Results of Full-Scale 1,4-Dioxane Synthetic Media Groundwater Remediation System

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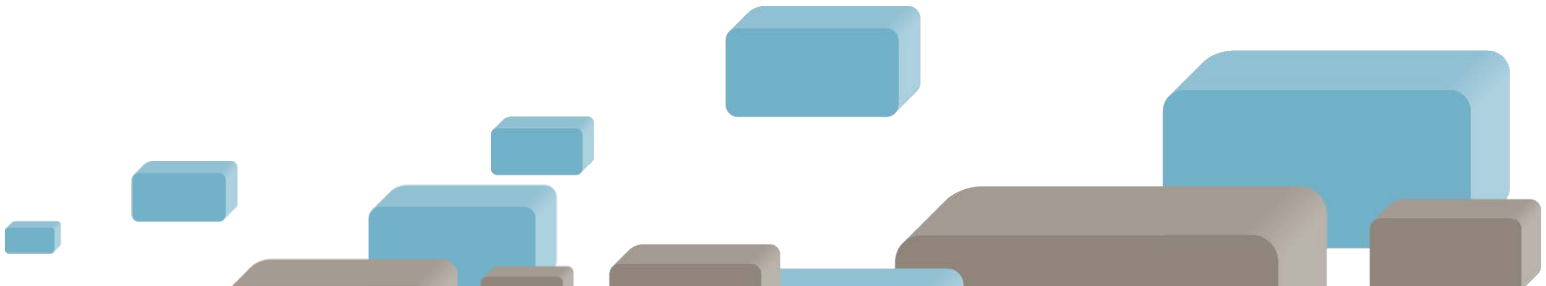
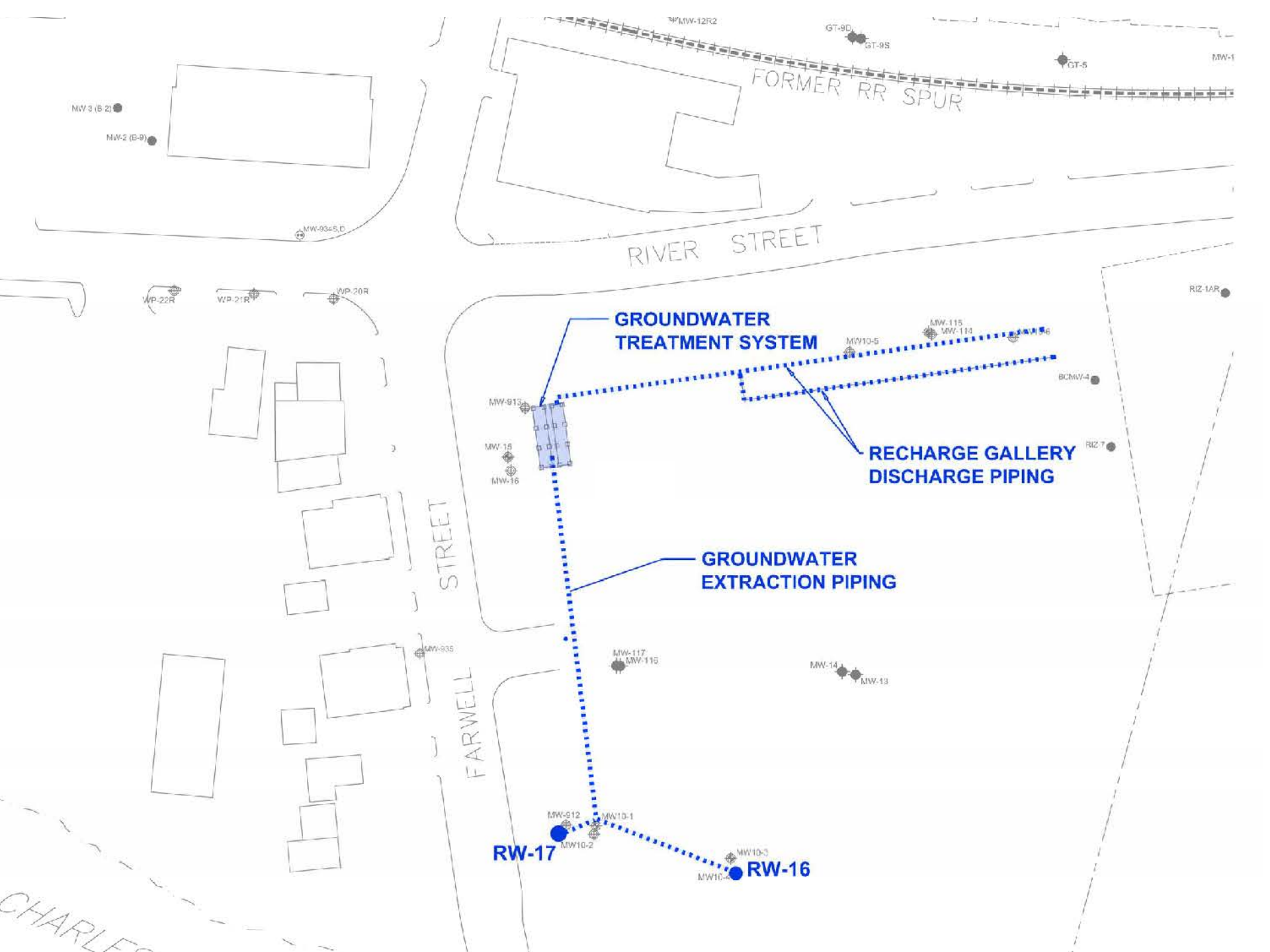


Background

- Site located in Waltham, Massachusetts
- Contaminated groundwater remediation
- Design basis
  - Flow = **15 gpm**
  - 1,4-dioxane = **20 - 60 µg/l**
  - Total Chlorinated VOCs **= 2,000 – 9,000 µg/l**
- Modular system design for future relocation
- 1,4-dioxane permit limits
  - Originally 3.0 µg/l
  - **Now 0.3 µg/l**


GROUNDWATER
TREATMENT SYSTEM
RECHARGE GALLERY
DISCHARGE PIPING
GROUNDWATER
EXTRACTION PIPING
RW-17
RW-16
FORMER RR SPUR
RIVER STREET
FARWELL
STREET
MW-12R2
GT-9D
GT-9S
GT-5
MW-1
MW-3 (B-2)
MW-2 (B-9)
MW-9345,D
WP-22R
WP-21R
WP-20R
RIZ-1AR
MW-115
MW-114
MW10-5
BCMW-4
RIZ-7
MW-913
MW-15
MW-16
MW-935
MW-117
MW-116
MW-14
MW-13
MW-912
MW10-1
MW10-2
MW10-3
MW10-4

Project Objectives

1. Provide long-term contaminant migration control

2. Achieve compliance with present and future permit limits

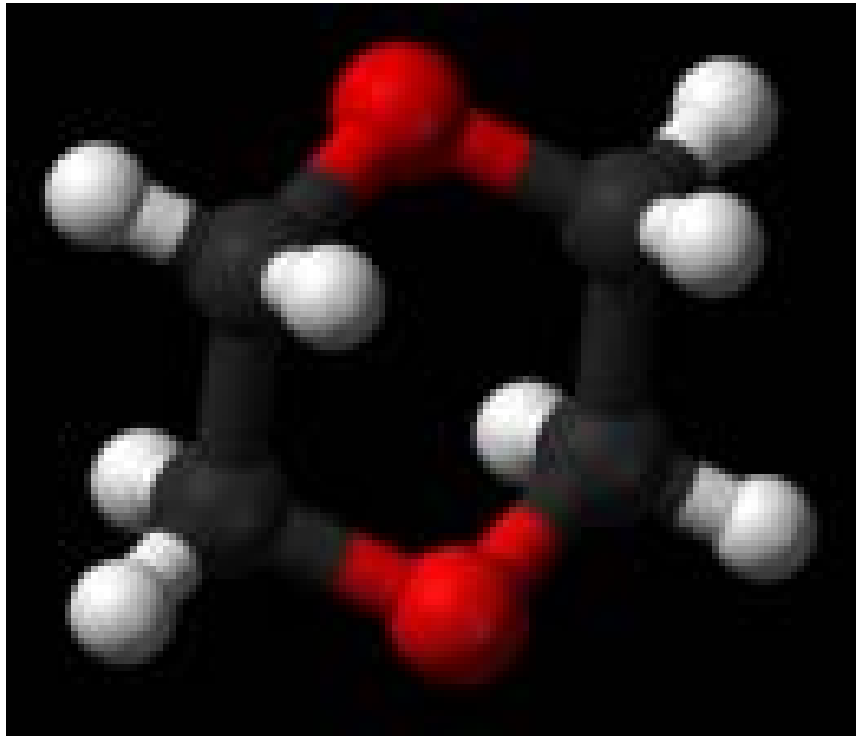
3. Learn from this smaller system in anticipation of replacing an existing, upgradient 100-gpm air stripper

1,4-dioxane

- Stabilizer for chlorinated solvents, e.g. 1,1,1-TCA
- Wetting agent for polyester and paper processing
- Residue in cosmetics, shampoos, automotive coolants, fumigants

Why is 1,4-Dioxane a Challenge?

- Miscible in water
- Low volatility, low sorption
- Difficult to measure
- Difficult to remediate (recalcitrant)
- Travels rapidly in subsurface; plume often extends beyond extraction wells
- **Once discovered, often the driver for cleanup**



1,4 Dioxane: Treatment Options

Biological

Air Stripping

Advanced Oxidation

Synthetic Media (Resin)

Reverse Osmosis

GAC

Challenges with Existing 1,4-D Treatment Technologies (AOP)

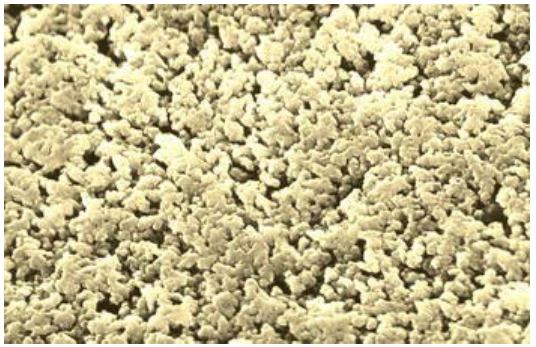
- Struggle with variable influent loadings
- Delivery, storage and consumption of regulated chemicals (e.g. H_2O_2)
- Frequent change-out of costly UV lamps
- Bromate and hex chrome formation potential
- TSS/turbidity/TDS reduces effectiveness
- Subject to free radical scavengers
- pH-sensitive
- Mixed full scale results

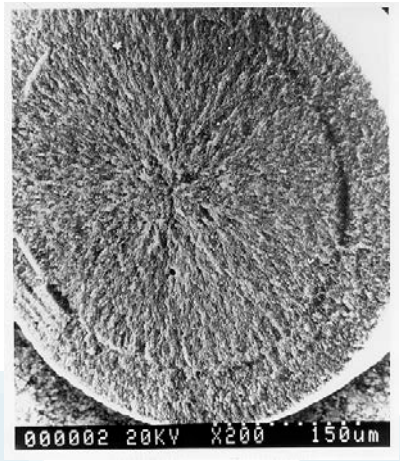
Advanced Oxidation
(fair)

There has to be a better way!

Unique Properties of Dow's AMBERSORB™ 560

- Hydrophobic
- Unique pore size distribution
- High affinity for organic compounds: (**simple** adsorption mechanism)
- Can achieve non-detect effluent concentration at substantial loading rates
- Can typically reuse (regenerate in-place) indefinitely
- Durable structure



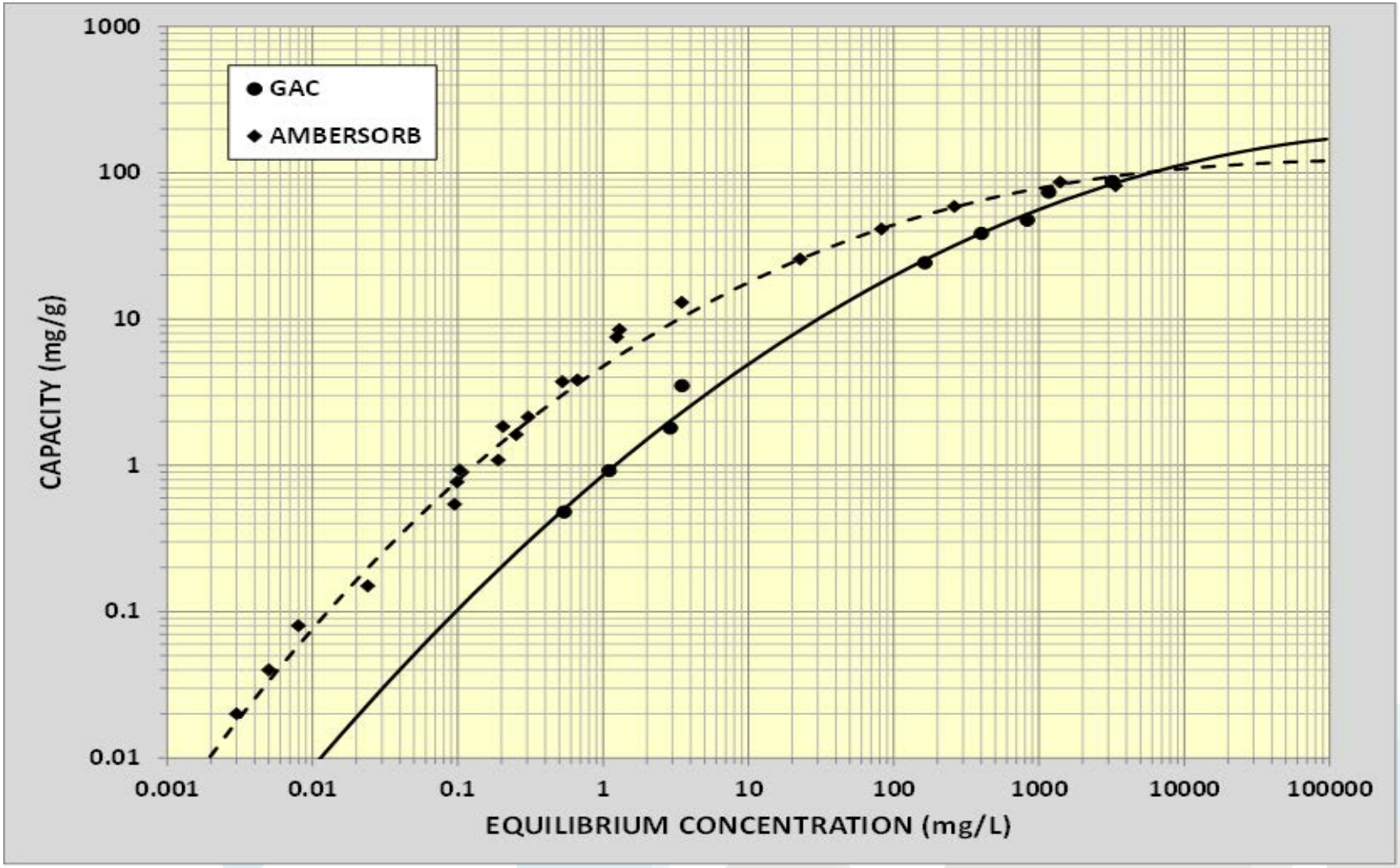


Alternative Solution: Synthetic Media

Derived from plastics, Synthetic Media can be used to collect various contaminants from liquids, vapor or atmospheric streams and be reused indefinitely

AMBERSORB™ 560

AMBERSORB vs. GAC



AMBERSORB 560
Removal to ppb or Sub-ppb Levels

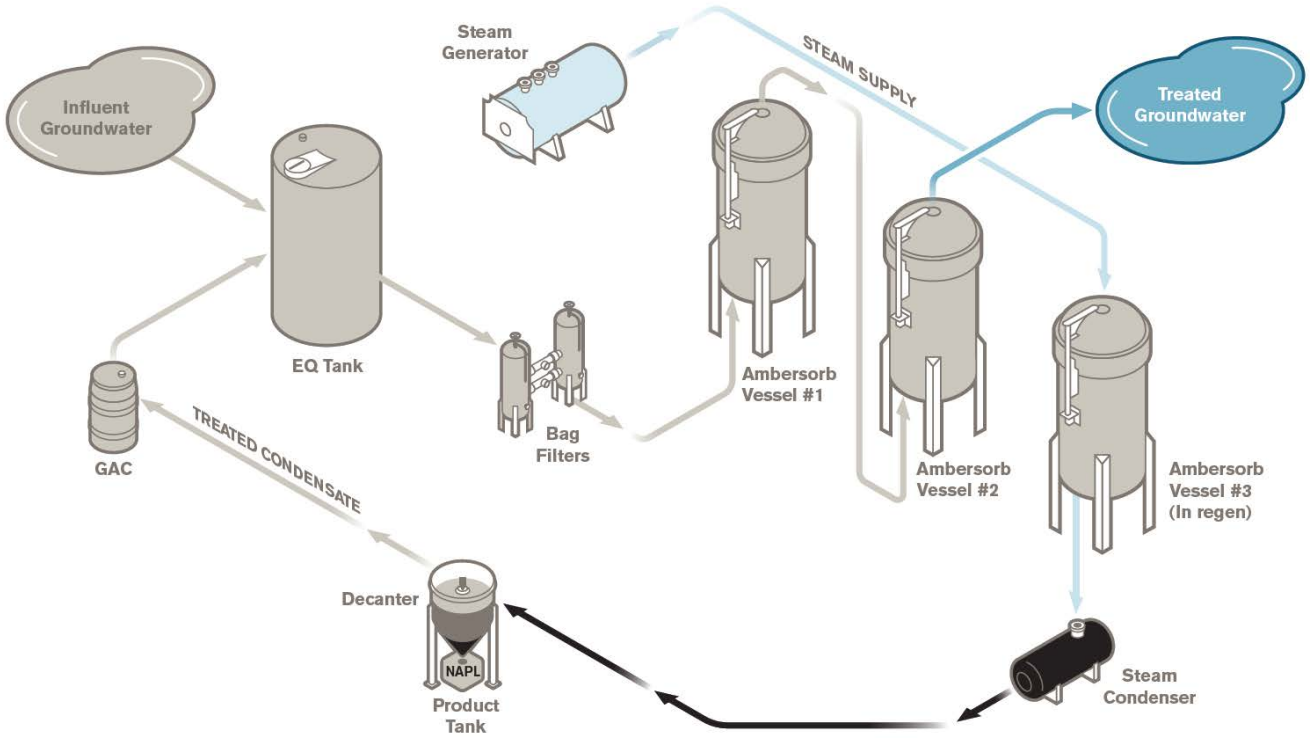
BTEX	DDE	
PCE	Alachlor	
TCE	**1,4-Dioxane**	
1,1-DCE	MtBE	
1,1,1 TCA	DFP (Diisopropyl Fluoro Phosponate)	
1,2-DCA	DMMP (Dimethyl Methyl Phosphonate)	
DCM	2,4-D	
cis-1,2-DCE	Cresol	
VC	IPA	
Acetone	Permethrin	
MEK	Dicofal	
MIBK	Endrin	
Phenol	Toxaphene	
Chlorophenol	Heptachlor	
Dichlorophenol	Aniline	
Trichlorphenol	Pyrdine	
Aldrin	Caprolactam	
Dieldrin	Ethyl Acetate	
DDT	Triton X100	

First Ambersorb System for Groundwater: Lake Charles, LA

- Operating Since 1999
- Treating 1,2-DCA from > 2,000,000 ppb to ND @ 5 ppb
- Recovery and reuse!
- 15 years of loading and regenerating media
- No replacement of media

The Bottom Line at the Waltham Site

Installing a synthetic media system will allow reliable, consistent compliance with low 1,4-dioxane standards, today and into the future.



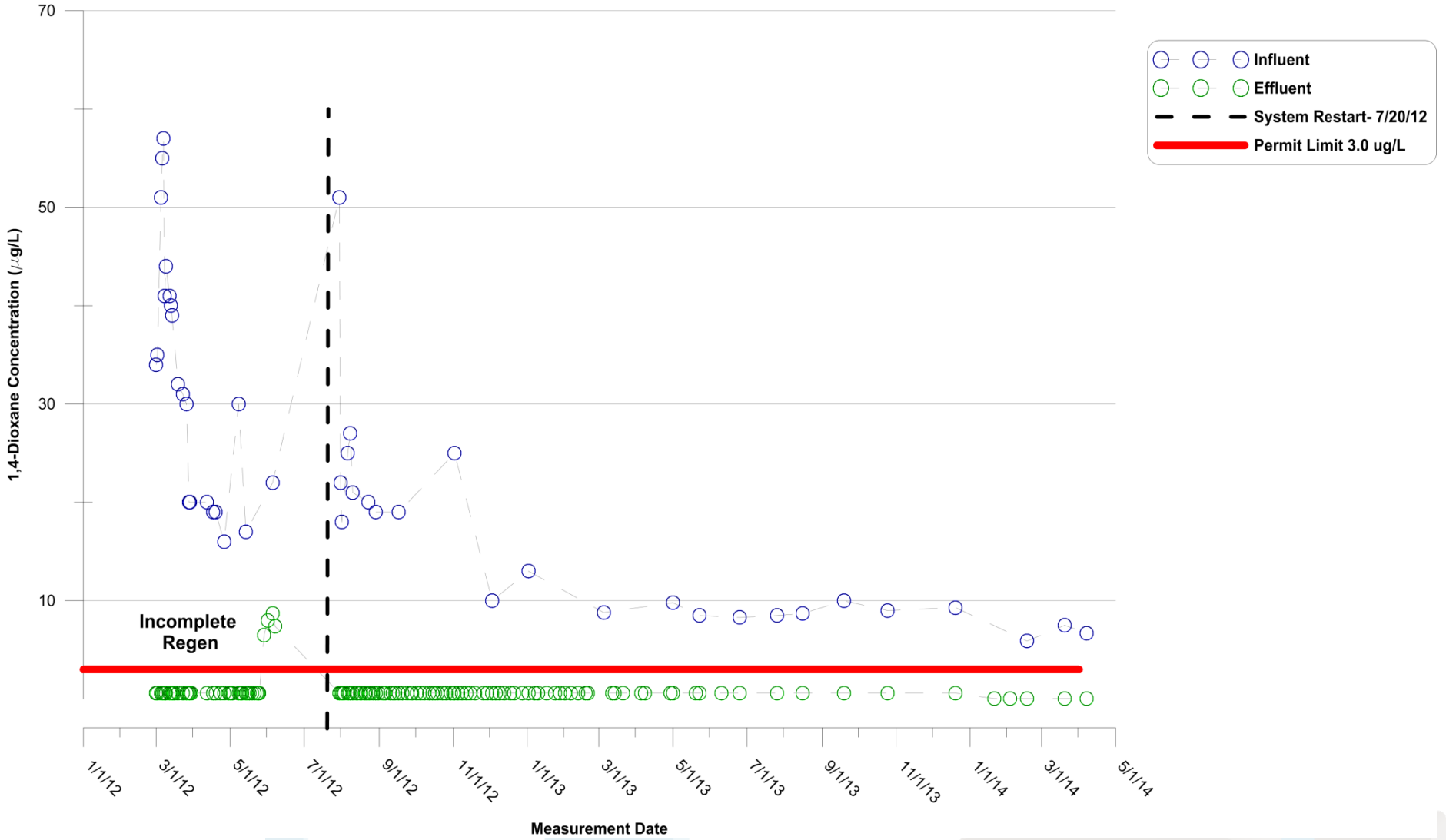
- http://craesay.squarespace.com/storage/ect/Process_Flow.html

Bench and Pilot Testing

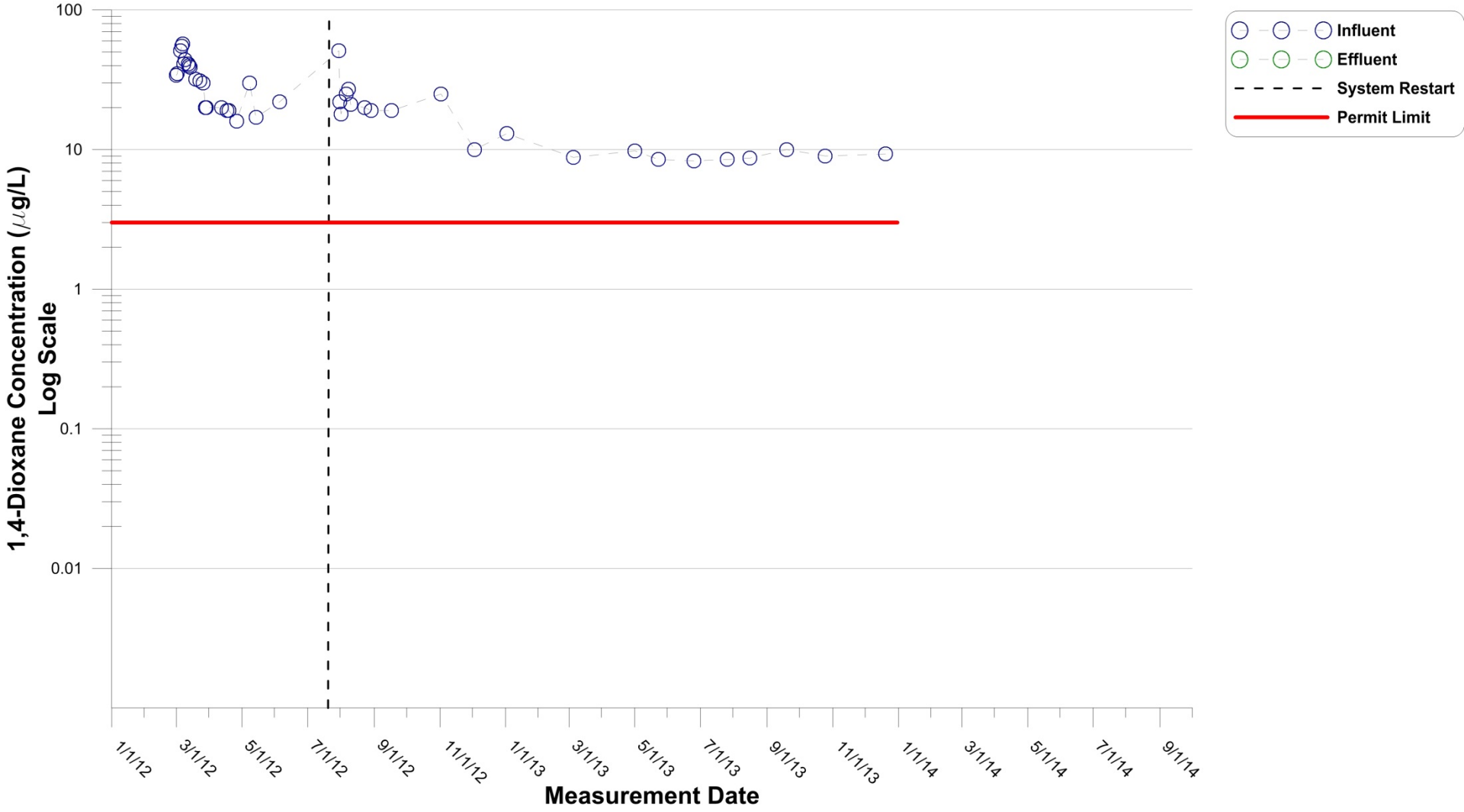
Modular System Design

Results and Discussion

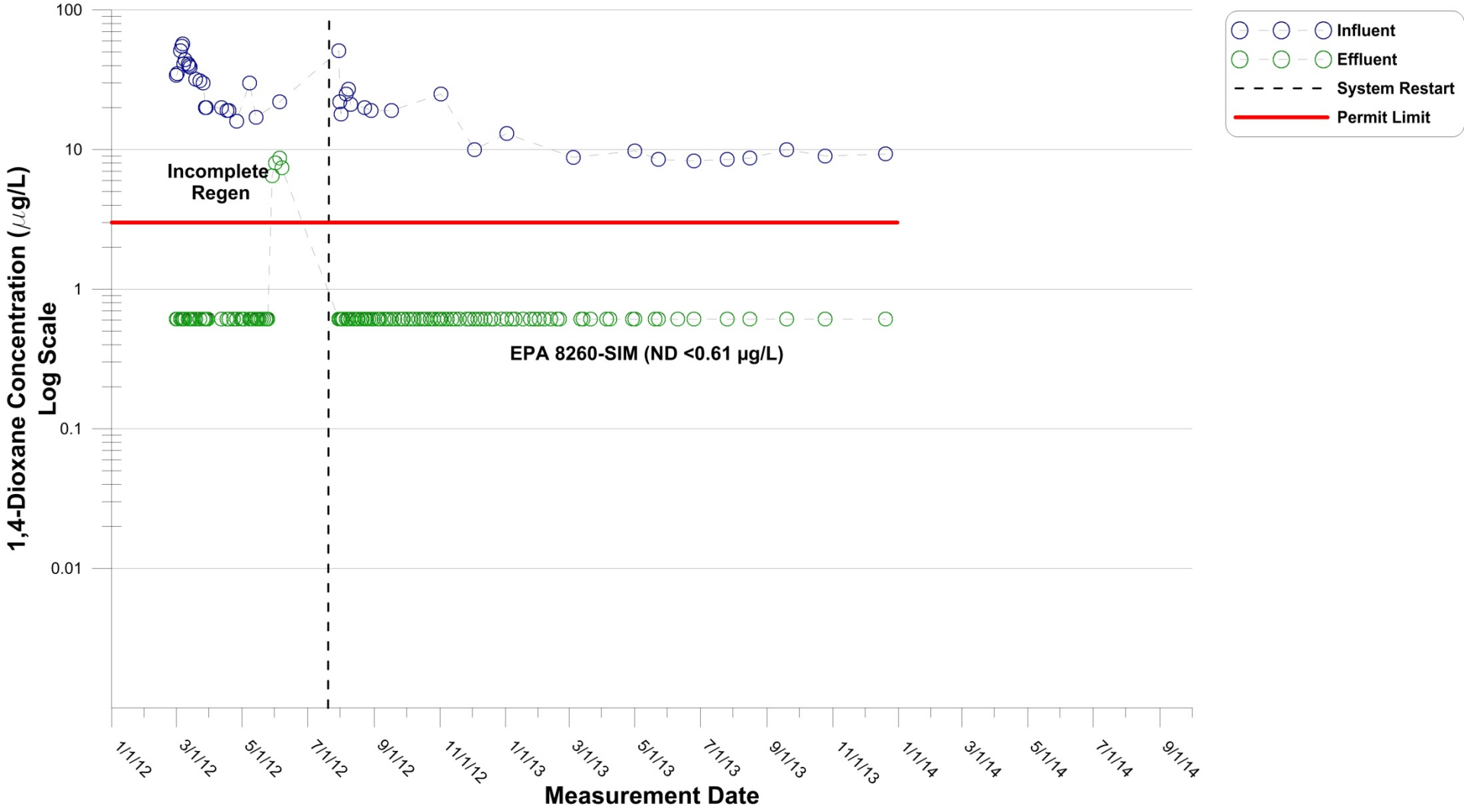
Influent and Effluent 1,4-Dioxane



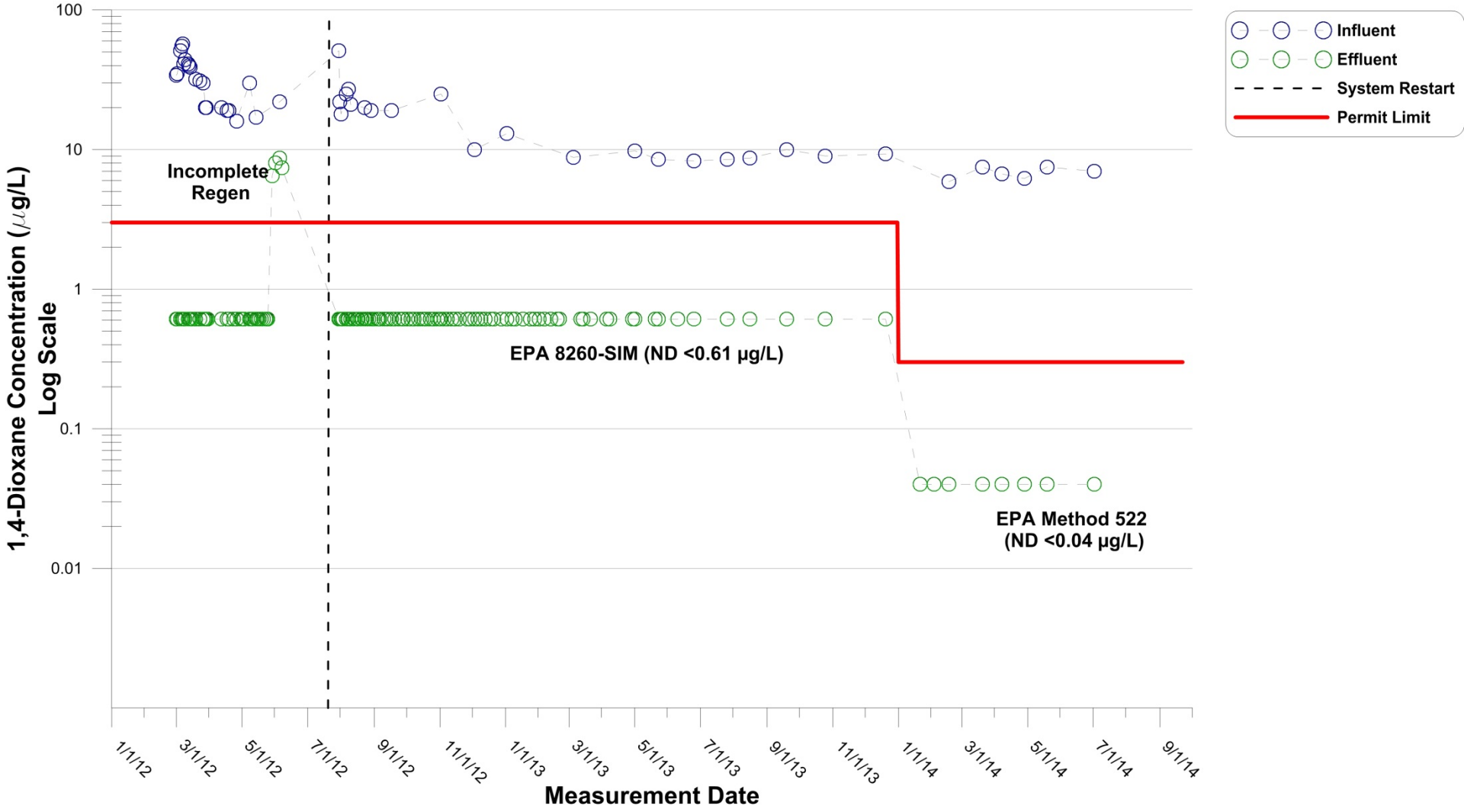
Influent 1,4-Dioxane



Influent and Effluent 1,4-Dioxane

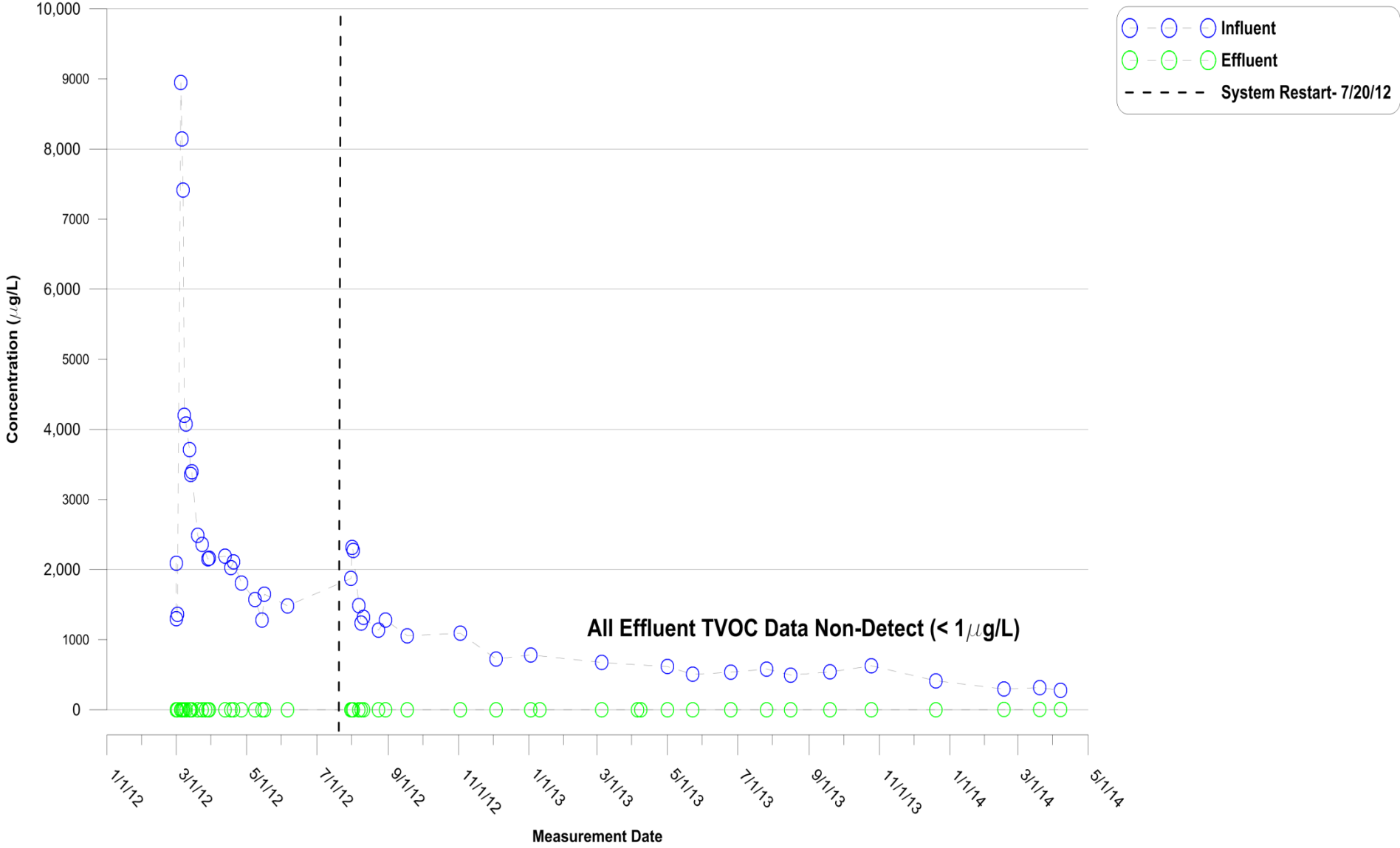


Influent and Effluent 1,4-Dioxane



Influent and Effluent TVOCs

Influent and Effluent TVOCs



Lessons Learned

- Need to fully regenerate media
- Materials of construction: low pH of condensate
- Consider local boiler requirements
- Small, dedicated Synthetic Media team improves communication and execution: the birth of ECT
- Synthetic Media systems are robust and dependable

Summary

- Long-term contaminant migration control 
- Consistent performance, regardless of changing influent conditions
- No stranded capital! Consistently less than new 0.3 µg/l limit without having to upgrade system
- Several valuable lessons learned
- Now applying the lessons from this successful installation in design and construction of larger, 100-gpm system on site

Acknowledgement of Co-authors

- Chip Burkhardt, P.G., Raytheon
- John Berry, P.E., ECT

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