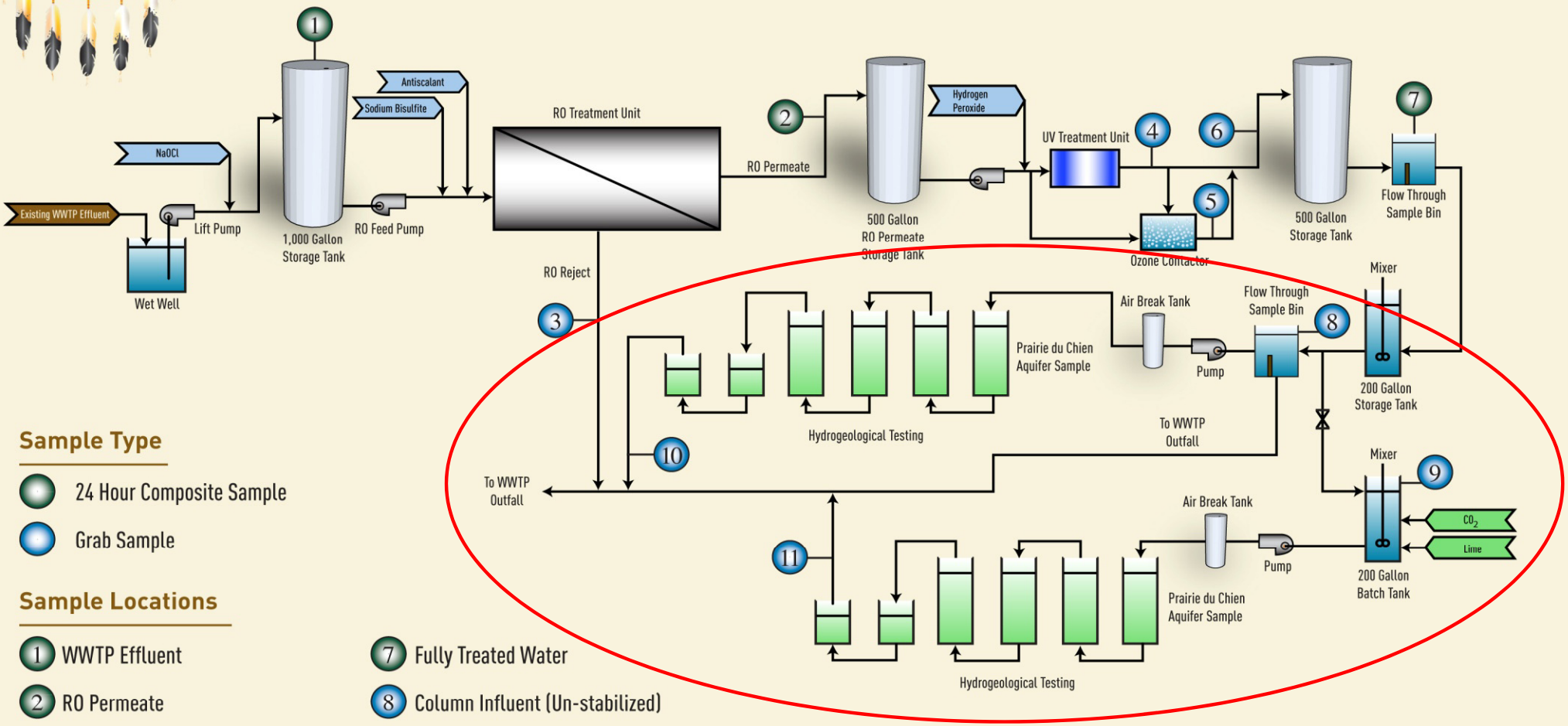

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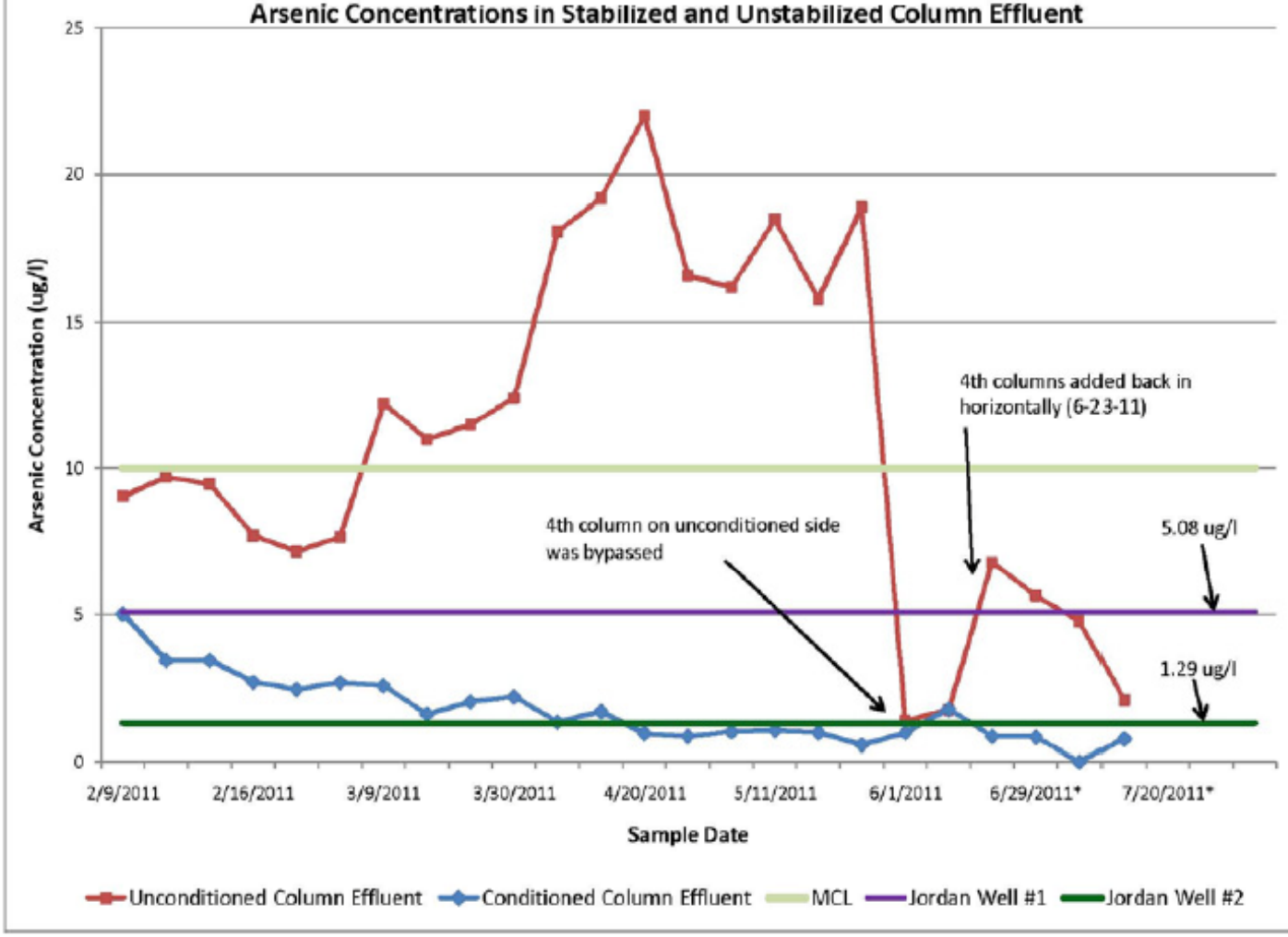
Column Test Results: Arsenic

Figure 6.8

Arsenic Concentrations in Stabilized and Unstabilized Column Effluent



Column Test Results

- Stabilized water
  - Calcium – similar influent/effluent
  - Total Dissolved Solids – slight increase
  - Magnesium, Silicon, Strontium – increase less than unstabilized
  - Sodium, Potassium, Aluminum, Barium – increase similar to unstabilized

Proposed System

- Drill 3 wells
- 2 in operation at any time
- 350,000 gallons per day

- Status
  - On hold indefinitely
  - Installed irrigation reuse system

Summary

- Area has adequate water
- Predicted future drawdown
- SMSC has
  - Geologic advantage
  - Existing facilities
- Testing shows that water quality can be assured

Shakopee Mdewakanton Sioux Community

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