FDEP Division of Waste Management Updates and Emerging Contaminants

Teresa Booeshaghi
Assistant Director
Division of Waste Management
October 2019

Division of Waste Management Organization

Tim Bahr
Director
Division of Waste Management

Teresa Booeshaghi
Assistant Director
Division of Waste Management

Waste Cleanup Program
Jennifer Farrell
Program Administrator

Petroleum Restoration Program
Natasha Lampkin
Program Administrator

Legislative, Business Planning, External Affairs
Wayne Kiger
Program Administrator

Permitting & Compliance Assistance Program
Kim Walker
Program Administrator

Shared Admin Services
Lisa Sparkman-Allen
Operations & Program Manager

DoD, Brownfields & CERCLA Site Screening
Laura Barrett
Environmental Administrator

District & Business Support
Brian Dougherty
Program Manager

Solid Waste Program & Permitting
Cory Dilmore

Financial Management & Procurement
Fletcher Herrald
Program Administrator

Petroleum Restoration Section 1
Matt Ingham
Environmental Administrator

Brownfields & CERCLA
Kelly Crain
Environmental Manager

Operational & Program Performance
Theresa Oquendo
Environmental Administrator

Compliance Assistance
Amanda Dorsett
Environmental Administrator

Division Budget Affairs
Griffin Kolchakian
Operation & Management Consultant Manager

Petroleum Restoration Section 2
Ken Busen
Environmental Administrator

Waste Site Cleanup
Bill Burns
Environmental Administrator

Solid & Hazardous Waste
Glen Perrigan
Environmental Manager

Petroleum Restoration Non-ATC Management
Susan Fields
Environmental Administrator

Dry-cleaning
Aaron Cohen
Environmental Administrator

Waste Reduction & Registration
Karen Moore
Environmental Administrator

Petroleum Restoration ATC Management
Blake Miller
Environmental Administrator

Site Investigations
Dave Phillips
Environmental Administrator

Hazardous Waste Prog & Permitting
Michell Smith
Environmental Administrator

Division of Waste Management PFAS Efforts

- Development of Provisional Cleanup Target and Screening Levels
- Unregulated Contaminant Monitoring Rule 3 (UCMR3)
- Certified Fire Training Facilities
- Drycleaning Solvent Cleanup Program Sites
- State Cleanup Program Sites
- Department Of Defense Sites

Provisional Cleanup Target Levels

Provisional Groundwater Cleanup Target Levels (PGCTL)

- **PFOA: 70 ppt (0.07 ug/L)**
- **PFOS: 70 ppt (0.07 ug/L)**
- **PFOA + PFOS: 70 ppt (0.07 ug/L)**

Developed using non-cancer GCTL equation in 62-777, F.A.C.. Assumptions consistent with EPA calculation of Health Advisory Level (HAL).

Provisional Cleanup Target Levels

Provisional Soil Cleanup Target Levels (PSCTL)

- **PFOA: 1.3 mg/kg residential, 25 mg/kg commercial/industrial, 0.002 mg/kg leachability**
- **PFOS: 1.3 mg/kg residential, 25 mg/kg commercial/industrial, 0.007 mg/kg leachability**

Developed using non-cancer GCTL equation in 62-777, F.A.C., chemical specific properties and reference dose developed by EPA in their 2016 HAL calculation.

PFAS Screening Levels

Irrigation Well Screening Levels (IWSL)

Chemical	Residential (ug/L)	Industrial (ug/L)
PFOA	6.7	750
PFOS	72	370

Derived using the irrigation water equations developed by the University of Florida in the January 14, 2009 IWSL letter. Uses updated assumptions from the 2011 Exposure Factors Handbook and an oral RfD of 2E-05mg/kg-d.

PFAS Screening Levels

DRAFT Surface Water Screening Levels

- For the protection of human health, surface water screening levels for the consumption of freshwater and estuarine finfish and shellfish include:
  - 0.150 ug/L for PFOA
  - 0.004 ug/L for PFOS

Developed in consultation with the Division of Environmental Assessment and Restoration.

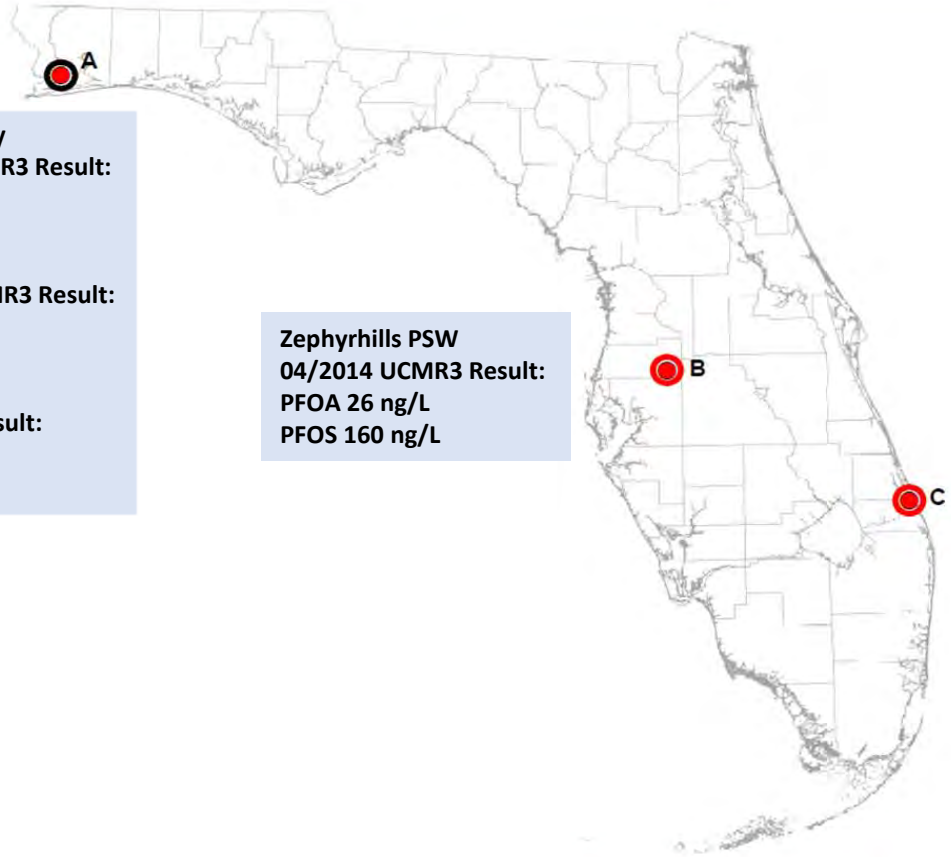
UCMR3

ID	UCMR PFAS Site
A	Emerald Coast Utilities Authority
B	Zephyrhills Fire Department
C	City of Stuart

Emerald Coast Utilities Authority
11/2014 Spanish Trail PSW UCMR3 Result:
PFOA not detected
PFOS 66 ng/L

05/2014 Bronson East PSW UCMR3 Result:
PFOA 24 ng/L
PFOS 160 ng/L

11/2014 Hagler PSW UCMR3 Result:
PFOA 65 ng/L
PFOS 380 ng/L



Zephyrhills PSW
04/2014 UCMR3 Result:
PFOA 26 ng/L
PFOS 160 ng/L

Stuart PSW
07/2014 UCMR3 Result:
PFOA not detected
PFOS 180 ng/L

Status
- < CTLs
- > CTLs

- FDOH Results < HAL
- FDOH Results > HAL
- Awaiting FDOH Results
- Yet to be Sampled by FDOH

Florida UCMR 3 PFAS Sites Assessment Results
With Associated Florida Department of Health
Community Well Survey Sample Results
As of August 29, 2019

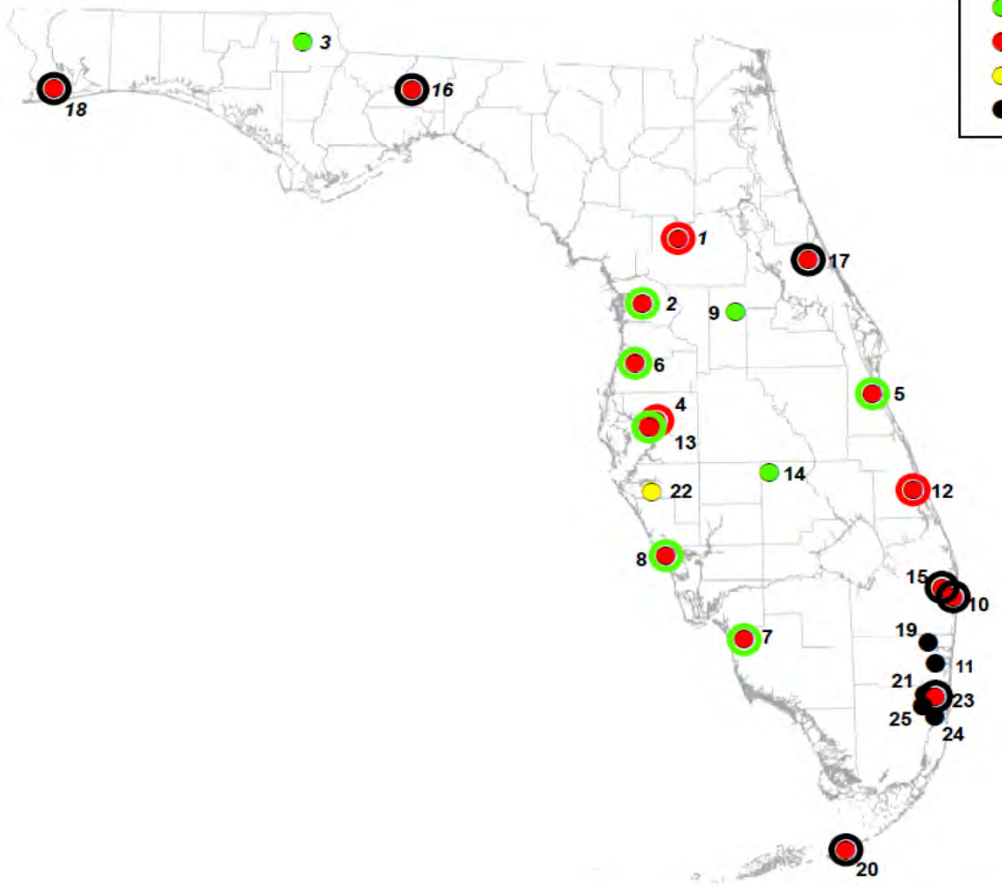
UCMR: Third Unregulated Contaminant Monitoring Rule (2012)
PFAS: Per- and polyfluoroalkyl substances
CTL: Cleanup Target Level
HAL: Health Advisory Level
FDOH: Florida Department of Health

N

50 Miles

Certified Fire Training Facilities

ID	Training Center
1	Florida State Fire College
2	Citrus Sheriff Fire Training Center
3	Chipola College
4	Hillsborough Community College
5	Melbourne Fire Training Facility
6	Pasco County Fire Rescue Training Center
7	Bonita Spings Fire Control and Rescue District
8	Englewood Fire Department
9	Lake Tech Fire Academy
10	Palm Beach State College
11	Plantation Fire Department
12	Indian River State College
13	Tampa Fire Rescue Training Facility
14	South Florida State College
15	Palm Beach County Fire Rescue
16	Tallahassee Fire Department
17	Volusia County Fire Training Center
18	Pensacola Fire Department
19	Coral Springs Fire Academy
20	Monroe County Training Academy (Joe London)
21	City of Hialeah Training Facility
22	Manatee Technical Institute Fire Academy
23	Miami Dade College
24	City of Miami Fire Rescue Training Center
25	Miami Dade Fire Rescue



Florida Fire Training Facilities PFAS Assessment Results With Associated Florida Department of Health Community Well Survey Sample Results As of October 23, 2019

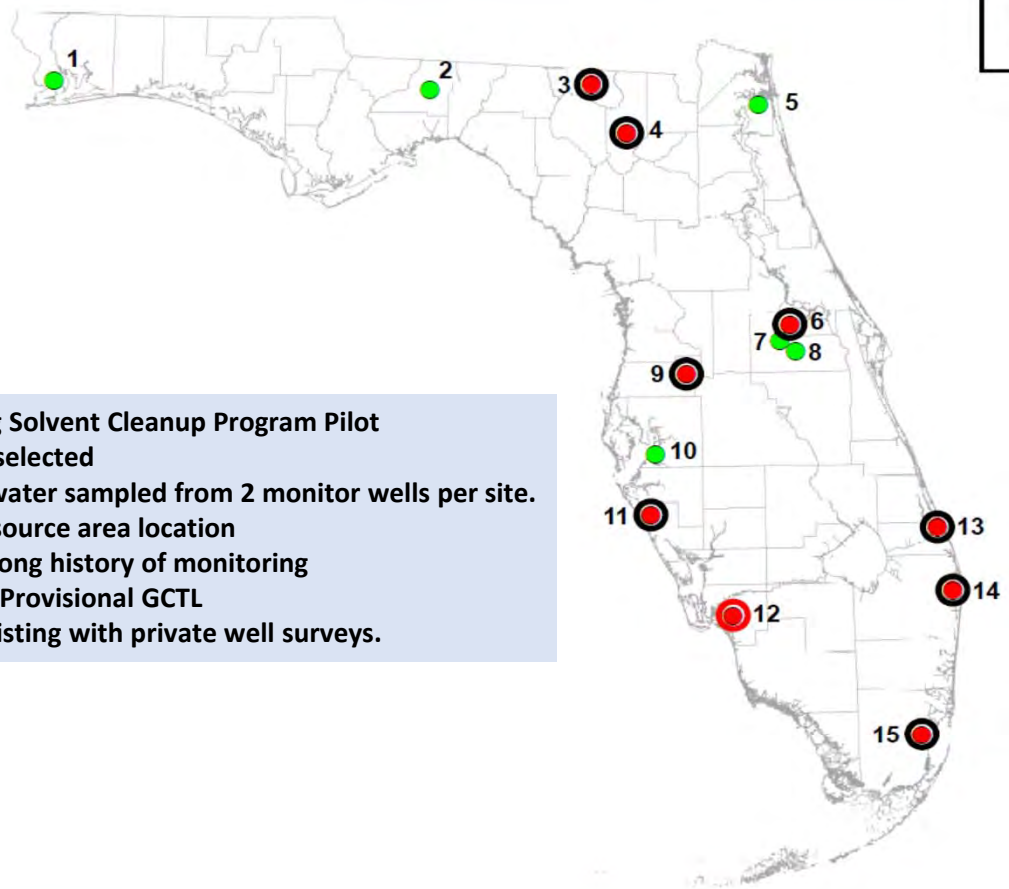
Facilities are listed in order of priority to be addressed
PFAS: Per- and polyfluoroalkyl substances
PFOA: Perfluorooctanoic acid PFOS: Perfluorooctanesulfonic acid
ng/L: nanograms per Liter
GCTL: Provisional Groundwater Cleanup Target Level
HAL: Health Advisory Level
FDOH: Florida Department of Health

N

50 Miles

Drycleaning Solvent Cleanup Program Pilot

ID	Dry Cleaner
1	Vick's Cleaners
2	Randolph's Dry Cleaner
3	Jasper Laundry and Dry Cleaner
4	Moses Cleaners
5	Former Sages Dry Cleaners
6	Celebrity Dry Cleaners, Inc.
7	Nanak Cleaners
8	Dryclean World
9	Touch of Quality Dry Cleaners
10	Touch of Class
11	North Trail Laundryland
12	Dolphin Fabricare
13	Classic Cleaners
14	Cinderella Cleaners
15	International Professional



Drycleaning Solvent Cleanup Program Pilot

- **15 sites selected**
- **Groundwater sampled from 2 monitor wells per site.**
  - **source area location**
  - **long history of monitoring**
- **9 sites > Provisional GCTL**
- **DOH assisting with private well surveys.**

Florida Drycleaning Solvent Cleanup Program
PFAS Sample Results With Associated
Florida Department of Health
Community Well Survey Sample Results
As of October 17, 2019
Florida Department of Environmental Protection

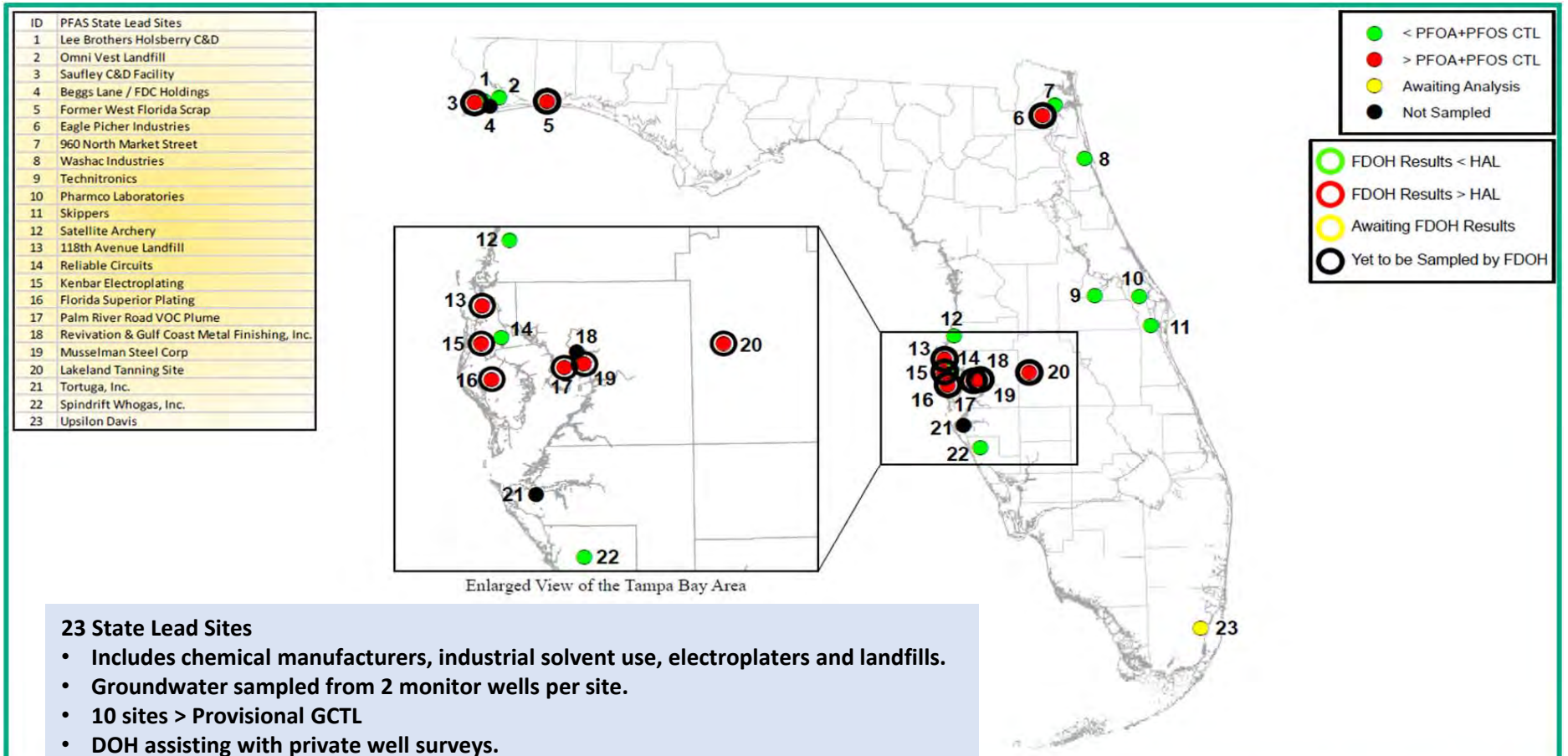
PFAS: Per- and polyfluoroalkyl substances
PFOA: Perfluorooctanoic acid
PFOS: Perfluorooctanesulfonic acid
CTL: Provisional Cleanup Target Level
HAL: Health Advisory Level
FDOH: Florida Department of Health

N

50 Miles

State Lead Cleanup Sites

ID	PFAS State Lead Sites
1	Lee Brothers Holsberry C&D
2	Omni Vest Landfill
3	Saufley C&D Facility
4	Beggs Lane / FDC Holdings
5	Former West Florida Scrap
6	Eagle Picher Industries
7	960 North Market Street
8	Washac Industries
9	Technitronics
10	Pharmco Laboratories
11	Skippers
12	Satellite Archery
13	118th Avenue Landfill
14	Reliable Circuits
15	Kenbar Electroplating
16	Florida Superior Plating
17	Palm River Road VOC Plume
18	Revivation & Gulf Coast Metal Finishing, Inc.
19	Musselman Steel Corp
20	Lakeland Tanning Site
21	Tortuga, Inc.
22	Spindrift Whogas, Inc.
23	Upsilon Davis



23 State Lead Sites

- **Includes chemical manufacturers, industrial solvent use, electroplaters and landfills.**
- **Groundwater sampled from 2 monitor wells per site.**
- **10 sites > Provisional GCTL**
- **DOH assisting with private well surveys.**

Florida State Lead Sites PFAS Sample Results With Associated Florida Department of Health Community Well Survey Sample Results As of August 29, 2019

PFAS: Per- and polyfluoroalkyl substances
PFOA: Perfluorooctanoic acid
PFOS: Perfluorooctanesulfonic acid
CTL: Cleanup Target Level
HAL: Health Advisory Level
FDOH: Florida Department of Health

N

50 Miles

PFAS at Federal Facilities

Air Force: 9 bases with PFAS onsite above HAL/PGCTL and/or PSCTL. No Off-Base sampling performed.

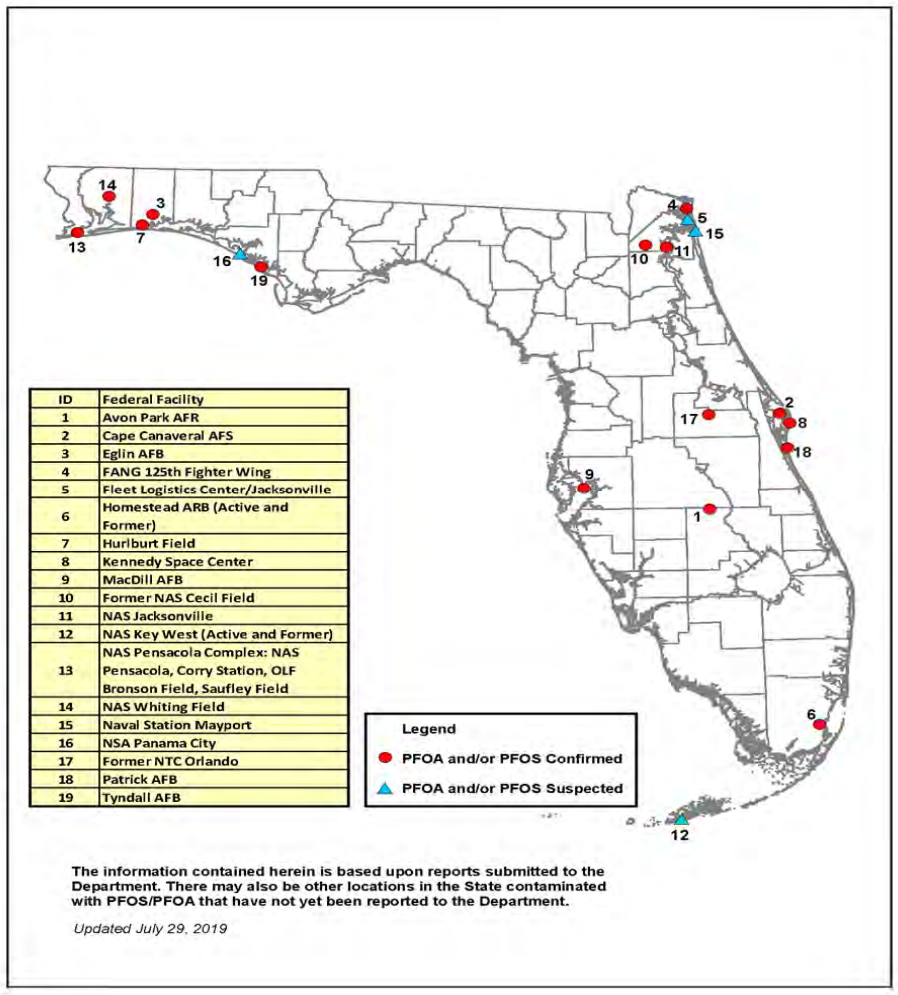
Air Force BRAC: 1 former base with PFAS in onsite soil.

Navy: 5 bases/outlying Fields with PFAS onsite above HAL/PGCTL and/or PSCTL. 2 bases have offsite private well impacts above HAL/PGCTL.

Navy BRAC: 2 former bases with PFAS in onsite groundwater above HAL/PGCTL. No offsite samples above HAL/PGCTLs to date.

NASA: Confirmed PFAS onsite above HAL/PGCTL. Investigations ongoing.

National Guard: Investigations ongoing. No information provided to the Department yet.



ID	Federal Facility
1	Avon Park AFR
2	Cape Canaveral AFS
3	Eglin AFB
4	FANG 125th Fighter Wing
5	Fleet Logistics Center/Jacksonville
6	Homestead ARB (Active and Former)
7	Hurlburt Field
8	Kennedy Space Center
9	MacDill AFB
10	Former NAS Cecil Field
11	NAS Jacksonville
12	NAS Key West (Active and Former)
13	NAS Pensacola Complex: NAS Pensacola, Corry Station, OLF Bronson Field, Saufley Field
14	NAS Whiting Field
15	Naval Station Mayport
16	NSA Panama City
17	Former NTC Orlando
18	Patrick AFB
19	Tyndall AFB


Questions?
FLORIDA DEPARTMENT OF
ENVIRONMENTAL PROTECTION

Perfluoroalkyl Substances (PFAS)
Human Health Considerations

Dr. Christopher M. Teaf

Center for Biomedical & Toxicological Research
Florida State University

Hazardous Substance & Waste Management Research
Tallahassee, FL

Air & Waste Management Association
Tallahassee, FL
October 2019

HSWMR
Hazardous Substance & Waste Management Research, Inc.

Reported Health Effects

- **Noncancer**
  - Increased serum cholesterol, liver enzymes/weight, uric acid
  - Delayed mammary gland development; decreased immune response, delayed skeletal ossification (*used for proposed RfD*); potential reduced fetal growth from prenatal exposure
  - Potential immune hazard to humans
  - Effects often extrapolated from high dose animal studies
- **Cancer**
  - Not genotoxic
  - Animals – liver, testes, mammary glands, pancreas
  - Humans - suggested links to testicular, kidney, thyroid
  - IARC - Group 2B; possibly carcinogenic
  - EPA - not classified as to carcinogenicity; "suggestive"
  - USEPA SAB (2006) – "likely", not updated

C8 Panel Studies

- Exposure, health studies 2005-2013 Ohio Valley communities
- Concluded "probable link" to C8 exposure
  - ✓ *high cholesterol*
  - ✓ *ulcerative colitis*
  - ✓ *thyroid disease*
  - ✓ *cancer (testicular, kidney)*
  - ✓ *pregnancy-induced hypertension*
- Inconsistencies in the studies and newer epidemiology

… PFAS Criteria Chaos Ensues

- Several states have developed their own drinking water criteria for PFOA and PFOS, and some have developed criteria for other PFAS as well.
- Resultant numbers reflect different conclusions:
  - ✓ critical effect upon which to derive a safe dose
  - ✓ how study data should be interpreted
  - ✓ how animal data should be extrapolated to humans
  - ✓ what drinking water ingestion rate to use
  - ✓ what relative source contribution value to use, etc.
- As a result, little consistency for state drinking water limits

Thanks to Dr. Leah Stuchal, UF

Florida DEP Health-based Criteria

- **Provisional GCTL**
  - 70 parts per trillion (0.070 ppb), equal to EPA Health Advisory
  - evaluated as individual or sum of PFOA + PFOS
  - basis developmental (RfD of 0.00002 mg/kg•day)
- **Alternate SCTL**
  - PFOA 1.3 mg/kg Res; 25 mg/kg Comm/Ind; 0.002 mg/kg Leach
  - PFOS 1.3 mg/kg Res; 25 mg/kg Comm/Ind; 0.007 mg/kg Leach
- **Provisional Irrigation Screening Levels**
  - PFOA 6.7 ug/L Res; 750 ug/L Comm/Ind
  - PFOS 72 ug/L Res; 370 ug/L Comm/Ind
- **Draft Surface Water Screening Levels**
  - PFOA 0.150 ug/L; PFOS 0.0004 ug/L (*fish/shellfish*

Examples of Other State PFOA Levels

Alaska	400 ppt
Maine	70 ppt
Minnesota	35 ppt
New Hampshire	38 ppt
New Jersey	14 ppt
Texas	290 ppt
Vermont	20 ppt

Thanks to Dr. Leah Stuchal, UF

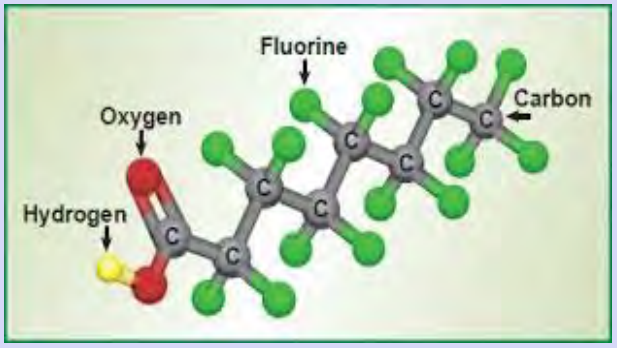
PFAS Exposure Assessment Issues

- Exposure - found in blood of nearly all people tested
- Bioaccumulative but levels of blood PFOA decreasing
- Drinking water exposure often localized
- PFOA in water often linked to industrial sites, fire training areas, landfills, WTPs, home septic systems
- Attention will need to be paid to association vs causation as the toxicology moves forward

10^{-6} to 10^{-4}

PFAS Summary

- Persistent; exposure not uncommon
- Diverse pharmacodynamic, toxicity profiles in animals
- Human epidemiology studies inconclusive
- Risk assessment uncertain, reflected in agency guidance
- Multidisciplinary efforts - evaluate new evidence
- Additional questions remain with shorter chain PFAS



Per- and Polyfluoroalkyl Substances (PFAS) Site Investigations and Lessons Learned

Eric Sager, P.G.
Clearwater, Florida

Geosyntec consultants

Florida Chapter AWMA Conference
FDEP Division of Waste Management Updates and Emerging Contaminants
October 30, 2019

PFAS Site Investigations

Geosyntec consultants

- Prepared Investigation Work Plans for airports in California
- Conducted site investigations at a large Federal facility (over 650 samples and 150 locations) and 14 other AFFF-use facilities in Florida
- **Prepared PFAS-specific SOPS**

Scopes of Work

- Reviewed aerial photos, site documents, and current/historical investigations, including NTSB's Aircraft Accident Reports
- Completed site visits and interviewed people with historical knowledge
- Prepared Work Plans with figures and tables summarizing areas of investigations, sample locations, depths and rationale
- **Collected samples from multiple media**
  - **Supply wells (evaluate potential exposure and decon water source)**
  - **Direct push technology and monitoring well groundwater sampling**
  - **Surface water sampling**
  - **Sediment sampling**
  - **Soil sampling**

Sources Investigated

Geosyntec consultants

Sources Investigated

Field Planning/Readiness = Informed Staff

- Geosyntec and subcontractors
- **Staff that can make real-time decision and ask informed questions**
- Lead to identification of AFFF-use site

Why PFAS-Specific SOP?

- Avoid cross-contamination, false positive results
  - PFAS potentially present in variety of commonly-used materials
  - Low method detection limits (low to sub ng/L)
- Current sampling guidance reflect abundance of precaution, rather than scientific findings
  - Guidance varies state by state, still in infancy
  - Rapid changes to state of knowledge, state and federal guidance and regulations

PFAS Considerations – Sampling Materials

Geosyntec consultants

Try to avoid

- ☹ Polytetrafluoroethylene (PFTE)
- ☹ Viton™ (i.e., fluoroelastomers)
- ☹ Stain- or water-resistant materials, as these are typically fluoropolymer-based
- ☹ "Fluoro" materials
  - Fluorinated ethylene propylene (FEP)
  - Ethylene tetrafluoroethylene (ETFE)
  - Polyvinylidene fluoride (PVDF)
- ☹ LDPE in direct contact with the sample

Safe to use

- ☺ High-density polyethylene (HDPE), silicone, acetate, stainless steel
- ☺ Low-density polyethylene (LDPE) materials, as long as they do not directly contact the sample
  - For example, PFAS can sorb to porous LDPE tubing

- ❖ If an item cannot be easily avoided, use QA/QC samples to confirm no cross-contamination (e.g., field blanks)

PFAS Considerations - Sample Bottles, Packaging and Shipping

Geosyntec consultants

Safe to Use	Try to Avoid	Why?
HDPE containers and screw caps	Glass sample containers	PFAS adherence to glass surfaces
Sample preservative (e.g., Trizma®)	--	Used to remove free chlorine in drinking water method 537
Sample container labels, shipping and handling labels, chain of custody record	--	--
LDPE (e.g., Ziploc®) bags	Aluminum foil (sometimes used for fish tissue samples)	PFAS can be used as a protective non-stick layer on aluminum foil
Regular (wet) ice	Chemical (e.g., blue) ice packs, unless it is in a sealed bag	Potential to be contaminated from previous field events
Hard-shell coolers, bubble wrap, duct tape, packing tape	--	--

PFAS Considerations – Field Personnel

Geosyntec consultants

Try to Avoid

- X Water or stain-resistant boots and clothing
- X Clothing recently laundered with a fabric softener
- X Coated HDPE suits
- X Latex gloves
- X Sunscreen and insect repellants containing fluorinated compounds as ingredients, such as polyfluoroalkyl phosphate esters
- X Cosmetics, moisturizers, hand cream, and other related products which may contain PFAS
- X Food wrapper and packaging

Safe to Use

- ✓ Boots made of polyurethane, polyvinyl chloride (PVC), rubber, or untreated leather
- ✓ Other field boots covered by PFAS-free (e.g., polypropylene) over-boots
- ✓ Rain gear made of polyurethane, PVC, wax-coated, vinyl or rubber
- ✓ Clothing made of synthetic (e.g. polyester) or natural (e.g. cotton) fibers
- ✓ PPE (safety glasses, reflective vests, hardhats, disposable powder-free nitrile gloves
- ✓ Uncoated HDPE suits
- ✓ Sunscreen and insect repellant tested and found to be PFAS free
- ✓ Bottled water and hydration drinks

PFAS Considerations – Field Personnel

Geosyntec consultants

Attachment A. Daily Sampling Checklist

Date: _____

Site Name: _____

Weather (*temperature/precipitation*) _____

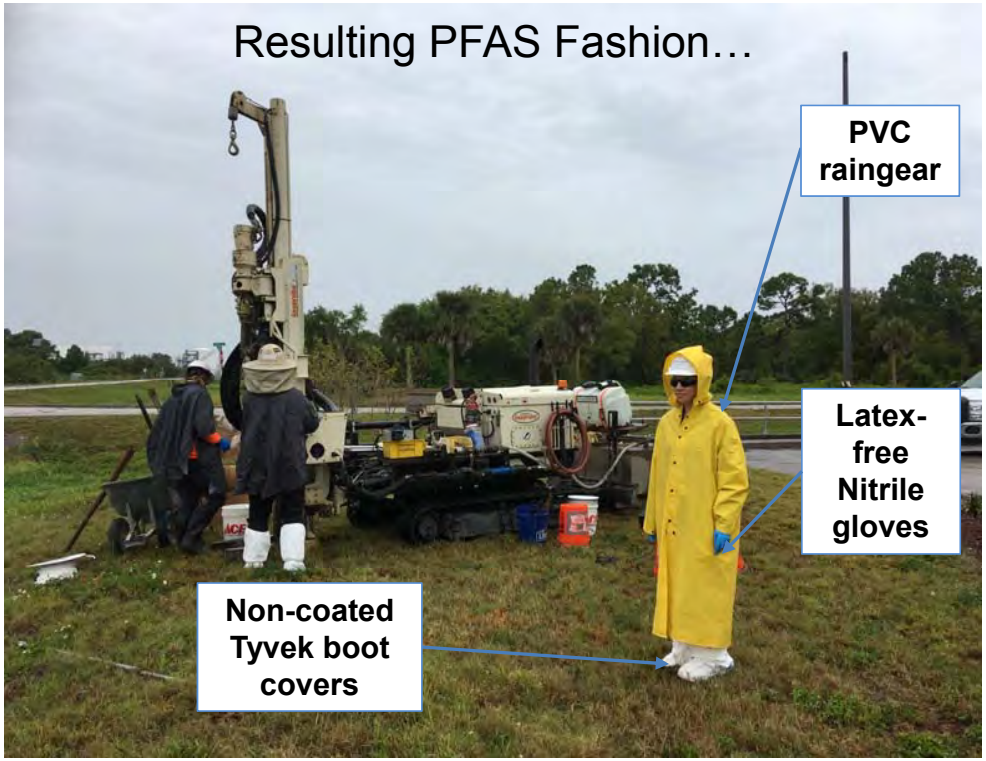
Please check all boxes that apply and describe any exceptions in the notes section below along with QA/QC methods used to assess potential sample cross-contamination as a result.

Field Clothing and PPE

- ☐ No water- or stain-resistant boots or clothing (e.g., GORE-TEX®)
- ☐ Boots made of polyurethane, PVC, rubber, or untreated leather
- ☐ Clothing has not been recently laundered with a fabric softener
- ☐ No coated HDPE suits (e.g., coated Tyvek® suits)
- ☐ Field crew has not used cosmetics, moisturizers, or other related products today
- ☐ Field crew has not used sunscreen or insect repellants today, other than products approved as PFAS-free

Field Equipment

- ☐ Sample containers are made of HDPE or polypropylene, not LDPE
- ☐ Sample caps are made of HDPE or polypropylene and are not lined with Teflon™
- ☐ No materials containing Teflon™, Viton™, or fluoropolymers
- ☐ No materials containing LDPE in direct contact with the sample (e.g., LDPE tubing)
- ☐ Equipment in direct contact with the sample is made from stainless steel, HDPE, acetate, silicon, or polypropylene
- ☐ No plastic clipboards, binders, or spiral bound cover notebooks
- ☐ No waterproof field books
- ☐ No waterproof or felt pens or markers (e.g., certain Sharpie® products)
- ☐ No chemical (blue) ice, unless it is contained in a sealed bag



Importance of QA/QC Samples

Geosyntec consultants

	Sample Type	Purpose	Ratio
QA/QC	Field duplicates (water)	Assess field and analytical precision, sample heterogeneity	1:10
	Equipment blanks	Confirm decontaminated equipment is PFAS-free	1:10
	Field blanks	Assess ambient contamination within the field and laboratory	1 per cooler and/or area
	Matrix spike/matrix spike duplicates	Assess interferences caused by the sample matrix (DoD only)	1:20
	Temperature blanks	Cooler temperature	1 per cooler

Other Considerations - Decon Water Sources: Pros and Cons

- Laboratory-certified PFAS-free water
  - Known source
  - Small volume and expensive
- On-site water source
  - Large volumes and least expensive
  - Potential PFAS detections and client sensitivities
- Drilling subcontractor and/or Geosyntec office water source
  - Large volumes and less expensive
  - Potential PFAS detections

Other Considerations - Evolution of Decontamination Procedures

Geosyntec consultants

Bucket decon procedure

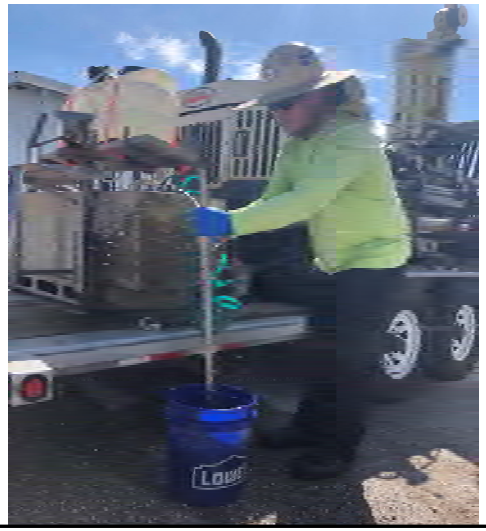
Centrally-located decon pit with pressure washing

Other Considerations - Evolution of Decontamination Procedures

Geosyntec consultants

1. Pressure wash

2. Liquinox scrub



3. Final rinse through vertical screen

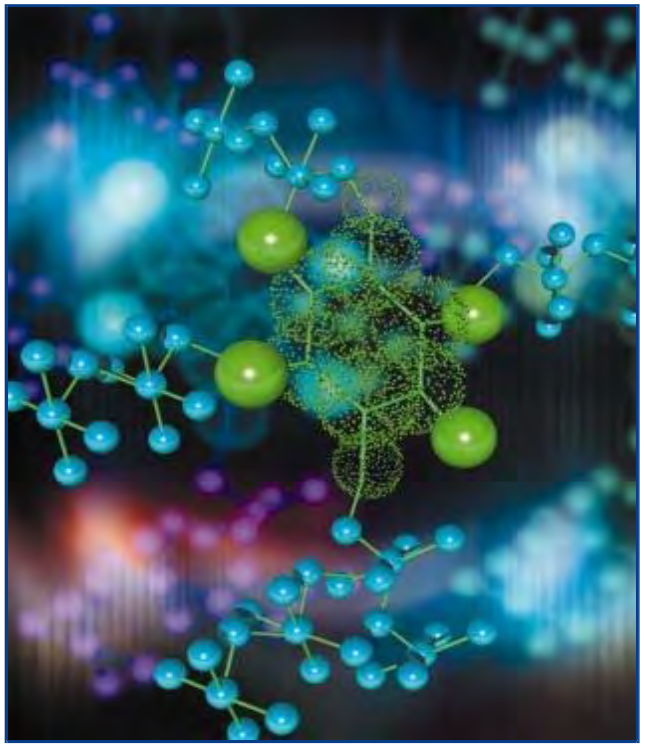
Sample	PFOA	PFOS	PFBS	PFHXS
Initial Sample	**3500**	**2300**	**4100**	**33000**
Before decontamination	13	1.4 U	59	4.1
After 1st rinse with pressure washer	1.3 U	1.3 U	2.6 U	1.3 U
After liquinox scrub and 2nd rinse	1.3 U	1.3 U	2.5 U	1.3 U
After final rinse	1.3 U	1.3 U	2.6 U	1.3 U

Other Considerations – Investigation Derived Waste

- Cradle-to-grave liabilities
  - Landfill leachate
  - “Treated” aqueous discharge
  - Biosolids
- Landfills and water treatment facilities beginning to refuse waste derived from PFAS/AFFF sources

Contact Information

Eric Sager, P.G.
Principal Geologist
Phone: 727.330.9952
esager@geosyntec.com



Forensic Analyses of PFAS

Who's PFAS Is It?

- Numerous potential PFAS sources
- Forensics is a means of limiting liability
- PFAS liabilities can be intimidatingly large
- Multiple forensic tools applicable



PFAS Forensic Tools

Geosyntec consultants

Multiple potential forensic tools available. The science is still emerging!

Forensic Tools for Multiple Compounds

- Chemical fingerprinting
- Ratio comparisons
- Multivariate analysis
- Fate and transport properties

Forensic Tools Unique to PFAS

- Isomer comparison
- Application of specialized analyses like TOP Assay

PFAS Forensic Tools: AFFF

- Multiple AFFFs likely used at most sites (3M, National Foam, Ansul, Angus, Buckeye, Fire Service Plus)
- Two AFFF manufacturing methods
  - 3M → PFOS and homologues (PFSAs), both branched and linear isomers
  - All others → PFOA and homologues (PFCAs), fluorotelomer alcohols (e.g. 6:2 FTOH), polyfluorinated compounds, no PFOS, only linear PFAS
- Unique differences (chain lengths, abundance of surfactants, intermediates, side products)

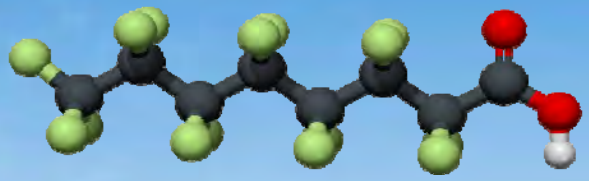
eurofins | Environment Testing TestAmerica

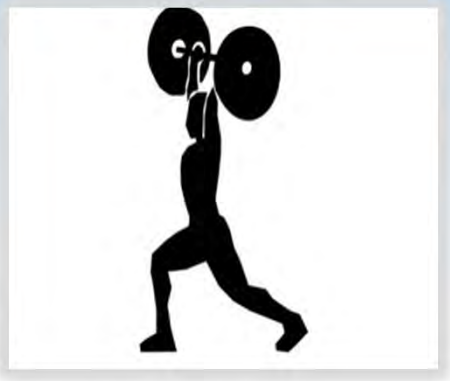
PFAS: An Introduction to the Chemistry and Analysis

Presented by:
Taryn McKnight, Product Manager
Eurofins TestAmerica

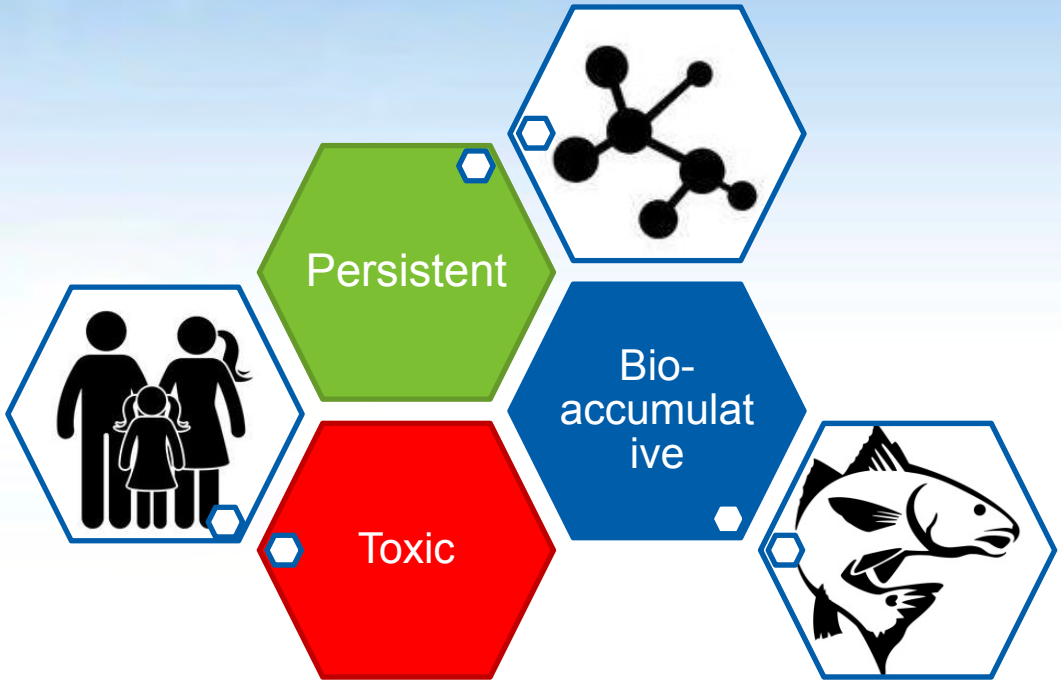
What are PFAS?

Synthetic compounds formed from **carbon** chains with **fluorine** atoms attached





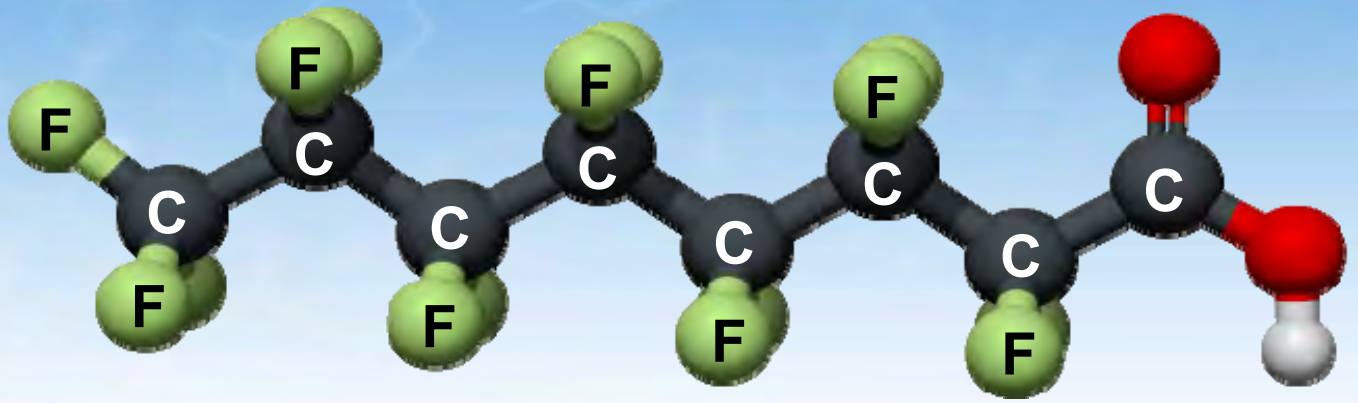
The **C-F bond** is one of the shortest and strongest in nature



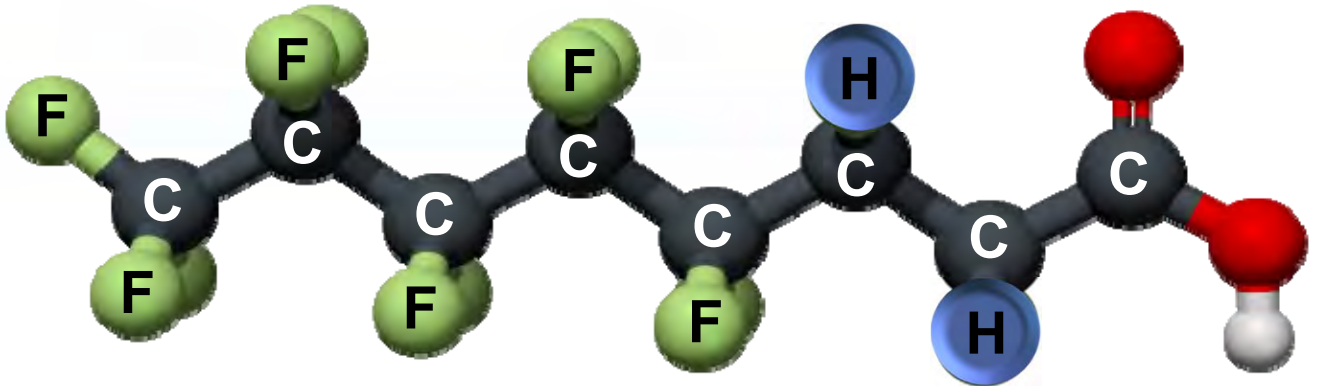
eurofins | Environment Testing TestAmerica

Per and Poly?

Perfluorinated = Completely Fluorinated

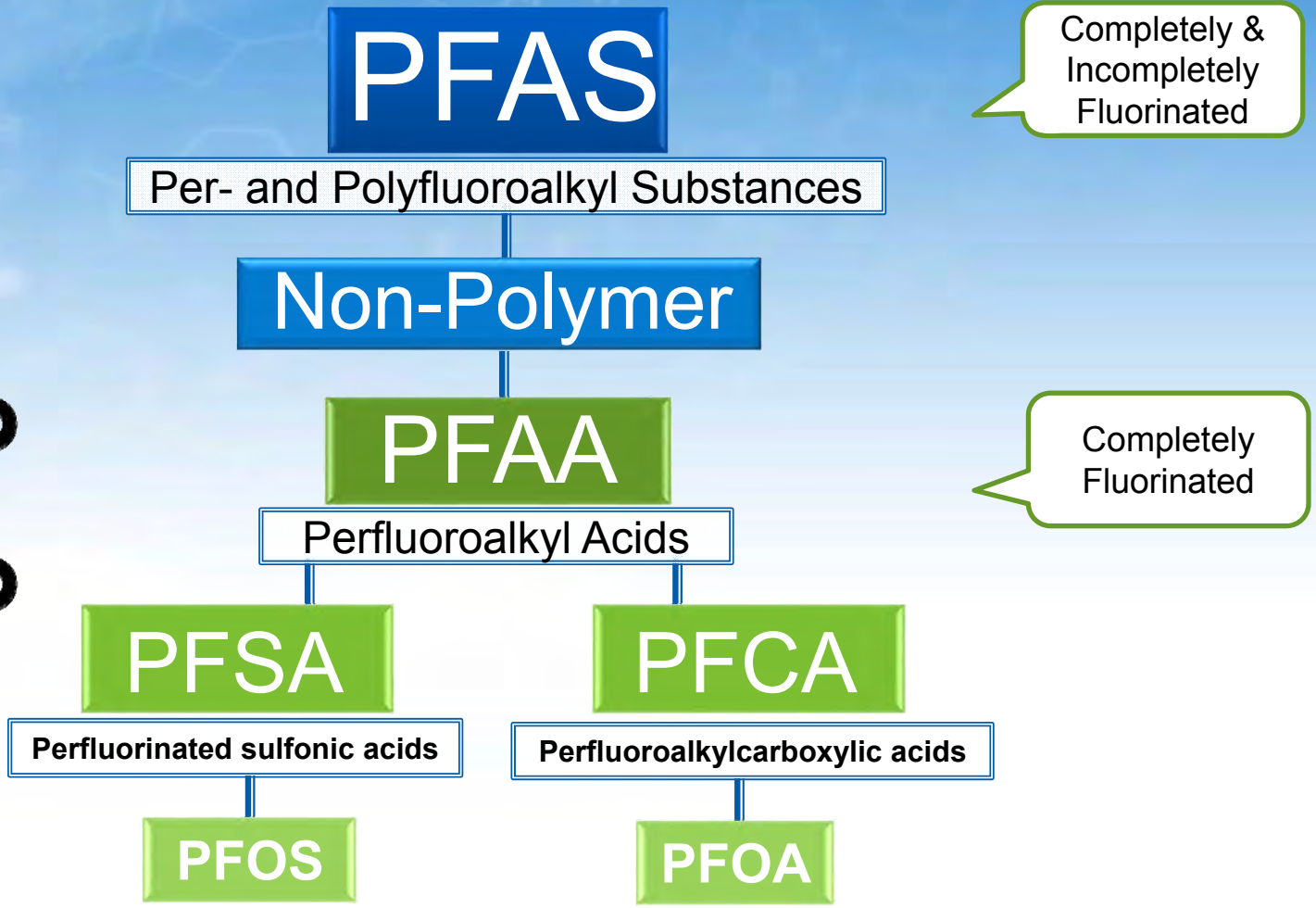


Polyfluorinated = Incompletely Fluorinated



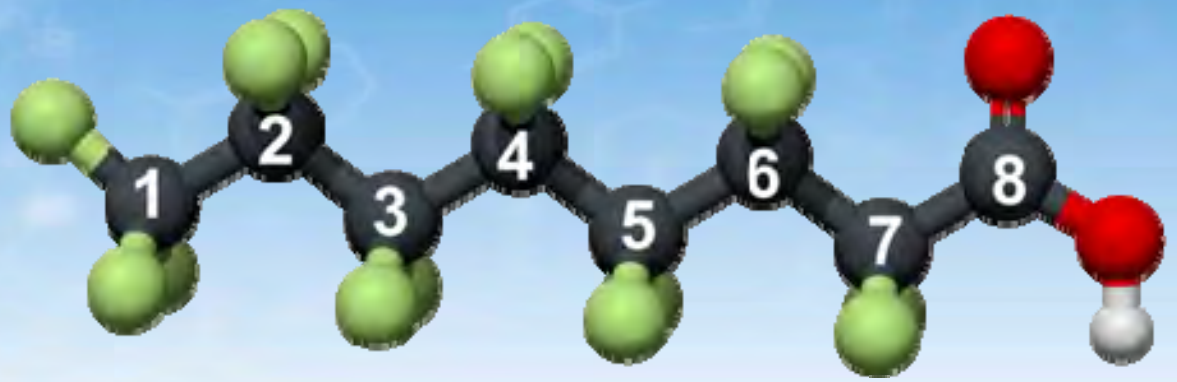
eurofins | Environment Testing TestAmerica

Nomenclature



eurofins | Environment Testing TestAmerica

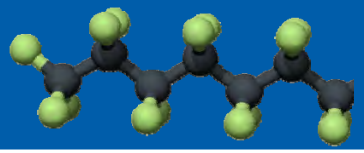
Carbon Chain Nomenclature



Acronym	Compound Name	Chain Length
PFDA	Perfluorodecanoic acid	C10
PFOA	Perfluorooctanoic acid	C8
PFHxS	Perfluorohexanesulfonic acid	C6

eurofins | Environment Testing TestAmerica

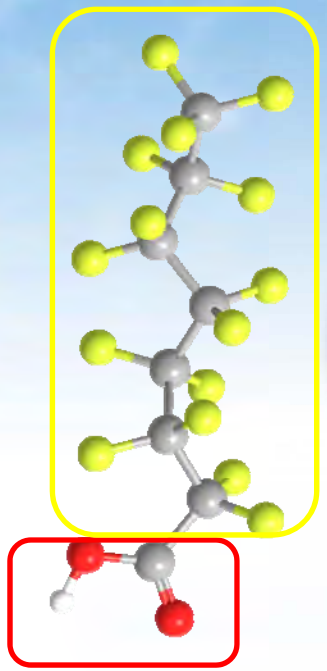
Chemical Structure

Chain Length	• ≥8 carbon atom PFCAs • ≥6 carbon atom PFSAs
Carbon backbone 	• Inert, Persistent & Bioaccumulative
Functional Group 	• Our ability to capitalize on the desirable qualities

eurofins | Environment Testing TestAmerica

Surfactant Properties

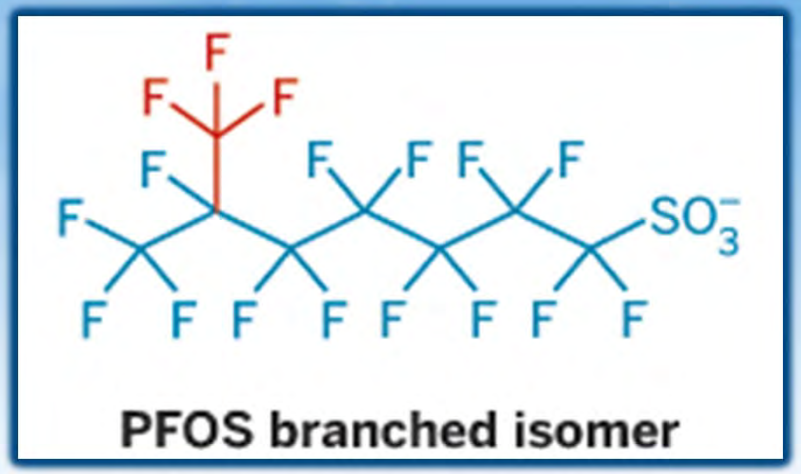
Fluorocarbon “Tail” = Hydrophobic and Oleophobic

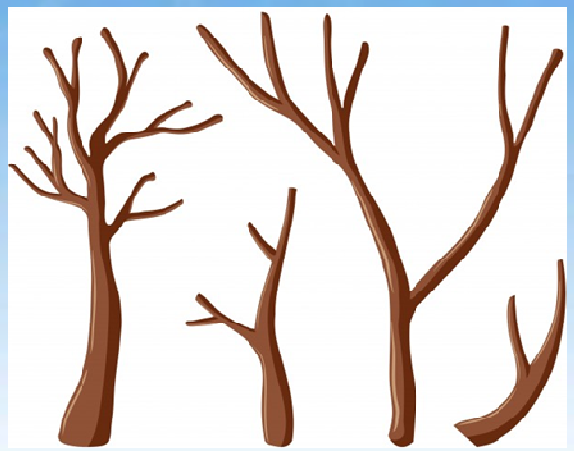


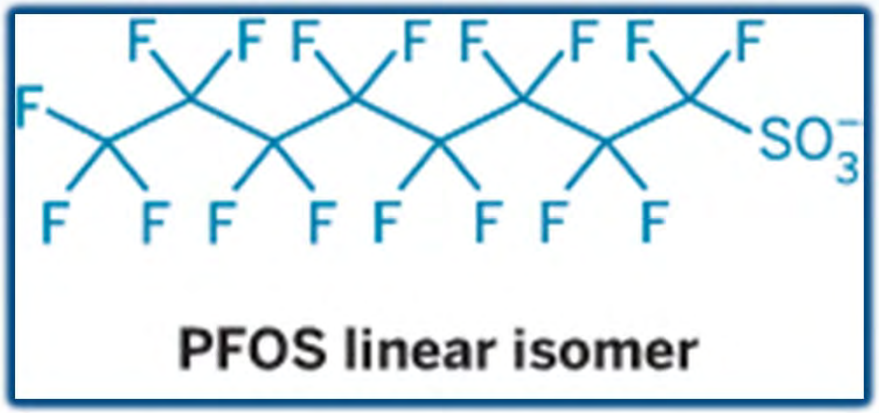
Functional Group “Head” = Hydrophilic

eurofins | Environment Testing TestAmerica

Branched & Linear Isomers



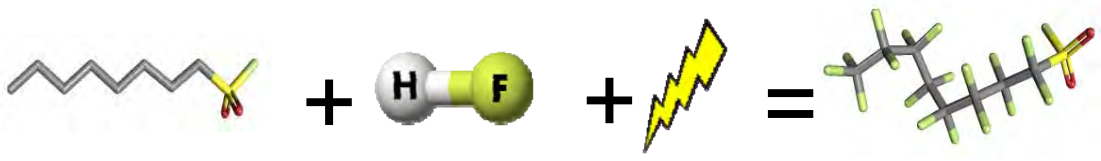




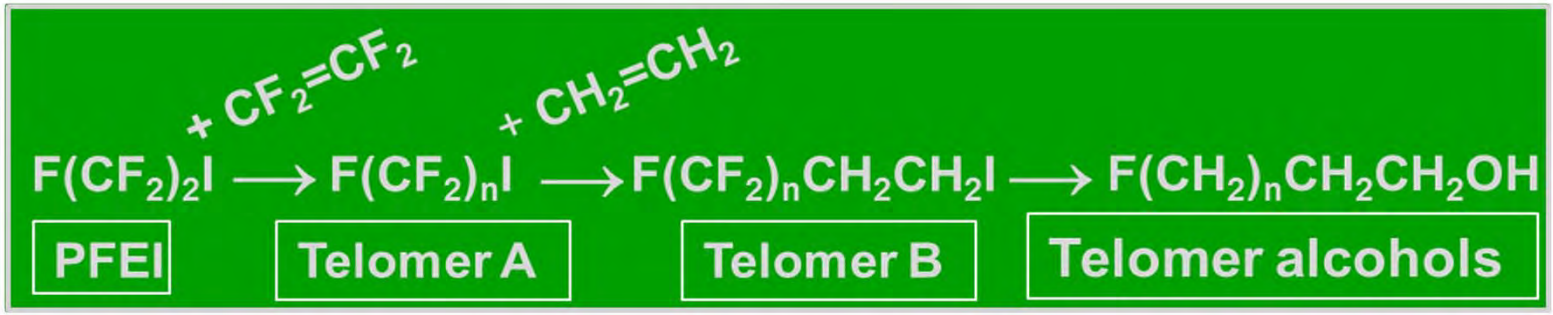
eurofins | Environment Testing TestAmerica

PFAS Formation

ECF Reaction = B&L & Unintended Byproducts



Telomer Reaction: Unintended Byproducts & Precursors



eurofins | Environment Testing TestAmerica

Where do they come from?

Raw Materials
Industrial Chemicals

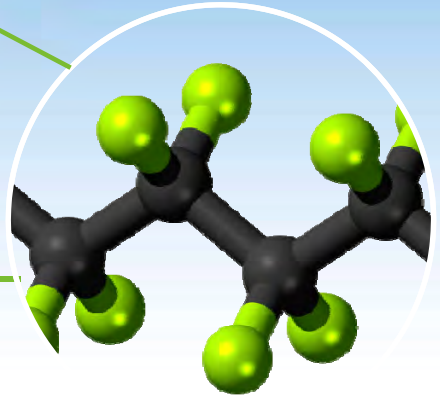
Fire Training
Emergency Response

Stain Resistant,
Water Repellant,
Non-Stick Products

Manufacturing

AFFF

Consumer Products

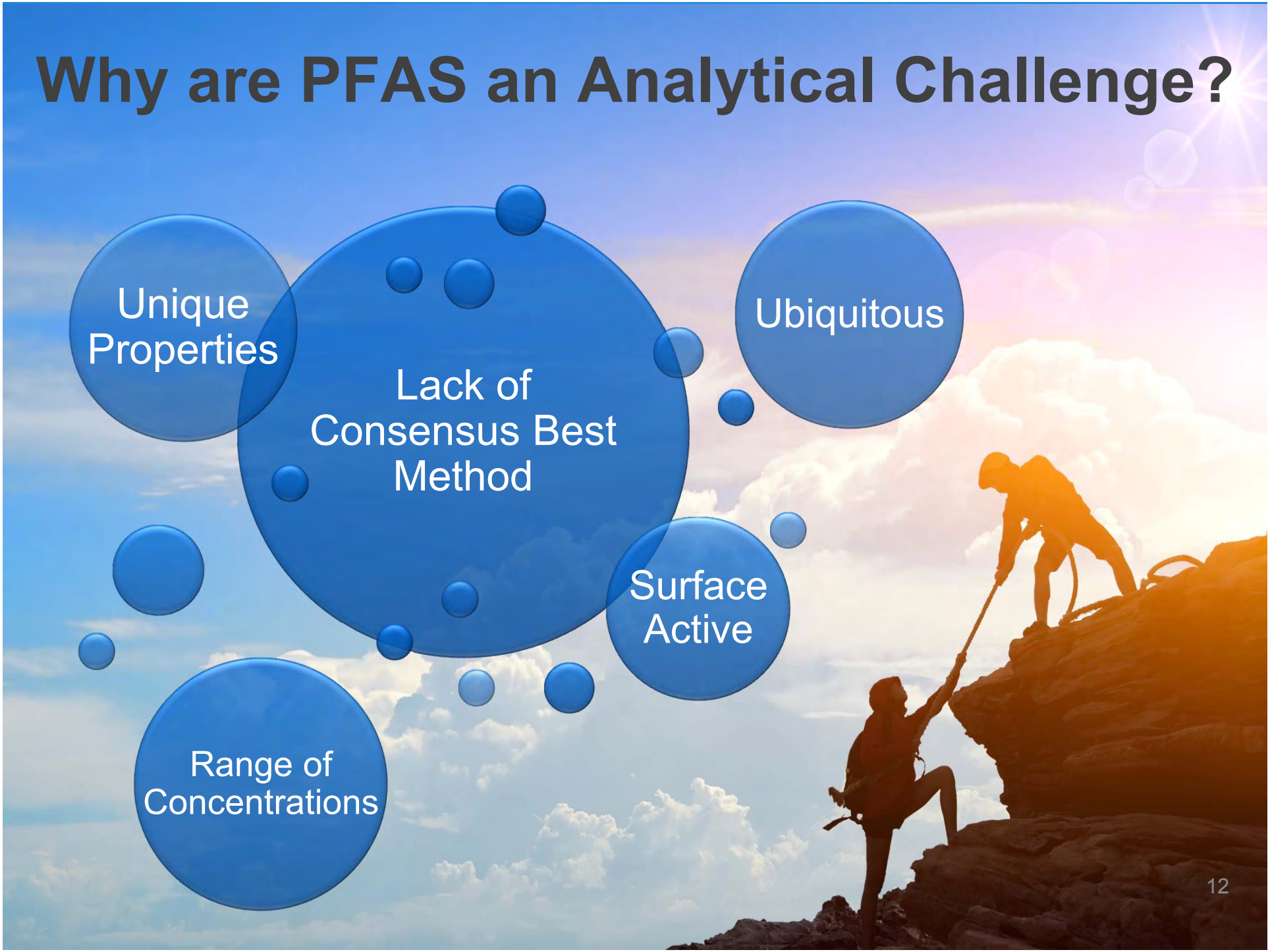


eurofins | Environment Testing TestAmerica

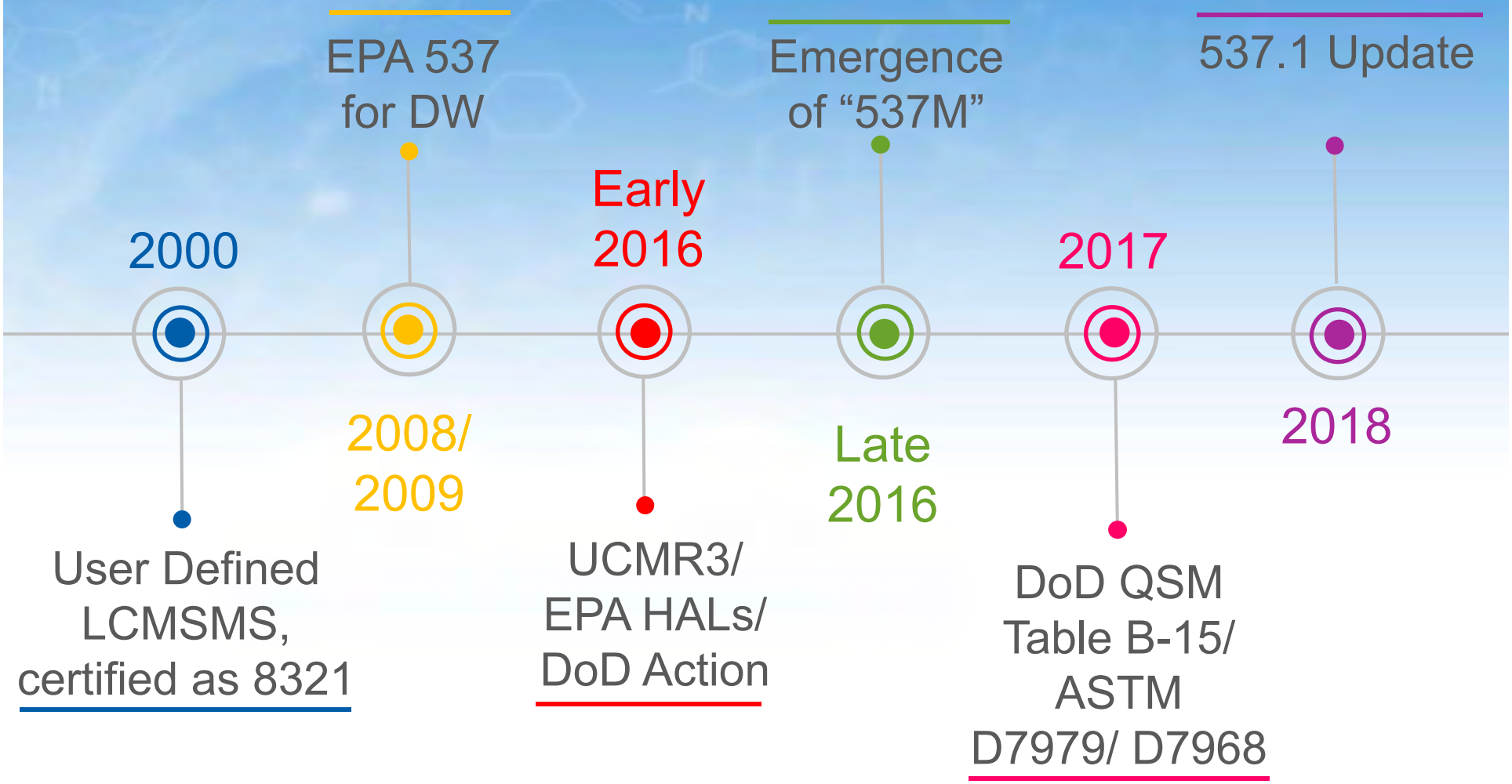
Replacement Chemicals

	Legacy Manufacturers		
Original Chemical	PFOA	PFOS	PFOS
Replacement Chemical	HFPO-DA "GenX"	DONA	F-53B

Why are PFAS an Analytical Challenge?



Methods Timeline – Past to Present



eurofins | Environment Testing TestAmerica

EPA Method 537.1
"A Drinking Water Method Only"

UPDATE TO 537 REV1.1

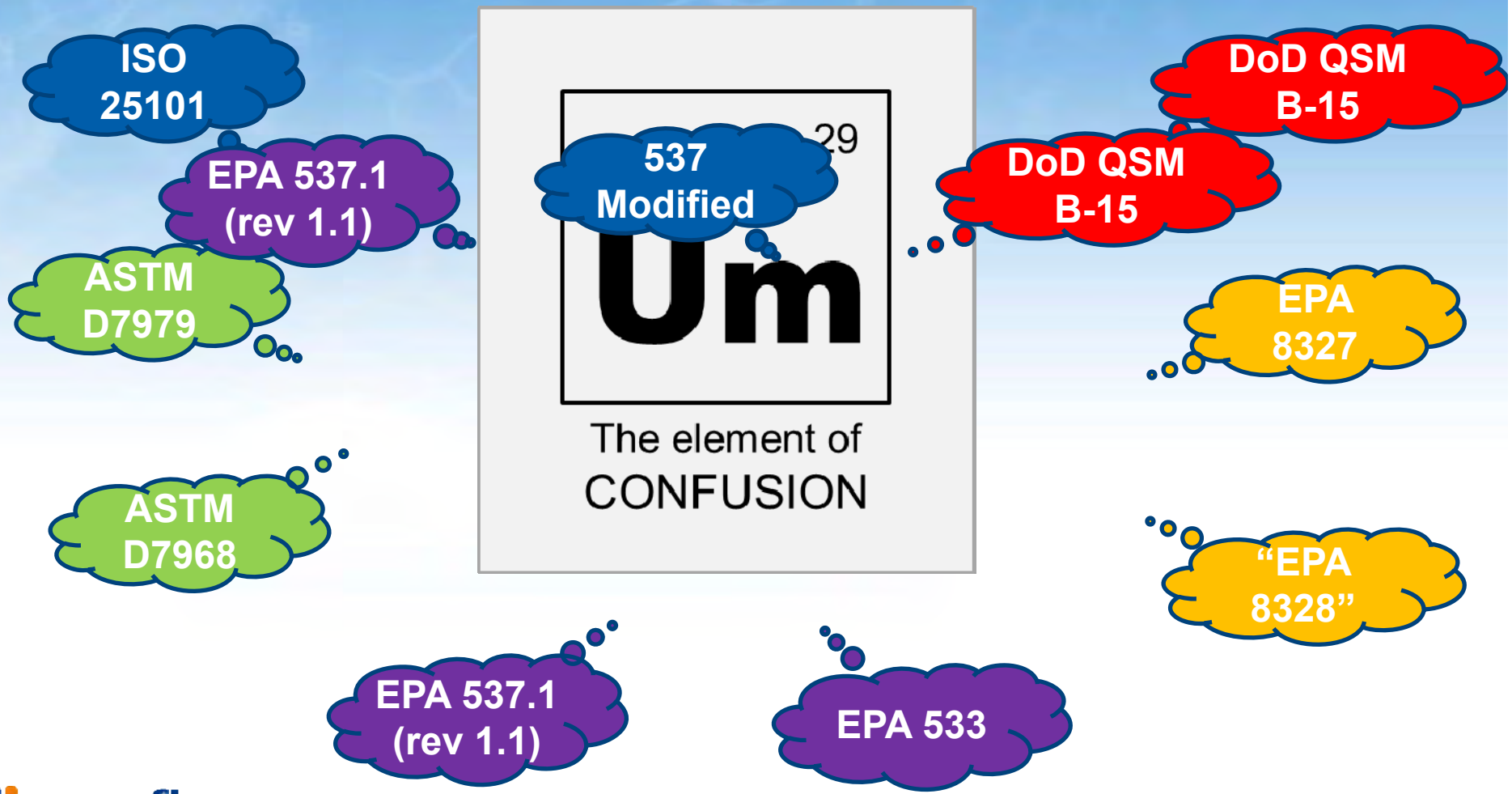
Features	Method 537.1
Matrices	Drinking Water
Analyte List	14 + 4 replacement chemicals
Sample size	250 mls
Holding times	14 days for extraction
Aqueous Extraction	SPE SDVB
Analysis	LCMSMS - no confirmation ion
Branched and Linear Isomers	Yes, for available standards
Quantitation	Internal standard
Reporting Limits	(2 ppt - 40 ppt)
Isotope Recovery Correction	No
LCS recovery limits	70-130

eurofins | Environment Testing TestAmerica

Groundwater, Soil, Tissue?

What method do we use for non-potable water & solid matrices?

537 "Modified"



eurofins | Environment Testing TestAmerica

Available vs. Future

7979
- Non-potable Aqueous
- No SPE, Direct Inject, External Standard

8327
- SW-846 Draft Method for Non-potable Aqueous
- No SPE, Direct Inject, External Standard
- *Public Comment Period Closed Aug 23, 2019*

537M
- User Defined Method, All Matrices
- SPE, Isotope Dilution, Comparable to DoD QSM Table B-15

"8328"
- EPA Draft Method, All Matrices other than DW
- SPE, Isotope Dilution, Comparable to DoD QSM Table B-15
- *Unknown, perhaps 2020*

537.1
- EPA Published Method, Drinking Water Only
- SPE, Internal Standard

533
- EPA Draft Method, Drinking Water, possibly non-potable
- SPE, Isotope Dilution and/or Internal Standard, TBD
- *Undergoing 3rd Party Validation NOW*

eurofins | Environment Testing TestAmerica

Analyte Description
Perfluorobutanoic acid (PFBA)
Perfluoropentanoic acid (PFPeA)
Perfluorohexanoic acid (PFHxA)
Perfluoroheptanoic acid (PFHpA)
Perfluorooctanoic acid (PFOA)
Perfluorononanoic acid (PFNA)
Perfluorodecanoic acid (PFDA)
Perfluoroundecanoic acid (PFUnA)
Perfluorododecanoic acid (PFDoA)
Perfluorotridecanoic Acid (PFTriA)
Perfluorotetradecanoic acid (PFTeA)
Perfluorobutanesulfonic acid (PFBS)
Perfluorohexanesulfonic acid (PFHxS)
Perfluoroheptanesulfonic Acid (PFHpS)
Perfluorooctanesulfonic acid (PFOS)
Perfluorodecanesulfonic acid (PFDS)
Perfluorooctane Sulfonamide (FOSA)
N-methyl perfluorooctane sulfonamidoacetic acid (NMeFOSAA)
N-ethyl perfluorooctane sulfonamidoacetic acid (NEtFOSAA)
Perfluoro-1-pentanesulfonate (PFPeS)
Perfluoro-1-nonanesulfonate (PFNS)
6:2FTS
8:2FTS
4:2FTS
DONA
HFPO-DA (GenX)
F-53B Major
F-53B Minor

NPW & Solids

EPA Draft
Target Analyte List

Replacement
Chemicals

Questions