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Colloidal Activated Carbon used to Reduce PFAS and Chlorinated Solvent Concentrations

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REGENESIS, Sr. Technical Manager/PFAS Program Manager



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Problem Statement

- **Multiple PFAS point sources**
- **Comingled with PCE plume**
- **Identified at the property boundary and migrating off-site**
- **Many potential downgradient receptors**
- **Limited budget for field testing of remedial technologies**

- **Question:**
Can CAC be used to mitigate the risk of PFAS to the sensitive receptors?

Grayling Army Airfield



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Site Description



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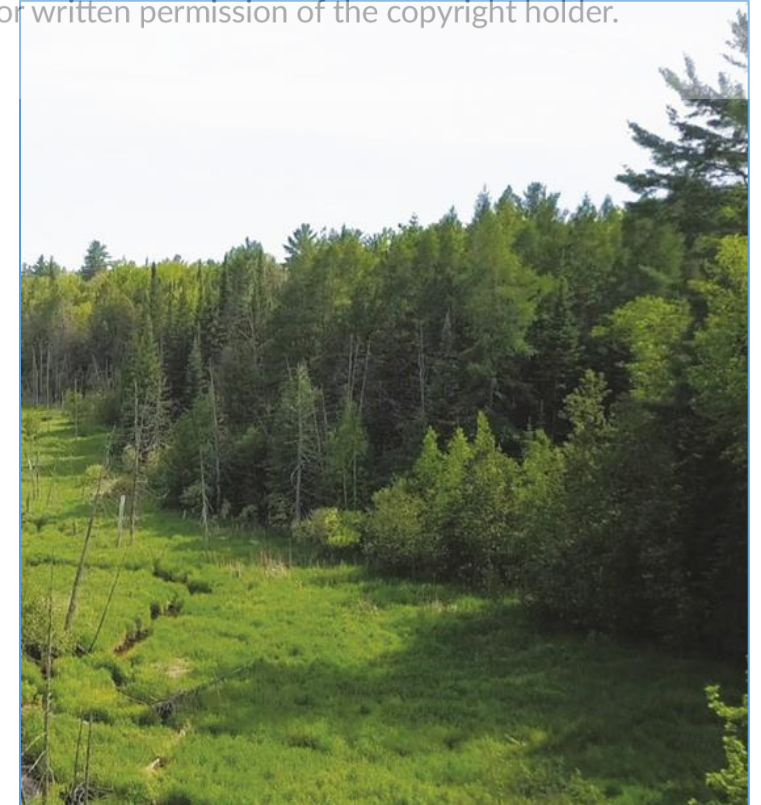
Site Location: Camp Grayling Joint Maneuver Training Center

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- Founded 1913
- 147,000 acres
- Largest National Guard training center in the country
- Training facility for military, emergency responders, and private-sector from all over the world
- Home to the Grayling Army Airfield

Grayling Army Airfield (GAAF)

- 900-acre
- Built during World War II



Former Bulk Fuel Storage Area

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Aquifer:

- Sand & Gravel with some clay layers
- ~250'/yr gw seepage velocity
- Treatment Interval 15-27'bgs

Contaminant levels:

- 10 µg/L PCE
- 130 ng/L Total PFAS (PFOS, PFHxS)

Sensitive Receptors:

- Residential areas
- Surface water bodies
- Property Boundary



Former Bulk Fuel Storage Area **REGENESIS**[®]



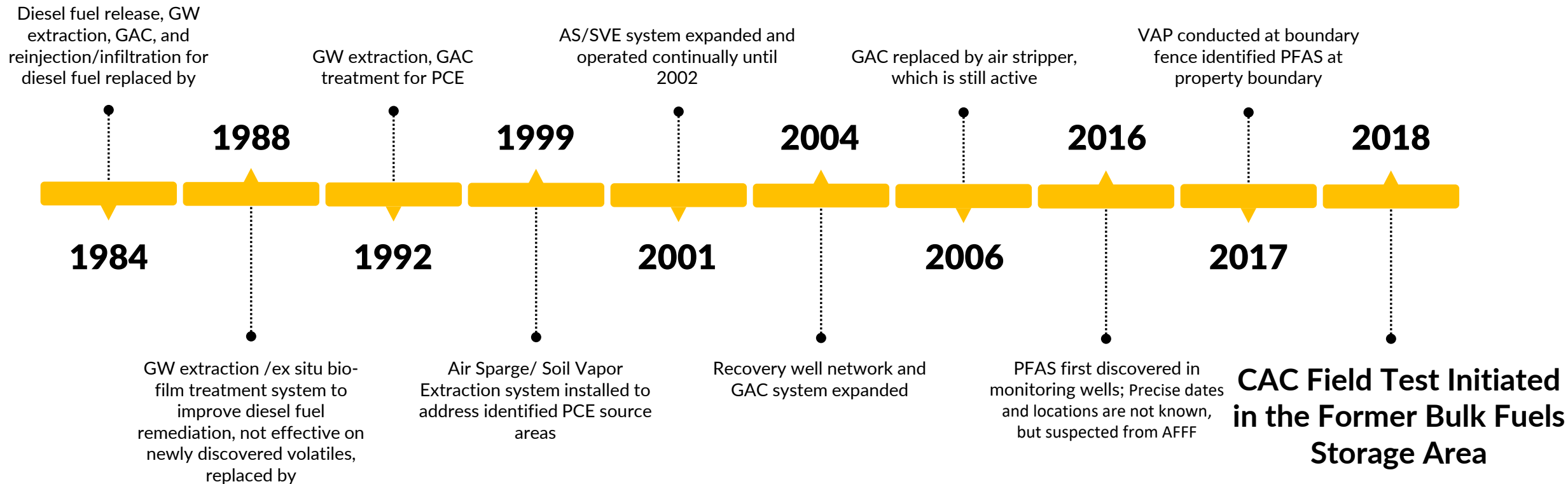
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Remediation History



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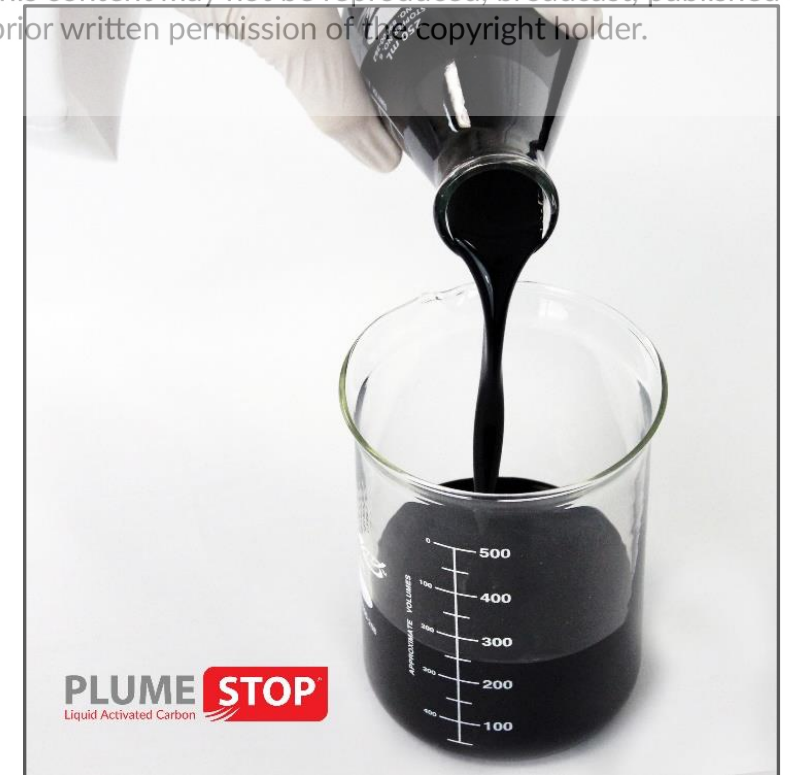


Colloidal Activated Carbon

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- Size: 1 – 2 μm
 - 2-3 OOM smaller than GAC (500-1,000 μm)
 - Size of a red blood cell
 - Suspended in water/polymer
 - Distributes widely at low pressure
 - Huge surface area that allows for extremely fast sorption
 - Converts polluted aquifer into purifying filter



Why Colloidal Activated Carbon?

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- **Limited destructive options**
- **Low Cost**
 - No O&M costs or generated waste
 - Reapplication only after years/decades
- **Localized containment/concentration of PFAS**
 - Pair with future destructive technologies?
- ***In Situ* Sequestration**
 - Preventing contaminant migration
 - Removes exposure → removes the immediate risk

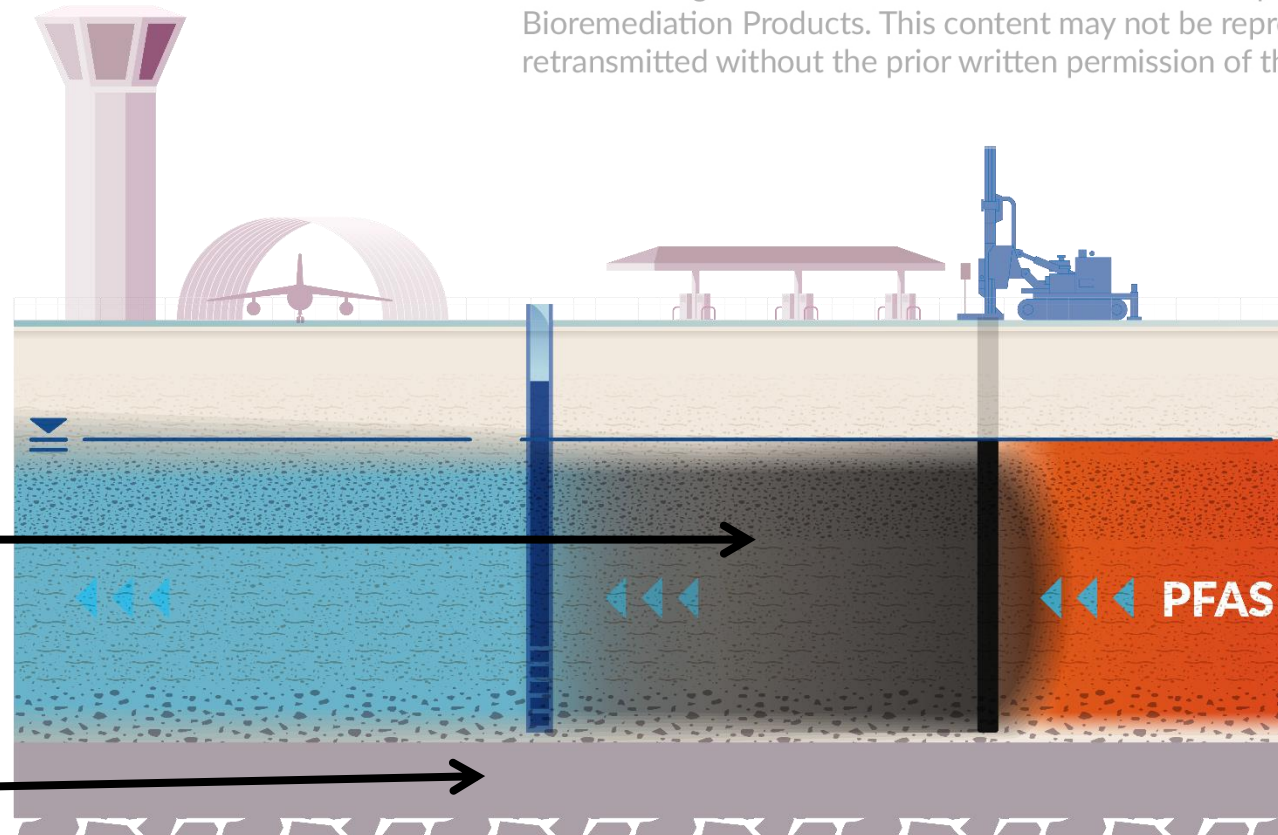


Treatment of Flux Zones and Control of Back Diffusion



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CAC: Modes of Action



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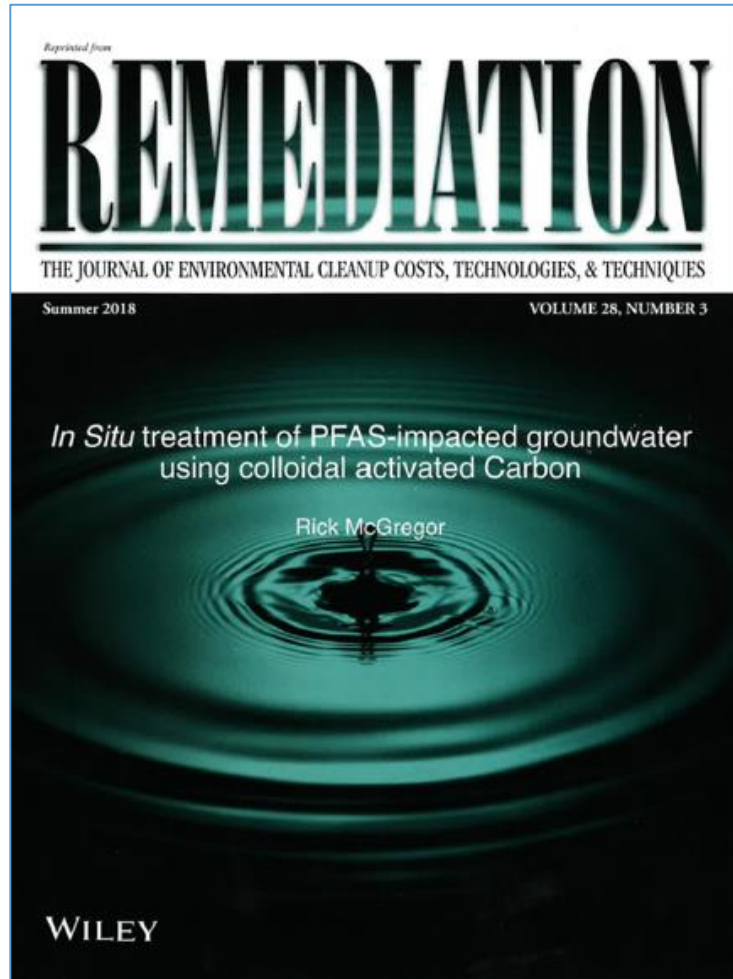
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- **Dynamic adsorption**
 - Not a permanent immobilization
- **Effect: Increases the retardation of a PFAS plume**
 - Groundwater retardation factor of 1
 - Natural retardation factors for PFAS: 3-20
 - Retardation factors achievable with CAC: 10,000
 - Containment for decades
 - PlumeForce Modeling™
 - Third Party Modeling (scientific articles available)



Longevity-Third Party Review

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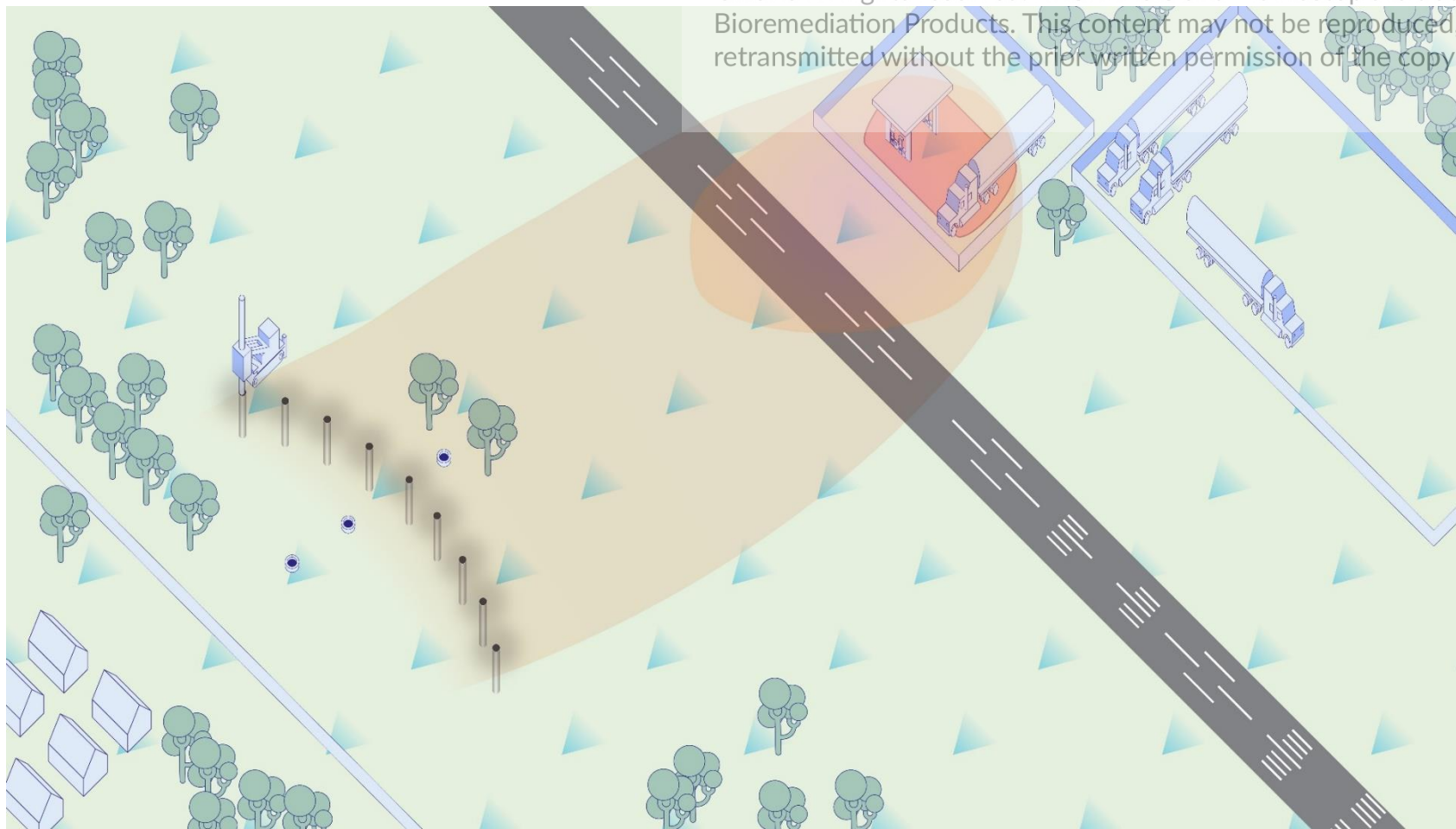
- **University of Waterloo, Waterloo, Ontario, Canada**
- **University of Toronto, Toronto, Ontario, Canada**
- **Longevity-Conclusions:**
 - **Porewater Solutions, Ottawa, Ontario, Canada**
 - Increased by CAC concentration injected
 - Length of treatment area
- **In Situ Remediation Services Ltd., St. George, Ontario, Canada**

Simple Plume Cut-Off Barrier



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PlumeForce[™]

- Long-Term Prediction Model
- Competitive Sorption and Degradation (if applicable)
- Compound Specific Isotherms
- VOCs, PFAS, etc.

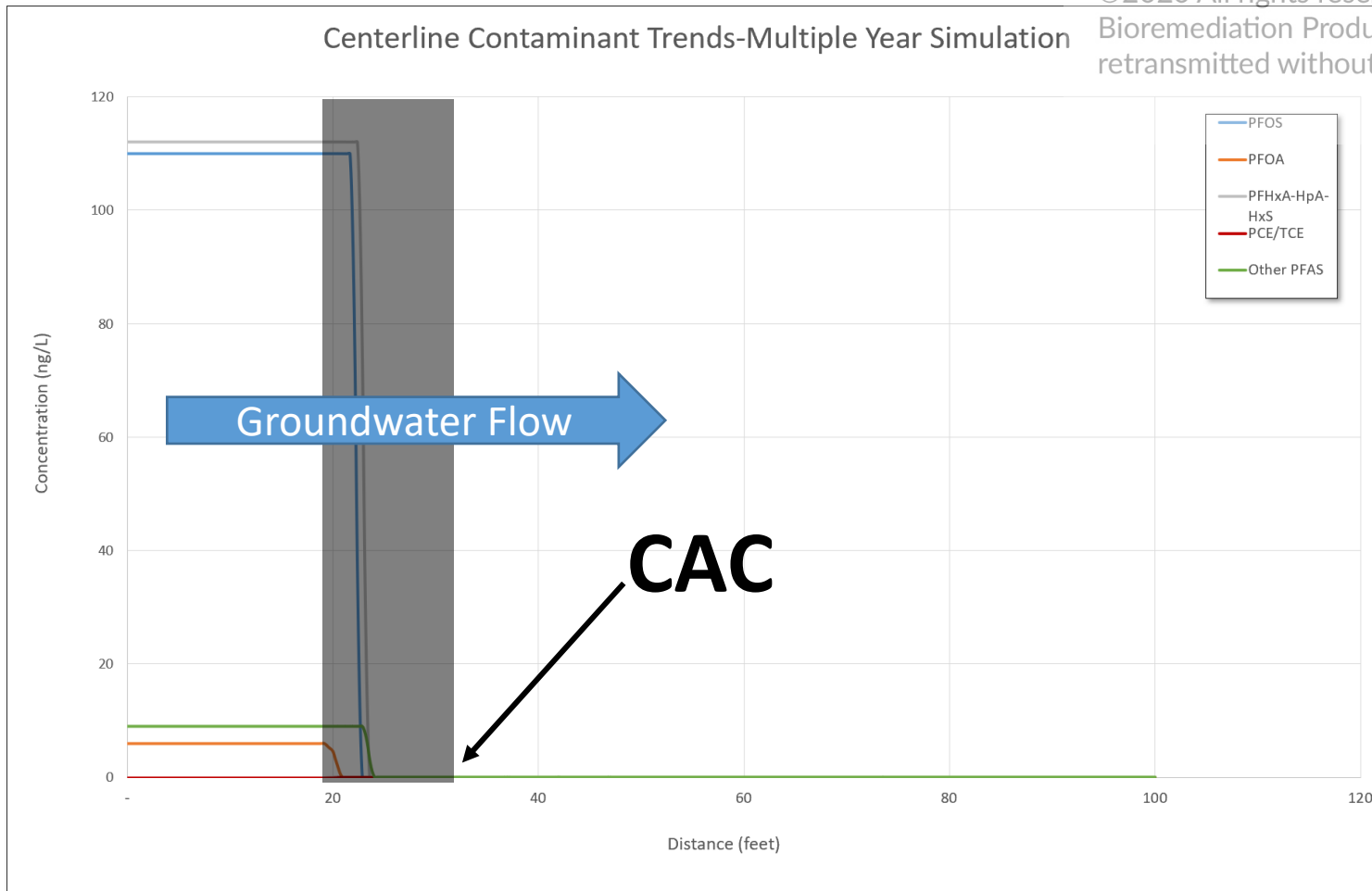
Considerations

- Soil Type/Porosity
- Groundwater Seepage Velocity/Mass Flux
- Vertical Variations
- Barrier Thickness
- Carbon Demand
- Time

Modeling in the Design Process

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Inputs

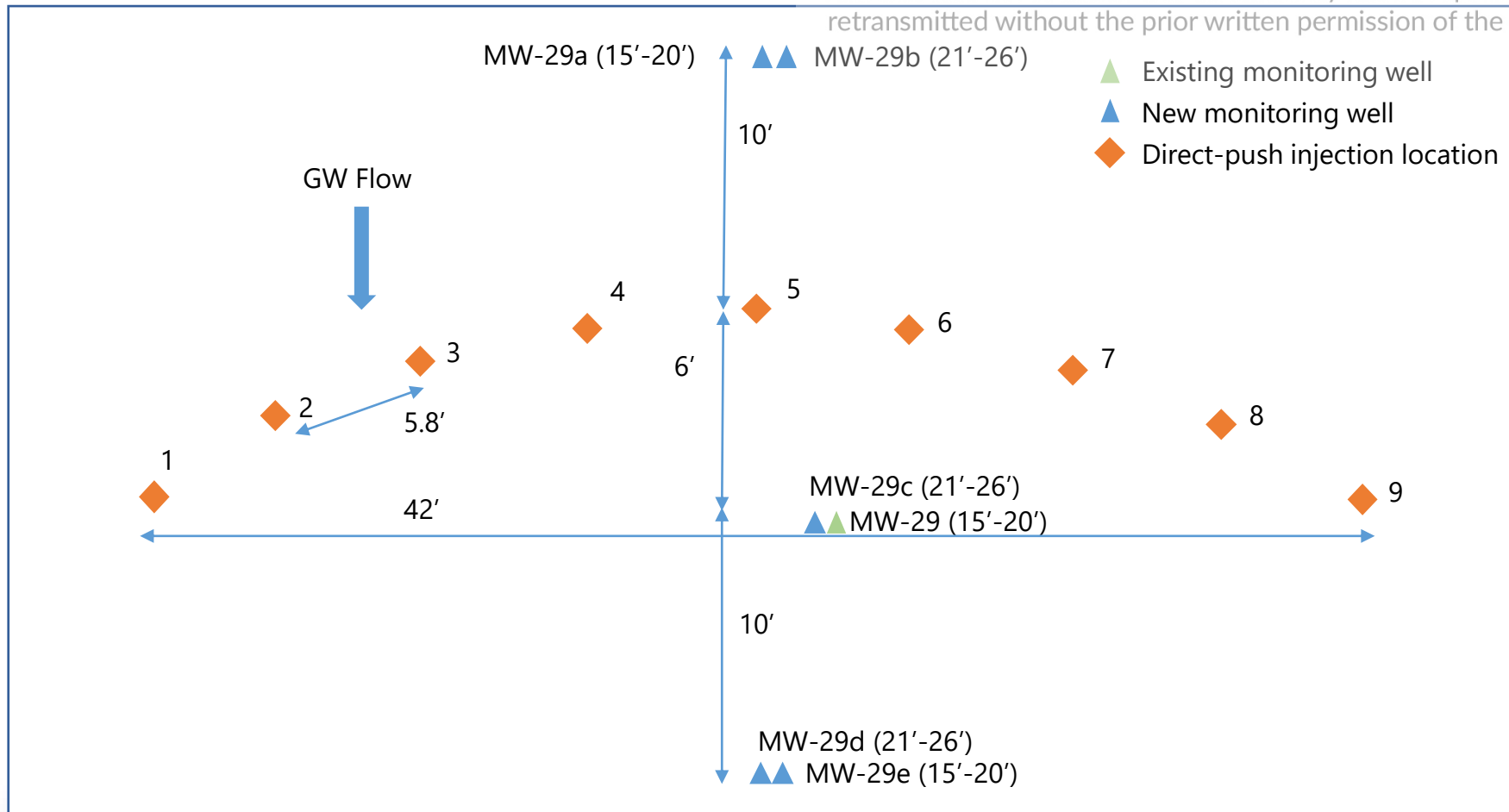
- GW 219 feet/year
- Infinite Source
- PFOS 110 ng/L
- PFOA 8 ng/L
- PFHxA -HpA - HxS 112 ng/L
- Other PFAS 9 ng/L
- PCE 10 ug/L
- No degradation of any PFAS compound or CVOC's
- Time (>75yrs)

Field Test Layout



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Field Test Layout



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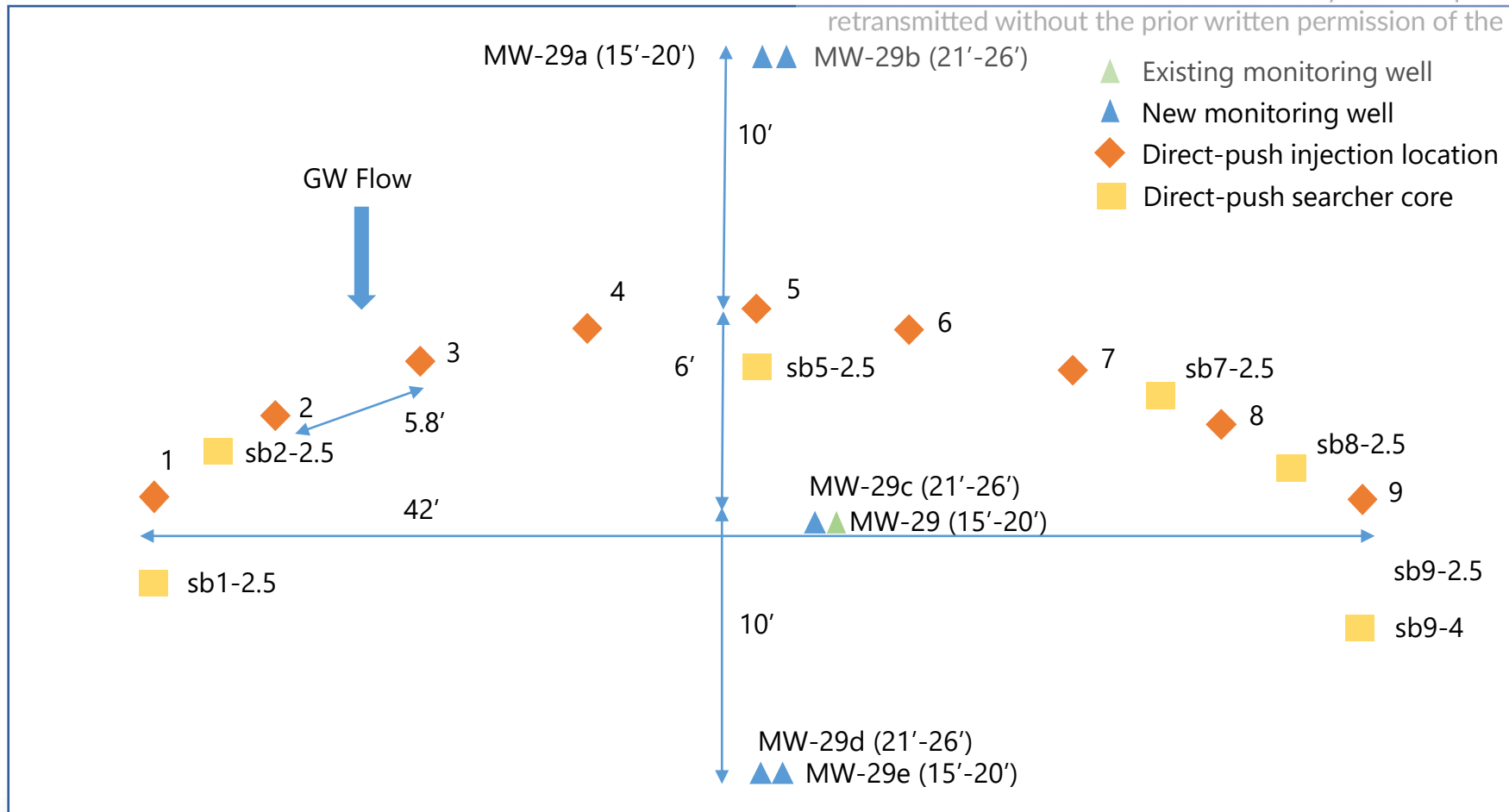


Field Test Layout



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CAC-Distribution Confirmation

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27 feet bgs

0 feet bgs

15 feet bgs

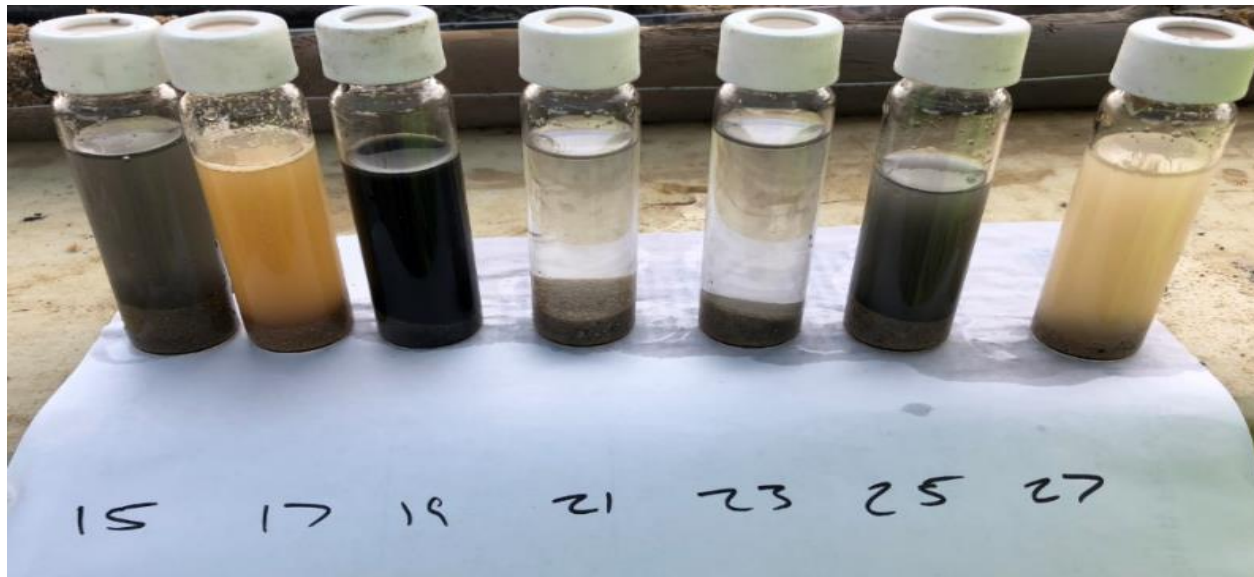
30 feet bgs

CAC-Distribution Confirmation



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Soil Vial Shake Test

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27 feet bgs

0 feet bgs

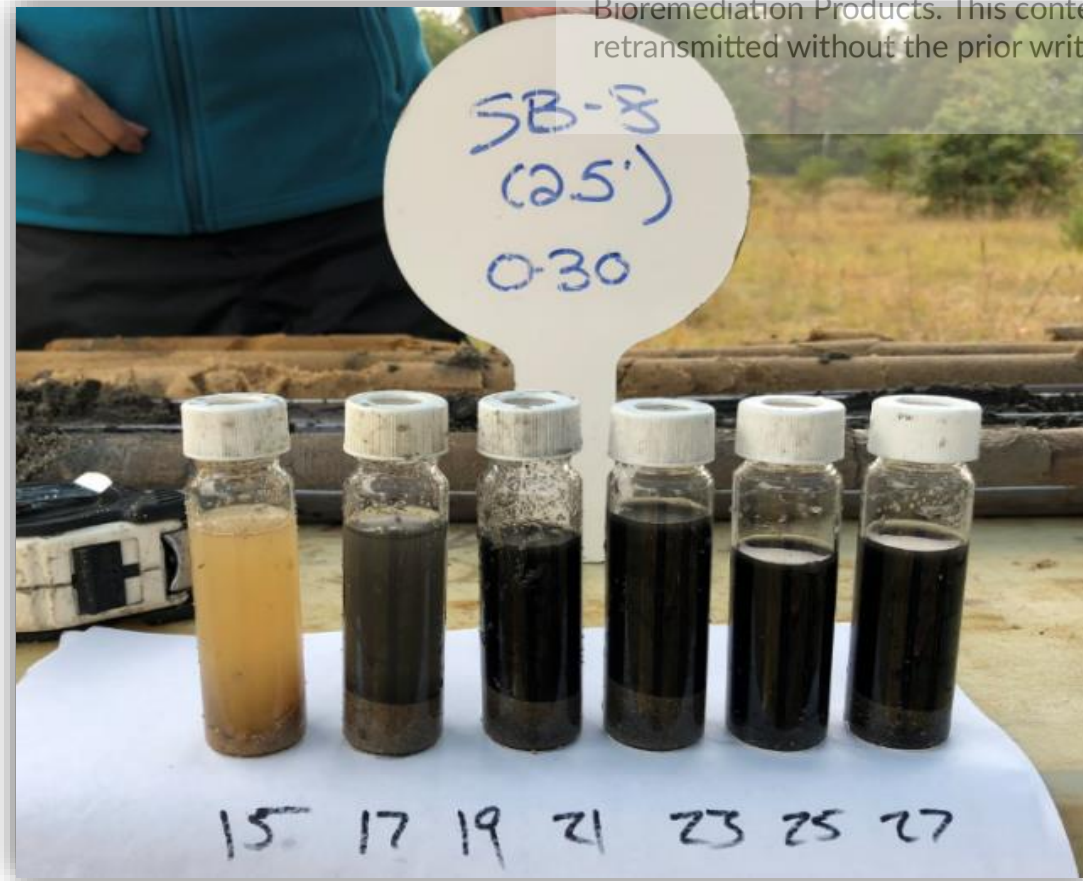
15 feet bgs

30 feet bgs

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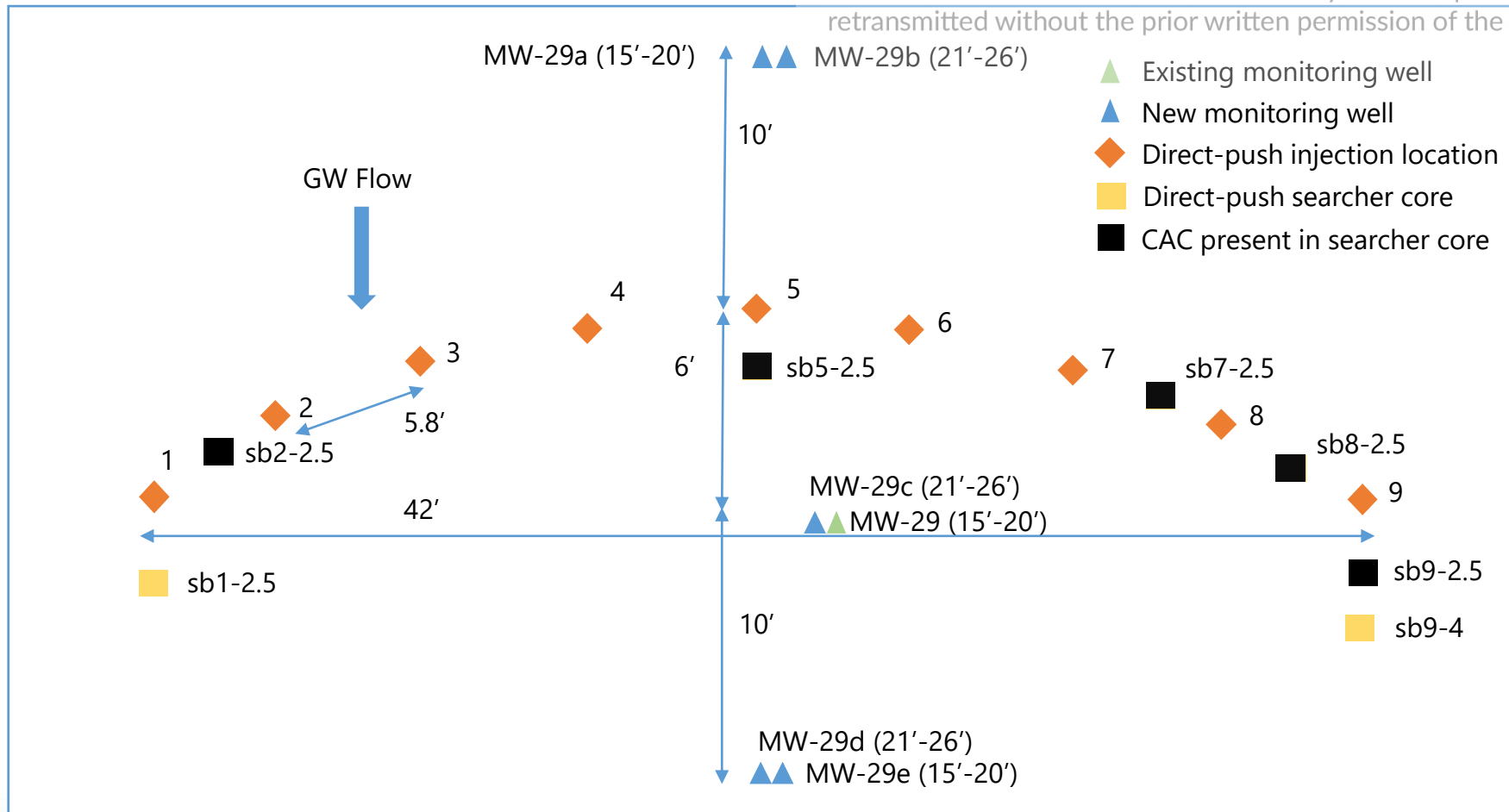


Field Test Layout



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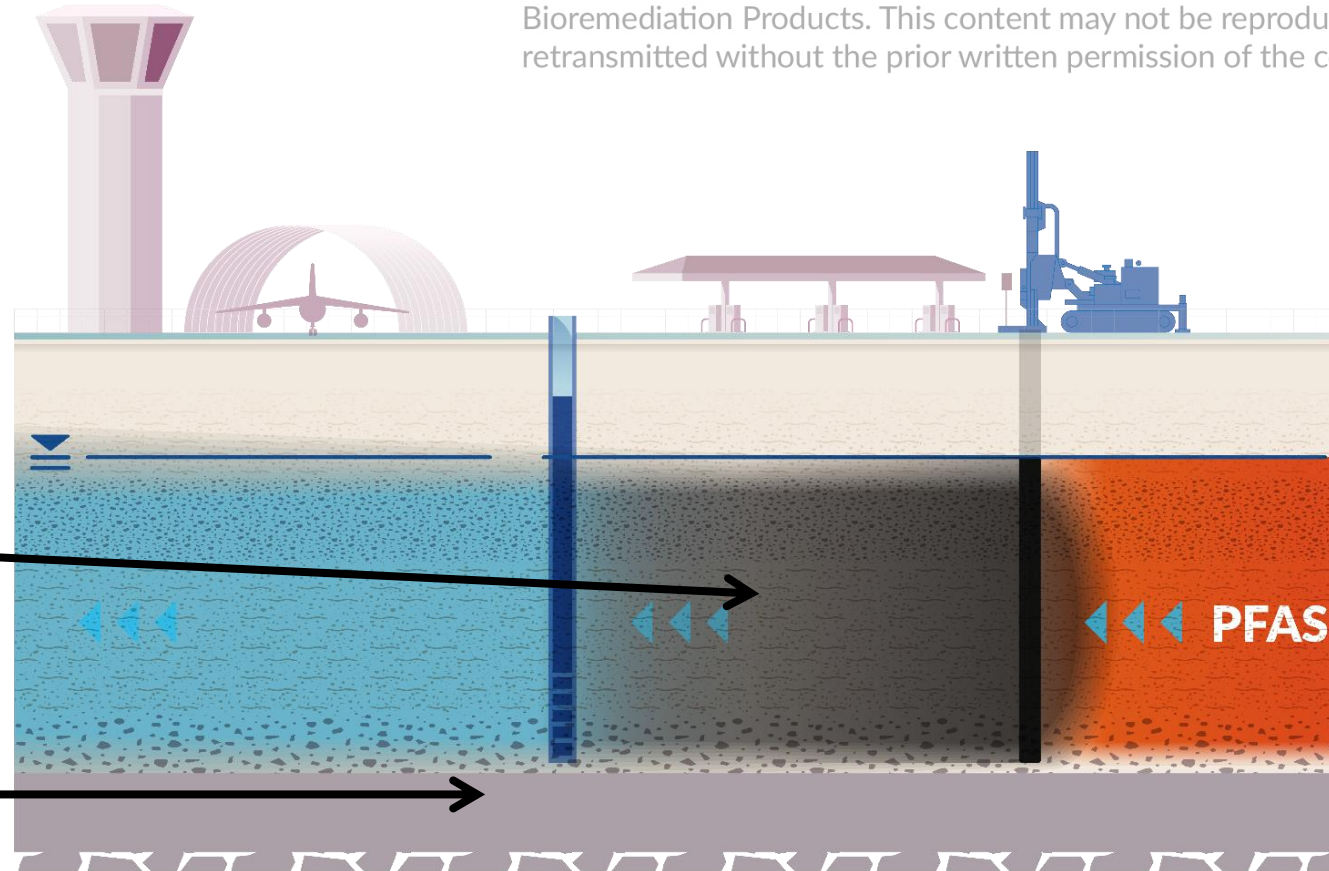


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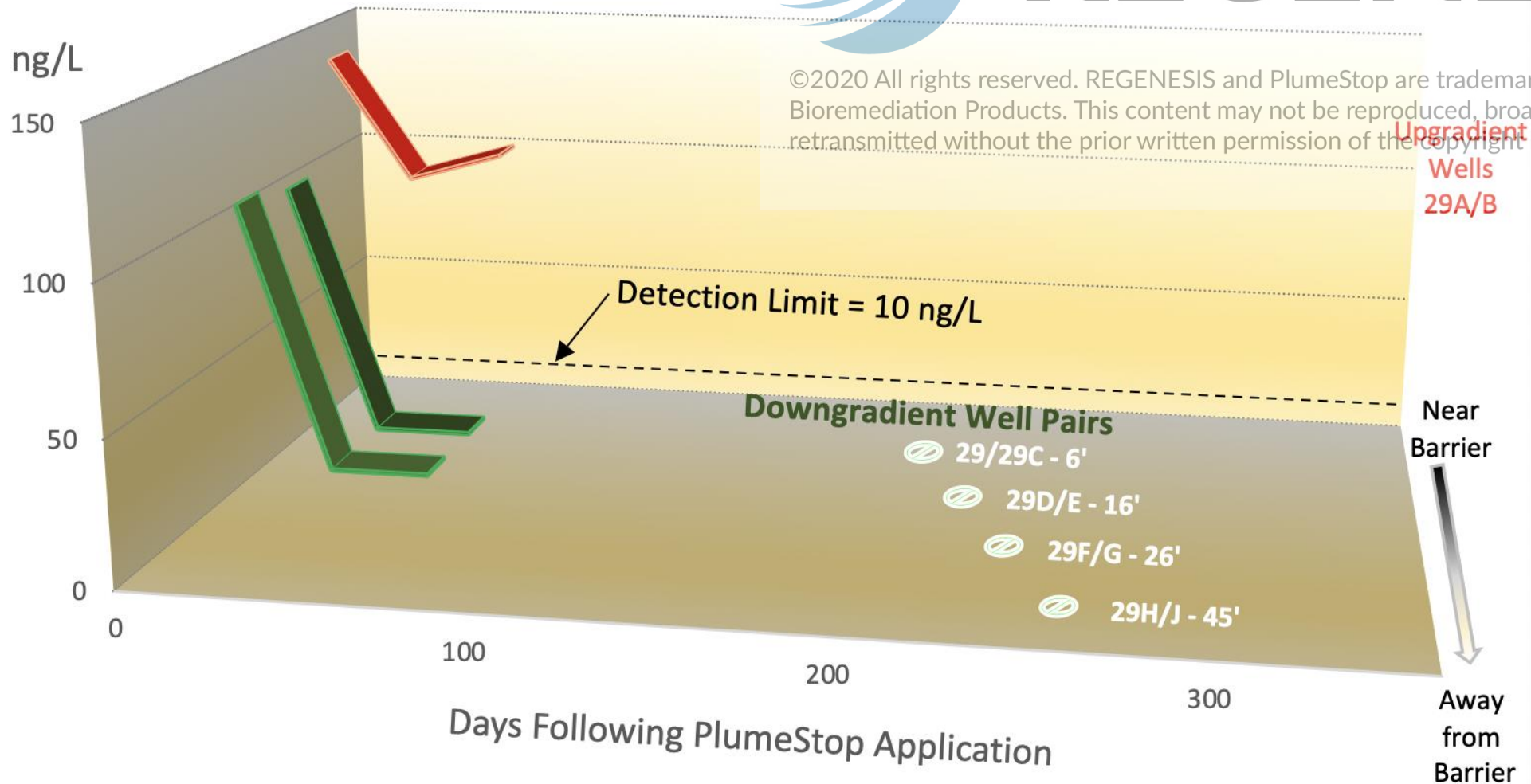
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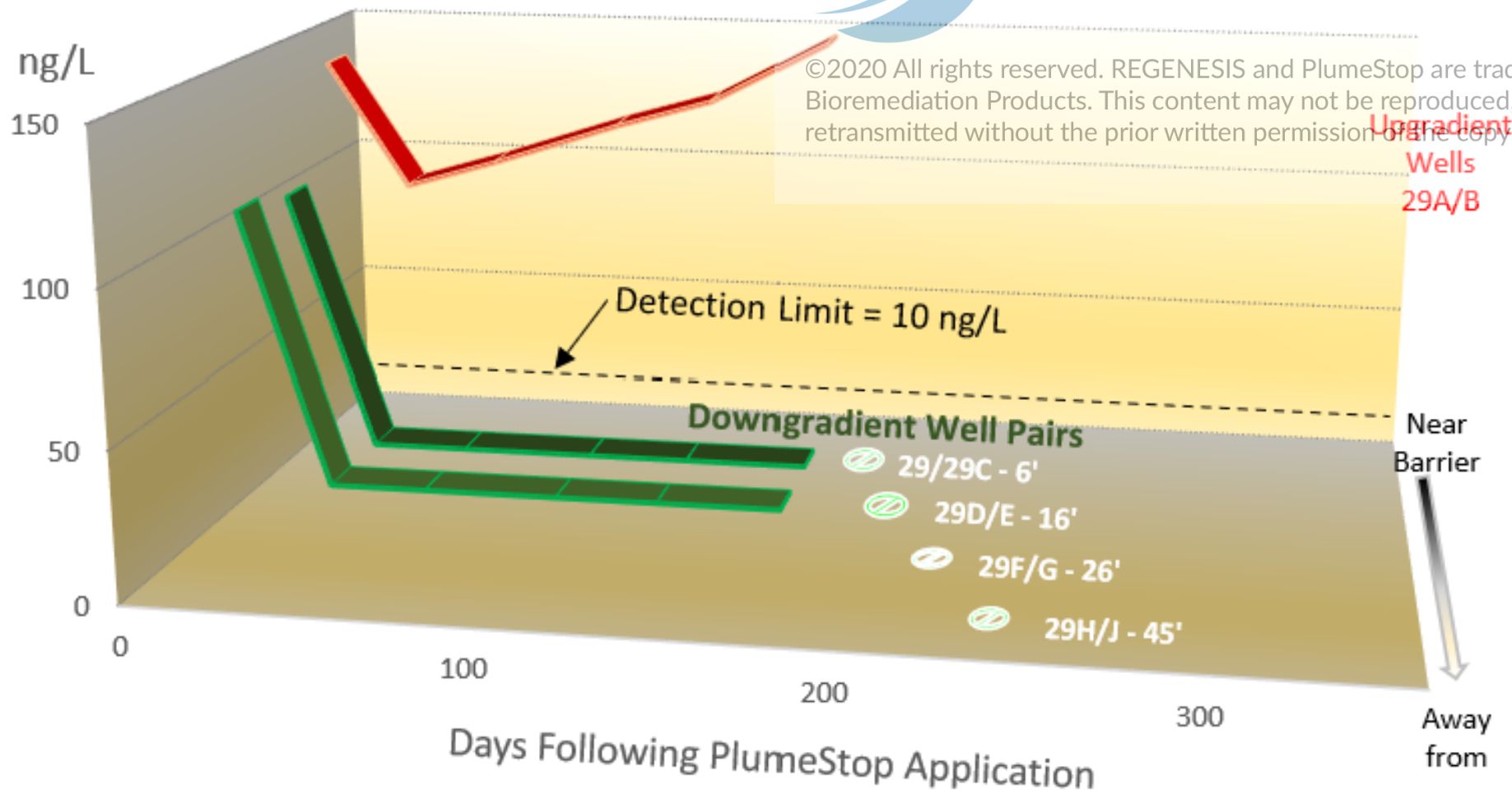


Average Total PFAS in Monitoring Wells Upgradient and Downgradient of PlumeStop Barrier

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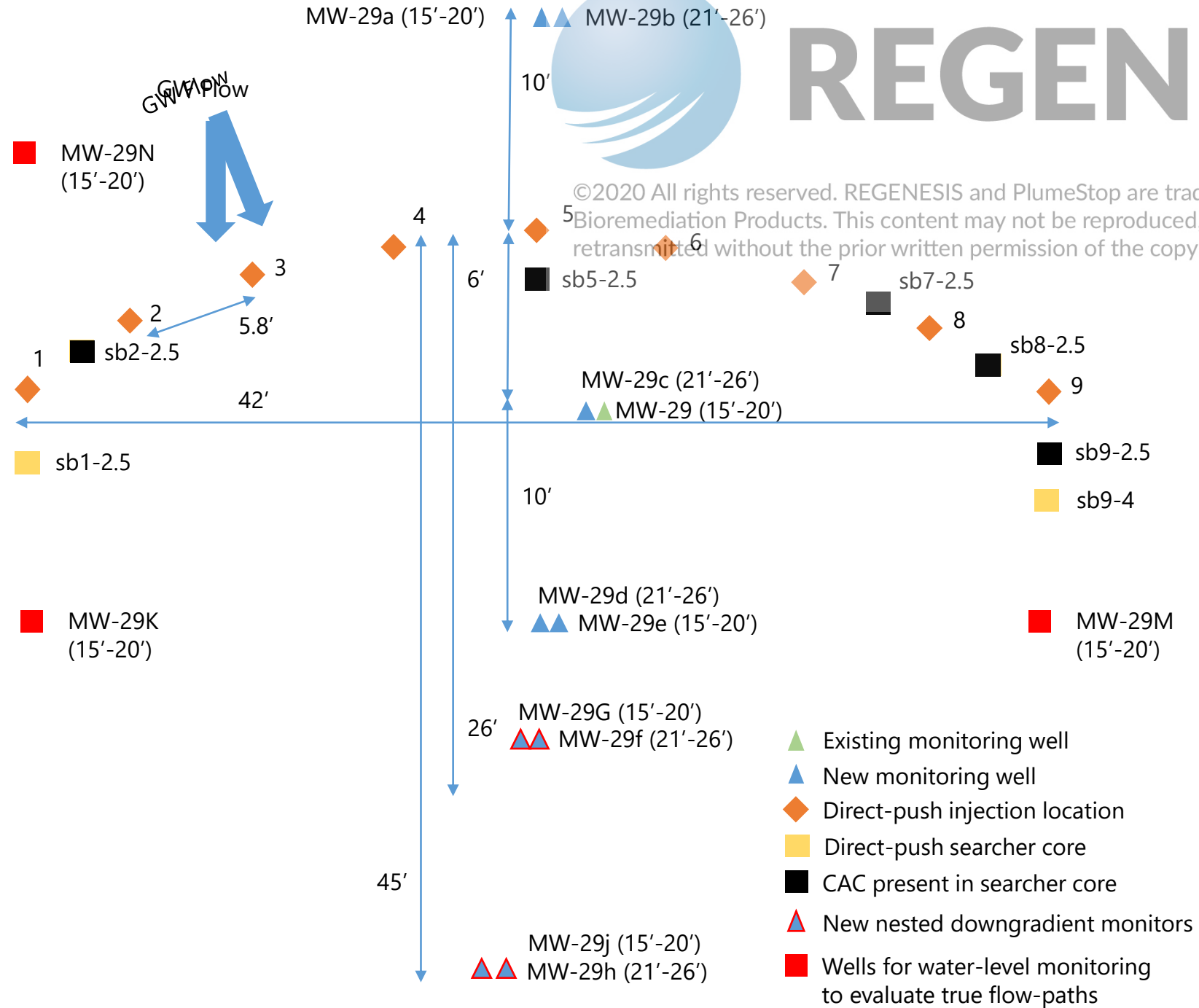


Average Total PFAS in Monitoring Wells Upgradient and Downgradient of PlumeStop Barrier



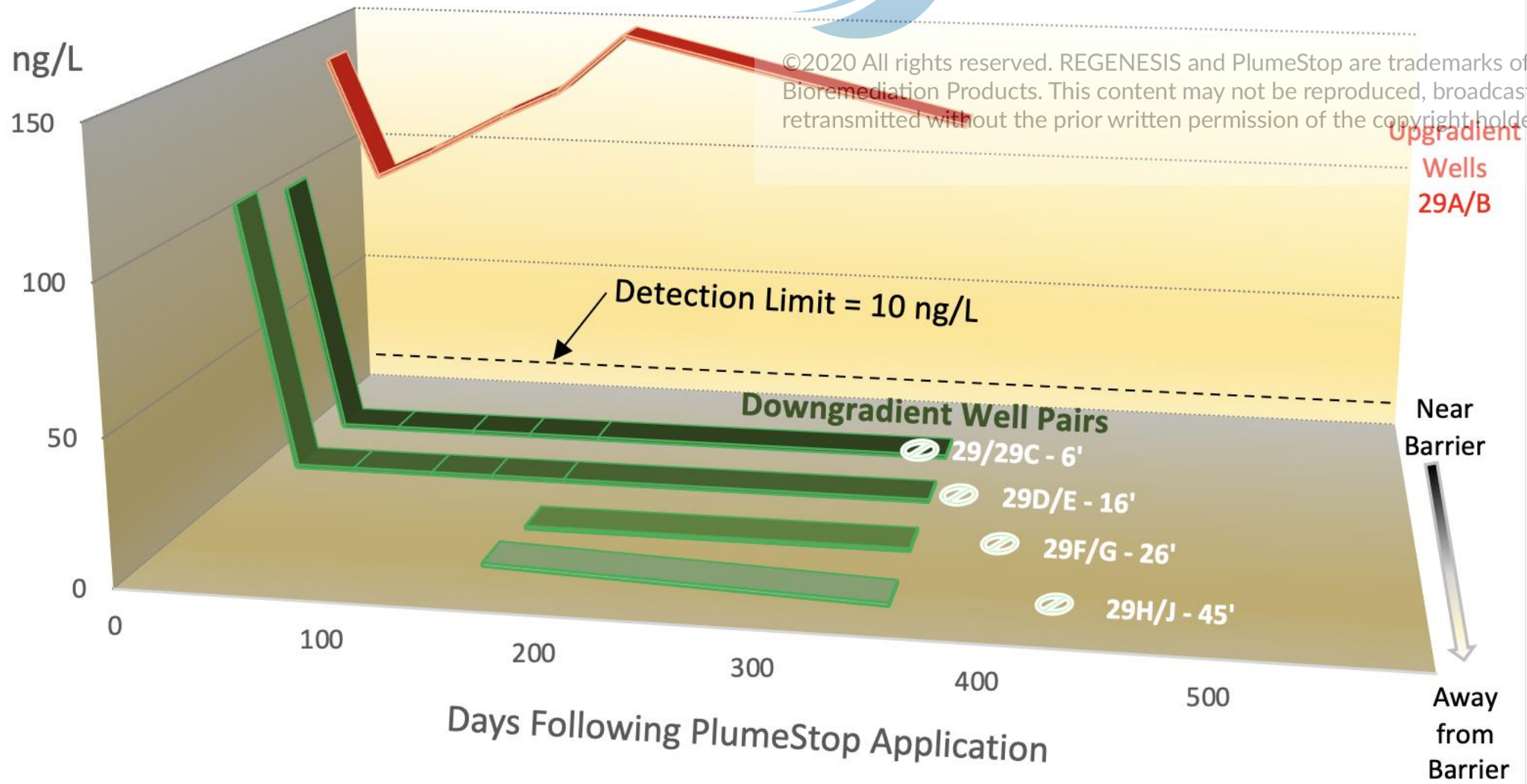
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Average Total PFAS in Monitoring Wells Upgradient and Downgradient of PlumeStop Barrier

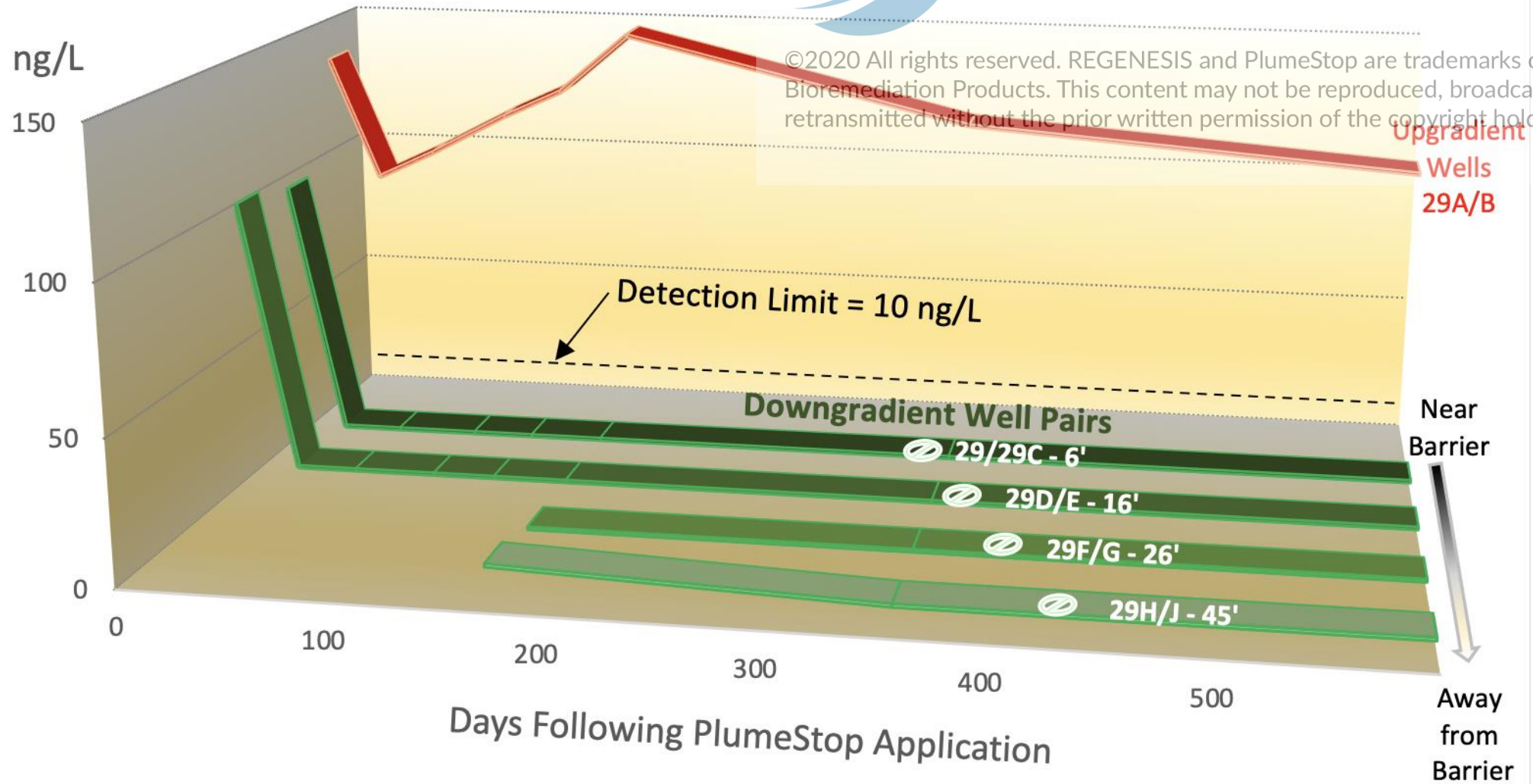
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Average Total PFAS in Monitoring Wells Upgradient and Downgradient of PlumeStop Barrier

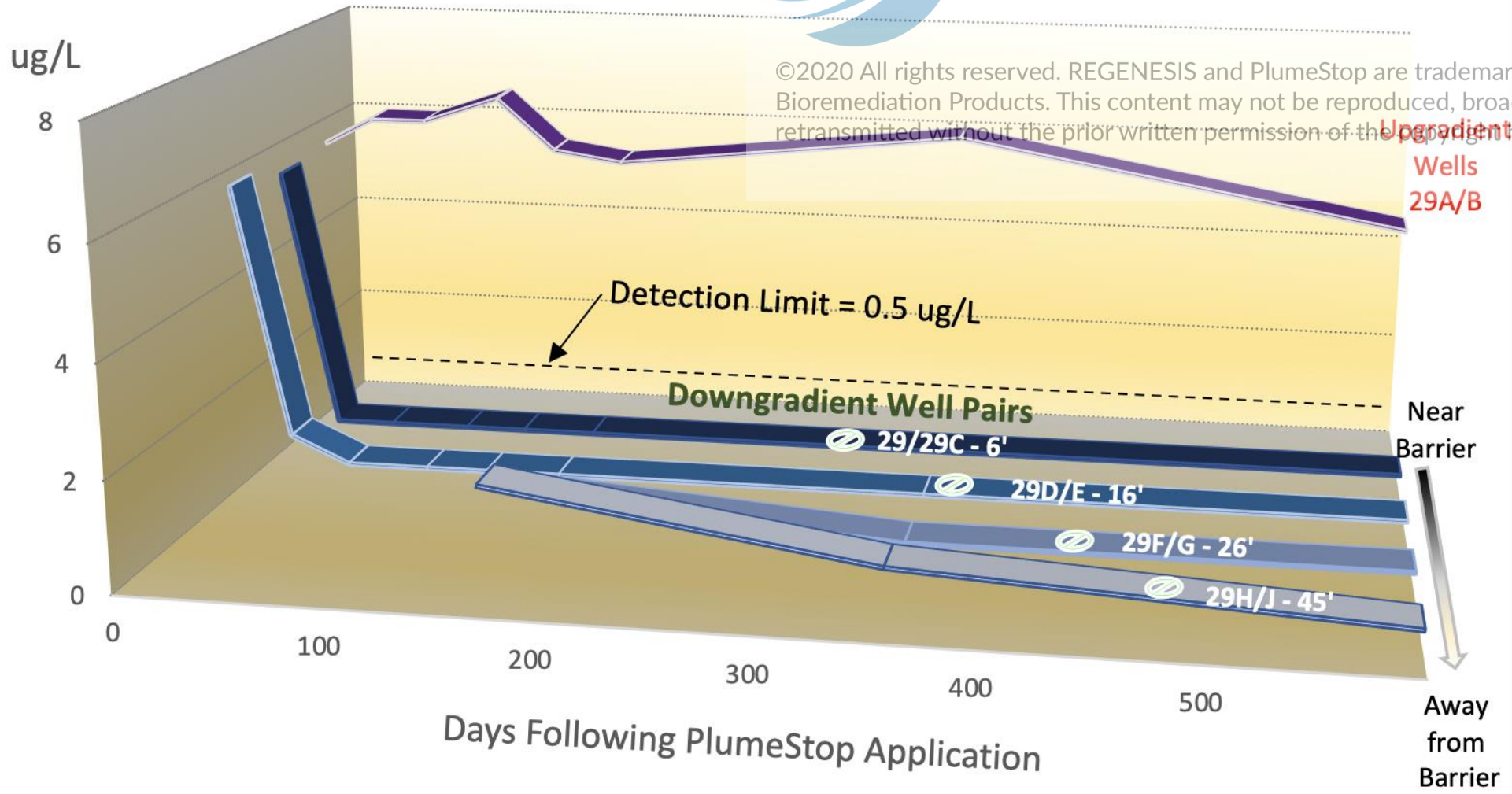
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Average Total PCE in Monitoring Wells Upgradient and Downgradient of PlumeStop Barrier

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Summary



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- **Very Successful Test**
 - Verified distribution of CAC
 - Sustained reductions of PFAS and PCE over time
 - Anticipated to last for decades
 - Low cost alternative for possible remediation

- **ANSWER: Yes, CAC can be used to eliminated risk to potential multiple receptors!**



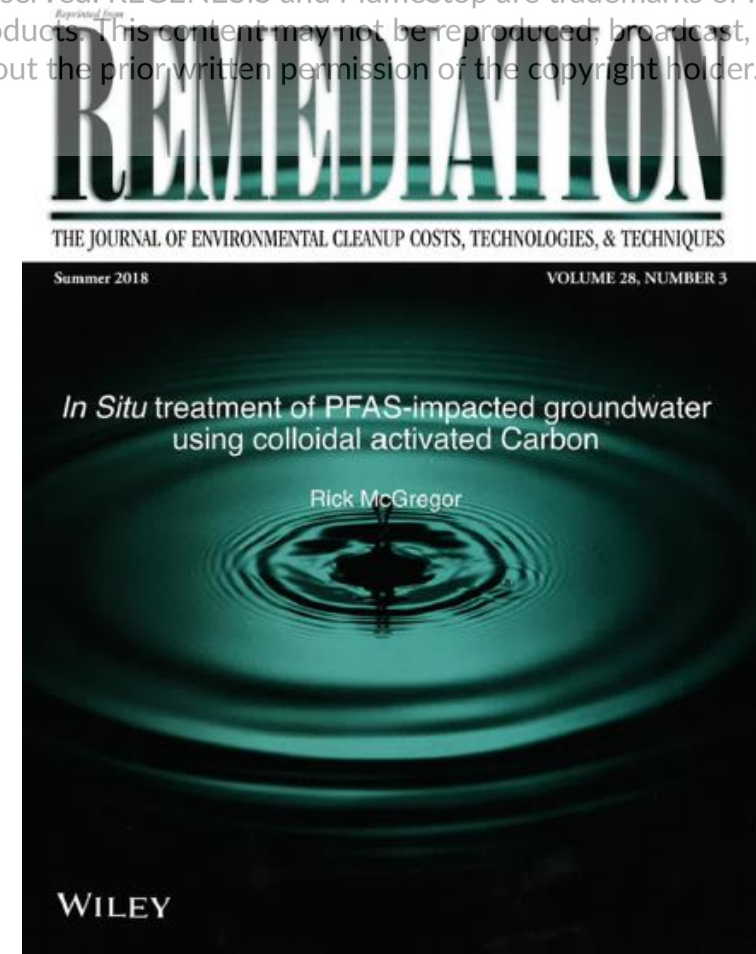
PFAS Research Articles



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- **In-Situ treatment of PFAS-impacted groundwater using colloidal activated carbon**
- <http://www2.regenesis.com/pfas-wiley-article>
- **Evaluating the longevity of a PFAS *in situ* colloidal activated carbon remedy**
- <http://www2.regenesis.com/grant-carey-wiley-remediation-journal>



Thank you



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Thank you!

QUESTIONS?

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