

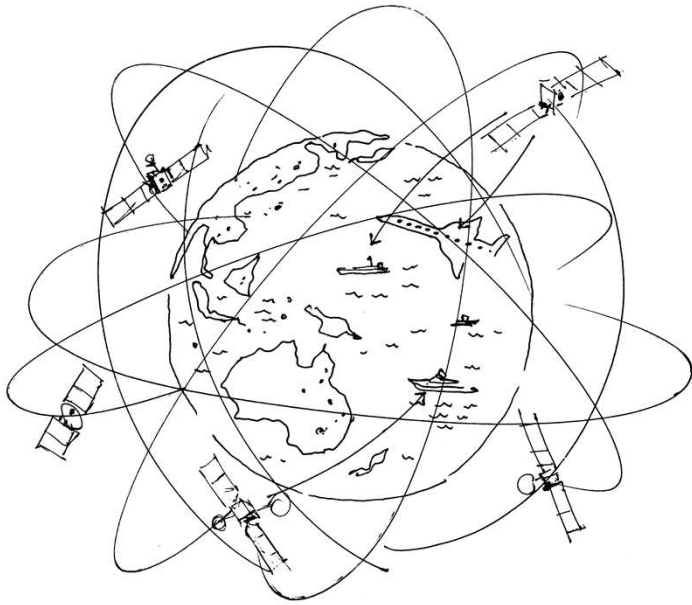
ENVIRONMENTAL FORENSICS AND GIS TECHNOLOGY APPLIED TO PER- AND POLYFLUOROALKYL SUBSTANCES (PFAS)

REMTECH EUROPE

23 September 2020

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Discussion Topics



- Why are PFAS conducive to forensic assessment?
- Forensics applied to Site-Specific Case Studies
 - Discovery of Unknown Source
 - Screening tools (TOP, TOF)
 - “Old” AFFF versus “New” AFFF
- Geospatial identification of potential PFAS source zones

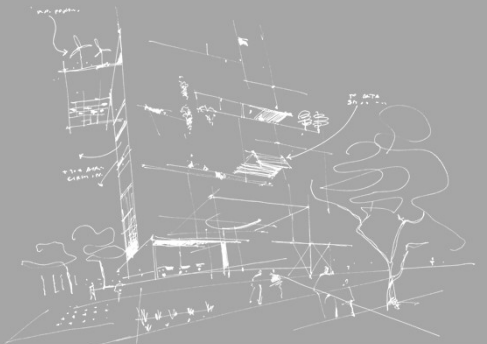
Environmental forensic assessment

- What is environmental forensic?
 - Who's responsible?
 - What is that stuff?
- Environmental forensics applied to PFAS
 - Sources (industrial, consumer products, different products for different uses)
 - Knowledge of PFAS physical-chemical properties
 - Fate and transport factors
 - Chemical methods for individual and bulk of PFAS
 - Complex toxicology



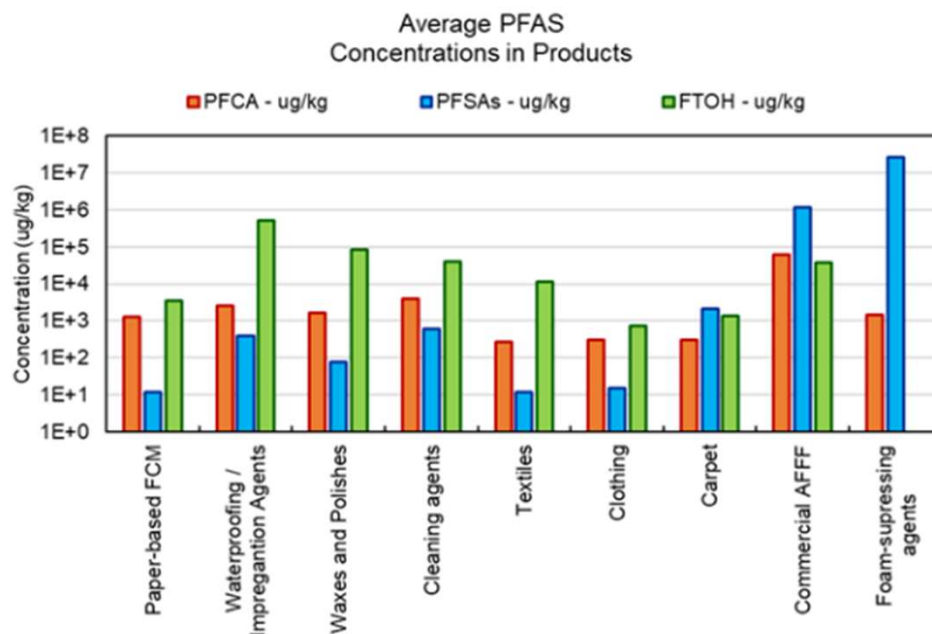
Chemical Complexity Affects Uses and Mobility Assessment

- Multiple Lines of Inquiry approach
- “Screening level” assessment: useful and inexpensive
- “Conclusive” assessment is almost impossible

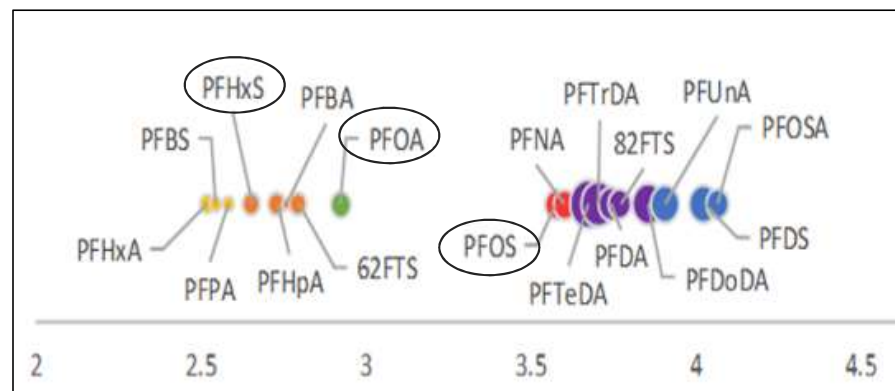


Sources and chemical characteristics

- Know your sources and products (Build a library of PFAS usage)



- Relative mobility affects transport and distribution
- Can be incorporated into assessment to interpret observed chemistry

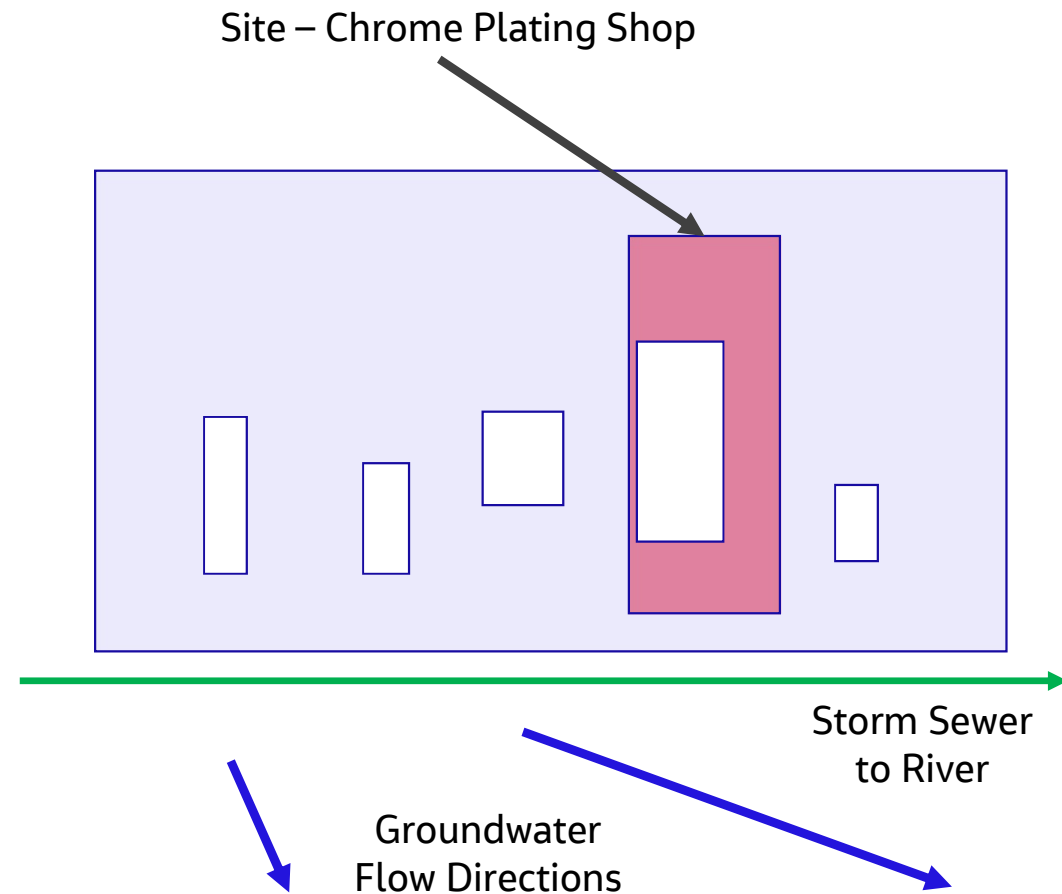


Forensics applied to Site Specific Case Studies

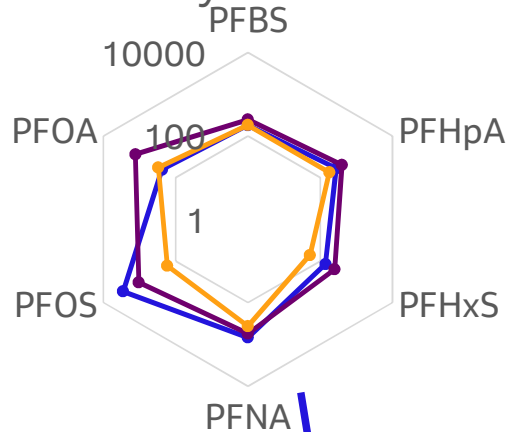


Discovery of Unknown Sources

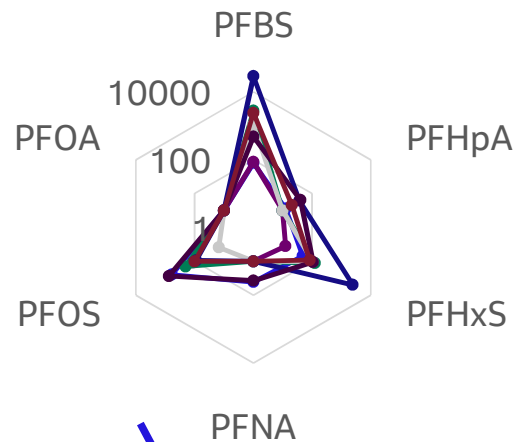
- Abandoned site in an industrial area
- Chrome plating shop, unknown whether they used a PFAS mist suppressant
- Had a fire, AFFF may have been used



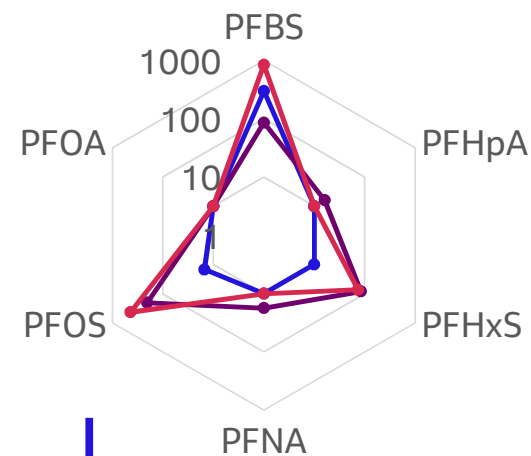
Off-Site South: More Carboxylates



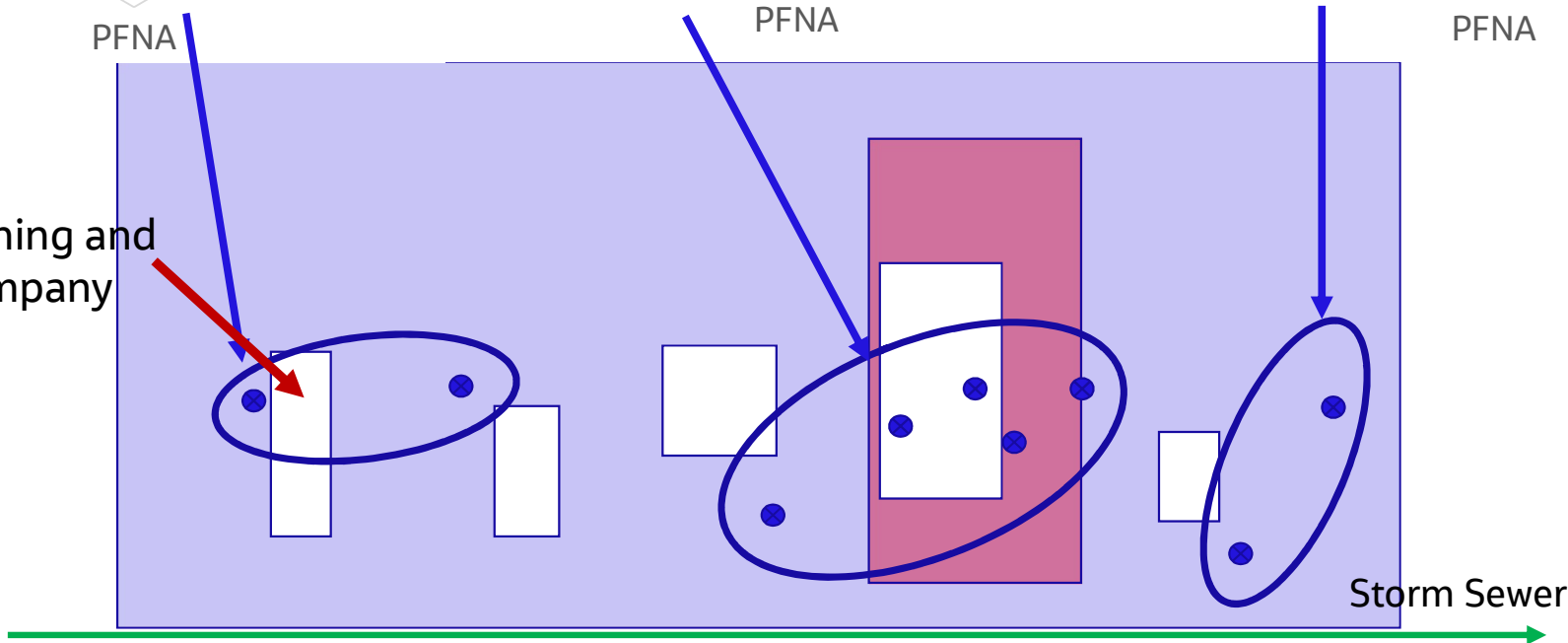
On-Site: Sulfonate Rich



Downgradient: Sulfonate Rich

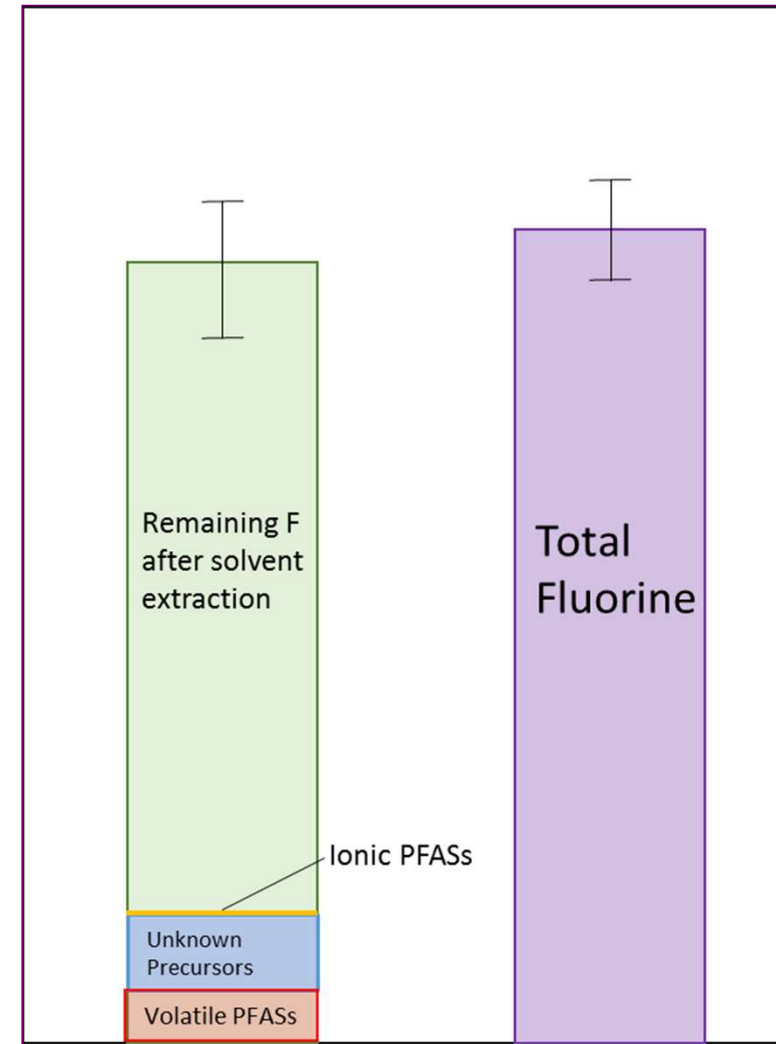


Carpet cleaning and treating company



Forensics/Fingerprinting Tools

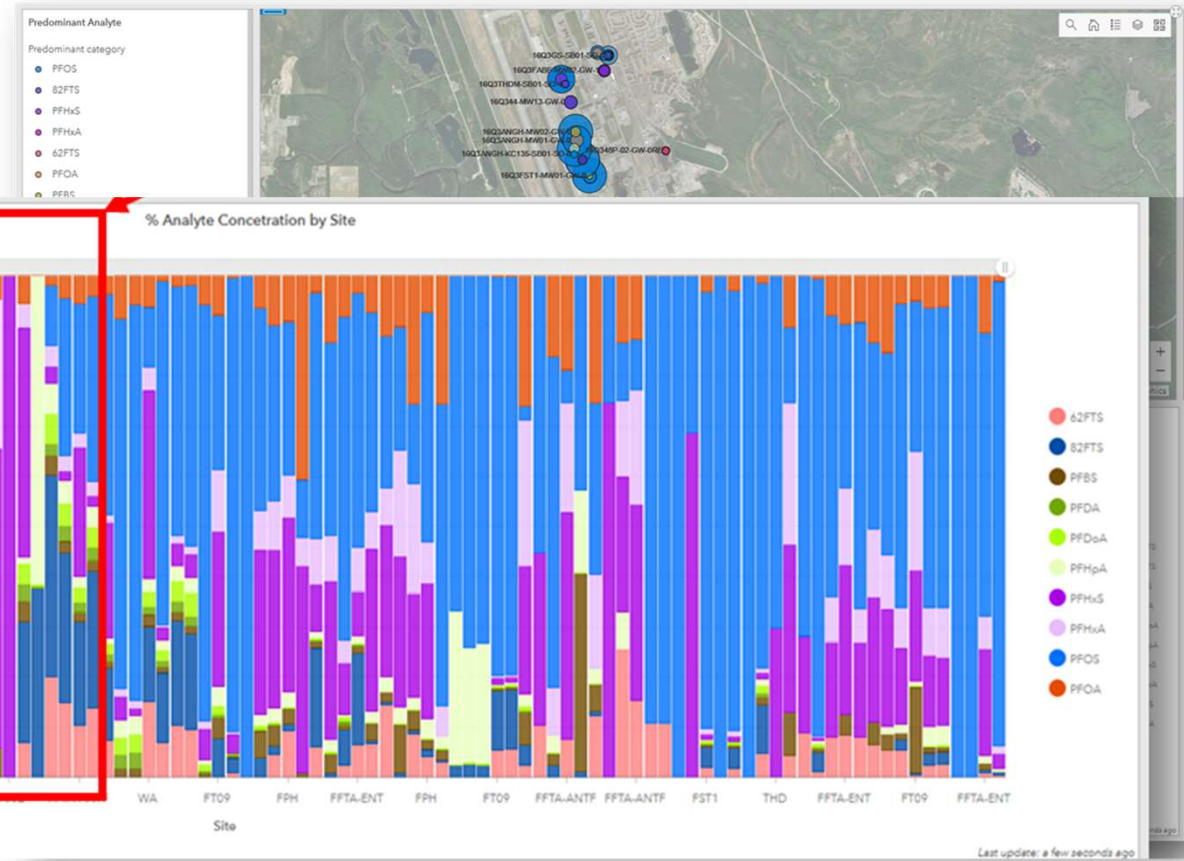
- 1000's of compounds; test methods only target a few
- Regulated PFAS are simple, highly fluorinated acids - PFOS, PFOA and similar (PFAAs)
- Compounds that degrade to PFAAs are called "precursors"
- Precursors can be estimated using a non-standard test (TOP Assay), but that too misses a large amount of PFAS mass
- PIGE or Total Organic Fluorine tests capture entire PFAS mass



Robel et al., 2017, Ritter et al., 2017

PFAS Release Timing

- Differentiation based on timeframe of AFFF release
- Blues are sulfonate-rich (PFOS, PFH₂S, elec proc)
- Pink rich prec fluoi
- Sugc olde com AFFI



6:2 FTS

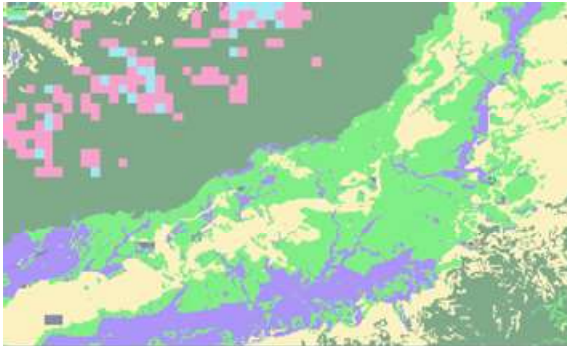
8:2 FTS

Geospatial identification of potential PFAS source zones

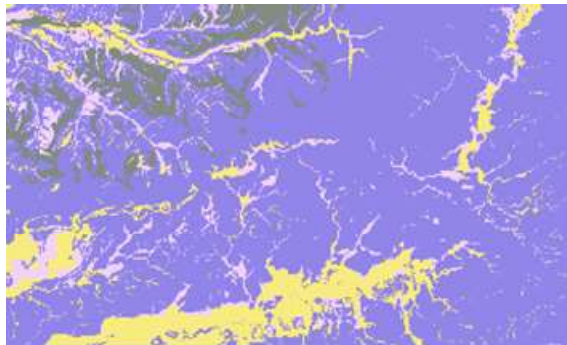


Nationwide Drinking Water Source Vulnerability Assessment

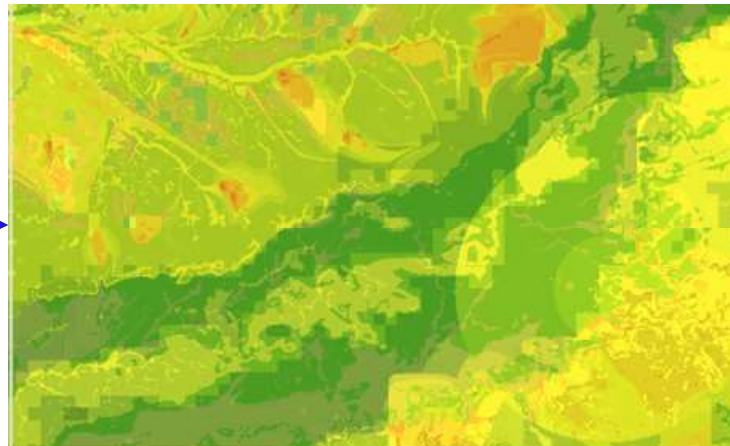
Bedrock Groundwater Vulnerability



Superficial Groundwater Vulnerability



Groundwater Risk Heat Map



Drinking Water Zones

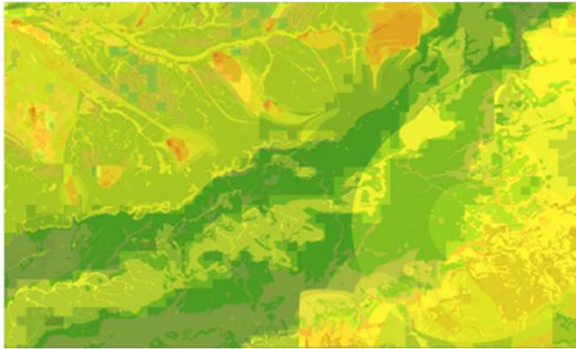


GW Supply Protection

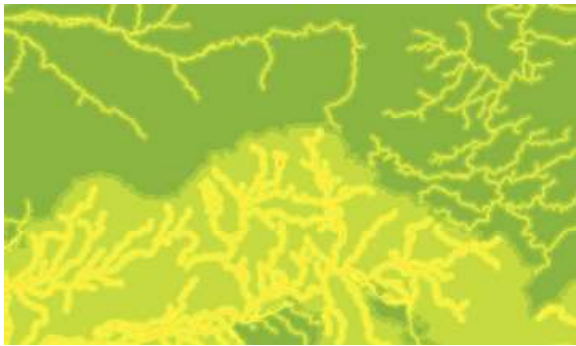


Combined Risk Ranking using Spatial Analysis

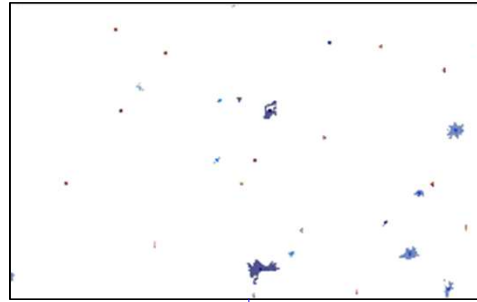
Groundwater Risk Heat Map



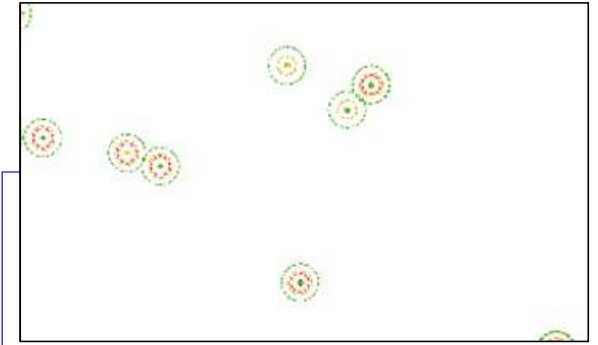
Surface Water Risk Heat Map



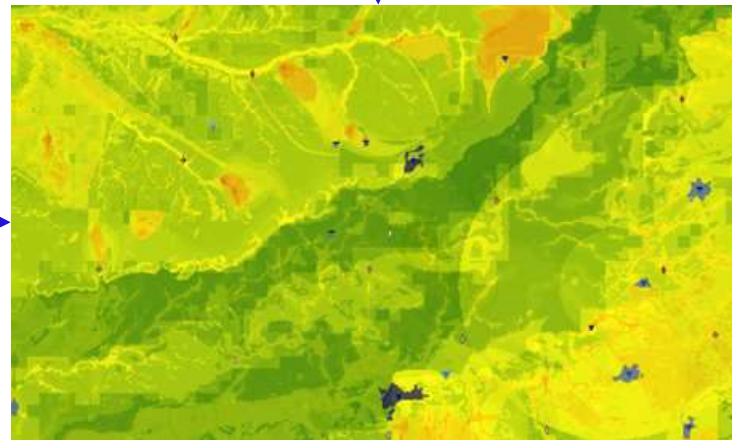
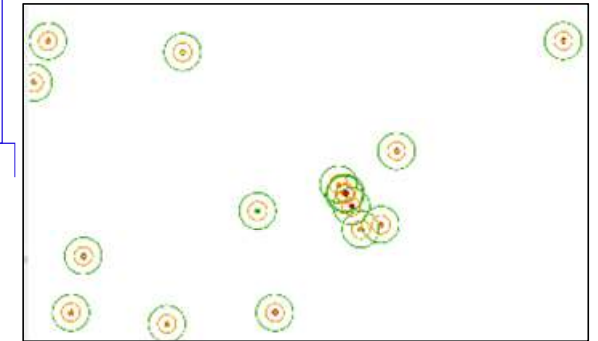
Potential source sites from open source data



Groundwater Data Quality Score



Surface Water Data Score



Combined assessment with site ranking

PFAS Chemical Assessment



PFAS substances



Dataset 1

- PFBS_av
- PFHxS_av
- PFOS_av
- PFBA_av
- PFPeA_av
- PFHxA_av
- PFHpA_av
- PFNA_av
- PFOA_av



Dataset 2

- PFHpA_av
- PFHxA_av
- PFNA_av
- PFOA_av
- PFOS_av
- PFPeA_av

Takeaway messages and looking ahead

1. Forensics/Fingerprint not a “conclusive” assessment but inexpensive, be cautious about using this resource
2. Multiple Lines of Inquiry
3. GIS tool including multicriteria analysis is an effective way of identifying sites which have higher environmental sensitivity
4. **The future of forensics and PFAS assessment**
 1. Further development of Fingerprinting and analytical methods
 2. Use of GIS to foster search and evaluation of vulnerable areas
 3. Machine learning and AI to help practitioners and client understanding and “digest” the huge amount of data

- **P** – it’s **P**ersonal (polluted water, food consumption)
- **F** – **F**orever chemicals (long lasting, persistent)
- **A** – **A**ccountable (responsible consumer and industrial usage)
- **S** – **S**inister (diabolical* chemicals)
- * cit. John Cherry University of Guelph

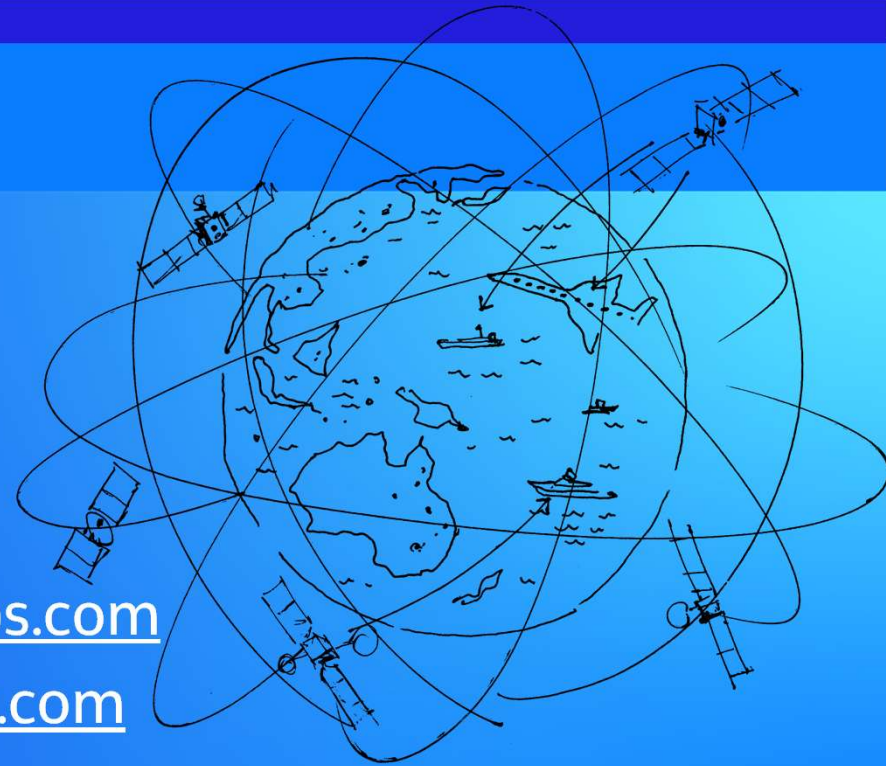
Thank You!

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