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Welcome to the Vadose Zone: The Use of Lysimeters and Analytical Tools in the Evaluation of PFAS Sources at Three (TWO) Sites in New Hampshire

Presented By:
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Outline

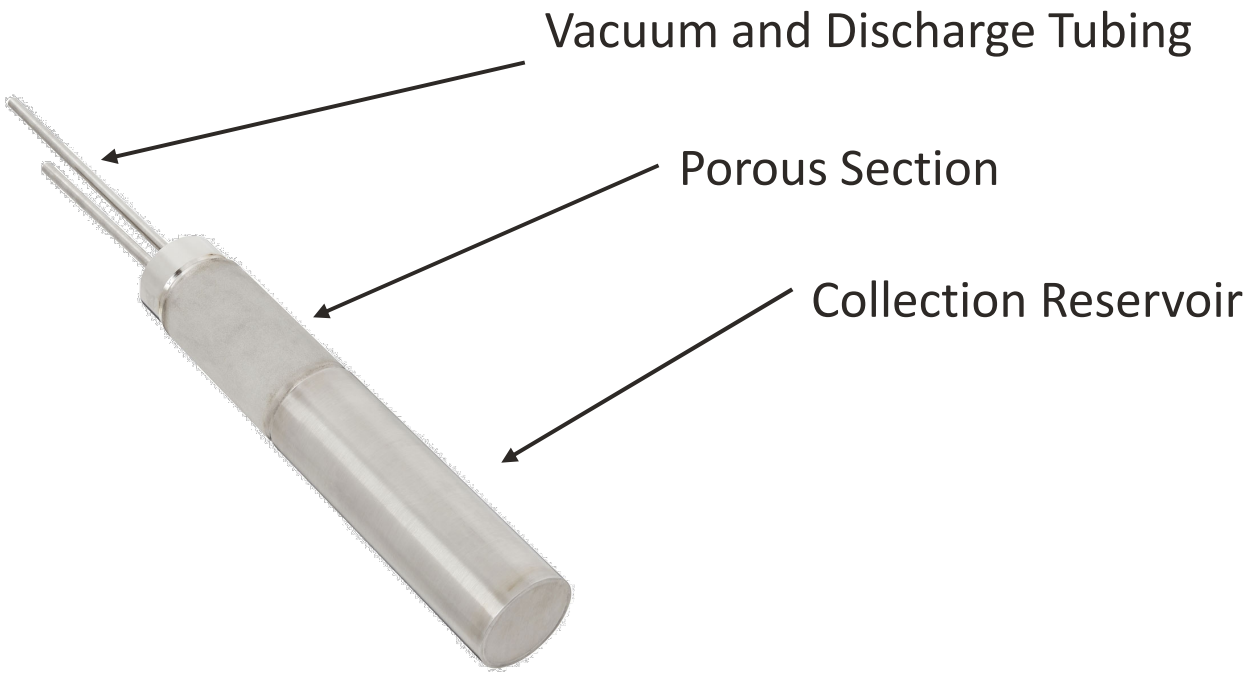
Introduction to Lysimeters

Case Studies & Lessons Learned

- Middle School, *Central, NH*
- Ottati & Goss / Kingston Steel Drum Superfund Site, *Kingston, NH*

What is a lysimeter?

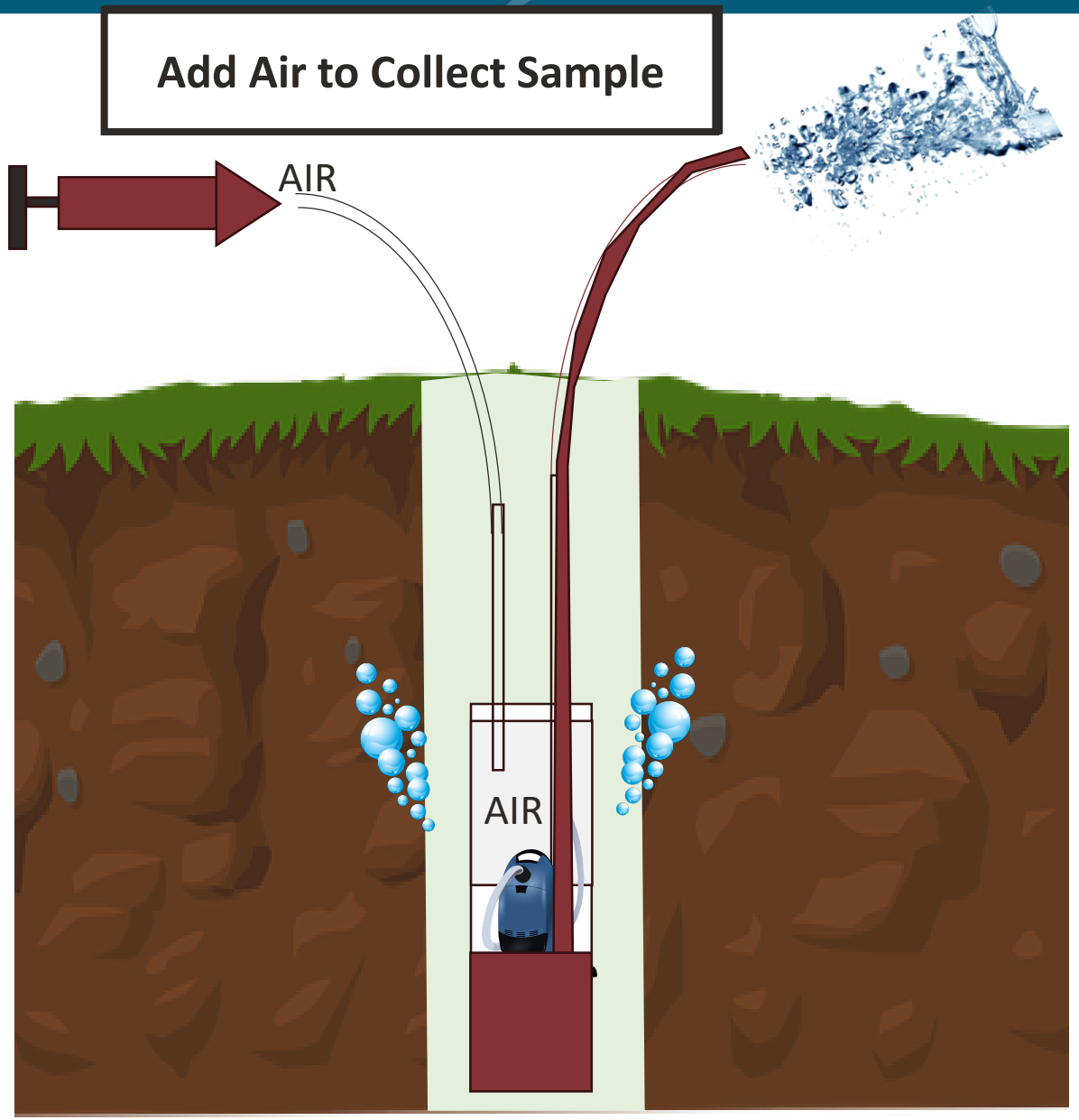
- A probe that collects soil moisture



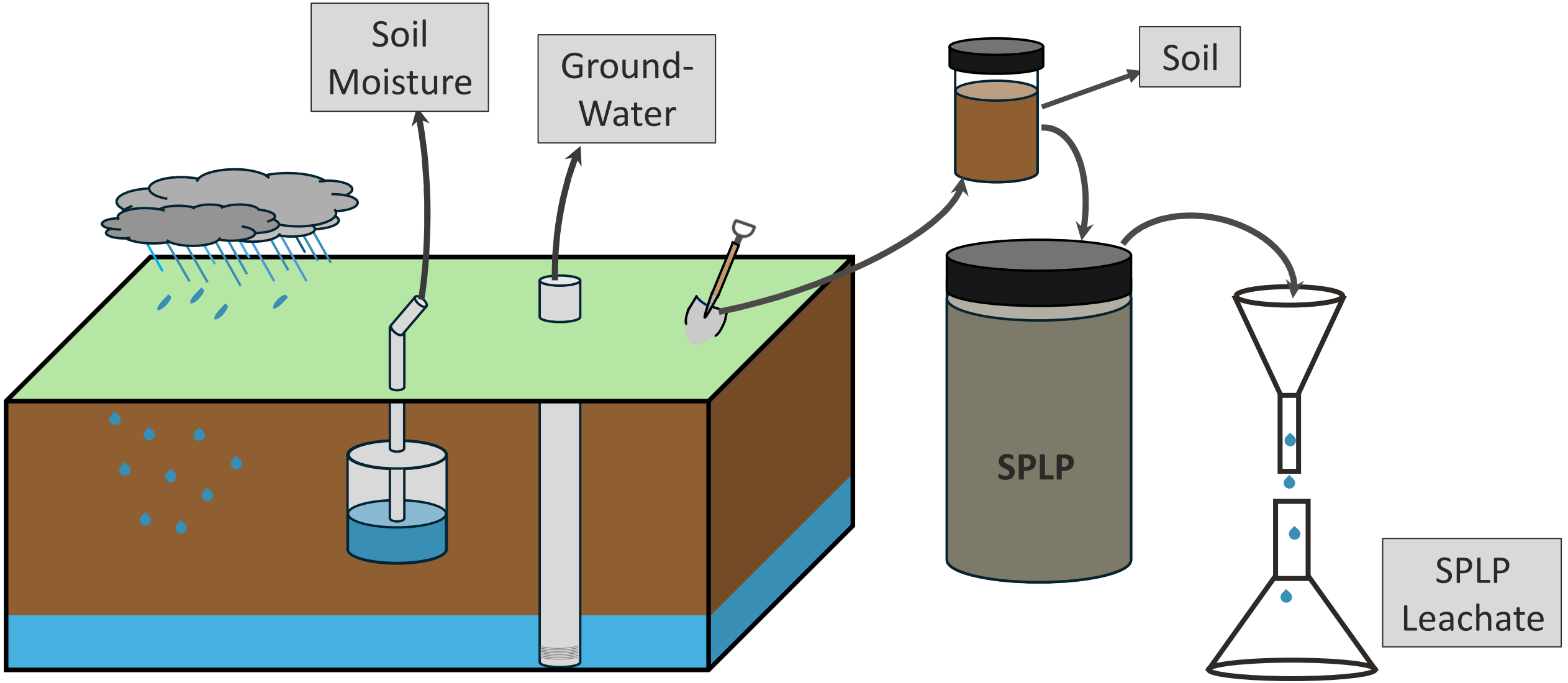
Why use a Lysimeter?

- Evaluate contaminant leaching from unsaturated soil

Collecting a Sample



Conceptual Sampling and Analysis Model



How do the results of these 4 samples compare for PFAS?

Figure by Sean Duncan

PFAS Solubility

Carboxylic Acids are **more soluble** than Sulfonic Acids

Short chains are **more soluble** than long chains

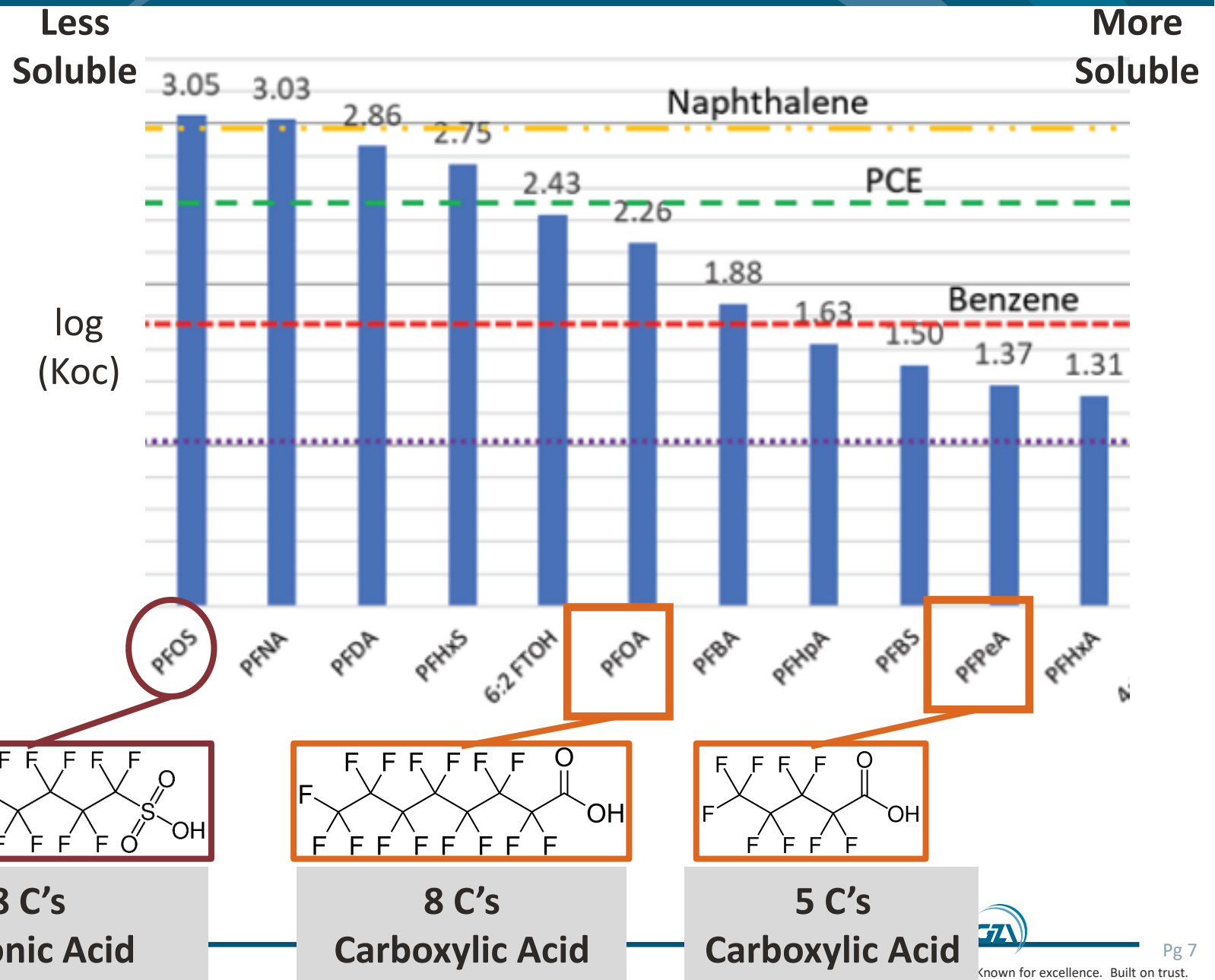


Figure from "PFAS Fate and Transport 2021" NGWA, https://my.ngwa.org/

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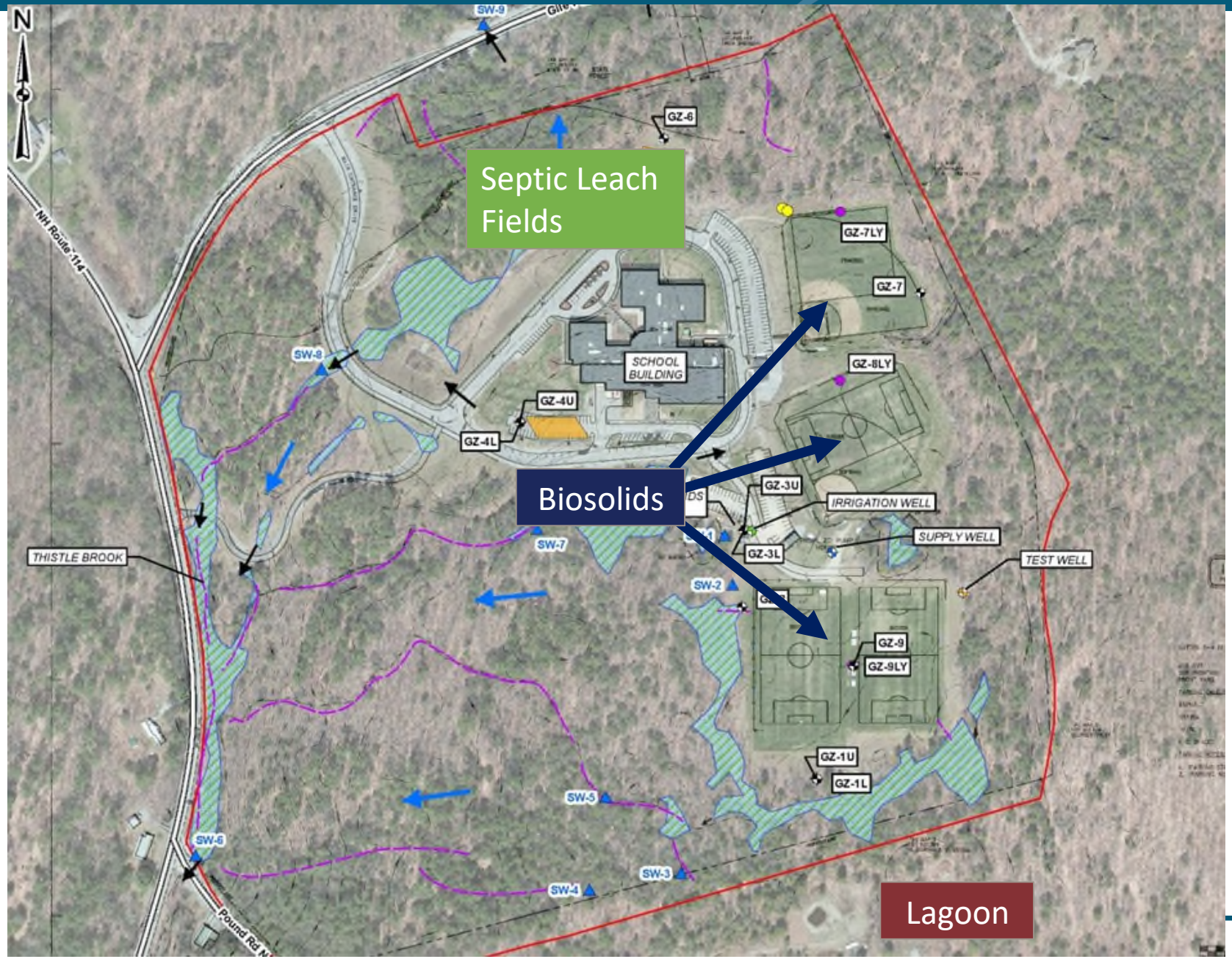
Case Study No. 1: Middle School

Central NH

Case Study No. 1 – Middle School



- Undeveloped Site prior to construction of School in 2007
- PFOA detected in potable water supply sample at conc exceeding NH AGQS in 2019

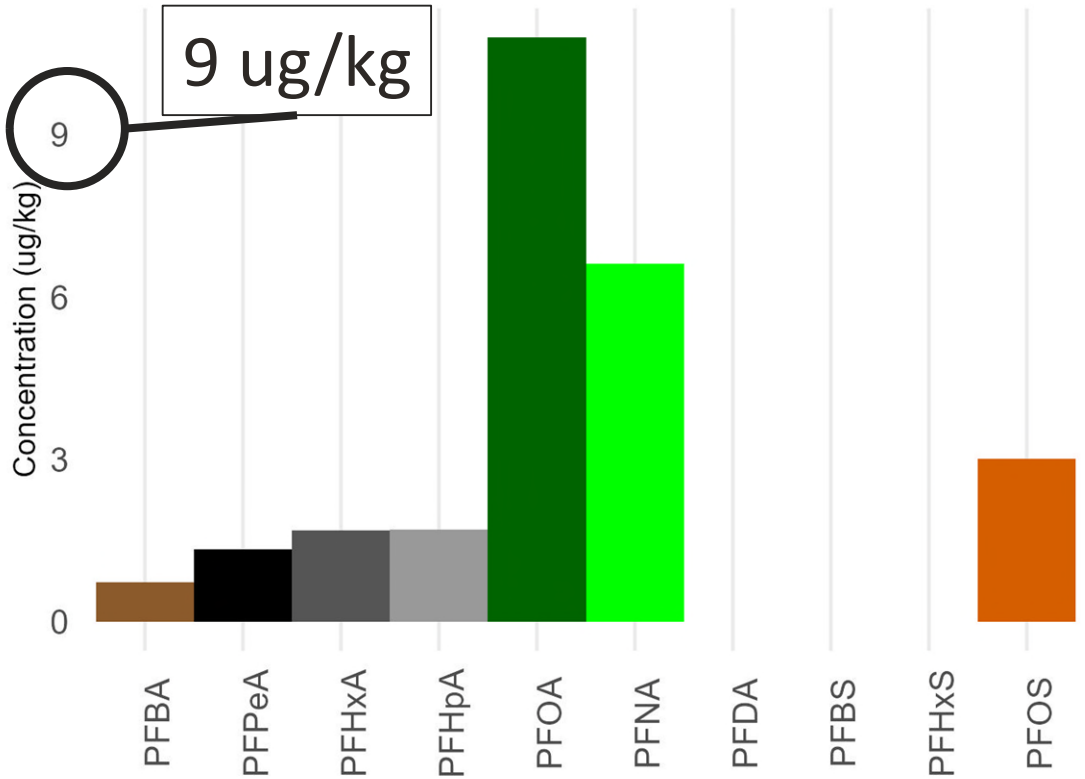
Possible sources:

- On-site septic leach fields
- Surface application of biosolids on athletic fields
- Upgradient off-site lagoon of unknown use

Case Study No. 1 – Middle School

Can these levels of PFAS in soil result these concentrations and patterns in groundwater?

Soccer Field Soil Sample



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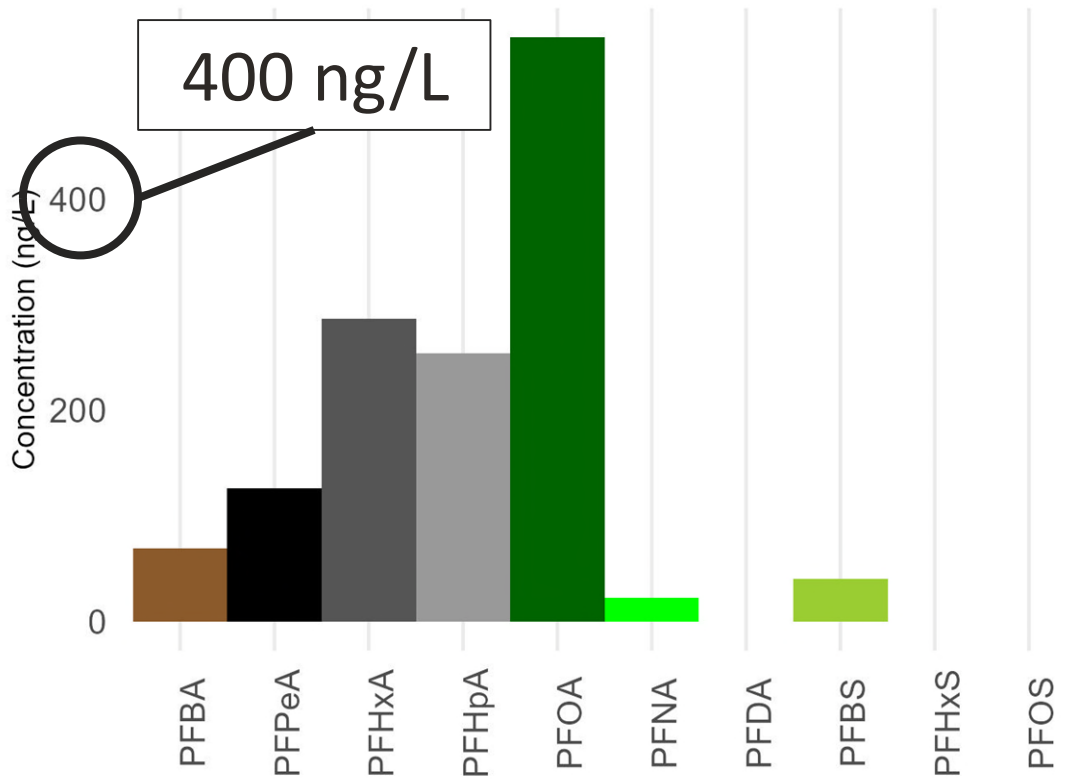
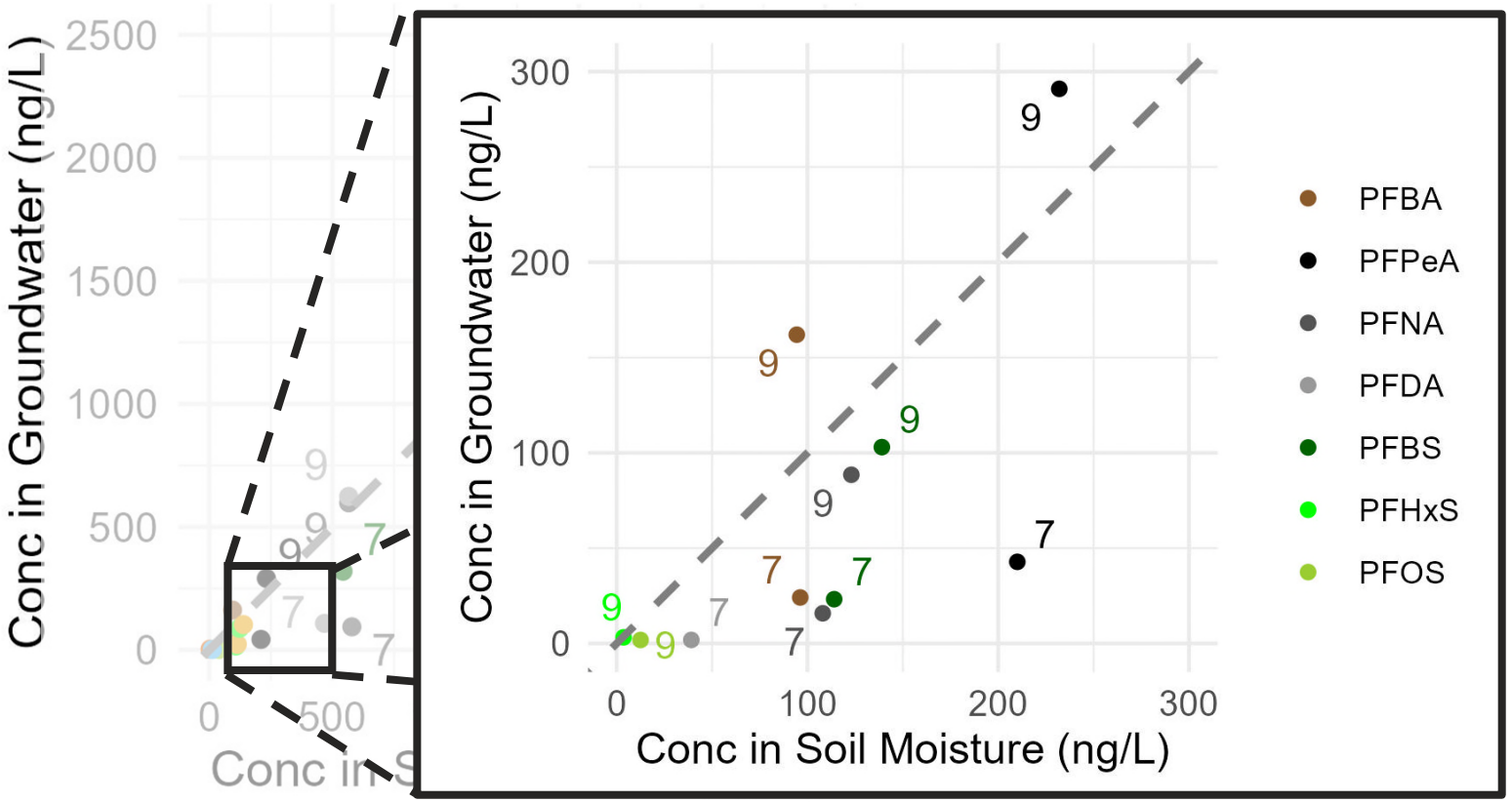
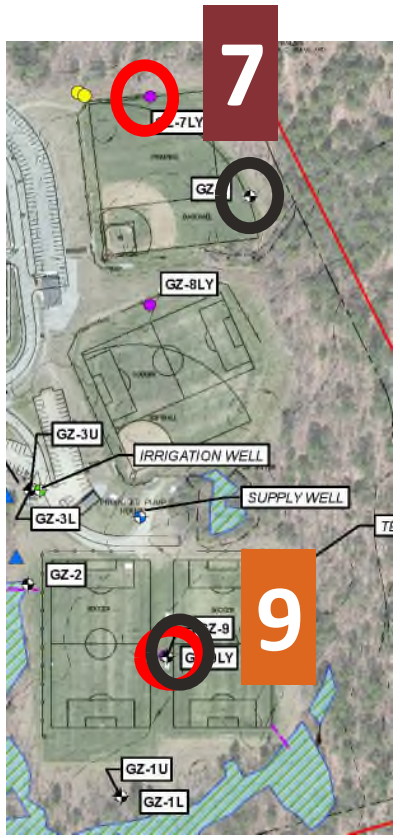
Groundwater Sample



Concentrations in Lysimeters and Proximate Shallow Groundwater Wells*





Lysimeters

Monitoring Wells

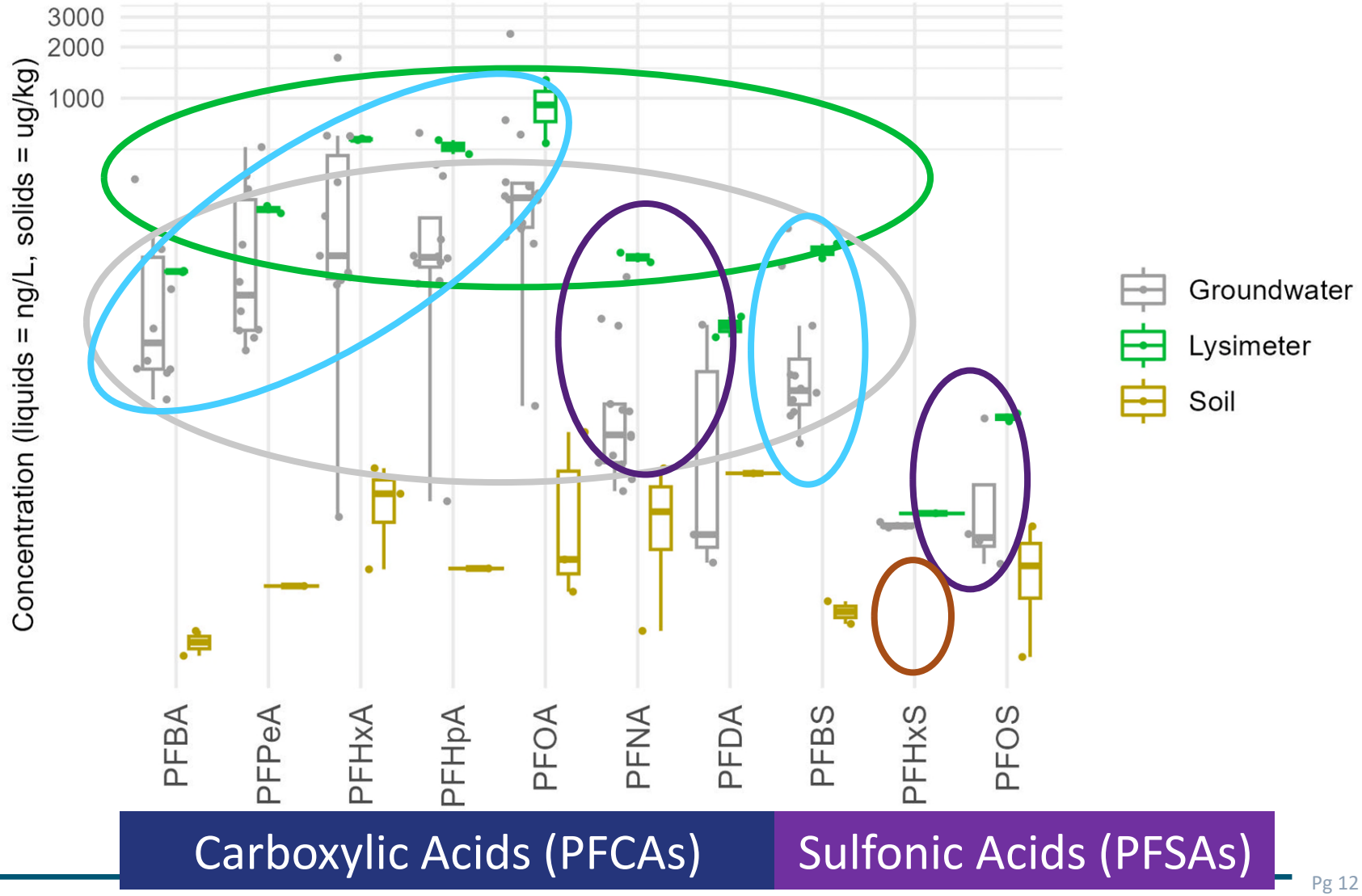
***No comparable soil samples**

- Concentrations in Lysimeters generally higher than in Groundwater

Case Study No. 1 – Middle School

Distribution of PFAS Detections Across all Samples

- Higher concentrations in soil moisture vs. GW
- Concentrations of shorter trend higher than longer in water
- Some detections in water NOT in soil



Case Study No. 1 – Middle School

Conclusion: YES, “low” soil concentrations can result in “high” groundwater concentrations

Lessons Learned

- Lysimeters results differ from groundwater—often higher
- Lysimeters and groundwater may contain PFAS not detected in soil
- Expect differentiation of PFAS into lysimeter moisture / groundwater based on k_D’s
- Consider sampling soil where lysimeters are installed

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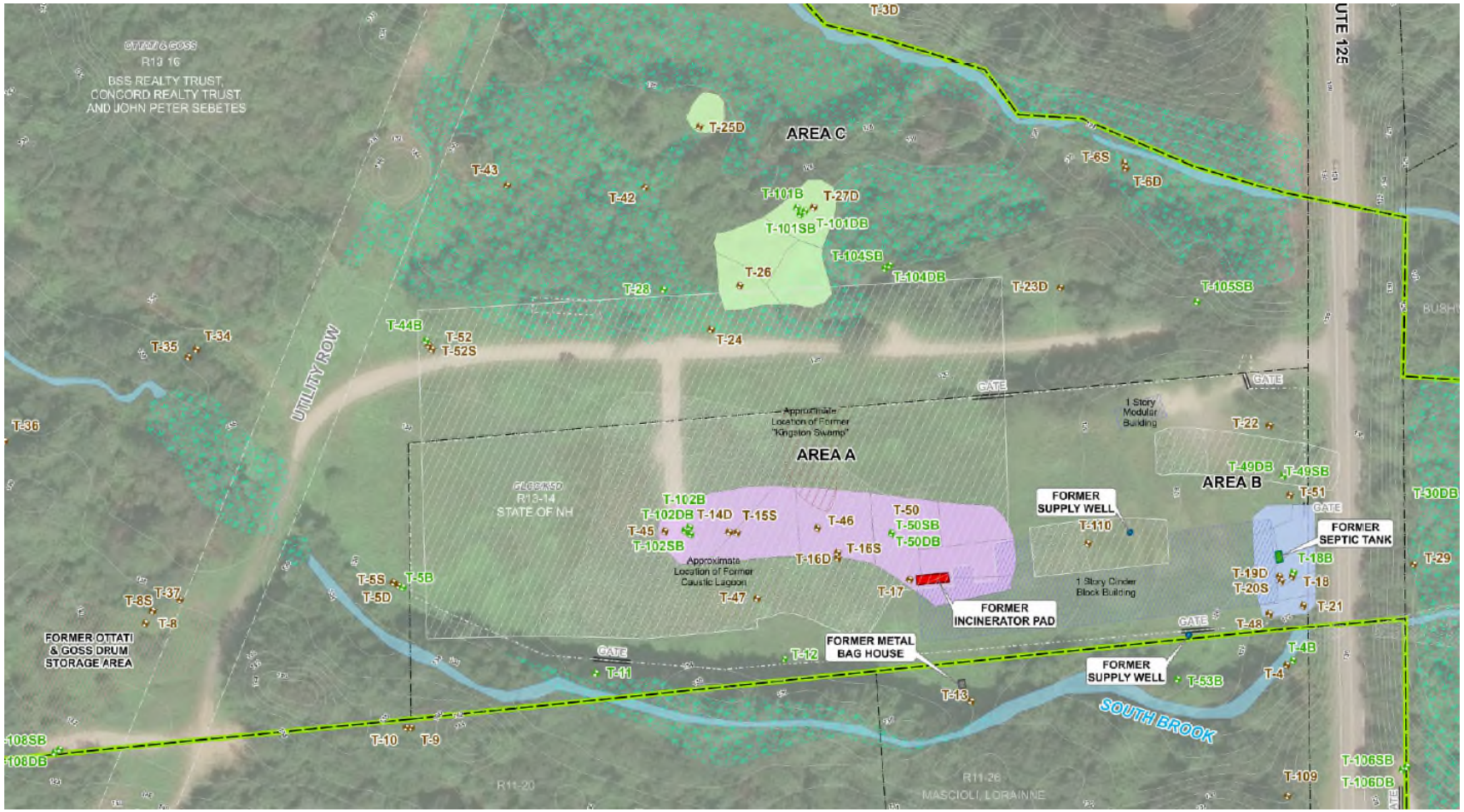
Case Study No. 2: Ottati & Goss / Kingston Steel Drum

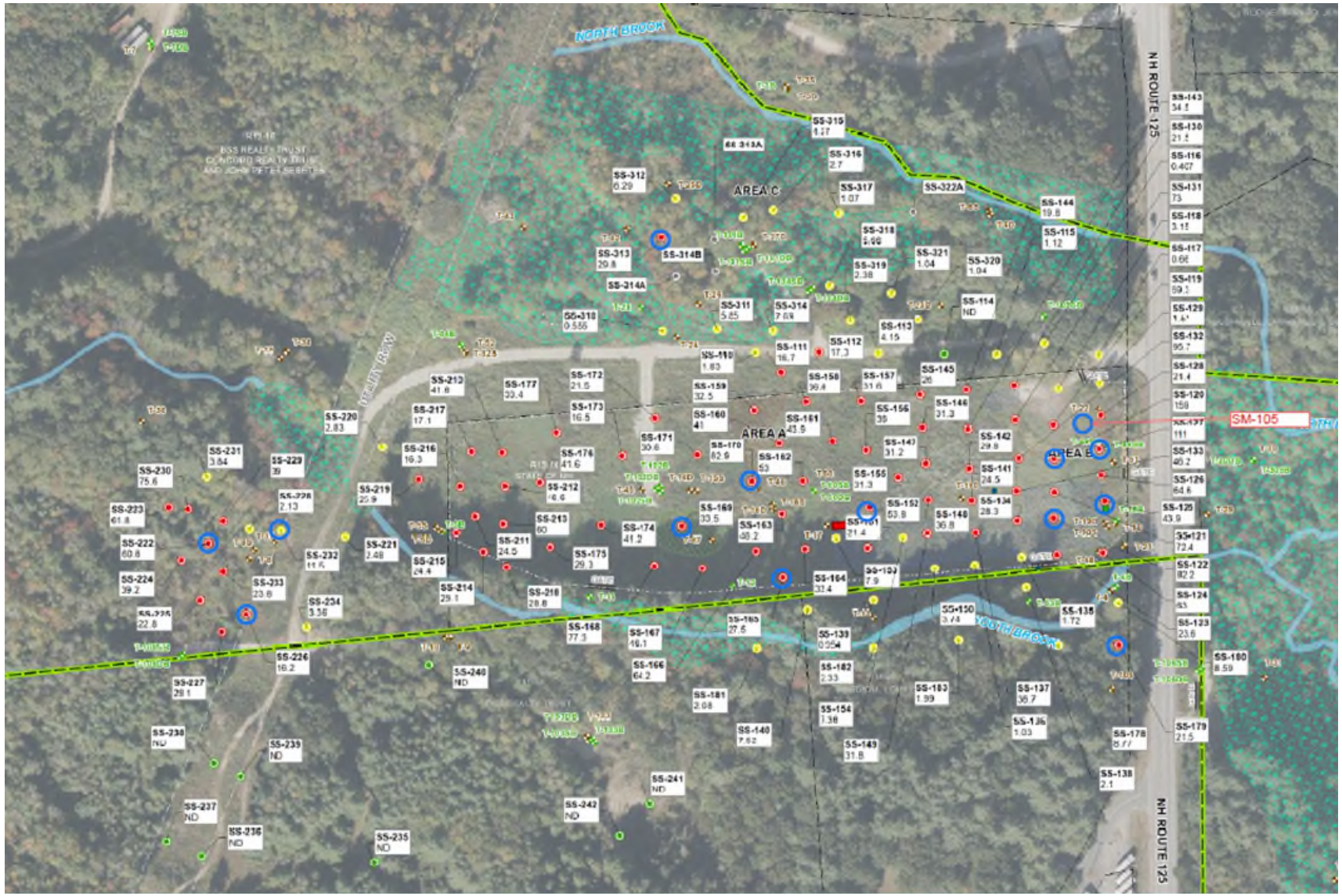
Kingston, NH

Case Study No. 2 – Ottati & Goss / Kingston Steel Drum



- Former drum and container reconditioning facility.
- GZA involved in the Remedial Investigation in the early 1980s.
- Contaminants: VOCs, SVOCs, metals, and PCBs.
- Remediation: in-situ chemical oxidation and thermal treatment.
- PFAS identified in groundwater in 2018.

Case Study No. 2 – Ottati & Goss / Kingston Steel Drum

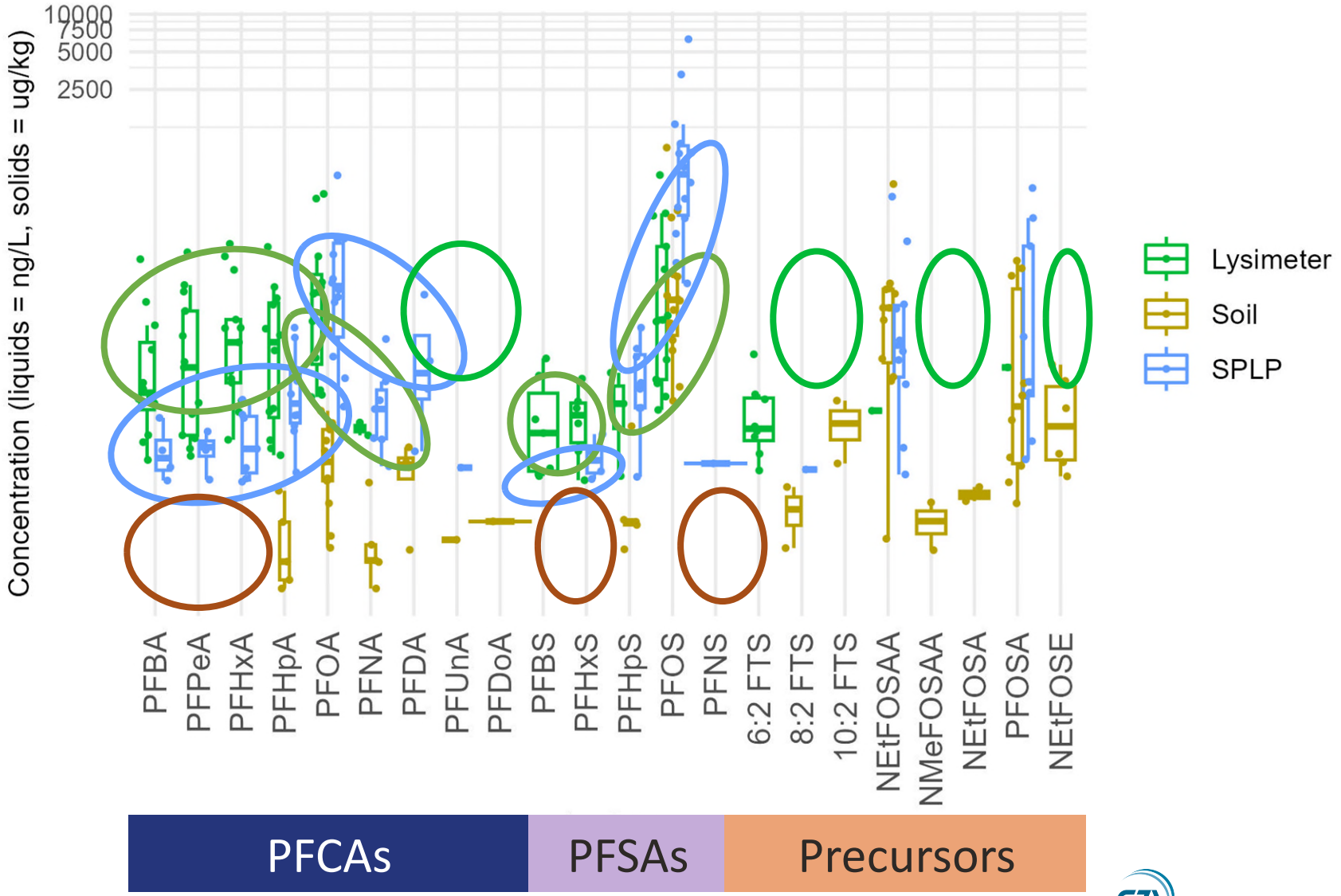


Is Soil the Source?

- 152 vadose zone soil samples analyzed for PFAS.
- 8 locations selected for lysimeter installation.
  - 14 Samples (includes pairs of shallow and deep)
- Co-located soil samples for Total and SPLP PFAS collected during installation.

Distribution of Detections Across Lysimeter Locations

- Conc. Short chains higher in lysimeters than SPLP leachate
- Reversed for Long chains
- Some PFAS detected by lysimeters and SPLP but not seen in soil
- Some PFAS detected in soil and SPLP but little or none in lysimeters



Conceptual Sampling and Analysis Model

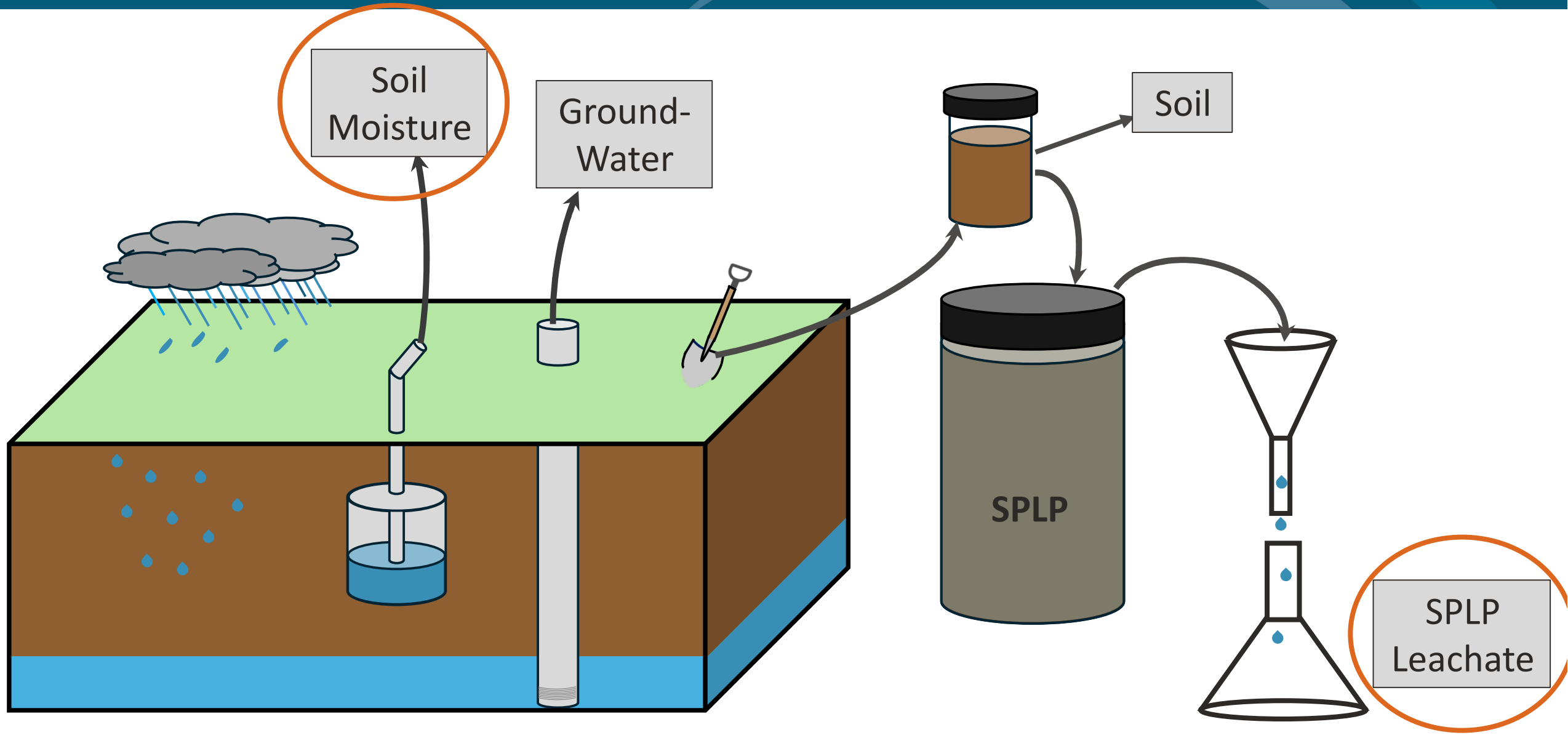
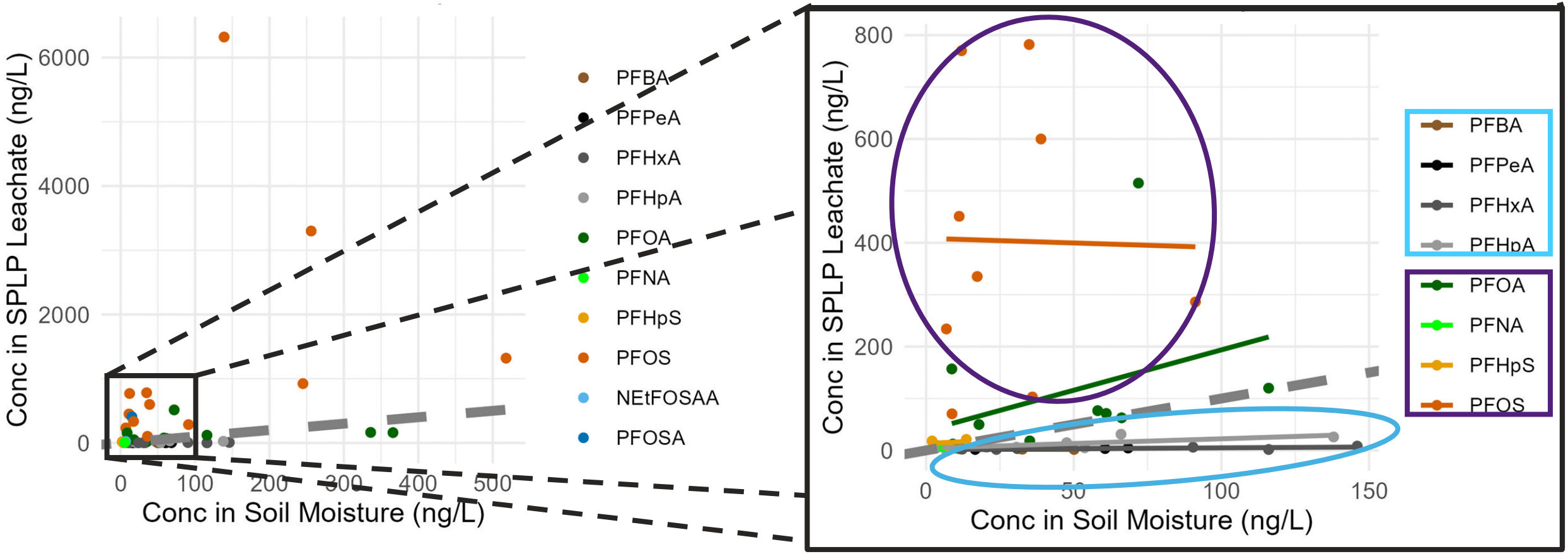


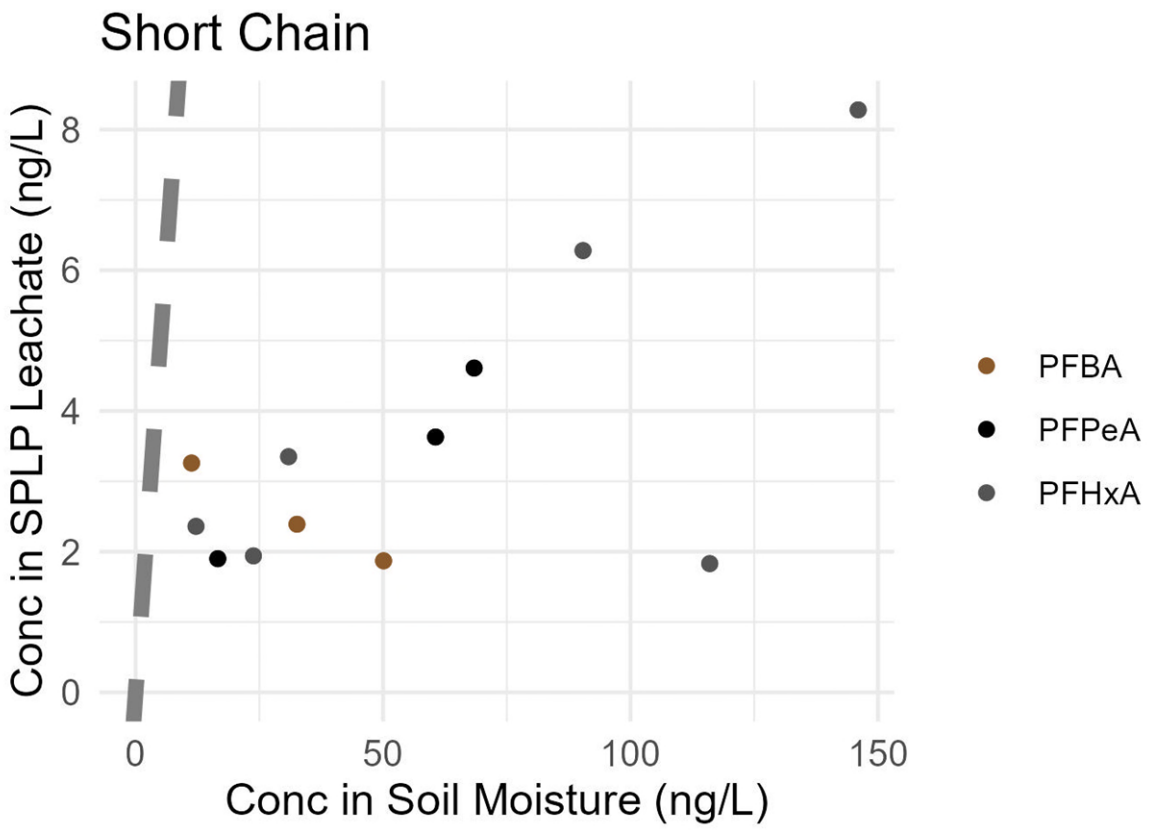
Figure by Sean Duncan

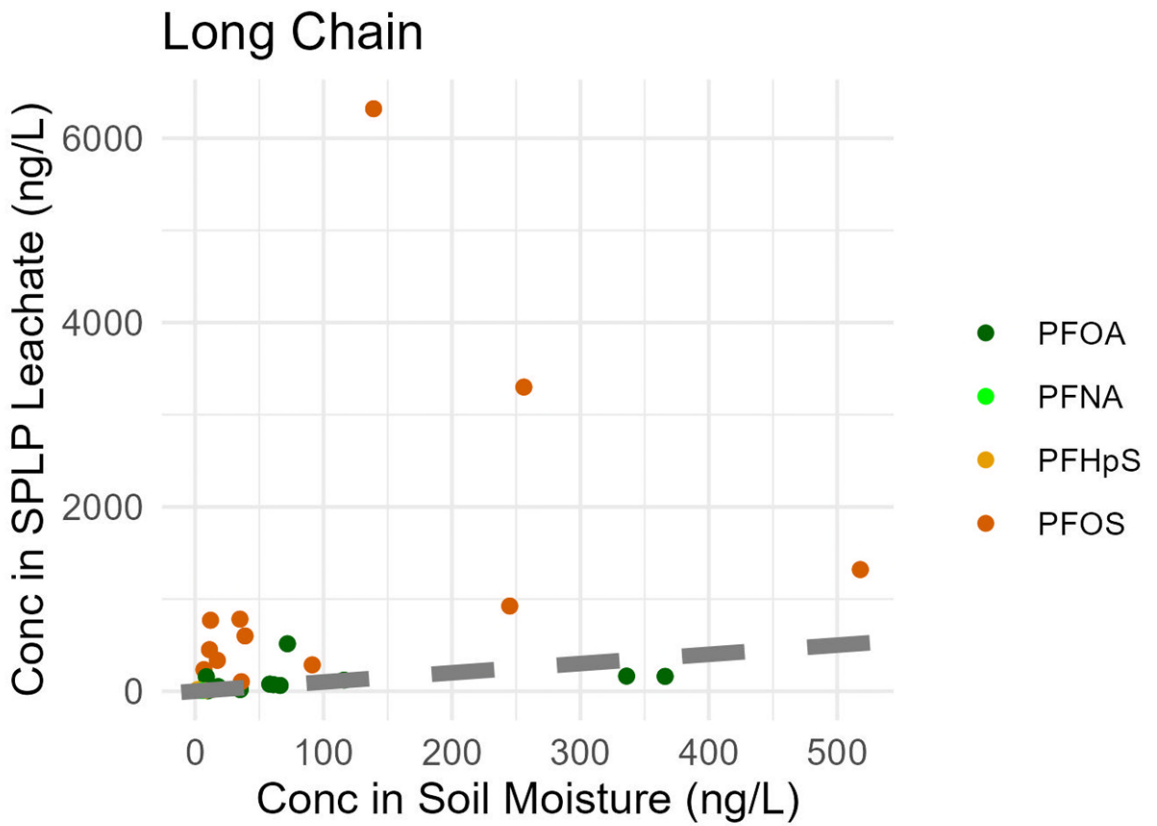
PFAS Concentrations in SPLP Leachate vs Soil Moisture



Appears to be a distinction between **Long chain** and **Short chain** compounds

SPLP vs Soil Moisture

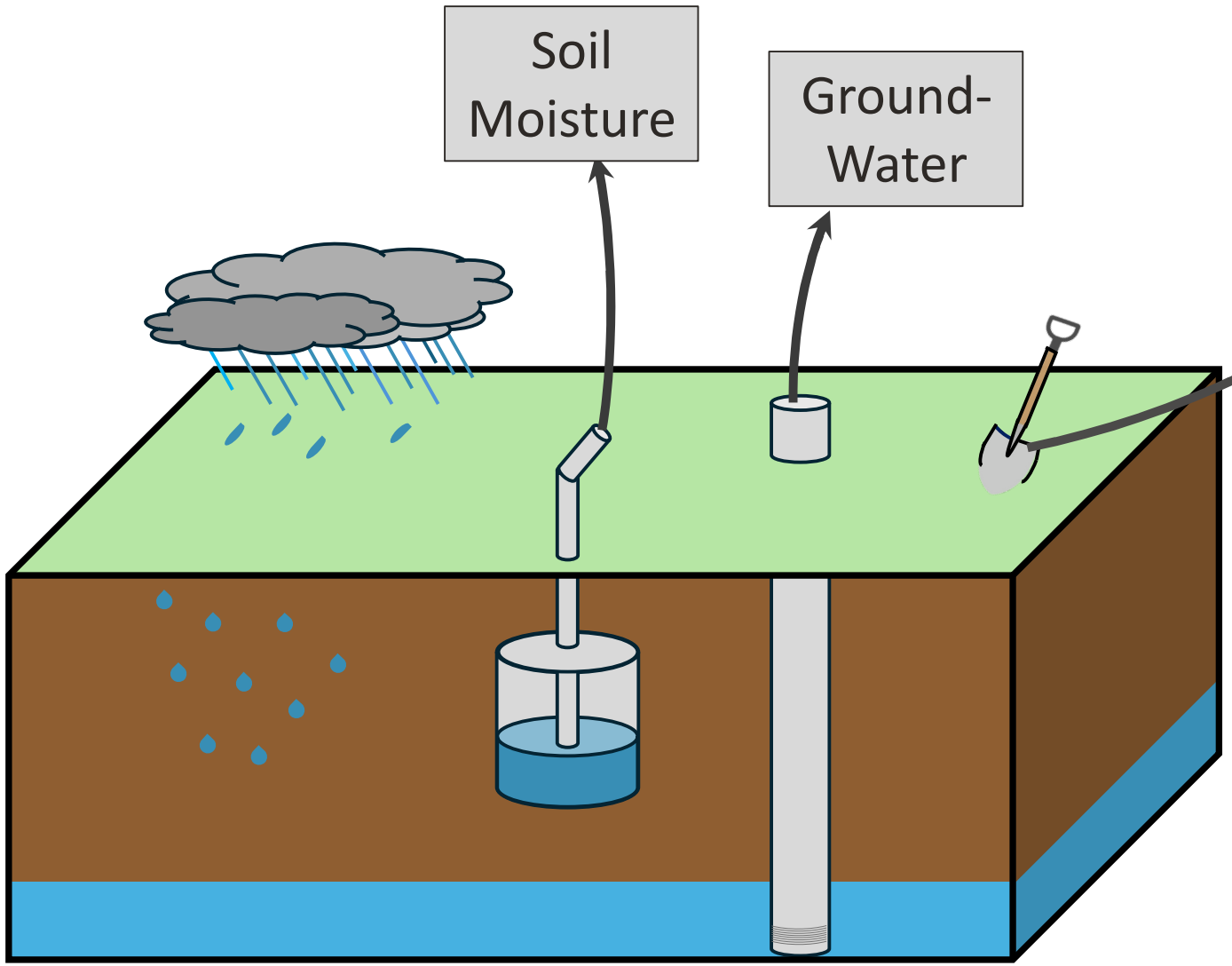


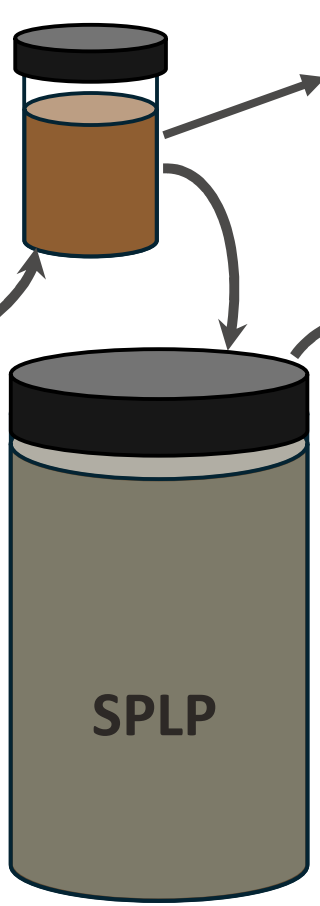


For Short Chain:
SPLP *underestimates* leaching

For Long Chain:
SPLP *overestimates* leaching

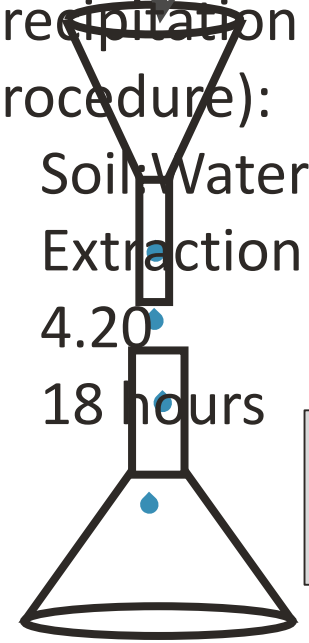
Conceptual Sampling and Analysis Model





SPLP: (Synthetic Precipitation Leaching Procedure):

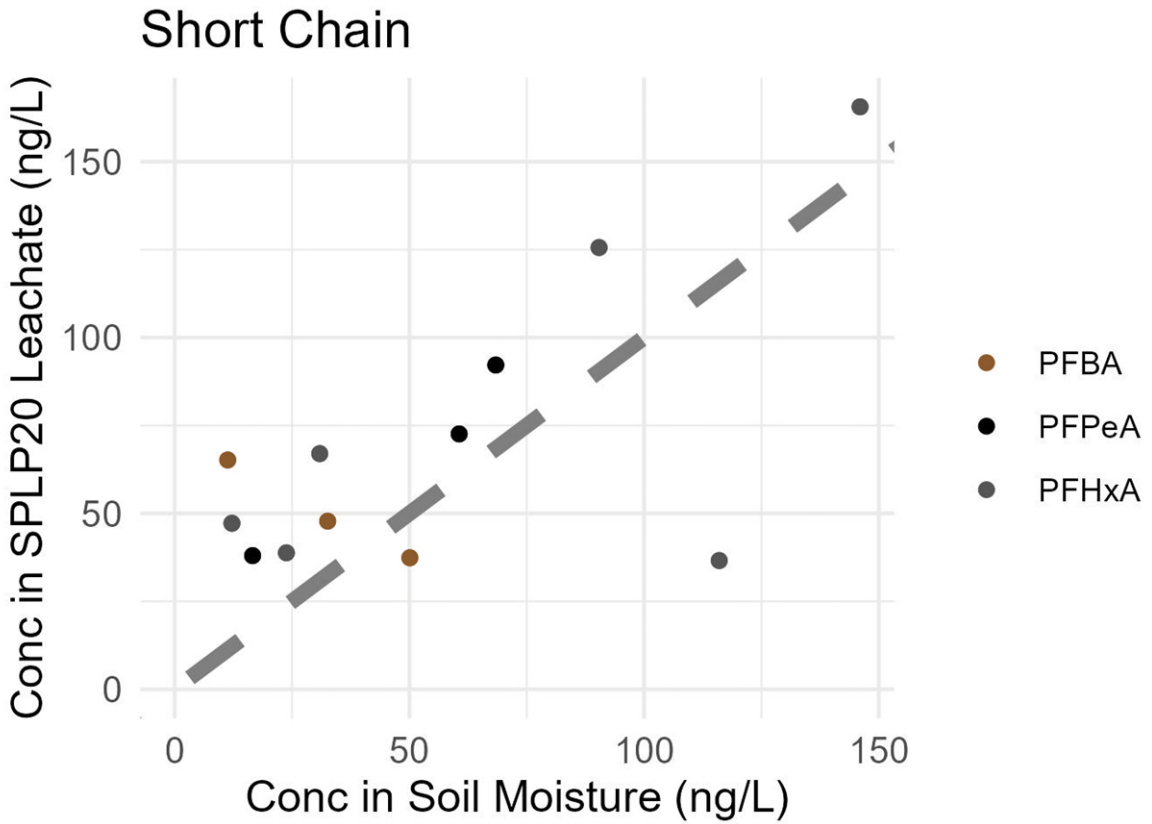
- Soil:Water of 1:20
- Extraction fluid pH = 4.20
- 18 hours

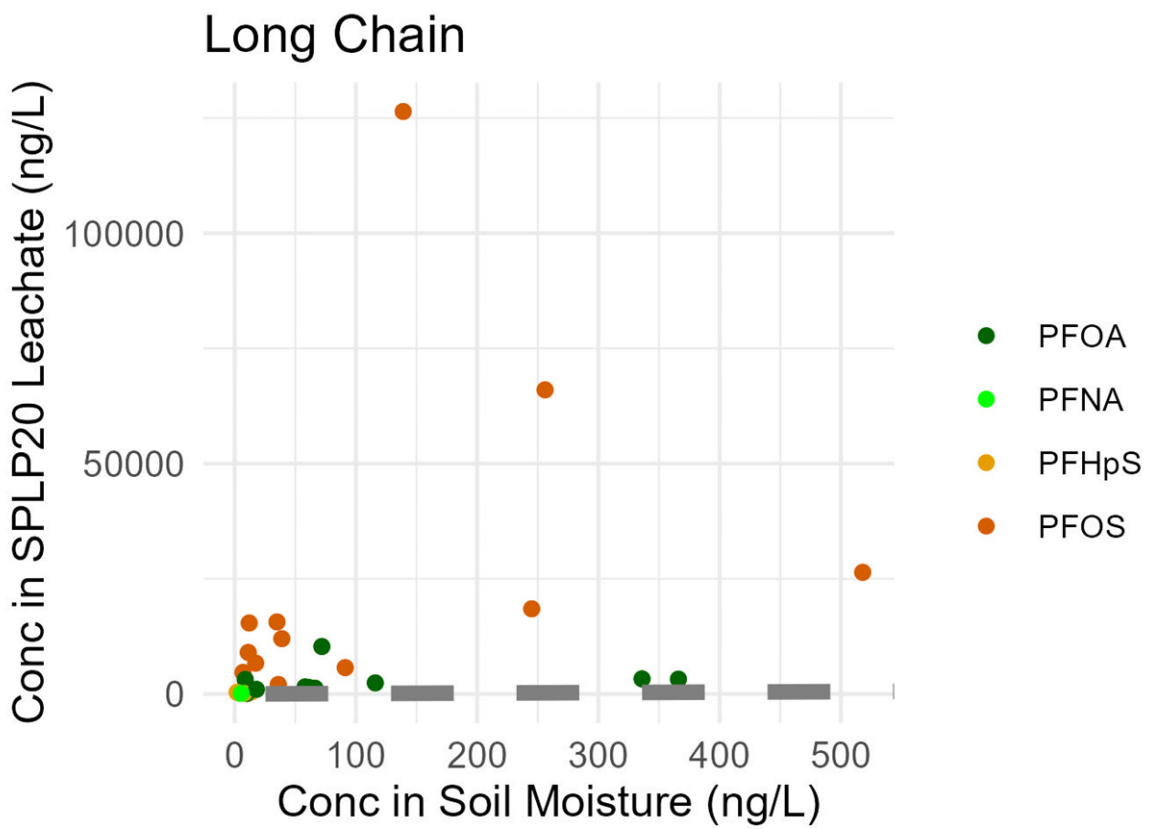


SPLP Leachate

Figure by Sean Duncan

SPLP20 vs Soil Moisture





For Short Chain: SPLP20 is closer to Lysimeter

- Dilution of what was dissolved in pore water?

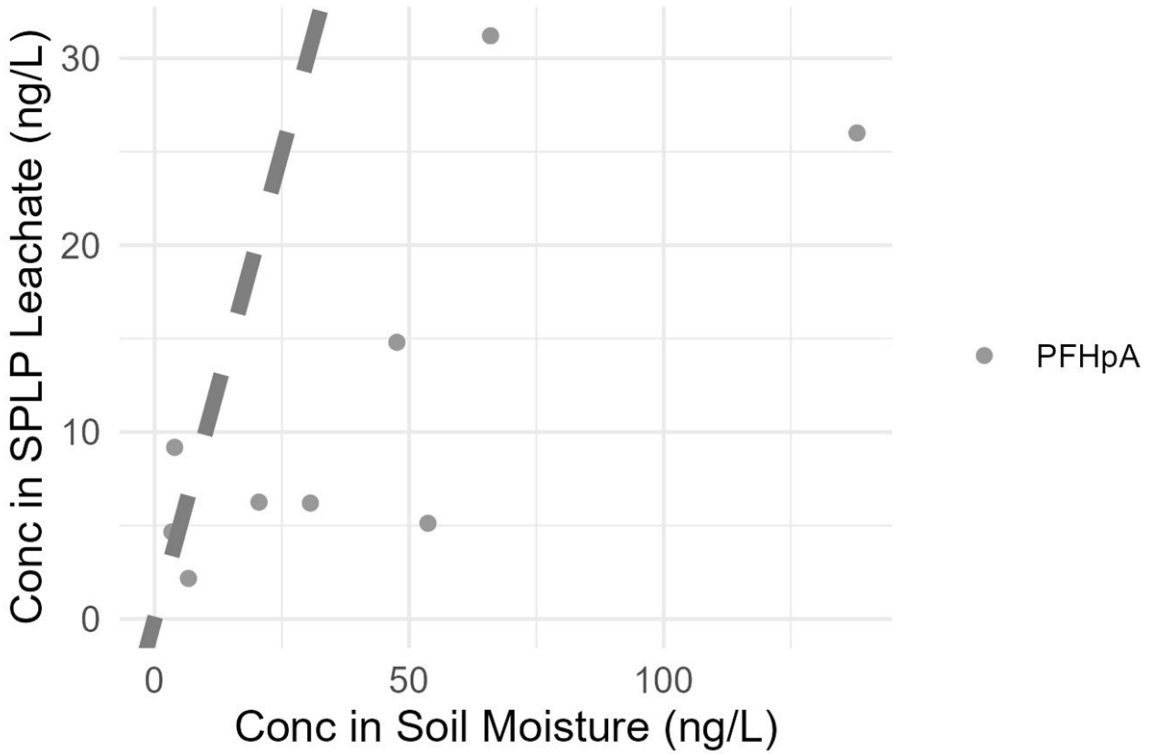
SPLP extracts more longer chain compounds.

Could something else provide a correlation?

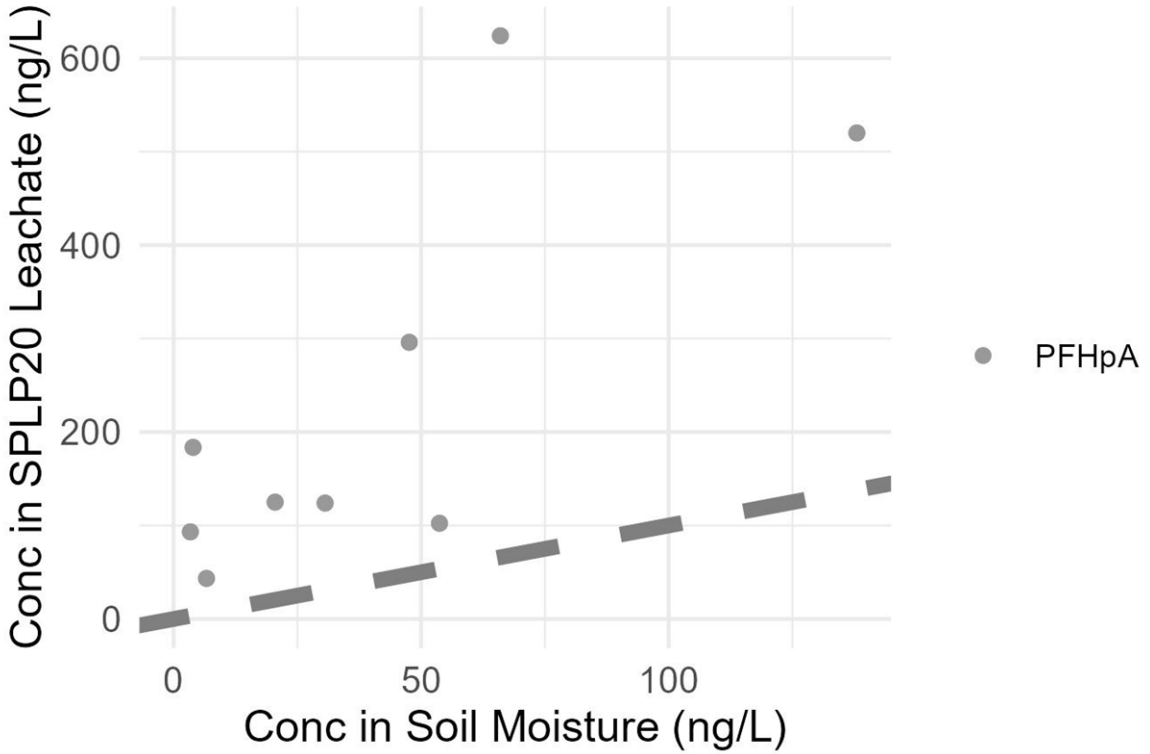
- pH?
- Organic Content of Soil?

PFHpA

SPLP vs Soil Moisture



SPLP20 vs Soil Moisture



PFHpA is between Long and Short

Conceptual Sampling and Analysis Model

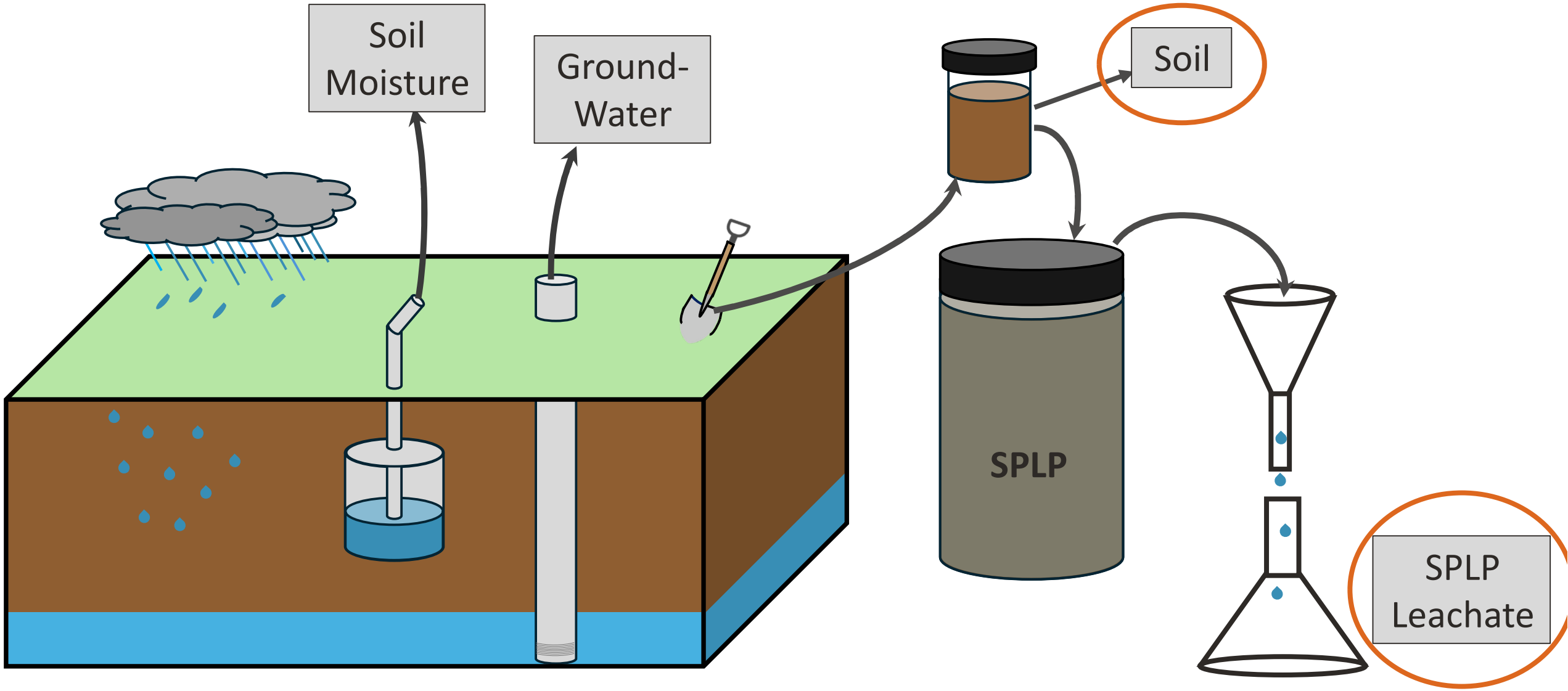
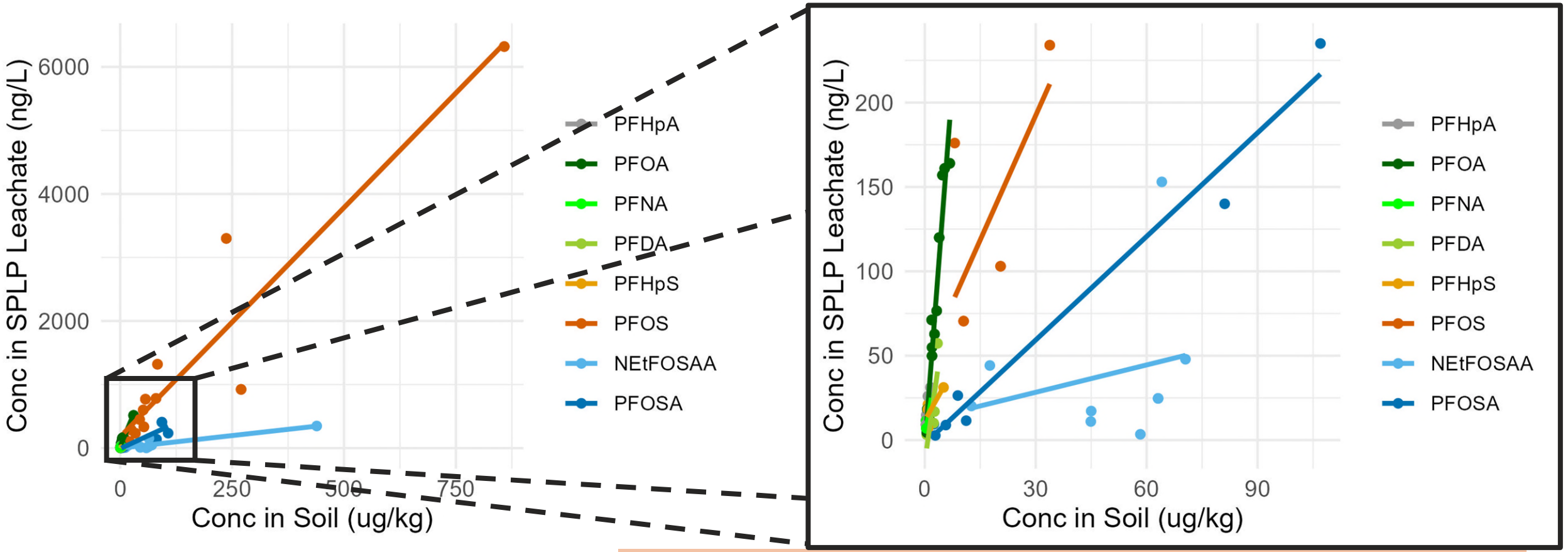


Figure by Sean Duncan

SPLP Leachate vs Soil



Note: No PFCAs shorter than PFHpA were detected in Soil

Slopes of best-fit lines trend with solubility trends:

- PFCAs more soluble than PFSAs
- Shorter chains more soluble than Longer chains

Conceptual Sampling and Analysis Model

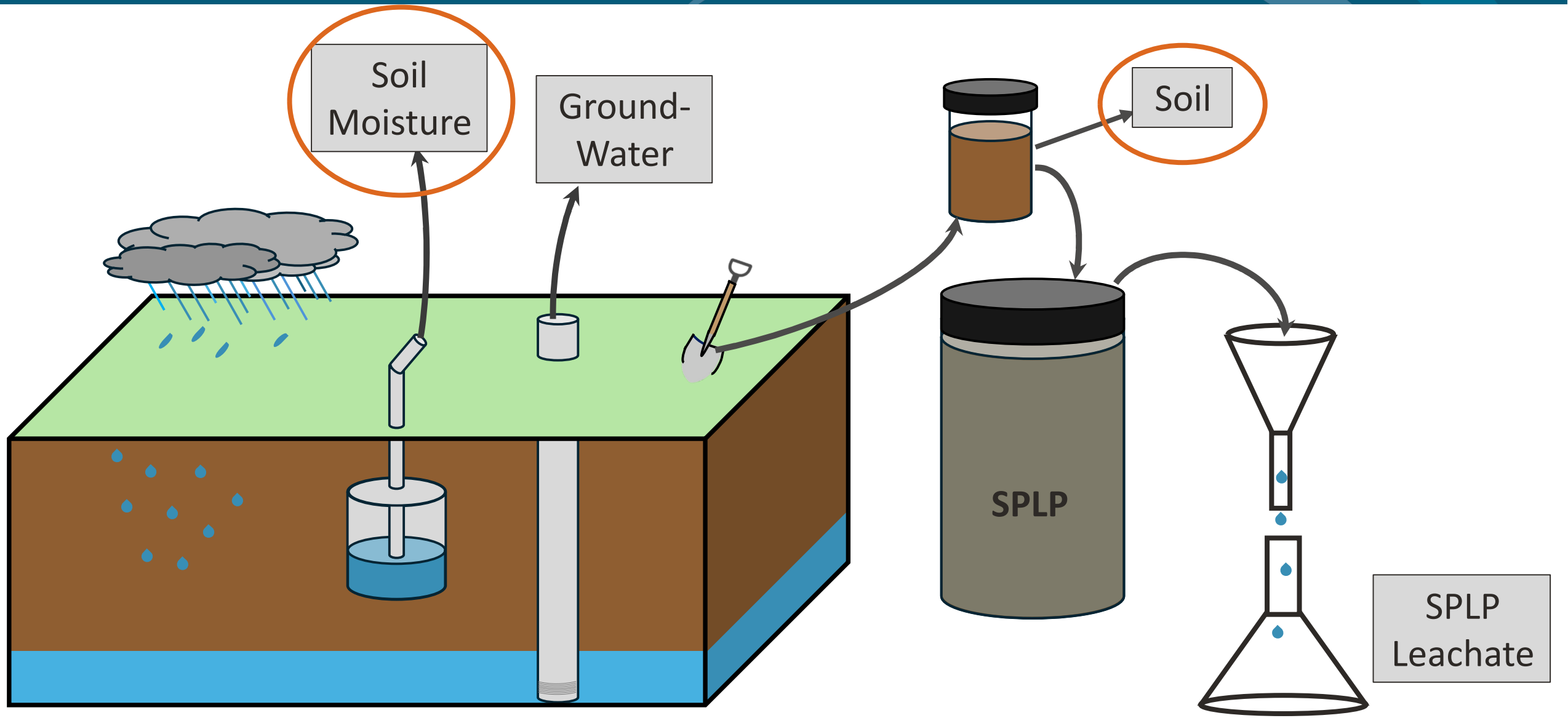
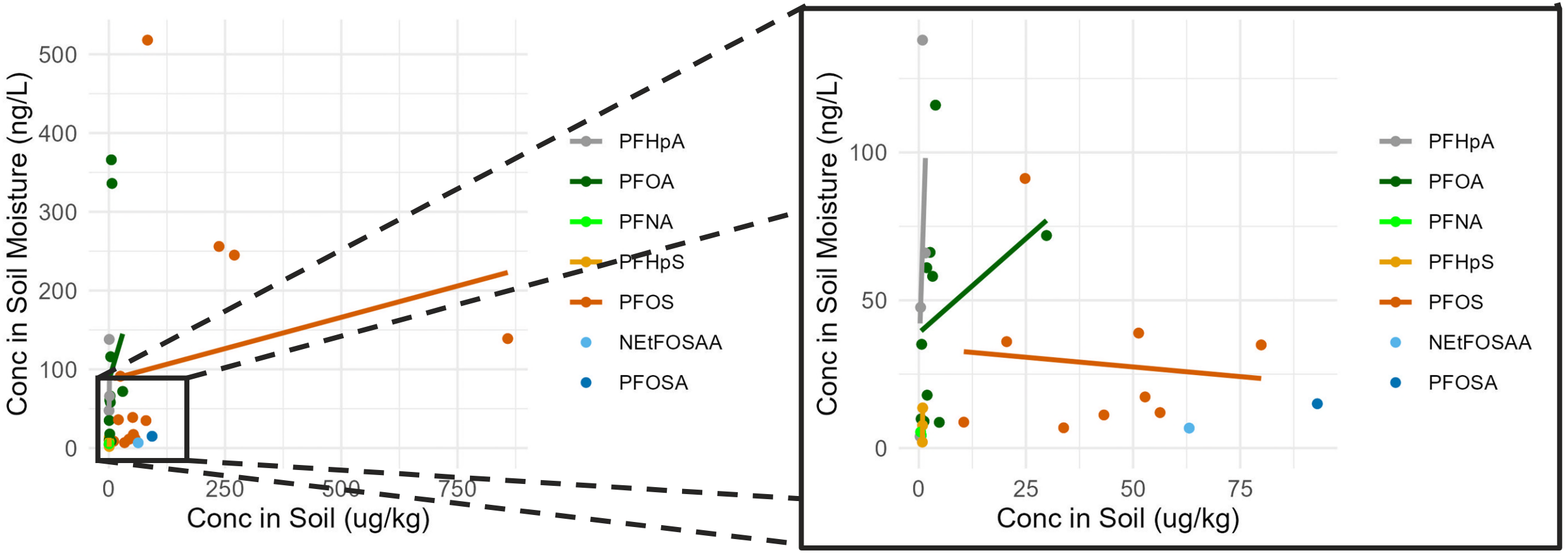


Figure by Sean Duncan

Soil Moisture vs Soil



Note: No PFCAs shorter than PFHpA were detected in Soil

Some trend in solubility?

There is clearly something else to consider

Case Study No. 2 – Ottati & Goss / Kingston Steel Drum

Conclusion: Appears that soil is a (the?) source, but the extent to which requires additional study.

Lessons learned:

- Taking soil samples where and when lysimeters are installed is helpful.
- Expect detection differences between soil, lysimeters, and SPLP.
- It's hard to know if other parameters (TOC, pH, soil grain size, co-located groundwater, etc.) might be helpful if they are not collected.

Thank You!

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Stop by Booth B22

Special Thanks:
Matthew Bergen,
Assistant Project Manager, GZA

Grant R. Carey, Ph.D., P.Eng.,
President
Porewater Solutions

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Central NH Middle School Project
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- **PIC:** Jim Wieck (Bedford, NH)
- **C/R:** Kate McDonald (Portland, ME)

O&G/KSD Superfund Site
- **Client:** NH Dept of Environmental Services
- **PM:** Kate McDonald (Portland, ME)
- **PIC:** Jim Wieck (Bedford, NH)
- **C/R:** Mark Wingsted (Meredith, NH)

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