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Exploring the Increasing Environmental Risk of PFAS

Throughout my forty plus year career in the environmental testing industry, we have witnessed the occurrence of several historical environmental disasters, such as the Love Canal, Times Beach, Deepwater Horizon, and most recently, Flint, Michigan. However, these infamous events have a pattern, in that it is quite possible that another unfortunate incident is currently in progress.

The phrase "Slow Motion Train Wreck" is an apt description of this phenomenon, as it conveys the slow, inexorable unfolding of tragic consequences that is characteristic of these high profile environmental disasters.

These "Environmental Train Wreck" events generally unfold in this sequential manner:

- First, a potential problem or a generalized environmental threat is identified, but there is muted concern because there is insufficient data to determine the breadth and depth of the potential problem, or even to be sure that there really is a problem.
- Then the "drilling down" process begins. Specific contaminated sites begin to be identified, the specific nature of the contaminants become better characterized and the scope of the problem begins to metastasize.
- As the outline of a potential disaster becomes more evident, graphic stories begin to emerge that personalize the tragedy in terms of individual health impacts, economic harm or environmental damage.
- Eventually, as the national media pick up the story, the tragedy now becomes

both visual and visceral; oil soaked birds, abandoned towns, sickened children, etc.

- Finally, after widespread scientific investigation, testing and analysis, the complete scope of the tragedy is fully quantified and remediation begins.

And, in the aftermath—with perfect hindsight—an underlying truth again becomes obvious: “we should have seen this one coming.”

The newest potential “Train Wreck” that could be happening is not associated with a specific contaminated site, but rather with a class of chemical compounds referred to as per- and polyfluorinated alkyl substances, generally referred to as PFAS.

How does PFAS fit this Pattern?

If you have been following the polyfluorinated alkyl substances story over the past three years or so, you might have seen the emergence of the same depressing pattern.

It started with the recognition that the same chemical properties that have made PFAS so useful in commerce have also positioned these substances to be uniquely harmful environmental contaminants. PFAS features a combination of hydrophilic and hydrophobic properties in the same molecule and are highly resistant to thermal and chemical degradation.

These properties make PFAS highly useful components of water and oil resistant paper, fabrics and leather, for making non-stick cooking pans, and for the production of highly effective firefighting foams. Since PFAS possesses such useful properties, their manufactured and commercial use has become widespread.

Consequently, over many years in commerce, this widespread use also guaranteed the widespread environmental release and dispersion of PFAS. Ironically, the very same chemistry that made PFAS so useful has also made the substance extremely persistent in the environment. It is highly bioaccumulative and can also function as endocrine disruptors to subtly affect biological processes.

Recognition slowly dawned that this combination of extensive use and dangerous properties had created a high potential for human exposure and potential health consequences. PFAS made its way on to the “radar screen” of environmental concern and monitoring. At first, monitoring was limited and targeted on drinking water, but as evidence of adverse environmental impacts accumulated, it became much more widespread and sophisticated. Now, with the development of advanced LC-MS/MS analytical methods, entire scientific symposia are devoted to the subject.

Current Status of PFAS

Polyfluorinated alkyl substances has now spread at trace levels over the entire globe. Widespread testing has also shown the trace-level presence of PFAS in the blood of humans and animals worldwide, with markedly higher levels in people having close proximity to heavily contaminated sites (airport firefighters, industrial workers, etc.).

These growing exposure-accumulation revelations have heightened the concern about potential human health effects. Although PFAS are not acutely toxic, animal exposure studies have enhanced the concern about subtle interference with sensitive biological processes.

And finally, although no specific human health impacts have been quantified, PFAS are now believed to pose a long term chronic exposure risk, particularly to sensitive populations (e.g., infants). Based upon these concerns, in 2016 the USEPA issued a Health Effect Advisory for PFASs in drinking water at the level of 70 ppt.

This past year we began to see the emergence of reports of alleged human health impacts. These early reports—although largely anecdotal and not well documented—eerily fit the “Train Wreck” pattern and potentially represent the proverbial “tip of the iceberg” of an emerging environmental disaster.

In Belmont, Michigan, where PFAS was used in the manufacturing of waterproof leather for boots and other outdoor gear, there are signs of local groundwater and environs PFAS contamination. Some groundwater samples have shown PFAS levels as high as 490,000 ppt. Lower levels of contamination—but still above the EPA’s 70 ppt Health Advisory level—were found in 78 wells. Lawsuits have been filed which allege 3 deaths tied to drinking water with elevated PFAS levels.

Similar reports are bound to emerge as we consider the large numbers of airports and air bases where PFAS-based fire suppression foams have been used for decades, both in training exercises and in actual deployment. And these don’t even begin to include the widespread, low-level consumer exposure to PFAS containing fabrics and packaging.

So, What Now?

So, what is to be done? Clearly, much more monitoring, testing, and data collection will be required. Essential to this effort is the urgent development of new, modern analytical methods with better resolution and accuracy. Equally important is the development of more rapid, high throughput methods to accelerate the acquisition of data. Therefore, it is noteworthy that the upcoming Environmental Monitoring Conference in New Orleans, LA (August 6-9, 2018) will devote a full-day symposium to the subject of PFAS: "Characterization of Polyfluoroalkyl Substances in the Environment".

Here are some other examples of recent analytical method developments for polyfluorinated alkyl substances:

- A rapid testing protocol based upon on-line SPE coupled with LC-MS/MS to speed the analysis of water samples. This advanced method will allow more rapid environmental characterization.
- An LC-MS/MS method for the characterization of PFAS in soil and sediment. This work is needed because solid media can serve as repositories for PFAS and become a secondary contamination source from which PFAS can migrate and cause further human exposure
- A recent LC-MS/MS method combined with SPE and QuEChERS sample preparation for measuring trace levels of PFAS in milk and cheese.

So, if there is a bright spot to the PFAS challenge, it lies in the fact that LC-MS/MS technology has come of age and is being widely applied to the environmental testing and monitoring challenge.

However, the last paper cited above is a stark reminder that PFAS is not only a persistent environmental pollutant and a threat to the drinking water supply, but it is also a potential threat to the food supply.

Dairy cattle might consume contaminated water or be exposed to feed grown in contaminated soil. This creates the potential for PFAS to pass into milk and other dairy products like cheese and butter. This pathway could potentially create an additional source of PFAS input to humans. Therefore, to assess these risks, accurate analytical methods are also required to test food products.

In recent years the manufacturing of PFAS has been curtailed in the United States and Europe and many objectionable uses of PFAS have been discontinued. Therefore, the addition of new sources of PFAS to the environment has clearly peaked. This is a very positive step, but by no means can we assume that the crisis is over.

Unfortunately, the train has already left the station and the “train wreck” will continue as PFAS migrates further into the environment and human exposure opportunities expand. Certainly, the rapid growth and deployment of PFAS environmental analytical methodology just discussed will eventually give us a comprehensive picture of the scope of the PFAS problem.

However, we can already be quite confident that further characterization will confirm what is already intuitively obvious: an environmental train wreck has indeed occurred and there will be a very high price to pay. We must continue our PFAS investigations, but perhaps a more critical question looms before us: what might the next potential environmental disaster be and what can we do now to head it off?

The knowledge that environmental train wrecks are still possible, grants us the ability to avoid them—if we start early and act with foresight.

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Summary

Article Name

PFAS: Another Slow-Motion Environmental Train Wreck?

Description

To stop environmental disasters from occurring, we must look at the patterns. Dave Kennedy, PhD., intends to do with the increasing risk of PFAS.

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