



**AECOM**



## Enhanced In-situ Chemical Reduction followed by Enhanced Bioremediation to treat Cis-1, 2-DCE And VC

Lead author: Amit Haryani, PE, LSRP, AECOM

Presented by: Josephine Molin, FMC Corporation



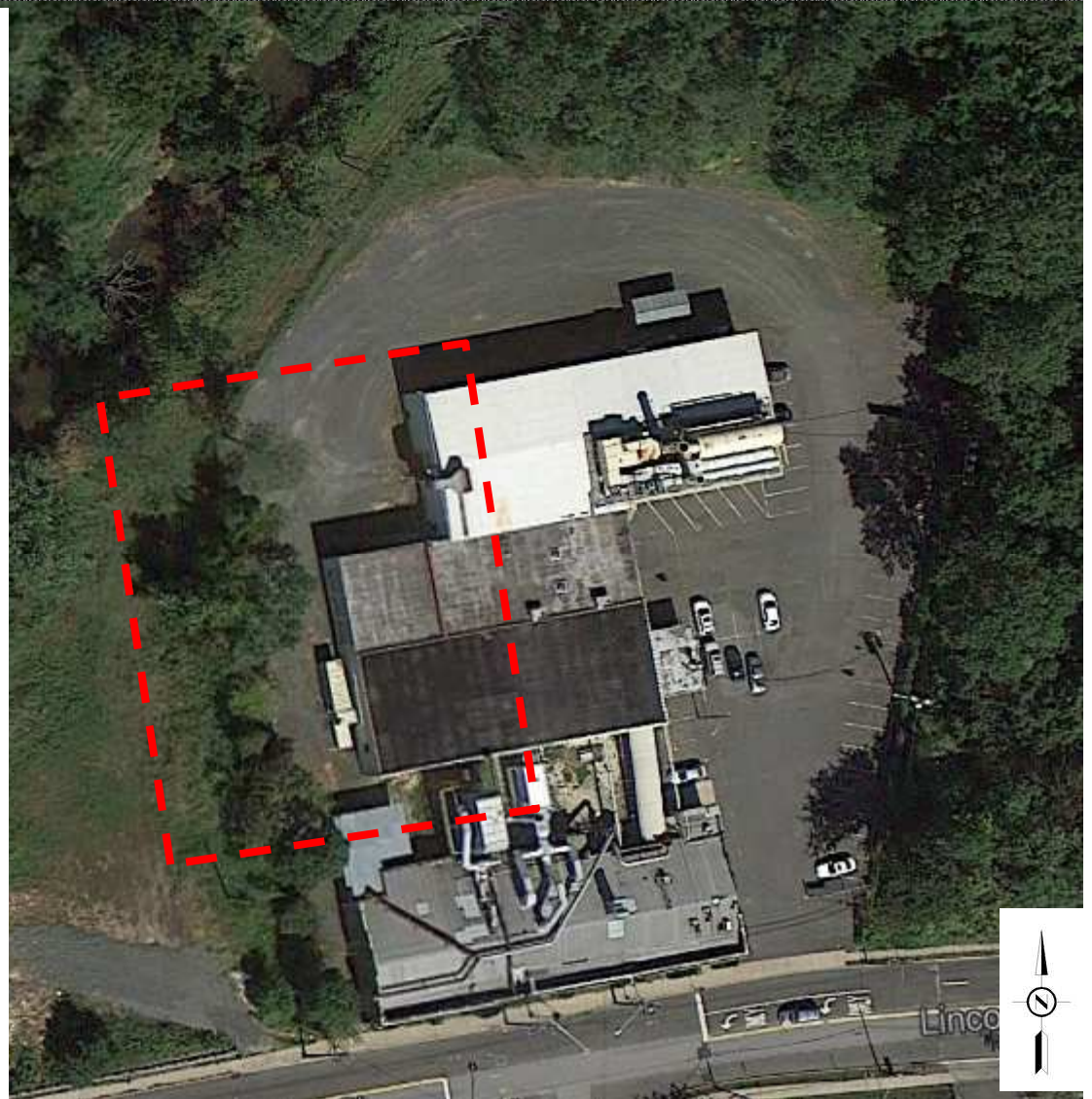
# Site Background

- Confidential Site in NJ
- Site History
  - Former Auto repair Garage
  - Currently a manufacturing facility for over 30 years



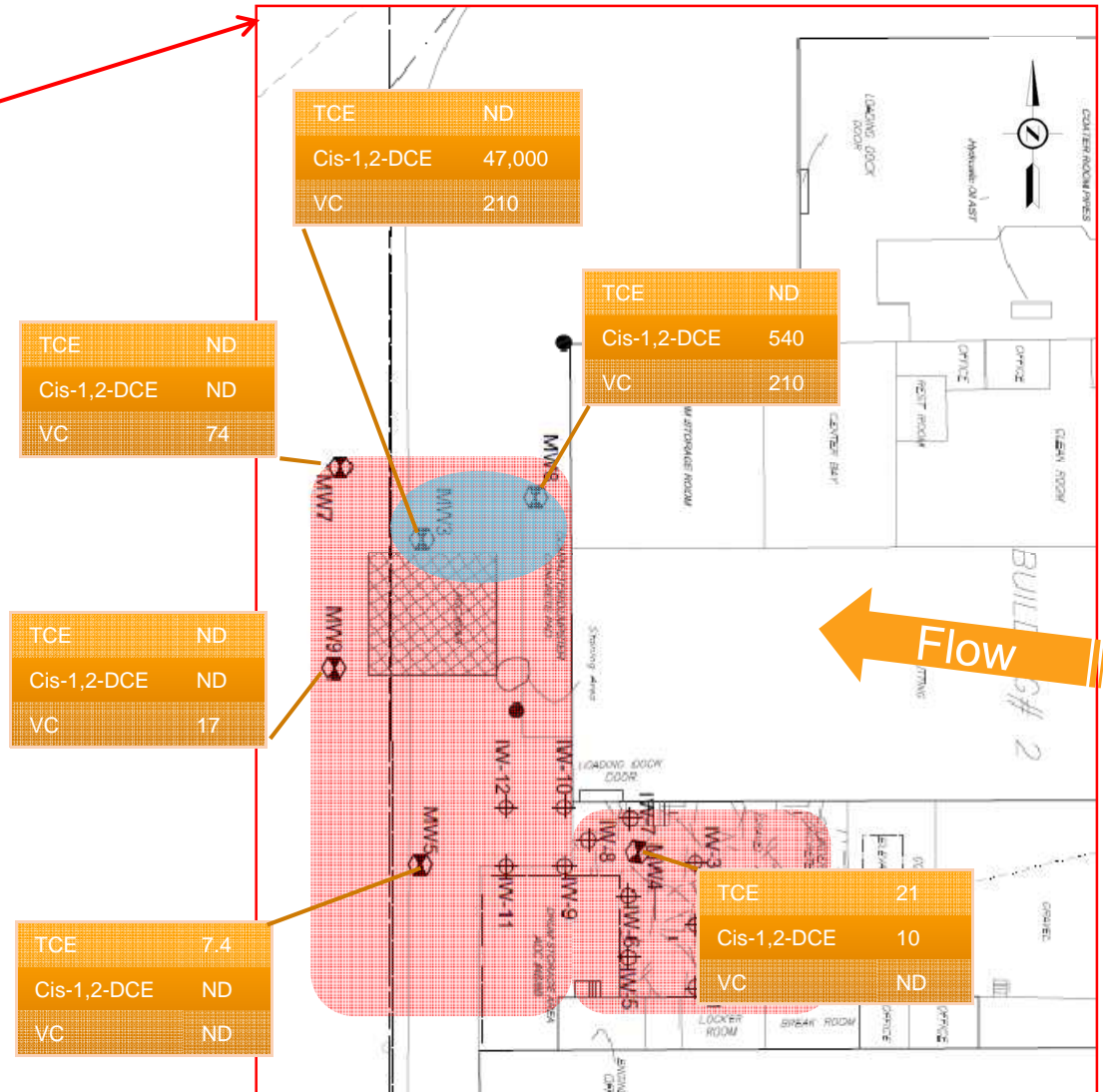
# Investigation History

- Compactor Pad Investigation
  - Staining around the pad observed during Phase I investigation
  - No resistance while advancing the sampling rod
  - Test pit to evaluate subsurface
  - Extremely deteriorated drum carcasses with stringy material
    - TCLP samples collected
      - TCE exceeded TCLP criteria
    - Source of buried drums unknown
  - CVOCs (mainly cis-DCE) measured in groundwater at concentrations up to 47 mg/L
    - Impacts localized within Site boundaries





# CVOCs Measured in Groundwater



# Remedy Selection

- Site Constraints
  - Water body within 100-ft of the site
  - Water main pipe (preferential pathway) within 50 ft
  - Unknown extent of the buried drum field
- Remedies Evaluated
  - ISCO: Potential impacts to water body
  - P&T: Not aggressive enough
  - AS&SVE: Potential sink hole concerns
  - ISCR + Drum Removal: Retained
- Substrate:
  - EHC in situ chemical reduction compound





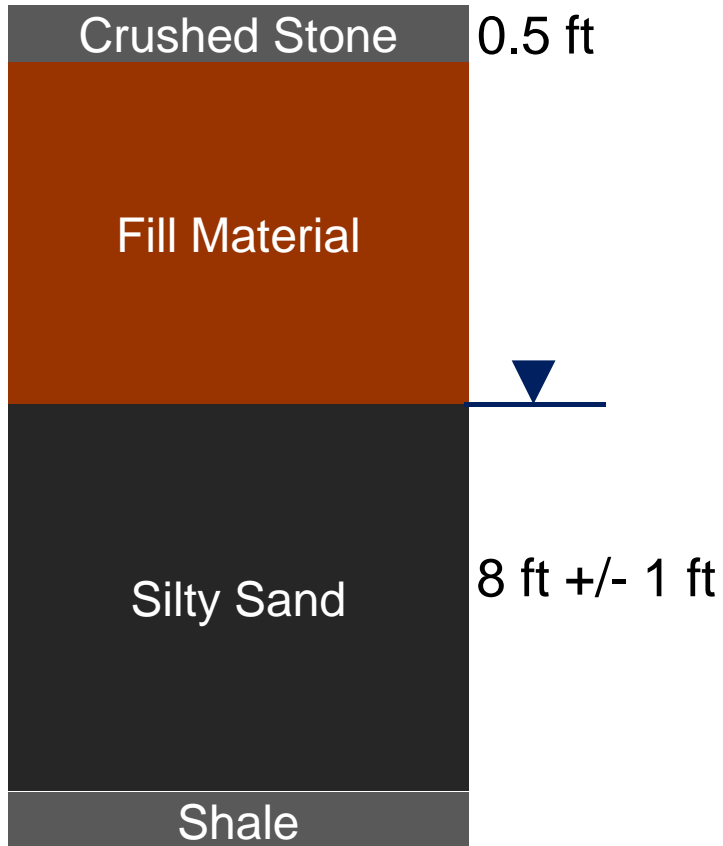
# Remedial Strategy

- Excavate and Remove Buried Drums
  - Drums and impacted soil above water table
- ISCR to treat GW impacts
  - Direct placement of EHC into soil at base of excavation
  - Supplemental EHC injections in sidegradient plume area via direct push



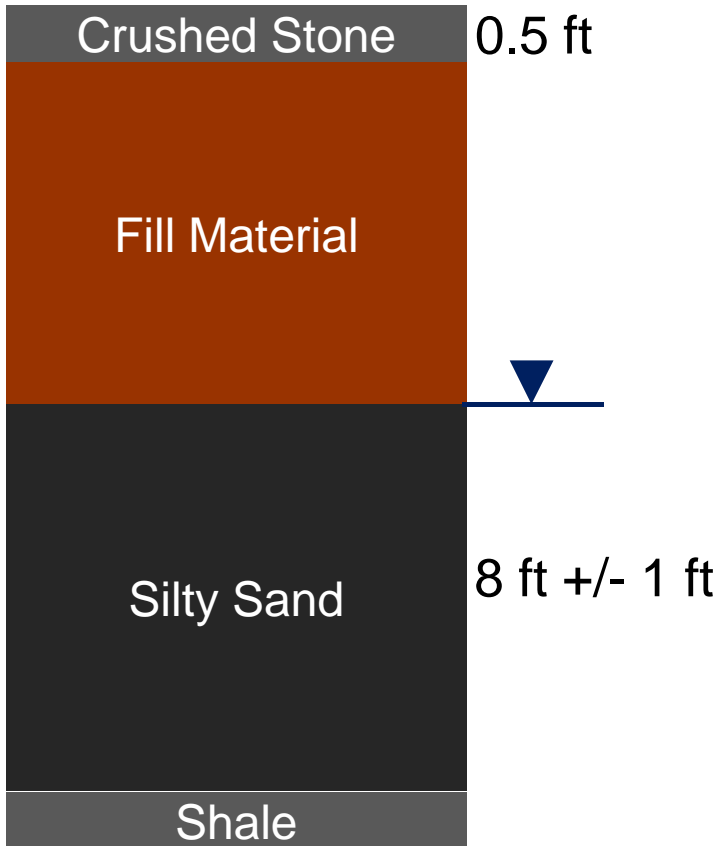
# Source Area and Drum Removal

- Soil and drums removed from an area measuring 25' x 35' x 8' deep
- Six roll-offs of impacted soil removed
- 42 drum carcasses removed



# EHC<sup>®</sup> Blending

- EHC mixed into soil at base of excavation from 8-16 ft bgs
- Dosage: 1 wt% EHC (to native soil mass)
- 1,300-lb of EHC added
- Mixed in-place using buckets







# EHC<sup>®</sup> Composition

- EHC is delivered as a dry powder and includes the following:
  - Micro-scale zero valent iron (standard ~40%)
  - Controlled-release, food grade, complex carbon (plant fibers) (standard ~60%)
  - Major, minor, and micronutrients
  - Food grade organic binding agent
- Sustainable Solution:
  - scrap metal
  - food production by-products





# EHC<sup>®</sup> Mechanisms and Attributes

## Organic Carbon

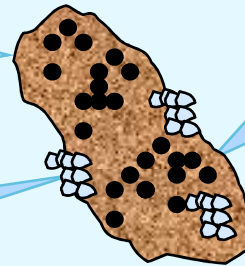
- Slow release of volatile fatty acids (VFAs)
- Electron donor for microbial reduction of CVOCs and other oxidized species such as O<sub>2</sub>, NO<sub>3</sub><sup>-</sup>, SO<sub>4</sub><sup>2-</sup>

## Micro-scale ZVI

- Abiotic degradation
- O<sub>2</sub> scavenger
- Generates Fe<sup>2+</sup>, OH<sup>-</sup> and H<sub>2</sub>

## Bacterial Cluster

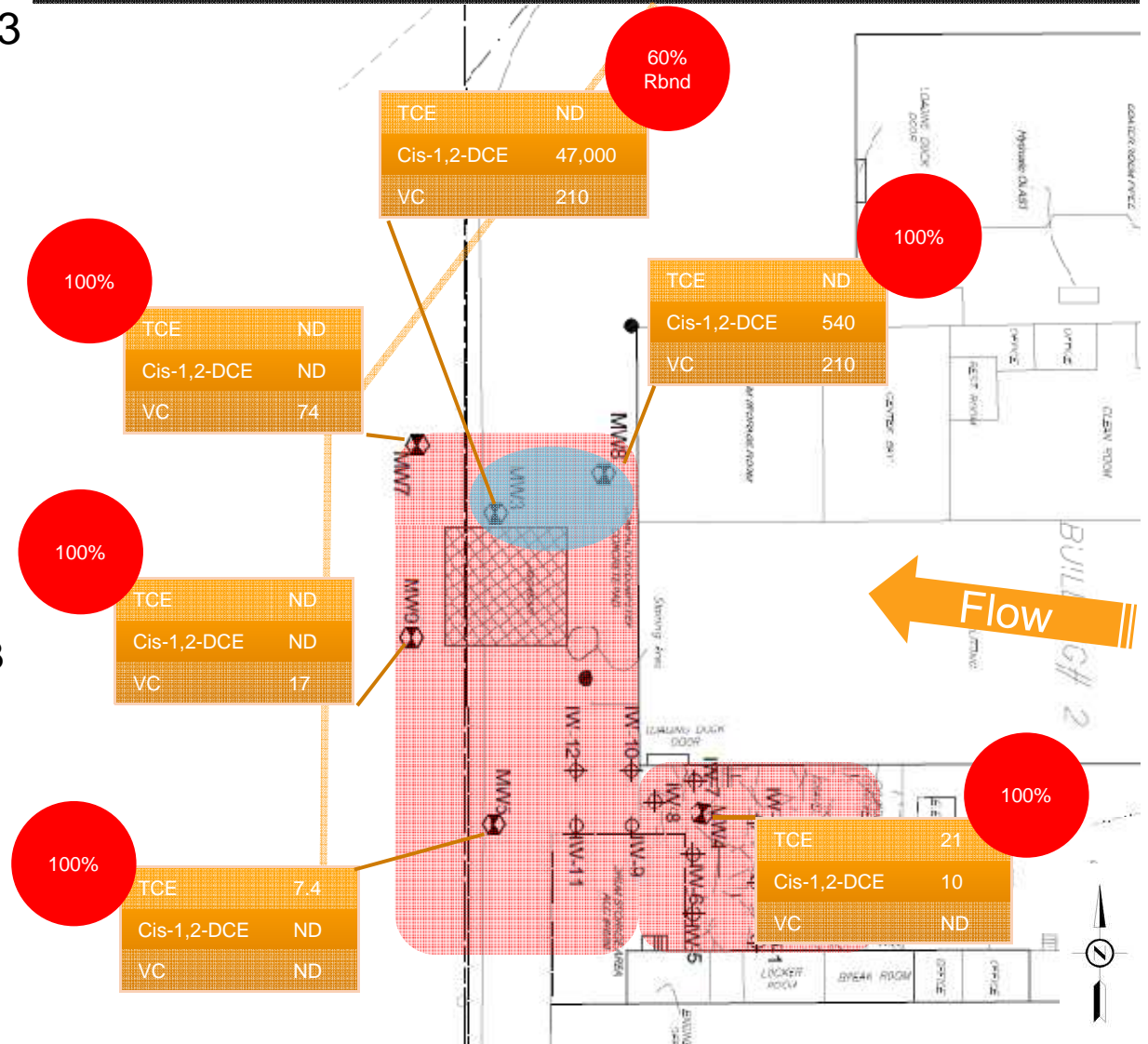
- Hydrophilic, fibrous organic carbon provides ideal surface area for microbial growth



- Self-buffered (alkalinity from ZVI corrosion off-set by acidity from VFAs):
  - Prevents ZVI passivation from mineral coatings
  - Maintains pH favorable for microbial growth
- Combined oxygen consumption from carbon fermentation and iron oxidation:
  - Generate Strongly reducing conditions
- Longevity = 4-5 years

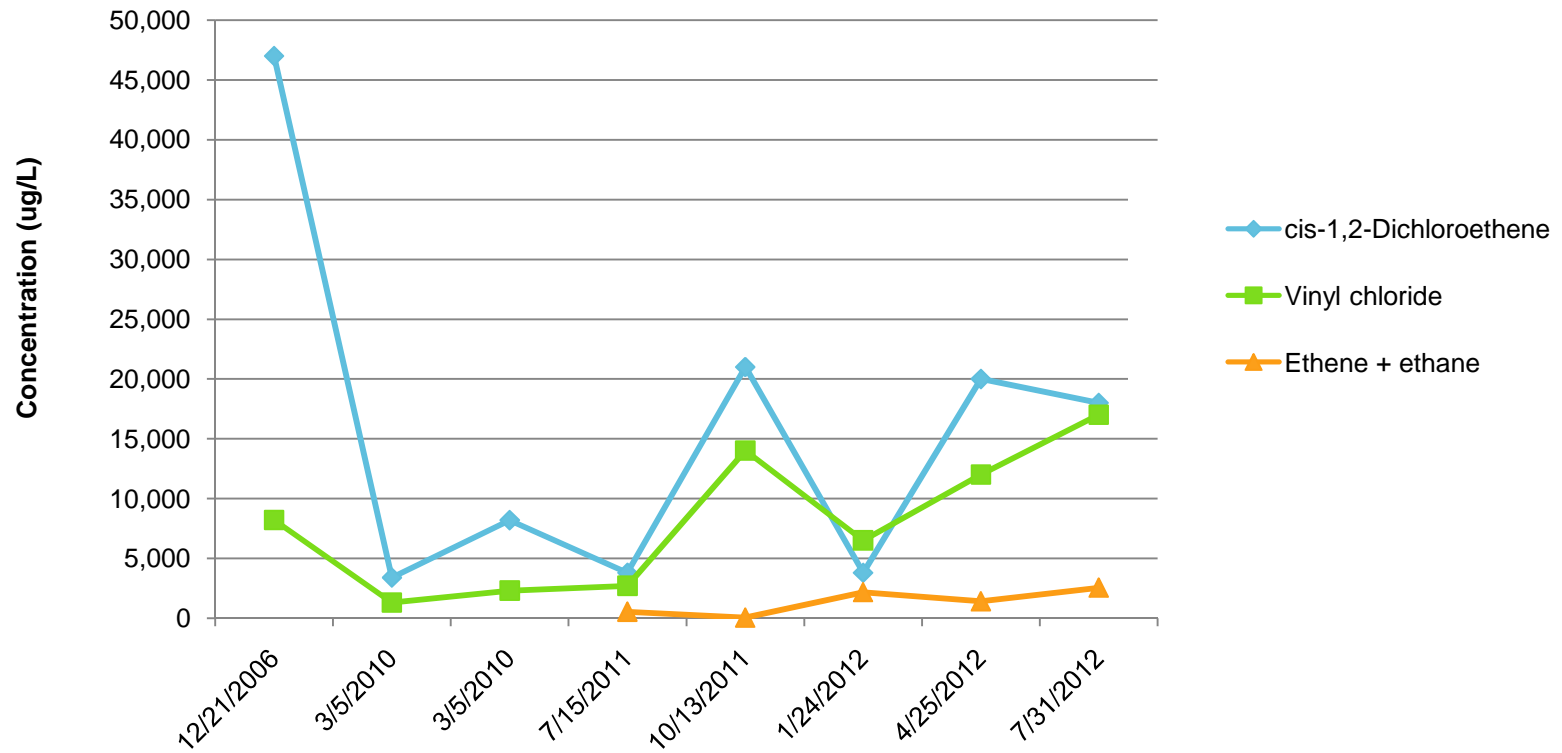
# EHC Application Results

- Highest concentrations at MW-3
- VFA peaked in 1<sup>st</sup> Qtr post DARAMEND application
  - Except in MW-4/MW-5 (3<sup>rd</sup> Qtr)
- Methane, Ethane , Ethene peaked in 3<sup>rd</sup> Qtr post application
- Dechlorinating bacteria peaked in 2<sup>nd</sup> Qtr
  - Most significant growth in MW-3 and MW-8
- Rebound in MW-3, possible additional buried drums
- BTEX decreased in MW-8 but not MW-3



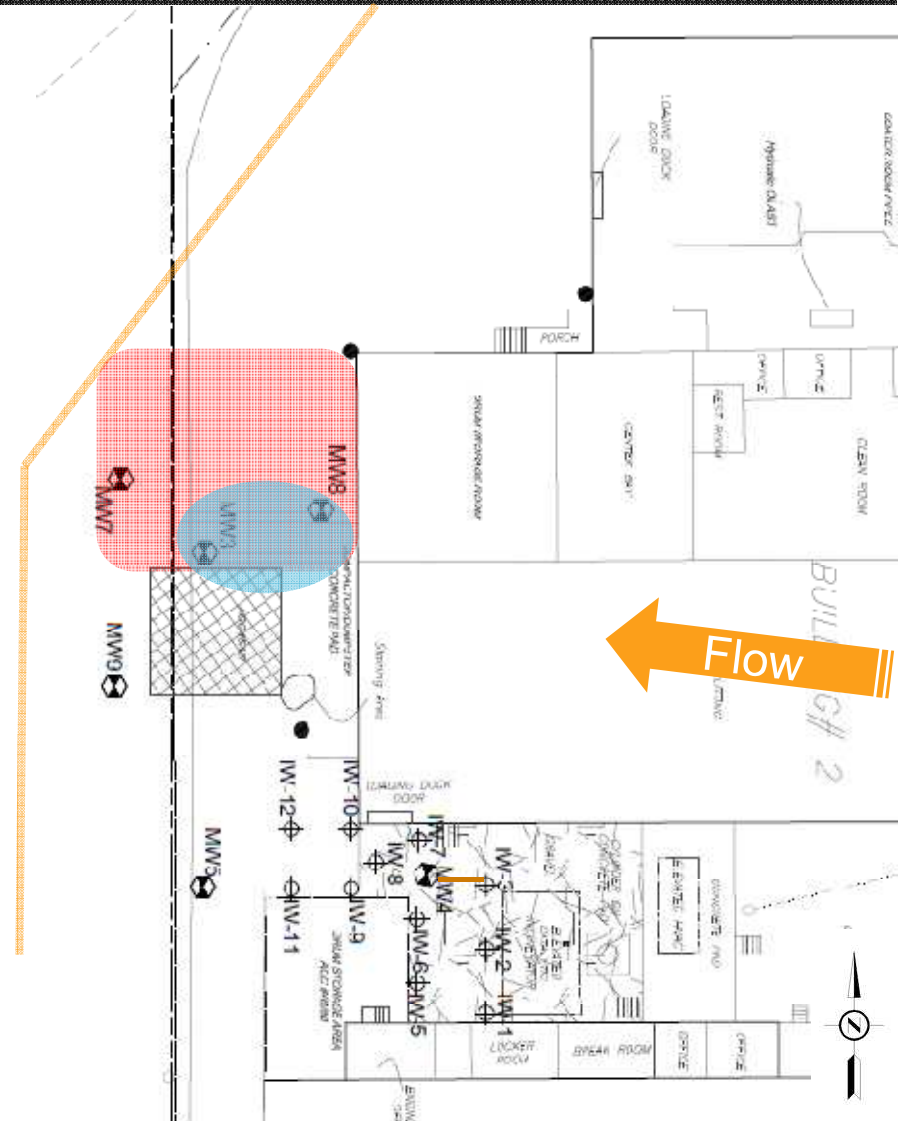


# Results – MW-3



# Additional Investigation

- Hot Spot Delineation revealed
  - Potential additional buried drums
  - Fringe of the plume
  - Low Dechlorinating bacteria count
- Recommendation
  - Additional round of DARAMEND/EHC application with DHC
- Still waiting for UIC permits to conduct work.





The background of the slide is a photograph of a marina. Numerous sailboats with white hulls and tall masts are docked at a pier. In the foreground, there are large, reddish-brown rocks in the water. A seagull is captured in flight in the upper right portion of the image. The sky is clear and blue, and a town is visible in the distance across the water.

# Questions

**Amit Haryani, PW, LSRP**  
**Senior Project Manager**  
**212.798.8571**  
**[Amit.Haryani@aecom.com](mailto:Amit.Haryani@aecom.com)**

**Josephine Molin**  
**Technical Sales Manager**  
**FMC Environmental Solutions**  
**773.991.9615**  
**[Josephine.molin@fmc.com](mailto:Josephine.molin@fmc.com)**