

2016
**Membrane
Technology**
CONFERENCE & EXPOSITION



Time to Clean Again?

Changes in Cleaning Frequency and Effectiveness at the
Richard A. Reynolds Groundwater Desalination Facility

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SPI

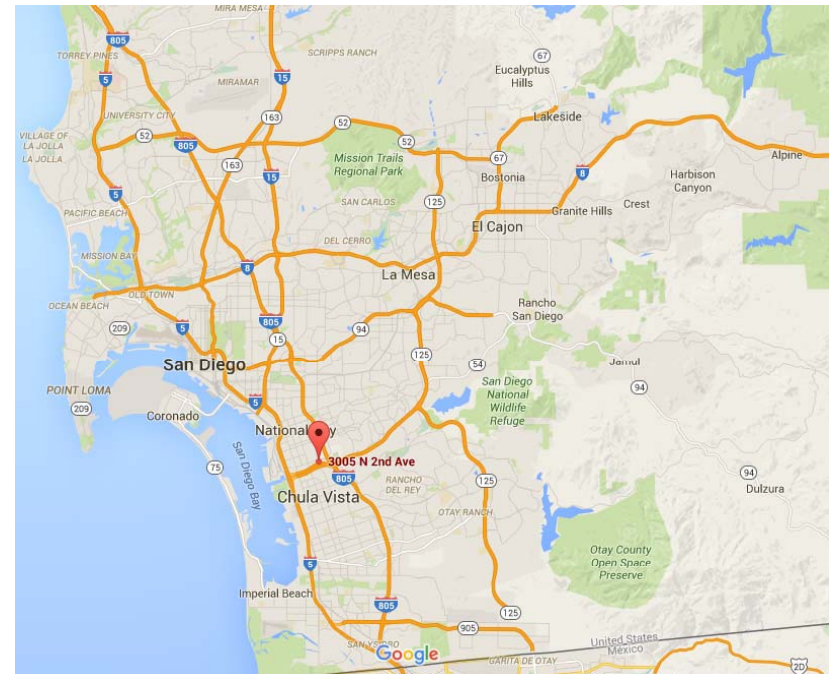
Overview

- Agency and Facility Background
- Historical Operating Data
- Cleaning History
- Cleaning Effectiveness
- Cleaning Investigation and Optimization
- Summary



Background: R.A.R. Facility

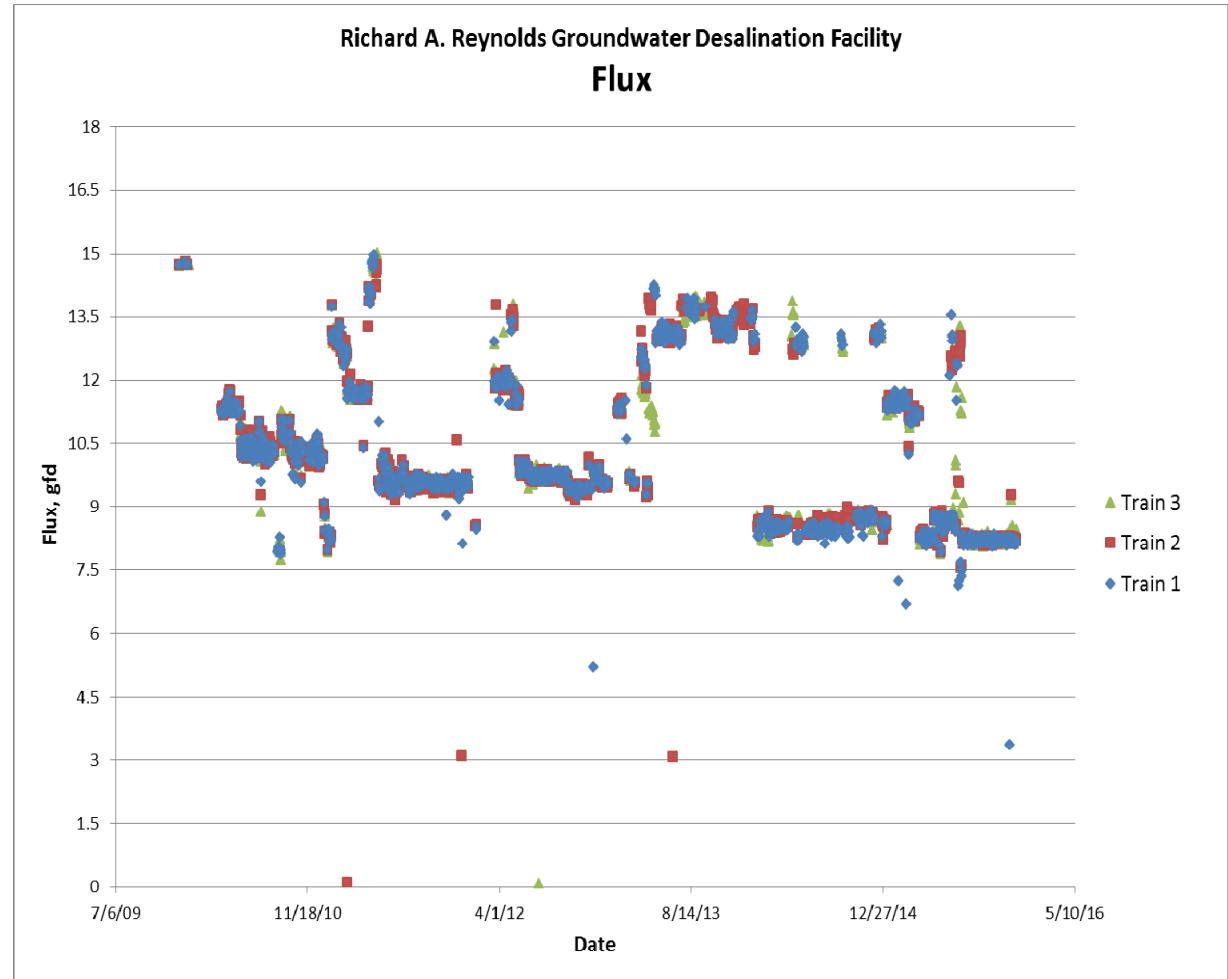
- Maximum daily production of 4 mgd sourced from six brackish groundwater wells
- Final product water quality goals:
 - TDS < 500 mg/l
 - Chloride < 250 mg/l
 - Manganese < 0.05 mg/l
- 3 RO trains in a 20:10 array at 81% recovery
- Bypass blend water is treated through an iron and manganese removal system
- Current membranes are Toray TMG20-400C installed in January 2010
- Upcoming expansion will add five new brackish groundwater wells and increase capacity to 10 mgd



Historical Operating Data

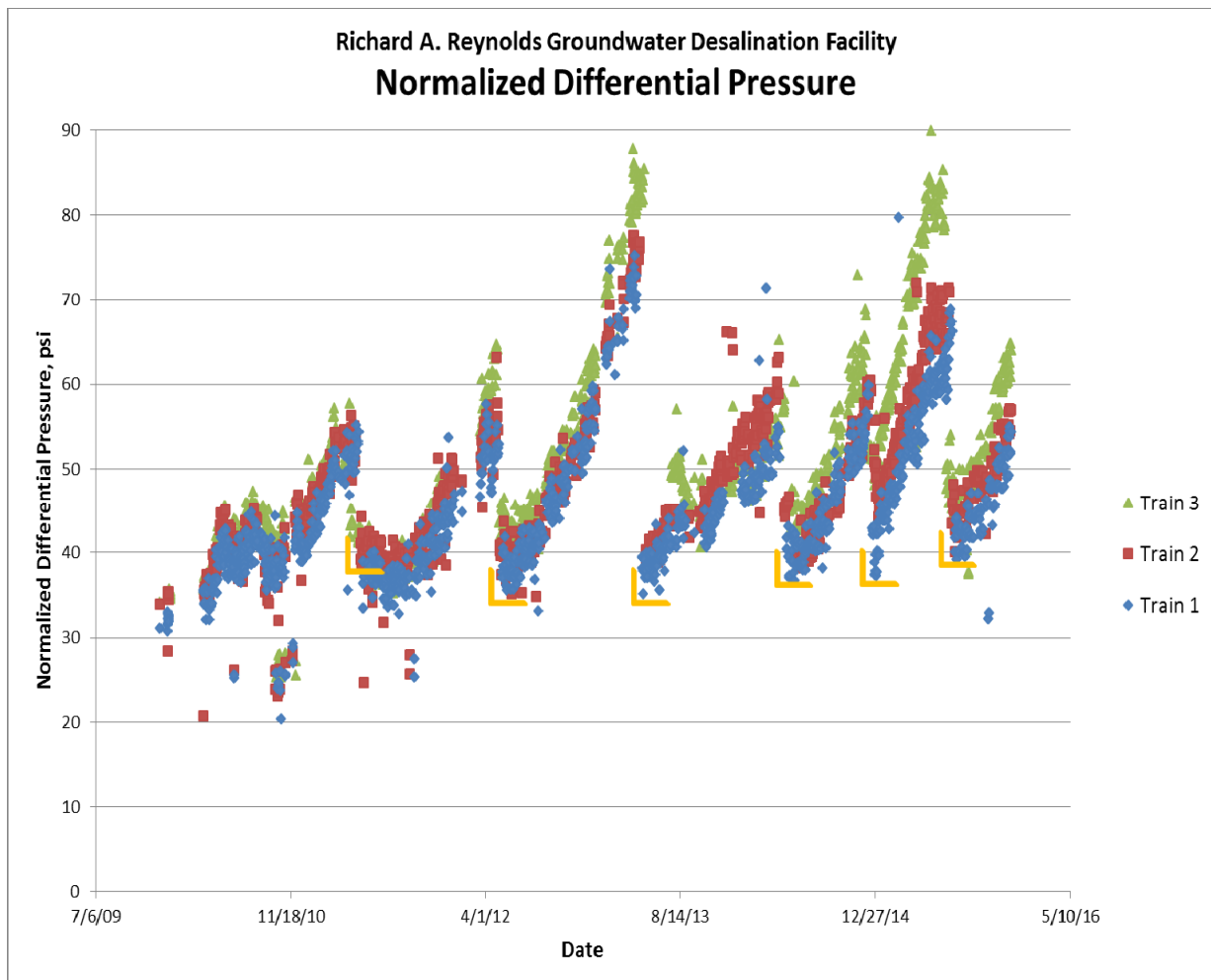
Typical Operating Conditions:

- Dry season flux: 9.5 gfd
- Wet season flux: 12-14 gfd



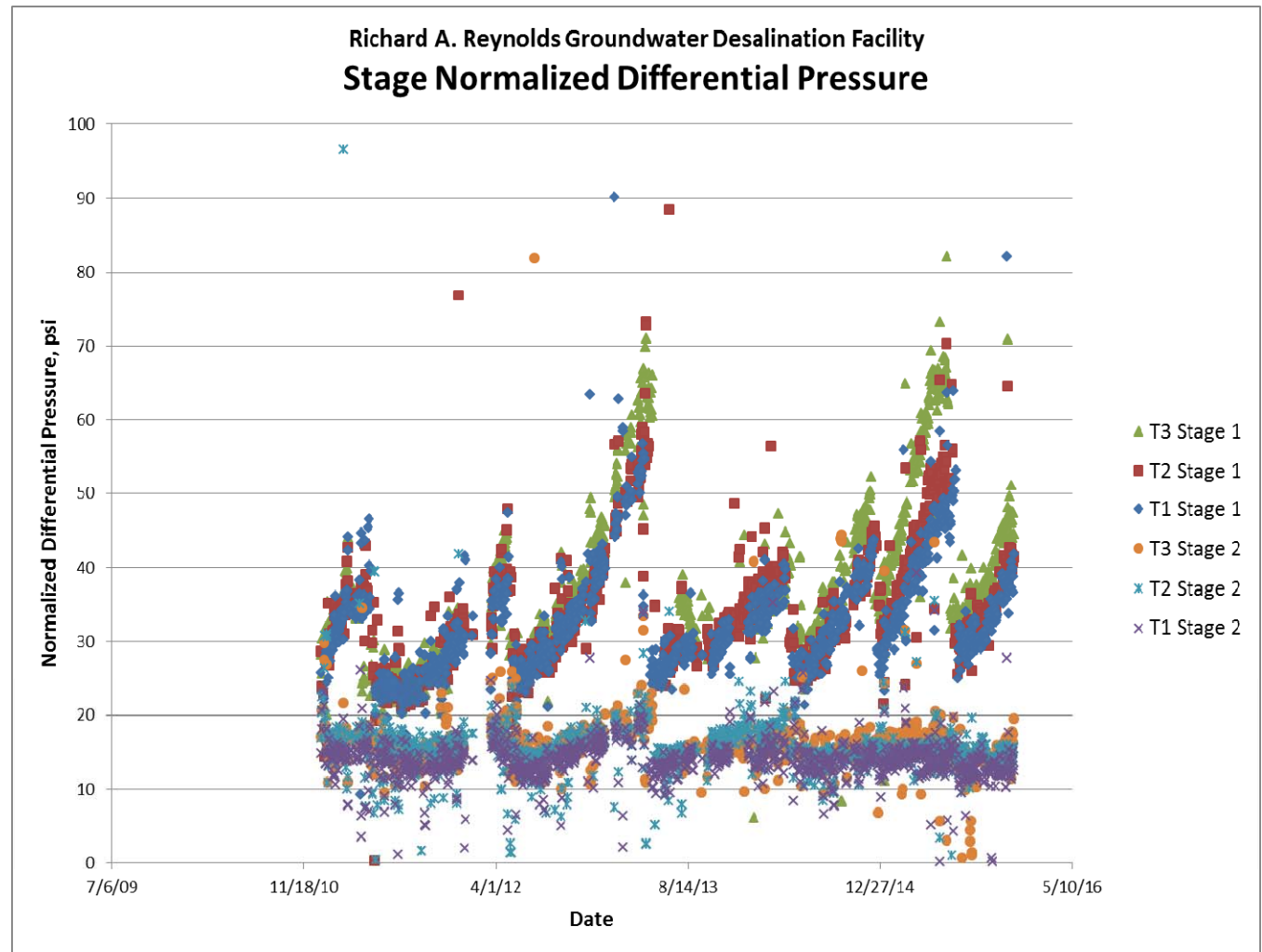
Historical Operating Data

Membrane cleaning has been initiated based on significant increases in normalized differential pressure values.



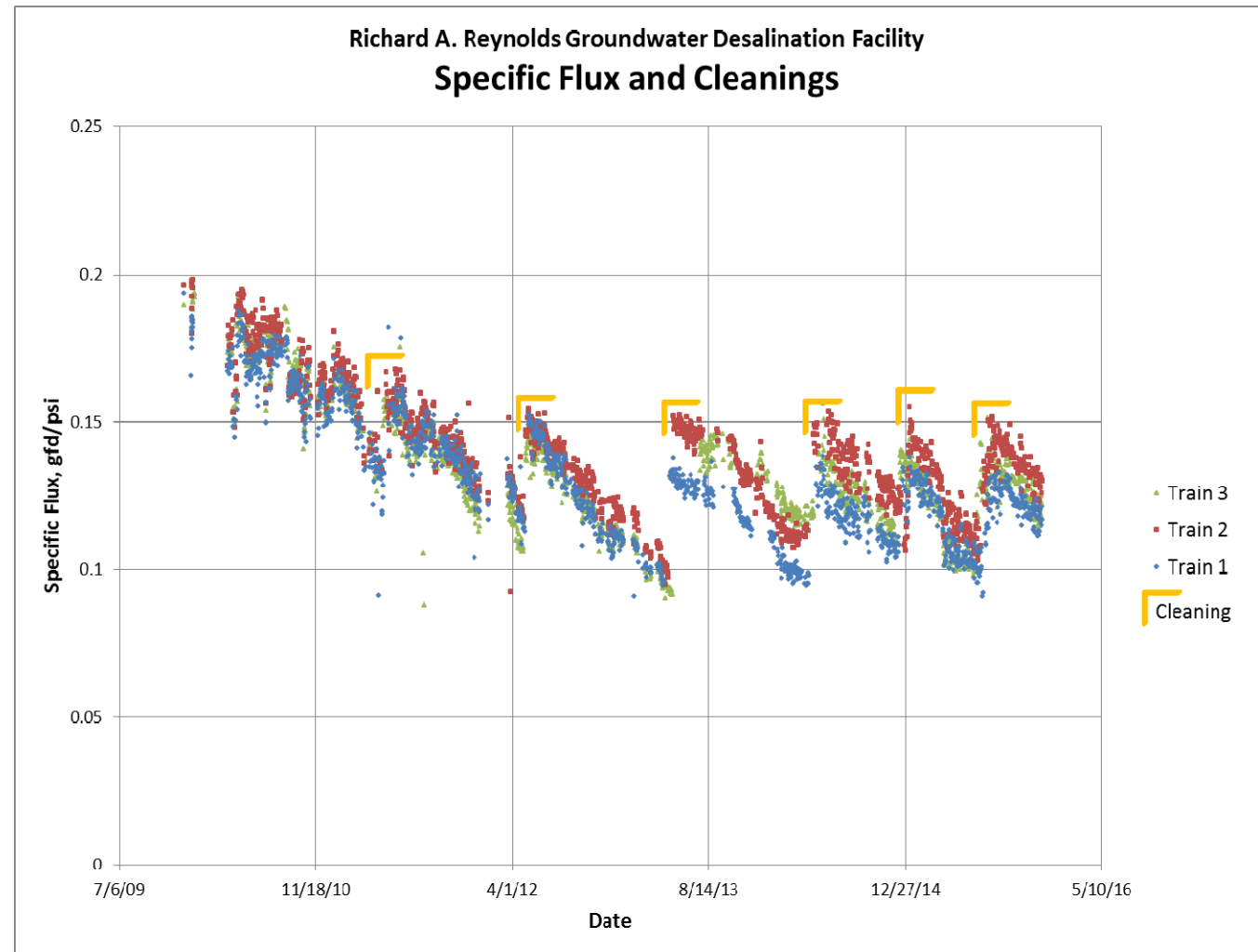
Historical Operating Data

Increases in differential pressure are localized in the first stage.



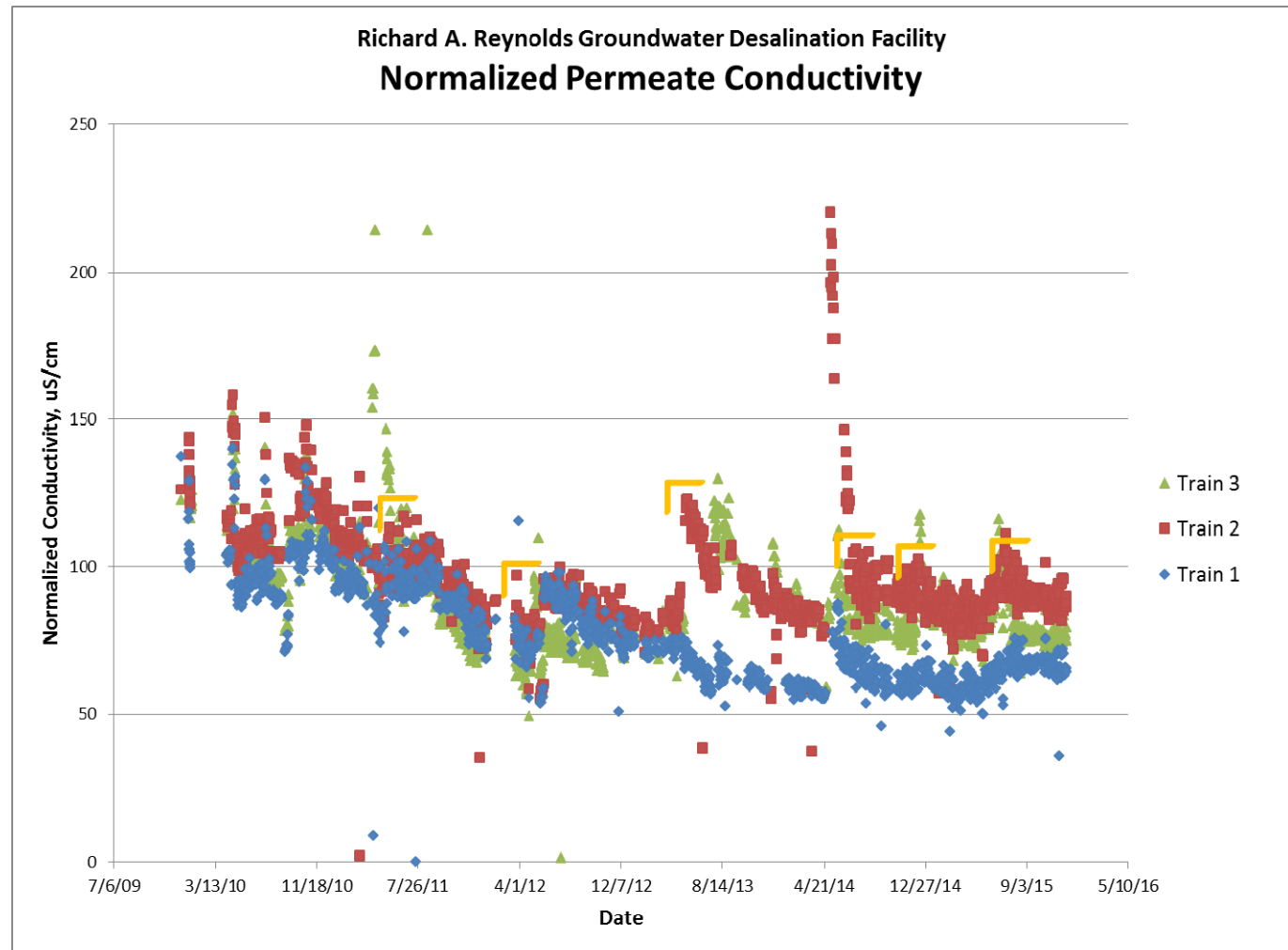
Historical Operating Data

There has been a consistent decline in specific flux.



Historical Operating Data

Normalized permeate conductivity values have actually improved over time.



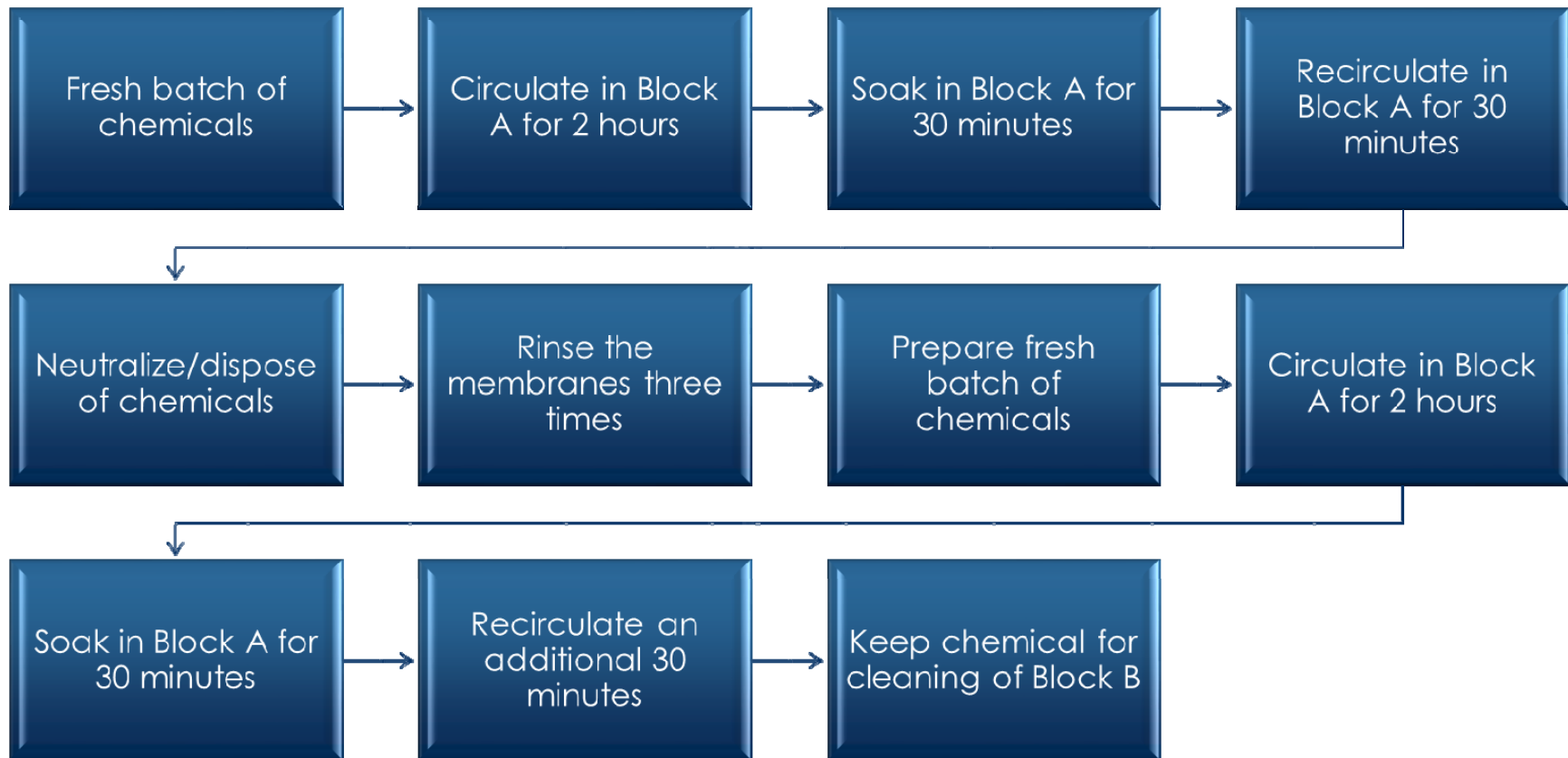
Cleaning History

Date	Train 1	Train 2	Train 3
May 2011	1 st stage only Avista P303	1 st stage only Avista P303	1 st stage only Avista P303
May 2012	1 st stage only Avista P303	1 st stage only Avista P303	1 st stage only Avista P303
May 2013	1 st and 2 nd stage Avista P303	1 st and 2 nd stage Avista P130	1 st stage only Avista P130
May 2014	1 st stage twice 2 nd stage once Avista P130	1 st stage twice 2 nd stage once Avista P130	1 st stage twice 2 nd stage once Avista P130
December 2014	1 st stage twice 2 nd stage once Avista P130	1 st stage twice 2 nd stage once Avista P130	1 st stage twice 2 nd stage once Avista P130
June/July 2015	1 st stage twice 2 nd stage once Avista P130	1 st stage twice 2 nd stage once Avista P130	1 st stage twice 2 nd stage once Avista P130



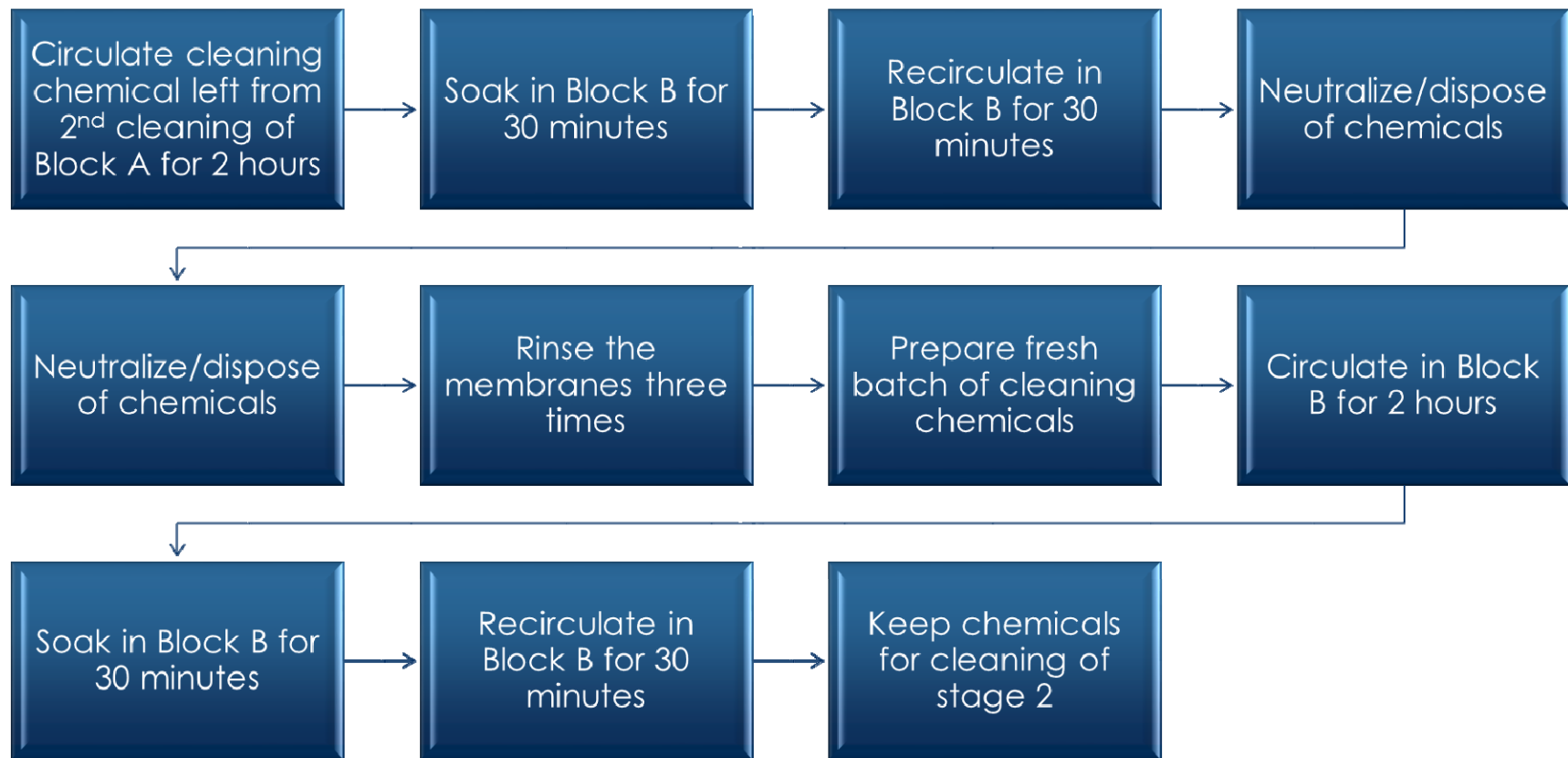
Cleaning History

Cleaning Procedure: Stage 1 Block A



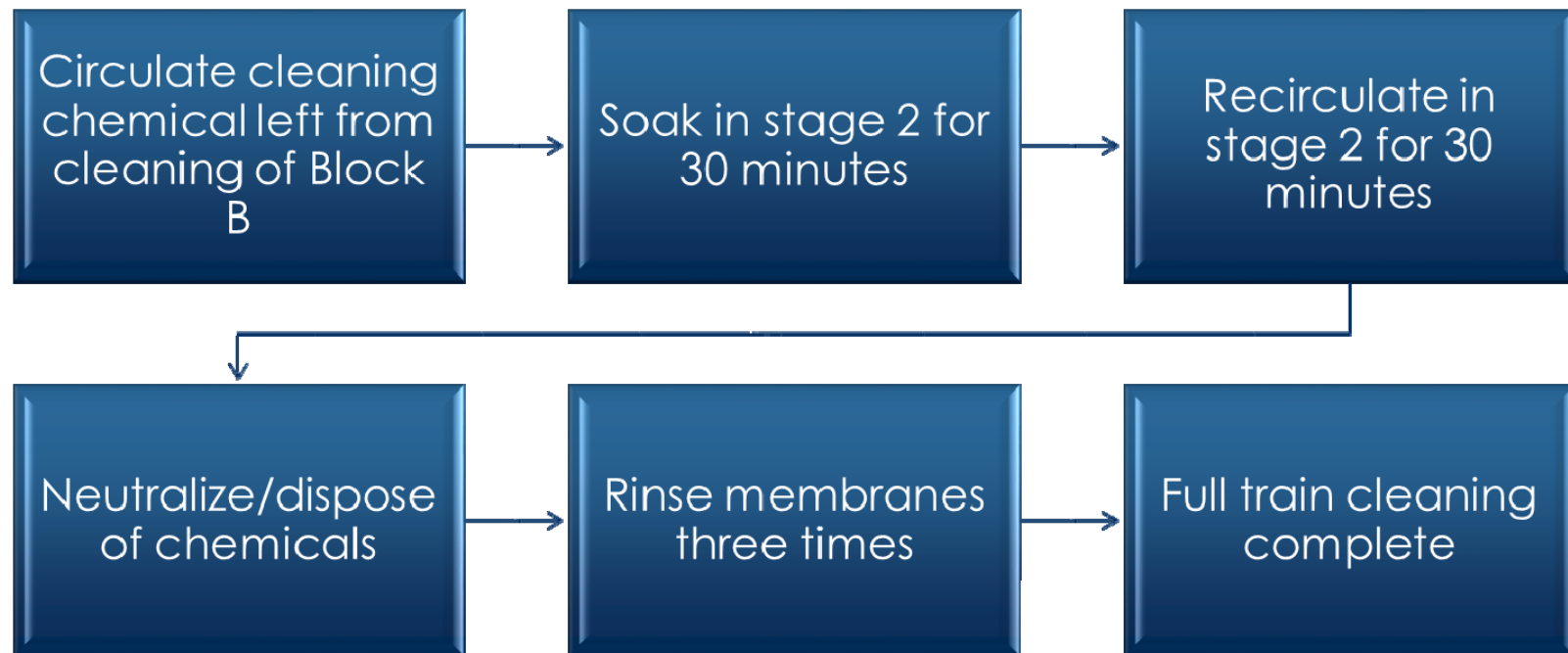
Cleaning History

Cleaning Procedure: Stage 1 Block B



Cleaning History

Cleaning Procedure: Stage 2



Cleaning History

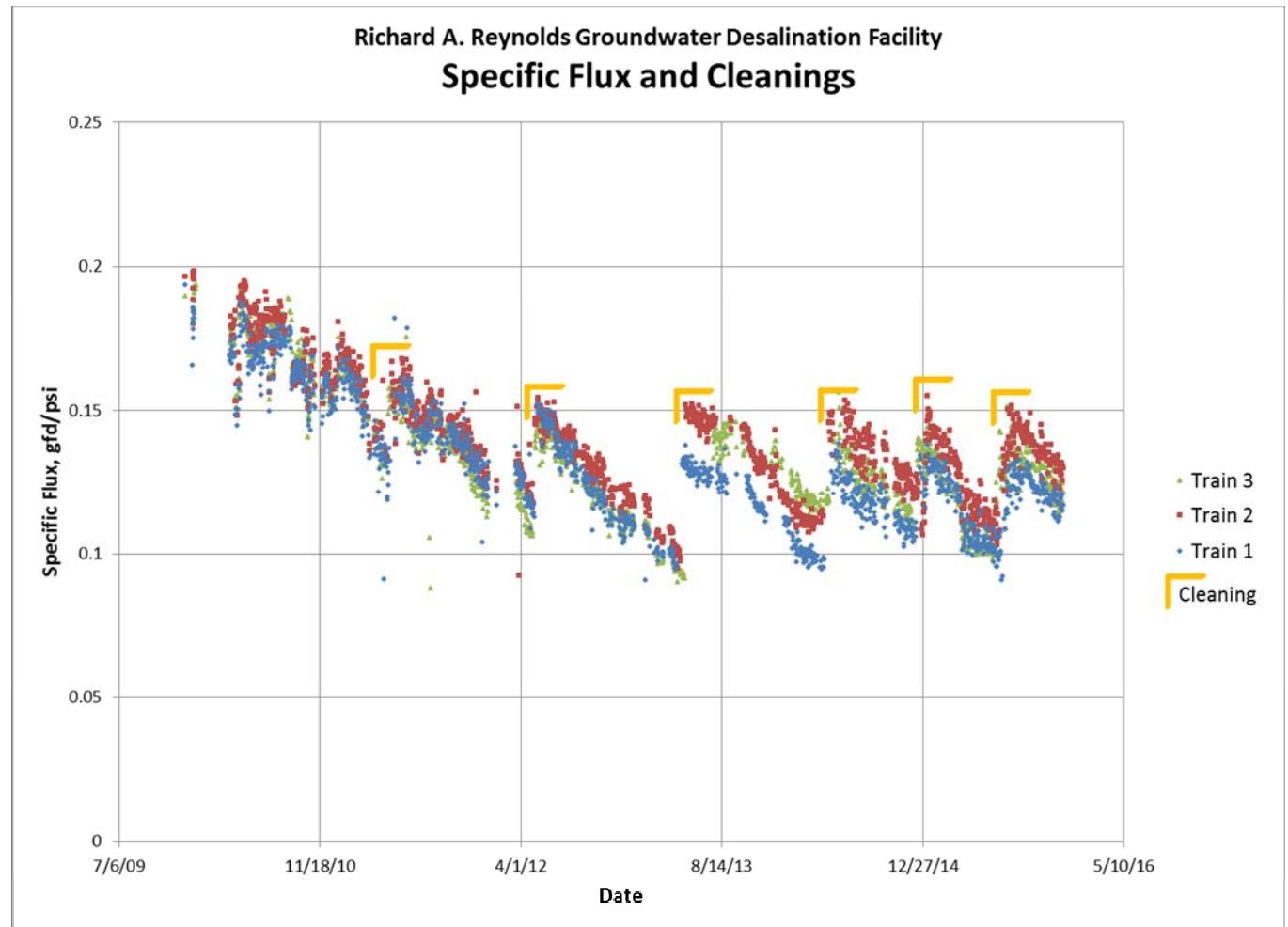
- Cleaning Results

- Initial cleaning interval was 1 year and cleanings were performed with the Avista RoClean P303 cleaner.
- The third cleaning of train 1 in 2013 yielded less effective results which prompted a cleaning investigation and element autopsies
- Cleaning trials were performed by Avista and a new cleaner for the third clean (2013) of trains 2 and 3 was selected, Avista P130.



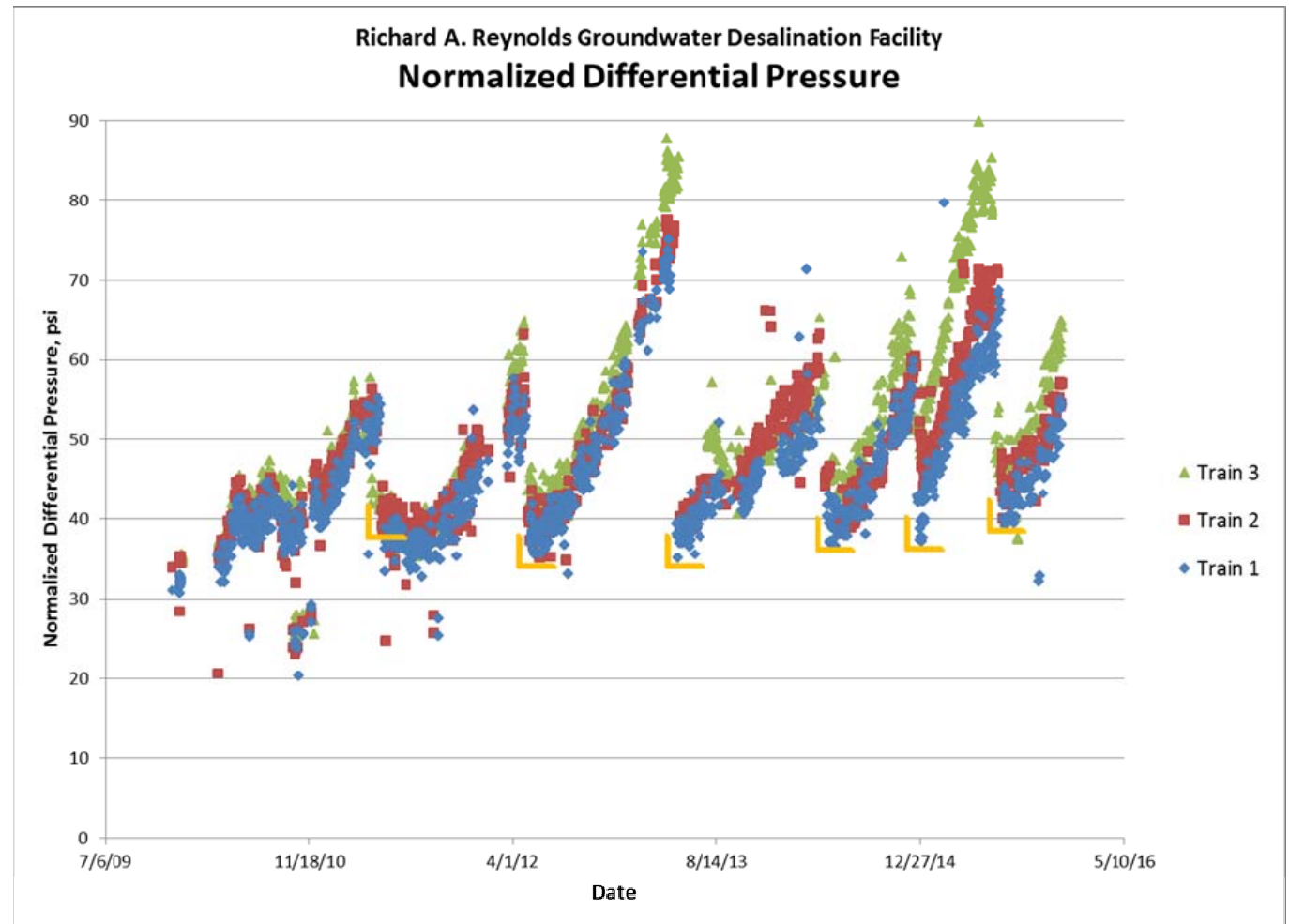
Cleaning Effectiveness

Specific Flux



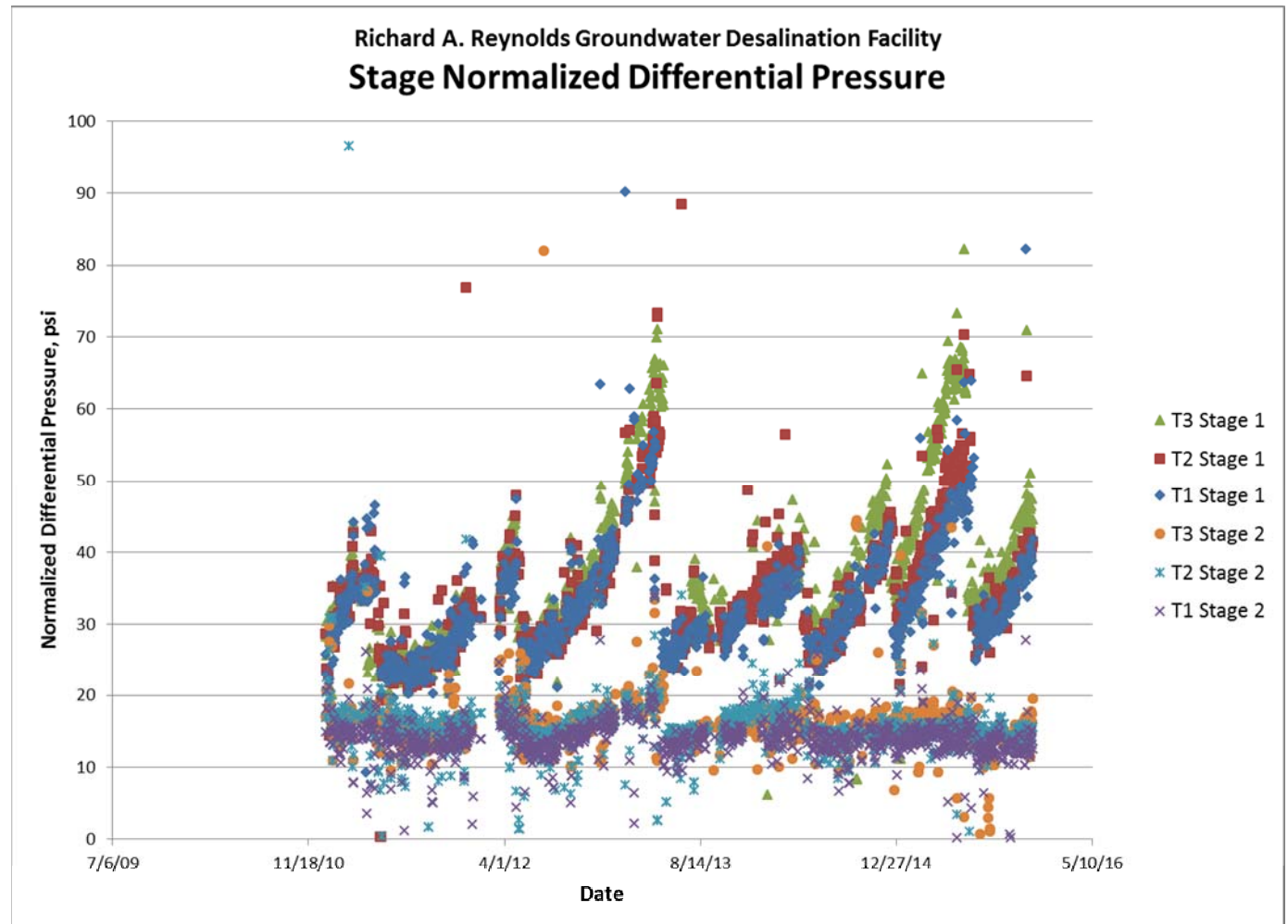
Cleaning Effectiveness

Overall
Normalized
Differential
Pressure



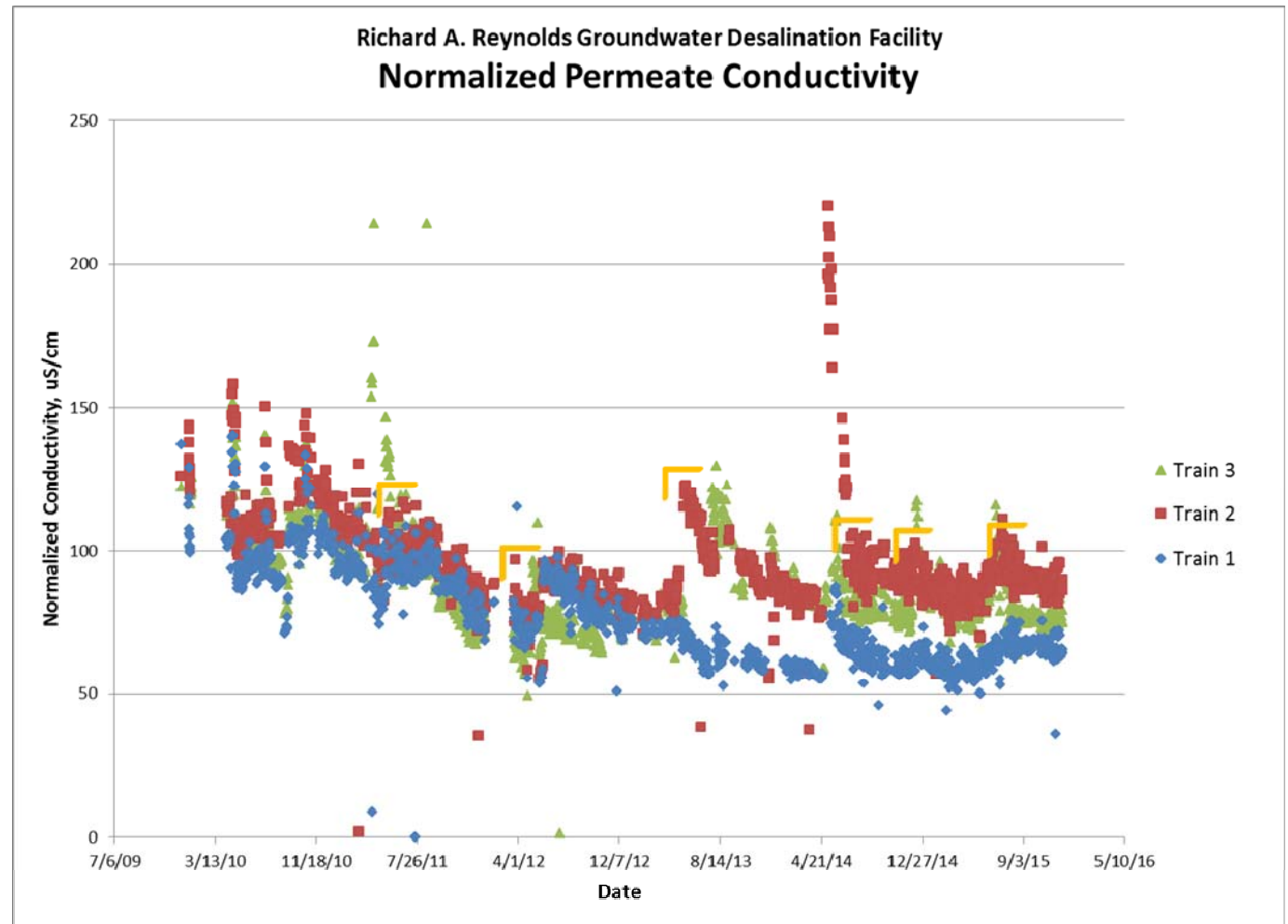
Cleaning Effectiveness

Stage
Normalized
Differential
Pressure



Cleaning Effectiveness

Normalized Permeate Conductivity



Cleaning Investigation and Optimization

Membrane autopsies revealed heavy iron fouling and physical damage.



Feed ATD (left) and concentrate ATD (right)

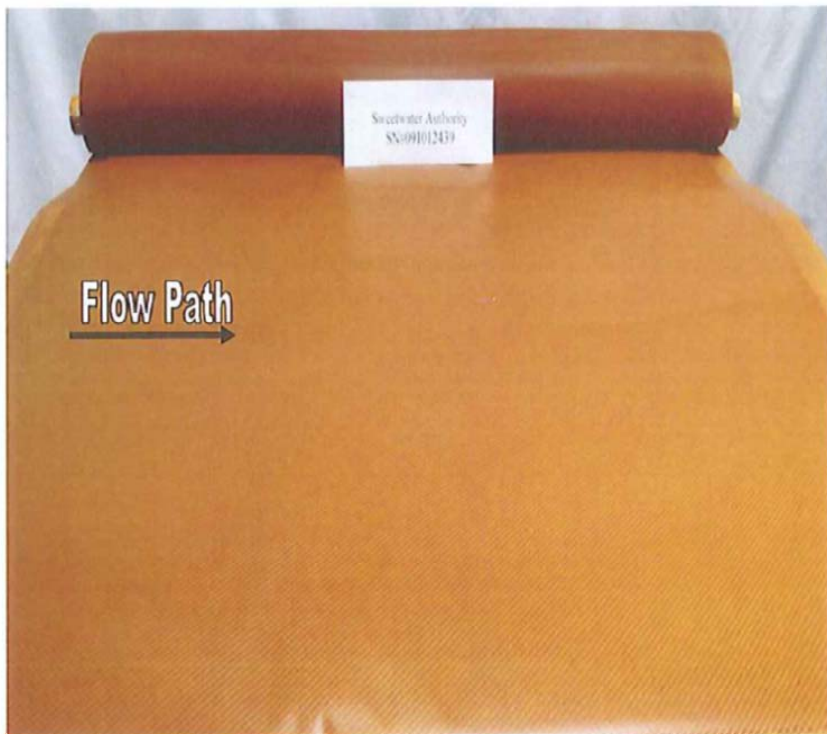


Feed scroll end (left) and concentrate scroll end (right) of SN#091012439



Cleaning Investigation and Optimization

The membrane surface
of a lead element in the first stage.



Exposed membrane surface for SN#091012439



Image of membrane surface from feed end for SN# 091012439



Cleaning Investigation and Optimization

The membrane surface
of an element in the second stage



Exposed membrane surface for SN#090910283



Image of membrane surface from feed end



Cleaning Investigation and Optimization

Wet test data for elements removed from a first stage vessel

Position	Serial #	Test	Delta psi	Normalized Flow	Normalized Reject %	Weight lbs.	Notes
1	101011381	Pre-Clean	25	3.06	98.3	43	Iron/Separated Vexar
		Post-Clean	6	5.73	98.4		Iron/Separated Vexar
2	091032348	Pre-Clean	13	3.61	95.7	40	Iron/Separated Vexar
		Post-Clean	5	5.67	97.0		Iron/Separated Vexar
3	091012480	Pre-Clean	10	3.26	98.9	36	
		Post-Clean	5	6.20	99.1		Iron
4	091021639	Pre-Clean	14	3.95	99.2	37	
		Post-Clean	5	5.50	99.2		Iron
5	091012472	Pre-Clean	6	4.83	99.0	35	
		Post-Clean	3	5.97	99.2		
6	091032345	Pre-Clean	7	5.04	98.9	35	
		Post-Clean	5	6.07	99.1		
7	091032337	Pre-Clean	7	5.07	98.6	35	Fouling/Organic
		Post-Clean	4	5.93	99.0		Fouling/Organic



Cleaning Investigation and Optimization

Wet test data for elements removed from a second stage vessel

Position	Serial #	Test	Delta psi	Normalized Flow	Normalized Reject %	Notes
1	090910267	Pre-Clean	7	5.08	98.2	
		Post-Clean	3	6.06	99.0	
2	091011539	Pre-Clean	7	5.19	98.7	
		Post-Clean	3	6.05	99.0	
3	091021614	Pre-Clean	7	5.19	98.6	
		Post-Clean	3	6.02	99.1	
4	091011465	Pre-Clean	7	5.27	99.2	
		Post-Clean	3	6.00	99.2	
5	091021598	Pre-Clean	7	5.60	99.1	
		Post-Clean	3	6.30	99.1	
6	091021566	Pre-Clean	7	5.60	99.0	
		Post-Clean	3	6.06	99.1	
7	091021634	Pre-Clean	6	5.04	98.6	
		Post-Clean	5	6.00	98.0	Fouling/Organics



Cleaning Investigation and Optimization

- High pH cleaning test

- Two lead elements from a first stage vessel and one tail end element from a second stage vessel were removed from train 3 and cleaned with a high pH cleaner.
- Results of the test showed no significant improvement in normalized flow or rejection following the high pH clean.

Position	Serial #	Test	Delta psi	Normalized Flow (gpm)	Normalized Reject %	Notes
1	091021585	Pre-Clean	5	5.08	97.4	Extruding Vexar
		Post-Clean	5	6.19	92.4	
1	101011381	Pre-Clean	5	5.06	98.4	
		Post-Clean	5	6.07	98.5	
14*	90910267	Pre-Clean	6	6.05	99.0	
		Post-Clean	6	6.33	99.1	



Summary

- Changes in the fouling behavior and the resulting diminishing effectiveness of the P303 cleaner suggested that the nature of the foulant had changed over the first three years of plant operation.
- Membrane autopsies, cleaning studies, and element replacements were initiated to address increases in the fouling rate from 2013 to 2015.
- After identifying the foulant and where the fouling was occurring, a new cleaning product was selected, Avista P130, which yielded more effective results.
- The cleaning procedure was optimized and the fouling rates stabilized.



Questions?

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