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consultants

# Per- & polyfluoroalkyl substances (PFAS)

James Rayner & Adrian Nordone  
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# OUTLINE

What are PFAS?

Where do PFAS come from?

Are PFAS harmful?

PFAS remediation

PFAS product regulation

Considerations for liability insurance

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## What are PFAS?

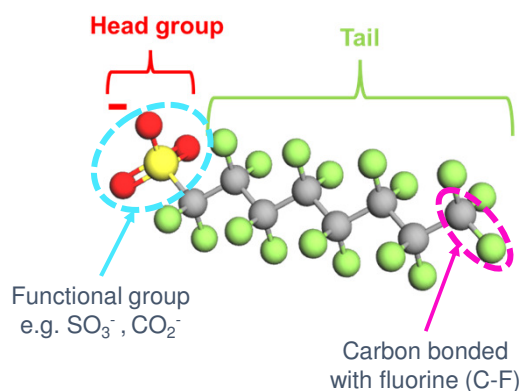
**Per- & poly Fluoro Alkyl  
Substances\***

12,000+ synthetic organic  
chemicals containing C-F

4,700 PFAS registered with  
CAS

\*Polyfluorinated compounds (PFC) no longer used

PFAS Molecular Structures



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# PFAS characteristics

### Persistence

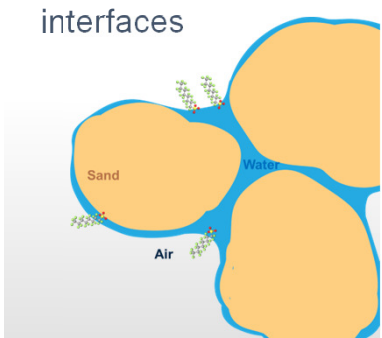
- No biodegradation
- “Forever chemicals”

### Mobility

- Very soluble in water

### Surfactant

- Accumulate on surfaces & at interfaces



### Toxicity

- Health effects identified
- Regulated low dose health effects

### Bioaccumulation

- Accumulate in tissues
- Biomagnification through food chain

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# Types of PFAS

## Non-polymer

### Perfluorinated

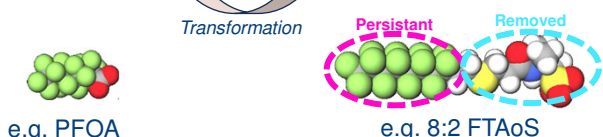
- Perfluoroalkyl Acids (PFAAs)
- Perfluoro carboxylic acids (PFCAs)
- Perfluoro sulfonic acids (PFSAs)
- Perfluoroalkane sulfonamides

### Polyfluorinated

- Fluorotelomers
- Sulfonates (FTSAs)
- Carboxylates (FTCAs)
- Alcohols (FTOHs)
- Polyfluoroalkane sulfanido ethanols
- Polyfluoroalkane sulfanido acetic acids

“Terminal PFAS” “Precursors”

Transformation



e.g. PFOA e.g. 8:2 FTAoS

## Polymer

Fluoro-polymers

Perfluoro propyl ethers (PFPE)

Side-chain fluoro polymers

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## PFAS nomenclature

**PFAS is not PFOS, PFOS is not PFOA**

Prefix	No. carbons	Functional Group	Acronym	Name
PF = perfluoro	O = octa (8 carbons)	A = carboxylate OR carboxylic acid	PFOA	Perfluorooctanoic acid OR <b>Perfluorooctanoate</b>
PF = perfluoro	O = octa (8 carbons)	S = sulfonate or sulfonic acid	PFOS	Perfluorooctane sulfonic acid OR <b>Perfluorooctane sulfonate</b>

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## PFAS nomenclature

**PFOA is not PFBA, PFOS is not PFBS**

Prefix	No. carbons	Functional Group	Acronym	Name
PF = perfluoro	O = octa (8 carbons)	A = carboxylate OR carboxylic acid	PFOA	Perfluorooctanoic acid OR <b>Perfluorooctanoate</b>
PF = perfluoro	O = octa (8 carbons)	S = sulfonate or sulfonic acid	PFOS	Perfluorooctane sulfonic acid OR <b>Perfluorooctane sulfonate</b>
PF = perfluoro	B = buta (4 carbons)	A = carboxylate OR carboxylic acid	PFBA	Perfluorobutanoic acid OR <b>Perfluorobutanoate</b>
PF = perfluoro	B = buta (4 carbons)	S = sulfonate or sulfonic acid	PFBS	Perfluorobutane sulfonic acid OR <b>Perfluorobutane sulfonate</b>

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# PFAS nomenclature

**“Short chain”**

- More mobile
- Less toxic
- Less bioaccumulation
- Currently unregulated

e.g.  
PFBS (C4), PFPeS (C5)  
PFBA (C4), PFPeA (C5), PFHxA (C6), PFHpA (C7)

**“Long chain”**

- Less mobile
- More toxic
- More bioaccumulation
- Regulated

e.g.  
PFHxS (C6), PFHpS (C7), PFOS (C8), PFNS (C9), PFDS (C10)  
PFOA (C8), PFNA (C9), PFDA (C10)

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# PFAS uses

**...not just for fire fighting...**

*Unique physical and chemical properties allow for widespread commercial and industrial applications... and leads to widespread environmental occurrence*

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**FLUOROTECHNOLOGY MAKES IMPORTANT PRODUCTS FOR VITAL INDUSTRIES POSSIBLE**  
FluoroCouncil member companies voluntarily committed to a global phase-out of long-chain fluorocemistries by the end of 2015, resulting in the transition to alternatives, such as short-chain fluorocemistries that offer the same high-performance benefits, but with improved environmental and health profiles.

- ELECTRONICS**: Improves insulation, weatherability, transparency and static resistance. Provides smooth and smudge-resistant touch screens.
- FIRST RESPONDERS**: Offers life-saving protection in safety gear and firefighting foams used to fight flammable liquid fires.
- AUTOMOTIVE**: Provides every automotive system with durability, heat and chemical resistance and vapor barriers. Increases reliability of engine compartment wiring and gauges and improves auto safety by reducing engine compartment fires. Protects carpets and seats against stains, soil, oil and water.
- OIL AND GAS**: Provides reliable equipment to help improve the safety and affordability of oil field and pipeline operations. Improves the reliability and safety of fuel system seals and hoses, O-rings and downhole, and field equipment gaskets.
- MILITARY**: Enables apparel and equipment to provide high-barrier skin protection in extreme environments and against chemical warfare agents.
- CHEMICAL/ PHARMACEUTICAL MANUFACTURING**: Provides sterile, corrosion-resistant coatings, linings and equipment.
- HEALTHCARE**: Serves as high dielectric insulators in medical equipment that relies on high frequency signals, like defibrillators, pacemakers and MRI, PET and MRI imaging devices. Used to treat medical garments, drapes and dexter curtains to protect against the transmission of diseases and infections.
- OUTDOOR APPAREL/ EQUIPMENT**: Creates tearable membranes and long-lasting finishes that provide water repellency, oil repellency, stain resistance and soil release with abrasion-resistant finishes for apparel and equipment.
- SEMICONDUCTORS**: Enables the ultra-pure manufacturing environments necessary for micro-electronics. Used for plasma machinery, etching materials, cleaning fluids and wetting surfactants for chemical etching.
- ALTERNATIVE ENERGY**: Enables lithium batteries, fuel cells and solar panels, which contribute to reduced emissions and energy costs.
- AEROSPACE/ DEFENSE**: Enables chemical-resistant tubes, hoses and fluid seals; high and low temperature brake and hydraulic fluids used in aircraft control systems and brakes; and ultra-high frequency wire and cable insulation necessary for navigation, fly-by-wire control and aircraft communications.
- BUILDING CONSTRUCTION**: Enhances durability, UV resistance and anti-corrosive properties to lengthen the lifetime of infrastructure, facades and surfaces.

FluoroTechnology is the use of fluorine chemistry to create any fluorinated product. When fluorine and carbon atoms join together, they create a powerful chemical bond. The use and manipulation of this bond gives FluoroTechnology its distinct properties of strength, durability, heat-resistance and stability. These properties are critical to the reliable and safe function of myriad products that industry and consumer rely on every day.

FluoroCouncil  
For FluoroTechnology  
www.FluoroCouncil.org

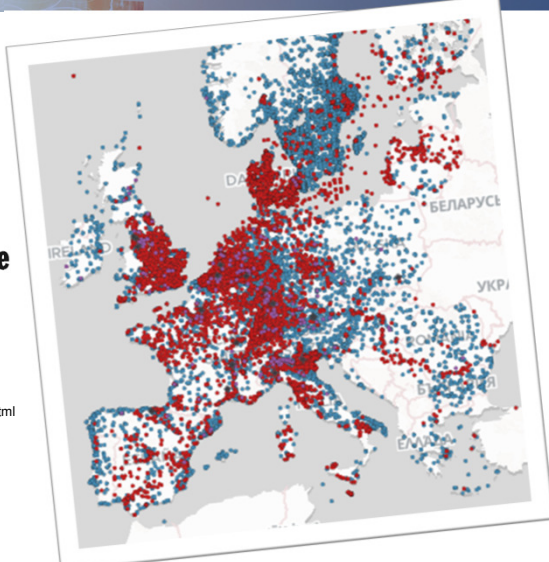
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# PFAS are everywhere

**'Forever pollution': Explore the map of Europe's PFAS contamination**

[https://www.lemonde.fr/en/les-decodeurs/article/2023/02/23/forever-pollution-explore-the-map-of-europe-s-pfas-contamination\\_6016905\\_8.html](https://www.lemonde.fr/en/les-decodeurs/article/2023/02/23/forever-pollution-explore-the-map-of-europe-s-pfas-contamination_6016905_8.html)



PFAS Users

Known PFAS contamination

Potentially Contaminative Land Use

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# It's raining PFAS

**Rainwater everywhere on Earth unsafe to drink due to 'forever chemicals', study finds**





**New Antarctic Study Shows Levels of "Forever Chemicals" are Increasing**

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# Potential exposure to PFAS

**Complex linkages**

**Primary & secondary sources**

- Industry
- Incidents
- Utilities

**Multiple pathways**

- Soil
- Water
- Air/dust
- Food
- Products

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# Are PFAS in environment harmful?

**THE DEVIL WE KNOW**  
A PERFECT FILM. RIVETING, POWERFUL AND IMPORTANT!  
DARK WATERS  
ONE OF THE DANGEROUS COVER-UPS IN AMERICAN HISTORY

Amara Strande PFAS Legislation

Nordic Council of Ministers  
**THE COST OF INACTION**  
A socioeconomic analysis of environmental and health impacts linked to exposure to PFAS

- Widespread PFOA wastewater pollution, West Virginia & Ohio
- Increased cancers and other health problems
- 3,000+ lawsuits settled for \$700m

- PFAS polluted water resources affecting 170,000 residents in Minnesota
- Cancer and health problems linked to PFAS exposure
- \$850m settlement

- Affecting thyroid gland, liver, fat metabolism & immune system
- Annual health-based costs to all EEA countries €52-84bn if PFAS not treated

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# PFAS environmental remediation

## Remediation Challenge

- Complex mixtures
- Scale
- Stringent objectives (ng/L)

## Available Technologies

### Ex-situ

- Incineration
- Disposal

### In-situ

- Containment
- Non-destructive

### Future

- In situ, destructive
- Treatment trains
- Demonstrating performance

## Treatment Costs

### By EEA country\*

- €10-20bn per year environmental cleanup
- Water treatment works €100-200m
- Airports €1-10m

### Potential cost savings

- On-Site £1-2m CAPEX
- OMM <10% current cost for off-Site incineration



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GLOBAL PRODUCT STEWARDSHIP  
 CHALLENGES - PFAS PRODUCT  
 REGULATIONS AND CASE STUDIES

## PFAS. Why All The Fuss? – They're Everywhere!

**PFAS are ubiquitous in commerce, our homes, and the environment**  
**Consumer Products and Industry - Oil/water repellency, heat/friction**  
**Textile, carpet, paper, food, AFFF ...**  
**General Population – Bloodstream**

- Aerospace
- Alternative energy
- Automotive
- Chemical manufacturing
- Electronics
  - Fluid resistant clothing
  - Implants, patches and grafts
  - Low friction coatings
- Photolithography
- Performance chemicals
  - Building and construction – weather resistant coatings
  - Hydraulic fluids
  - Fuels
  - Industrial surfactants
- Oil and gas – enhanced recovery
- Metal plating and etching
- Paints, varnishes, sealants, waxes and polishes
- Plastics
  - Polymer manufacturing, Resins
- Semiconductors
- Wire manufacturing and coating



## World Famous Scientist Speaks Out



In between being a Hollywood A lister and following years of research and multiple publications in peer-reviewed medical journals, Mark Ruffalo comes to an inciteful conclusion regarding the dangers of PFAS...

*'There's nothing you can do without coming into contact with it. It's intense, man. It's huge.'*

Me being facetious aside, PFAS have gained a massive amount of negative attention and when Hollywood stars get in on the act – you know you've got problems.

# Human Health Implications of PFAS Exposure

- Liver effects
- Immunological effects (decreased vaccination response and efficacy, asthma)
- Developmental effects (lowered birth weight)
- Endocrine effects (thyroid disease)
- Reproductive effects (decreased fertility)
- Cardiovascular effects (pregnancy-induced hypertension)
- Cancer (testicular, kidney)



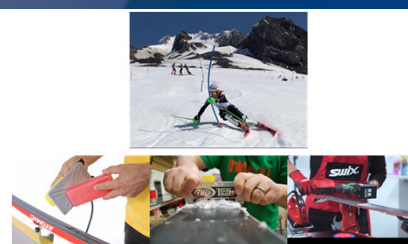
Overall, human studies (epidemiology) are not convincing but combined with animal data, there is definitely cause for concern

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# Who is Being Exposed?

## Ubiquitous – Blood Serum Levels

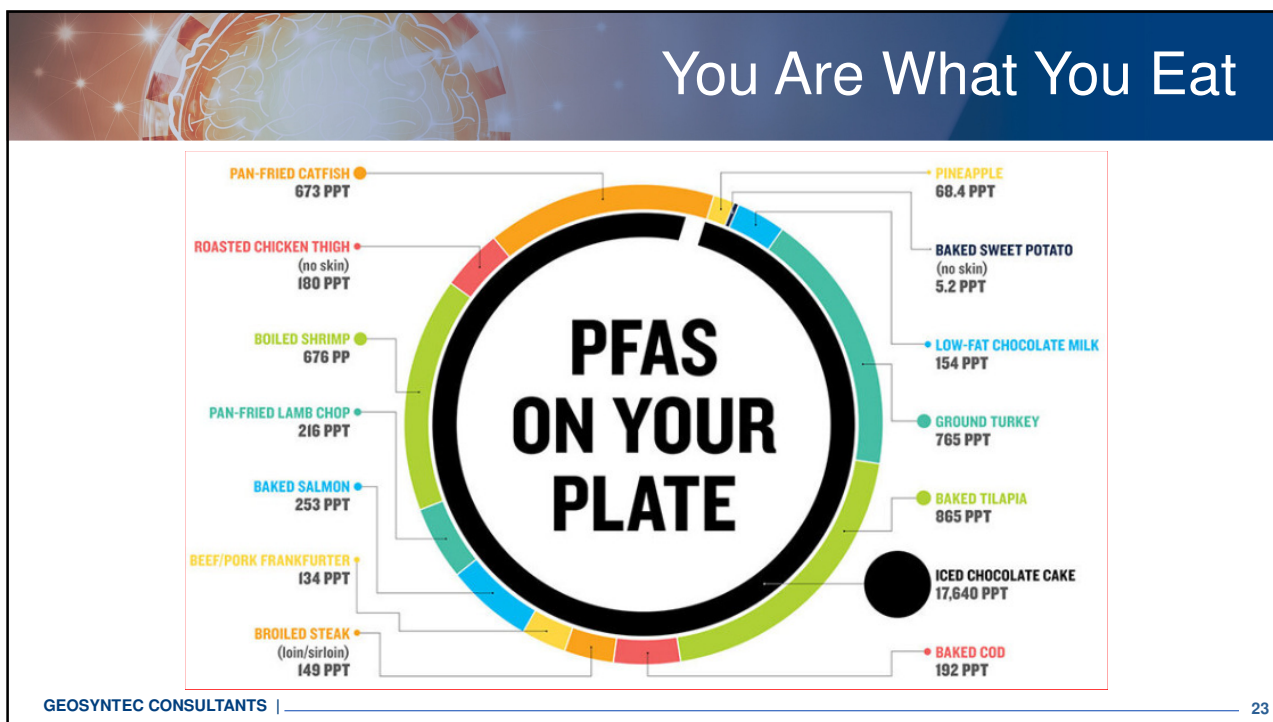
- **Industrial Workers** – PFAS production and manufacturing, operations such as application of protective coating
- **Firefighters** – inhalation related to firefighting foam
- **General Public** – food and drinking water – **97% have measurable levels**
- **Ski Technicians** – 1000x that of the general public



Not all doom and gloom –  
blood concentrations are falling

	PFOA (Avg Blood Level, ug/L)		PFOA (Avg Blood Level, ug/L)	
	1998-2000	2017-2018	1998-2000	2017-2018
Manufacturing Workers (Decatur, AL)	899	???	941	???
US Gen. Pop.	5.2	1.4	30.4	4.3
		~75% Reduction		~85% Reduction

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## Health Effects Uncertainty = Regulatory Reaction

March 14, 2023 – USEPA announced the proposed **National Primary Drinking Water Regulation (NPDWR)** for six PFAS. The proposed Maximum Contaminant Levels (MCLs) are **4 parts per trillion (ppt) for PFOA and PFOS**

The European Food Safety Authority has set a new *safety threshold* for the main perfluoroalkyl substances, or PFAS, that accumulate in the body. The threshold – a group *tolerable weekly intake (TWI)* of 4.4 nanograms (ppt) per kilogram of body weight per week – is part of a *scientific opinion* on the risks to human health arising from the presence of these substances in food.

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4PPT is One Drop in 5  
Olympic Swimming Pools

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## Changing/Developing PFAS Regulations Will Result in Costs/Liabilities

Contaminated site clean up including inherited liabilities following M&A, investment in active site discharge control and fugitive releases, cost of replacing PFAS with other more acceptable (and more expensive?) products, cost of loss of performance once PFAS removed, personal injury and environmental damage litigation.....

Dupont Escrow Agreement Aggregate cap of \$4 billion in escrow contributions and expense payments – just the beginning?

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## Global Product Stewardship (GPS) – Managing PFAS Going Forward

- Product safety support
  - Is the product safe and sustainable as used for humans and the environment at all stages of product lifecycle from raw material sourcing, manufacturing to marketing/use and disposal?
- Global product regulatory compliance
  - Strategic and technical support to meet current and emerging regulatory compliance requirements wherever the product goes
  - PFAS regulations, bans, restrictions and reporting obligations are a critical global business issue

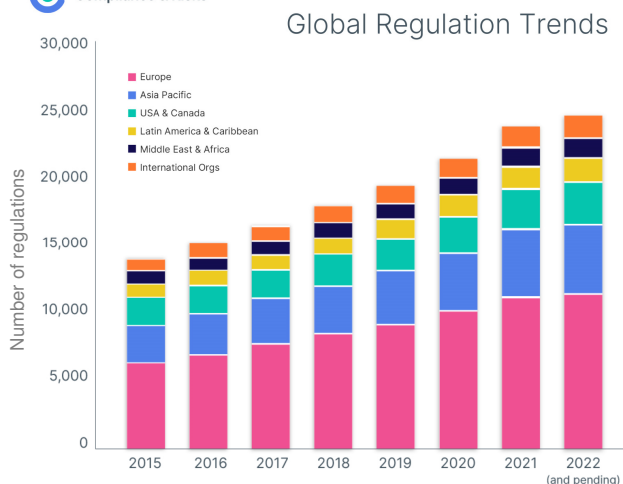
***Multinational corporations need high value global product stewardship support for their products and businesses***

## Global Product Stewardship (GPS) – Managing PFAS Going Forward

- Global product stewardship – a critical business function
  - Proliferating PFAS and PFAS-containing product regulations: a management of change challenge
  - Relevance and materiality of GPS in mergers and acquisitions (M&A) due diligence and post-merger support
- Geosyntec supports clients by analyzing the business significance of proliferating PFAS regulations, and forensic assessment of raw materials, products, and supply chain compliance and risks
- Global Regulatory Surveillance - we track regulations globally and advise MNCs on compliance – we also include PFAS obligations/vulnerabilities are part of GPS M&A DD.....Nobody likes surprises!

## A Global Management of Change Challenge for Everybody

 Compliance & Risks



- Global proliferation of chemical product regulations drives multinational corporation enterprise risks
- Europe (EU) is continually leading the way with proliferating chemical product regulations
- These pose significant risk to current business and also pose a material risk for many M&A deals globally

Source: Regulatory Trends in Household Appliances: a 12-18 Month Outlook - Compliance & Risks (complianceandrisk.com)

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## PFAS Regulations in the European Union

- 5 member states proposed a REACH Annex XVII restriction covering ~10,000 PFAS across a wide range of uses, over 5,600 comments submitted during 2023 public consultation. ECHA and member states are now evaluating ... Possible entry into Force 2024/2025 could disrupt many businesses!
- Different definitions of PFAS internationally, but a lot of overlap between US and EU PFAS Lists



**Insights gained from current TSCA 8(a)(7) driven PFAS diligence in US can give companies a head start in mitigating business risks from the upcoming PFAS restrictions in Europe!**


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## PFAS Regulations in the United States

- US EPA has been working towards increased PFAS federal regulations; however, multiple states are enacting laws that will restrict or ban PFAS compounds in finished products



 **Oregon**  
 **Rhode Island**  
 **Maine**  
 **California**

 **Washington**  
 **Minnesota**  
 **Nevada**

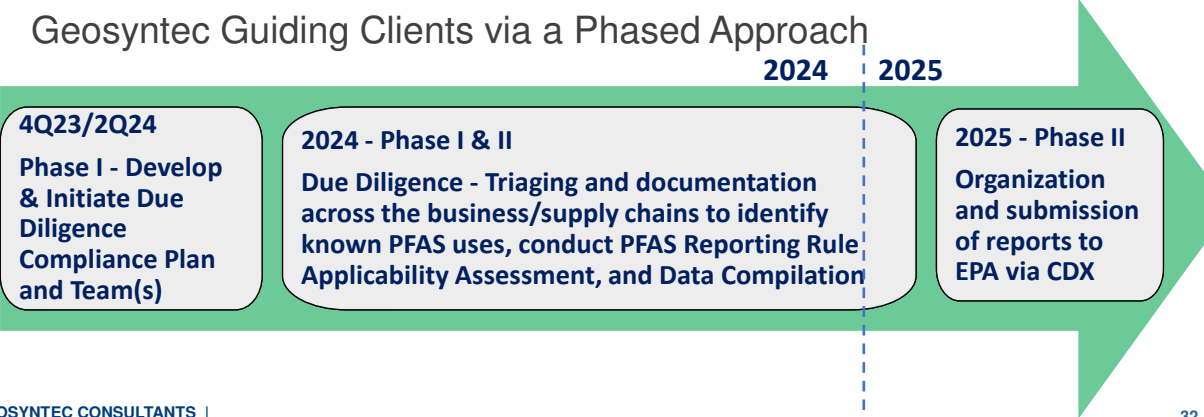
- These laws will regulate PFAS in separate ways, have varying definitions, limits, exemptions, timelines, reporting and record keeping obligations

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## PFAS Regulations in the United States

- New TSCA 8(a)(7) PFAS reporting and recordkeeping requirements
  - Requires manufacturers or importers of PFAS products to submit information to EPA for each year since January 1, 2011
- Geosyntec Guiding Clients via a Phased Approach



**4Q23/2Q24**  
Phase I - Develop & Initiate Due Diligence Compliance Plan and Team(s)

**2024 - Phase I & II**  
Due Diligence - Triaging and documentation across the business/supply chains to identify known PFAS uses, conduct PFAS Reporting Rule Applicability Assessment, and Data Compilation

**2025 - Phase II**  
Organization and submission of reports to EPA via CDX

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## Case Study: TSCA PFAS REPORTING RULE

### Article Importers

- 1) **Determine whether you are an article importer**
- 2) **Determine what articles are imported**
  - Volume of articles imported (by quantity or weight)
- 3) **Determine whether the articles have PFAS**
  - Packaging is included in evaluation
- 4) **Determine the industrial and consumer/commercial processes and uses of applicable articles**
  - Product and function categories
- 5) **Do your industrial processes create PFAS byproducts**
- 6) **Fill out information through the CDX system and file with EPA**

### Manufacturers/Importers of PFAS

- 1) **Determine if you are a manufacturer or importer of PFAS**
- 2) **Determine how much PFAS is manufactured or imported**
- 3) **Determine the industrial and consumer/commercial processes and use**
- 4) **Determine byproducts produced**
- 5) **Determine whether there is any environmental or health information**
  - a) Not limited to the 10-year lookback period
- 6) **Determine reasonably likely worker exposure**
- 7) **Determine disposal process for PFAS**
- 8) **Fill out information through the CDX system and file with EPA**

## PFAS liability takeaways

Effective liability management involves environmental clean-up & ongoing PFAS product stewardship to control future use of these products

- PFAS and PFOS are not the same thing. PFAS is a class of 12,000+ compounds, with varying characteristics. Does the policy specifically cover the PFASs of potential concern?
- Does the organization have a robust product stewardship programme that covers the whole of their supply chain from raw material supply to product disposal?
- Does the organization include both site contamination and supply chain product stewardship during M&A due diligence?
- Can the organization demonstrate that it is compliant with current PFAS legislation and has management of change processes in place to comply with developing legislation?

Thank you for your attention



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