Aquifer Storage and Recovery in Florida

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Presented by:

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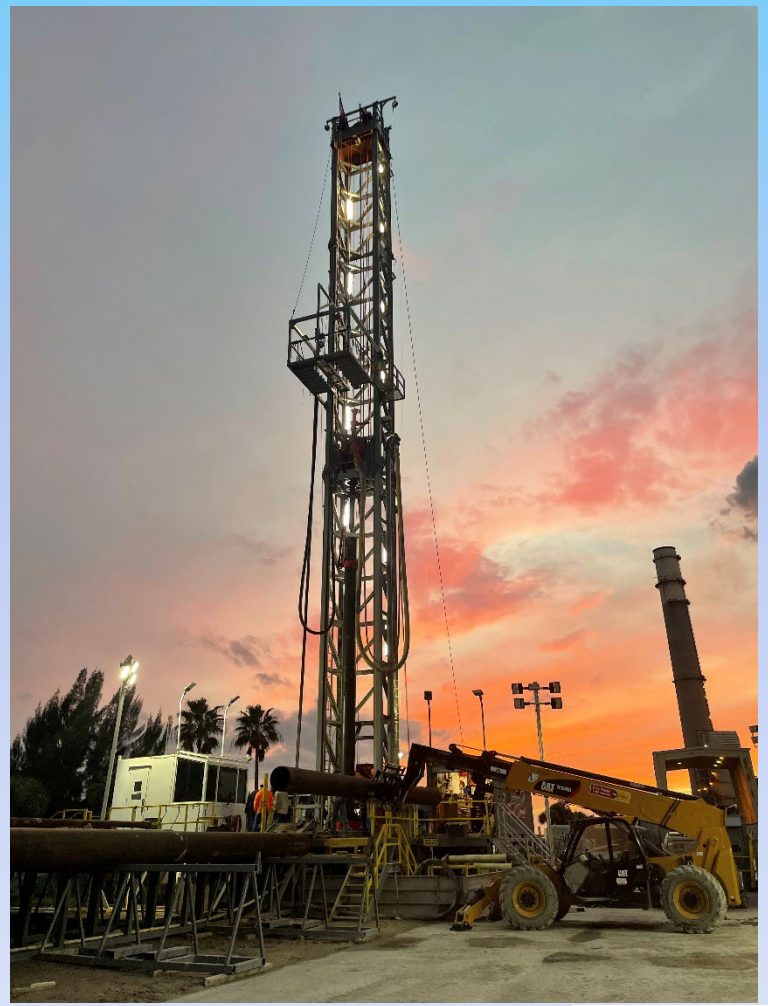
Aquifer Storage and Recovery in Florida

- Issues and limitations
- Examples of successful systems
- Considerations that could expand the use of ASR

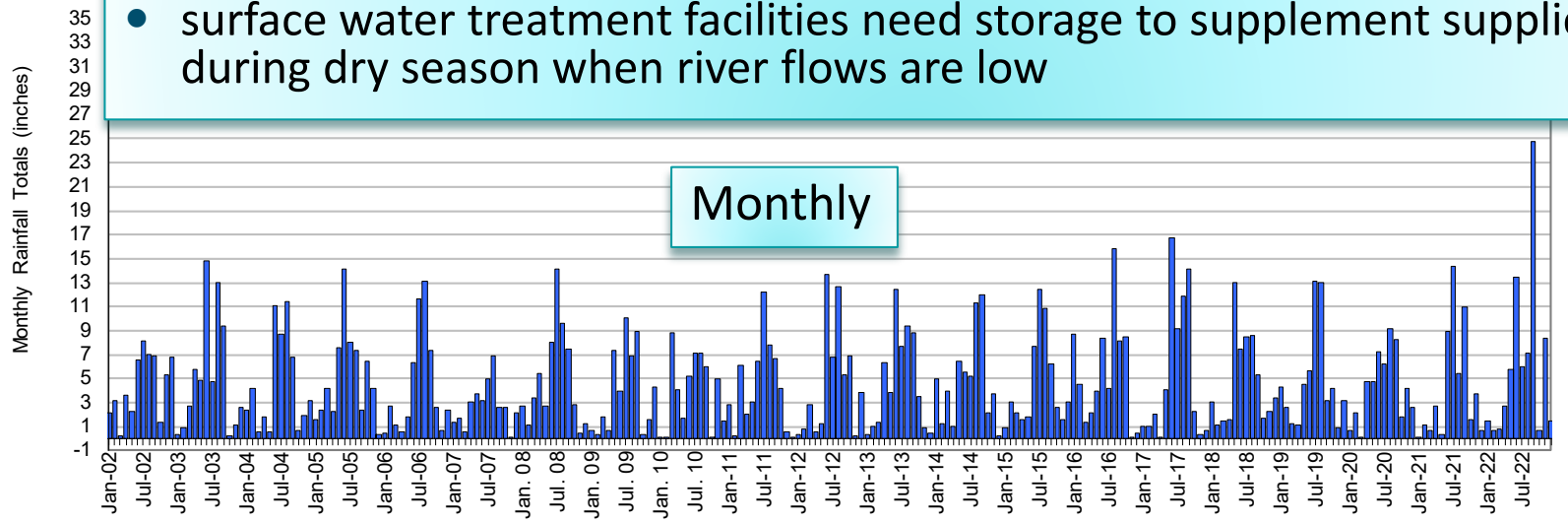
Aquifer Storage and Recovery in Florida

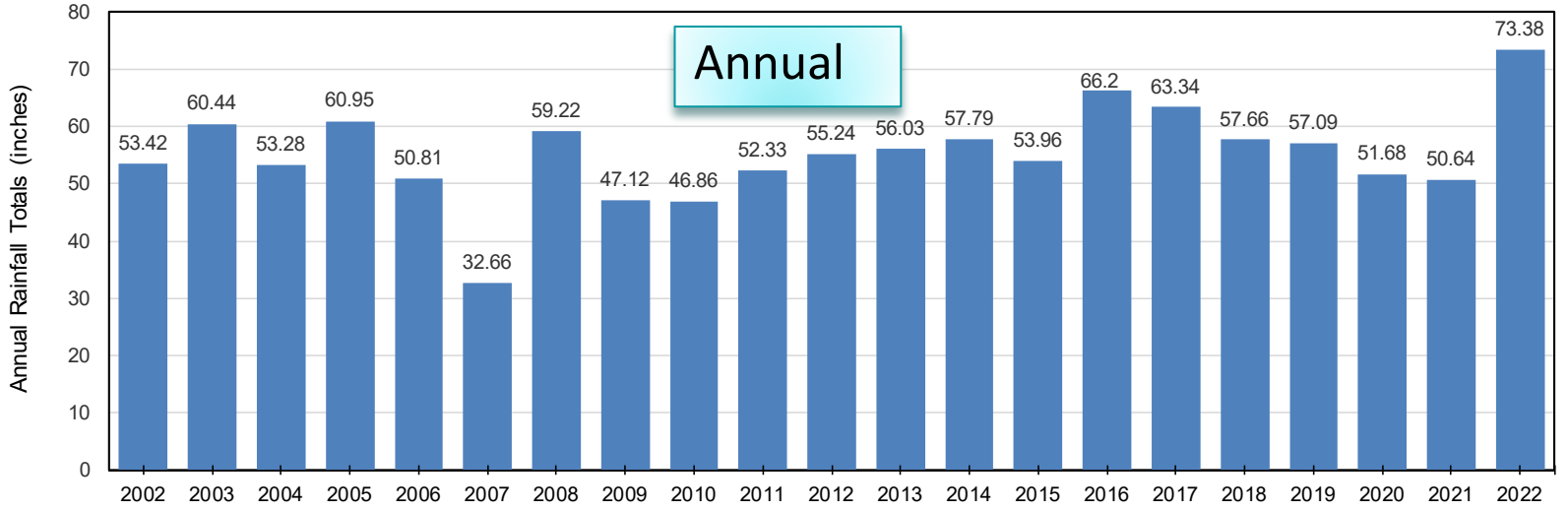
- Regulated by the Florida Department of Environmental Protection (FDEP), FDEP has primacy for the UIC program in Florida
- UIC Rules - Chapter 62-528 FAC
- ASR is a Major Class V Well
- Generally - Potable, Reclaimed, partially treated surface water?
- Water conservation strategy for protecting water resources



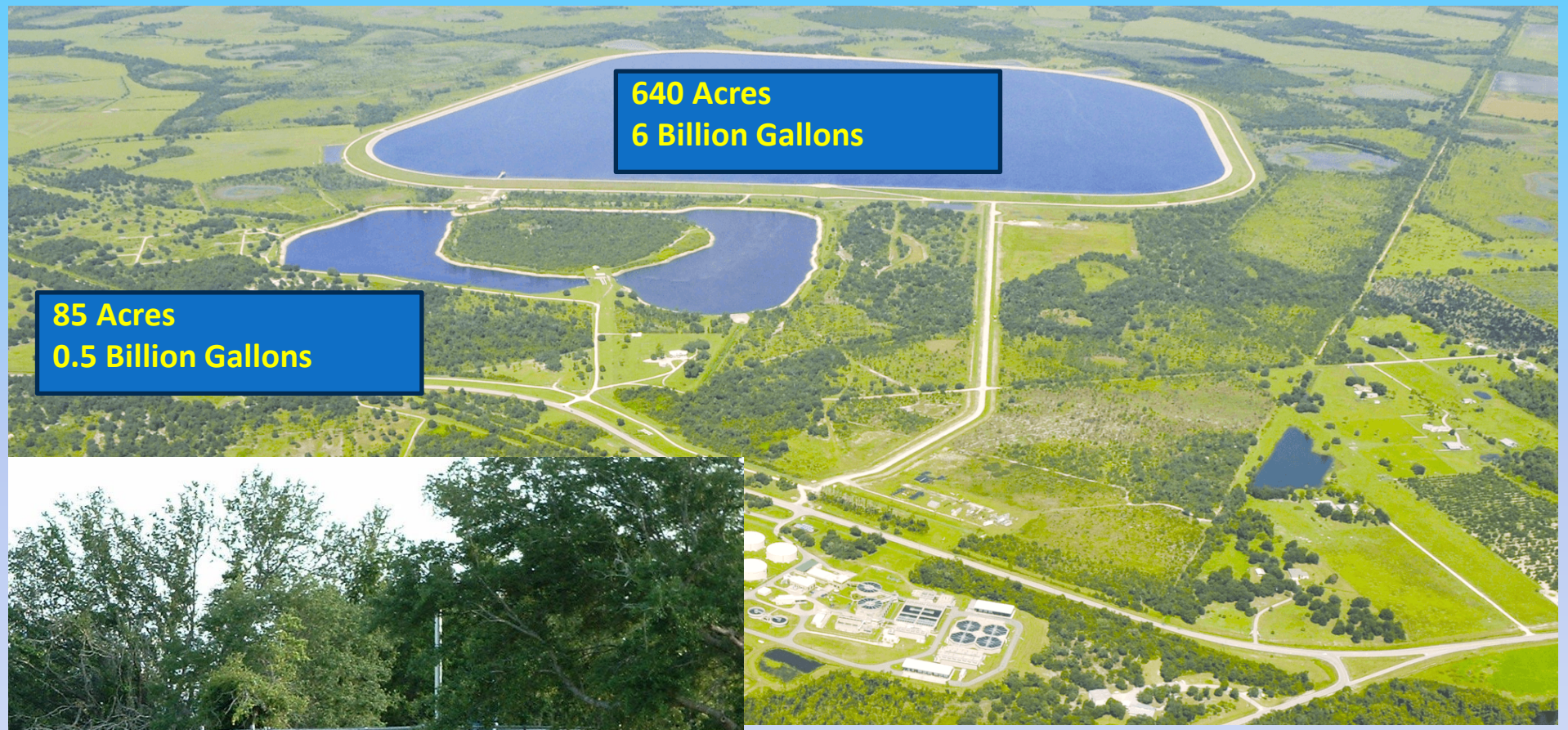
Aquifer Storage and Recovery in Florida

- Florida receives approximately 53-inches of rainfall per year
- surface water treatment facilities need storage to supplement supplies during dry season when river flows are low



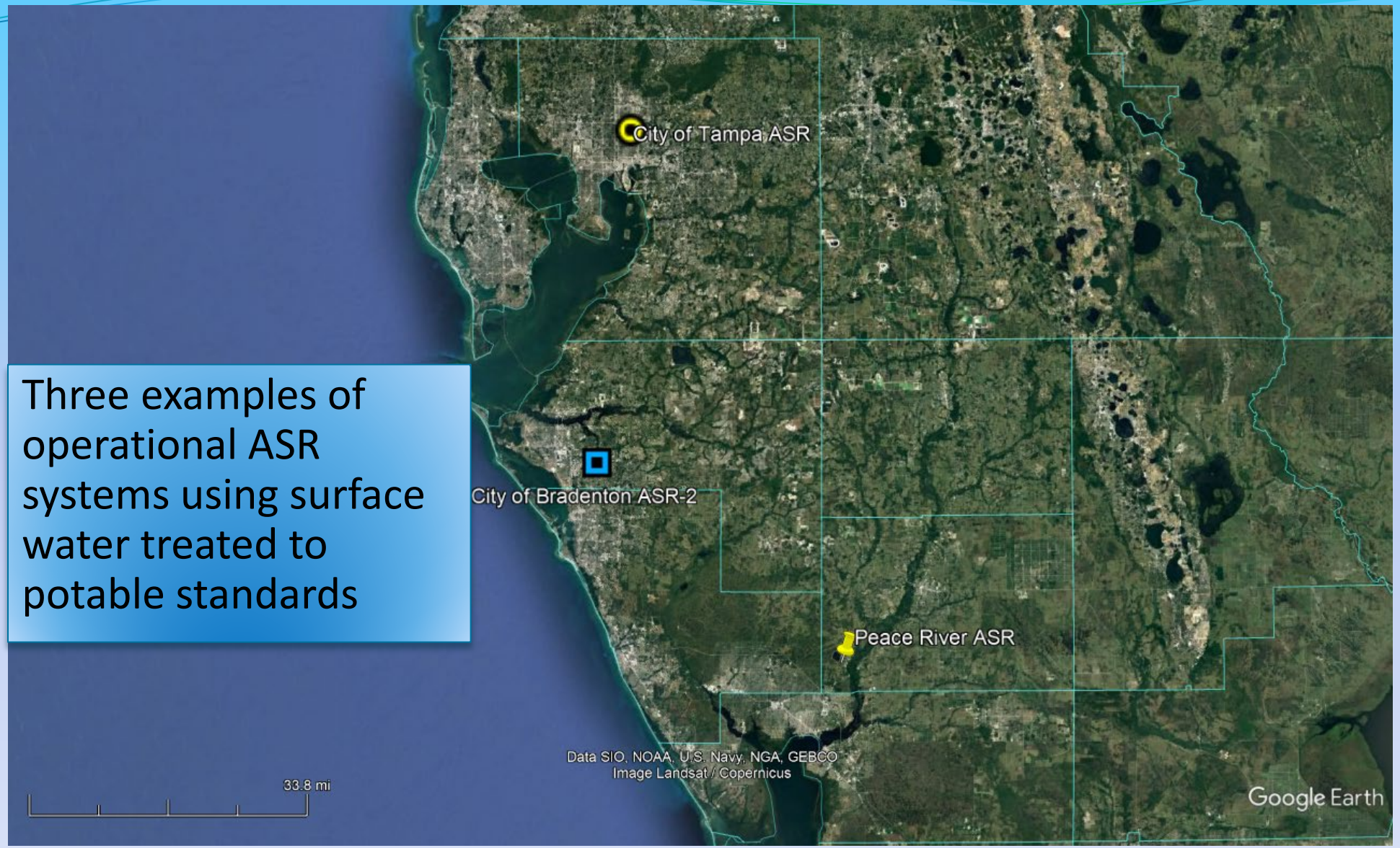


Aquifer Storage and Recovery in Florida



21 ASR wells
0.1 acres
9 Billion Gallons (…but not really)

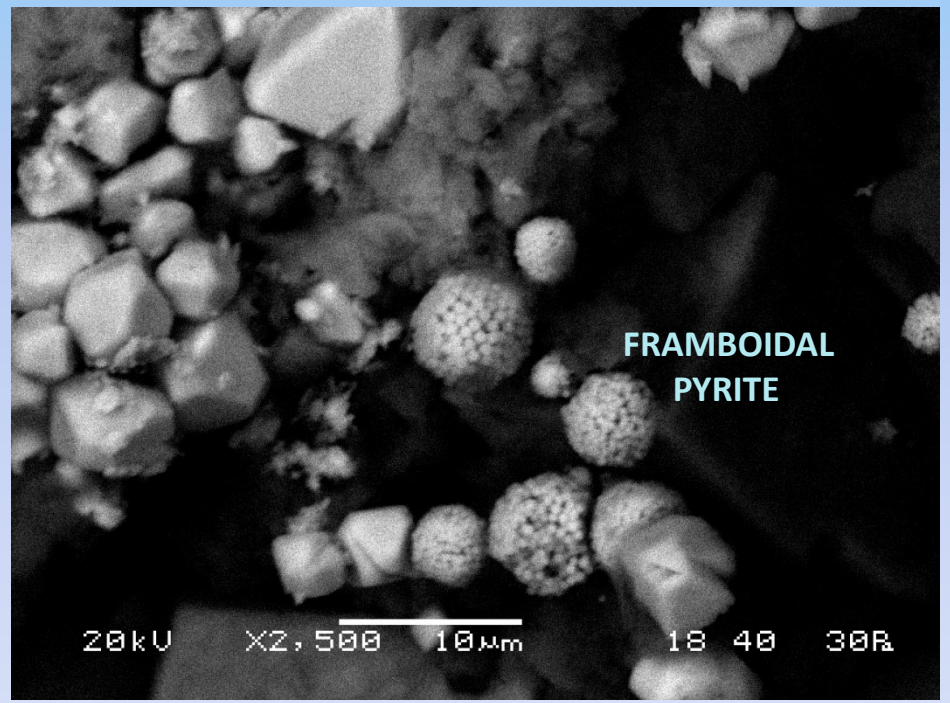
Source: Peace River Manasota Regional Water Supply Authority

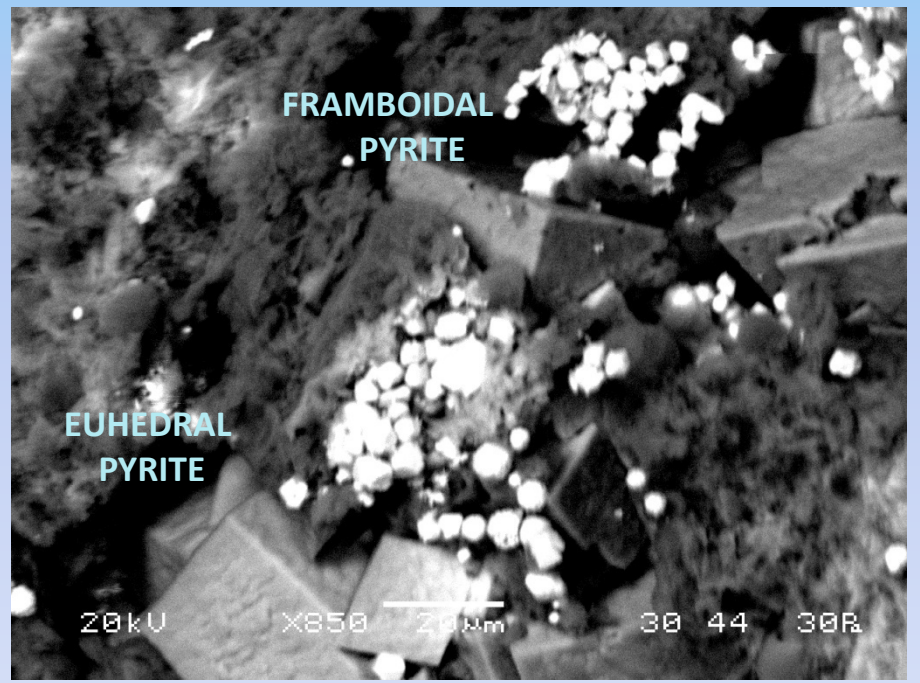


Three examples of operational ASR systems using surface water treated to potable standards

Arsenic Mobilization

- Issue came to the forefront in early 2000s
- Drinking water standard decreased from 50 ppb to 10 ppb
- Associated with pyrite in Limestone/Dolostone formations





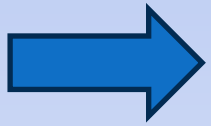
(Price and Pichler, 2006)

Arsenic Mobilization

Geochemical interaction related to the difference in Oxidation Reduction Potential between source water high in dissolved oxygen and reducing environment of native groundwater

Source Water

> +300 mV



Native Groundwater

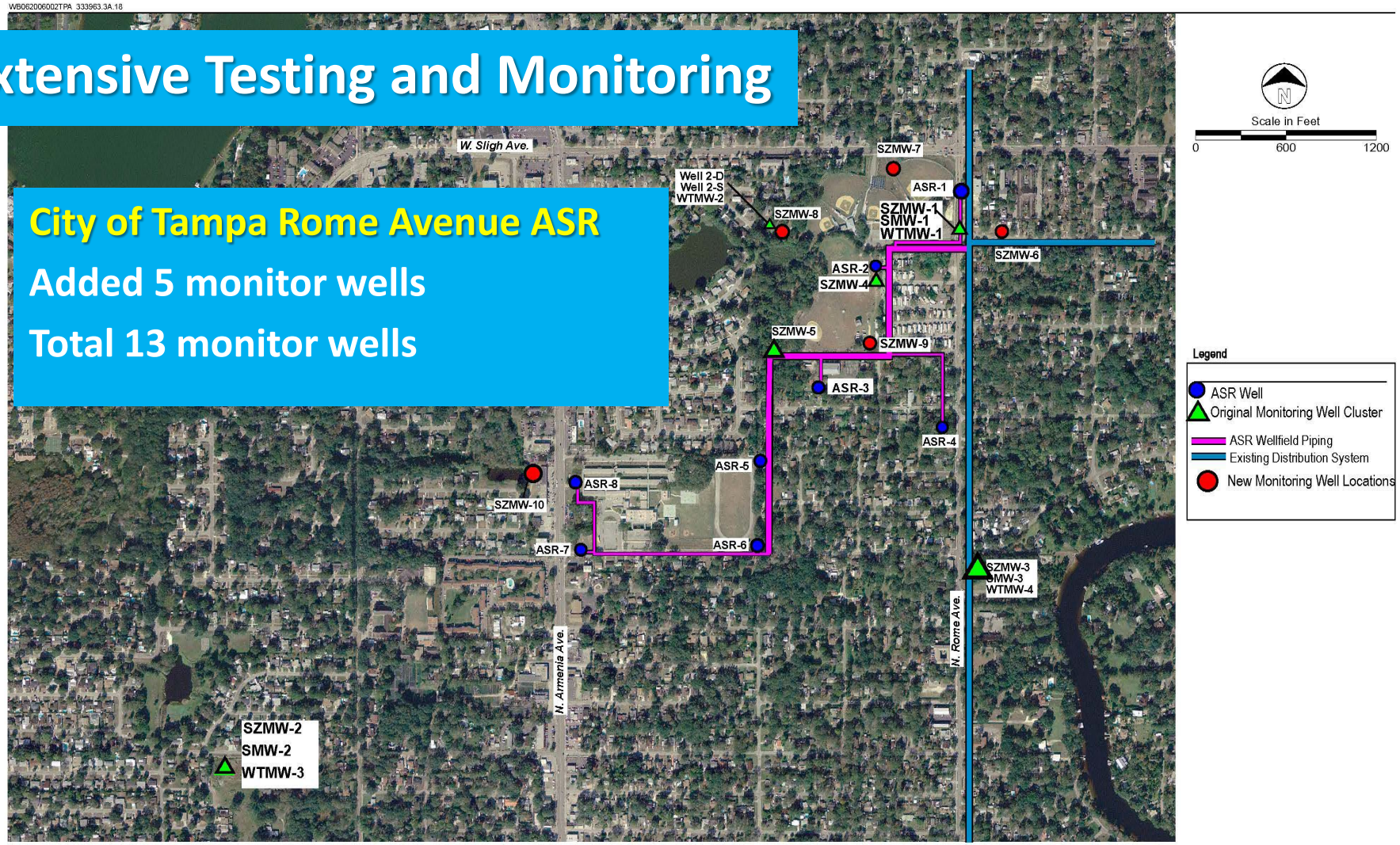
< -300 mV

Extensive Testing and Monitoring

City of Tampa Rome Avenue ASR

Added 5 monitor wells

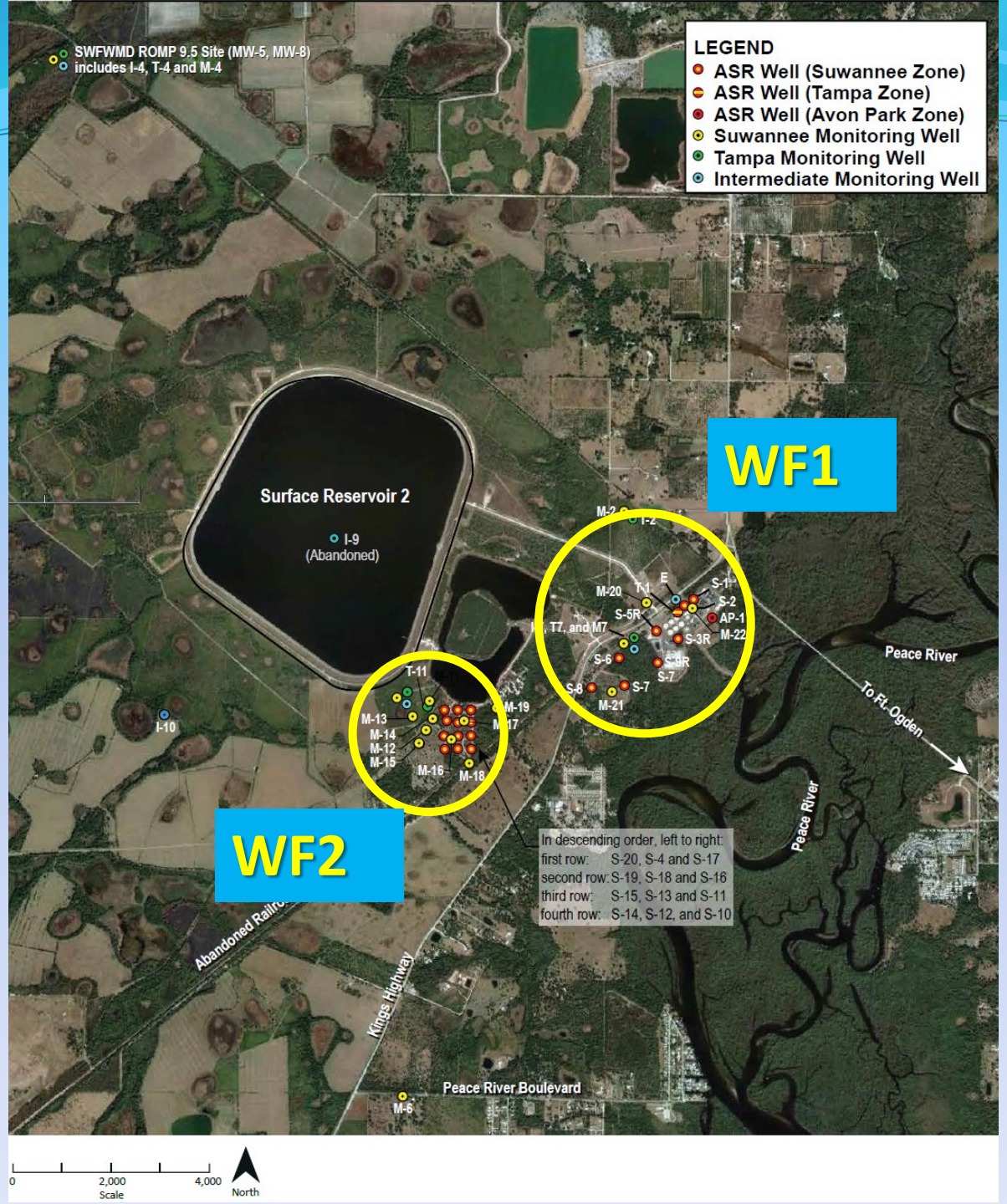
Total 13 monitor wells



Source: CH2M HILL (May 2003)

FIGURE 1-2
Rome Avenue ASR and Monitoring Well Location Map

CH2MHILL



Peace River Facility

21 ASR wells

Added 13 monitor wells

Total 24 monitor wells

Peace River Facility
WF2

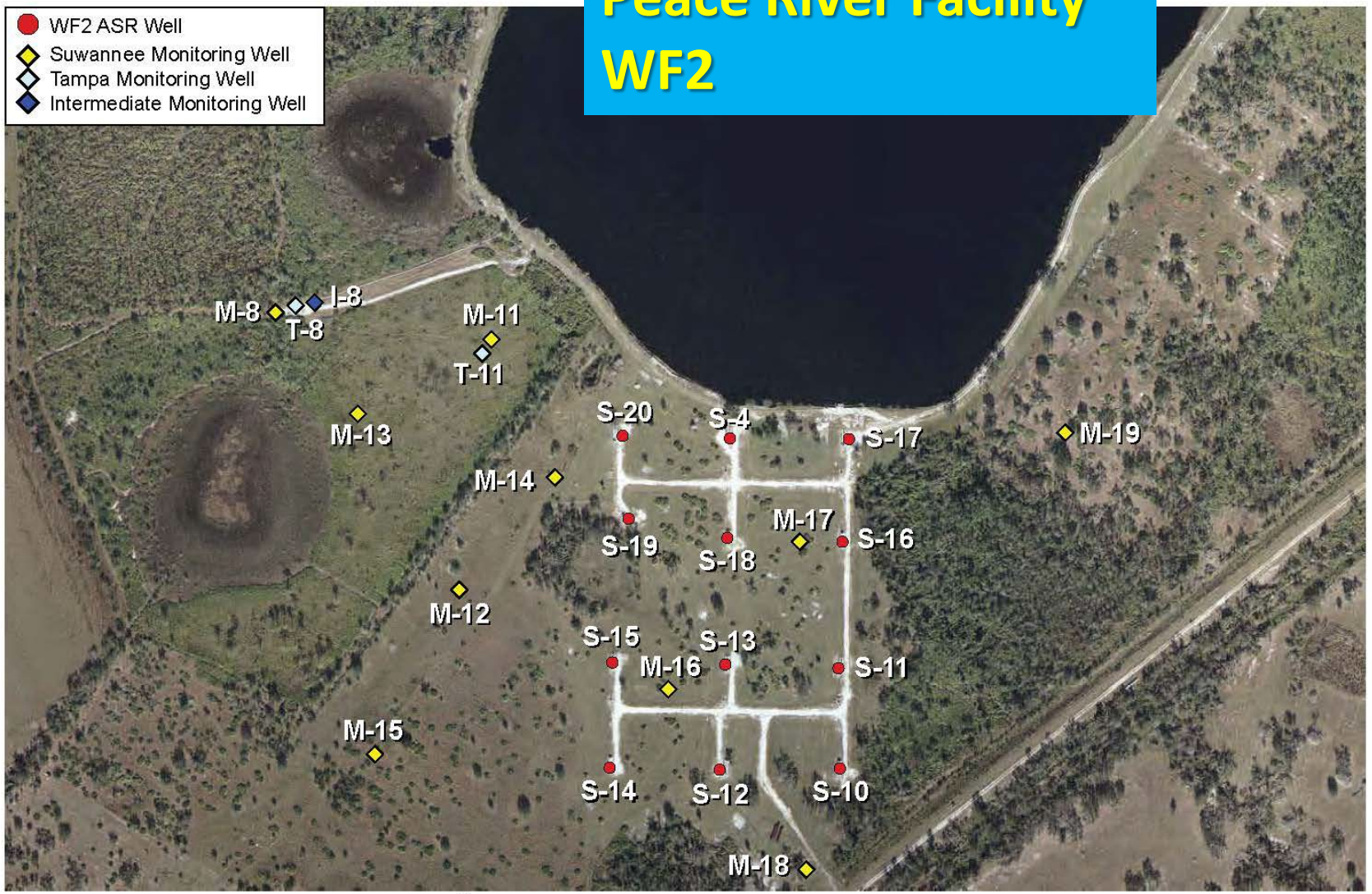
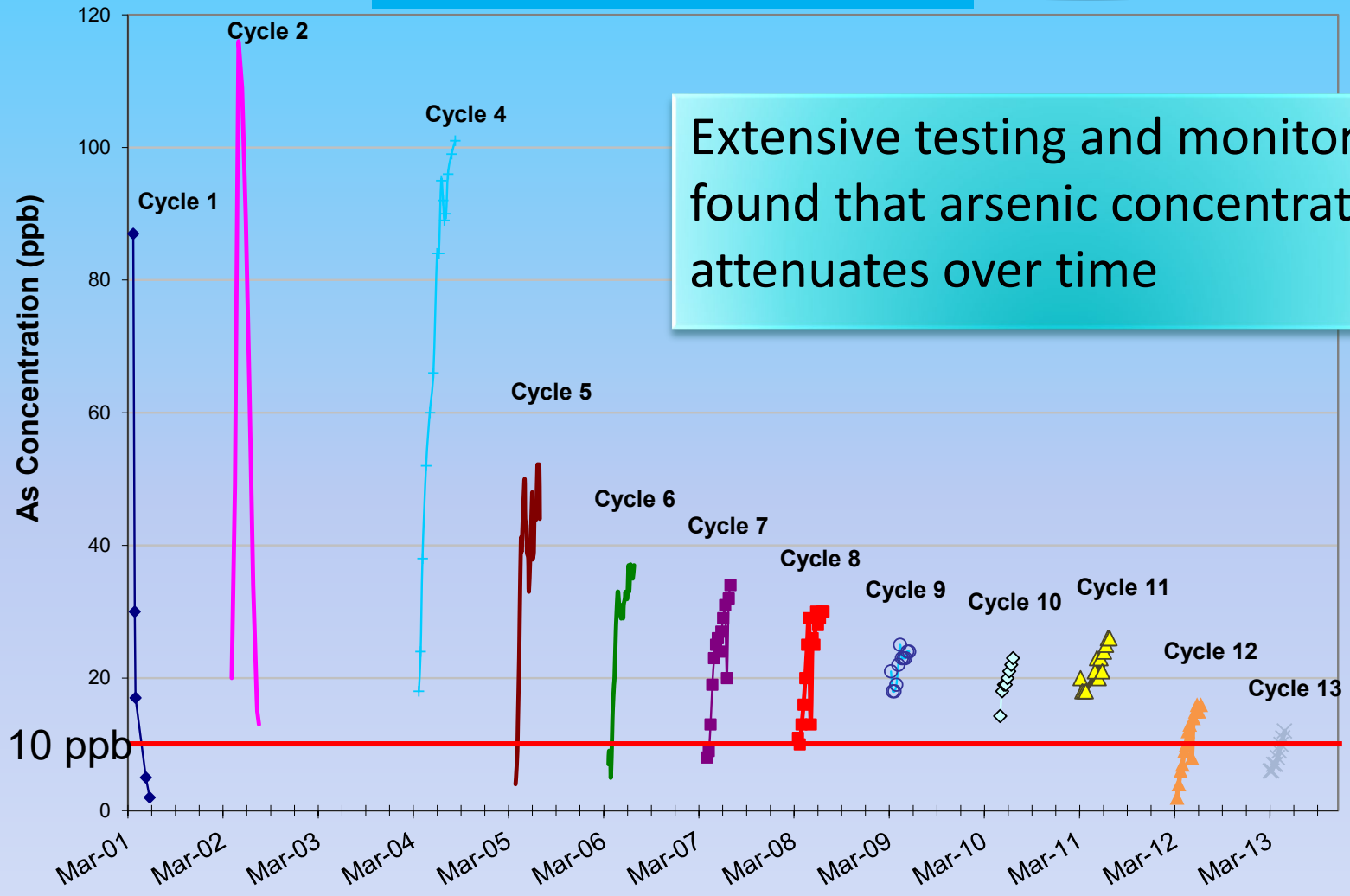


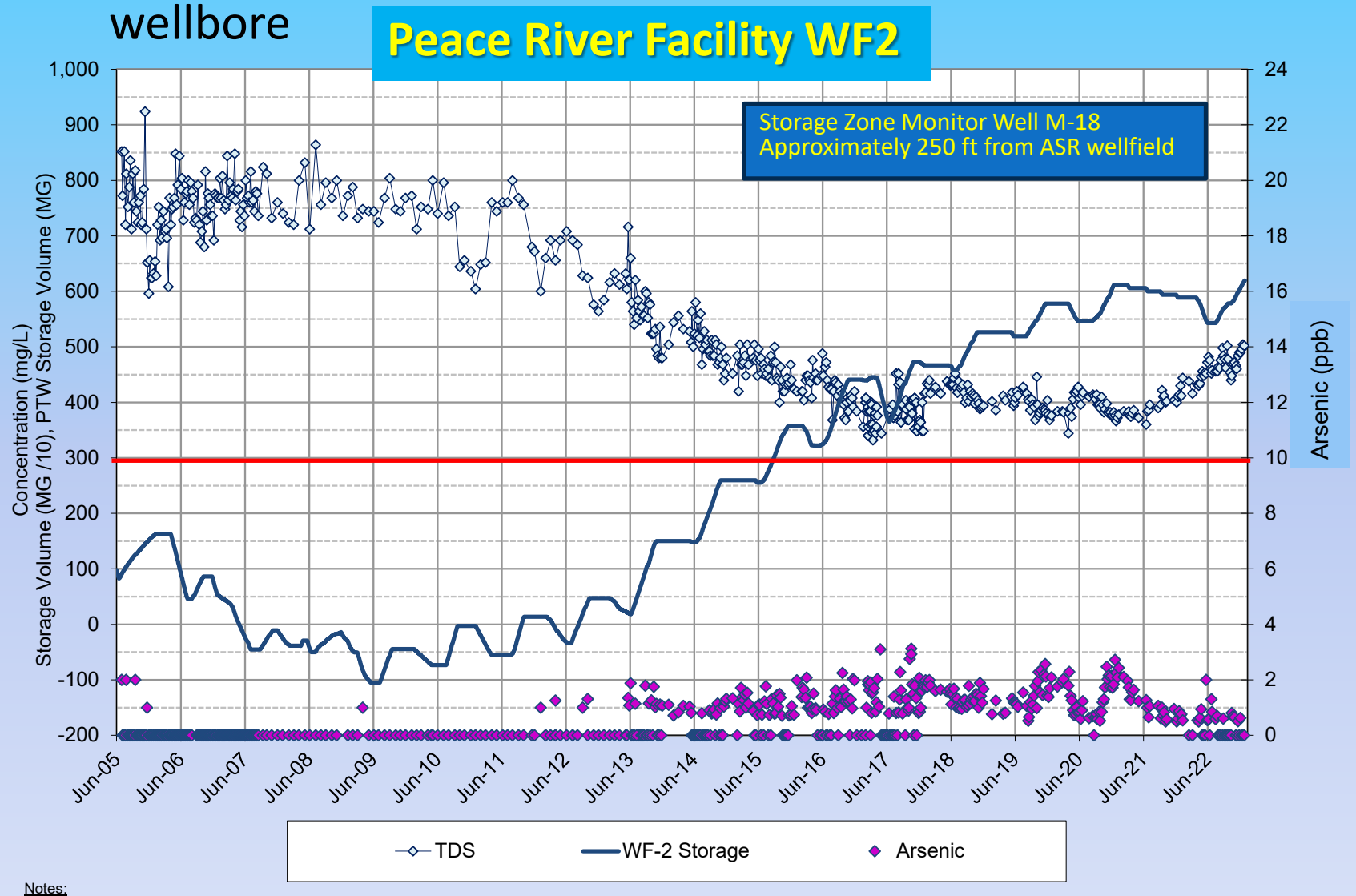
FIGURE 1-4
WF2 Site Plan

Rome Ave ASR-7



Extensive testing and monitoring found that arsenic concentration attenuates over time

….and demonstrated that mobilization is near the wellbore



Notes:
For the purpose of this graphic any readings below the laboratory method detection limit were assigned zero
Sampling events for the PTSW testing occasionally resulted in duplicate samples on the same day, in that instance the result with the higher concentration of the two samples was used

Rome Ave ASR Storage Zone Monitor Wells all < 10

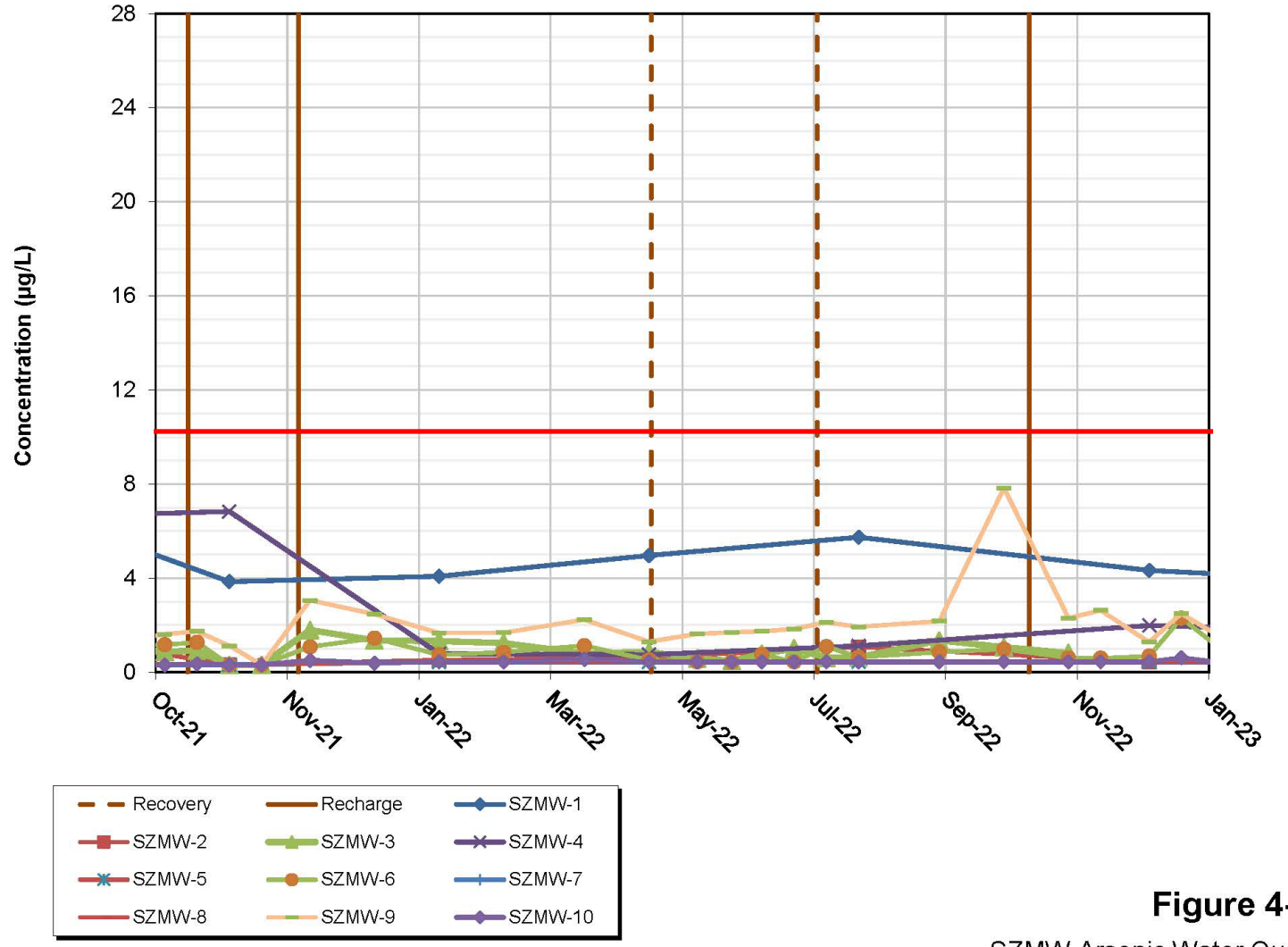


Figure 4-32

SZMW Arsenic Water Quality

Regulatory Outcome

Regulators Recognized

- Extensive data confirmed the localized nature
- Injected water meets DWS
- Recovered water with elevated arsenic is re-treated before distribution to the public

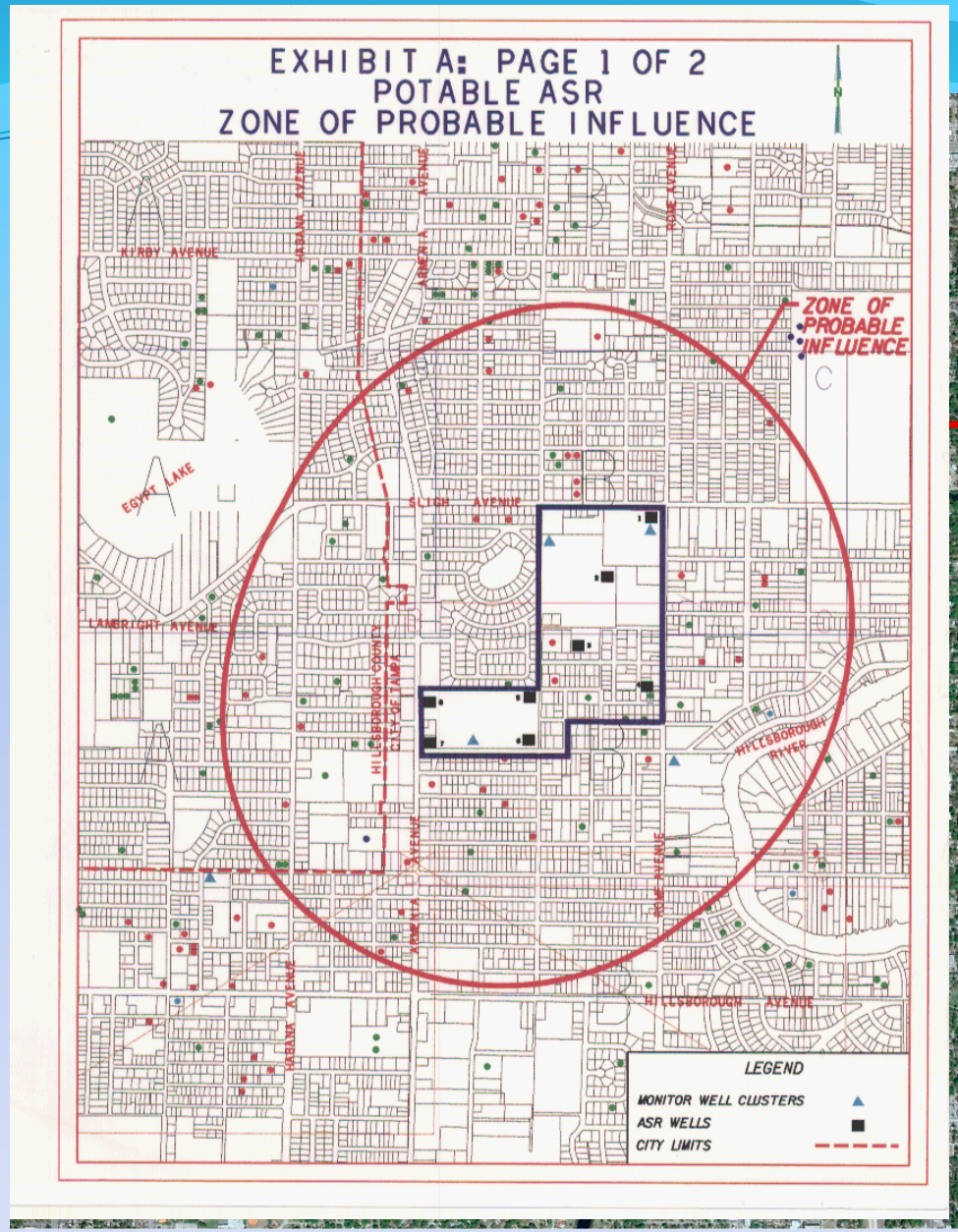
EPA issued a guidance letter in 2013 supporting Florida's use of ASR.

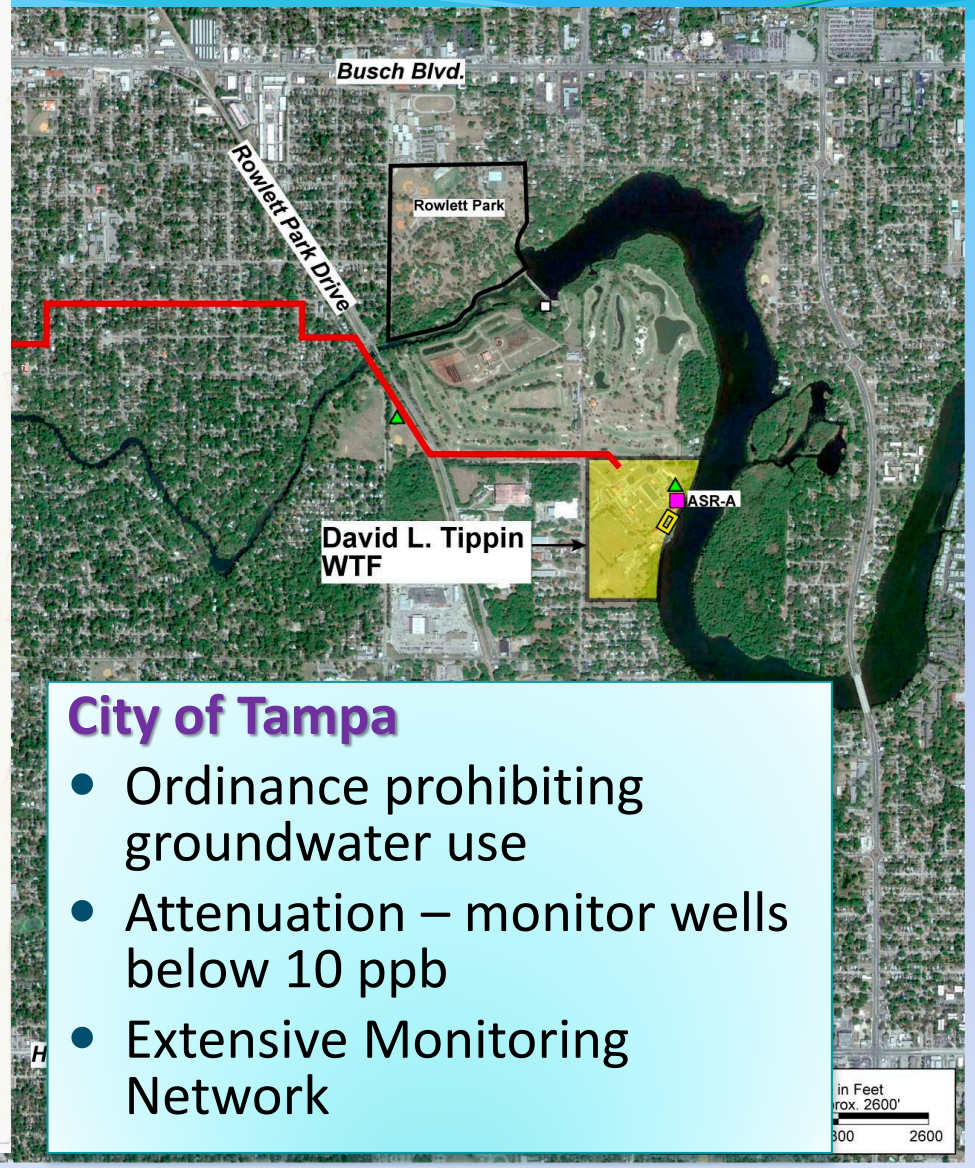
If the FDEP issues a permit for a system that arsenic mobilization occurs it shall include conditions designed to meet goals of the SDWA. Mainly that the burden of public health protection is not transferred from the public water system to another user of the USDW. This may be accomplished by implementing "site access controls" such as institutional controls, property interests, or ordinances.

If a system demonstrates public health is protected through:

- Institutional control of water
- Reduction of arsenic mobilization (DO removal, attenuation)
- Monitoring

ASR can continue to be permitted



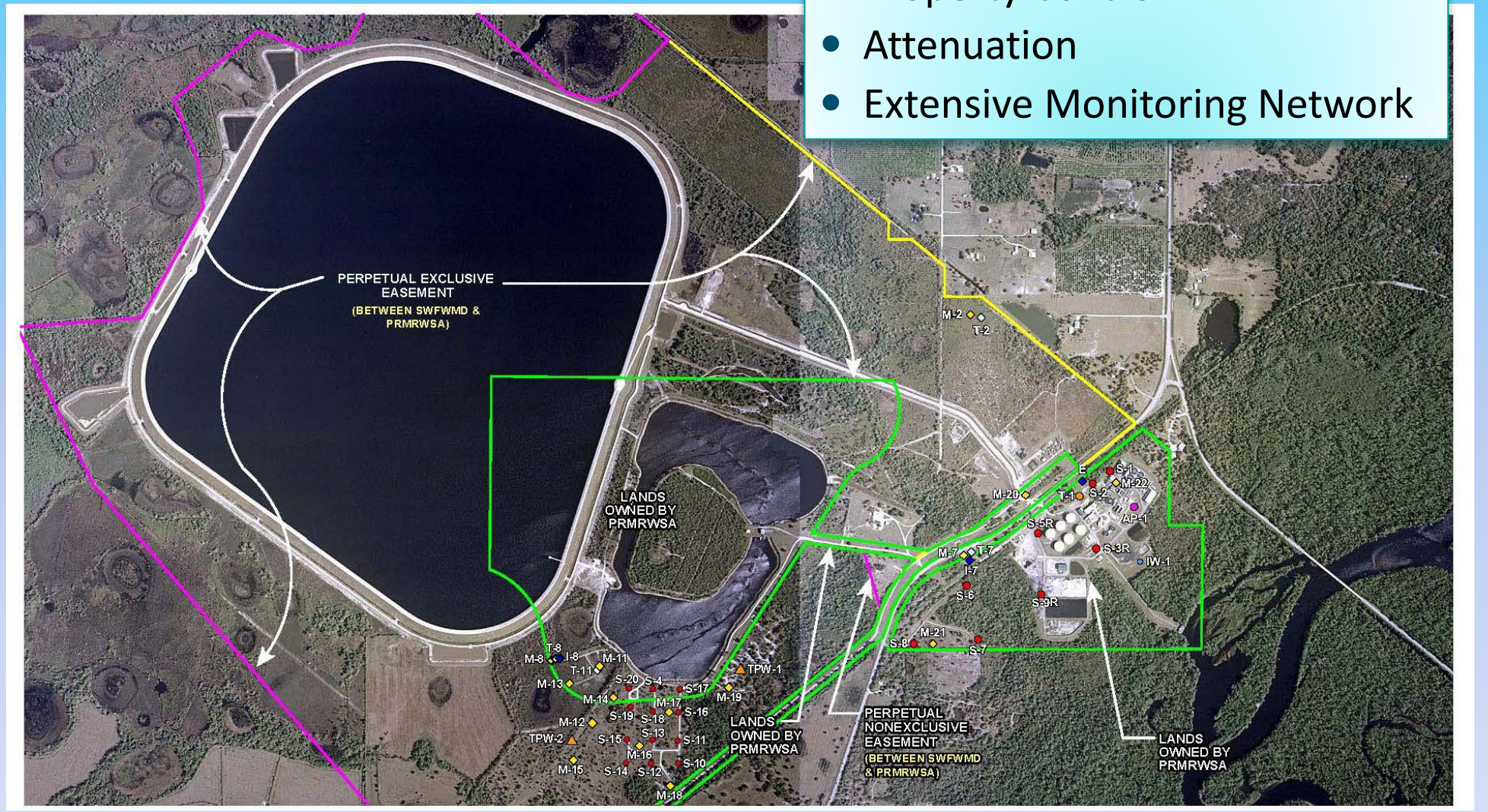


City of Tampa

- Ordinance prohibiting groundwater use
- Attenuation – monitor wells below 10 ppb
- Extensive Monitoring Network

Peace River Facility ASR

- Property Control
- Attenuation
- Extensive Monitoring Network



City of Bradenton

- Dissolved Oxygen Removal

FIGURE 2-1
Location Map
Bill Evers Reservoir ASR-2 System

F1-LocationMap.ai 4/29/16

Aerial Source: Google Earth 1/28/19

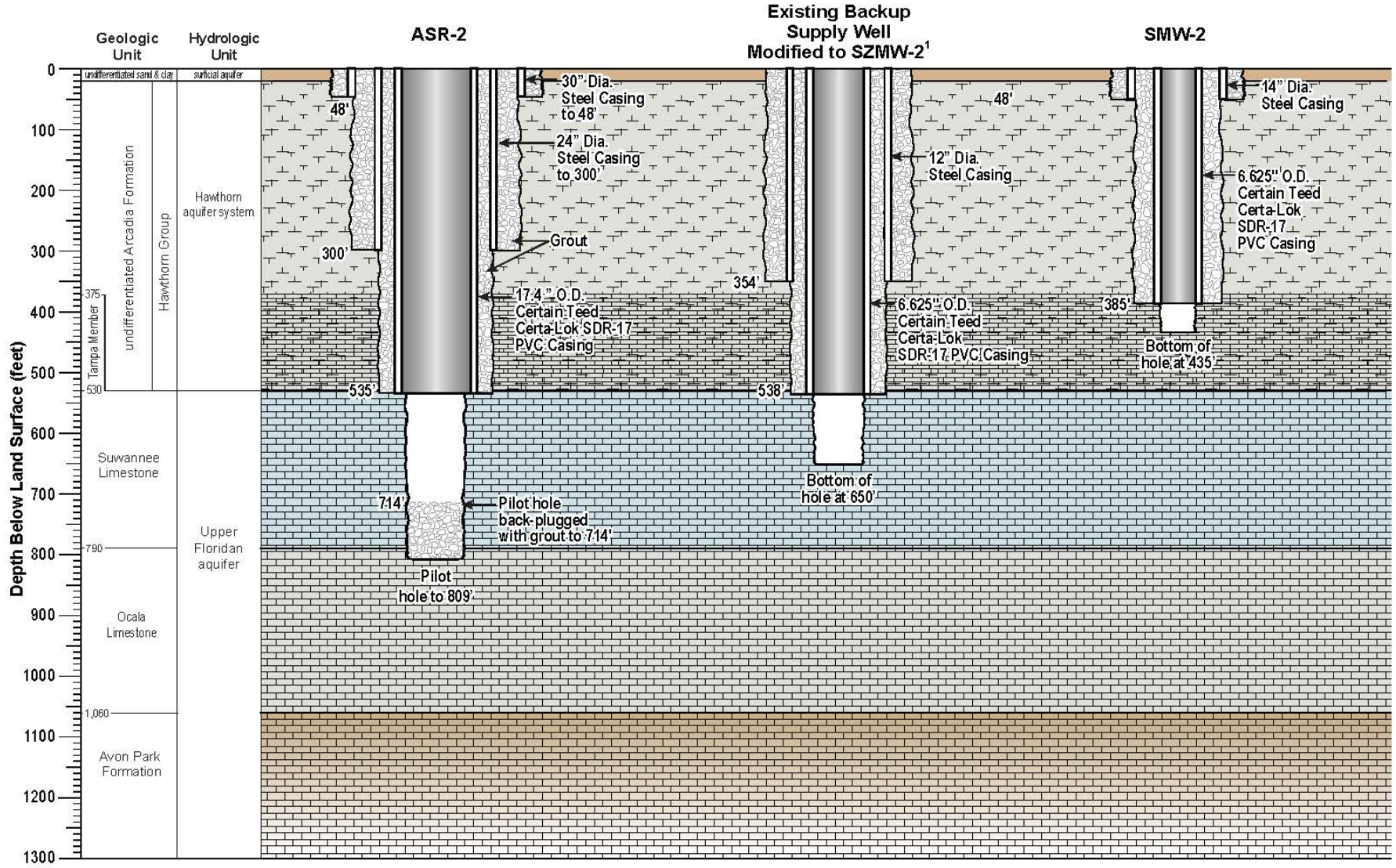
North

0 250 500

Appox. Scale in Feet

FIGURE 2-2
Site Map
Bill Evers Reservoir ASR-2 System

6/19/19



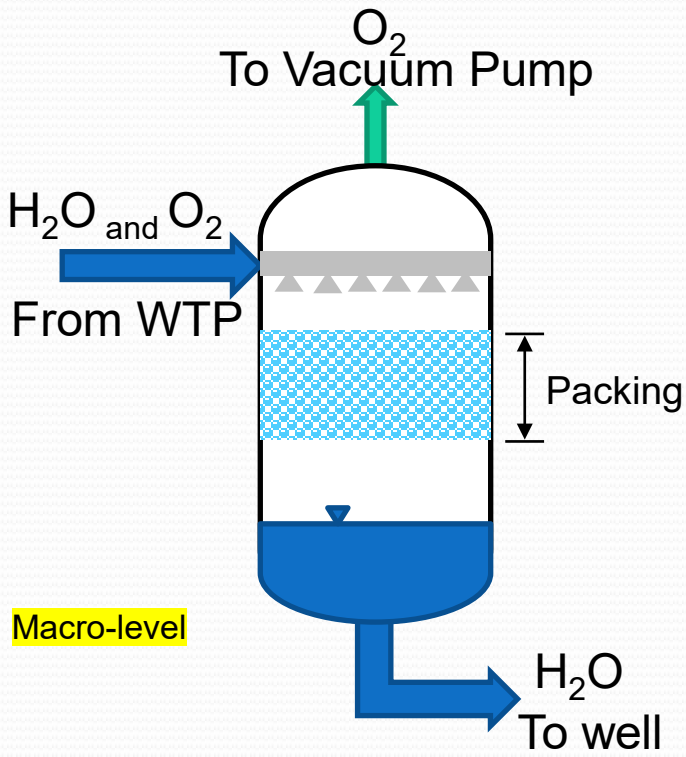
NOTE: The 12-inch diameter steel casing to 354-feet bls at SZMW-2 was pre-existing and was not constructed during thecompletion of this project.

FIGURE 2-3
Well Construction Details and Stratigraphic Column
Bill Evers Reservoir ASR-2 System

8-19-20

Degasification Tower Process

Mass Transfer in Packed Towers

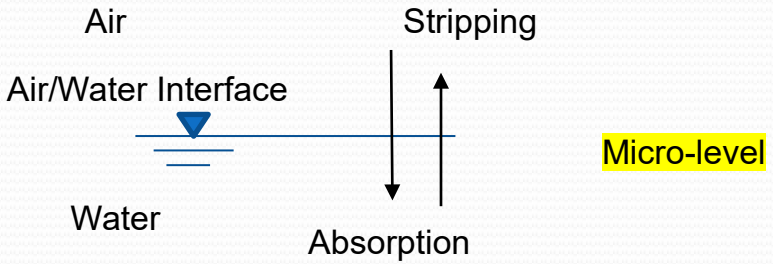


Design and Process Performance is a function of:

- P = Pressure
- T = Temperature
- C = Concentration
- Q = Flowrates
- NTU = number of transfer units
- HTU = height of transfer unit
- Packing material
- Gas removed – O2, CO2, H2S, etc..

Typically sized using modeling software

Gas Liquid Mass Transfer



Micro-level

Degasification Tower ASR-2

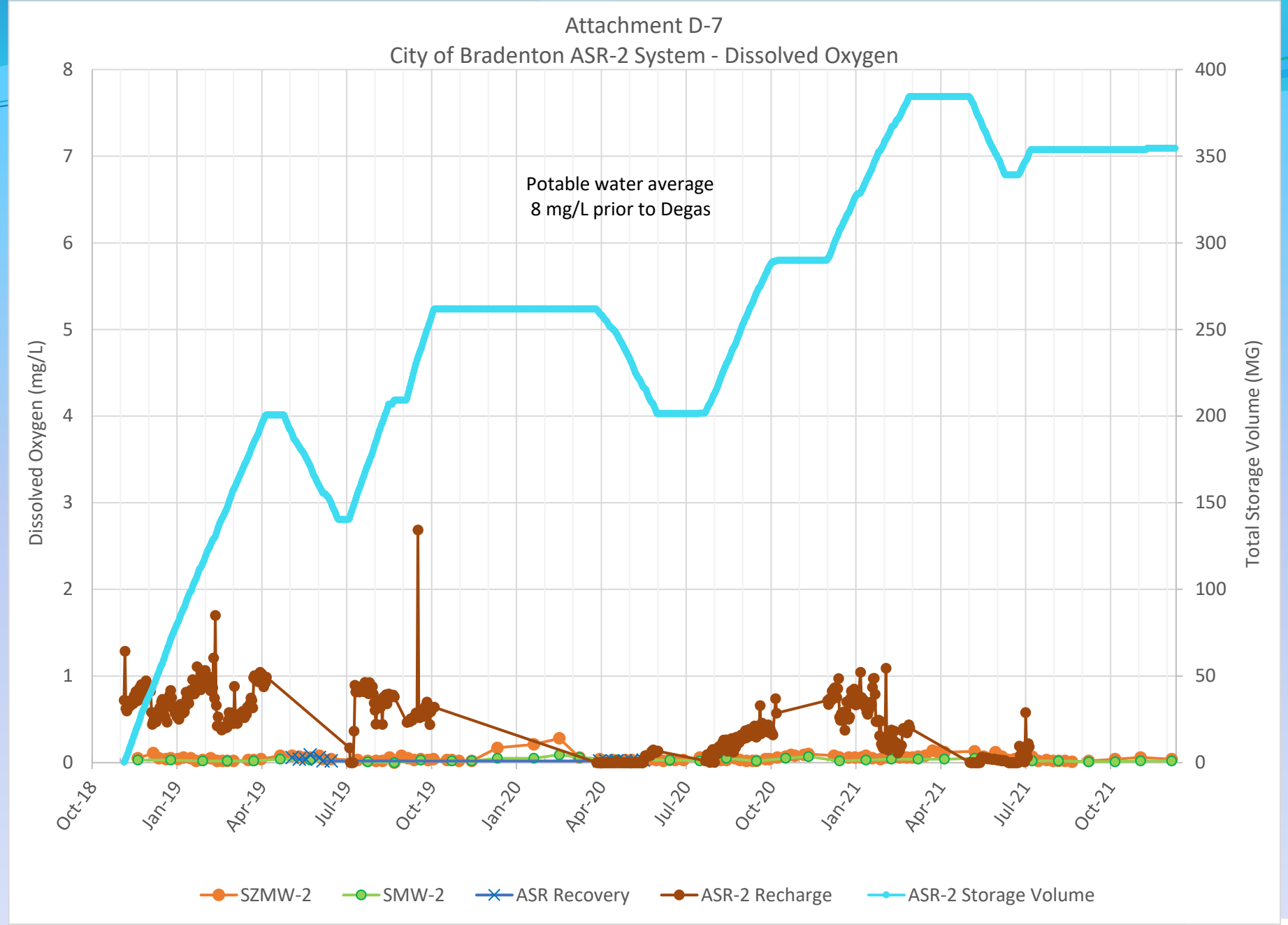
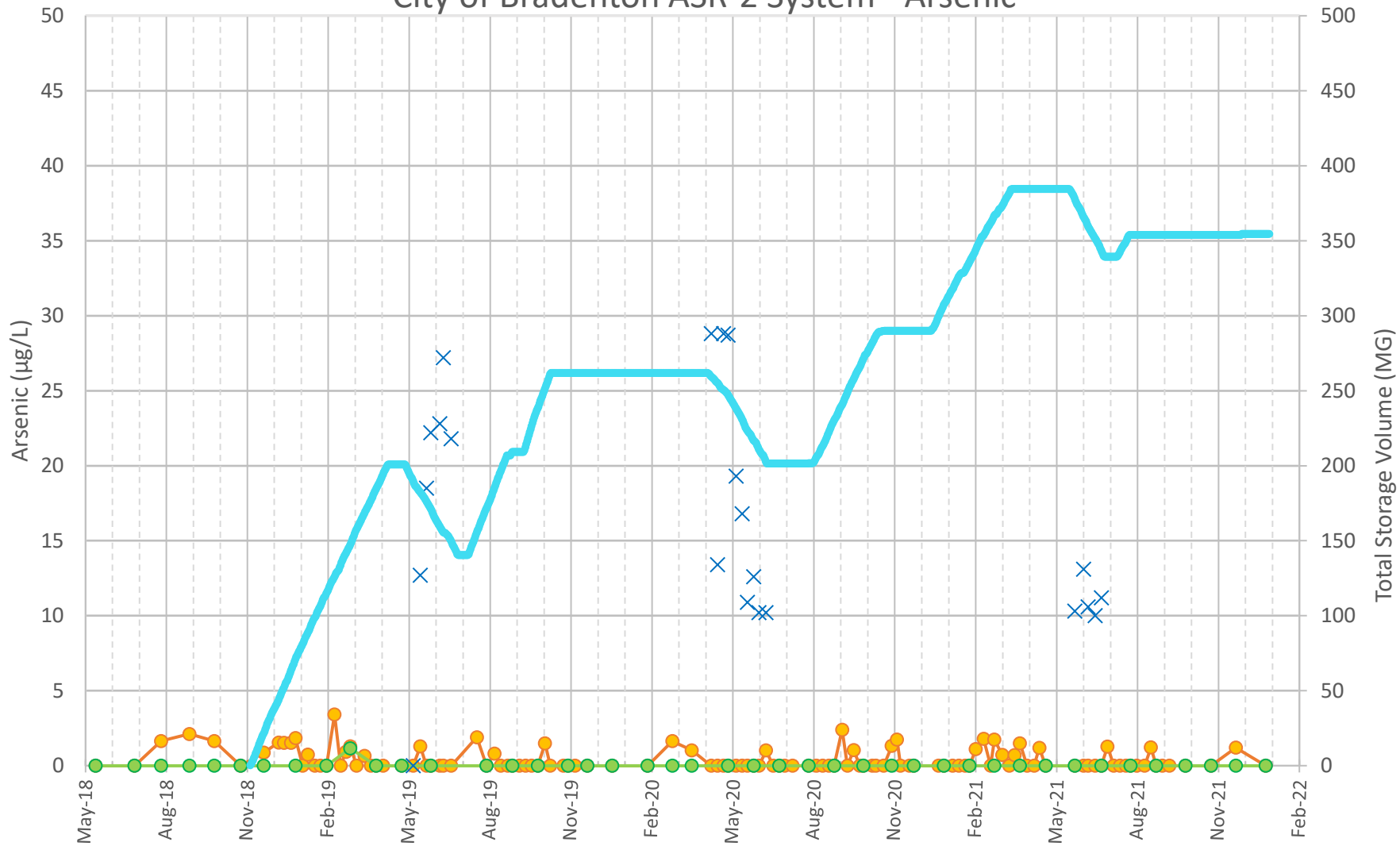

Attachment D-7
City of Bradenton ASR-2 System - Dissolved Oxygen
Potable water average
8 mg/L prior to Degas
Dissolved Oxygen (mg/L)
Total Storage Volume (MG)
0
1
2
3
4
5
6
7
8
0
50
100
150
200
250
300
350
400
Oct-18
Jan-19
Apr-19
Jul-19
Oct-19
Jan-20
Apr-20
Jul-20
Oct-20
Jan-21
Apr-21
Jul-21
Oct-21
SZMW-2
SMW-2
ASR Recovery
ASR-2 Recharge
ASR-2 Storage Volume

Figure D-1

City of Bradenton ASR-2 System - Arsenic



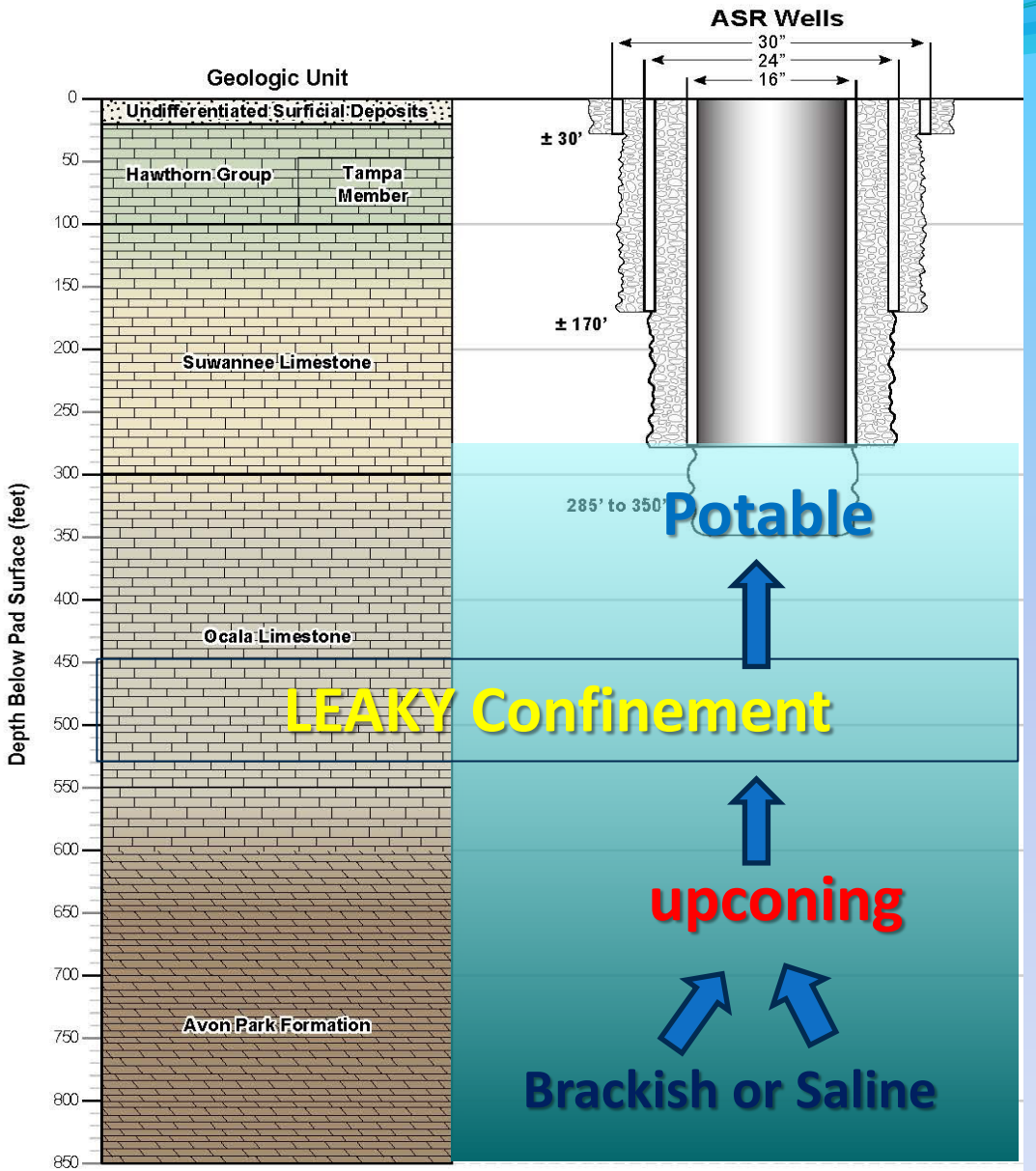
data below the laboratory method dection limit (MDL) is graphed as 0, values between the MDL and practical quantitation limit (PQL) is shown as a real value

Summary of Successful Operation

- City of Tampa Rome Avenue Park ASR
  - operating for over 20 years
  - capable of providing up to 10 MGD of water during dry season
- Peace River Facility ASR
  - has been in operation over 40 years
  - provides storage resilience during the dry season
  - 21 ASR wells up to 1 MGD each
- City of Bradenton Bill Evers WTP ASR-2
  - successfully implemented a DO removal system to mitigate arsenic mobilization
  - receive operation permit after two cycle tests
  - provide approximately 1 MGD during dry season

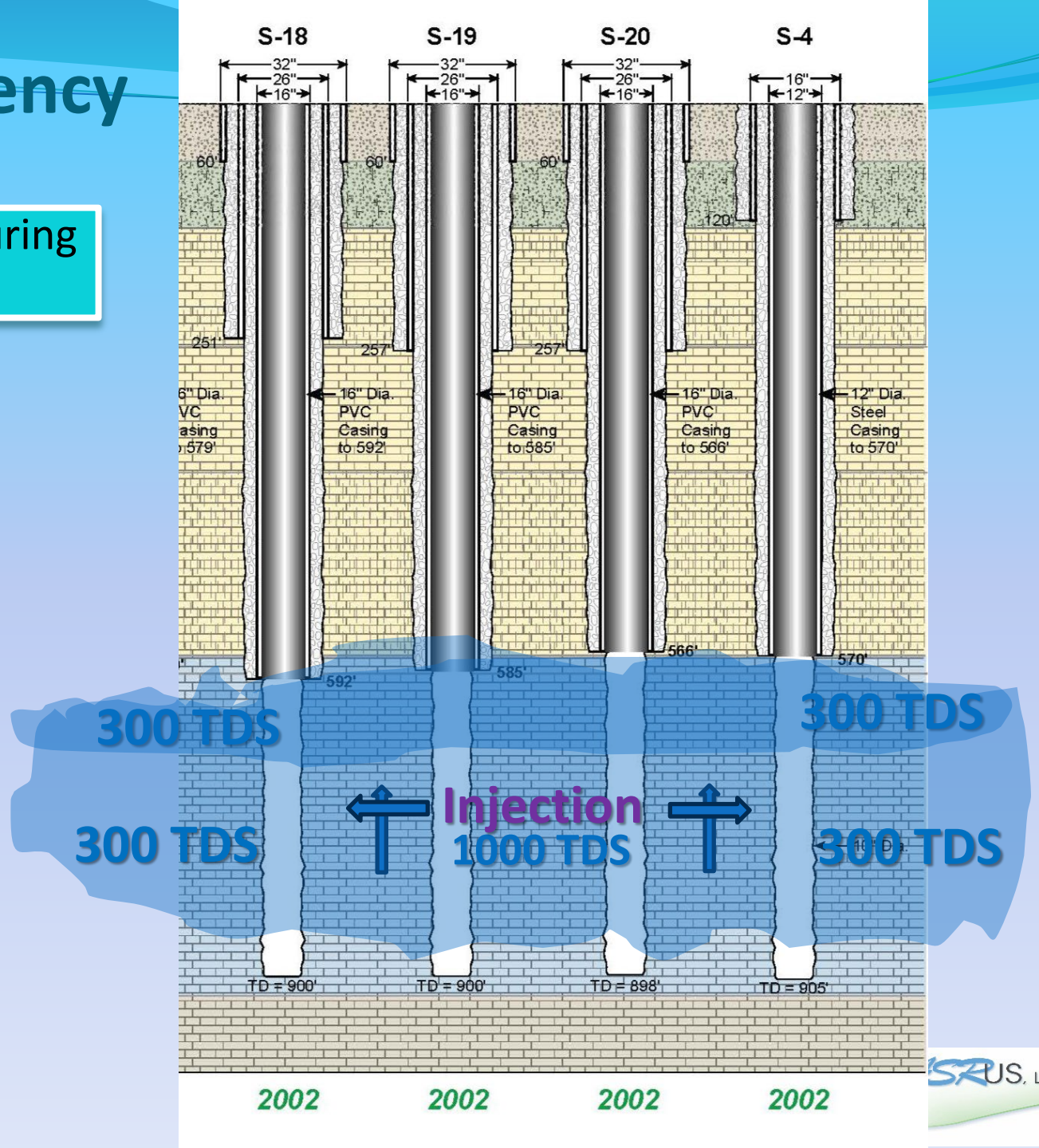
Recovery Efficiency

- Targeted zones often within leaky aquifers
- Transition zone to brackish or saline water is often near the base of the ASR well
- Under significant pumping stresses may induce upconing



Recovery Efficiency

Density Stratification during storage periods



Recovery Efficiency

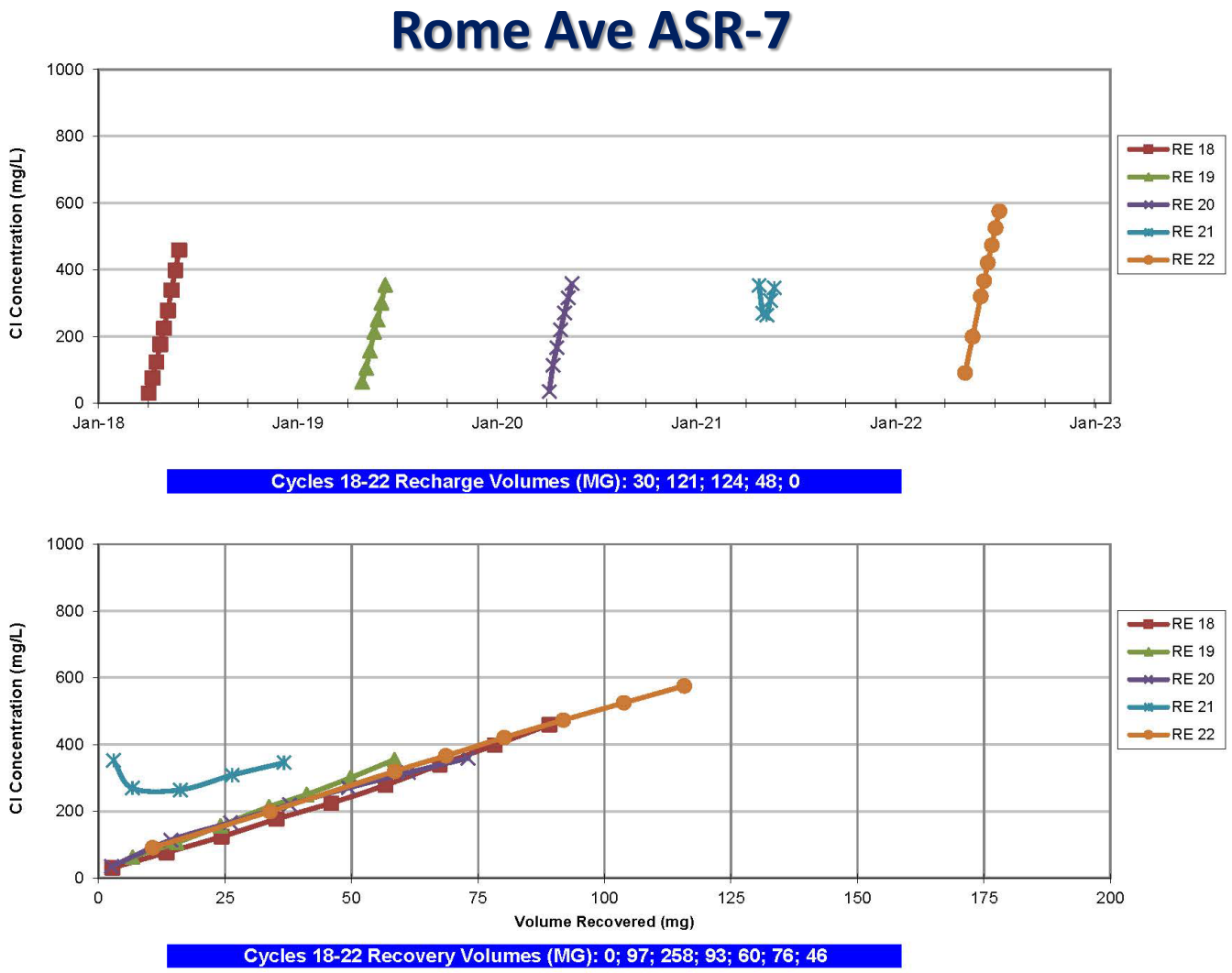
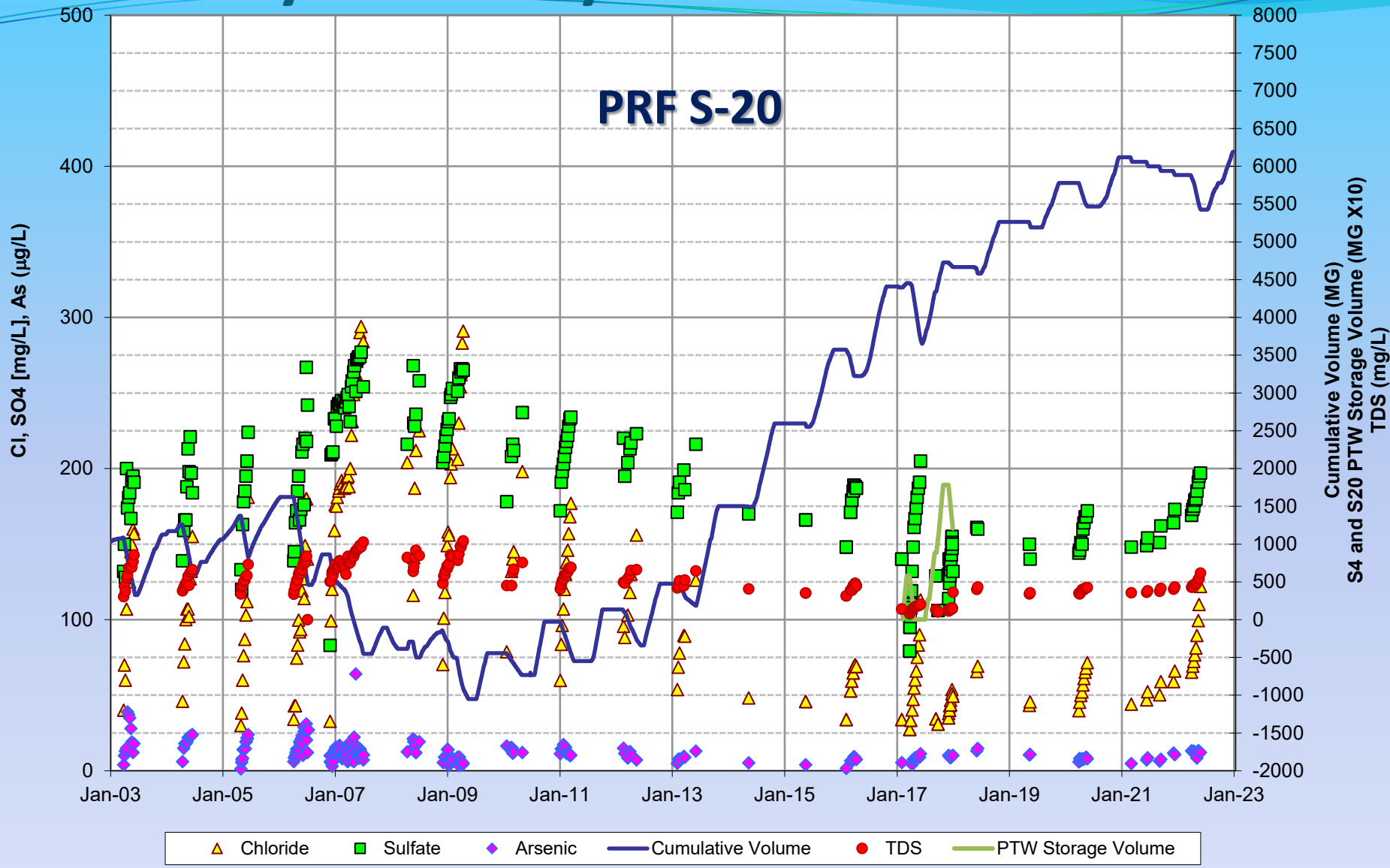


Figure 4-13
ASR-7 Chloride - Cycles 18-22

Recovery Efficiency



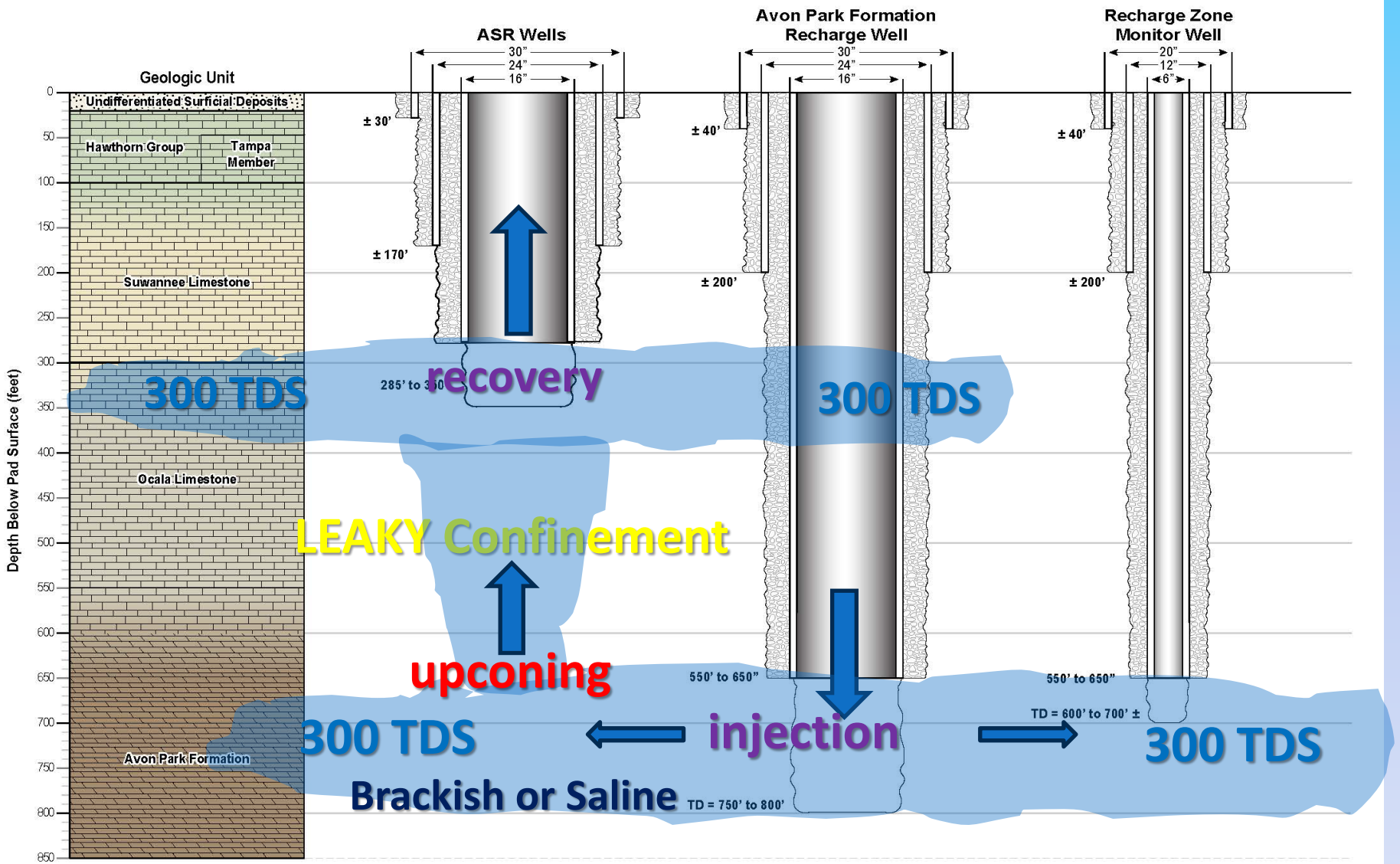
Recovery Efficiency Impact

- Limited recovery volumes
- Added operational cost
- Requires blending capacity
- Native groundwater in the recovered water may have other quality issues (e.g. H2S, bromide)

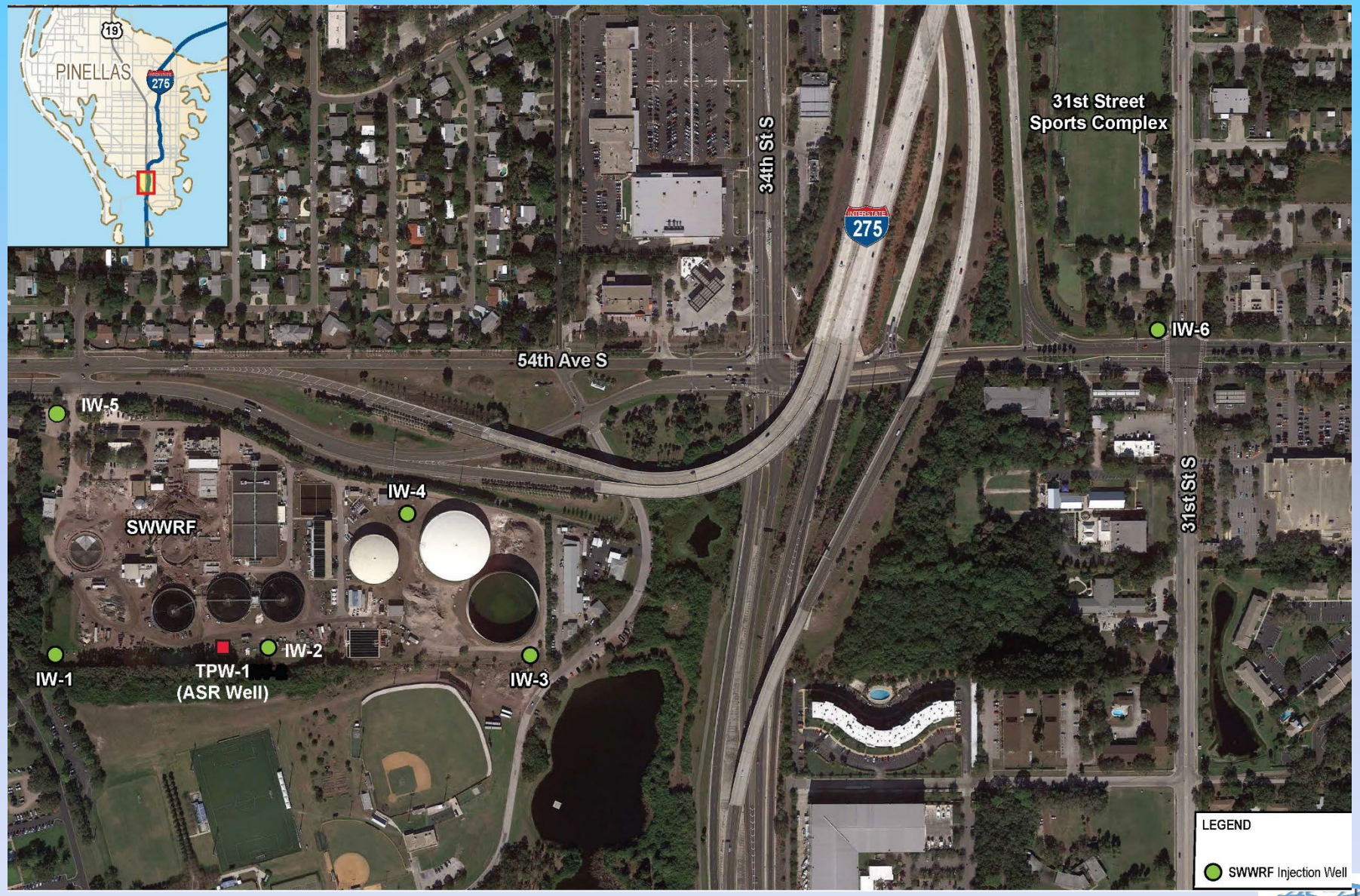
Strategies to Improve Recovery Efficiency

- ASR storage interval with excellent confinement above and below
- ASR zone in area a greater separation from salinity transition zone
- Groundwater offsets for water “left behind” – potential for additional groundwater use allocation elsewhere
- AR and ASR combination

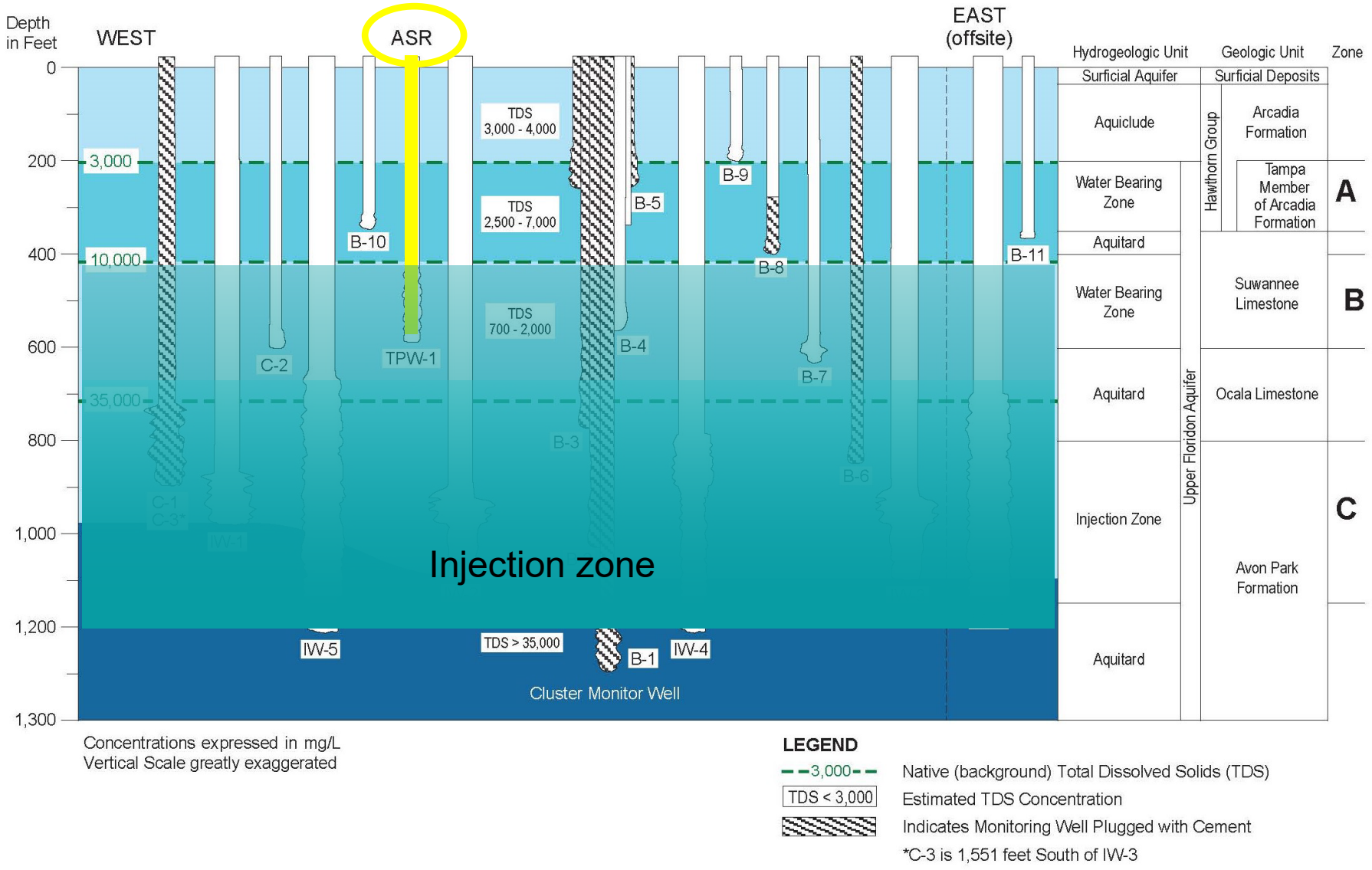
ASR Aquifer Recharge Combination



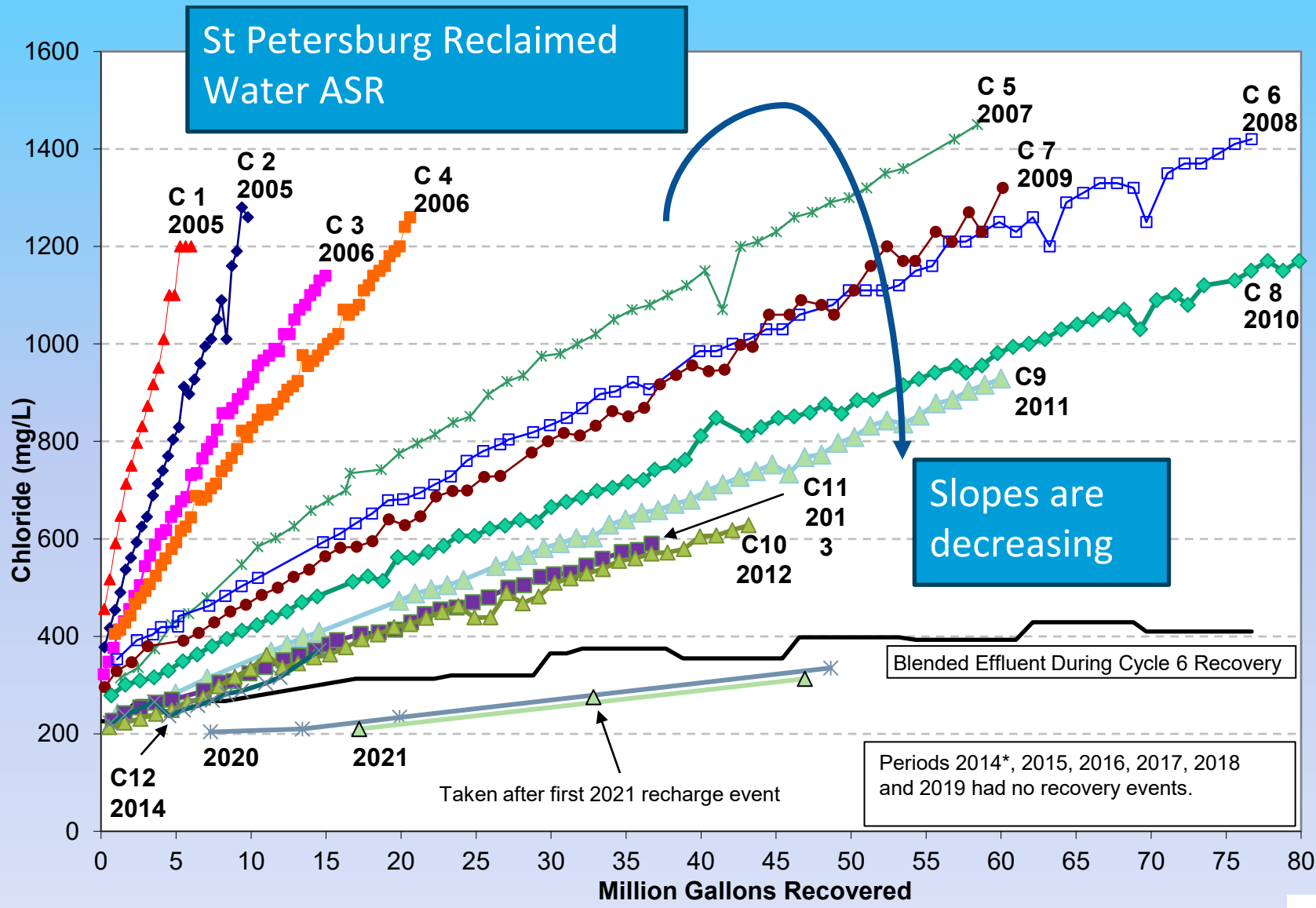
Example – City of St Petersburg Reclaimed ASR



City of St Petersburg SWWRF ASR



Upward Migration Made ASR Feasible



Partially Treated Surface Water

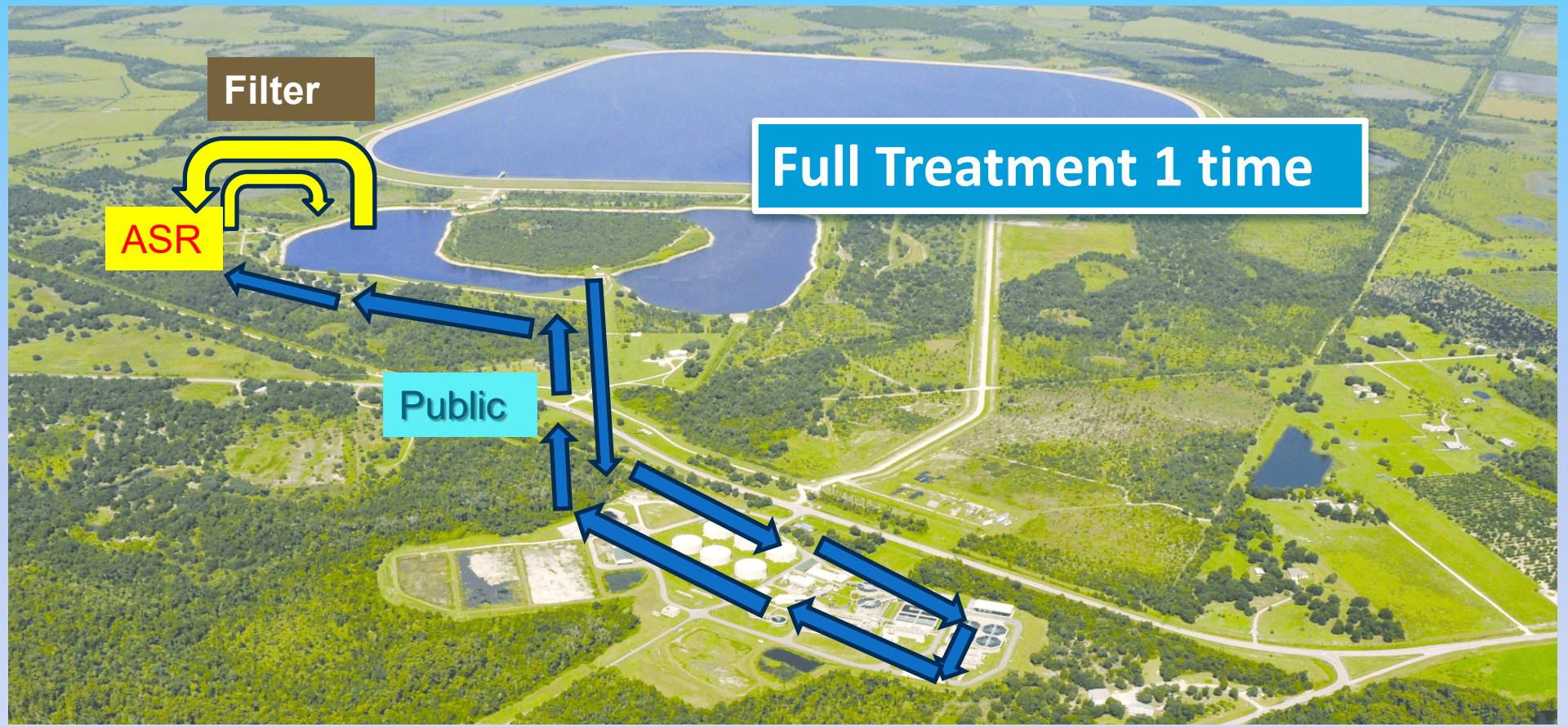
For ASR to be cost competitive with other storage options must find a way to reduce cost

ASR generally requires full treatment twice = double the treatment cost

AND

Recovery efficiency may only allow 50-70% of invested water

Partially Treated Surface Water Peace River Facility



Partially Treated Surface Water Peace River Facility

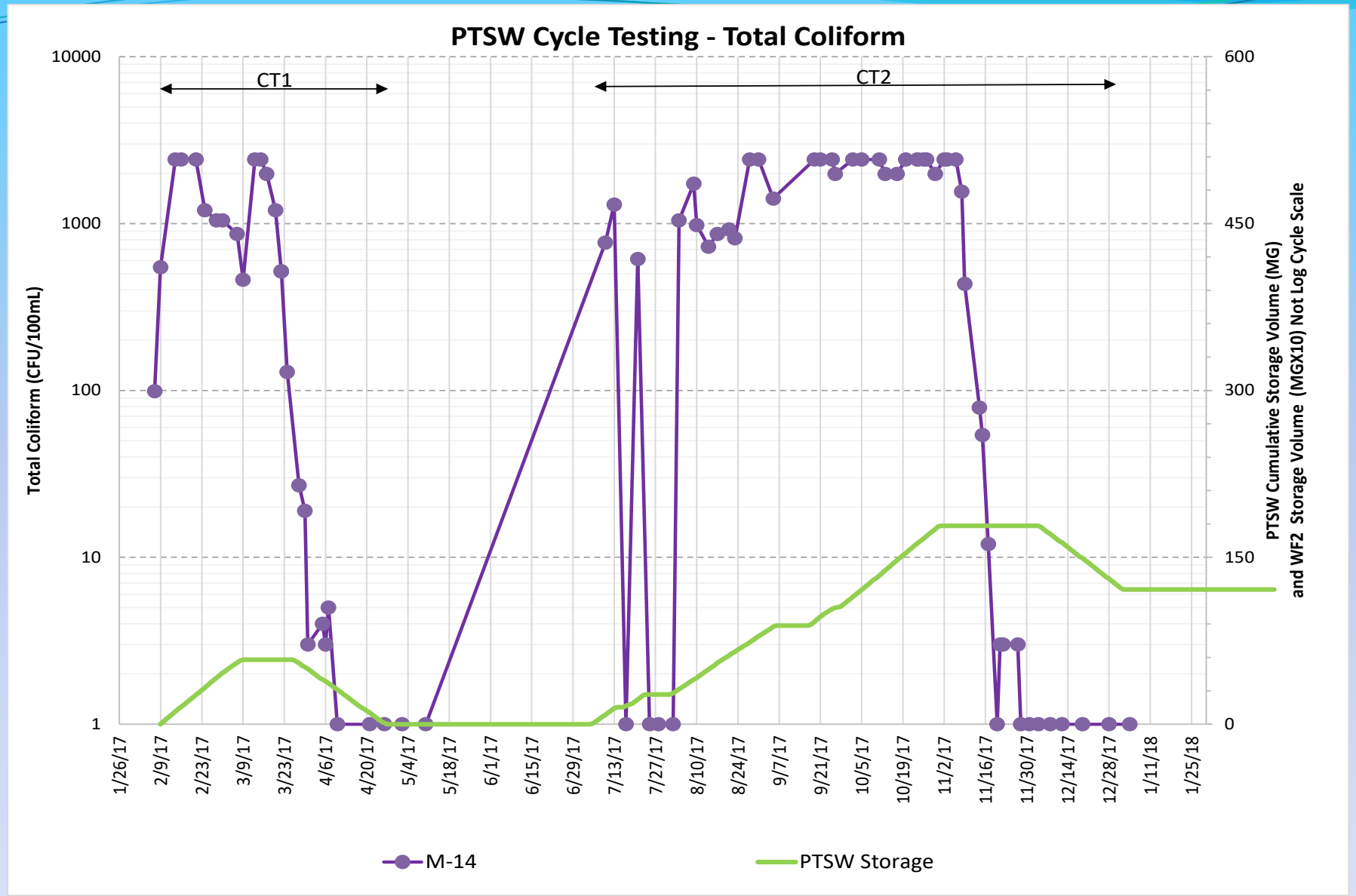
Regulations

- Total coliform standard for groundwater discharge in Florida is 4 colony forming units per 100 milliliter (CFU/100mL)

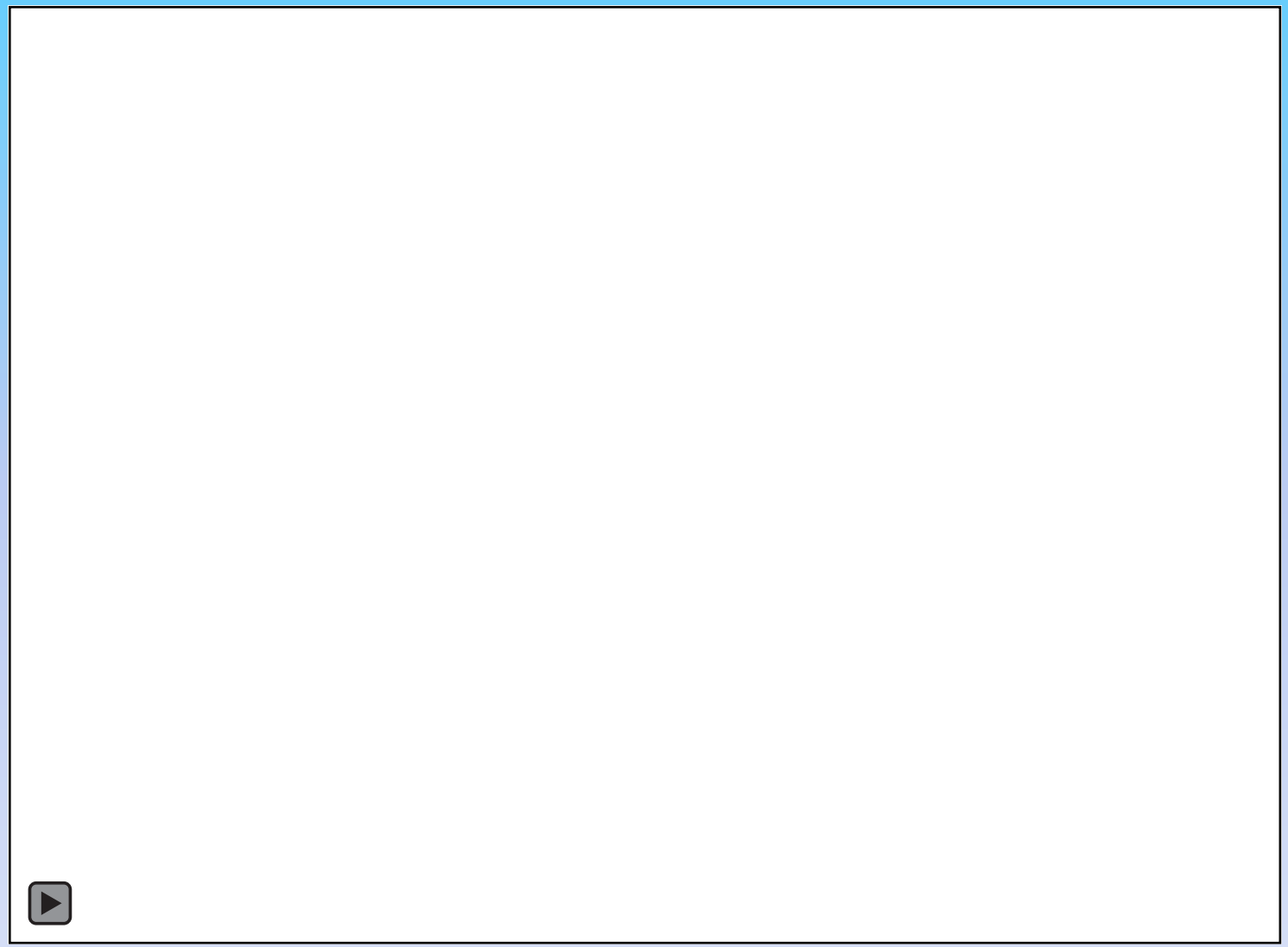
Pilot Test in 2017

- Received zone of discharge (ZOD) for total coliform from FDEP to perform pilot test to demonstrate inactivation of coliform in subsurface
- Conducted two Cycle Tests using reservoir water (filtered only)

Partially Treated Surface Water Cycle Test Results



Natural Groundwater Recharge



Source: USGS Bill Lewelling

Questions