



**HRSD**

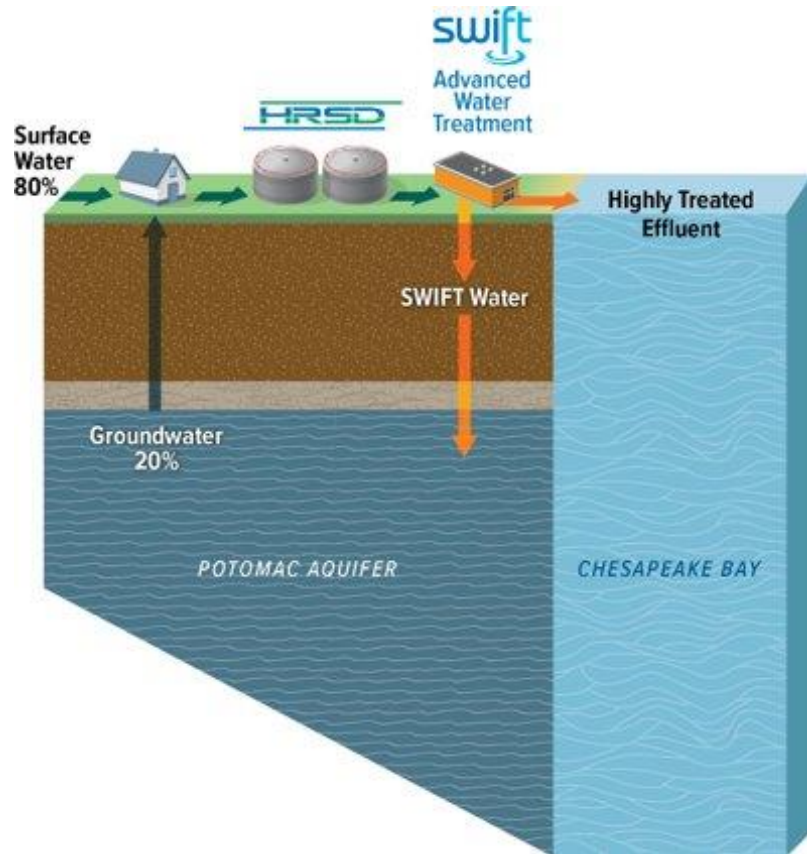
# A Partnership for Potable Reuse: Achieving 1,4-Dioxane Removal through Cometabolic Biological Pretreatment

Micaela Griffin, P3 Specialist  
September 17, 2024

HRSD provides service to 20 cities and counties of southeastern Virginia and the Eastern Shore, an area of nearly 5,000 square miles with a population of more than 1.9 million.

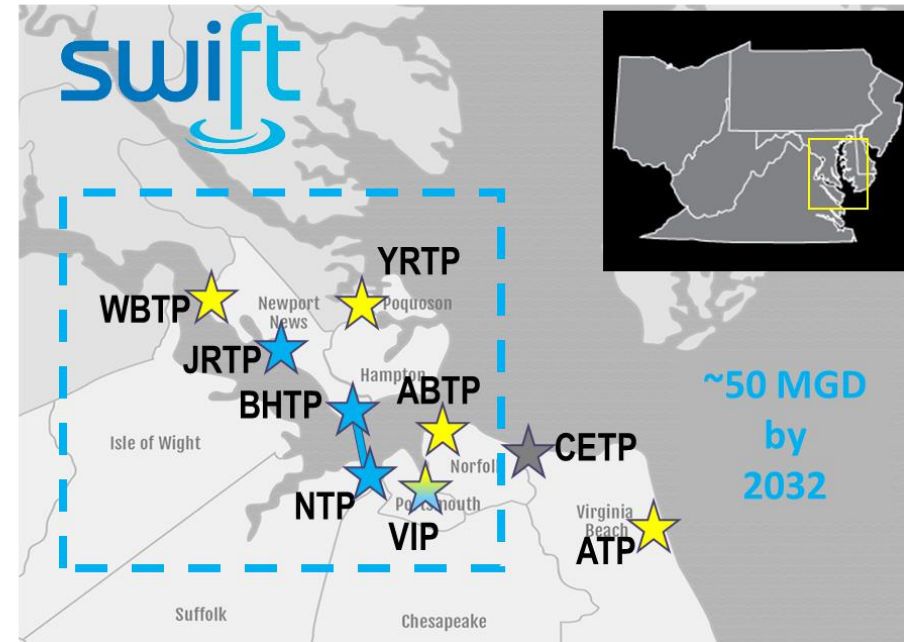
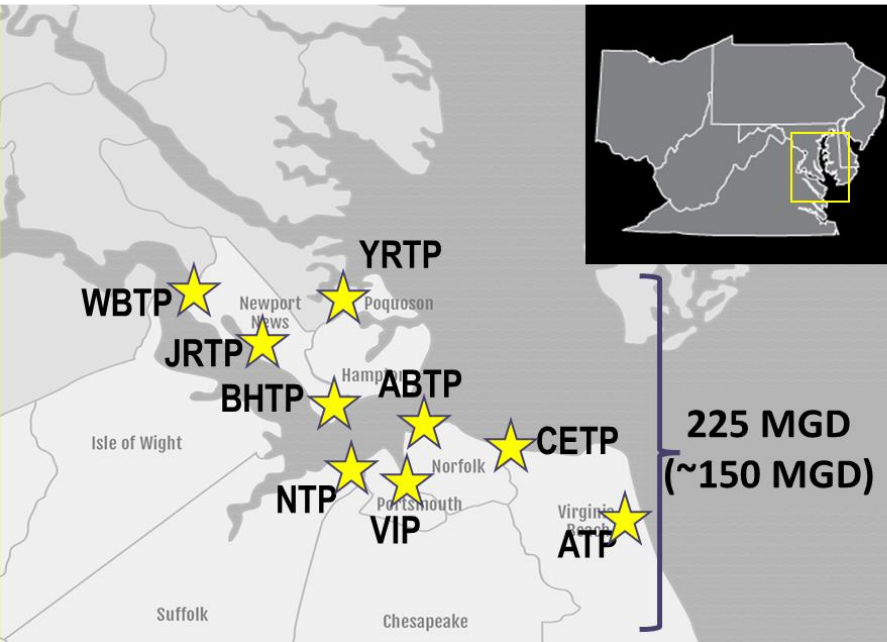


## Sustainable Water Initiative for Tomorrow (SWIFT)

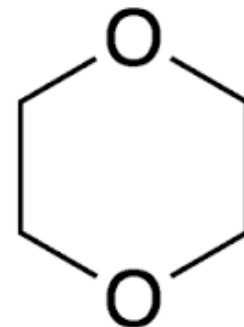


- Treat water to meet drinking water standards and replenish the aquifer with clean water to:
  - Provide regulatory stability for wastewater treatment
  - Reduce nutrient discharges to the Bay
  - Provide a sustainable supply of groundwater
  - Reduce the rate of land subsidence
  - Protect the groundwater from saltwater intrusion

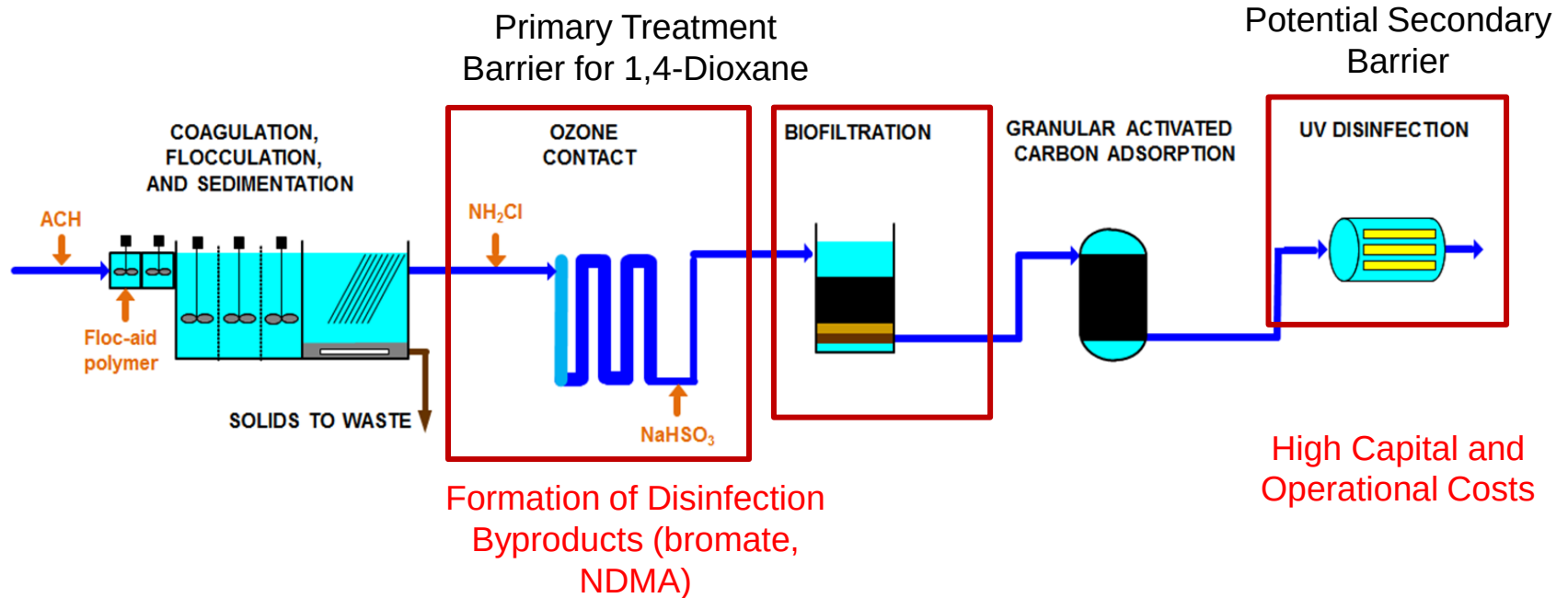
# SWIFT Goal: ~50 MGD by 2032



- 1,4-dioxane (1,4-D), NDMA, NMOR, Bromide, and more!
- 1,4-D
  - Industrial solvent stabilizer
  - Manufacturing byproduct in many household products
  - EPA classified as a probable human carcinogen
  - Adverse health effects to the liver and nasal tissue



## SWIFT – Treatment Process and Balancing Treatment Objectives



REMEDIATION Winter 2016

### Case Study and Retrospective: Aerobic Fixed Film Biological Treatment Process for 1,4-Dioxane at the Lowry Landfill Superfund Site

Leslie Cordone

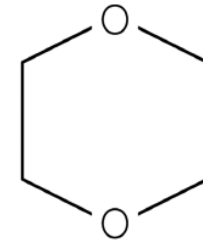
Chris Carlson

William Plaehn

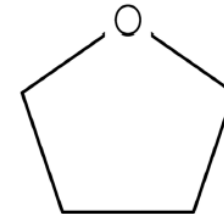
Timothy Shangraw

David Wilmoth

An aerobic fixed film biological treatment system has been successfully treating recovered ground-water/landfill leachate containing 1,4-dioxane, tetrahydrofuran (THF), and other constituents since 2003. The most likely mode of 1,4-dioxane biotransformation is via a cometabolic pathway in the presence of THF. Pilot studies conducted during the process development phase established a design basis process loading factor of 0.6 g 1,4-dioxane and THF (as chemical oxygen demand [COD])/g total solids per day and proved the efficacy of the process. Full-scale design includes the use of three parallel moving bed bioreactors with effluent recycle capability. Removal efficiencies in excess of 98 percent have been documented for 1,4-dioxane. Evolving operational challenges are associated with recent trends in 1,4-dioxane pretreatment discharge limitations in combination with ongoing process optimization and increased influent flow rate conditions associated with seasonal precipitation patterns. ©2016 Wiley Periodicals, Inc.



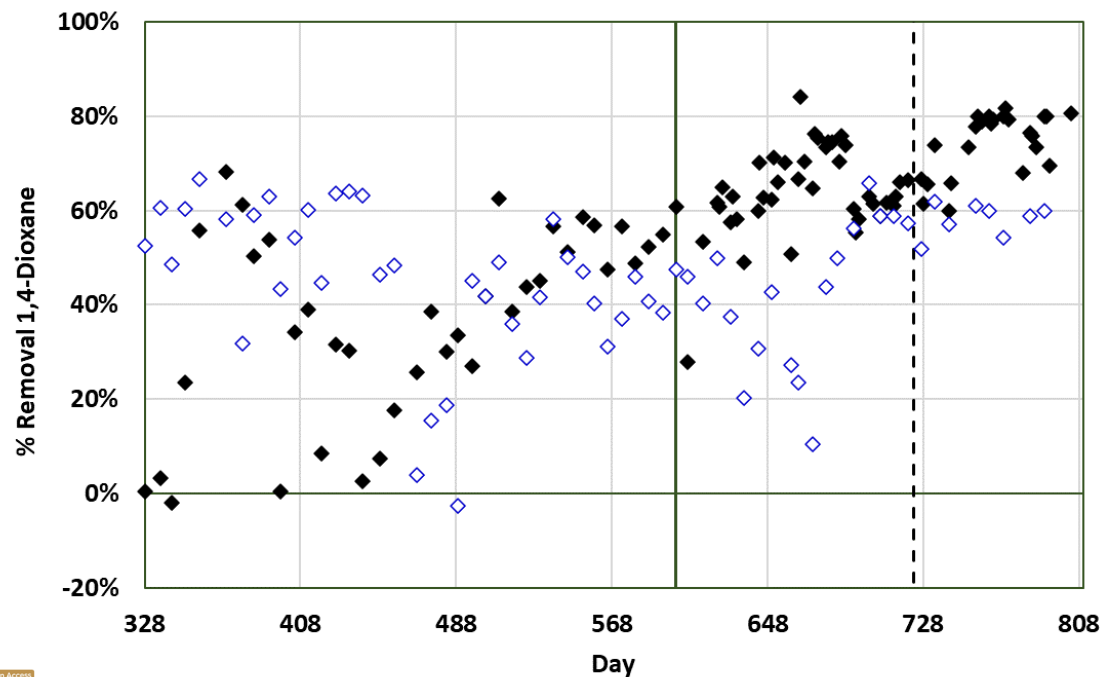
1,4-dioxane  
 $C_4H_8O_2$



Tetrahydrofuran (THF)  
 $C_4H_8O$

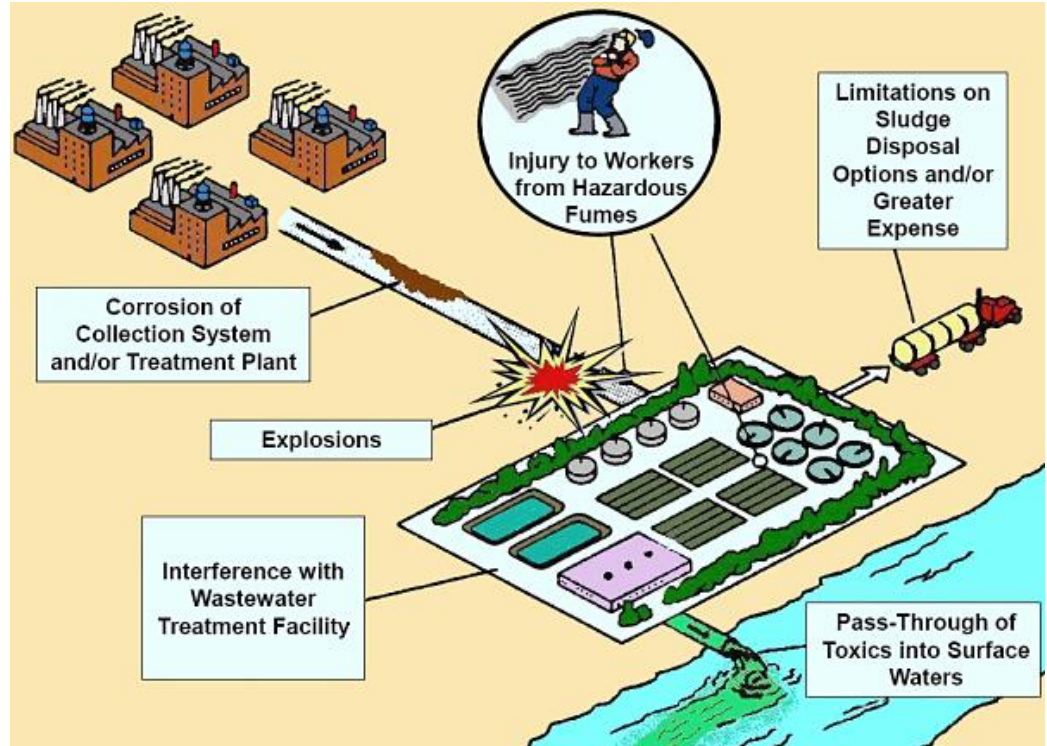
Exhibit 2. Chemical structure 1,4-dioxane and THF

## SWIFT – Cometabolism in Pilot BAFs



## HRSD's Pretreatment & Pollution Prevention (P3) Department

- 113 Permitted facilities
- Inspections
- Hauled Waste Program
- Wastewater Sampling
  - Compliance & Surcharge
  - Non-regulatory (SWIFT)

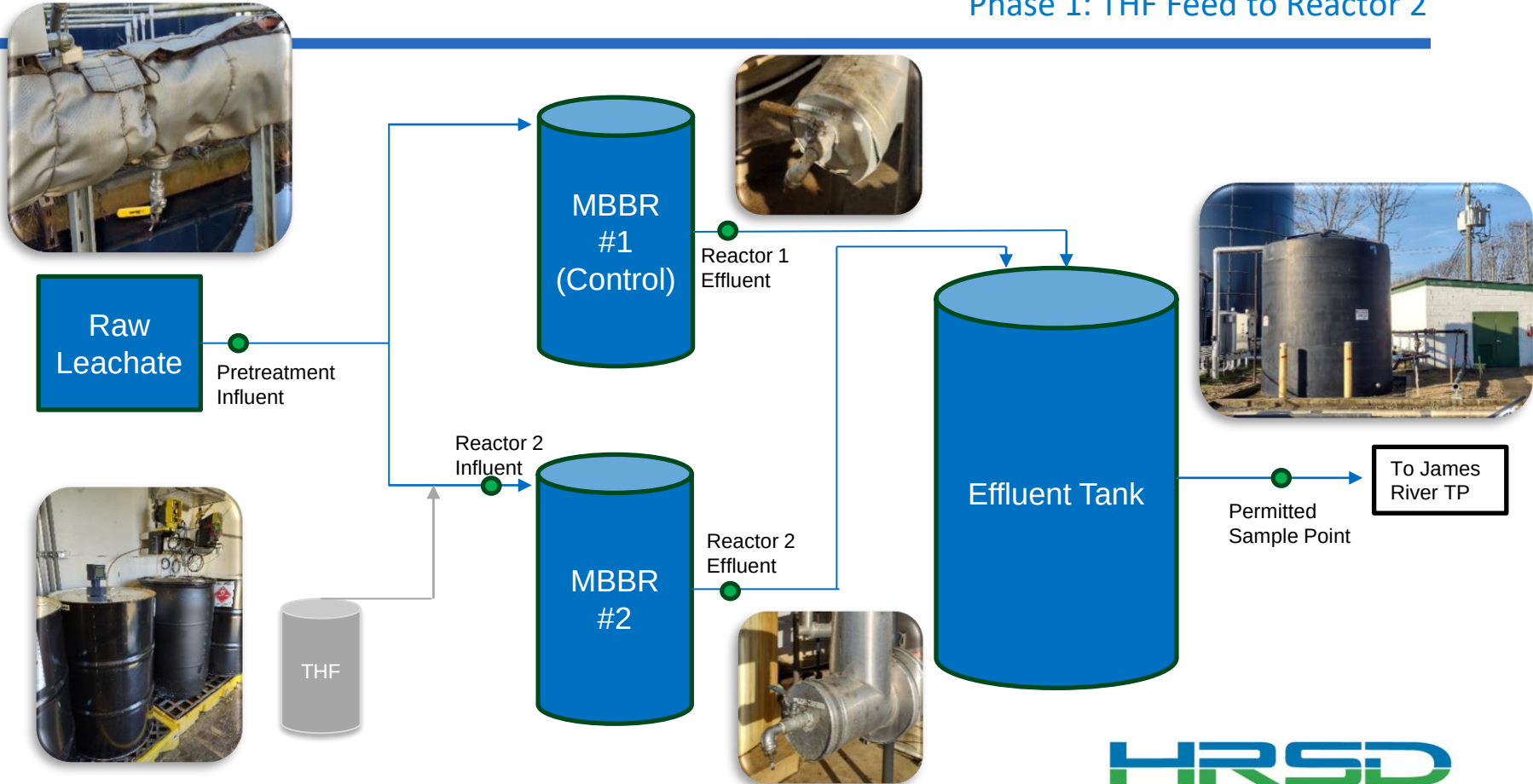


- Landfill Leachate

- Average flow: 55K GPD, but highly variable
- Biological pretreatment
  - Two (2) 20K gal moving bed biofilm reactors (MBBRs)
- 1,4-D average of 71 ug/L in final effluent

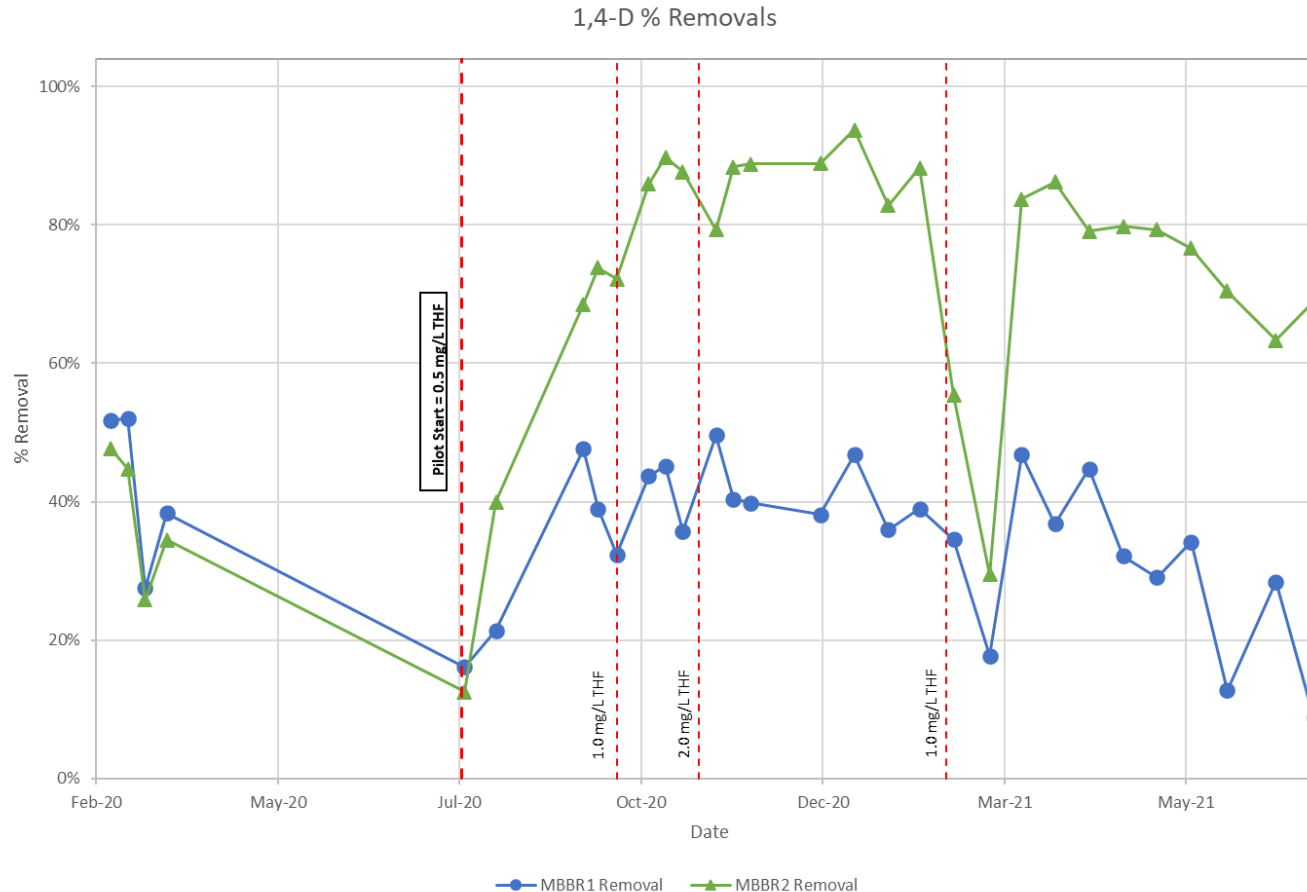


## Phase 1: THF Feed to Reactor 2



## 1,4-D % Removal: Phase 1

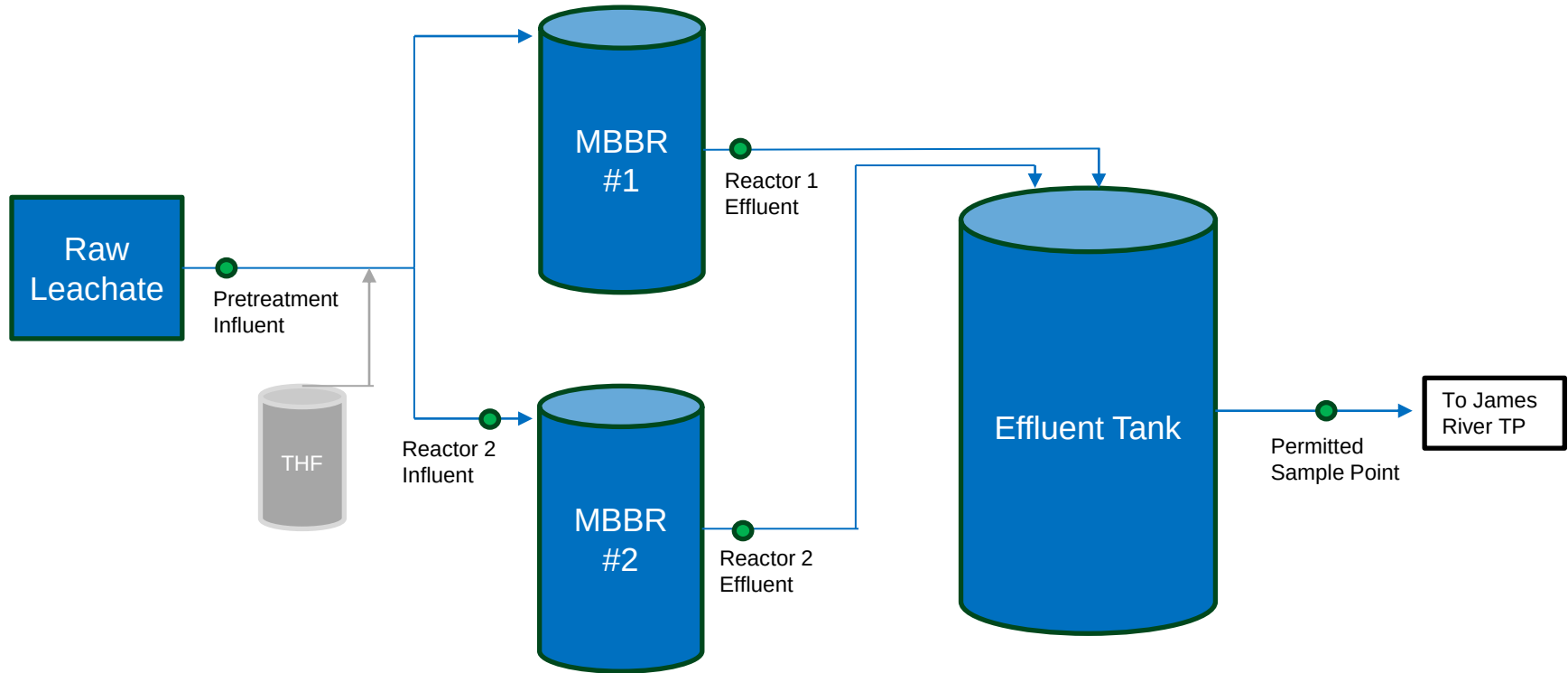
- Pre-Pilot: Avg. 1,4-D removal 40%
- Phase 1: July 2020



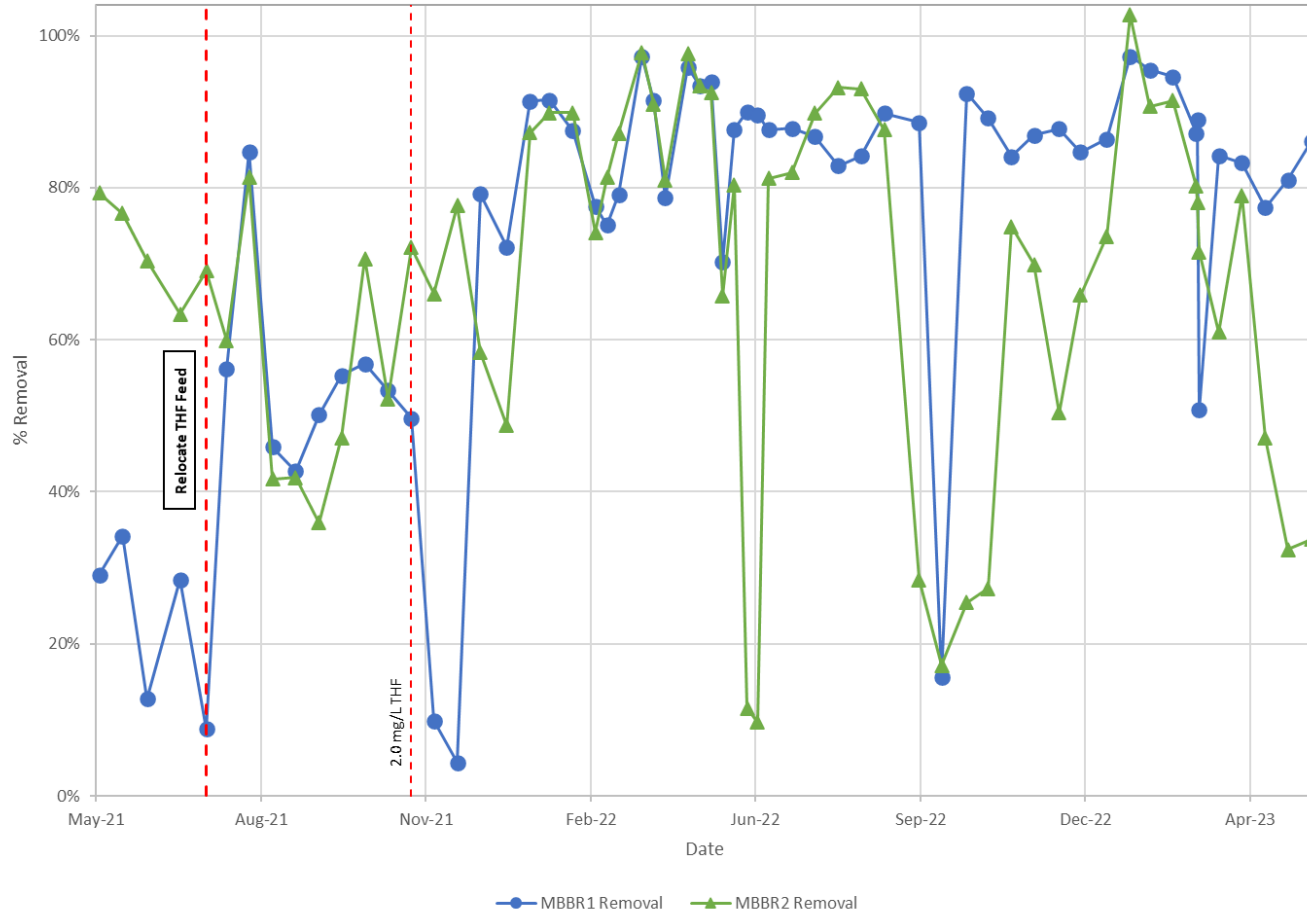
### Average 1,4-D % Removal

|           |     |
|-----------|-----|
| Reactor 1 | 37% |
| Reactor 2 | 75% |

## Phase 2: Relocated THF Feed Point



1,4-D % Removals



## 1,4-D % Removal: Phase 2

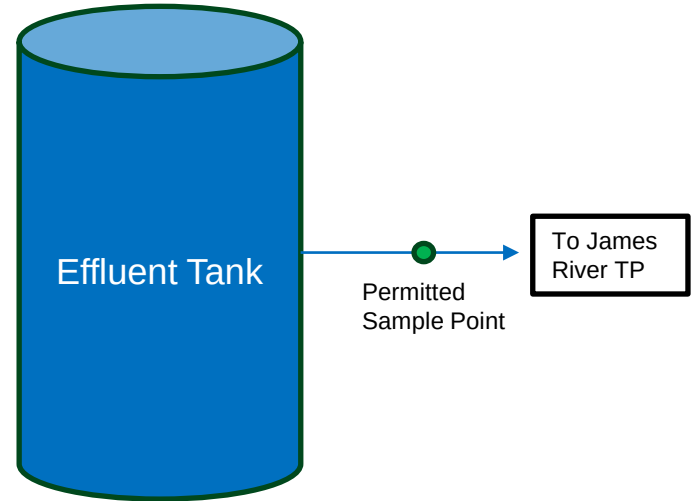
- Phase 2: July 2021-present
- Both reactors receiving additional THF

### Average 1,4-D % Removal

|           |     |
|-----------|-----|
| Reactor 1 | 74% |
| Reactor 2 | 70% |

## Average 1,4-D in BLF Final Effluent

| Phase     | 1,4-Dioxane (ug/L) |
|-----------|--------------------|
| Pre-Pilot | 71                 |
| Phase 1   | 45                 |
| Phase 2   | 27                 |



- Continue to feed THF at 2mg/L
- Need consistency in reactor operation
  - Benchtop sampling and/or continuous analyzers
- Continued HRSD sampling/oversight

- Mutually beneficial partnership
- Opportunity to strengthen relationship with industry
- Cost savings
  - Minimal changes to Bethel Landfill
  - No UVAOP at JRTP SWIFT (saving approximately \$10M in capital and \$0.5M per year in operating expense)
- Huge thanks to HRSD's CEL, Hannah Stohr (SWIFT Research Intern) and WM





RESEARCH ARTICLE | Open Access |

## **Pretreatment for potable reuse: Enhancing the biological removal of 1,4-dioxane from landfill leachate through cometabolism with tetrahydrofuran**

Hannah Stohr , Rohan Menon, Micaela Griffin, James Sabo, Mike Martin, Brian Brazil, Charles Bott

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