Managing Nitrates & Groundwater Extraction Systems

Business & The Environment Conference
6th December 2022

Brendan Robinson

Partner
Portland, Oregon
Brendan.Robinson@erm.com

© Copyright 2022 by The ERM International Group Limited and/or its affiliates ('ERM'). All Rights Reserved. No part of this work may be reproduced or transmitted in any form or by any means, without prior written permission of ERM.

The business of sustainability

ERM

Nitrates in Groundwater Extraction Systems

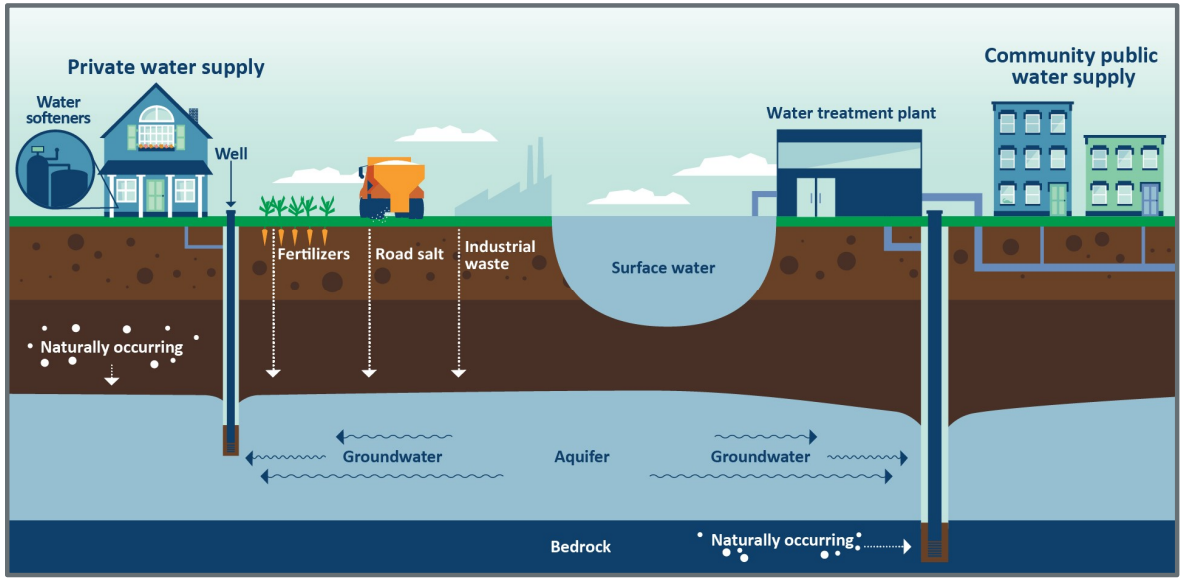
Groundwater Extraction Systems

- GW Extraction systems are used for:
  - Water supply - Drinking water, irrigation, commercial/industrial uses
  - Remediation - Hydraulic containment, In situ treatment, soil flushing
  - Dewatering - Construction
- Discharge of extracted and treated water to:
  - Surface water, municipal systems, infiltration, land application
  - Limitations on nitrates in effluent discharge
- Sources of nitrates to groundwater extraction (and treatment) systems:
  - Contaminant in groundwater
  - Generated in treatment processes (e.g., organics breakdown byproduct, nutrient for biological treatment process)
- Nitrates usually treated using anoxic biological process units
  - Large treatment volumes, energy intensive systems

Remediating Nitrates in Groundwater

Nitrate Impacted Groundwater

- Active nitrogen fertilizer production facility, operating since late 1950's
  - Historical releases of fertilizer components, primarily nitrates, to soil
    - Soil impacts
    - Groundwater impacts from soil leaching
    - Groundwater to surface water discharge risk

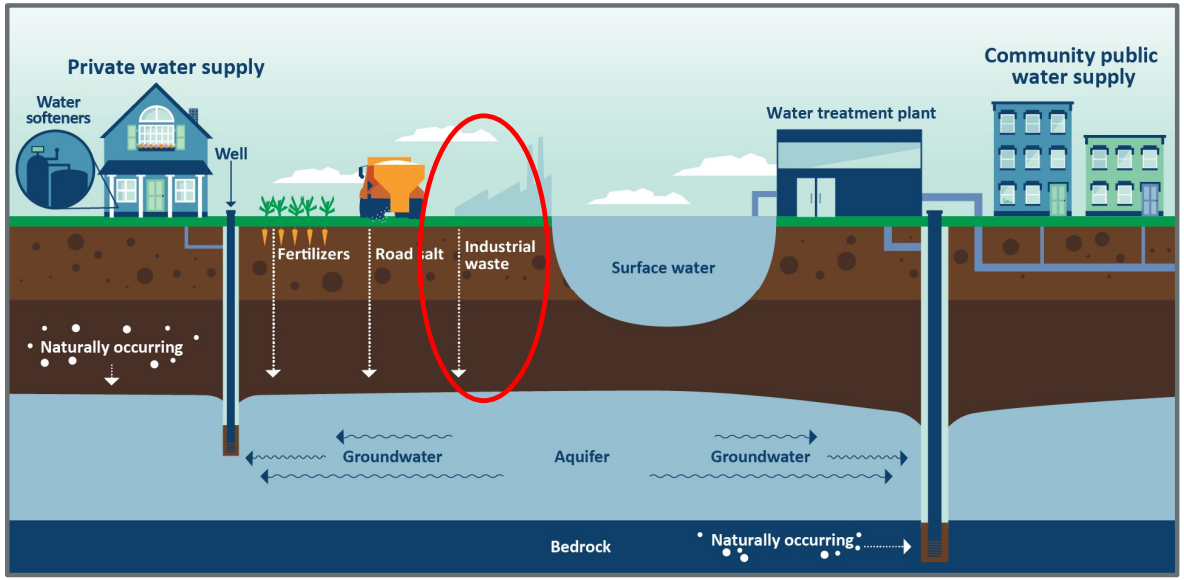


Infographic credit: Michigan DHHS

Remediating Nitrates in Groundwater

Nitrate Impacted Groundwater

- Active nitrogen fertilizer production facility, operating since late 1950's
  - Historical releases of fertilizer components, primarily nitrates, to soil
    - Soil impacts
    - Groundwater impacts from soil leaching
    - Groundwater to surface water discharge risk



Infographic credit: Michigan DHHS

Remediating Nitrates in Groundwater

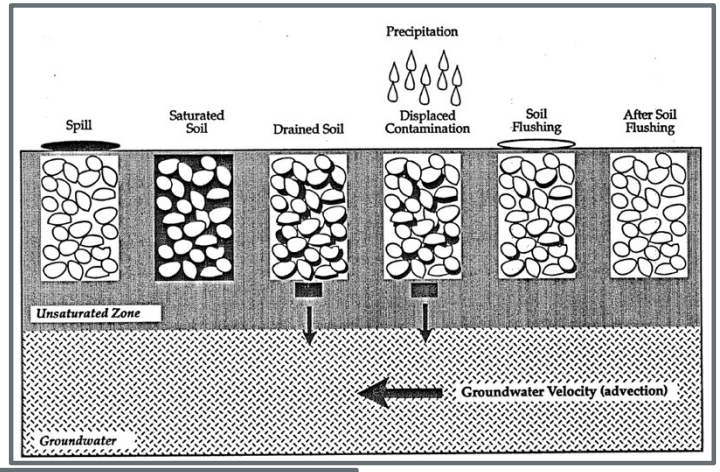
Remedial Approach

- Hydraulic containment
  - Groundwater extraction system to capture nitrate-impacted groundwater
  - Extracted water used to irrigate cropland (alfalfa, fescue, ryegrass)
    - Harvested several times per year
- Significant compliance requirements regarding nitrogen balance
  - Performance monitoring of groundwater and soil.
  - Extraction rates, nitrogen concs, irrigation rates, evapo-transpiration rates, nitrogen loading, nutrient demand

Remediating Nitrates in Groundwater

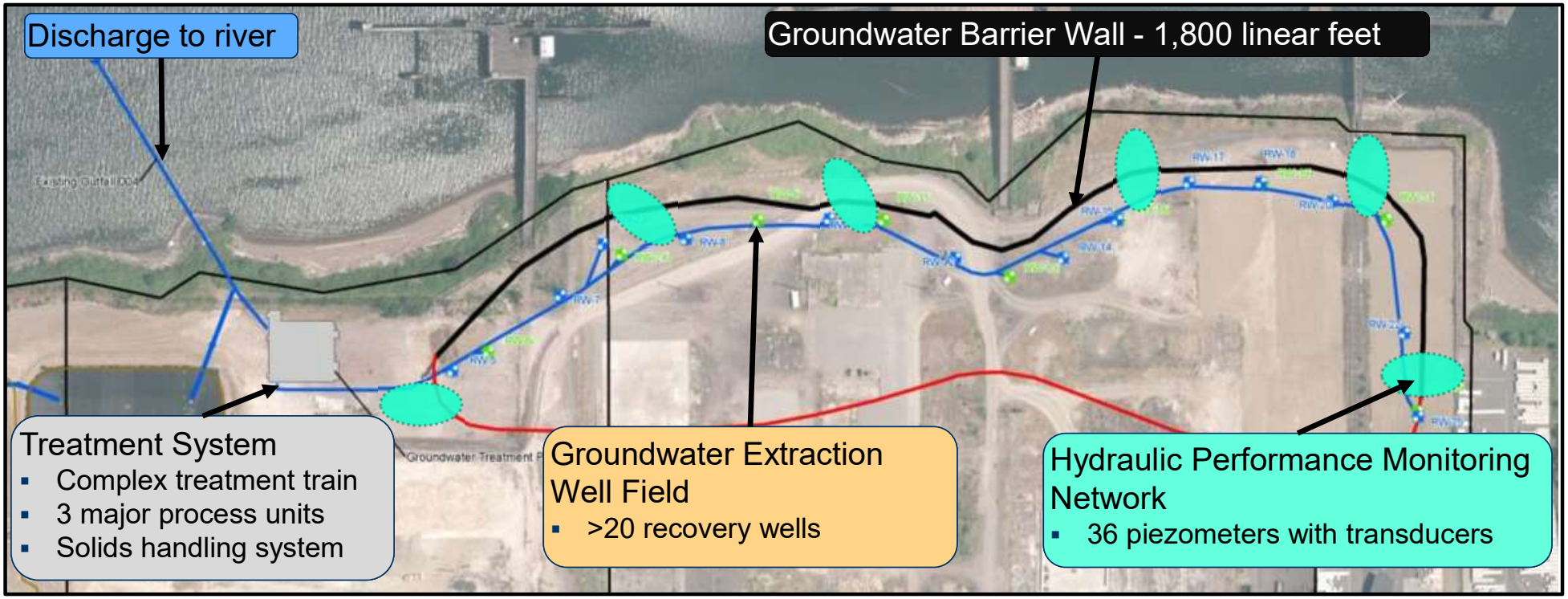
Remedy Implementation

- Extraction system operating > 20 years
  - Expanded in 2017
- Performance evaluation indicates nitrates are slowly decreasing
  - Achieve clean up goals in >60 years
- Focused soil flushing in source areas proposed to accelerate cleanup
  - Achieve clean up goals in less than 10 years
- Address potential risk more quickly
  - Cost savings >$10M
- Pilot study underway



Biological Treatment of Groundwater

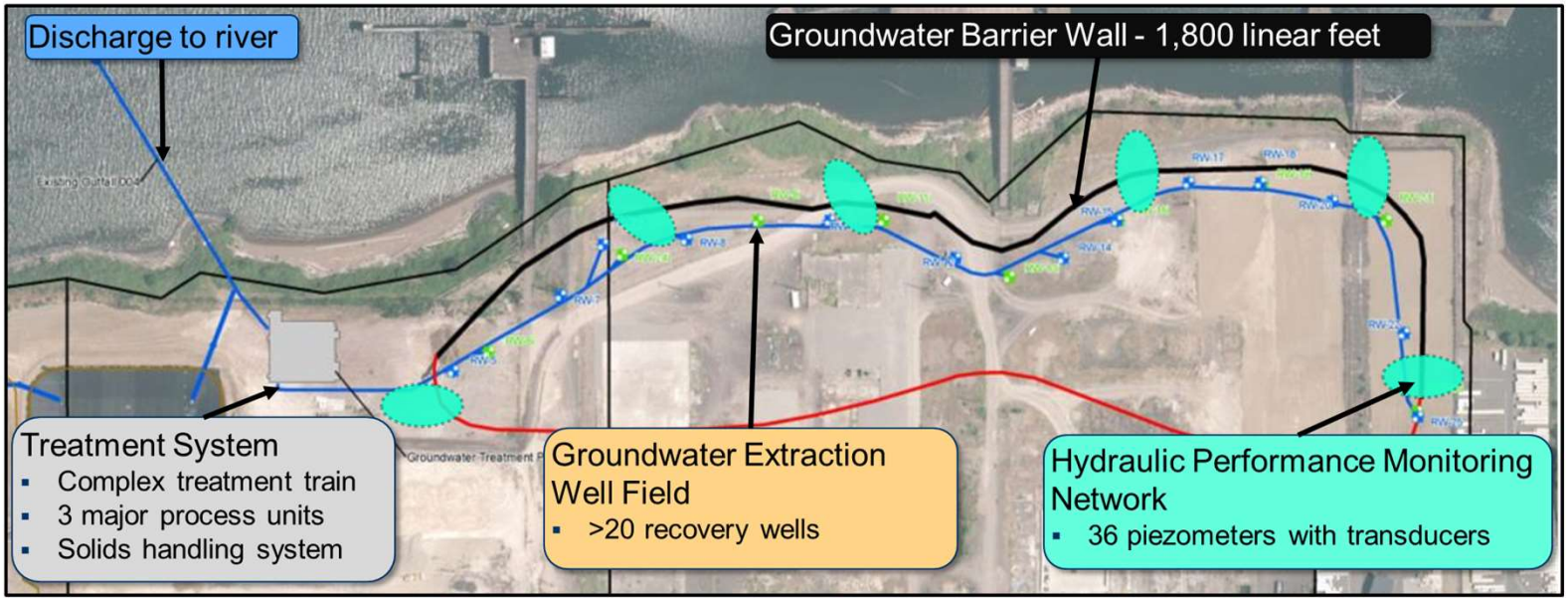
Groundwater Extraction and Treatment System



Biological Treatment of Groundwater

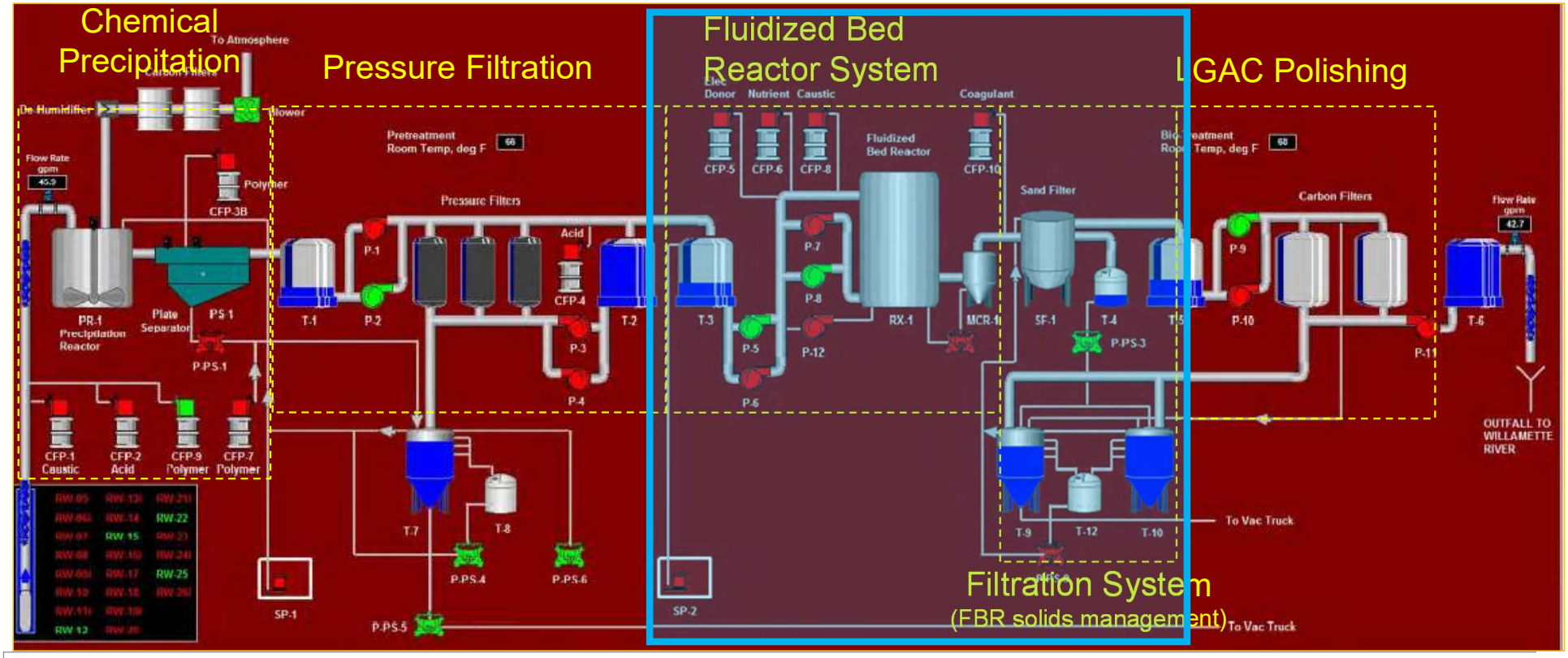
Groundwater Extraction and Treatment System

- Hydraulic containment
  - Pesticides, BTEX, cVOCs,
  - As, Cr(VI), Perchlorate

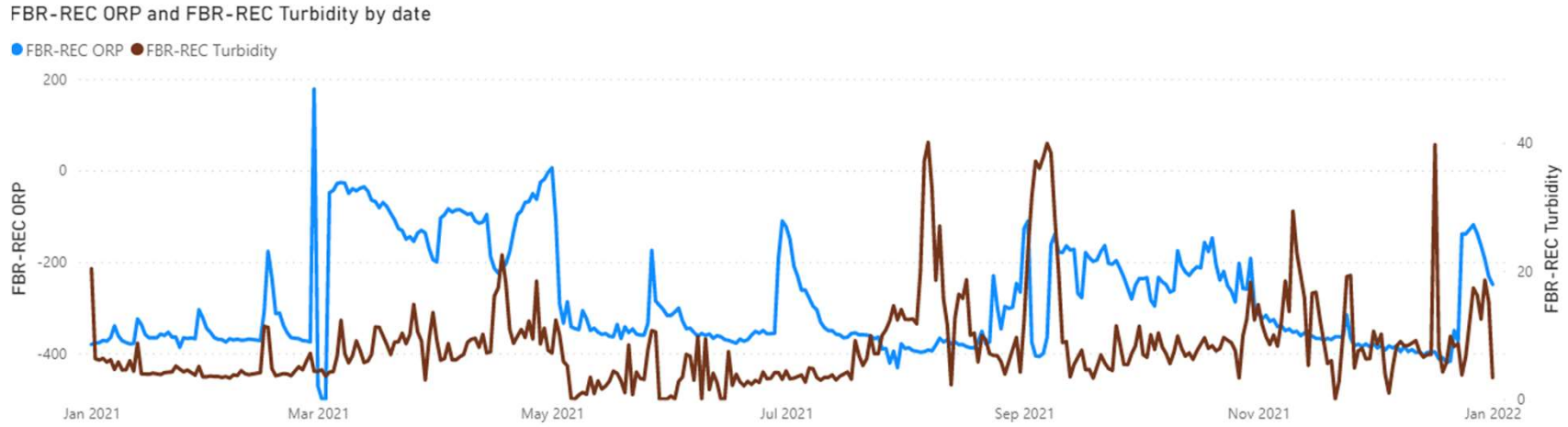


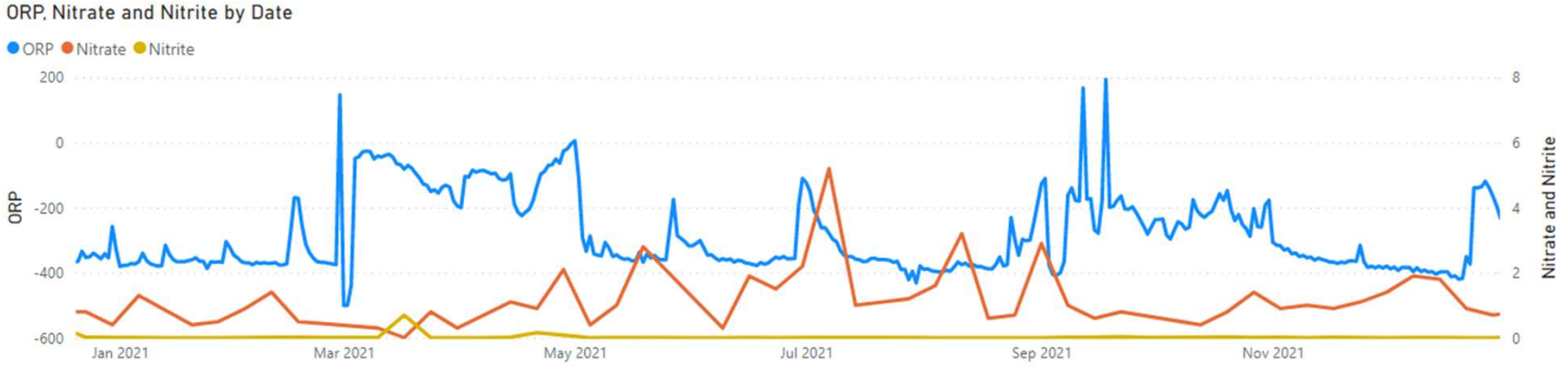
Biological Treatment of Groundwater

Groundwater Treatment System

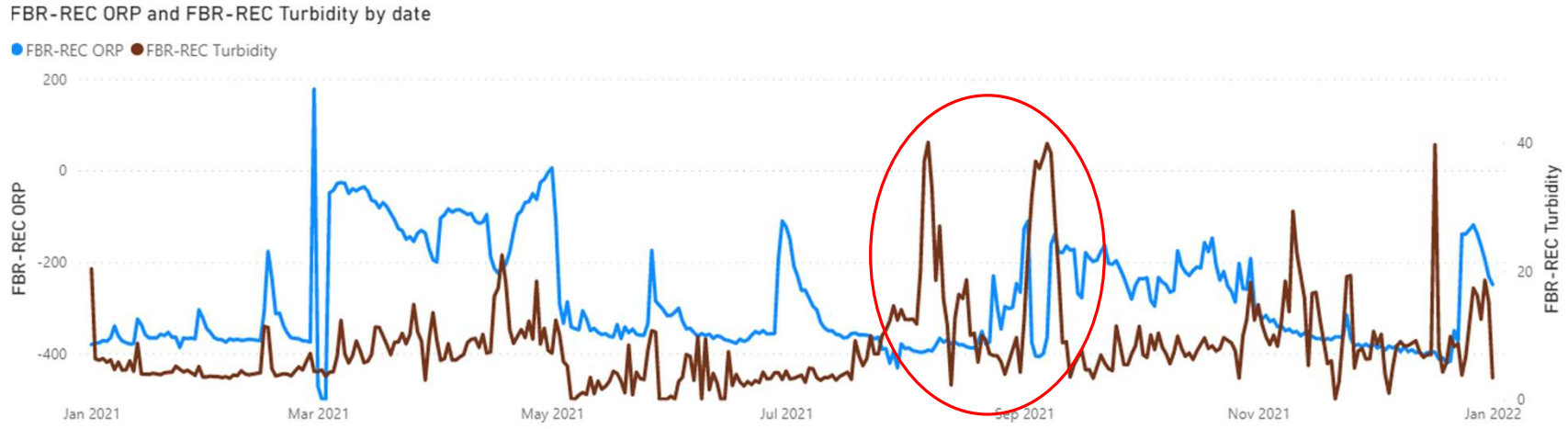


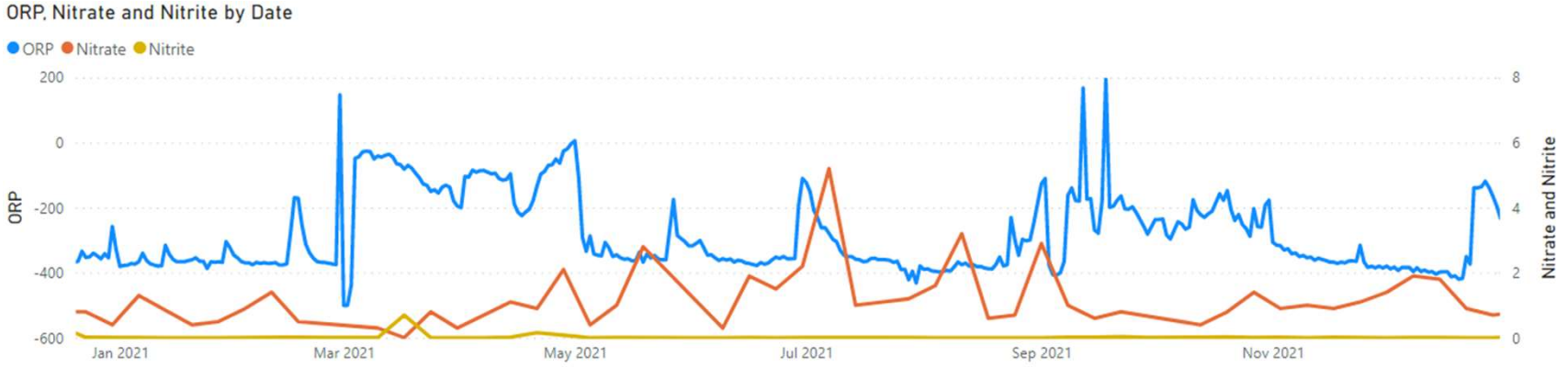
Management of Biology (Turbidity and Nitrates)



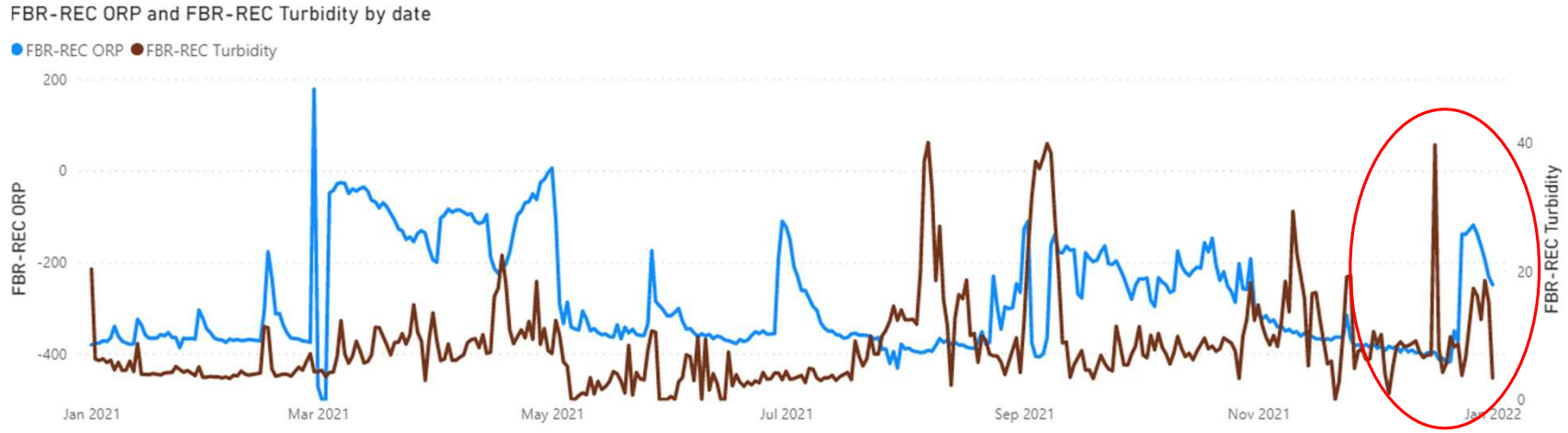


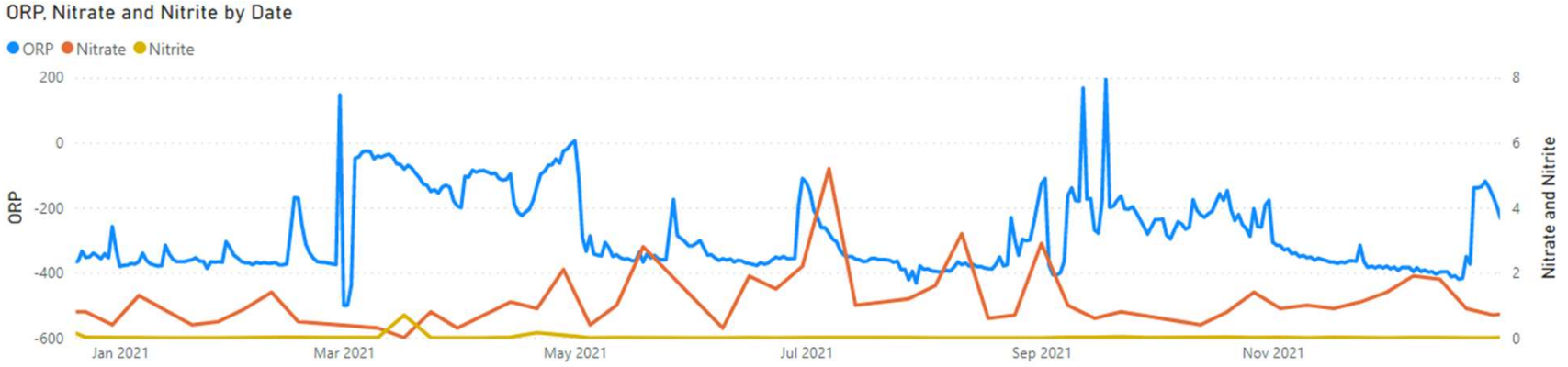
Management of Biology (Turbidity and Nitrates)





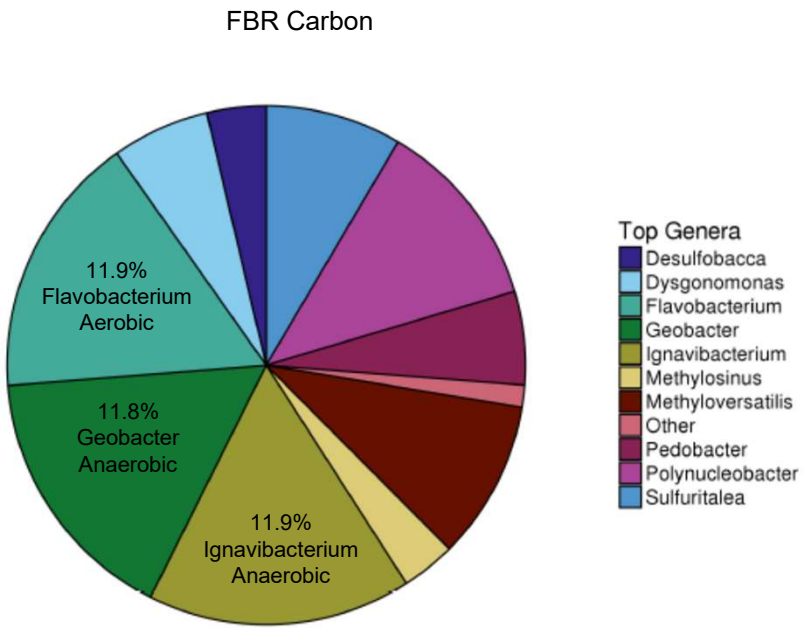
Management of Biology (Turbidity and Nitrates)

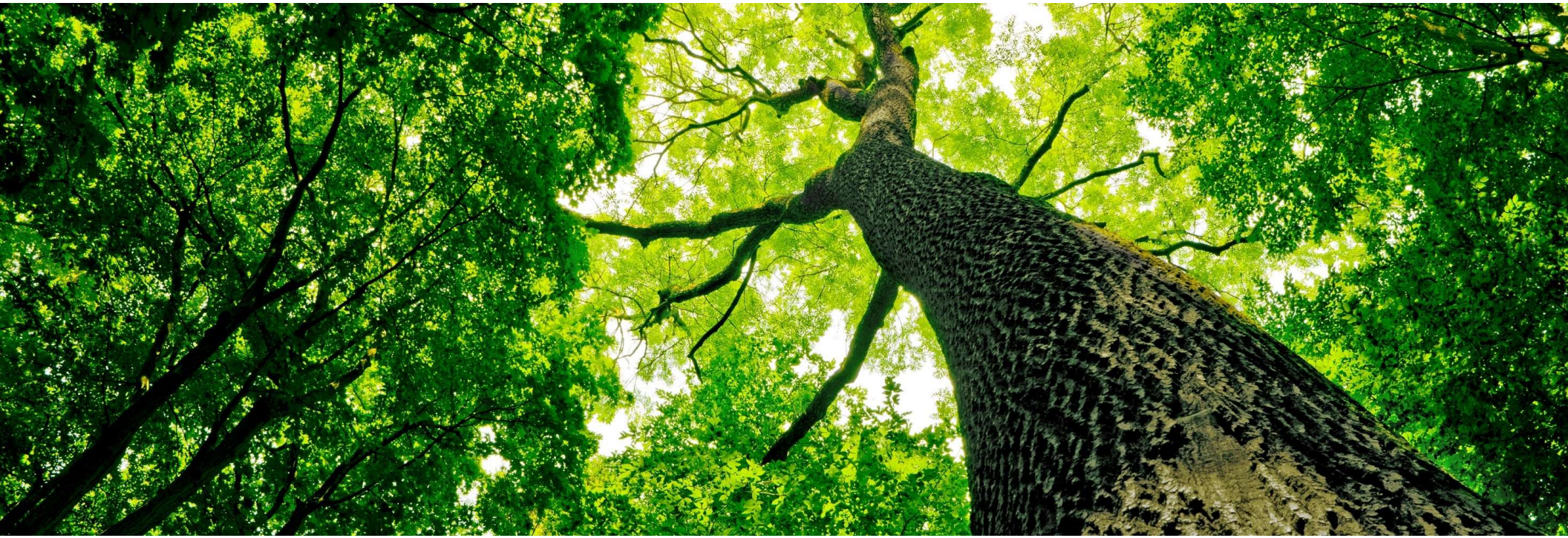




Optimization of Biological Treatment

- Some ammonia nitrogen from urea converted to nitrite and nitrate
  - Presence of nitrate and limited nitrite suggests nitrification, limited denitrification
- Nitrate spikes correlated to increased turbidity (bad!) and decreases in perchlorate reducing reactions
- Performance optimized at Low ORP (below -200 mV)
  - Degradation of chlorate and perchlorate in anoxic conditions
  - Aerobic AND anaerobic strains of bacteria present simultaneously
- Manage FBR inputs of oxygen (influent, sparging) and carbon (acetic acid) to achieve steady low levels of:
  - ORP
  - Residual Nitrates





Thank you

Brendan Robinson

Partner
Portland, Oregon
Brendan.Robinson@erm.com

www.linkedin.com/company/erm

https://www.facebook.com/InsightsERM

The business of sustainability

ERM