

## **Surface Introduced Contaminants and their effects on Soil and Ground Water**

In my quarter of a century of experience as a practicing geologist and hydrogeologist, I have been involved in the investigation and remediation (clean-up) of many surface and subsurface releases of noxious, toxic and materials considered hazardous when found in uncontrolled environments. For the purpose of this informational paper, I will focus on materials that are used every day, but when released into the environment can and do create a negative environmental impact. The case in point is fuel grade petroleum hydrocarbons, better known as gasoline, diesel and motor oil.

We often think that a few small spills of fuel on the ground cause no harm; after all, we spray pesticides/herbicides all the time. However, when properly applied, the latter have a designed lifetime and breakdown within days. Fuel doesn't. Even when a little fuel is spilled on a porous surface it begins migrating downward. Granted, a few drops do not go far, but soils (porous material) retain many of the chemicals found in fuel. I have sampled and had tested soils from sites that have been abandoned for years and have found concentrations of fuel above the action limit of 100 mg/kg (ppm) (1).

Normally a few drops of fuel do not warrant concern, however, the cumulative effect of many drops DO warrant concern – a very real concern. The negative impact of Surface Introduced Contaminants (SICs) can be devastating, not only to the overlying soils but also to the underlying ground water. The majority of the world obtains their potable water from ground water. Once this water has been impacted by fuel, it is no longer potable. The majority of the residents in this and surrounding counties obtain their water from shallow water wells. Often called bored or surface wells, these wells are at the greatest risk from surface contamination and its impact. The following cases are just a few of the many I have investigated and worked with (2).

PC# 06-4348 – Small leak in a fuel line - leak repaired shortly after discovery. Result: ground water contaminated with several inches of free fuel on the surface of the water well.

PC#04-4426 – Small leak in a fuel line – leak repaired after many gallons had slowly leaked out. Result: over a foot of oil in the shallow water well.

PC#04-4605 – fuel tank spilled. Result: ground water impacted with dissolved phase fuel.

PC# 05-4140 – Small line leak. Ground water impacted with recoverable oil and water well impacted with free oil.

PC# 01-4884 – Small line leak. Ground water impacted with recoverable oil in water well.

All the above sites are the result of the cumulative negative impact of just drops of fuel onto the soil surface. Now think about many motorcycles that might be fueled, with spills happening, wrecks with fuel and motor oil spilt, not to mention the leaking oil pans, all on soil. Each individual incident may be minor, but the cumulative effect can very well poison our most precious resource – ground water. We can survive without many things, but try to live without water.

Some people may believe that the soils have to be sandy in order for fuel to move down and into the ground water and that a clay or marl will stop any vertical movement. Not so. Clays are great for a pond liner, as water and clay can make a relatively impervious barrier. However, petroleum fuels desiccate most clays and with the desiccation, the clay cracks (micro fissures) allowing for relatively easy movement, downward and into ground water.

How does fuel contaminate ground water after all it floats? Yes fuel has a lighter specific gravity than water and it does float, but some of it also dissolves in water. For example, methyl tert butyl ether (MTBE), which is being used in our reformulated gasoline, has a solubility factor of almost 40% (3). Basically that means that if you pour MTBE into water, about 60% will float, the rest is dissolved. There are of course many variables associated with the previous statement, but I hope that the concept is understood.

I have collected thousands of ground water samples across the Commonwealth of Virginia and when fuel grade Petroleum Hydrocarbons are the intent of my investigation here is the minimum I have the water tested for:

Total Petroleum Hydrocarbons in the Gasoline Range (TPH-GRO)

Total Petroleum Hydrocarbons in the Diesel Range (TPH-DRO)

Methyl Tert Butyl Ether (MTBE)

Benzene (B)

Toluene (T)

Ethyl Benzene (E)

Xylenes (X)

Naphthalene

TPH-GRO and TPH-DRO are the totals of all petroleum hydrocarbon analytes (compounds) found in the sample. These results are reported in mg/l or parts per million (ppm).

MTBE and BTEX are reported in ug/l or parts per billion (ppb), with Naphthalene reported in mg/l.

The following are the current Environmental Protection Agency's (EPA) maximum contaminant levels (MCL) for drinking water for each of the regulated compounds (4):

MTBE – currently proposed levels are between 20 and 40 ug/l (ppb)

Benzene – 0 ug/l

Toluene – 1 mg/l

Ethyl Benzene – 0.7 mg/l

Xylenes – 10 mg/l

The MCL's for drinking water in the Commonwealth of Virginia are 0 (zero), for all the above compounds, in all private water wells. It does not take much fuel to contaminate water, only a few drops at a time.

How much is 1 mg/l (ppm) in real terms? One part per million is the equivalent of one second in just over 11 ½ years. One ug/l (ppb) is the equivalent of one second in just over 31 ½ years. Think about it the next time you spill some gas on the ground, and then think about the cumulative effects of that happening all day.

One final note: 1 tablespoon of gas can potentially make 1,000,000 gallons of water non-potable...

#### References:

- 1 – Virginia Department of Environmental Quality – Action Level for petroleum contaminated soils.
- 2 – Noted files and many more can be viewed at the Virginia Department of Environmental Quality's Piedmont Regional Office {(804) 527-5020} through the Freedom of Information Act.
- 3 – Discussions with Mr. Greg Hudson, Chemist and Director of EnviroCompliance Laboratories, Ashland, Virginia (804) 550-3971.
- 4 – [www.epa.gov/safewater/contaminants](http://www.epa.gov/safewater/contaminants)

Special thanks go to God, who gave me an inquisitive mind and the talent to comprehend what happens underground. After all, geology underlies us all...

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